Ultrasonic Rhinoplasty and Septoplasty for Dorsum Preservation and for Dorsum Structural Reconstruction

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KEYWORDS

• Ultrasonic rhinoplasty • Ultrasonic septoplasty • Dorsum preservation • Dorsum structural reshaping • Piezoelectric instruments • Piezotome • Nose ostectomies • Rhinosculpture • Preservation rhinoplasty • Push Down • Let Down

KEY POINTS

- Ultrasonic rhinoplasty and septoplasty is the use of piezoelectric instruments (PEI) to perform the bone work during rhinoplasty and septoplasty. It is used in Preservation Rhinoplasty and in Structural Rhinoplasty.
- PEI are gentle instruments selective on bones and hard cartilages, that never create unwanted fracture or comminution, and preserve bone stability, unlike blunt force instruments (osteotomes, rasps)
- PEI allow the safe use of a full open or closed approach allowing the visualization of the whole bony vault to perform osteotomies, ostectomies and rhinosculpture.
- Ultrasonic rhinoplasty and septoplasty ease dorsum preservation by controlling the osteotomies and ostectomies for foundation techniques, osteotomies and rhinosculpture for surface techniques, and the bony septal trimming for high, intermediate and low strips.
- Ultrasonic rhinoplasty and septoplasty allow to control and smoothen the osseocartilaginous dorsum when structural reshaping of the dorsum is performed after hump removal, avoiding in most cases the use of concealment graft in the keystone areas.

INTRODUCTION

Preservation rhinoplasty has gained a significant popularity in recent years. Preservation of the dorsum is one of the key sequences of many preservation rhinoplasties.[1] It most often consists in lowering the cartilaginous or osseocartilaginous roof while preserving its central structure. To achieve such lowering, it is necessary to weaken this septotriangular pyramid (STP) by acting on the underlying structures that support it:

- The nasal septum
- The connections between the upper lateral cartilages (ULC) and the nasal bones, often improperly called ligaments, and also the pyriform attachments
- The nasal bones (nasal proper bone and ascending branch of the maxilla)

The precise control of this lowering results from the way in which the support structures of the STP are weakened and from the stabilization of the STP in its new position.

In some cases, however, the profile line should not be changed. This usually involves decreasing the width of the bone pyramid and/or STP. Because no lowering is planned, the support structures must be preserved.

Finally, the dorsum is raised when the profile line must be moved forward. The support structures of the STP must be interrupted to increase its projection thanks to elevation spreader grafts positioned higher than usual on the septum. The whole

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dorsum can be raised, or only the lower part of it to lift the supratip area of the dorsum, depending on the length and the placement of the spreader grafts.

Bone preservation, in its integrity and in its attachments with the ULC, is an important element of stability in the immediate and long term. Bone stability, however, prevents the development of bone lowering for impaction techniques. This bone stability is directly dependent on the width and length of the cut bone flap, the persistence of connections with adjacent bones and cartilages, the preservation of the support structures of these bones (underlying periosteum and mucosa), and finally the reconstitution of bone stabilization when necessary.

Regarding the bone and cartilaginous structures of the nose, there are three actors to consider:

1. Bones and cartilage
2. The instruments used
3. The surgeon

BONES AND CARTILAGE

It is easy to assess the characteristics of cartilage by touch or by using instruments. The fineness, flexibility, and elasticity of cartilage plays an important role in the cartilage reshaping techniques used (eg, trimming, sutures, sliding flaps, support grafts), and the shape and position of these cartilages.

However, it is impossible to evaluate the same characteristics of nasal bones without piezoelectric instruments (PEI). A piezoelectric saw and a piezo rasp give an immediate feedback on the hardness of the bone and its thickness. From the first osteotomy performed, one can evaluate the flexibility and elasticity of the bones. These parameters have important consequences on the type of osteotomies to be performed, if those osteotomies are complete or partial, the location of osteotomies, and the association with a more or less extensive rhinosculpture.[2,3]

Schematically, for hard bones, osteotomies need to be more extensive and generally complete so that the bones can move properly. The saw should be oriented in a more sagittal way so that the obliquity of the cutting line allows the bones to move more easily. It is eventually necessary to be a little higher by 1 mm laterally and lower cephalically to allow the bones to move more easily. Conversely, for thin bones, partial osteotomies are usually sufficient except in some cases of very wide bone pyramid, because these thinner bones move much more easily. A more horizontal cut may be desirable to preserve some bone stability. In case of very flexible and elastic bones, it may be necessary to use a bone wedge in the fracture line of the lateral osteotomies to prevent the bones from spreading or coming out in case of impaction. Brittle bones require the realization of complete osteotomies to avoid unwanted fractures.

In case of foundation techniques, lateral, transverse and medial osteotomies are mandatory, with additional ostectomy of the webster triangle and eventually part of the sidewalls for Let Down. The impaction is easy in case of thin bones. Conversely in case of thick bones, the ostoeotomy location should be 1 mm more medial for the lateral osteotomies and 1 mm more caudal for the transverse and root osteotomies.

THE INSTRUMENTS USED

The specificities of PEI are as follows:[4]

- To perfectly control the position and path of the fracture lines without causing any unwanted or radiated fractures. These osteotomies are made under complete visual control as soon as an extended open or closed approach is performed.
- To preserve the supporting force of the underlying structures (ULC, periosteum, mucosa, osseocartilaginous attachments or ligaments) because of their selectivity.
- To allow the realization of rhinosculpture, that is a progressive abrasion of the bony cap. This rhinosculpture changes bone biomechanics by making the bone flexible at first while maintaining its integrity. If continued, all the bony cap is removed but ULC are preserved, and the osseocartilaginous attachments. This rhinosculpture is essential in the areas of the dorsal and lateral keystone for the structural reconstruction of the dorsum, but also for cartilaginous impaction techniques and as a complementary gesture to be performed on a persistent bone hump during push down/let down techniques.
- To allow to mobilize and orient the nasal bones in a precise way according to the position and the path of the osteotomy, and eventually the use of bone sutures (simple to perform in a full open approach after using an ultrasonic drill to drill holes from each part of the fracture line), and the use of grafts in the osteotomy line.

These instruments must be used gently by constantly cooling the working area of the insert thanks to the integrated irrigation, which must be set to at least 60 mL/minute. Therefore, the use of a suction retractor is highly recommended so as not to be bothered by water. There are 2 types of suction retractors: one for open ultrasonic rhinoplasty and the other for closed ultrasonic rhinoplasty, or when only a tunnel is developped on the bony sidewalls without central undermining of the skin. Suction speculum of dierent leght exist also for ultrasonic septoplasty. It is undesirable to press the bones with these instruments. Each insert requires a certain gesture to optimize its use.

It is also important to note that not all piezoelectric motors (units) are similar in their characteristics and in their power or in the use attributed to them. For example, many piezo units are designed solely for dental use and do not have approval for use in the operating room. Inserts designed for maxillofacial surgery are thicker and wider because they are intended to cut a much denser and thicker maxillary bone than the nasal bones. The defect at the cutting line is then greater, with a more prolonged bone healing and especially an increased risk of bone instability, but also a risk of bone defect perception in the areas where the overlying skin is thin. These inserts are resterilizable five times. Then they can wear out and be less effective, in the same way that an osteotome wears out. An osteotome can be sharpened, which is not the case for PEI.

The inserts for rhinoplasty are as follows: (1) short inserts more specifically for open ultrasonic rhinoplasty (**Figs. 1–6**), (2) long inserts more specifically for closed ultrasonic rhinoplasty and ultrasonic septoplasty **Figs. 7–11**.

THE SURGEON

PEI allows inexperienced surgeons to achieve nearly the same degree of precision in bone surgery and septum surgery as experts. It is indisputable that it takes some experience to obtain reliable and reproducible results in nose bone surgery. However even the most experimented surgeons can't be aware of the bone biocharacteristics before the surgery. Therefore, they can't adapt the type of osteotomies, ostectomies and the use of rhinosculpture to those characteristics. Finally, even experts can hardly control accurately the bone movements, final position and orientation if a full open or closed approach is not used.

THE DIFFERENT TECHNIQUES OF PRESERVATION OF THE DORSUM WITH PIEZOELECTRIC INSTRUMENTS

For all these techniques, the extensive subperiosteal dissection of the bone pyramid in its entirety allows a perfect visualization of the anatomic variations of the bones, but also of the osteotomies. It also makes it possible to combine on all parts of the pyramid osteotomies, ostectomies, and rhinosculpture to precisely reshape the bone pyramid. This extensive degloving of the bony vault, called full open approach or full closed approach (4) allows also to controle precisely bone mobilization and orientation, but also stabilization with sutures and grafts placed in the osteotomy site. The only drawback of the full open or closed approaches is an increased swelling in the following post-operative weeks that can be decreased by appropriate per and post op medications and taping, but also by an extended bone abrasion with the rasps to create a good skin adhesion.

Osteotomies are done by some surgeons through small tunnels endonasally or even percutaneous, but with a significant risk of bone and skin burn. An abundant cooling of the skin and of the bones with cold saline must then be

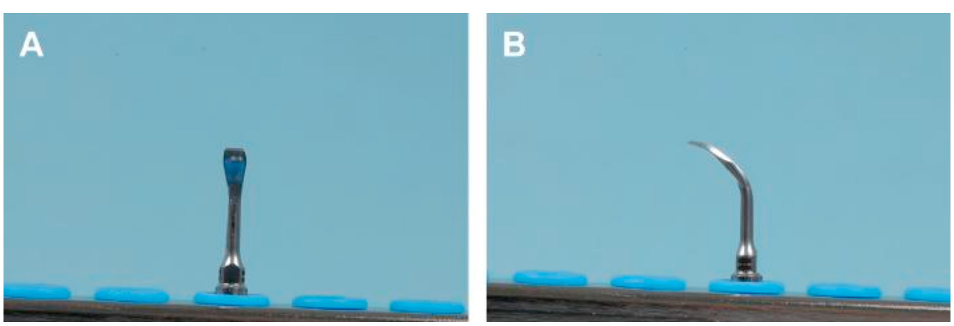

Fig. 1. (*A, B*) Scraper (RHS1). This instrument is the most aggressive of all. It is intended to make ostectomies. Its use is primarily reserved for areas where the bones are very thick and dense, such as the radix and the central part of the bony hump, the side walls. Its use in areas where the bones are not very thick should be careful to avoid creating bone defects. The incorrectly used scraper can damage the ULC: this is an additional reason to switch to rasping when most of the bone has already been removed in the treatment of a bone hump. The scraper is especially useful in case of strong, high, wide radix. It is also useful in the initial treatment of a pronounced hump, especially when the bones are thick. It is also used when a global bony vault rhinosculpture is performed.

Fig. 2. Strong rasp (RHS2H) and fine rasp (RHS2F). Rasps are very soft instruments that allow one to make rhinosculpture. It abrases gradually the bony cap, which gradually modifies the biomechanical characteristics of the bones. Bones gradually become moldable and shapeable with rhinosculpture. In addition, sutures are passed through the refined bones in some cases, depending on the characteristics of the bones. Finally, these rasps do not damage the ULC. Rasps are essential in most cases of hump treatment, whether it is preservation or structural remodeling of the hump. They enable removal of the bony film from the lateral and dorsal keystone regions in a precise and atraumatic way for the underlying cartilages, thus allowing the anatomic reconstruction of the middle third or the lowering of the STP.

performed. Therefore external piezo ostoeotomies should be done very cautiously.

Bone Impactions (Push Down)

Piezoelectric saws allow a perfectly controlled shift downward of the bony pyramid under direct vision, whether it is an open or closed approach. The saws used are usually the thickest (RHS3 L and R), because they cause a slightly more significant defect at the fracture line facilitating bone sliding downward. The orientation of the saws for lateral osteotomies is more sagittal to promote bone sliding at this level.

Osteotomies are located 1 to 2 mm inside the nasofacial groove for lateral osteotomies, and 1 to 2 mm under the cephalic edge of the bones of the nose for transverse and root osteotomies, depending of the bone thickness as mentioned previously. These are areas where the bones are usually thick and move less easily than if these same osteotomies are performed closer to the piriform orifice (ie, more medially and lower), but this localization gives a little more stability and control over the movement of the bones, and also avoids deformations stair step deformity at the osteotomies.

The lateral osteotomy is started at the cephalic part of the Webster triangle, that is to say a little higher than for the usual lateral osteotomies, so as to avoid a blocking point at this level. For the same reason, the junction between the lateral osteotomy and the transverse osteotomy is rounded and not at a right angle.

To keep a more stable central hinge at the root, it is better to use thinner saws on the most medial part of the transverse osteotomies and for radix osteotomy. The high osteotomy of the perpendicular plate of the ethmoid (PPE) performed with the long saw joins the radix osteotomy started on either side of it, to bevel the radix osteotomy and avoid a collapse of the radix or a step deformity. In other wirds, the radix ostoeotmy is begun on both sides by sawing through the superficial aspect of the bone, and ended from inside with the long piezo saw in continuation with the PPE osteotomy. This PPE osteotomy is always necessary because the radix osteotomy is always located high (very cephalic) on the bone pyramid.

The sequence of osteotomies is performed before septum resections because there is no radiated fracture in ultrasonic rhinoplasty. This

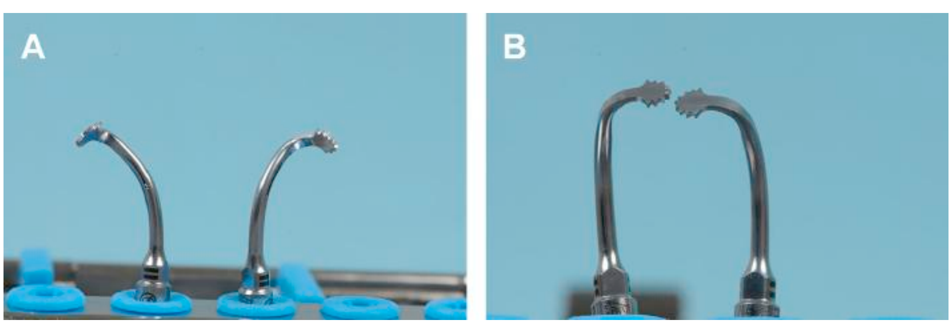

Fig. 3. (*A, B*) Saws for right lateral osteotomies (RHS3L) and left (RHS3R). The saws for lateral osteotomies have a design that allows to simply start the osteotomy very low in the area of the Webster triangle and follow the nasofacial groove to its upper edge. They are a little thicker than the other saws because the ascending branch of the maxilla is usually much thicker. They are preferred for lateral and transverse osteotomies for bone impaction techniques, because they create a greater defect on the fracture lines allowing a more marked slippage of the nasal bones.

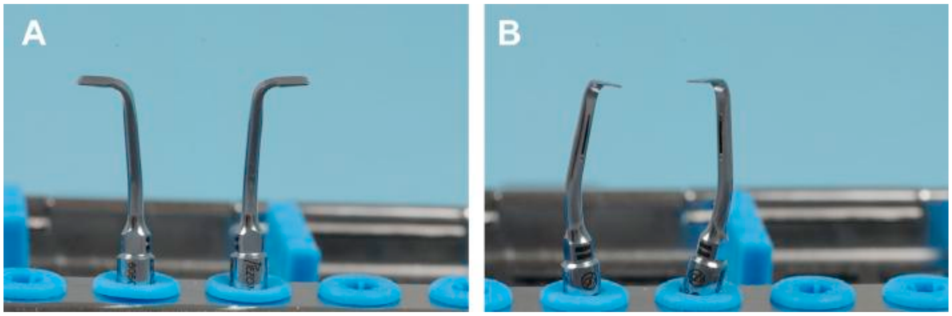

Fig. 4. (*A, B*) Saws for transverse osteotomies right (RHS4L) and left (RHS4R). Saws for transverse osteotomies are thinner, because they are intended to cut thinner bones (the nasal proper bones, the bony septum). They are also used in foundation impaction techniques for root osteotomies, which are complete or incomplete depending on whether one wishes to keep a median bone hinge or not.

allows one to assess, thanks to the piezo, the hardness or flexibility of the bones, and their ability to move more or less easily. Thus the resections of the septum have to be more cautious in case of very mobile bones, and conversely more marked in case of very stable thick bones.

In some cases of a wide bone pyramid, a paramedian or oblique median osteotomy may be added to reduce this bony width. This osteotomy is safely possible thanks to the strong support of the nasal bones provided by the periosteum and the mucosa, which are preserved under the nasal bones.

Finally, rhinosculpture is frequently combined with the osteotomies previously described to correct persistent bone convexities, but also to weaken the osteocartilaginous junction of the dorsal keystone to help flatten the top of the hump. This rhinosculpture with the rasps can be carried out at the beginning, but also after osteotomies, even on fully mobile bones.

In addition, these osteotomies performed before septum surgery make it possible to lift the roof of the STP to visually control perfectly the septum osteotomies once the first septal cut is made.

This septum surgery is thus made more precise and easier thanks to the visualization of the entire septum. The absence of a radiated fracture at the skull base allows the realization of safe osteotomies and ostectomies at the cephalic part of the PPE, which are often necessary to correct high septal deviations. Those osteotomies and ostectomies prevent an overlap of the deviated PPE from creating an axis deviation of the bone pyramid.

Another important advantage of long PEI is to allow the harvesting of significant intact pieces of osteocartilaginous septum for the purpose of supporting grafts even when a high strip is performed. Indeed in these cases, the Killian septal L ensuring the maintenance of the septum is shifted downward. The extended septal harvesting may weaken the stability of this septal L. This is even more true when a septum flap connected to the septotriangular roof is made to lower the latter in the Tetris technique[5] and in the Z flap.[6]

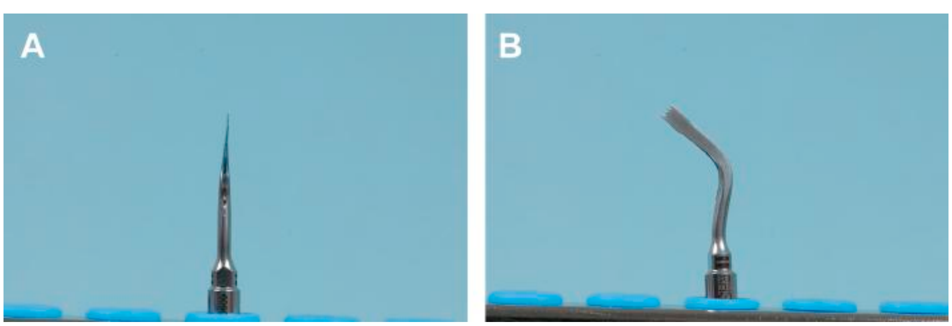

Fig. 5. The straight saw for median and paramedian osteotomies (RHS5). These saws are as thin as possible to perform osteotomies especially in places where the overlying skin is thin, so that the osteotomy is not noticeable. This is the case for median or paramedian osteotomies. But these saws are used for very fine bone cuts, such as when the bone on the impacted hump fragment is kept and/or when an osteotomy is performed in the area of the lateral keystone as in the Ishida technique. It is also used to make controlled ostectomies in let down techniques or when crisscross osteotomies are done to flatten convex bones. It is also useful for osteotomies or ostectomies of the nasal septum in the treatment of septal deviations, vomerian spurs.

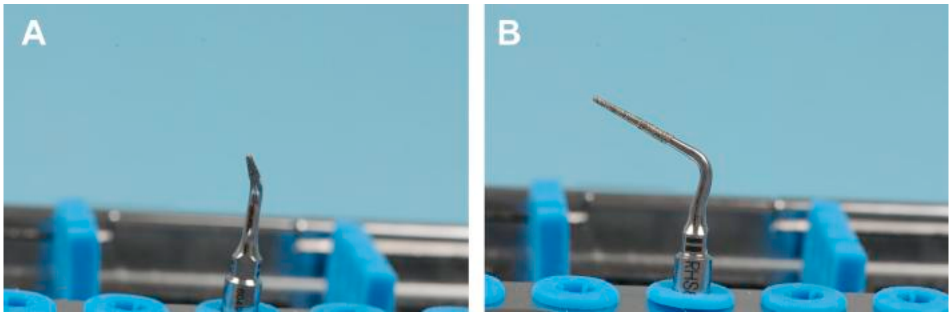

Fig. 6. (*A, B*) The drill to pierce the bones (RHS6). The drill is used to make holes in the bones, to suture bones to each other, or to puncture bones that are used to support cartilage. These sutures allow one to control the position of the nasal bones, but also to stabilize unstable bones, or to secure the nasal septum to the nasal spine or the nasal bones.

Finally, the extended open or closed approach allows the simple use of wedge sustain grafts in the caudal part of the lateral osteotomies, to stabilize the bones and secure the new position of the nasal bones, therefore avoiding any lateral movement of the bony vault. This approach allows also the simple use of various sutures between the ULC and the remaining septal strut to stabilize the STP in its new position.

Bone Lowering (Let Down)

The principles are the same as for bone impactions, except that an ostectomy is performed on the most caudal portion of the ascending branch of the maxilla to remove part of the Webster triangle to avoid any blocking point at this level. This ostectomy is performed either with a small straight saw or with the scraper. Unlike gouge ostectomies, ostectomies with PEI are easily done regardless of the thickness and density of the bones. Some surgeons do more extensive ostectomies of the sidewalls to ease the lowering of the bony vault. However this maneuver may create a long term weakness of the bony vault.

Otherwise, the sequence is the same as for push down except bone stabilization, which cannot be performed.

Cartilage Impactions

PEI plays an important role here to perfectly smooth the nasal bones on the area of the lateral keystone (where a bony cartilaginous disjunction is performed), but also to cut precisely the bone fragment left possibly intact on the area of the dorsal keystone (Ishida technique).[4] Small ostectomies are also performed with a thin saw on the area of the lateral keystone in the Ferreira-Ishida technique.[7,8]

The perfect smoothing of the nasal bones is a crucial point in these surface techniques, where

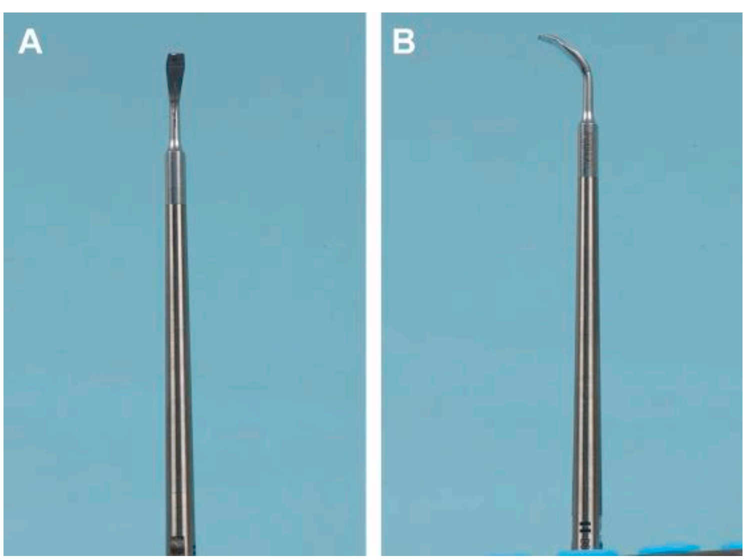

Fig. 7. (*A, B*) The long scraper. Like the short scraper, it allows ostectomies to be performed through a closed access, especially on the upper part of the nose.

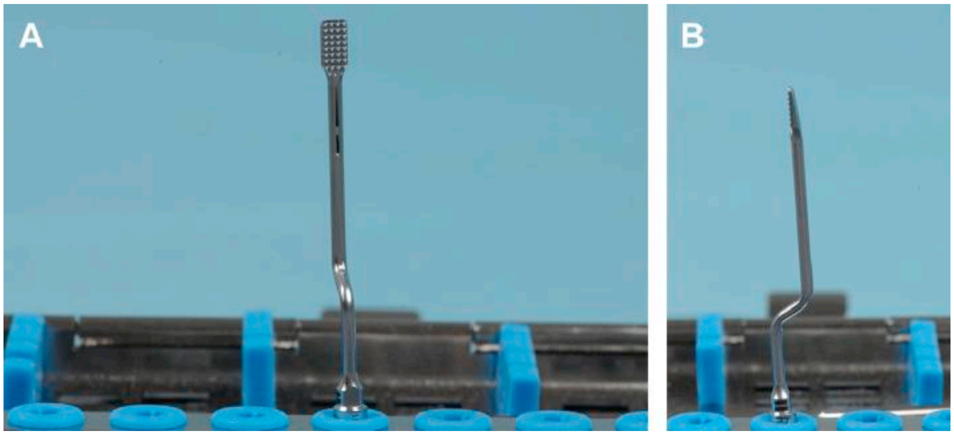

Fig. 8. (*A, B*) The long rasp. It allows the bone to be rasped down by closed approach on all parts of the bone pyramid. It is also used to correct a small residual bone hump during a touch up: a simple tunnel made internally enables one to reach the area to be treated and to rasp the residual bony hump without damaging the adjacent tissues.

unlike foundation techniques, an osseocartilaginous disjunction is performed on an area where the skin is usually thin. Piezo rasps are an indispensable tool to ensure a smooth transition and avoid bone roughness. Thanks to those rasps, concealment grafts are rarely necessary in the keystone area.

The Reductions in Width of the Osseocartilaginous Pyramid Without Modification of Height

In some cases, a reduction in the overall width of the nose is necessary without having to change the profile line by more than 1 mm. It is then possible to perform complete osteotomies with piezo: low lateral osteotomies, paramedian osteotomies, and transverse osteotomies. The peculiarity is that the paramedian osteotomy is performed without opening the middle third with a small straight saw (RHS5).

If the STP is still a little wide, several possibilities are available:

- Resect the cartilaginous corners (or shoulders) at the junction with the bone when they are protruding, which causes a prominent appearance on the oblique views. This maneuver can, however, generate residual defects if these cartilaginous corners are pronounced or if the overlying skin is thin. In these cases it is preferable to open the middle third to fold in the ULC to reshape the cartilaginous prominence.

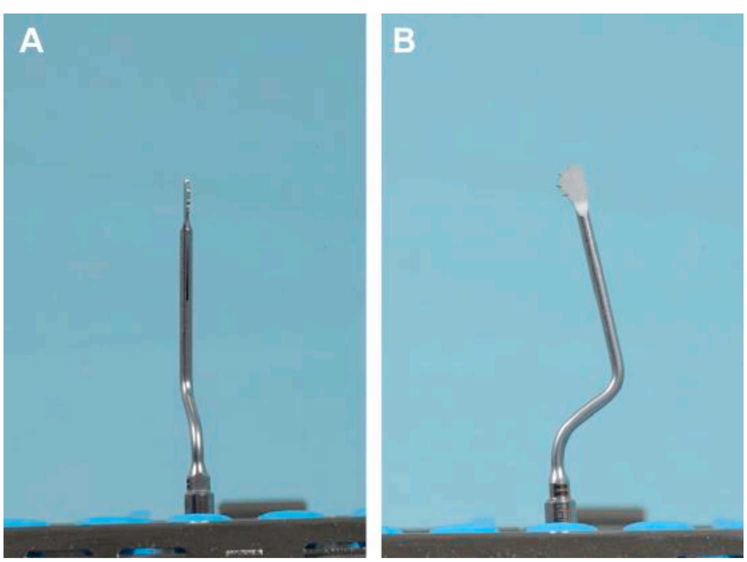

Fig. 9. (*A, B*) The straight long saw. It is intended to perform lateral and paramedian osteotomies by closed approach. Its length makes it possible to reach the most cephalic part of those osteotomies. It also plays an important role for osteotomies of the bony septum, whether in septoplasty, septum harvesting, or septum resections as part of dorsum preservation. For this last point, the long saw precisely cuts and trims the perpendicular plate of the ethmoid (PPE), but can also cut from below the nasal bones at the radix, allowing a beveled cut of the radix intended to allow a sliding of the bone downward rather than a sinking of the root in bone impaction techniques.

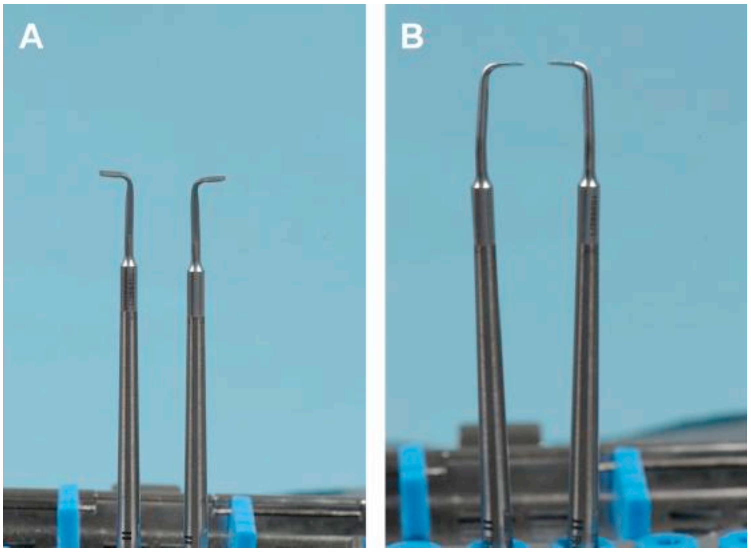

Fig. 10. (*A, B*) The right and left curved long saw. These two saws make it possible to perform transverse osteotomies by closed route, and osteotomies of the root by closed route in bone impaction techniques. They are also used for posterior osteotomies of the septum as part of septoplasty, septal harvesting, and septum cuts for dorsum preservation, especially for low strips.

- Partially incise the ULC over their entire height at the level of the desired dorsal aesthetic line, which attenuates the cartilage spring and reduces the width of the middle third.
- Perform U-shaped sutures with prolene at the top of the cartilaginous vault when the triangular cartilages are not weak (which would create cartilaginous deformations) to reduce the width of the middle third.

The Elevations of the Osteocartilaginous Pyramid (Push Up)

The osseocartilaginous pyramid is generally raised by performing the same osteotomies as in a push down, but by raising it thanks to spreader grafts positioned higher than normal, which allows this elevation.[9] PEI makes it easier to perform very high transverse and root osteotomies, to avoid the occurrence of a stair step when the bony pyramid is ascended.

The long piezo saw also makes it possible to carry out a precise incision of the PPE at its highest part, without the risk of radiated fracture, to allow the ascent of the pyramid.

Segmental elevation of the STP can be made to prevent or treat a supra tip saddling, i.e. when the supratip is too low after a DP. Two spreader grafts are placed and sutured at the dorsal part of the septum higher than the septum in its supratip location, usually obliquely to be lower on the septum more cephalically, without extending far in it's cephalic aspect. Those spreader grafts lift the

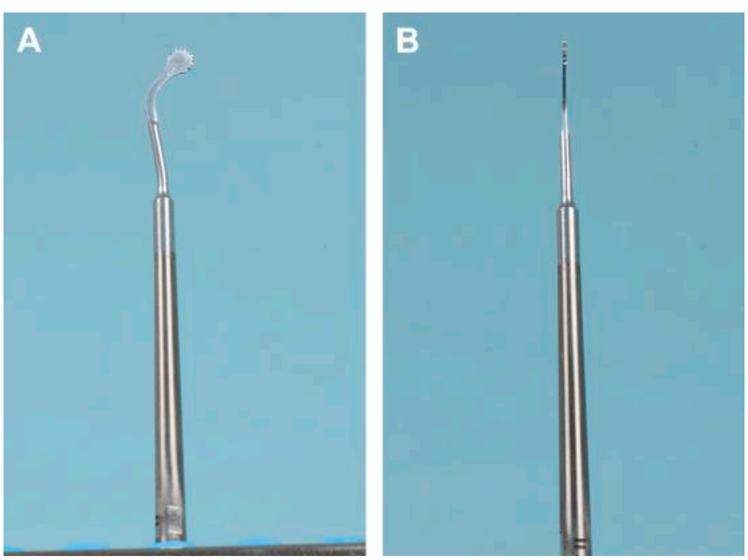

Fig. 11. (*A, B*) The long fan saw. This saw is used for closed lateral osteotomies, but it is also useful for cutting the bony septum, especially in portions where it is thick as frequently for the vomer.

supratip segment of the STP. Those spreader grafts can be extended caudally to add an end to end septal extension graft.

Lateralization of the Osseocartilaginous Vault (Lateral Push)

These are cases when a strong asymmetry of the bony pyramid makes its overall rotation desirable. In these cases, the osteotomies are that of a push down on one side (side where the nasal bones are the longest) and a let down on the other side. The precise ostectomy is easily performed at the nasofacial groove on the side where the bony vault must be rotated.

Bone wedge grafts placed in the lower part of lateral osteotomy make it possible to secure the final position of the bone pyramid.

Rhinosculpture is frequently used as an adjunctive procedure because the reliefs of the bony vault are generally different from the two sides and the rotation of the pyramid does not completely correct these differences in relief.

Realization of High Strips

Resections of bone septum are usually performed with mechanical instruments, especially with a gouge (or rongeur).[10] However, these instruments are used blindly and any twisting movement must be avoided so as not to destabilize the osteocartilaginous junction of the septum.

The interest of piezo instruments for the resection of the PPE is to make very precise cuts under direct visual control to avoid any radiated fracture at the skull base or toward the cartilaginous septum that could destabilize it. The preservation of septal stability is even more important when a significant septal harvesting will be made for the use of structural grafts. PEI allow to harvest significant pieces of septum preserving the stability of the remaining L strut in high strip procedures.

Realization of Low Strips

Here too bone resections are usually made with a rongeur after disinsertion of the osteocartilaginous junction of the septum over its entire height. These resections concern the upper part of the PPE, the lower part of the vomer, and the anterior part of the bony septum.[11] However the bony septum trimming cane be done with piezo saws for a very precise bone resection.

The use of piezo still allows one to perform all bone resections under direct visual control, and also avoids mucosal breaches. Bone incisions are made on the concave side of the bone.

The solid fixation of the septal flap to the anterior nasal spine is fundamental in this technique. The realization of a slit in the middle part of the anterior nasal spine with the right saw and holes on both sides thanks to the ultrasonic drill allows one to enclose the edge of the septum and to solidarize it in a solid way using nonresorbable sutures.

THE TECHNIQUE OF STRUCTURALLY RESHAPING THE DORSUM WITH PIEZOELECTRIC INSTRUMENTS

Hump removal according to traditional techniques has been the source of aesthetic and functional defects that have been greatly reduced by the reconstruction of the dorsum using spreader grafts and/or spreader flaps. However, even in these cases, small defects are not uncommon in the osseocartilaginous junction areas (dorsal and lateral keystone), an area where the often thin skin reveals all the defects either immediately or over time.

However, it is possible to avoid these defects thanks to a perfect bone resection in the keystone. This is done by rhinosculpture with ultrasonic rasps. Those inserts are essential to gradually remove the bony cap at the keystone areas, where this bone film is often thin, without damaging the ULC that will be used completely for the reconstruction of the dorsum. After the extended rhinosculpture of the dorsal and lateral keystone areas, the ULC are incised tangentially to the septum, rising much higher than if there had only been a traditional rasping of the hump. This is when the roof is opened in a controlled way to be quickly closed in a controlled and solid way after septoplasty.

Lateral osteotomy is performed very low in the nasofacial groove from the Webster triangle to the highest part of the side wall, whenever it is necessary to reduce the base of the nose.

Paramedian osteotomy is performed whenever the width of the lateral keystone needs to be reduced. This osteotomy begins at the place where the ULC have been incised and oblique outward going toward the head of the eyebrow, to stop as high as possible on the nasal bone.

Finally, these two osteotomies are joined by a transverse osteotomy when the nasal pyramid remains too wide after the two previous osteotomies. This is usually the case when the bony vault is very broad or when the bones are stiff and strong.

A rhinosculpture adjunct is frequently needed to perfectly smooth the bone pyramid.

The new profile line is determined exactly by the resection of the septum to its dorsal part. Then the septoplasty is performed with the possibility to harvest significant intact pieces of bone and cartilage if needed, and the middle third is reconstructed:

- At the most cephalic part, that is to say at the osseocartilaginous junction, the ULC are folded inside and positioned at the desired level with the help of needles. They are then sutured to the septum by use of PDS 5–0.
- Spreader grafts are positioned a little more caudal than usual, about 2 to 3 mm below the profile line, and they extend downward further than the anterior septal angle to make it possible to achieve an end-to-end septal extension graft.

The obliquity of spreader grafts is variable depending on whether one seeks to lower the entire profile line or lower the cephalic part but raise the caudal part.

The ULC are then sutured just above the spreader grafts, 1 mm under the edge of the septum (unless the middle third must be widened: the ULC are then sutured at the septum level). Needles are used to position ULC at the desired level and obliquity, and how these cartilages are sutured by the PDS points also determines the width of the middle third. The exact height of the profile line is therefore controlled, depending on what has been defined and the change in the position of the tip. Moreover the width of the STP is also determined by the way in which the ULC are sutured, but also by the cephalocaudal and lateral tension (depending on the folding of the ULC) that is put on these cartilages.

OTHER APPLICATIONS OF PIEZOELECTRIC INSTRUMENTS IN BONE CONTOURING OF THE NOSE

The Rhinosculpture of the Entire Bony Pyramid

Isolated rhinosculpture to correct a hump and a too wide bony pyramid is only possible when this pyramid is moderately too wide and the hump is modest (less than 2 mm). No osteotomy is then performed: the bony vault is generally reduced by the use of the scraper and rasps.

Removing the bony cap in the dorsal keystone area pops out the cartilaginous hump, which can actually become more pronounced than the original hump. The resection of the perichondrium at this level makes it possible to lower the profile line by 1 mm. If this is not enough, it is necessary to switch to a cartilaginous push down or if prefered to a foundation technique.

Crisscross Osteotomies

It is possible to correct excessive bone convexity by frame osteotomies. These crisscross osteotomies performed with a very thin saw make it possible to flatten a bone convexity while maintaining bone stability. They are rarely used, but their main indication is when there is convexity with very fine bones. If a rhinosculpture were used, it would result in a defect because of the thinness of the bones.

Some surgeons advocate the use of extended crisscross osteotomies on the sidewalls, but controlling the bone shape and stability may then be difficult.

ARE ELECTRICAL INSTRUMENTS COMPARABLE WITH PIEZOELECTRIC INSTRUMENTS?

Electrical instruments (eg, saws, rasps, burrs) share with PEI the advantage of not creating an unwanted fracture. However, these instruments are not selective: they cut or damage all tissues in contact with the insert. As a result, they can damage the supporting structures of the bones, but also cartilage, ligaments, and all subcutaneous tissues. Finally, the shape of the electric saws does not make it possible to adapt the path of the lateral osteotomies to the sinuosities of the nasaofacial groove. The endonasal approach of these lateral osteotomies means that the fracture line is located always higher (more dorsal) than the piezo lateral osteotomy performed in the nasofacial groove. This more lateral localization with the piezo allows for better bone stability.

The criticism often made to PEI of greater slowness does not hold for the nasal bones, which are generally thin and quickly remodeled or cut with piezo instruments, as soon as the adapted inserts are used.

DISCUSSION

Dorsum preservation techniques have developed to avoid the defects of classical hump reduction techniques (Joseph type) at the osseocartilaginous junction. To correct a hump, it is necessary to create an area of bone or osseocartilaginous weakness. This is either at the top of the pyramid, or a little lower at the bone cartilage junction, or at the base of the pyramid. The closer one gets to the top of the pyramid, the thinner the skin is in general and the more visible the defects can be.

The use of PEI in rhinoplasty has been a paradigm shift for bone remodeling. Thanks to the disruptive technology of piezo surgery, it has become possible to reshape the bones of the nose in a gentle and precise way, without creating a radiated fracture or bone instability. Initially, ultrasonic rhinoplasty allowed the correction of all types of humps and asymmetries of the nasal bones by stripping the bones on the hump area through extensive rhinosculpture, to transform the osseocartilaginous hump into a purely cartilaginous hump. It was then possible to simply reshape this hump by opening the septotriangular junction in a cephalic way, folding in the ULC and suturing them to the septum after redefining the dorsal profile line.

However, the versatility of this ultrasonic approach of the middle third that can be applied to all types of humps, all types of bones and cartilage has long been ignored, and the techniques of dorsal preservation have emerged to avoid the usual defects of the middle third, but also to facilitate the use of the closed rhinoplasty without having the difficulties related to the middle third reconstruction through a closed approach.

The structural hump reshaping with the PEI is based on bone and cartilaginous stability, to better control the fate of these structures. Structural techniques should preserve the bone stability with bone movements that are, depending on the location and direction of the osteotomies, rotation, translation, or lowering.

Conversely, the treatment of the hump and dorsum as part of dorsum preservation is based on bone instability, essential to bone impactions, that is, techniques acting on the base of the bone pyramid. For these techniques, the use of mechanical instruments that cause splinters and comminution at the fracture line is not a problem, because it facilitates bone lowering.

Foundation techniques in dorsum preservation (push down and let down) are based on bone sinking or lowering and require bone instability.

Preserving or restoring bone stability is not a purely theoretic, short- and long-term question:

- In the short term, bone instability can be the cause of an exaggerated bone collapse creating a step deformity, a residual hump, an asymmetry, or an axis defect of the bone pyramid.
- In the medium to long term, bone instability could create weakness, especially in case of shock, wearing heavy glasses, or certain masks.

PEI preserves bone stability by preserving the underlying bone support. We can imagine that the risk of deterioration, especially in the medium and long term, is reduced if bone stability is preserved or restored at the end of the operation.

PEI also makes it possible to perform all types of osteotomies on the bony pyramid and on the septum precisely without radiated fracture, regardless of the thickness and quality of the bone. This is notably useful for the PPE that must be precisely trimmed in high-strip and low-strip techniques.

Regarding the surface techniques of dorsum preservation (cartilaginous push down), the interest of the piezo is more to obtain a smooth osseocartilaginous transition at the keystone areas thanks to ultrasonic rasps. The use of fine ultrasonic saws also makes it possible to cut the bone precisely and imperceptibly on the dorsal or lateral keystone area, especially for techniques that preserve the bony cap in case of lowering of the hump.

SUMMARY

PEI allows novice or inexperienced surgeons to quickly master the different techniques of dorsum preservation or structural reshaping of the dorsum by avoiding several defects or complications. The realization of osteotomies, ostectomies, and rhinosculpture under direct visual control without risk of uncontrolled fracture allows a great precision and a great softness in the mobilization and the bone reshaping, for the preservation and structural management of the dorsum. PEI also helps to preserve bone stability and septum stability when cuts or bone remodeling are carried out appropriately.

Ultrasonic rhinoplasty and ultrasonic septoplasty have shown that they have a place for preservation rhinoplasty or structural rhinoplasty alongside more traditional techniques.

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Doxycycline Sclerodesis – "Rhinodesis" - For Enhanced Soft Tissue Adhesion in Rhinoplasty: A Preliminary Study

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Conflict of Interest: The authors declare that they have no conflict of interest.

Abstract:
The use of doxycycline as a sclerosing agent is well-established.(1,2,3) Given the clinical efficacy of doxycycline sclerosant therapy, we embarked upon a study to evaluate the efficacy of small-volume liquified doxycycline particularly in thick skinned rhinoplasty patients to promote re-adhesion of the nasal skin-soft tissue envelope (SSTE) thereby minimizing surgical dead space and enhancing surface contour, to improve the eventual outcome of surgery.
We present 2 clinical case series using rhinodesis. All patients were treated with the same rhinodesis protocol that included conventional splinting and taping. The first series consisted of 102 consecutive primary rhinoplasties with medium to thick nasal skin treated via open rhinoplasty. Doxycycline solution at a concentration of 20 mg/ml was applied beneath the skin flap using a 14-gauge angiocath inserted through small gaps in the marginal suture line following closure, retained for 2-3 minutes, and then expressed from the dead space. Firm manual compression of the SSTE was maintained for at least one additional minute, and the splint was then applied. The second series consisted of 25 thick-skinned primary rhinoplasties that were also treated with open rhinoplasty using the same rhinodesis protocol. However, the second group was evaluated with serial post-operative ultrasonography to characterize the soft-tissue response to rhinodesis, particularly within the tip and supratip regions.
Results revealed enhanced skin adherence in nearly all patients when compared to traditional taping and splinting alone. Ultrasonic examination demonstrated enhanced adherence of the subcutaneous tissue to the nasal framework and suggest that rhinodesis is effective at minimizing dead space in majority of thick-skinned rhinoplasty patients. No complications were observed.
Doxycycline can be used easily and safely to seal the surgical dead space post-rhinoplasty and minimize degradation of nasal contour with excellent outcome.

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Doxycycline Sclerodesis – "Rhinodesis" - For Enhanced Soft Tissue Adhesion in Rhinoplasty: A Preliminary Study

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Abstract

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Results revealed enhanced skin adherence in nearly all patients when compared to traditional taping and splinting alone. ultrasonic examination demonstrated enhanced adherence of the subcutaneous tissue to the nasal framework and suggest that rhinodesis is effective at minimizing dead space in majority of thick-skinned rhinoplasty patients. No complications were observed. Doxycycline can be used easily and safely to seal the surgical dead space post-rhinoplasty and minimize degradation of nasal contour with excellent outcome.

'Conflict of Interest: none declared'.

Introduction

Post-operative soft tissue swelling remains a common and bothersome consequence of cosmetic nasal surgery that occurs to varying degrees in virtually every rhinoplasty patient. In the thin-skinned nose, surgical swelling is usually minimal and surgical enhancements are usually evident far sooner. However, delayed shrink-wrap contracture of the SSTE in a thin-skinned nose can lead to unwanted skeletonization and prominence of the nasal framework, and to progressive distortion of a surgically weakened nasal framework with poor long-term outcomes. In contrast, the thick-skinned nose is fraught with unfavorable physical characteristics and healing responses that make rhinoplasty far more challenging. Owing to its increased overall thickness resulting from dermal thickening, adnexal hypertrophy, and a hypertrophic SMAS layer, thick nasal skin often lacks adequate pliability and compliance for favorable coaptation to the nasal framework (4). Consequently, beneficial modifications to the nasal framework may be muted, distorted, or hidden entirely (5,6). This is particularly true in the nasal tip and supra-tip regions. Moreover, thick, non-compliant skin is frequently accompanied by weak contractile properties, and the collective impact of a thick, non-compliant, and non-contractile SSTE is impaired coaptation and re-adherence to the underlying skeletal framework, and an increased propensity for dead space formation. Moreover, large reductions in skeletal volume and/or excessive post-operative swelling both serve to further impair re-adherence and further exacerbate dead space formation. Ironically, thick nasal skin is also naturally predisposed to swelling with a greater capacity for interstitial fluid accumulation. Even when thick skin securely re-adheres to the modified skeletal framework, excessive skin thickness alone serves to obscure the underlying skeletal framework, to diminish surface definition, and to create an amorphous nasal contour.

For this reason, selective and judicious excision of the hypertrophic SMAS layer (found immediately deep to the subdermal fat) has been used to convert ultra-thick nasal skin (measuring 5.0 mm or greater in thickness) to intermediate nasal skin (measuring approximately 2.0 – 2.5 mm in thickness) which is far more compliant and manageable (5,7). However, care must be taken not to penetrate the subdermal fat since major feeding vessels to the nasal SSTE are present in this layer. SMAS debulking provided one of the earliest methods of enhancing re-drape of the overly-thick SSTE and circumventing the pitfalls of excessive skin thickness and is used regularly in both primary and revision rhinoplasty for improved outcomes (5,7). Regardless of skin thickness, when the SSTE is subjected to dead space formation, excessive subcutaneous fibrosis often results in permanent thickening and stiffening of the SSTE. In the thick-skinned nose, dead space-mediated fibrosis serves to exacerbate the already suboptimal compliance, pliability, and bulk of the SSTE while further masking beneficial framework modifications that might otherwise produce desirable cosmetic refinements in surface topography. Such undesirable soft tissue changes are typically most evident in the nasal tip and supra-tip regions, where ironically, well-defined surface topography is most critical. Unfortunately, in a subset of cosmetic rhinoplasty patients, excessive swelling of the SSTE alone can progress to permanent skin thickening, elimination of desirable surface definition, and profound patient dissatisfaction. These characteristics are often more prevalent in specific ethnic groups such as individuals with African, Hispanic, and Native American Heritage (6). In these and other ethnic groups, thick skin is often characterized by large pores and oily sebaceous skin, which is associated with especially poor compliance, distensibility, and bulk, as well as with poor contractile capacity and prolonged and sometimes permanent SSTE swelling. Moreover, postoperative swelling and contour distortion can provoke considerable anxiety for patients and surgeons alike, owing to the prolongation of recovery and the uncertainty of resolution (8). Serial post-operative injections with Triamcinolone and/or 5 Fluorouracil are often administered to eliminate SSTE swelling and to avoid permanent fibrosis, but results are widely variable and associated with potential complications such as dermal thinning, telangiectasias, fat necrosis, wound infection, pigmentation issues, and/or free graft resorption. Hence, the potential for scar-mediated skin thickening remains a major drawback of cosmetic nasal surgery, and many surgeons are reluctant to treat the thick-skinned nose due to its challenging soft-tissue anatomy and adverse healing responses.

Seasoned rhinoplasty surgeons have long recognized that post-operative derangements in tip contour and definition are typically more severe in noses with poor SSTE re-drape and subsequent dead space formation. Dead space is thought to allow fluid accumulation and/or clot development that frequently progresses to fibrosis and permanent thickening of the SSTE. In fact, the authors submit that control of SSTE re-drape is one of the most difficult aspects of rhinoplasty to predict and to control. Moreover, these issues are amplified following large reductions in nasal volume, and for some patients, the SSTE simply will not conform to a smaller skeletal framework because of its thick and non-compliant SSTE. For this reason, it is often wise to maintain a quasi-large nasal framework with strong tip projection and strong dorsal height that approach, but don't exceed, the upper limits of cosmetic acceptability (5,6). This forcibly stretches and thins a non-compliant SSTE thereby enhancing surface definition. In general, when dealing with thick nasal skin, it's better to create a strong nose with an attractive contour, than a weak nose with ill-defined contour. Although traditional splinting and compression can potentially minimize dead space formation and reduce the risk of post-operative pathology, patients with thicker and less compliant skin are more likely to experience prolonged and/or permanent swelling despite appropriate splinting and compression. As an alternative, some surgeons have begun to advocate quilt-like mattress sutures, so-called "skin contour sutures", to compress the SSTE. However, the potential risk of visible suture tracks, flap ischemia, and/or even skin necrosis have limited widespread adoption of this management approach. On the other hand, the technique appears to be safe and effective in the hands of experienced surgeons (9). Other surgeons advocate "ligament" preservation and/or ligament reconstruction to preserve or reconstitute the natural SMAS attachments that connect the skin to the outer nasal framework. Such ligaments include the Pitanguy, scroll, piriform, and inter-crural "ligaments" that naturally tether the SSTE to select areas of the nasal framework (10,11). However, ligament preservation compartmentalizes the surgical field, thereby greatly limiting visibility and direct surgical access, and potentially prohibiting commonly used techniques that are only possible with wide-field exposure through an open rhinoplasty approach. Nevertheless, ligament reconstruction in an open approach has proven to be a valuable adjunct in the appropriate patient, but loss of supra-tip contour and tip definition can still occur, particularly when tip projection or nasal length increase appreciably.

To combat the sequela of excessive dead space formation and optimize SSTE re-drape, the authors have been using liquid Doxycycline as a potentially safe and biocompatible "glue" to promote re-adhesion between the SSTE and the underlying nasal framework, thereby potentially obliterating rhinoplasty dead space. Liquid doxycycline has long been used successfully to eliminate stubborn fluid accumulations within the human body, including Morel-Levallee lesions (MLL), persistent fluid or air accumulations between the parietal and visceral pleura as occurs with pleural effusion and pneumothorax, as well as post-surgical seromas (4,12,13,14,11). Given the ongoing difficulty in controlling SSTE re-drape following rhinoplasty, and the successful clinical use of doxycycline in a wide range of persistent soft-tissue fluid accumulations, the authors embarked on a 2-part pilot study to evaluate the use of doxycycline “rhinodesis” in cosmetic open rhinoplasty. Cleary, any mechanism that facilitates secure and rapid skin re-adherence without dead space formation would be a welcome addition to the rhinoplasty armamentarium.

One author (AMK) has been using ultrasound for over a decade to monitor the healing quality and thickness of the dermis and subcutaneous tissue post-rhinoplasty. During these evaluations, a third fluid layer was discovered (most often in thick-skinned noses) which forms between the SSTE and the skeletal framework. This layer, called the “scar/fluid layer”, or “dead space layer” could be treated directly with steroid and/or 5-FU injections under direct ultrasonic visualization (15). In addition, the impact of interval injections can be monitored with serial ultrasonic assessments, and the dead space layer can be quantitated over time in response to treatment. Hence, ultrasonography has become a valuable tool in the rhinoplasty armamentarium.

Methods:

Two concurrent series are included in this study. The first is a series of 102 open rhinoplasty patients who underwent cosmetic rhinoplasty over a period of 6 months. As per the protocol, doxycycline rhinodesis was administered at the end of surgery immediately prior to nasal splint application. Exclusion criteria included ultra-thin nasal skin (with the potential for excessive nasal skeletonization following sclerodesis) and patients with known allergies to doxycycline or other tetracycline-class antibiotics. Skin thickness was subjectively assessed by the treating surgeons using the Obagi skin pinch test, as previously described by Kosins and Obagi (16). Patients with intermediate or thick nasal skin were included regardless of age, gender, ethnicity or demographics. All cases underwent open rhinoplasty with a minimum follow-up period of 6 months.

As per the protocol, doxycycline rhinodesis was performed at the conclusion of surgery immediately following closure of the marginal and columellar incisions. One hundred milligrams of doxycycline were added to 5.0 mL of 0.9% saline (or sterile water for injection) to achieve a final doxycycline concentration of 20 mg/ml. Using a 14-gauge angiocath that was inserted through gaps in the marginal incision, doxycycline solution was injected beneath the nasal skin flap throughout the subcutaneous pocket, and particularly within the tip and supra-tip. The rhinodesis solution was left within the dead space for 3-5 minutes, and the residual fluid was then expressed from dead space. The skin flap was held firmly against the nasal framework for one additional minute to promote re-adhesion before application of the nasal splint. Post-operative care was like any other rhinoplasty case. The nasal splint was removed after one week at the first post-op visit, and patients were taught to tape at night for approximately one month. At their 1 week and 1 month post-operative visit, the patients were subjectively evaluated by the primary surgeon for supra-tip skin adherence and tip/supra-tip edema. A second series of 25 primary open rhinoplasty patients with thick skin as determined by the Obagi skin pinch test underwent doxycycline rhinodesis using the same treatment protocol except that a small-bore fat grafting cannula was used for the injection of doxycycline. All cases underwent external rhinoplasty with ultrasonographic assessment beginning at one month post-operatively, and with a minimum follow-up period of 3 months. Ultrasound was used to objectively measure the SSTE and its re-adherence to the nasal framework. Typically, at 1 month, 3 layers are visualized in the SSTE – dermis, the subcutaneous layer, and a fluid/scar layer, and all 25 patients were evaluated to measure the presence or absence of the fluid/scar layer.

RESULTS:

In the first group, a total of 102 patients were included who underwent surgery from September 2022 through February 2023. The average patient age was 24 years (ranging from 19 to 47), and 89 patients were female, while 13 were male. All patients underwent tip suturing, and the tip was supported on a septal extension graft to prevent post-operative loss of tip projection/support. All patients had at minimum six months follow-up to remain in the study group. At the first post-operative visit, we observed less edema and palpable skin adhesion to the underlying skeleton. At the second post-operative visit (1 month), skin re-drape was subjectively evaluated and found to be significantly better than when doxycycline was not used. The skin was noted to be more securely adherent to the nasal skeleton, while SSTE edema appeared to be substantially less than expected. During the subsequent six months of follow-up, no complications of doxycycline administration were observed.

In the second group, a total of 25 primary rhinoplasty patients were included who underwent surgery from April 2023 to June 2023. The average patient age was 28 years (ranging from 16 to 58 years), and 21 patients (84%) were female. All patients studied were found to have thick skin by the Obagi skin pinch test. This cohort underwent an open rhinoplasty (with AMK) with a laminated septal extension graft (TACO graft) for maximum tip support and ligament reconstruction to help close dead space. Defatting of the tip/supra-tip was not performed for consistency in this study. Likewise, ligament reconstruction of the Pitanguy ligament and scroll ligament system allowed for the containment of the doxycycline rhinodesis solution in the supratip and tip regions without expansion into the mid-vault. In 22 of 25 patients (88%), no fluid/scar layer was observed using ultrasonography at 1 month post-operatively. These 25 patients were compared to a previous cohort of patients with thick skin who did not undergo doxycycline rhinodesis. In this non-rhinodesis group, only 11 of 25 patients (40%) had minimal to no fluid/scar layer observed at their one-month post-operative visit (16).

Clinically, patients were felt to have less inflammation and better adherence, particularly in the supra-tip region, and no complications were observed during the follow-up period. (Figure 1,2)

DISCUSSION:

Several aspects of this study and doxycycline rhinodesis merit discussion including the mechanism of action~~,~~ its application to rhinoplasty, the therapeutic indications, and the goals for future study.

Sclerosing Action of Doxycycline

The use of doxycycline for the treatment of persistent Morel-Levallee (MLL) lesions is well-studied. Morel-Lavallée lesions occur after closed, degloving soft tissue injuries. They are uncommon but can be dangerous and life-threatening, requiring immediate attention and emergency intervention (4,8). These are mainly post-traumatic lesions resulting from blunt-force shearing forces (9,10,11,17). The key mechanism of injury is blunt-force separation of the skin and subcutaneous tissues from the underlying superficial muscle fascia (18,19). Shearing forces form a potential space that behaves much like surgical dead space, and the disrupted perforating vessels, capillaries, and lymphatic channels then fill the cavity with blood, lymph, serosanguinous fluid, and necrotic fat. At times, the cavity will persist or even continue growing as the inflammatory and metabolic biproducts within the collected fluid initiate and enhance cellular permeability, allowing for more fluid leak into the space (19). The accumulated fluids remain entrapped within the cavity as the ongoing inflammatory process leads to the formation of peripheral granulation tissue known as a fibrotic pseudo-capsule (19,20,21,22). Hypotheses for the sclerosing action of doxycycline in MLL include the destruction of mesothelial cells lining the pseudocyst, the inhibition of fibrinolysis, and the induction of fibroblast growth factors (12). Doxycycline has proven effective in large-volume MLL of up to 700 mL, with the average volume of treated lesions around 400 mL. All chronic and persistent pseudocysts exhibited a rapid cessation of fluid accumulation with no recurrence when treated with doxycycline (3,4). Preventing recurrence allows revascularization of the affected area with tissue and organ survival. In a case series of knee MLL injuries in football players reported by Tejwani et al., 3 out of 27 MLL cases (11%) were recalcitrant to conventional management with compression and aspiration, and 3 patients developed recurrent fluid collections. Doxycycline sclerodesis was then administered, and all 3 persistent MLLs were successfully eliminated, and players were able to return to football immediately (23). The authors concluded that refractory fluid collections could be expeditiously and safely treated with doxycycline sclerodesis (23). Finally, it should be noted that doxycycline sclerodesis has many other clinical applications that enhance dead space closure, including the treatment of stubborn pleural effusions, pneumothoraces, and post-operative seromas.

Other relevant literature to our study is likely post-operative seroma following abdominoplasty. In this operation, the skin and subcutaneous tissue are lifted off the abdominal fascia to remove an abdominal pannus. Following the operation, post-surgical seroma is the most common complication, leading to inflammation, loss of contour, fluid collection, pseudocapsule formation, irregular scar formation, and at times return to the operating room. Surgeons have focused on prevention with the use of fibrin glue, progressive tension sutures, and compression. Once a seroma forms, patients are treated with repeated/serial aspirations of fluid, compression garments, and restriction of activity. Doxycycline has also been used to successfully treat stubborn post-abdominoplasty seromas with outcomes similar to MLL lesions.

Application of doxycycline in rhinoplasty

The importance of effective SSTE re-drape following alterations in the nasal framework cannot be overstated. The benefits of even the most expertly crafted nasal framework can be negated by incomplete re-drape, dead space formation, and subsequent scarring and thickening of the SSTE. Various factors may interfere with re-adherence of the SSTE, including unfavorable skin types (e.g, oily and sebaceous, acne-prone, inflamed, scar-prone, etc.), excessive skin thickness, poor skin elasticity, excessive skin closing tension, and failed contracture of an over-sized SSTE. Moreover, certain ethnicities possess nasal skin with many of these unfavorable characteristics. Additionally, dead space is also more likely to develop in the presence of large size discrepancies between the SSTE and the nasal framework, or with poor hemostasis, excessive post-operative swelling, and other factors that prolong SSTE inflammation. Ultimately, a secure and complete apposition between all separated layers within the SSTE is essential for favorable healing, cavity obliteration, and contour optimization. It has been well established that sclerosants produce a fibrous union between disrupted tissue layers by triggering an inflammatory response characterized by protein coagulation and hyperosmolar cell destruction that initiates bridging fibrosis and pseudocyst closure. Additionally, the sclerosing action of doxycycline is hypothesized to include the destruction of mesothelial cells lining the pseudocyst, the inhibition of fibrinolysis, and the induction of fibroblast growth factors (12).

In this two-part rhinoplasty case series, early post-operative nasal contour was noticeably improved on clinical examination, and these observations were objectively confirmed in 22 of 25 patients (88%) using ultrasonographic evaluation that detected no post-operative scar/fluid layer development. This non-invasive means of assessing skin re-adherence has proven invaluable in evaluating rhinodesis outcomes, and for characterizing both normal and pathologic post-rhinoplasty healing responses in thick-skinned noses.

By using only 1.0-2.0 ml of doxycycline sclerosant (at a concentration of 20 mg/ml), expressing the fluid from the cavity after only 2-3 minutes, and manually compressing the SSTE firmly against the nasal framework for at least one minute, initially favorable outcomes were subjectively observed in nearly all patients studied in this series. The comparatively mild inflammation observed in this study contrasts with previous studies in which excessive soft-tissue inflammation was observed following doxycycline sclerodesis. However, in contrast to the conservative rhinodesis protocol used in this preliminary investigation, excessive inflammation was only observed with much higher doxycycline concentrations, prolonged tissue contact (exceeding 60 minutes), large treatment volumes, or when no effort was made to remove the sclerosant (24,25,26,27). Our consistent post-operative clinical findings suggest that unlike MLL and similar lesions, the rhinoplasty cavity can be sealed to prevent dead space formation with only a brief exposure to liquid doxycycline using comparatively small volumes. Doxycycline rhinodesis is also likely potentiated by the concomitant use of prolonged nasal splinting, as well as conventional hemostatic measures such as controlled hypotension, the administration of intravenous tranexamic acid, post-operative application of ice to the midface, etc. Finally, there is at least one case series in which small volume, low-dose doxycycline sclerosant therapy was used successfully in the face for cosmetic purposes. In a preliminary study by Godfrey et. al., doxycycline hyclate at a concentration of 10 mg/ml was injected into 15 consecutive patients for sclerosant therapy of idiopathic lower eyelid festoons and malar edema (28). In this study low-dose doxycycline sclerosant was administered by injection and no attempt was made to remove the sclerosant. The authors concluded that intralesional injections of doxycycline hyclate at a concentration of 10 mg/ml may represent an effective (non-invasive) treatment modality for cosmetic correction of lower eyelid festoons and malar mounds or edema. They also reported there were no significant complications following treatment apart from bruising at the injection site, transient burning sensation, and mild erythema in a minority of patients (28). Other reports of successful intralesional injection with doxycycline and other sclerosants have also been reported in patients with seromas, lymphatic malformations, and lymphoceles, and treatments were uniformly well tolerated (12, 13, 29).

Indications for sclerodesis use in rhinoplasty (rhinodesis):

Favorable re-drape and secure re-adherence of the SSTE to the modified nasal framework is a critical component of cosmetic nasal surgery. Unfortunately, effective treatments to control post-operative nasal contour in the thick-skinned rhinoplasty patient have been slow to evolve. Moreover, re-drape and re-adherence have proven especially challenging in rhinoplasty patients with thick nasal skin. As stated above, various factors can prevent skin flap adherence and allow dead space formation, which in turn can lead to blood or fluid accumulation and unwanted fibrotic thickening of the SSTE. Ultra-thick nasal skin is often notoriously non-compliant, resistant to contracture, and prone to poor surface coaptation, particularly following sizeable reductions in nasal volume (30,6). Thick-skinned patients frequently develop large dead space voids that mask the underlying skeletal framework and create an amorphous final surface topography. However, patients with thick nasal skin that present with pathologic skin conditions such as rosacea, acne, or hypertrophy of the cutaneous adnexa, can be treated medically (before and after rhinoplasty) with topical skin preparations, low-dose oral isotretinoin, and various peels and lasers for improved outcomes (16,17). Similarly, a hypertrophic SMAS layer will resist re-drape and re-adherence while adding as much as 4.0 mm of additional thickness to the SSTE in the authors' experiences. In patients with excessive skin thickness resulting from a discrete hypertrophic SMAS layer, selective excision of the SMAS will serve to thin the SSTE and greatly improve skin compliance, re-drape, and re-adherence for marked improvements in nasal topography (5,6). Because the tip and supratip seem to be particularly prone to persistent post-surgical swelling and contour irregularities, SMAS excision is typically confined to these areas, and care must be taken not to reduce skin thickness below 2.0 mm and not to disrupt the subdermal fat.

The collective impact of all treatment modalities can be evaluated with ultrasonography. One author (AMK) was able to evaluate both the quality of the healing response, and the thickness and appearance of the dermis and subcutaneous tissues using ultrasonographic imaging. Early ultrasonographic studies led to the discovery of a third (post-operative) tissue layer between the SSTE and the skeletal framework in thick-skinned patients. This scar/fluid layer can be selectively targeted with steroid and/or 5-FU injections under direct ultrasonographic visualization to reduce inflammation and preempt fibrosis. Additionally, the response to treatment within the "dead space layer" can be monitored and quantitated over time (15).

In the last decade optimizing re-drape has evolved into a multi-modality approach in which the SSTE is medically-optimized before surgery, surgically optimized intra-operatively (e.g., SMAS excision, ligament preservation, skin contouring sutures, etc.), and then medically-optimized again post-operatively. However, full control of the supra-tip has remained elusive even with a multi-modal approach and especially in thick-skinned patients. This may be a consequence of sizeable increases in tip projection or counter-rotation (made possible the advent of the septal extension graft) that longitudinally stretches and tightens the SSTE causing a tenting effective of the supra-tip skin that predisposes to dead space formation especially within the supra-tip. Regardless, the creation of a subtle but distinct supra-tip break is a common goal in cosmetic rhinoplasty of the feminine nose, and thick nasal skin often thwarts this important cosmetic objective.

Historically, re-drape and re-adherence of the supra-tip SSTE was achieved with various casting, taping, or splinting regimens, but outcomes were inconsistent and patient compliance was sometimes lacking. Then, in the last decade Cakir popularized the concept of ligament preservation and/or ligament reconstruction emerged and completely changed the way many rhinoplasty surgeons approach the nose, and further enhanced control of the supra-tip in select patients (**31**). More recently, the next iteration in surgical control of the supra-tip was the use of skin contour sutures (9). These interrupted transcutaneous mattress sutures serve to compress the inner and outer SSTE linings against the supra-tip skeletal framework for better contour and definition both externally and internally. Moreover, ultrasonic examination confirms that swelling and re-adherence is significantly improved with skin contouring sutures. However, these sutures are left in place for 5-6 days, and the potential risk of scarring or skin necrosis is ever-present, especially in patients with poor nutrient blood flow. While many of the authors (AMK, MK, RD) employ skin contour sutures regularly, sutures must be tied loosely to allow for inevitable post-operative swelling.

Figures (3)

Further Study

Finally, a potential new modality for the control of nasal tip re-drape has emerged in the form of doxycycline rhinodesis, and this pilot study marks an exciting new development in dead space prevention. Rhinodesis is readily accessible, simple, quick, inexpensive, and safe; and it may potentially obviate the need for skin contour sutures or ligament preservation. Based upon the favorable results of this preliminary study, it is reasonable to conclude that doxycycline sclerodesis can be used safely in most rhinoplasty patients. However, at the onset of this investigation, the exclusion criteria for rhinodesis included patients with thin nasal skin who are naturally predisposed to pathologic shrink-wrap skin contracture. We reasoned that thin-skinned patients might suffer excessive skeletonization of the underlying nasal framework from doxycycline-induced intensification of shrink-wrap contracture. Consequently, the initial 102 patients (treated by MK), and the subsequent 25 additional patients (treated by AMK), all had either intermediate or thick nasal skin, and were at little to no risk for shrink-wrap contracture. However, based upon the initially favorable clinical results with intermediate and thick-skinned patients (MK), several thin-skinned noses (undergoing large volume reduction rhinoplasty for pronounced tip bulbosity treated by RD), were also treated with doxycycline rhinodesis using the same treatment protocol. As of this writing, the subjective clinical outcomes in thin-skinned noses, while comparatively small in number, have also been favorable much like their intermediate-skinned counterparts. However, unlike the patients with thicker skin, the thin-skinned noses were all degloved using a sub-perichondrial dissection plane. We postulate that elevating the perichondrium in continuity with the overlying skin, and then using rhinodesis to promote rapid and complete perichondrial re-adherence, may serve to mitigate shrink-wrap contracture by restoring the soft-tissue “lamination” of the tip cartilages that serves to naturally stabilize the tip complex. Re-adherence of the perichondrium (and its attached overlying SSTE) to the tip cartilage may also be naturally more favorable given the uniformity of the tissue layers. Finally, it should also be noted that cephalic resections of the lateral crura were not performed in any of the thin-skinned patients, and the author used lateral crural tensioning to make the tip complex far more resistant to alar retraction from shrink-wrap contracture. Whether or not alar retraction would be exacerbated if rhinodesis was used following large cephalic resections in the absence of tensioning is presently unknown, but unsupported skin following a cephalic trim is highly susceptible to shrink wrap distortion in the thin-skinned nose. Further study of rhinodesis in the thin-skinned nose is needed to confirm the safety and efficacy of rhinodesis in this patient subgroup, but it appears likely that that rhinodesis stabilizes the SSTE and prevents excessive shrink-wrap when used in conjunction with a strong nasal framework and intact lateral crura. Similarly, further long-term study of rhinodesis outcomes in all skin types will be needed to confirm these preliminary subjective assessments. Nevertheless, based upon the initial subjective clinical outcomes and the favorable ultrasonographic assessments of this preliminary investigation, rhinodesis appears to be safe, well-tolerated, cost-effective, and a valuable adjunct to cosmetic nasal surgery.

Two authors (AMK and MK) now regularly uses ligament reconstruction/preservation, skin contour sutures, and rhinodesis in different combinations, while three other authors (AMK, MK and RD) regularly use SMAS debulking in combination with rhinodesis. Moreover, doxycycline can also be used in both open and closed approaches. Finally, the possibility of medical skin pre-conditioning, different surgical approaches, different dead space treatment modalities, and differing post-operative care regimens can now be tailored to specific patient needs for improved outcomes. However, further studies are needed to examine long-term results of rhinodesis, the effect of different modality combinations, and to determine which patients are best suited to a particular modality or combination of modalities. Future investigations into the long-term efficacy of rhinodesis are also needed in the thin-skinned nose as shrink wrap deformities often manifest slowly over time. Finally, characterizing precisely how rhinodesis and SMAS excision can be used in combination to potentially revolutionize management of the ultra-thick-skinned nose is another much needed avenue of future investigation.

A few limitations of this preliminary investigation should be noted. First, this is a pilot study and follow-up was limited to no more than 6 months. Second, none of the authors have had the opportunity to revise patients who underwent rhinodesis. Whether the tissues act differently during the initial dissection or during the final re-drape after revision or secondary rhinoplasty remains to be seen. However, with such a small volume for such a limited amount of time, it is believed that adverse effects should be minimal. Moreover, scar tissue in the supratip is already a problem because of dead space formation and fibrous tissue accumulation. Finally, it should be emphasized that doxycycline will not compensate for poor surgical technique or a skeletal framework that is not optimized for patient specific SSTE characteristics.

Conclusions

Obtaining favorable tip definition and supratip contour is predicated upon satisfactory control of the SSTE re-drape, which is often a frustrating part of the rhinoplasty healing process. This new modality of rhinodesis appears to be an easy and safe means of sealing the surgical dead space and preventing unwanted degradation in nasal surface contour. Further studies will be needed to elucidate how rhinodesis can be effectively combined with specific surgical maneuvers and other dead space-reducing modalities to optimize rhinoplasty outcomes.

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Figure 1a,1b,1c,1d: Pre-operative views prior to primary reduction rhinoplasty.

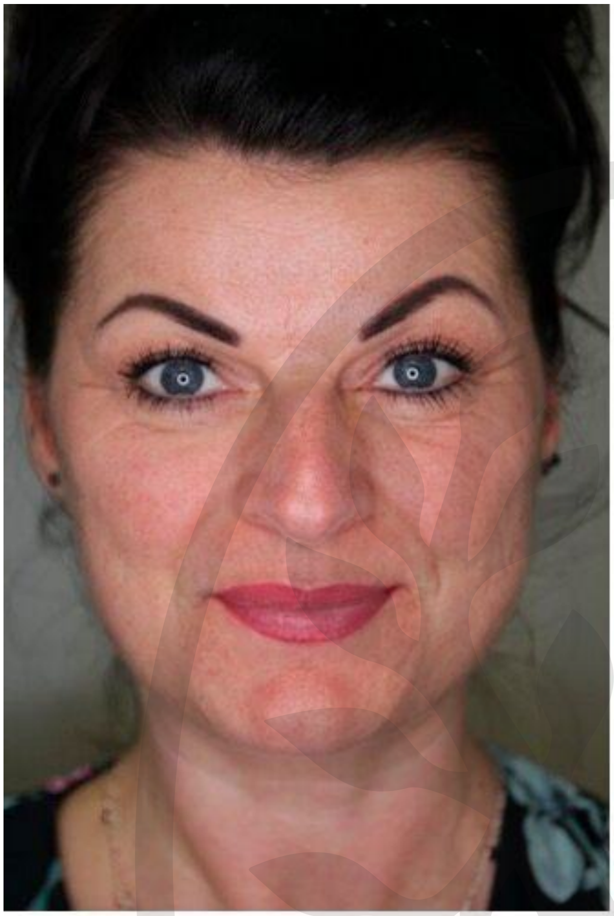
Figure 1e,1f,1g,1h: Corresponding post-operative views showing favorable surface definition and minimal swelling 9 days after external rhinoplasty with doxycycline rhinodesis.

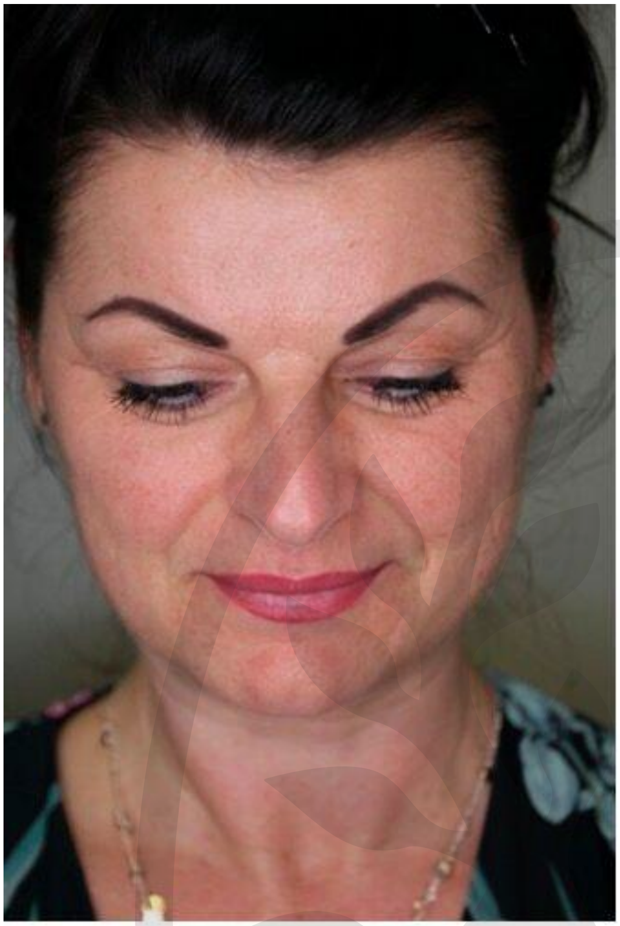
Figure 2a,2b,2c,2d: Pre-operative views prior to primary reduction rhinoplasty.

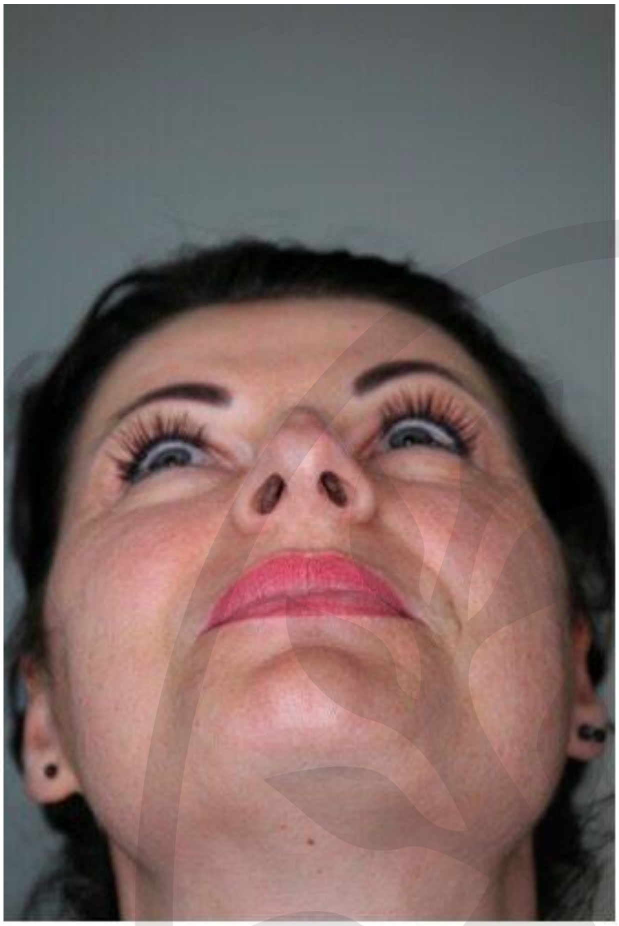
Figure 2e,2f,2g,2h: Corresponding post-operative views showing favorable surface definition and minimal swelling 9 days after external rhinoplasty with doxycycline rhinodesis.

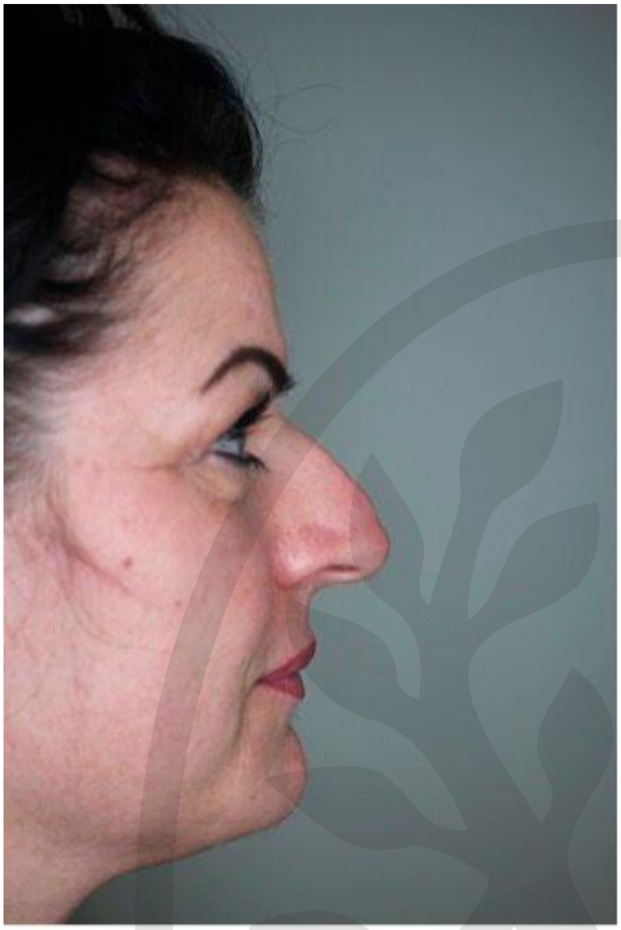
Figure (3a): The third layer is seen post-operatively as a fluid layer between the SSTE and skeletal framework, the dead space layer.

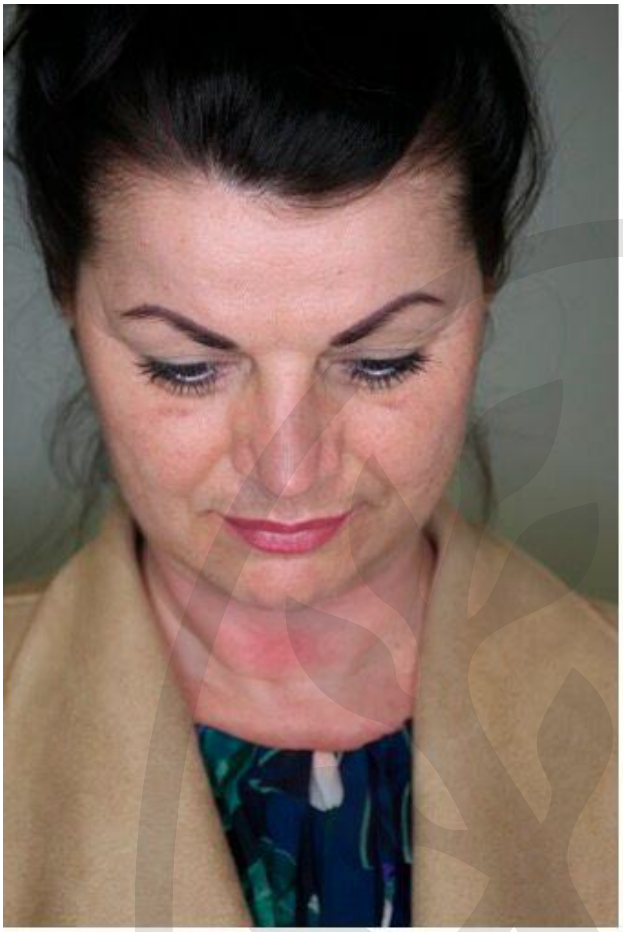
Figure (3b): The dead space layer is sealed.

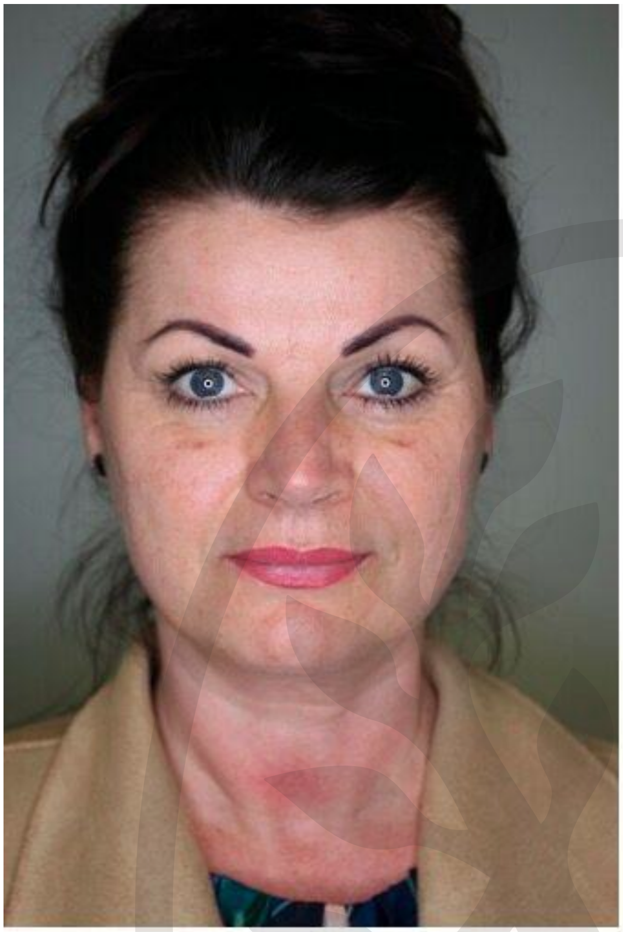


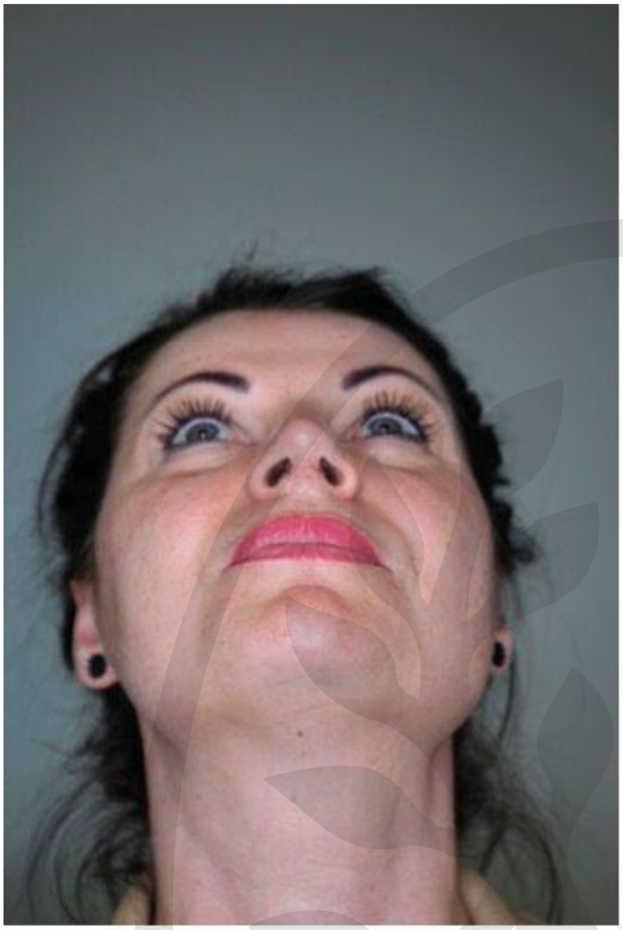


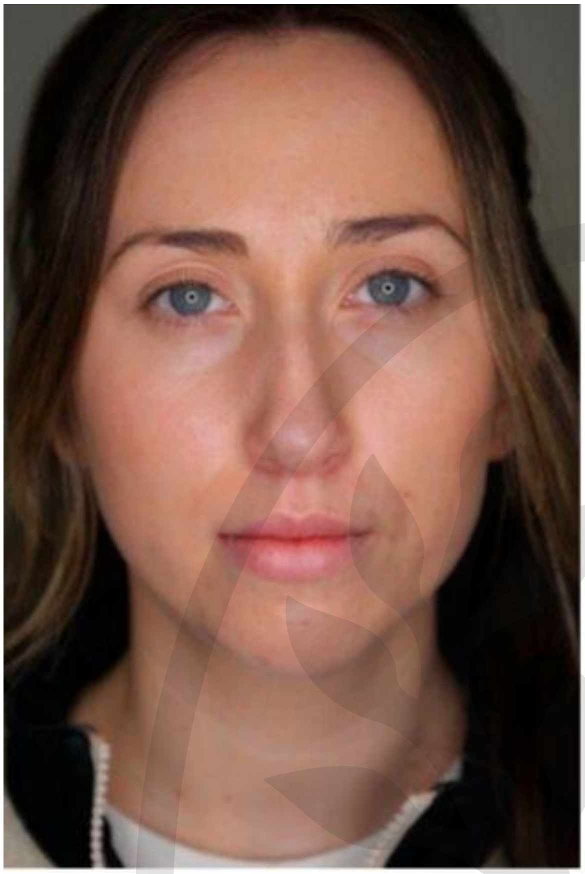


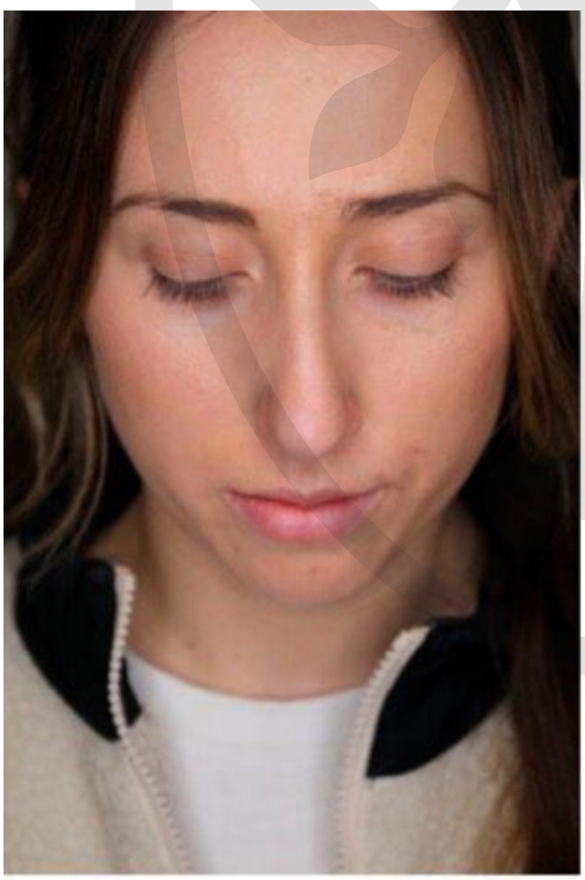


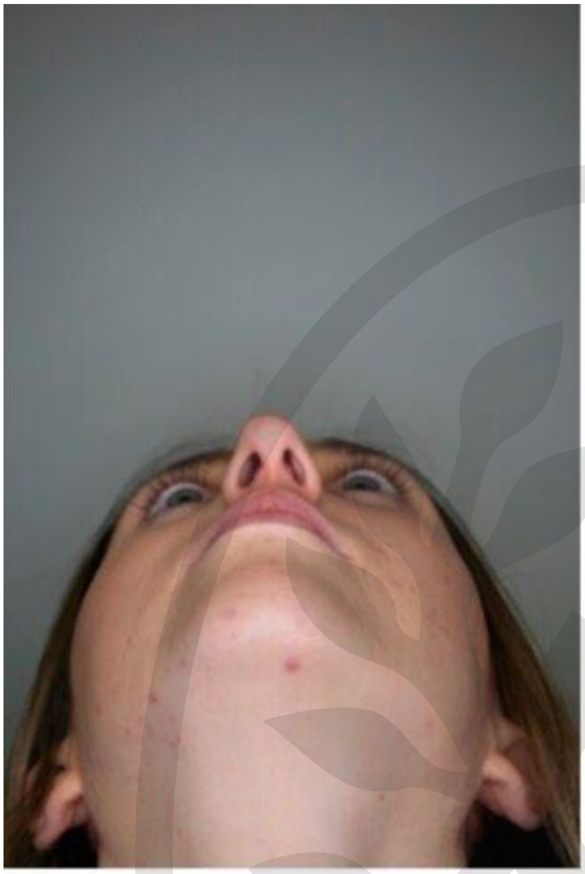


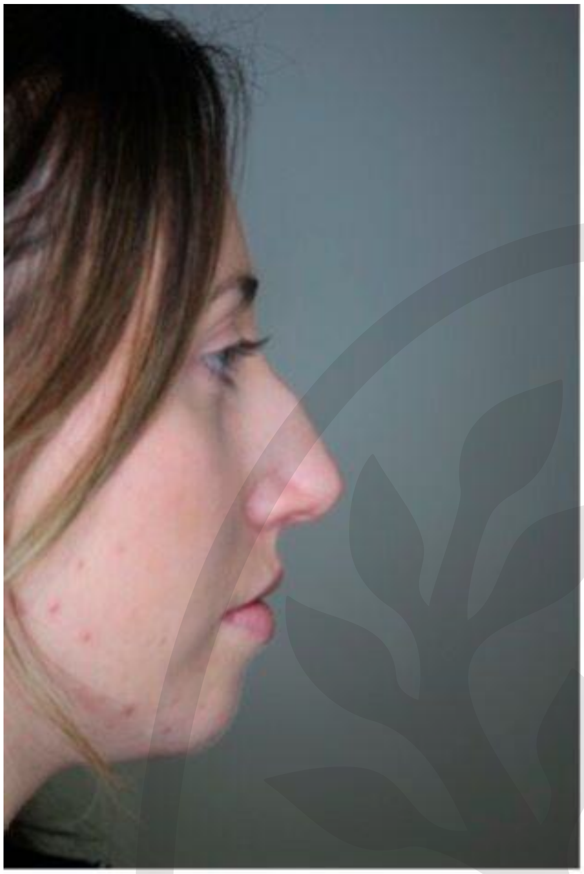


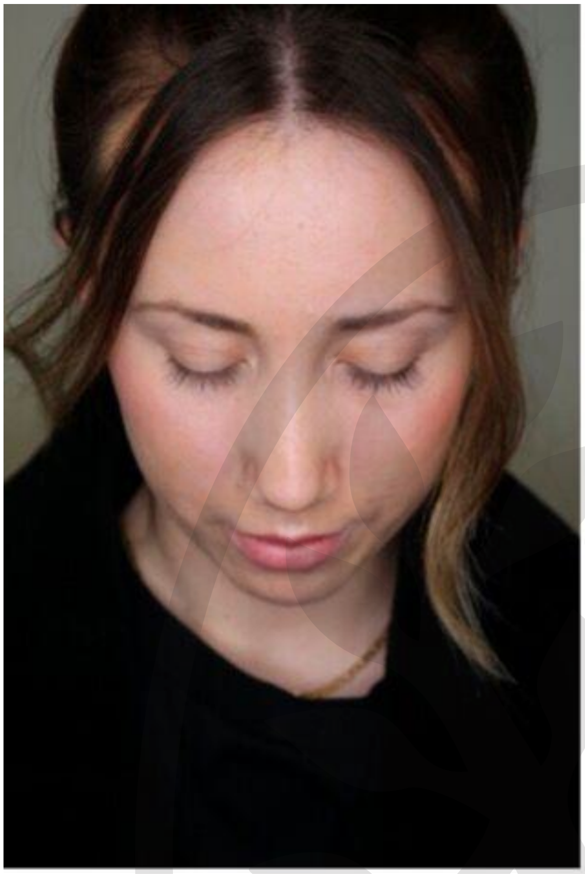


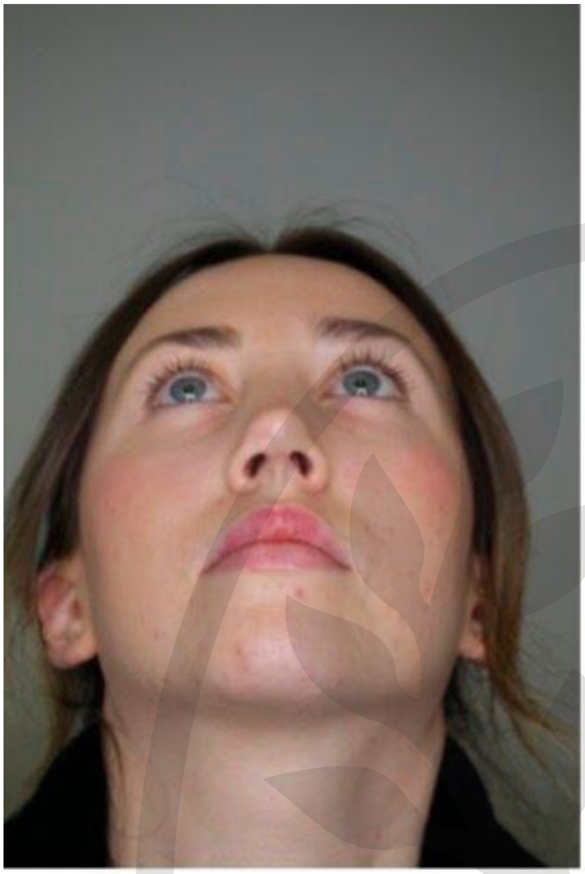


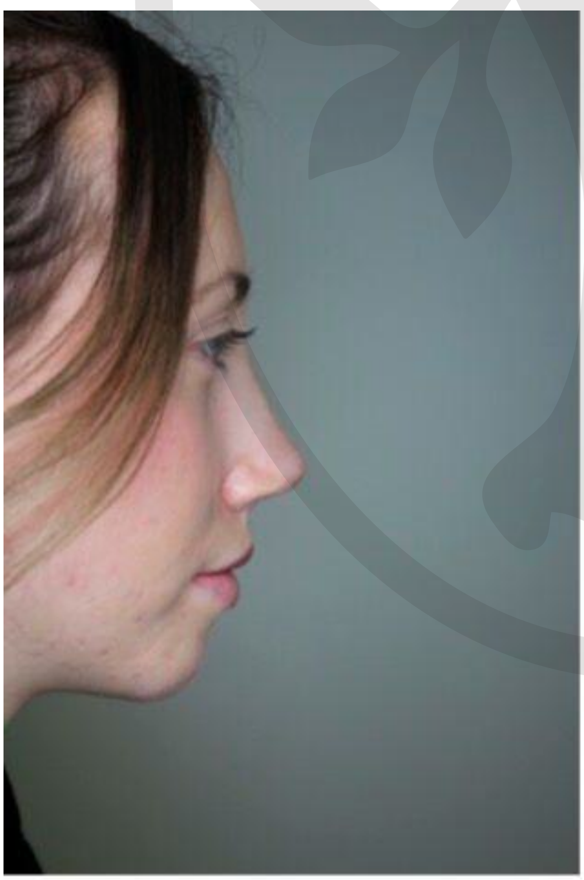


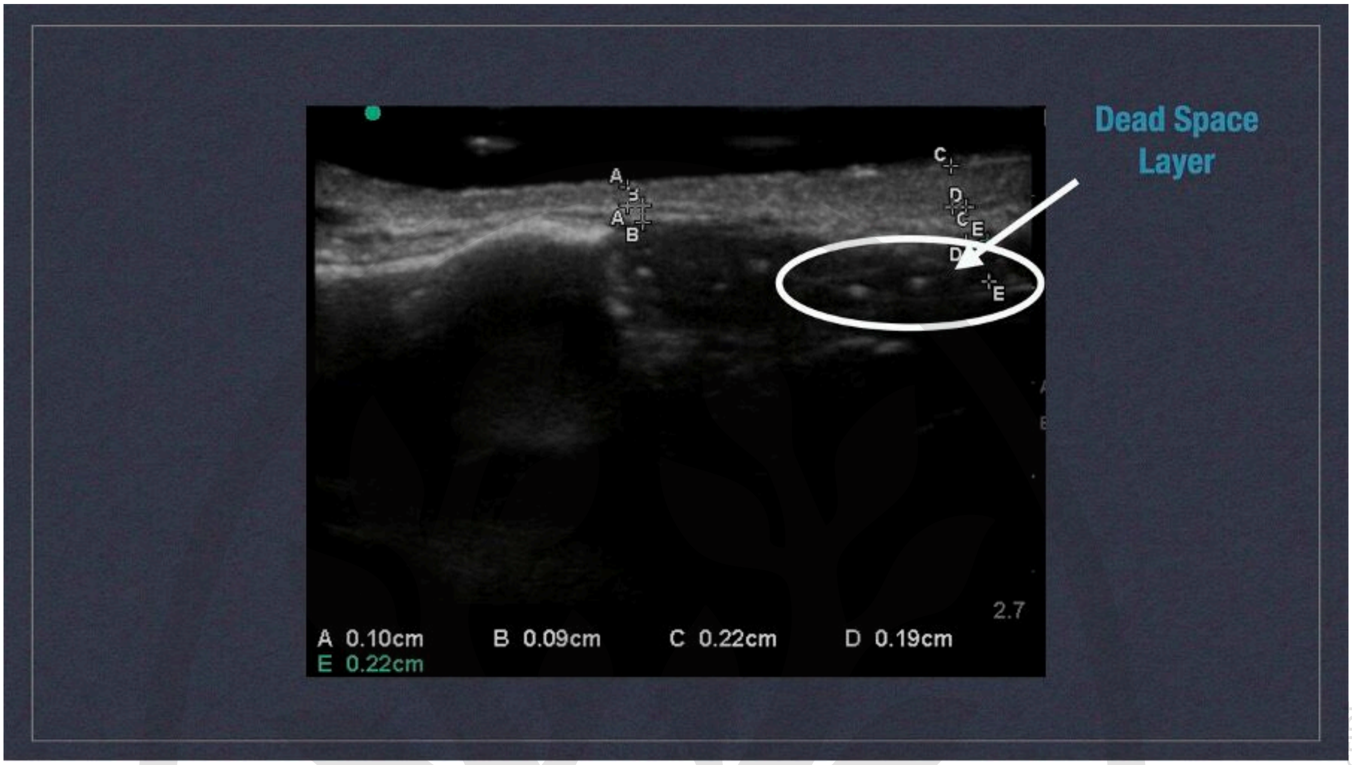


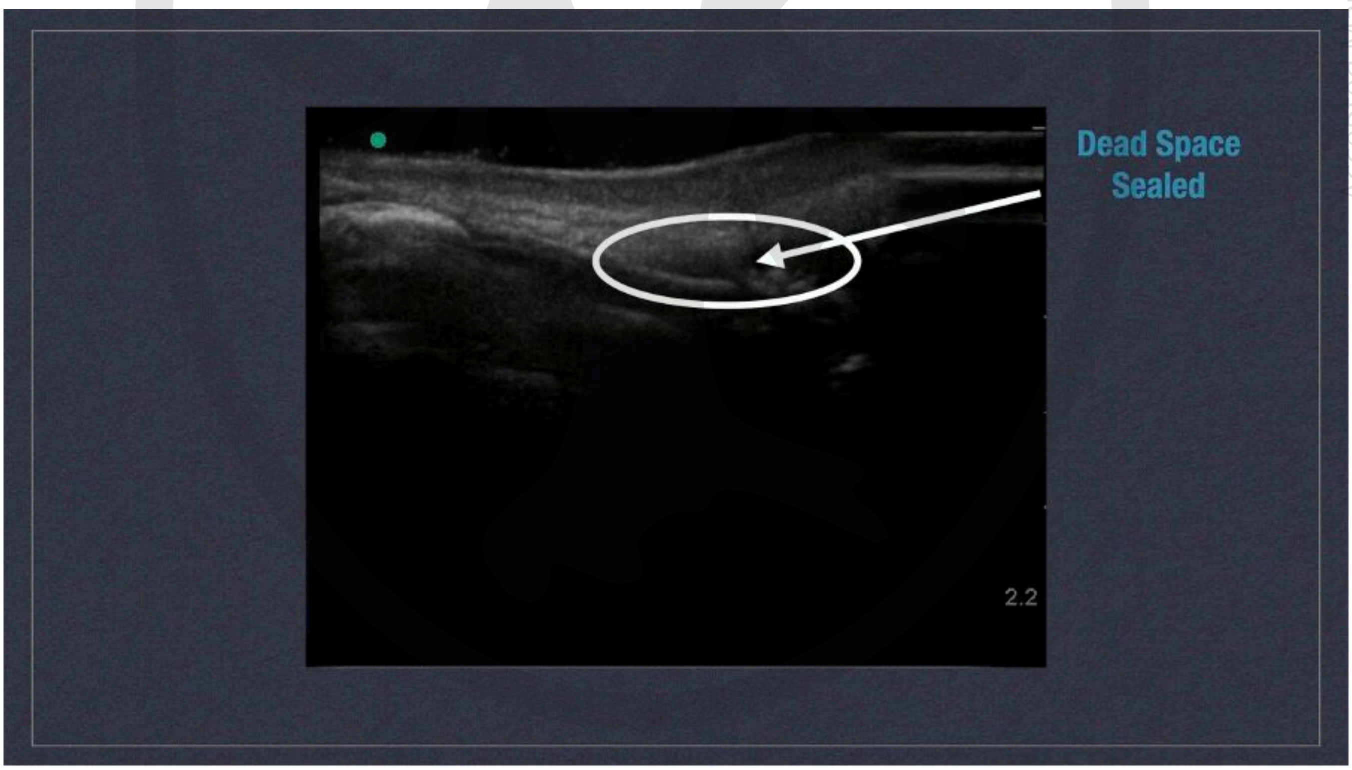









Dead Space
Layer
A 0.10cm
B 0.09cm
C 0.22cm
D 0.19cm
E 0.22cm
2.7


Dead Space
Sealed
2.2

Comparison of Blunt Force (Mechanical), Piezoelectric, and Electric Instruments in Bony Vault Management

Olivier Gerbault, MD[a,*], Nazim Cerkes, MD[b], Emmanuel Racy, MD[c], Vitaly Zholtikov, MD[d]

KEYWORDS

• Rhinosculpture • Osteotomy • Ostectomy • Bone stability • Ultrasonic rhinoplasty • Preservation rhinoplasty • Rhinoplasty

KEY POINTS

- Blunt force instruments can create unwanted fractures and comminutive fractures that depend on the surgeon's technique, the instruments used and the bones characteristics.
- Piezoelectric instruments and electric instruments don't create unwanted or comminutive fractures.
- PEI and EI can preserve more easily bone stability than blunt force instruments.
- New mechanical instruments tends to avoid blunt force: hand saws, rasps, rongeur, etc.

Video content accompanies this article at http://www.facialplastic.theclinics.com.

PANEL DISCUSSION

What is your preferred instrumentation for nasal bone surgery? Do you exclusively use it or combine it with other instruments? If so, what other instruments do you use, and under what circumstances? Do you have extensive experience using mechanical, electrical, and piezoelectric instruments?

What is your usual approach to the nasal pyramid? Please explain the positioning of incisions, the dissection plane(s), and the cephalic and lateral extent of the dissection. Under what circumstances do you modify your dissection? Please provide details of these modifications.

Is rasping of the nasal bones (or rhinosculpture) a routine technique you use to treat a dorsal hump? If yes, please specify the instruments used (with a photo if possible) and the exact extent of rasping on the nasal bones. Do you perform the same type of rasping for dorsum preservation techniques as for structural dorsum techniques? Please elaborate.

Are there any limitations to this rasping technique, or does it sometimes pose difficulties? If yes, what are they, and in which cases? How do you correct and avoid these difficulties? Do you observe any differences in rasping based on the type of instruments used (mechanical, electrical, piezoelectric)?

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Regarding lateral osteotomies: What instruments do you use (with a photo if possible)? What approach do you use for this osteotomy? Where does it start and end? Does this trajectory vary based on the appearance of the nasal pyramid or the technique used for dorsal hump correction (bony impaction or cartilaginous resection)?
Are lateral osteotomies with your preferred instruments sometimes a source of difficulties? If yes, what are they, and in which cases? How do you correct and avoid these difficulties? Do you observe any differences in lateral osteotomies based on the type of instruments used (mechanical, electrical, piezoelectric)?
Concerning paramedian or oblique medial osteotomies: What instruments do you use (with a photo if possible)? What approach do you use for this osteotomy? Where does it start and end? Does this trajectory vary based on the appearance of the nasal pyramid or the technique used for dorsal hump correction (bony impaction or cartilaginous resection)?
Are paramedian or oblique medial osteotomies with your preferred instruments sometimes a source of difficulties? If yes, what are they, and in which cases? How do you correct and avoid these difficulties? Do you observe any differences in paramedian or oblique medial osteotomies based on the type of instruments used (mechanical, electrical, piezoelectric)?
Concerning transverse osteotomies: What instruments do you use (with a photo if possible)? What approach do you use for this osteotomy? Where does it start and end? Does this trajectory vary based on the appearance of the nasal pyramid or the technique used for dorsal hump correction (bony impaction or cartilaginous resection)?
Are transverse osteotomies with your preferred instruments sometimes a source of difficulties? If yes, what are they, and in which cases? How do you correct and avoid these difficulties? Do you observe any differences in transverse osteotomies based on the type of instruments used (mechanical, electrical, piezoelectric)?
How have your techniques in this area changed over the last 2 y?

INTRODUCTION

The reshaping of the nasal pyramid has evolved significantly over the past 20 years. Mechanical instruments have been refined to minimize the bone trauma of osteotomies. Fine and sharp instruments are used to allow precise cutting. Highly efficient hand rasps and saws have been designed to avoid the inherent defects of conventional mechanical instruments. Indeed, these instruments can inadvertently cause radiated fractures and comminuted fractures that compromise bone stability and can create surface defects. Other mechanical instruments that do not involve blunt force have also been developed, such as nail clippers, rongeurs, and even the use of a scalpel blade.

Electric and piezoelectric instruments (PEI) have been developed to address these problems of uncontrolled fractures. These 2 types of instruments are similar, but PEI instruments are selective unlike electric instruments. This means that PEI cannot damage adjacent tissues. These instruments not only allow for precise rhinosculpture and osteotomies under direct visual control, but also for precise mobilization and stabilization of the nasal bones.

The article reviews the advantages and disadvantages of each method by comparing them for the most frequently performed procedures on the nasal bone pyramid in rhinoplasty: the necessary approach, removing the bony layer when treating humps, and finally each of the osteotomies.

Experts were invited to defend their preferred method. All but 1 had extensive experience in electric and piezoelectric rhinoplasties; this further validates the choices they have made over the years in reshaping the nasal bone pyramid.

Question 1: What is your preferred instrumentation for nasal bone surgery? Do you exclusively use it or combine it with other instruments? If so, what other instruments do you use, and under what circumstances? Do you have extensive experience using mechanical, electrical, and piezoelectric instruments?

Cerkes

My preferred instruments for nasal bone surgery are No: 15 blade, Cerkes Bone Nipper (Marina Medical İnstruments FL-USA), Cerkes 3-mm straight osteotome (Marina Medical İnstruments FL-USA), Cerkes Curved osteotome (Marina Medical İnstruments FL-USA), 5-mm delicate tip osteotome, and delicate 7 -mm Tastan Rasp (Medisoft Medical-TR). I always use the hand instruments mentioned earlier for bone reduction, osteotomies, and bone reshaping. In rare circumstances, I combine hand tools with the electrical instruments (power burr) particularly in cases with high radix for reduction of radix.

I have experience with electrical and piezoelectric instruments. They are useful tools, but their use elongates the surgery time and need larger periosteal degloving to execute the osteotomies and bone reshaping.

Gerbault

I have exclusively used PEI since 2013, except for septoplasty, where I had to wait until 2017 to have the first prototypes of long inserts to perform piezoelectric septoplasties and endonasal osteotomies. My journey into rhinoplasty began during my internship in 1990, initially using exclusively mechanical instruments in closed rhinoplasty and later in open rhinoplasty. I started with endonasal osteotomies and, from 2005 onwards, incorporated external osteotomies combined with internal or isolated osteotomies.

For nearly 20 years, I used rasps, osteotomes, chisels, bone scissors, and nail clippers while visiting some of the world's best surgeons very early on. On these occasions, I realized the frequent difficulties they could encounter during bone procedures, particularly osteotomies. It was because of the lack of control, reliability, and predictability in my osteotomies that I began using electric instruments in 2010, using burrs first, and then instruments developed by Dr Y Avsar in Turkey in collaboration with the Swiss laboratory Bien Air.[1] The limitations of these instruments, for me, were the lateral osteotomies performed in an enlarged tunnel without being able to precisely visualize the saw and being confined to a straight fracture line. Hence, I frequently continued to combine traditional osteotomes with electric instruments. Moreover, damage to the surrounding tissues with burrs and saws was not infrequent. I then had ultrasonic piezoelectric rhinoplasty instruments developed, first in 2013 with the NSK company, and then from 2014 with the Acteon company. In the end, I have over 20 years of experience with mechanical instruments, 3 years with electric instruments, and finally 12 years with piezoelectric instruments.

Racy

I use Electric power instruments (BIEN AIR RHINOSCULPTURE SET) since 2011(Video 1).
I quit mechanical instruments in 2013.
I use PEI for orthognathic surgery only (in every procedure).

Zholtikov

Since December 2016, I use PEI in 100% of the cases when bony pyramid work is needed. PEI allow me to do all the work on the bones, except for the radix osteotomy when performing Foundation Dorsal Preservation, I use a 2-mm chisel for the oblique osteotomy. Also, in cases of significant bony thickness at the base of the pyramid or in the radix or in cases of post-traumatic deviations or in some secondary rhinoplasties, I use first cylindrical or diamond burr, which allows to remove the necessary bony thickness very quickly, and then PEI for more precise sculpture and osteotomies. I have extensive experience using mechanical and electrical instruments, which I used for 12 years until 2016, and switched to using PEI in 2016, which has allowed me to significantly improve my own results.

Question 2: What is your usual approach to the nasal pyramid? Please explain the positioning of incisions, the dissection plane(s), and the cephalic and lateral extent of the dissection. Under what circumstances do you modify your dissection? Please provide details of these modifications.

Cerkes

Open rhinoplasty approach provides better visualization of nasal dorsum anatomy and easier execution of maneuvers. Using a mid columellar inverted V incision, skin flap elevation is performed on supra perichondrial level leaving all subcutaneous soft tissues within the skin flap. To perform basic nasal dorsum maneuvers such as hump removal, spreader flaps or spreader grafts, osteotomies, and onlay grafts, I described a different concept of nasal dorsum dissection called "the perichondro-periosteal flap."[2] In this technique, perichondrium of upper lateral cartilages (ULCs) and periosteum of nasal bone are elevated as a continuous flap on both sides (**Fig. 1**). Periosteal undermining on the bony dorsum is partial subperiosteal degloving. It is limited to the keystone area and on the cephalic part of the bony dorsum wide enough to execute medial oblique, transverse (and intermediate if required) osteotomies under direct vision. On the cephalic part of the bony dorsum, lateral extent of the dissection up to the medial canthal tendon but on the caudal portion of the nasal pyramid, it is limited just a few of milimeters lateral to the level of bony reduction. If an osteoplasty procedure is required to correct irregularities or asymmetries on the nasal bones, I perform a larger periosteal degloving, in particular cases total periosteal degloving for rhinosculpture.

Gerbault

I perform 95% open approaches, with dissection always supra perichondral on the lower lateral cartilages (LLCs) and ULCs, then subperiosteal on the entire or just a part of the nasal pyramid when

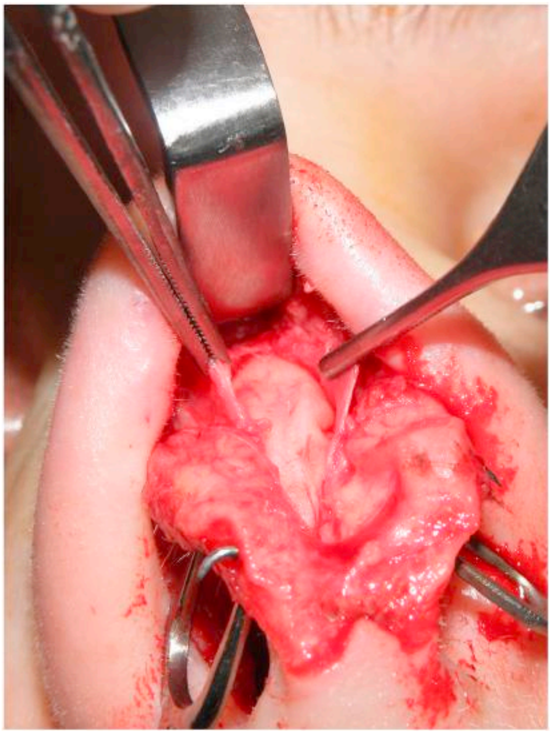

Fig. 1. Periosteal undermining.

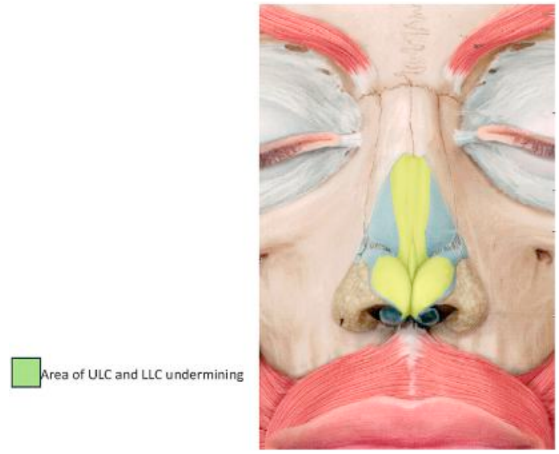

Fig. 2. Extent of soft tissues undermining.

bone modifications are necessary, which is the case for almost all patients. The marginal incision usually ends laterally at the turning point (except when transposition of lateral crura is performed, where it is extended externally) and crosses the columella at its midpoint with an inverted V-shaped design at the narrowest part of the columella. Subcutaneous tissue dissection between the medial and intermediate crura is systematically done since 2019 to ensure a robust Pitanguy flap and intercrural ligaments for traction on the supra-tip at the end of the procedure. This dissection continues supra perichondral from the anterior septal angle, lifting the intercrural ligament and interdomal ligament with the subcutaneous tissue flap between the medial crura (**Fig. 2**). Subperiosteal dissection is most often extended over the entire bony pyramid (full open approach), extending about a centimeter beyond the nasofacial groove and ascending beyond the nasofrontal suture in the midline (**Fig. 3**).[3,4] It is important to note that when bone impaction is planned (foundation technique), the procerus insertions are left intact to provide superficial support to the radix bones, meaning that the upper-middle part of the pyramid is not undermined. In cases where only lateral osteotomy and/or lateral rhinosculpture are performed, bone dissection is limited to the ascending branch of the maxilla, with subperiosteal access in continuity with the lateral crus and extending from the Webster triangle at the bottom to the most cephalic part of the ascending branch, beyond the insertion zone of the internal canthal ligament (**Fig. 4**). Lever-arm movement with a periosteal elevator is necessary to stretch the fibrous ligamentous attachments at the edge of the pyriform aperture, denser in the caudal part.

Racy

- I do a central dissection for the hump with a superior lateral dissection to help for transverse osteotomies.
- I only do extend dorsum dissection for a very croocked nose.
- I do lateral dissections through a 1 cm vertical pyriform incision into the nostril for lateral osteotomies.

Zholtikov

I use open approach rhinoplasty in most cases with combined approach in my practice, and use 3

Fig. 3. Extent of bony pyramid undermining in full open approach.

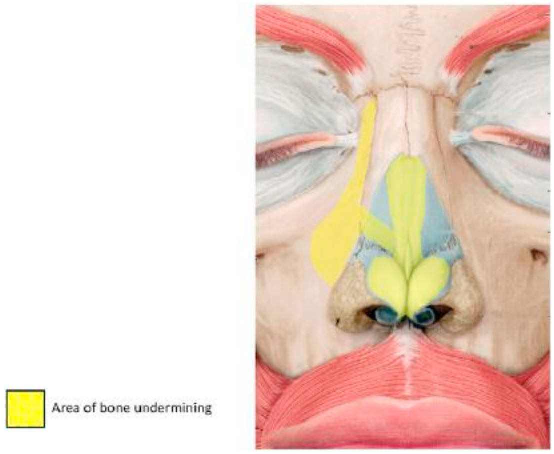

Fig. 4. Extent of bony pyramid undermining in limited lateral approach.

planes of dissection (sub-dermal or supra SMAS plane, sub-SMAS dissection, and dissection in supraperichondrial and subperiosteal plane), depending on the anatomic area where I work. I perform dissection in sub-dermal plane and sub-SMAS plane above the LLC, while keeping SMAS attachment in the scroll area projection, and then the dissection continues supraperichondrially above the ULC until key stone junction and then dissection goes on subperiosteally cranially above the bony vault.[5]

However, access to the bones depends on the dorsal technique I plan to perform. In cases where I perform Dorsal Preservation, I use a limited approach, with no soft tissue envelope (STE) elevation on the dorsum. Dissection performs in the subperiosteal plane over the base of the bony pyramid longitudinally from the keystone junction up to the cephalic part of the radix with a subperiosteal tunnel width of no more than 15 mm. Usually, the lateral pyriform aperture ligaments are stretched to allow wider access to the base of the nasal bony wall along the pyriform aperture (**Fig. 5**) Then, I can extend it in central part of the dorsum, in cases when it is necessary to modify the central dorsum additionally, but necessarily keeping the STE attachments to the lateral walls and to the radix area. That helps me to prevent excessive mobility of the bony pyramid, fully mobilized by circular osteotomies.

Whenever I perform Dorsal Modification or Dorsal Reconstruction techniques, I use a full open approach to the bones.[6] Full subperiosteal dissection of the bony vault performs longitudinally from the keystone junction up to the cephalic part of the radix and transversely from one ascending frontal process of the maxilla to the other side. In addition, it is necessary to undermine the periosteum beyond the nasofacial groove to achieve the requisite exposure. Usually, the lateral pyriform aperture ligaments are stretched to allow complete access to the nasal bony wall along the pyriform aperture (**Fig. 6**). The using of complete extended periosteum mobilization over the entire osseocartilaginous vault permits direct visual assessment of the deformities as well as piezo rhinosculpture to reduce asymmetries followed by appropriate precise osteotomies.[5]

Question 3: Is rasping of the nasal bones (or rhinosculpture) a routine technique you use to treat a dorsal hump? If yes, please specify the instruments used (with a photo if possible) and the exact extent of rasping on the nasal bones. Do you perform the same type of rasping for dorsum preservation techniques as for structural dorsum techniques? Please elaborate.

Cerkes

Hence, the rasps may damage the ULCs, perichondrium of ULCs, and periosteum on the keystone region; I do not prefer to use them for bony dorsum reduction. My preferred instrument to take the bony cap off is the No. 15 blade in the majority of my cases. In young individuals and females, a No. 15 blade easily takes off the bony cap on the keystone area (**Fig. 7**, Video 2). I found this method as the most delicate and the least traumatic way to remove the bony cap. In some males and some older patients, nasal bones are thicker and cutting the bone with a No. 15 blade can be difficult. In such patients, I use a 5-mm straight chisel which has a blade-like cutting edge to remove the bony cap. After removal of the bony cap using a No. 15 blade or 5-mm chisel, I use specific bone scissors (Cerkes Dorsum Nipper-Marina Medical Instruments, FL, USA) for additional reduction from the nasal bones (**Fig. 8**, Video 3). The tip of the scissors are delicate that can fit into small spaces on the bony dorsum and make very precise cuts (**Fig. 9**). With this bone scissors even after the osteotomies, an additional bony reduction can be performed without destabilizing the nasal bones.

Although the rasps are not my preferred instruments for bony cap removal and bony dorsum reduction, in some cases, I use a 7-mm Tastan fine rasp (Medisoft Medical-TR) for reduction of the cephalic portion of the nasal bones and radix area under direct vision with care (**Figs. 10** and **11**). In cases with significantly high radix disproportion, I prefer to use an electrical instrument (power burr) which eases the procedure and shortens the operating time.

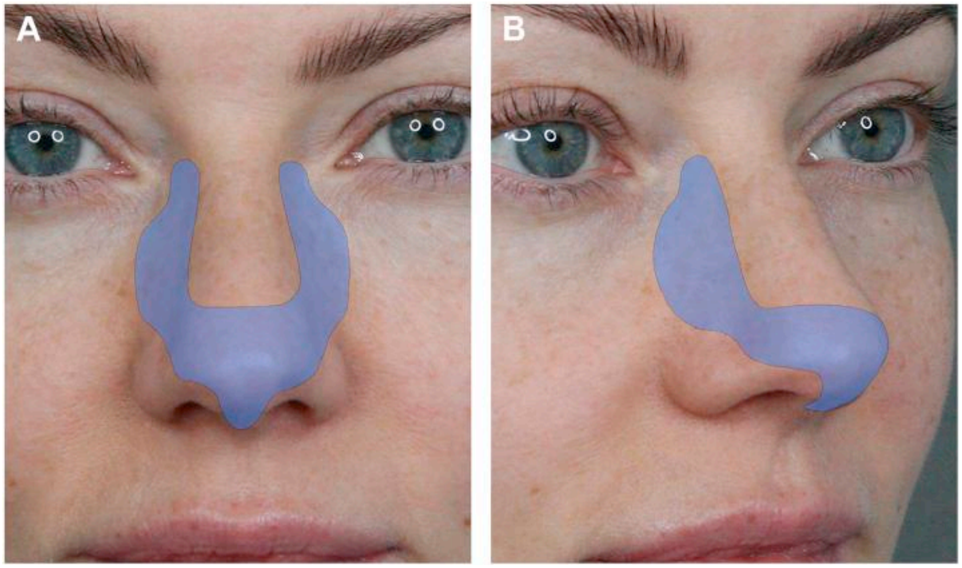

Fig. 5. (*A, B*) Limited dissection. The blue area is dissected part.

Gerbault

Rhinosculpture with piezoelectric instruments has the advantage of being selective, gradually reducing bone thickness without damaging adjacent structures such as cartilage, skin, and muscles.

All areas where the bone is too convex are flattened by rhinosculpture. Exceptions include as follows

- If the bone is thin or has already been refined by rhinosculpture, and the bone color starts to change, indicating significant bone thinning. Osteotomies in 2 perpendicular axes are then performed to flatten the bone without creating a defect (criss cross osteotomies).
- If a bone lowering of the dorsum is planned in the context of an osseocartilaginous surface dorsal preservation (DP) (Ishida and Ferreira-Ishida techniques).[7,8]

If a dorsum structural technique is chosen, the extent of rhinosculpture depends on the type of hump: it involves the dorsal keystone area (DKA) if the hump is mainly marked in profile, the lateral keystone area (LKA) if the hump is mainly marked from three-quarters view, and often both areas.

If a DP surface technique is used, rasping rhinosculpture is essential to avoid irregularities,

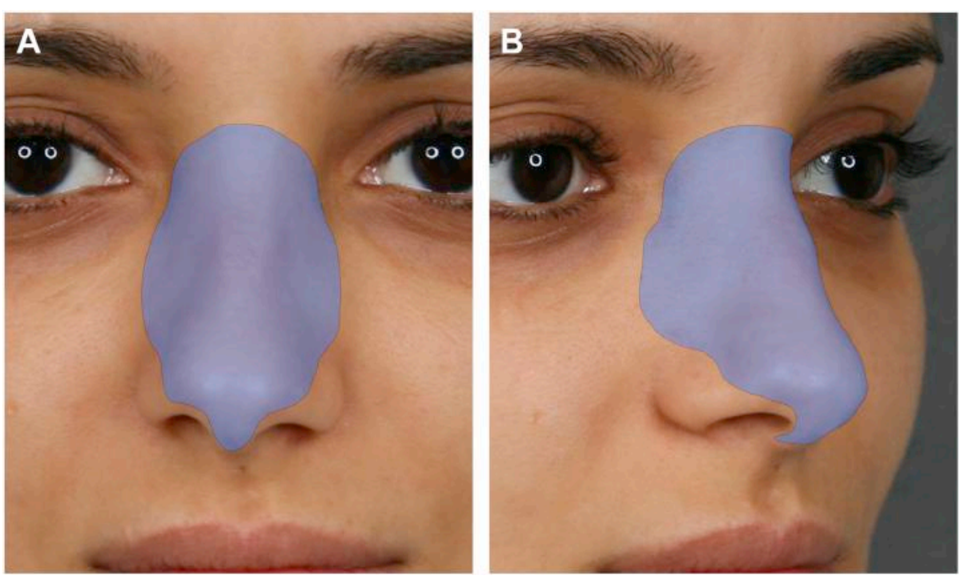

Fig. 6. (*A, B*) Full open approach. The blue area is dissected part.

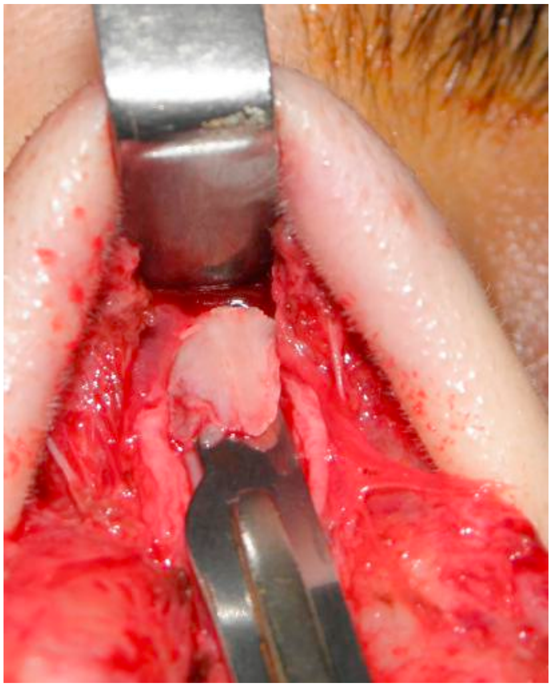

Fig. 7. Bony cap removal.

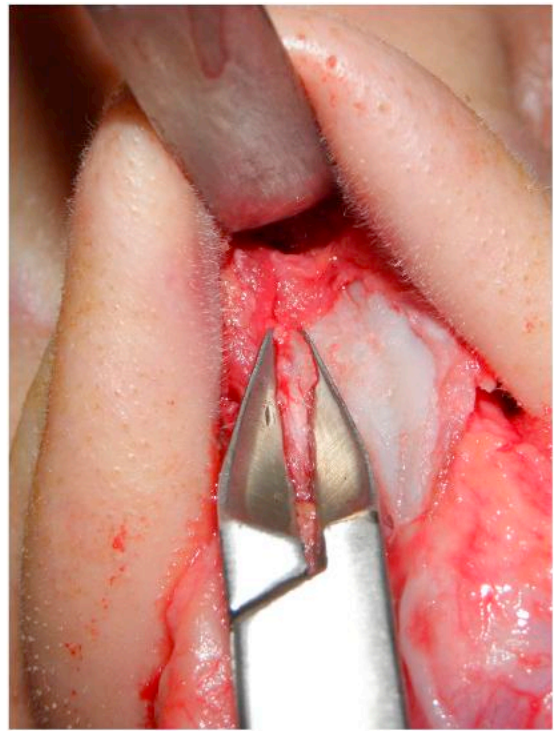

Fig. 9. Additional Bone Reduction with bone scissors.

especially in the LKA areas. However, it is done after the dorsum central and paramedian osteotomies in the Ferreira Ishida technique.

If a DP foundation technique is used, rhinosculpture allows reshaping the bony profile after impaction. This is especially useful when the nasal bones have an S shape, to convert it in a V shape pattern.

In all DPs, dorsum rhinosculpture allows better flexibility of the dorsum to change its shape, but it can also weaken the strength of the dorsum.

The instruments chosen for rhinosculpture are the scraper (RHS1) (**Fig. 12**) in areas where the bone is thick and dense. This instrument actually performs a rapid ostectomy, but less homogeneous than rasps. It is the only instrument that can damage the ULC when the hump is removed if not used appropriately. In almost all cases, the flat rasp is used after the scraper to smooth out the small irregularities often found after using the scraper.

Conversely, rasps perform a true rhinosculpture by gently and progressively removing bone layers (RHS2 and RHS7) (**Figs. 13** and **14**). Long rasps are used when a closed approach is performed (**Fig. 15**) Piezo rasps have 2 different grains depending on whether the bone is thick or thin, but also depending on the fineness of the overlying skin. This allows changing bone's characteristics, making the bones more malleable and flexible, allowing in some cases to pass sutures through

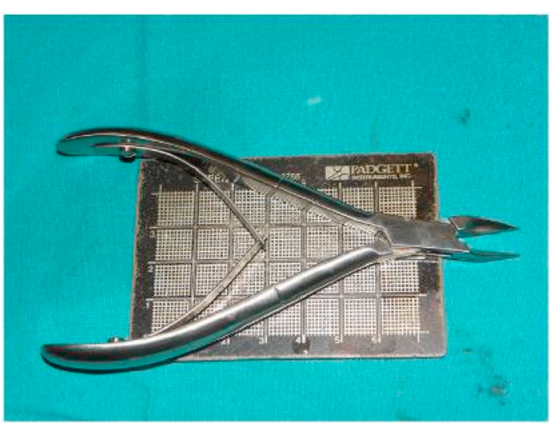

Fig. 8. Bone Nipper.

Fig. 10. Tastan fine rasp.

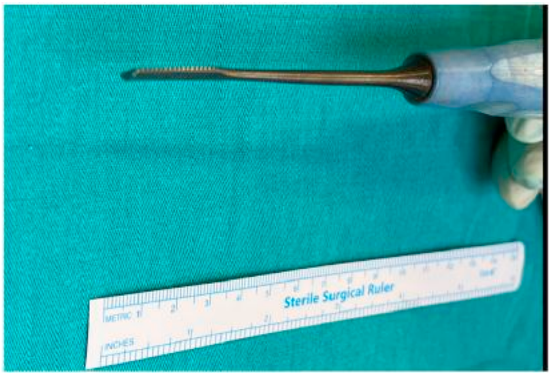

Fig. 11. Power burr.

them without completely removing the bones. Trumpet-shaped rasps are more effective than flat rasps for rhinosculpture of thick bones, especially when treating the lateral walls: they are as efficient as electric burrs.

Racy

For rasping the bone, I use 3 types of rasps.

First rasp is a rough one (for strong bone). It can be used with a rotating alternating saw (the bulldozer way). You always have to move and never stay in the same place to avoid irregularities.

The second one is the diamond rasp. Smoothing bone and cartilage.

The third one is a little one for revision surgery, or little spin.

I rarely do nasal preservation, but I can rasp a residual hump with the diamond rasp.

Zholtikov

As well as access to the bony pyramid, the use of rhinosculpture for the treatment of the dorsal hump depends on the technique of working on the dorsum. I perform rhinosculpture in almost 100% of the cases when work with the bony pyramid is necessary. When performing Dorsal Preservation and there is no need for additional modification of the dorsum, I usually perform rhinosculpture only to reduce bone thickness and asymmetries at the base of the bony pyramid, but not for the treatment of the dorsal hump. This makes it possible to prevent impairment of breathing due to inward displacement of the thick bones of the base of the bony pyramid. Conversely, in cases where I perform Dorsal Modification or Dorsal Reconstruction techniques, I almost always remove the bony cap and reduce the asymmetries on the entire surface of the bony pyramid with Ultrasound Rhinosculpture. In this case, the rougher work of removing bone thickness is done with the Scraper, and then the bone surface and keystone area is more precisely treated with flat rasps. **Figs. 16** and **17** The main advantage of Ultrasound Rhinosculpture is the ability to remove the bony cap without damaging the upper laterals, which completely eliminates the "open roof" deformity.

Question 4: Are there any limitations to this rasping technique, or does it sometimes pose difficulties? If yes, what are they, and in which cases? How do you correct and avoid these difficulties? Do you observe any differences in rasping based on the type of instruments used (mechanical, electrical, piezoelectric)?

Gerbault

The limits of rhinosculpture are excessively thin bones, where it could create a bone defect. In these cases, correcting a convexity involves osteotomies performed in 2 perpendicular axes called criss-cross osteotomies.[2] Conversely, in the case of very dense bones, the use of a scraper or trumpet-shaped rasp in the first instance allows rapid reduction of bone volume.

Mechanical rasps work perfectly, but they are most effective when bones are thin or medium. It is very challenging to reduce convexities of the sidewalls with this type of instrument. Moreover, these rasps are not selective and can damage the ULC. Electric rasps are also effective, but like mechanical rasps, they are not selective and can damage the ULC and the soft tissues.

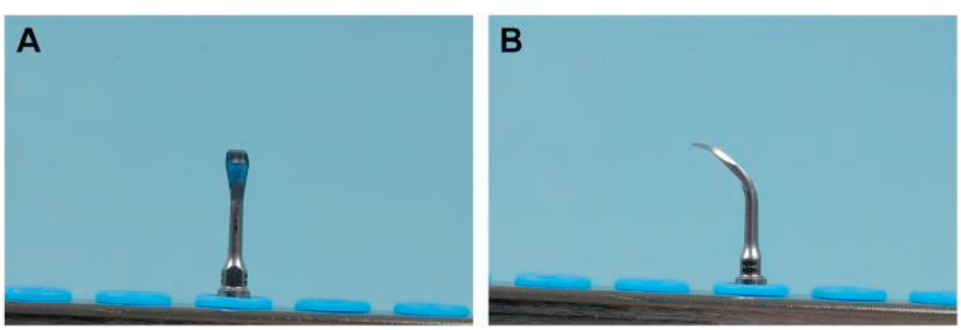

Fig. 12. (*A, B*) The scraper (RHS1).

Fig. 13. The flat rasps (RHS2H & RHS2F).

To be comprehensive, the bony cap can be effectively removed on the DKA using an osteotome. This becomes more challenging if one aims to remove the bony cap on the LKA, as it involves a curved surface. The risk is damaging the ULC, hindering preservation of the dorsum in case of DP, or impeding anatomic reconstruction of the dorsum in case of structural dorsum approach.

Ultimately, for removing a bony cap, refining bones, or correcting convexity through rhinosculpture, it seems logical to use piezoelectric instruments, which are particularly precise and only affect the bones while sparing all soft tissues, rather than electric or mechanical instruments that can damage cartilages as well as subcutaneous tissues.

Racy

I am so used to electrical rasp; I cannot imagine using other instruments. I need a little water. I have never had a burn.

Zholtikov

In some cases of severe bone thickness and dense bone tissue, using only PEI for rhinosculpture may take longer than desired. In such cases, I first use electro power instruments, in particular cylindrical or diamond burr, which allows to remove the required bone thickness very quickly, and then PEI for more precise bone processing and osteotomies with flat rasps. In all other cases, the use of PEI allows to solve almost all the problems, including rhinosculpture and all variants of osteotomies.

Question 5: Regarding lateral osteotomies: What instruments do you use (with a photo if possible)? What approach do you use for this osteotomy? Where does it start and end? Does this trajectory vary based on the appearance of the nasal pyramid or the technique used for dorsal hump correction (bony impaction or cartilaginous resection)?

Cerkes

I perform the lateral osteotomies after the medial oblique (or paramedian) and transverse osteotomies. I always do internal low to low lateral osteotomies using a 3-mm straight (without guard) osteotome (Cerkes Micro Osteotome-Marina Medical Instruments, FL-USA) (**Fig. 18**). I do not elevate the periosteum off the maxillary bone on the osteotomy line while performing the lateral osteotomy except in the cases where I do bony resection from the base of the nasal pyramid. The lateral osteotomy starts from the pyriform aperture and extends in the cephalic direction along the base of the bony pyramid. The low to low osteotomy extends up to the medial canthus level, about 1 to 2 mm medial to the medial canthal tendon to avoid damage to the tendon. The lateral osteotomy is performed as a complete osteotomy to mobilize the base of the nasal bones medially. After completion of lateral osteotomies, the bones are mobilized medially using the thumb. The hinge of the fracture is the medial oblique and transverse osteotomy line which is usually a greenstick fashion fracture.

Although I perform low to low lateral osteotomy up to the medial canthal tendon in majority of cases, in patients with a narrow upper bony vault and radix, it is not necessary to extend the lateral osteotomy up to the medial canthal tendon. In

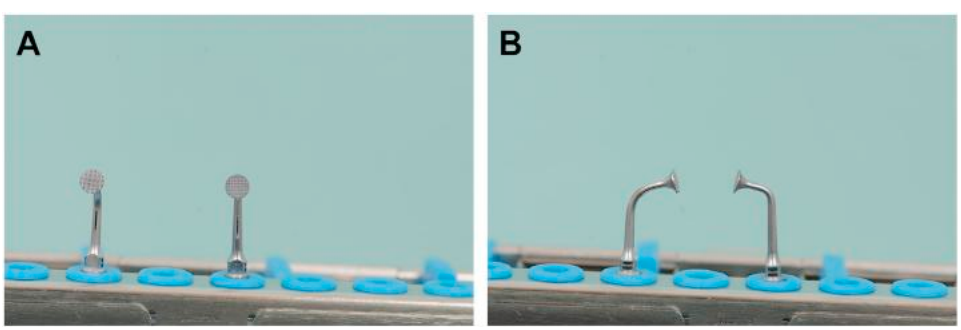

Fig. 14. (*A, B*) The trumpet rasps (RHS7H & RHS7F).

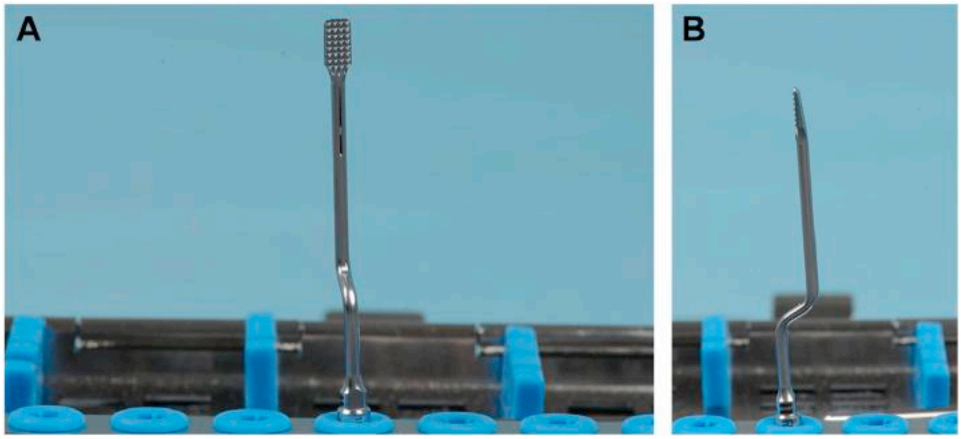

Fig. 15. (*A, B*) The long rasp (RHL2).

these types of bones, the medial oblique and/or transverse osteotomies are also placed caudal to medial canthus level in order to perform a caudal fracture line to avoid additional narrowing of the radix.

Gerbault

Lateral osteotomies are performed to narrow the width of the nasal pyramid base, which is often necessary when reducing, refining the nose, correcting a hump, or addressing asymmetry. The approach for open lateral osteotomies is usually through an extended open approach or a limited open approach to the dissection of the ascending branch of the maxilla as described in question number 2, performed if this lateral osteotomy is done alone without a planned surface modification on the dorsum. The same applies to the closed approach. These osteotomies are usually performed with rounded fan-shaped saws (RHS3R and L) (**Fig. 19**) that easily reach low on the maxilla at the Webster triangle and rise very high on the lateral wall while following the contours of the nasofacial groove. Indeed, it is mainly at the level of this natural relief where the maxillary

Fig. 16. Piezo head Scraper.

Fig. 17. Piezo head flat Rasp.

Fig. 18. Low to low lateral osteotomy with a 3-mm straight (without guard) osteotome.

bone begins to turn vertically to form the lateral wall of the nose that the lateral osteotomy is made in rhinoplasties that are not foundational DPs. It is therefore a lateral osteotomy that goes from very low to very low cranially (**Figs. 20** and **21**). The orientation of the saw defines the ease of the rotational bone movement: the more sagittal this orientation, the more easily the bone moves (**Fig. 22**). When a significant narrowing of the bony base is planned, it is preferable to perform a partial low ostectomy before completing the osteotomy to avoid the risk of obstructing the nasal fossa.

Closed lateral osteotomies are usually performed with small straight saws at the bottom (RHS5 or RSD1) (**Fig. 23**) and a long straight saw upwards (RHL5, RHL3) (**Fig. 24**).

When a foundational DP technique is performed, the path of the lateral osteotomy is different: it is more medial by about 1 cm and has a curvilinear shape upwards, to locate its cephalic part where the bone is usually less thick and without an angle between the lateral and transverse osteotomies (**Fig. 25**).

An ostectomy of the Webster triangle can be performed with a straight saw (RHS5) if the bony pyramid needs to descend more than 2 to 3 mm, to avoid obstruction of the nasal fossa (**Fig. 26**). This ostectomy can be continued upwards when one wants to significantly lower the bony pyramid or avoid any risk of obstruction, but this also increases bone instability.

Racy

I use an angulated lateral saw. It is a straight saw for a low-to-low osteotomy. For Structural rhinoplasty, the axis of sawing is horizontal to avoid a step.

The hand piece used has to be the rotating alternating saw (Bulldozer way).

For asymmetric push down, the side that has to be impacted needs a vertical cut to help the push down.

Zholtikov

I use 2 different approaches for osteotomies: Limited for Dorsal Preservation and Full Open for Dorsal Modification (DM) and Dorsal Reconstruction (DR). The lateral osteotomies are also performed differently. In Dorsal Preservation, I perform lateral osteotomies at the level of the nasofacial groove, smoothly transitioning in the area of the intercantal line cranially into transverse osteotomies without sharp angles (Banana types), most often double on each side, to remove a strip of bone and perform Let Down technique. This osteotomy technique makes it easier to perform bony impaction. In Dorsal Modification and Dorsal Reconstruction, I perform lateral osteotomies 2 to 3 mm below the nasofacial groove and thus on the ascending portion of the frontal process of the maxilla. The lateral osteotomies perform 2 to 3 mm cranial to the intercantal line, which allows giving the bony pyramid more stability and prevent excessive verticalization of the lateral walls (**Fig. 27**). In both cases, I use a PEI straight saw for the osteotomies (**Fig. 28**).

Question 6: Are lateral osteotomies with your preferred instruments sometimes a source of difficulties? If yes, what are they, and in which cases?

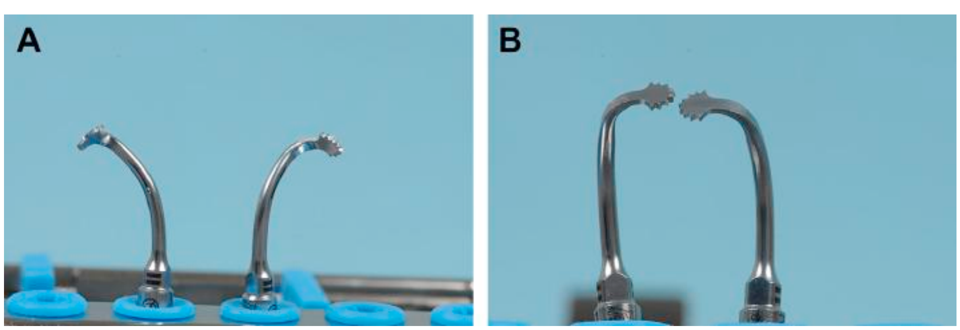

Fig. 19. (*A, B*) The fan shape saws (RHS3R & RHS3L).

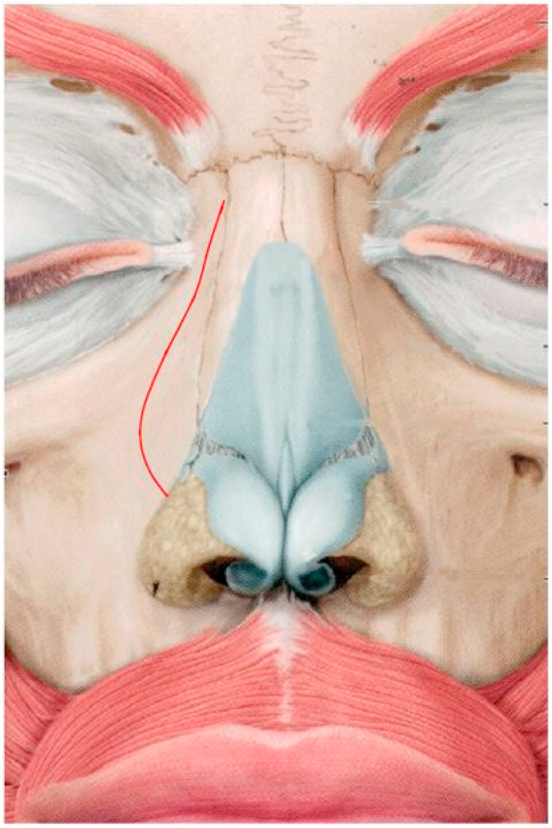

Fig. 20. Location of the lateral osteotomy except for foundation techniques.

Fig. 21. Lateral osteotomy with the fan shape saw.

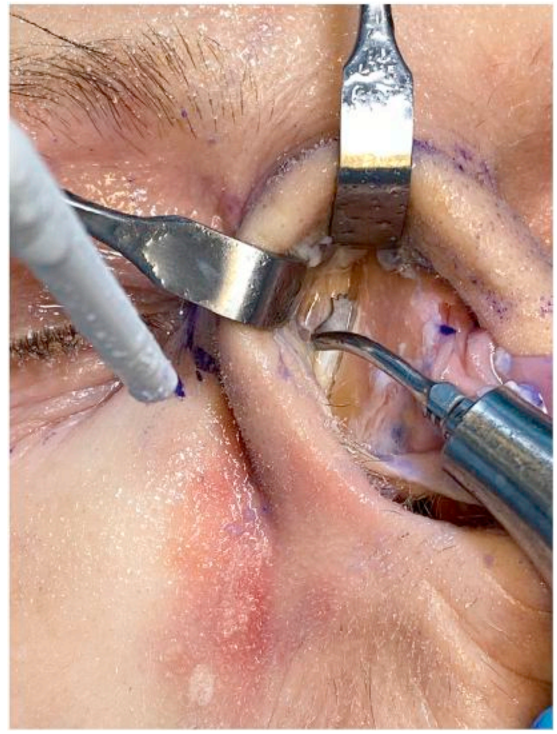

Fig. 22. Lateral osteotomy with the fan shape saw.

How do you correct and avoid these difficulties? Do you observe any differences in lateral osteotomies based on the type of instruments used (mechanical, electrical, piezoelectric)?

Gerbault

Lateral osteotomies performed with piezoelectric instruments do not cause comminution at the fracture line or radiated fractures, regardless of the characteristics of the bone. The bone is selectively cut without damaging the underlying periosteum and mucosa that maintain bone stability from below. This is fundamental to explain the differences with mechanical instruments.

The mechanical instruments use blunt force (pounding blows) to cut the bone, creating micro or macro comminutions and unintentional radiated fracture lines. These 2 phenomena depend largely on bone's characteristics but also on the quality of the osteotomes and the gestures made by the surgeon. To avoid these 2 problems, surgeons using osteotomes tend to place the osteotomy paths in positions where the bone is thinner, reducing the risk of comminution and unintentional fracture. This, however, increases bone instability and the risk of stairstep demarcation on the nasal pyramid, creating often a residual hump.

Furthermore, when mechanical instruments are used, bone stability relies on preserving a connection on the lateral walls between very loose and

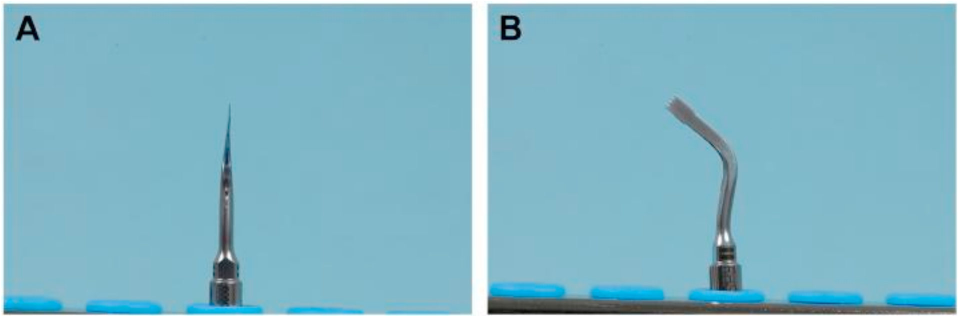

Fig. 23. (*A, B*) The straight short saw (RHS5).

mobile skin and the bones, and performing greenstick fractures between the different osteotomies. These greenstick fractures are difficult to control as they largely depend on the bone's characteristics (thickness, hardness, brittle appearance…).

Lateral osteotomies performed with electric instruments do not have this risk of comminution and radiated fracture, but the shape of the lateral saws allows only a straight fracture line ignoring the contours of the nasofacial groove, with an endonasal approach that places this osteotomy more medially than piezo osteotomies.

The use of piezo for lateral osteotomies allows easy and controlled cutting under direct vision of all types of bones, even the thickest and most brittle ones. Unlike lateral osteotomies with an osteotome, there remains elasticity of the cut bone and a more or less marked spring effect depending on the bone's characteristics, but also on the positioning of the osteotomy and the use of other osteotomies afterward. When the lateral osteotomy is done in isolation (partial osteotomy) and a spring effect persists, a graft, usually taken from the vomer, is placed at the caudal part of the fracture line to block the bone in a more internal position. This graft is called doorstop interposition graft.

Racy

I never had to use mechanical instruments for 11 years.

The learning is quite long and the cut became easy since I use the rotating alternating saw.

Zholtikov

This very lateral location of the lateral osteotomy would be virtually impossible if a conventional osteotomy were utilized. Consequently, the use of mechanical instruments, in my opinion, allows less control over the horizontal displacement of the base of the pyramid and can create excessive verticalization and asymmetries.

Question 7: Concerning paramedian or oblique medial osteotomies: What instruments do you use (with a photo if possible)? What approach do you use for this osteotomy? Where does it start and end? Does this trajectory vary based on the appearance of the nasal pyramid or the technique used for dorsal hump correction (bony impaction or cartilaginous resection)?

Cerkes

For paramedian osteotomies, I use a 2-mm delicate tip straight osteotome. I generally perform

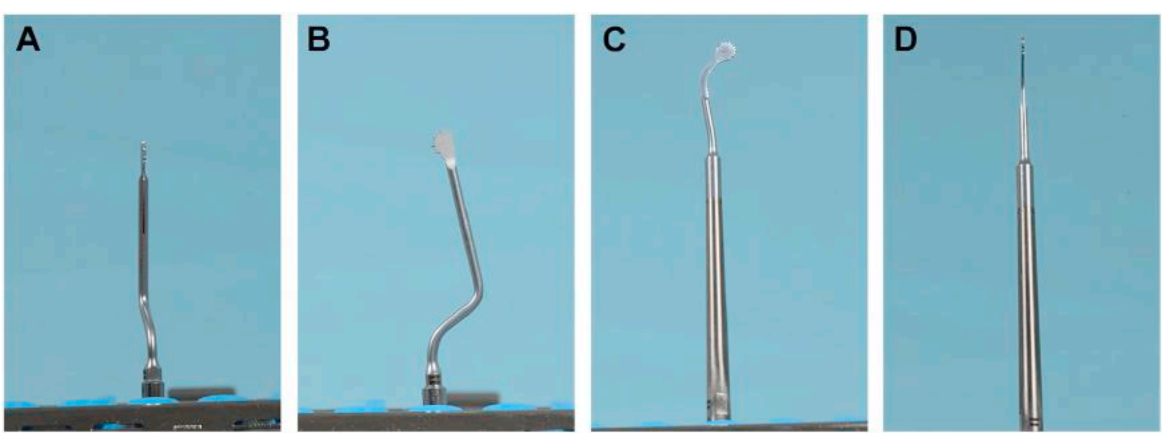

Fig. 24. (*A–D*) The straight long saws (RHL5 and RHL3).

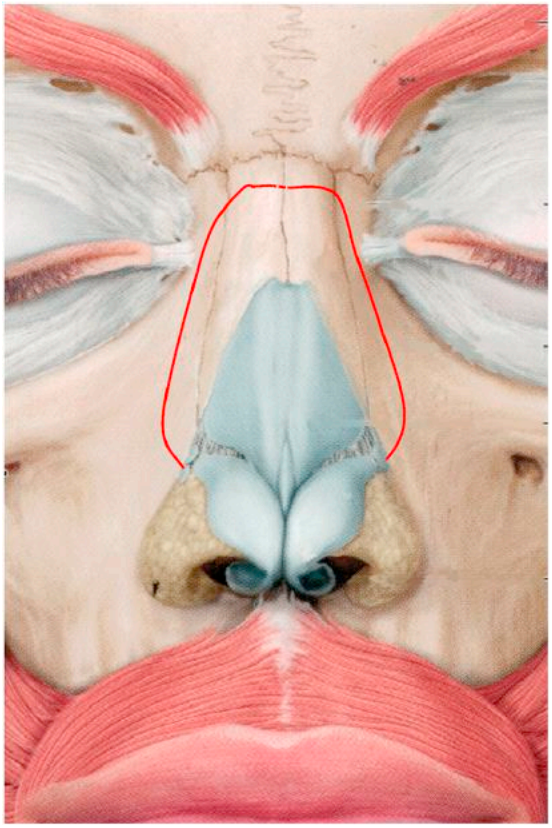

Fig. 25. Location of the lateral osteotomy for foundation techniques.

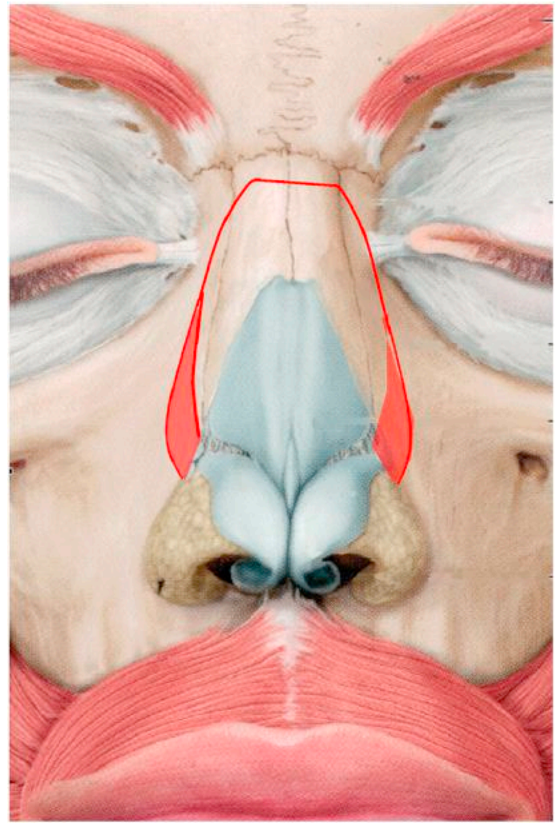

Fig. 26. Location of ostectomy for foundation techniques.

paramedian osteotomies in cases with wide bony pyramid or in cases with asymmetric bony dorsum without bony hump. The osteotomy starts from the most caudal point of the nasal bones. Location of the paramedian osteotomies will determine the width of the dorsal aesthetic lines on the bony dorsum.

For medial oblique osteotomy, I use a 4-mm specifically designed curved tip osteotome with a very sharp cutting edge (Cerkes Medial Oblique Osteotome, Marina Medical Instruments, FL, USA) (Fig. 29). This delicate tool is less traumatic to the adjacent tissues, produces less swelling compared to larger osteotomes, and does not produce heat as power instruments do. Using this tool, a controlled incomplete osteotomy can be done to perform a greenstick fashion fracture.

Medial oblique osteotomies help to define dorsal aesthetic lines while preserving the nasal bone on the radix area and prevents from the Rocker deformity. With open rhinoplasty approach, the osteotomies are performed under direct vision. The medial oblique osteotomy starts from the lateral inferior point of the remaining bony cup. The angle of the osteotomy is about 20° to 30° from the midline. The osteotomy usually continues up to the level of the medial canthus, but in cases with wide radix, it extends about 2 to 3 mm superior the medial canthus level. However, in cases with narrow radix, the osteotomy may end caudal to the medial canthus level.

When I do medial oblique osteotomy with the curved tip osteotome, I first score the osteotomy line with the tip of the osteotome, then the bone is penetrated step by step with the osteotome

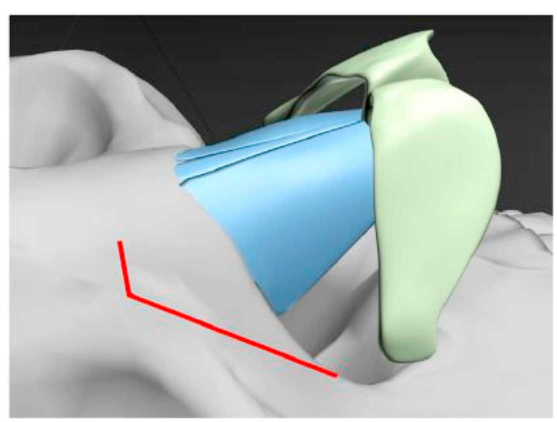

Fig. 27. Scheme of low to low lateral osteotomy and a partial length transverse osteotomy.

Fig. 28. Piezo head straight Saw.

using hand power (without using a mallet) from inferior to superior up to the level of the medial canthus (**Fig. 30**, Video 4). In most cases, I perform an incomplete osteotomy with partial penetration of the tip of the osteotome into the bone for a greenstick fracture on the osteotomy line. In cases with thick nasal bones, a mallet can be used to facilitate the osteotomy. However, to prevent the cracking of the nasal bones, careful and gentle hits should be done with the mallet. Cracking on the nasal bone can be the complication of this technique, but if the osteotomy is performed with care, it happens rarely. I have not experienced a complete fragmentation on the nasal bones in any of my cases so far.

Fig. 29. A 4-mm curved tip osteotome for medial oblique osteotomy.

Gerbault

Paramedian osteotomies are performed to reduce the width of the top of the nasal pyramid. This osteotomy is frequently necessary not only when the upper part of the pyramid is wide and cannot be reduced by simple rhinosculpture, but also when a hump is moderate or significant. I perform paramedian osteotomies (I do not use medial oblique osteotomies) after a medial or extended subperiosteal dissection of the bony pyramid, with very fine straight saws (RHS5) starting from the area of the dorsal keystone where the cartilaginous dorsal aesthetic lines (DAL) is located. The fracture line ascends vertically, diverging slightly outward (toward the medial eyebrow) as it progresses (**Figs. 31** and **32**). The end of this osteotomy is usually above the internal canthal line, at a location that is forbidden when osteotomes are used to avoid rocker deformity. Indeed, the higher this osteotomy goes, the thicker the bone, the harder it is to break with regular osteotomes or chisels, and prevents the medialization of the bone flap with this characteristic appearance of a wide remaining root.

Piezoelectric instruments, like electric instruments, are not affected by this issue because they cut very precisely through very thick bones.

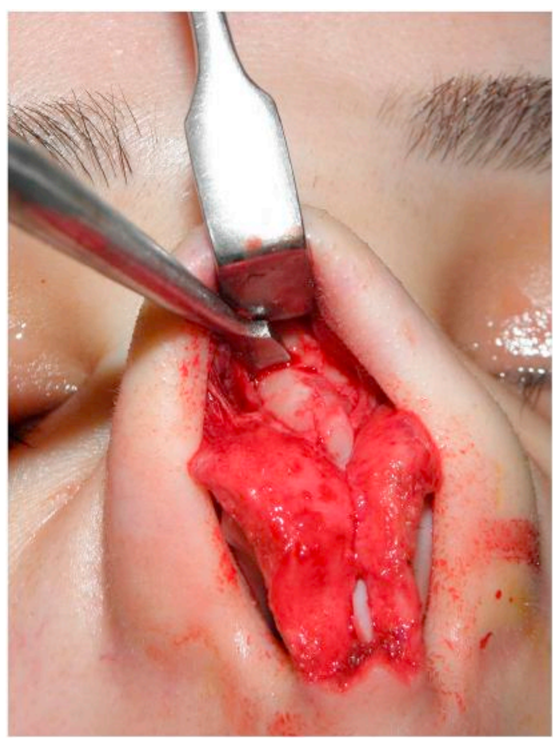

Fig. 30. Medial oblique osteotomy.

In the rare cases where the radix is very wide, this paramedian osteotomy must be a little wider, either by making a fine ostectomy with the same saw (RHS5), or by using a wider saw (RSD1) to create a larger bony defect.

Racy

After separating septum from the ULC with a 15 blade, the specific paramedian blade is introduced vertically with the rotating alternation saw (running for bottom to the top) and this is where I can break easily the blade because of the hardness of the frontonasal Beak which can be large.

If necessary, a slice of bone is cut in 1 side to help in fracturing a laterally deviated bone.

Zholtikov

For paramedian or oblique medial osteotomies, I also use the PEI straight saw. **Fig. 28** In many cases, however, I do not perform these osteotomies at all because there is no need for them. In those cases where it is necessary, such as with a wide dorsal part of the bony pyramid, I almost always perform paramedial instead of medial oblique osteotomies. Paramedial osteotomies are most often performed longitudinally from the dorsal keystone area up to the intercantal line usually 1 to 2 mm from the septum. **Fig. 33** They can be single or double on one or both sides, for example, to reduce the width of the central part of the bony pyramid or to create slots, to fix high spreader grafts in reconstructive dorsal augmentation.[9]

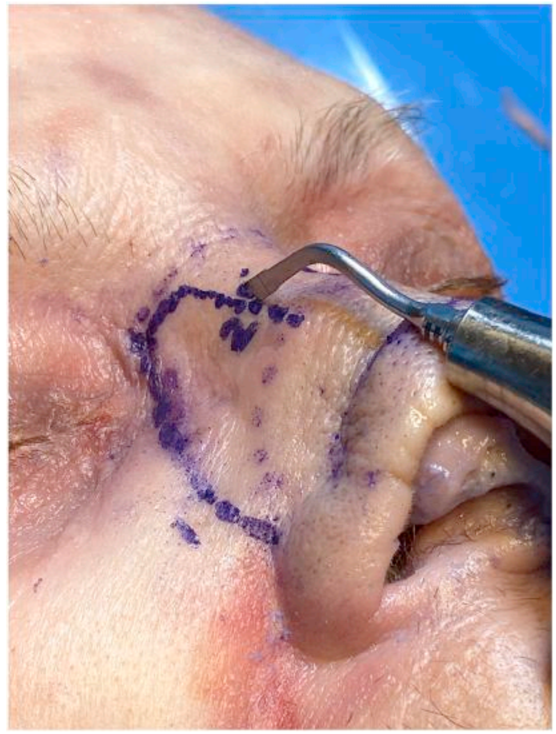

Fig. 32. Paramedian osteotomy with the straight saw.

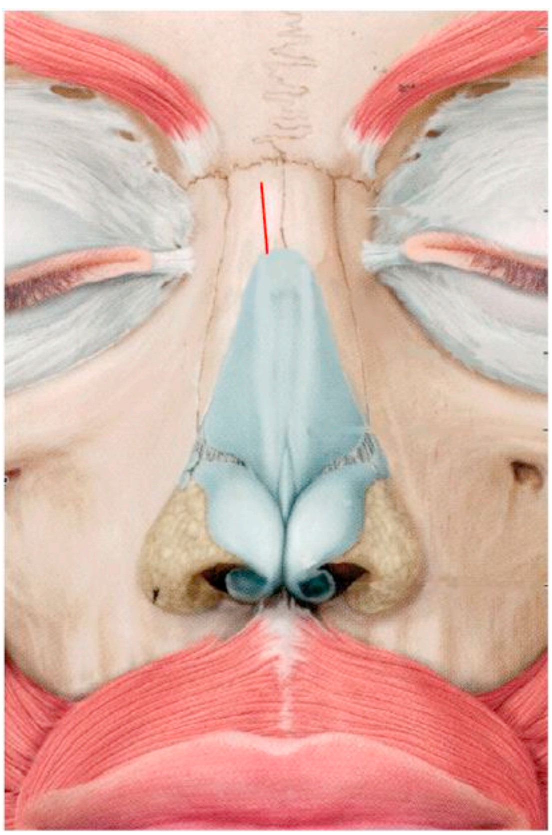

Fig. 31. Location of the paramedian osteotomy.

Question 8: Are paramedian or oblique medial osteotomies with your preferred instruments sometimes a source of difficulties? If yes, what are they, and in which cases? How do you correct and avoid these difficulties? Do you observe any differences in paramedian or oblique medial osteotomies based on the type of instruments used (mechanical, electrical, piezoelectric)?

Gerbault

The paramedian osteotomy is, for me, the most unforgiving, as the skin above it is usually thin. Well-positioned and performed with a very fine saw, preserving bone stability, this osteotomy generally does not cause problems. If its path is more lateral, especially for medial oblique osteotomies, the underlying bone support by the ULC is less. The bone fragment is then more unstable, with a significant risk of a visible stairstep deformity, which needs to be corrected by 4/0 polydioxanone sutures on either side of the osteotomy line after drilling holes with the ultrasonic drill. In case of a step deformity, the bony median fragment can also be rasped to smooth its visible edge.

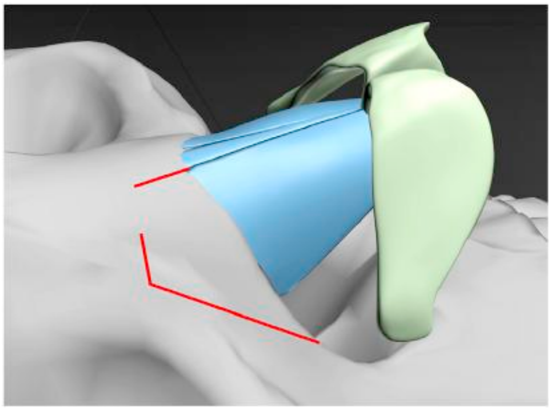

Fig. 33. Scheme of low to low lateral osteotomy and a partial length transverse osteotomy + paramedial osteotomy. However, there remains an intact bony segment between the anterior transverse and paramedial osteotomies.

Paramedian osteotomy can be combined with push-down/let-down osteotomies when the bony pyramid is wide. It is necessary not to lateralize this paramedian osteotomy, to avoid the risk of a stairstep deformity due to strong instability of the lateral wall bony flap.

Paramedian osteotomies can be performed closed using usually small straight saws at the bottom (RHS5 or RSD1), and a long straight saw upwards (RHL5).

Paramedian osteotomies can be performed with electric saws as precisely as with piezoelectric instruments. Narrow burrs or drills are sometimes used for these osteotomies, but with a more noticeable bone defect and therefore less bone stability with longer healing.

Finally, fine osteotomes are used for these paramedian or medial oblique osteotomies, but there are notable risks of radiated fractures at the caudal part (where the bone is thin), and significant risks of comminuted fractures at the cephalic part if this osteotomy is raised high. This is why it is usual to stay below the intercanthal line when osteotomes or bone chisels are used.

Split thickness osteotomies are sometimes attempted with osteotomes to avoid destabilizing the bones with the risk of uncontrolled bone sinkage creating a residual dent or hump at the level of the adjacent bone. However, they are very difficult to perform reliably without PEI because their success depends on the thickness and characteristics of the bones, and not only on the surgeon and osteotome used.

Racy

Paramedian and Transverse osteotomies are simple, but this is where the blades could break more.

Zholtikov

The use of PEI allows performing any variants of medial osteotomies very precisely and quickly without any difficulties, to remove any, even very thin strips of bone (up to 1 mm in width) in paramedial osteotomies without destroying the surrounding bony and cartilage structures, which, in my opinion, is difficult to perform precisely with conventional instruments.

Question 9: Concerning transverse osteotomies: What instruments do you use (with a photo if possible)? What approach do you use for this osteotomy? Where does it start and end? Does this trajectory vary based on the appearance of the nasal pyramid or the technique used for dorsal hump correction (bony impaction or cartilaginous resection)?

Cerkes

For transverse osteotomy, I use a 4-mm curved tip Cerkes Medial Oblique Osteotome, which is the same osteotome I use for the medial oblique osteotomy. The curved tip of the osteotome enables to perform the osteotomies internally under direct vision with a limited periosteal undermining when open approach is used. I believe that this delicate tool is the least traumatic to the adjacent tissues and very useful for transverse osteotomy. With this tool, an incomplete osteotomy can be done to perform a greenstick fracture.

The osteotomy usually starts at the superior end of the medial oblique/paramedian osteotomy. Its direction toward the medial canthus and it ends just above the medial canthal tendon (**Fig. 34**). An incomplete or complete transverse osteotomy can be performed depending on the case. The osteotomy can be performed as an incomplete osteotomy with partial penetration of the tip of the osteotome into the bone using the power of hand or a mallet. When mallet is used, the osteotomy should be done with gentle hits to avoid unwanted fragmentation of the nasal bones. In cases with

Fig. 34. Transverse osteotomy with a 4-mm curved tip Cerkes Medial Oblique Osteotome.

wide bony pyramid and asymmetric nasal bones, complete mobilization of the nasal bones is required. In this situation, a full cut (complete) transverse osteotomy should be performed instead of incomplete osteotomy using the same osteotome.

In cases with narrow radix, it is not necessary to do the transverse osteotomy at the medial canthus level or above. In such cases, the osteotomy can be placed more caudal to medial canthus to avoid additional narrowing of the radix.

Gerbault

Transverse osteotomies join lateral and paramedian osteotomies at their cephalic part (**Fig. 35**). They are necessary when the bony pyramid remains too wide despite lateral and paramedian osteotomies. Unlike the previous ones, they are simple to perform and do not create instability if performed very high on the nasal pyramid, above the intercanthal line. However, if performed too low, they can promote a depression of the bony flap with a visible stairstep deformity. These osteotomies are performed, after a generally extensive subperiosteal dissection, with very fine saws, one for the right side (RHS4L), the other for the left side (RHS4R) (**Figs. 36** and **37**). The same transverse osteotomies are performed with thicker

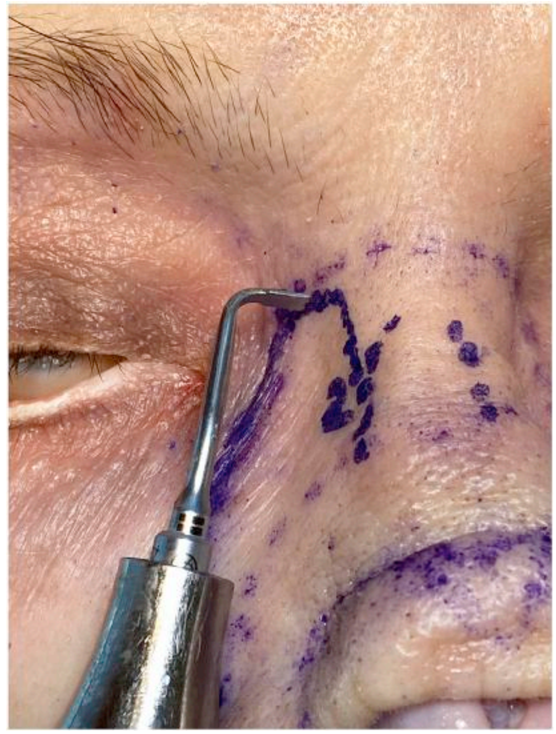

Fig. 36. The short-angled saws (RHS4R & RHS4L).

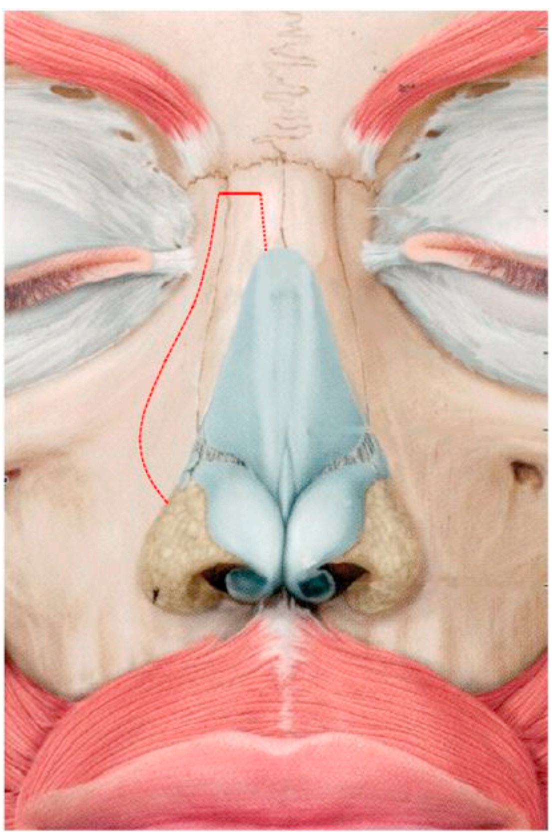

Fig. 35. Location of the transverse osteotomy.

Fig. 37. Transverse osteotomy with the angulated saw.

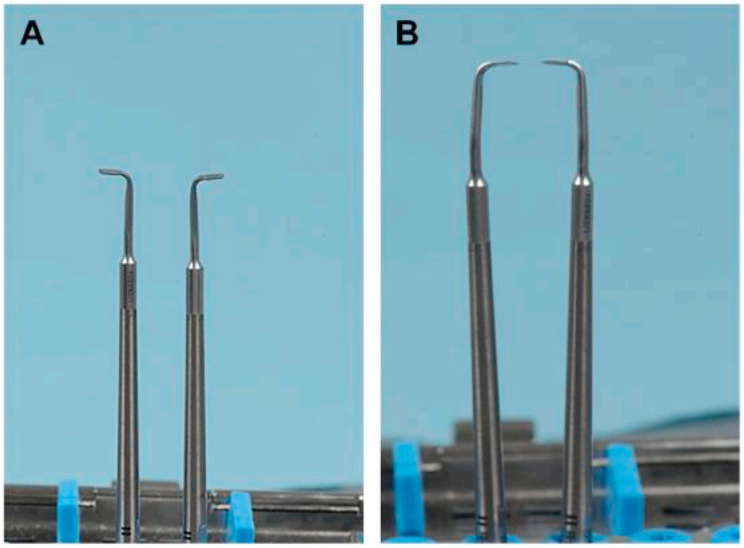

Fig. 38. (*A, B*) The long-angled saws (RHL4R & RHL4L).

saws (RHS3L and RHS3R) when more bone instability is desired, that is, in impaction bone techniques (foundation techniques). However, in these cases, the most medial part of these osteotomies is made through the non-dissected procerus muscle with fine saws (RHS4 L and R) to avoid depression of the radix. Those transverse osteotomies can be done through a closed approach with long saws (RHL4 R & L) (**Fig. 38**).

Racy

Transverse osteotomies are done with a specific oscillating hand piece for the upper part of the paramedian osteotomy to the upper part of the lateral osteotomy. It can be a complete cut or an incomplete cut for a greenstick fracture.

It is always a horizontal cut from the nasion to the anterior lachrymal crest.

Zholtikov

For transverse osteotomies, I use PEI right and left curved saws **Fig. 39**. Access, as I described earlier, depends on the dorsal technique. Limited approach for Dorsal Preservation and Full Open approach for DM and DR. In Dorsal Preservation, the transverse osteotomies continue smoothly from the lateral (Banana type) at the level of the intercanthal line and are combined with radix osteotomies on both sides. This allows mobilization of the entire nasal pyramid and bony impaction. In DM or DR, I most often perform partial transverse osteotomies that perform 2 to 3 mm more cranially than the intercanthal lines, connecting laterally with the lateral osteotomies and ending medially approximately 5 to 7 mm from the central (dorsal) part of the bony pyramid. The partial-length transverse osteotomy leaves a short

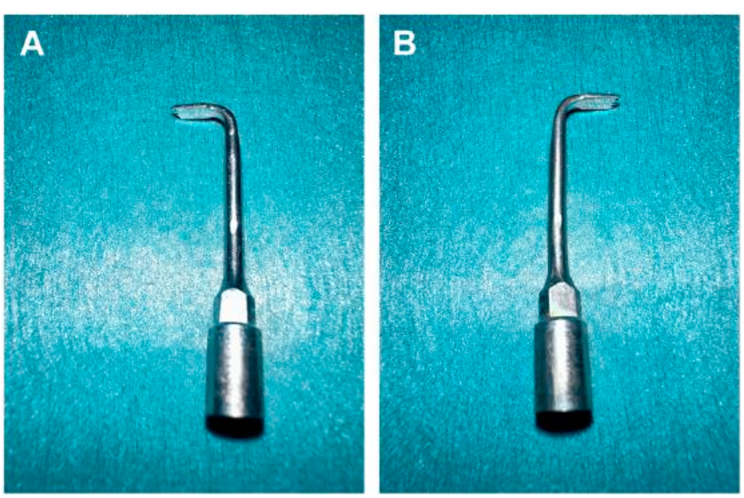

Fig. 39. (*A, B*) Piezo heads right and left curved Saws.

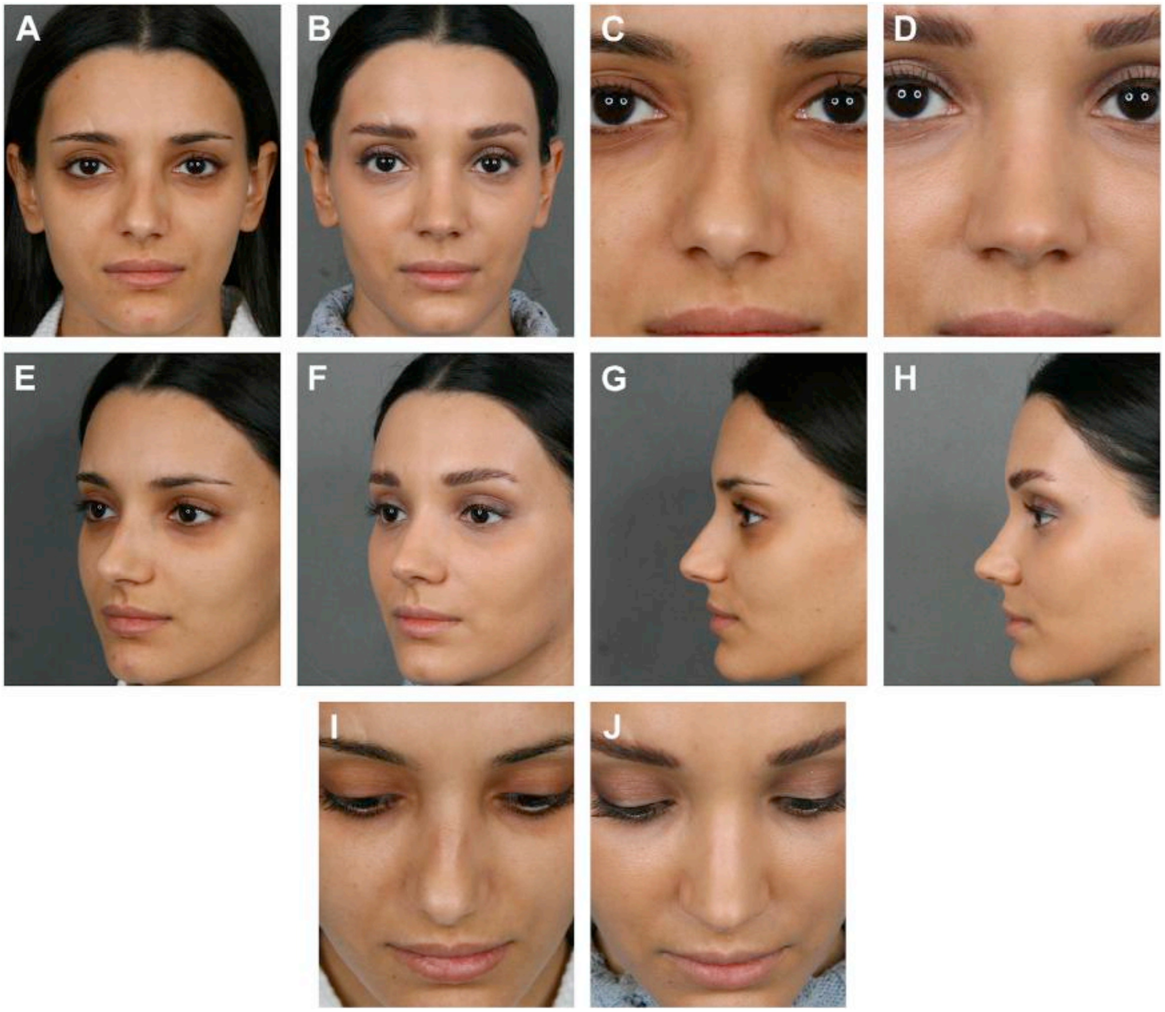

Fig. 40. This 25-year-old woman complained of having a deviated dorsum with a small hump as well as a bulbous, asymmetric tip. Following elevation of the skin envelope through an open approach, a full subperiosteal dissection of the bony vault was performed longitudinally from the keystone junction up to the radix, and transversely from one ascending frontal process of the maxilla to the other side. Then, ultrasonic RS of both sides of the bony pyramid was performed. The bony thickness was removed more from the lateral part of the bony pyramid on the left side (on the frontal process area of the maxilla) and from the medial part of the right bony side (on the area over the nasal bones). This maneuver shortened the length of the bony wall on the left side and elongated the bony wall on the right side. Next, the bony cap was removed with a piezo flat rasp and the cartilaginous vault was exposed cephalically for approximately 5 mm. Were no done osteotomies, only rhinosculpture. Then, following release of the ULCs, the dorsal septum and ULCs were lowered 2 mm. Next, elongated asymmetric pedestal spreaders (right side thinner, left side thicker) were inserted 1 mm below the ULCs and were then sutured to the septum above the spreaders. A septal extension graft was fixed between the spreaders. Lateral crura transposition with lateral crura strut grafts and tip sutures were utilized for tip reconstruction. Alar base reduction was performed to reduce alar flare. (*A, C, E, G, I*) Preoperative images; (*B, D, F, H, J*) 25 months postoperatively. RS, rhinosculpture; ULC, upper lateral cartilage.

segment of intact bone between the anterior end of the transverse osteotomy and the dorsum, thereby providing stability. This combination of osteotomies allows me to shift the bony pyramid base medially by several millimeters moving the base inward by straight elevator. In those cases in which mobilization of the lateral bony wall is inadequate, an additional paramedial or medial oblique osteotomy is performed. It should be noted that this additional osteotomy does not connect with the transverse osteotomy, and a bony bridge of at least 5 mm is maintained between them. In the cases when all of the performed manipulations were not enough to achieve symmetric and correct width of the bony pyramid, or in the cases of initially severe deviated bony pyramid when a complete osteotomy could not be avoided, then a combined lateral, transverse, and paramedial osteotomy performs, resulting in a U-shaped osteotomy.[10]

Question 10: Are transverse osteotomies with your preferred instruments sometimes a source of difficulties? If yes, what are they, and in which cases? How do you correct and avoid these difficulties? Do you observe any differences in transverse osteotomies based on the type of instruments used (mechanical, electrical, piezoelectric)?

Gerbault

Transverse osteotomies are the simplest and safest to perform as long as they are performed high enough. They can be partial or complete depending on the range of movement desired. These osteotomies are a bit more complicated to perform closed with RHL4 R and L inserts and require an extended closed approach to be performed, keeping only the central part of the nose where the procerus is respected as the only non-dissected part.

Racy

It could be difficult if the bone is very thick.

Zholtikov

Difficulties arise only with limited visibility, when using a limited approach for Dorsal Preservation, when the saw itself is not visible and the work is performed as close as possible to the dorsal part of the bone pyramid, in such cases, it is sometimes necessary to slightly widen the access to the sides for better visualization. In all other cases, difficulties arise very rarely, as the possibility of visual control allows osteotomies to be performed very precisely.

Question 11: How have your techniques in this area changed over the last 2 years?

Cerkes

In the last few years, I am using power instruments less frequently for bone reshaping. The 7-mm Tastan rasp is very delicate and powerful, and can fit into small spaces. It is a very useful tool in reshaping the nasal bones and correct irregularities on the surface of the nasal bones. Recently, I prefer it to power instruments in most cases.

Gerbault

In the last 2 years, I have used more dorsum preservation techniques (40% of cases in primary rhinoplasty). As a result, osteotomies have changed to adapt to Dorsal Preservation osteotomies. The bony pyramid was necessarily less stable in foundational techniques. I had to develop bone restabilization techniques with sutures and grafts placed in the fracture sites.

But above all, what has most changed my practice is the routine use of long piezo inserts, to perform any type of septoplasty, very precise septal resections particularly for dorsal preservation while keeping the ability of significant septal harvesting for structural use without septal destabilization, and to do more ultrasonic rhinoplasties via the endonasal route.

Racy

No changes.

Zholtikov

Over the last 2 years, I have started to use electro power instruments, particularly cylindrical or diamond burr, more frequently as the initial part of rhinosculpture to speed up the operation, especially in patients with thick bones at the base of the bony pyramid and in secondary cases. In addition, by using Dorsal Preservation and DM more frequently, the number of Dorsal Reconstruction I perform has decreased from 50% to 20% of all primary rhinoplasties (**Fig. 40**).

DISCLOSURES

Consultant for Acteon.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1016/j.fsc.2024.06.001.

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Auto-Rim Flap Technique for Lateral Crura Caudal Excess Treatment

Barış Çakır, MD; İsmail Küçüker, MD; İbrahim Alper Aksakal, MD; and Hacı Ömer Sağır, MD

Abstract

Background: There are many variables that influence nose tip harmony. Even in a rhinoplasty that appears successful in profile, one may see nostril asymmetries, alar retractions, or irregularities in the soft triangle, and patients express their dissatisfaction with these simple deformities.

Objectives: In this study, we define the ratio of caudal and cephalic excess of the lower lateral cartilage. We evaluate whether it is possible to eliminate nostril asymmetries and alar retractions by means of supporting the facet polygon with the help of a lower lateral cartilage auto-rim flap, a technique we have developed in our rhinoplasties.

Methods: The auto-rim flap was used successively on 498 primary rhinoplasty patients on whom the same surgeon operated between May 2013 and June 2015, performing marginal incisions.

Results: Of the 498 patients in the series, only 1 of the first 10 required a revision due to tip asymmetry related to the auto-rim flap. A minimal nostril asymmetry that did not require intervention occurred in 10 patients. In none of the patients could an increased alar retraction be seen postoperatively. All patients exhibited alar cartilage in the anatomically correct position.

Conclusions: With the auto-rim flap technique, a part of the caudal excess of the alar cartilage remains as a flap in the facet region; therefore, there is no need in the cephalic region to perform more of an excision than what is strictly necessary.

Level of Evidence: 4

4
Therapeutic

Accepted for publication July 25, 2016.

Rhinoplasty is a type of surgery that presents a high degree of difficulty. As surgeons develop their personal skills, they begin to assign more importance to fine details. One of the significant elements of personal development is the surgeons′ ability to judge their own results and to be up to date on techniques in order to achieve ideal results.[1]

One of the fields where rhinoplasty surgeons exhibit the greatest divergences in their work is the nose tip area. Even though surgeons have gained much greater control over the nose tip thanks to the development of open rhinoplasty techniques in the past few years, there is in fact still a need for new techniques. While developing new techniques, one should always keep in mind that surgeons will always prefer simple and effective ones.[2]

There are many variables that influence nose tip harmony. Even in a rhinoplasty that appears successful in profile view, one may see nostril asymmetries, alar retractions, or irregularities in the soft triangle, and patients express their dissatisfaction with these simple deformities. The fact that such asymmetries can be seen even with a well-practiced and well-performed tip-plasty technique leads us to think that they

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result from a cranial alar cartilage resection during which more than necessary has been resected. In our clinical practice we observed that the great width of the alar cartilage is not always related with cranial excess; in some patients this excess occurs in both cranial and caudal parts, while in others it is found isolated only in the caudal part.

The goal of this study is to define the ratio of caudal and cephalic excess of the lower lateral cartilage and to evaluate whether it is possible to eliminate nostril asymmetries and alar retractions by means of a lower lateral rim flap, a technique we have developed in our rhinoplasties.

METHODS

Aesthetic Nasal Polygons

The nose can be analyzed as aesthetic units using the concept of geometric polygons. A polygon is defined as a plane figure with at least 3 straight sides and angles. Evaluation of the nasal surface using polygons allows for the identification of shadows and highlights, which are linked to the underlying anatomic structures that can be surgically modified. Thus, the goal of surgery is to modify, rear-range, and/or reconstruct the nasal infrastructure, thereby creating nasal surface polygons that are symmetrical and aesthetically pleasing.

Working from the glabella downward, we can define the glabella polygon, the dorsal bone polygon, the dorsal cartilage triangle, the lateral bone polygons, the upper lateral polygons, the dome triangles, the lateral crus polygons, the interdomal triangle, the facet polygons, the infralobular polygon, the columellar polygon, and the footplate polygons (Figure 1). More detailed information about polygons can be found in the article "Rhinoplasty: Surface Aesthetics and Surgical Techniques."[1]

In all cases, we informed the patients about the surgical technique and received informed consent. This study was conducted in accordance with guiding principles set forth in the Declaration of Helsinki.

Classification of Lower Lateral Cartilage Excess

We examined the anterior and oblique preoperative photographs of 100 consecutive patients who wished to undergo primary rhinoplasty. These patients are also included in the following study as study subjects. All patients consulted with and were subsequently operated on by the same surgeon, and all were photographed preoperatively. Based on these photographs, we defined the ratio of the alar cartilage's caudal and cranial excess in terms of the patients' skin-cartilage relation (Figure 2). In order to describe cranial excess, we first identified the scroll line,[2] and then classified it as excess if the scroll line was positioned higher than normal. A normal scroll line is defined as such: the cranial is the projection of the medial part of the medial crura in cranial direction. A normal scroll line greatly depends on the surgeon's experience with the ideal nasal tip. During the cranial excision at least 6 mm of lateral crura must be left behind. Caudal excess is defined as the cartilage that exceeds the caudal border of the lower lateral crura, while progressing laterally in the medial direction. In the rim flap technique, we use this excess as the rim flap. However, in some cases, even though we used this excess as rim flap, there may still remain a caudal excess in the caudal part of the lateral crura, one that exceeds its lateral margin. In those cases, this lateral part is excised as caudal excess.

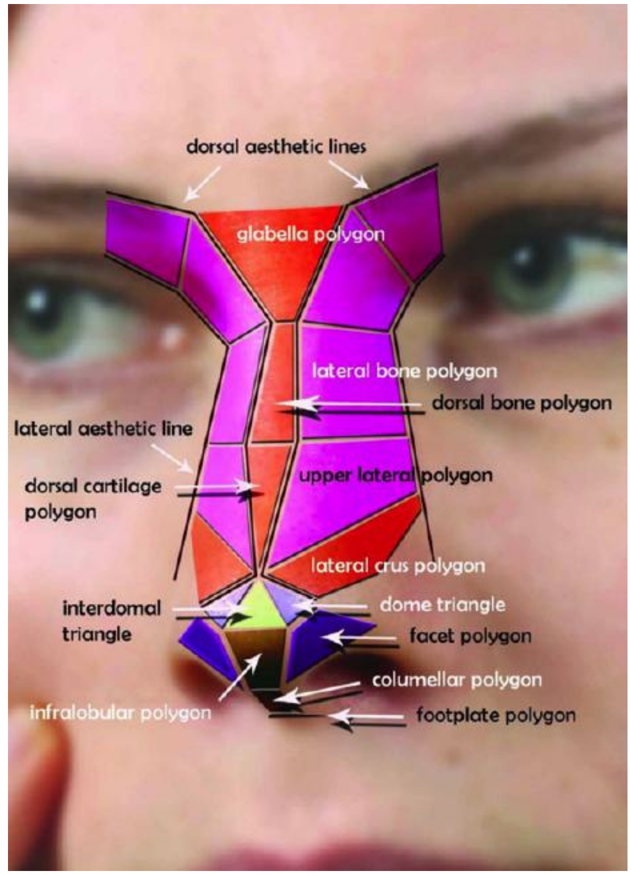

Figure 1. Illustration of aesthetic lines and polygons. Reprinted with permission from Oxford University Press.[2]

In contrast, while defining caudal excess, we examined the width of the facet polygon, and we identified it as such in those patients who had a narrowed facet polygon.[1]

Based on these data, we have classified the lower lateral crura under four groups.

- Class 1: No cephalic or caudal excess. In these patients the size of the facet polygon is adequate, and the scroll line is in the right position (2%) (Figure 3).

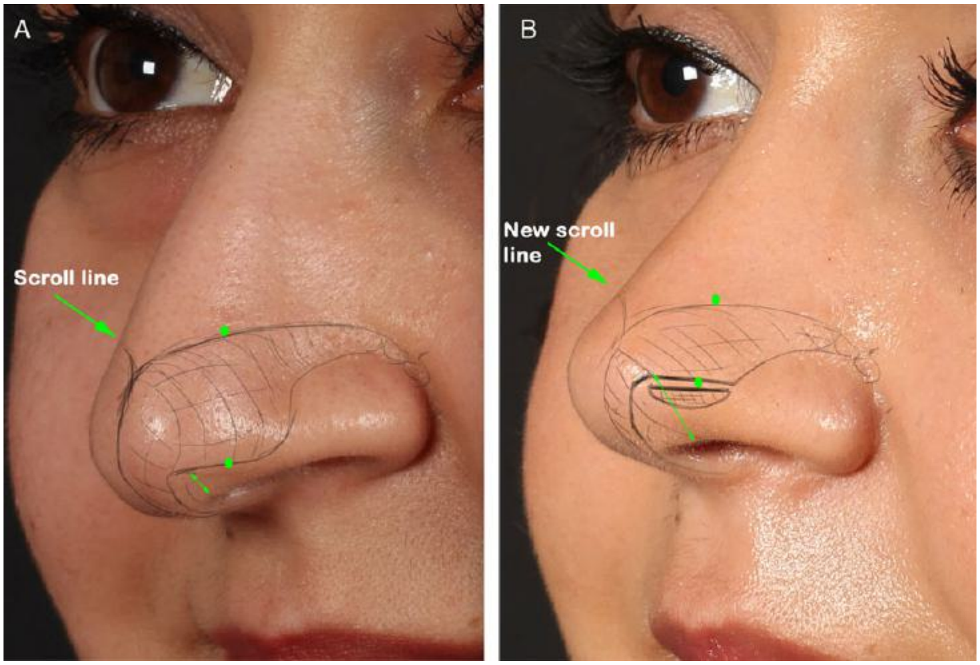

Figure 2. (A) Preoperative and (B) 6-month postoperative scroll line as demonstrated on a 28-year-old woman.

Figure 3. This 25-year-old woman is a representative Class 1 (no cephalic or caudal excess) subject.

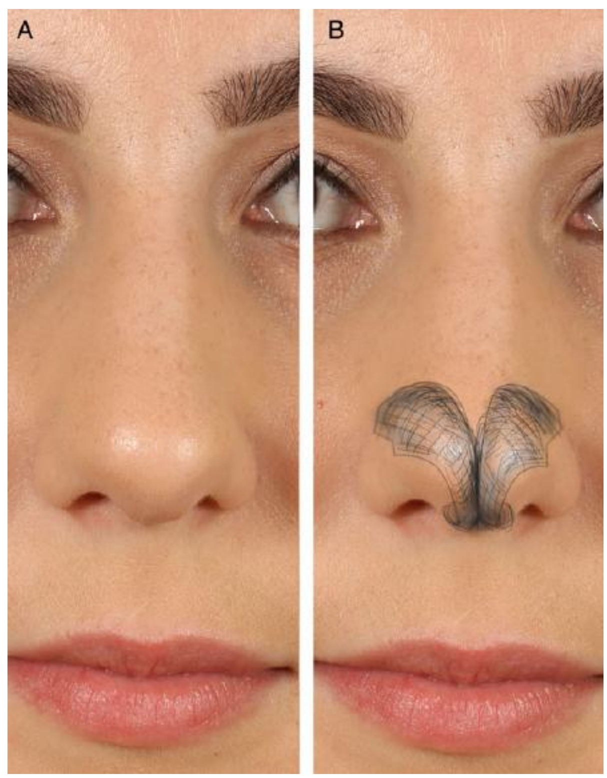

Figure 4. This 26-year-old woman is a representative Class 2 (isolated cephalic excess) subject.

Figure 5. This 25-year-old woman is a representative Class 3 (isolated caudal excess) subject.

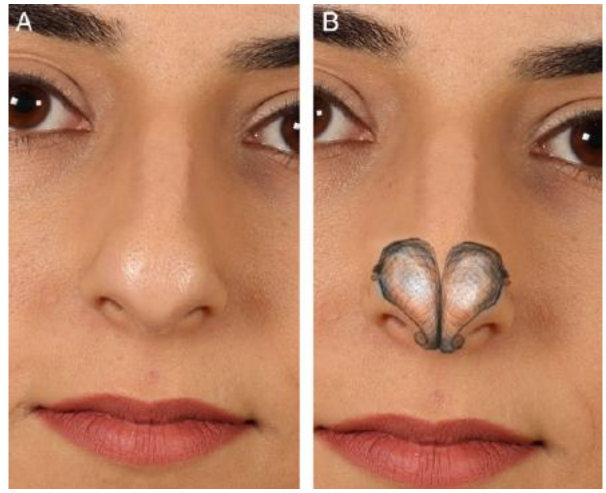

Figure 6. This 23-year-old woman is a representative Class 4 (cephalic as well as caudal excess) subject.

- Class 2: Isolated cephalic excess. The size of the facet polygon is adequate, but the scroll line is in a high position (22%) (Figure 4).
- Class 3: Isolated caudal excess. The scroll line is in the right position, but the facet polygon is narrow (18%) (Figure 5).
- Class 4: Cephalic as well as caudal excess. The scroll line is high and the facet polygon narrow (58%) (Figure 6).

Alar Auto-Rim Flap: The Surgical Technique

All surgeries were performed by the same surgeon (B.Ç.) in closed rhinoplasty technique, with a marginal incision. The fundamental aim of the auto-rim flap was to prevent the facet region from being affected by the cartilage excisions and to retain support. This was achieved by leaving part of the caudal cartilage in the skin. For leaving the cartilage in the skin, instead of an infracartilaginous incision, a straight intracartilaginous incision was applied to the lateral crura. In order to ensure a symmetrical, even incision, it is advisable to use a drawing, especially for the first cases. This cut must turn into an infracartilaginous incision 2 to 3 mm short of the dome in order to prevent nasal tip narrowing (Figure 7).

The width of the caudal cartilage piece to be left in the skin should be determined based on the amount of caudal excess. In patients with a caudal excess of more than 3 mm, a cartilage auto-rim flap of 3 mm should be left in the skin, while in patients with a caudal excess of <3 mm this should be 1 to 2 mm. A cartilage of more than 3 mm can cause bulbosity, because it will not behave like a rim flap, but like a lateral crus. Moreover, as the amount of cartilage left in the skin increases, the facet polygon will increase concomitantly. In patients who have a caudal excess in spite of a rim flap, an additional caudal resection of 1 to 2 mm from the lateral crus can be performed after the dissections. In very thin-skinned patients, instead of performing a direct resection from the lateral crus, an incision can be made and left attached to the mucosa. If necessary, this can be resected later. After this stage, one may disregard the cartilage left on the rim and continue with routine rhinoplasty. At the end of the surgery, the mucosa is closed in such a way that it does not protrude beyond the cartilage. If tightened too much, the suture will make it difficult for the rim flap to turn into the facet polygon due to the tension.

When combined with a lateral steal, the rim flap becomes an even more effective technique. With this combination, the rim flaps slide underneath the domes and support the soft triangle. In patients where a steal of more than 4 to 5 mm has been performed, the tip of the rim flap can extend beyond the lobule. In this case, the ala can be everted with a double hook and the tip of the rim flap shortened by 1 to 3 mm. If it appears too wide, the rim flap can be given a 1 to 2 mm cephalic resection with scissors. A video demonstrating the technique is available as Supplementary Material at www.aestheticsurgeryjournal.com.

Patient Series

The auto-rim flap was used successively on 498 primary rhinoplasty patients on whom the same surgeon operated between May 2013 and June 2015, performing marginal incisions. All primary rhinoplasty patients were included in this study, and only secondary ones excluded.

Based on the amount of caudal excess, a 2- or 3-mm auto-rim flap was left in the skin in all patients. On 18 thin-skinned patients, the cartilage flap was reduced to a

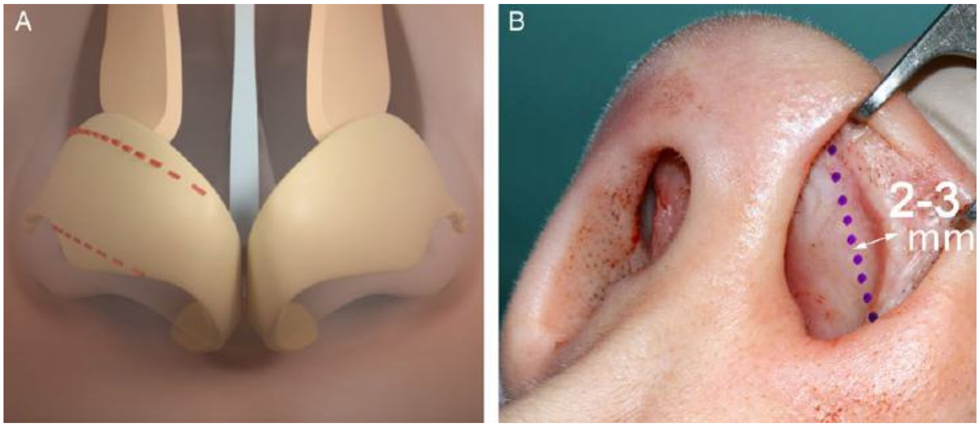

Figure 7. (A) Illustration of auto-rim flap. (B) Intra-cartilaginous incision demonstrated on a 29-year-old woman. Two to 3 mm of caudal lateral crura was left in the skin as rim flap.

Table 1. Summary

	Female ($n = 462$)	Male ($n = 36$)	Total ($n = 498$)
Mean age, years (range)	28.3 (18-56)	29.7 (18-52)	28.4 (18-56)
Average follow-up time (range)	16 mo (1 mo-3 y)	19 mo (1 mo-3 y)	16.2 mo (1 mo-3 y)
Rim flap without caudal resection	116	9	125
Rim flap with caudal resection of 1 mm	215	17	232
Rim flap with caudal resection of 2 mm	114	9	123
Rim flap with 1 mm mucosal rim flap	17	1	18

thickness of 1 mm due to the need to trim the rim flap. Regardless of the auto-rim flap, caudal resections were performed, of an additional 1 mm on 232 patients, and of an additional 2 mm on 123 patients. The surgeon saw no need for any additional caudal cartilage resection in 125 patients. In 20 of the 498 patients, an additional rim graft was required since the auto-rim flap did not provide adequate support in the lateral alar crura.

RESULTS

In this study, 498 patients undergoing rhinoplasty between May 2013 and June 2015 were investigated (462 women, 36 men). The mean age of the female patients was 28.3 years (range, 18-56 years) and the mean age of the male patients was 29.7 years (range, 18-52 years). The mean follow-up period was 16.2 months (range, 1 month-3 years). Additional demographic information is available in Table 1.

No quantitative measurements were done on patient photos, but with the help of a survey we asked all patients if they were satisfied with their nostril symmetry and alar cartilage retraction. Among the 498 patients, 10 complained about minimal nostril asymmetry, but none of them about alar retraction. Among 10 patients, only one demanded surgery to correct the nostril symmetry; the patient was treated with rim grafts to achieve the symmetry.

The average difference in the distance from the cranial point to the midline and sill was 3.2% (1%-8%) and 3.7% (1%-7%), respectively. In none of the patients could an increased alar retraction be seen postoperatively. Of the 498 patients in the series, only 1 of the first 10 required a revision, due to tip asymmetry related to the auto-rim flap. In this patient one could observe that a wider and longer rim flap had been performed on one side. A nostril asymmetry of more than 10% was detected only in 10 patients, and none of them demanded a surgical revision (Figures 8 and 9).

DISCUSSION

In one of his articles, Fomon stated: “He who masters the nose tip masters the rhinoplasty.”[3] Fomon thereby drew attention to the importance of nose tip surgery in rhinoplasty. The nose tip region, which contains the transition zones between cartilage and soft tissue, is the region where light reflections can be seen most often. Although

Figure 8. (A, C, E) Preoperative and (B, D, F) 1 year postoperative photographs of a 32-year-old woman (Class 4: cephalic as well as caudal excess) on whom 3 mm cephalic and 1 mm caudal alar cartilage excisions were done, with a 3 mm rim flap. The scroll line is lowered, nasal bulbosity is significantly decreased, and the facet polygon definition is more prominent.

many different tip-plasty techniques have been introduced, one can still observe asymmetries and retractions on the alae with these. In our opinion, the alar retractions are caused by too much cephalic resection from the lower lateral cartilage. When combining cephalic resections with additional maneuvers such as a lateral crural steal and tip sutures, the risk of encountering alar rim retractions and/or asymmetries increases as well. In the normal anatomy, the cephalic parts of the lower lateral crus and the upper lateral cartilages touch each other, and this support helps to define the position of the alar rim's arc.[4] Especially in cases where the lower lateral cartilage is wide and where a cephalic excision of more than 4 mm has been performed, the distance between the upper lateral cartilage and the cephalic parts of the lower lateral cartilages increases significantly, and the support of the

Figure 9. (A, C, E) Preoperative and (B, D, F) 1 year postoperative photographs of a 24-year-old woman (Class 4: cephalic as well as caudal excess) on whom 2 mm cephalic and 1 mm caudal alar cartilage excisions were done, with a 2 mm rim flap. A more prominent facet polygon with repositioned nasal tip with enough rim support can be observed.

upper lateral cartilages to the alar rim decreases. Particularly in medium- and thin-skinned patients, this leads to a transposition of the lower lateral crura towards the cranial and superior direction, which increases the retraction and visibility of the nostrils.

The anatomy of the lower lateral cartilages has been evaluated in a series of cadaver and live dissections performed in 2014. The clinical series demonstrated that the widest part of the lateral crus measures 7to 14 mm and that the average width amounts to 10.1 mm.[4] Another study suggests that a minimal cartilage width of 6 mm should remain in order to support the alar cartilages which in turn support the nostril.[5] In the light of this knowledge, a cartilage excision on the lateral crura of up to 7 to 8 mm turned out to be necessary in several patients. As a result of completely removing a cartilage of this size by cephalic excision, a very large gap occurred between the lateral crura and the upper lateral cartilages, and the lateral crura became malpositioned in the cephalic direction. In 1996, Gunter defined the phenomenon of alar retraction: a line is drawn between the front and back apices of the nostrils, and extending from the point where the nostril is most retracted to this line, another perpendicular line descends. The length of the latter line results in alar retraction.[6] In an ideal nose, this length should not be more than 1 to 2 mm. In a study dating to 2013, Alexander et al investigated the etiology and treatment of alar cartilage retractions. According to this study, a large portion of alar cartilage retractions are due to excessive cartilage excisions made during previous rhinoplasties; emphasis is put on the need for supporting the alar rim region so as to reduce alar cartilage retraction.[7] In order to give the nostrils structural support and prevent potential retractions, the literature has introduced various alar cartilage grafts[8-11] and flaps.[12-14]

To support the rim, Özmen et al and Gruber et al have used alar cartilage in the shape of a flap, instead of excising the cranial part of the alar cartilage. These techniques purportedly increase the strength of the alar cartilage. Yet, there is no clear evidence for their support to the rim area.[5,12] Kemaloğlu and Altınparmak in their study have shown that in patients with retracted alar cartilage, after retaining 6 mm of cartilage in the cranial part and turning the caudal part into a flap, this region can be supported by transposing this flap towards the rim.[13] This technique can only be applied in patients whose scroll line is in a normal position, since no cranial excision can be performed; moreover, because it requires fixation to the base with the help of a graft, it is a difficult surgical technique. Ercan et al introduced another flap adaptation in 2014.[14] With this technique, the integrity of the lateral crus is compromised due to the step incision to the lateral alar cartilage, and an attempt is made to support the alar rim by transposing the medial segment towards the caudal. The fundamental disadvantage of this technique is that it cannot protect the integrity of the lateral crus.

In contrast to Kemaloğlu and Ercan's technique, ours is meant to serve as prophylaxis rather than fundamental treatment. The purpose of the auto-rim flap is to prevent the loss of cartilage support to the facet polygon. Especially in cases where a lateral crural steal is performed, the natural position of the cartilage supporting the rim changes, and the facet area connected to the newly formed tip may remain empty. Since with the auto-rim flap technique the cartilage that supports this area is left underneath the skin at the beginning of the surgery, it continues to give support in the desired area. However, the method described by Özmen and Gruber also constitutes a version of the flap technique that we occasionally apply in order to strengthen the lower lateral cartilage, and it is technically possible to combine it with the auto-rim flap.

Because of social media, selfies have become very popular, and shadowing and lighting greatly determine their appearance. The facet polygon is the main region that gives shadowing to the nasal tip. In order to decrease the hollowness in this region, the facet polygon can be supported by additional cartilage, as it will increase the lighting in this area.

Grafts that can support the rim area have been described in the literature. While this graft is partly meant to reinforce the structure of the external nasal valve by increasing the strength of the lateral alar cartilage, it partly also decreases alar retraction by supporting the caudal part of the alar cartilage. Mostly alar contour grafts are employed to this end.[10,15] Yet, no matter how successful these grafts are in preventing alar retraction, problems may occur with harvesting or with their visibility underneath the skin, since anatomically they are not suitable for this area.[16] In order to preclude such problems, Gruber has suggested that the graft should be shaped to suit the anatomy.[16] However, the inserted cartilage grafts will still be much firmer than the normal anatomical structure of the lower lateral cartilage and, like every graft, will present difficulties with fixation and carry the risk of malpositioning. Grafts are prepared from similar tissues, but the rim flap is of the same tissue. Therefore, grafts will always have a higher risk of being visible and palpable. This risk is relatively small in patients with medium and thick skin, but in thin-skinned patients, if the grafts are thick and have sharp edges, the risk of visibility and palpability will be higher when performing rim flaps.

In terms of indications for the auto-rim flap, patients who do not have cephalic or caudal excess or who have isolated cephalic excess based on the structure of the lower lateral cartilage, are the most reliable group when it comes to alar wing complications (even if a rim flap is not performed). However, this group constituted only 24% of the entire population in our study—that is, 76% of our patients had caudal excess and were at risk for alar retraction. In these patients, removing the entire cartilage excess isolated from the cranial alar cartilage presents a risk for alar retraction. According to our clinical experience, a rim flap is indicated for these patients.

The patient group with a wide lateral crus related to combined cephalic and caudal excess constitutes the one most difficult to treat and with the most complications. In this context, we may discuss a sample patient with a lateral crus of 13 mm. If we decide to use a rim graft, we may choose to perform a cephalic trim of 7 mm, while leaving a lateral crus strip of 6 mm, and to support the alar cartilage by inserting a 3 mm rim graft. In addition, after leaving a 3 mm rim flap on the skin flap with the auto-rim flap technique, a 1 mm caudal resection and a 3 mm cephalic resection should be done. In this case, the 7 mm wide cartilage will have been narrowed, and a lateral crus of 6 mm remains.

While a 3 mm thick rim flap attached to the skin serves a function similar to a free rim graft of the same thickness, cartilage flaps do not carry typical risks such as harvesting or compromised contours and are technically easier to apply.[17] The rim graft technique requires the preparation of a graft and symmetrical placement. With the rim flap technique a symmetrical incision is generally sufficient to obtain a symmetrical rim flap. Since there is no need for opening a pocket in the skin, little trauma and edema occurs. As the lateral crura is convex or concave, the cephalic edge of the lateral crura is normally shorter than the midline of the lateral crura. While a cephalic resection removes only the short cephalic edge, the rim flap treats also the short caudal edge. Hence, treating the convex lateral crus is easier with a rim flap.

A beautiful nose tip must have a well-defined facet polygon or a soft triangle. The caudal edge of the lateral crus must create a clear linear highlight on the skin. This can best be seen on a photograph in diagonal view. In the age of social media, most people will often shoot selfies from an oblique angle or pose for photographs slightly diagonally. On photographs taken in low-light conditions, the polygon and lateral crus caudal highlights become particularly important. In addition to protecting the alae from retraction, the auto-rim flap forms a beautiful facet. An intracartilaginous incision made for a rim graft will lead to a linear highlight in the projection on the skin.

In isolated cephalic excisions, especially cephalic resections of more than 5 mm result in a change of the lateral crus' position towards the cephalic already during the surgery. Therefore, suturing the mucosa becomes more difficult. It may be necessary to remove the already completed sutures. Moreover, we are forced to rely on an uncontrolled secondary healing process. With the rim graft technique, since no defect forms between the lateral and the upper lateral crus, no change in the position of the lateral crus towards the cephalic will occur. Primary sutures on the mucosa will be possible. In fact, closing the mucosa will make the tip even more refined.

CONCLUSION

With the auto-rim flap technique, a part of the caudal excess of the alar cartilage remains as a flap in the facet region; therefore, there is no need to perform more of an excision from the cephalic region than what is strictly necessary. Furthermore, the flap gives the alar rim adequate support, and alar retraction can be prevented. Achieving this by means of a flap rather than cartilage grafts means that the contours will not be compromised, and the technique is easier to perform.

Supplementary Material

This article contains supplementary material located online at www.aestheticsurgeryjournal.com.

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ORIGINAL INVESTIGATION Rhinoplasty

Comparison of Dorsal Preservation Rhinoplasty Techniques: Functional and Aesthetic Review of Subdorsal Septal Strip Methods

José Enrique Barrera, MD*

Abstract

Objective: To compare subdorsal strip excisions in patients undergoing dorsal preservation (DP) rhinoplasty using patient-related outcome measures (PROMS).

Methods: Patients were treated from 2020 to 2022 using the modified subdorsal strip method (MSSM) or Z flap approach. A two-sample *t*-test determined whether there was a difference in functional and aesthetic scores using the NOSE, Sinonasal Outcome Test (SNOT-22), SCHNOS, and ESS scales.

Results: Seventy-one primary rhinoplasty patients met inclusion criteria at 12 months with an average age of 23 years (62 female, 9 male), with 35 (49%) undergoing the MSSM technique, while 36 (51%) receiving the Z flap. PROMS at 1, 3, 6, and 12 months postoperatively were compared. The average preoperative and postoperative NOSE score was 9.36 and −4.4 (standard deviation [SD] 3.1, $p < 0.001$). The average preoperative SNOT-22 score was 23.9 and −16.4 (SD 10.2, $p < 0.001$). ESS scores was average was 6.2 and −1.6 (SD 3.2, $p = 0.01$). The average SCHNOS total, functional, and cosmetic scores were 27.6 (6–47), 8.2 (0–20) and 18.7 (0–37), respectively, and −5.7 (SD 8.2, $p < 0.001$), −5.73 (SD 6.24, $p < 0.001$), −18.1 (SD 9.7, $p < 0.001$). No significant complications were found and no difference in PROMs among groups.

Conclusion: There was no difference in septal strip techniques as evaluated by PROMS.

Introduction

Dorsal preservation rhinoplasty shares a long history with structural rhinoplasty going back to Dr. Goodale's first publication.[1] The surgical technique first published addressed the dorsum by removing septal cartilage and bone and combining the operation with osteotomies. The contemporary of the Goodale technique is applied in modern dorsal preservation modifications of the modified subdorsal strip method (MSSM) and Z flap strip methods. The high-strip surgical technique was popularized by Lothrop and Cottle.[2–5] Further refinement of the high subdorsal strip technique has been published by Saban.[5] In regards to foundation principles addressing the ascending process of the maxilla and nasal bones, a wedge resection incorporated into the lateral osteotomy and transverse osteotomy has formed the basis for let-down dorsal preservation.[6,7]

Several authors have published their respective design and aesthetic outcomes with success using high-, mid-, and low-strip septal methods in patients presenting for dorsal preservation rhinoplasty.[8–13] A paucity in the literature exists in validating by patient-related outcome

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KEY POINTS

Question: Does a difference exist in septal strip methods after preservation rhinoplasty as measured by patient-related outcome measures?

Findings: There is no difference among dorsal preservation patients undergoing a Z flap versus MSSM technique at 1, 3, 6, and 12 months postoperatively.

Meaning: Subdorsal strip methods in dorsal preservation rhinoplasty can achieve improvement in functional and aesthetic patient reported outcomes.

measures (PROMS) of these techniques. Our study aims to compare septal strip methods in patients undergoing dorsal preservation rhinoplasty as measured by Nose Obstruction Symptom Evaluation (NOSE), SNOT-22, Epworth Sleepiness Scale (ESS), and Standardized Cosmesis and Health Nasal Outcomes Survey (SCHNOS) scores.

Methods

Dorsal preservation techniques using a mid-strip approach to the septum via the MSSM or Z flap approach were compared. All patients underwent let-down boney strip maneuvers. The age range included patients from 14 to 68 years old. Forty-five outcome measures were assessed including the NOSE, Sinonasal Outcome Test (SNOT-22), SCHNOS, ESS, and standardized before and after photographs preoperatively and at 1, 3, 6, and 12 months.[14–17] IRB approval was obtained. The surgical technique used has been previously published.[18]

Septal incisions can be performed with either a modified subdorsal strip method (MSSM) (Fig. 1A) or a modified Z flap incision (Fig. 2A). The subdorsal strip as published by Most[12] was compared to a modified Cottle method popularized by Kovacevic.[13] In this study, patients were consecutively evaluated and treated with these techniques. In total 71 patients were retrospectively studied, 35 MSSM patients and 36 Z flap patients, after completing their PROMS before and after surgery.

Results

A retrospective review of 71 primary rhinoplasty patients who underwent dorsal preservation was included. Of

Fig. 1. (A–L) Sixteen-month follow-up after modified subdorsal technique. Overall percent improvement and average change in patient reported NOSE (10–2), SNOT-22 (37–2), SCHNOS (32–0), and ESS (4–2) scores. ESS, Epworth Sleepiness Scale; NOSE, Nose Obstruction Symptom Evaluation; SCHNOS, Standardized Cosmesis and Health Nasal Outcomes Survey; SNOT-22, Sinonasal Outcome Test.

these, 35 patients underwent the MSSM technique, while 36 patients underwent the Z flap technique with available data to report PROMS postoperatively at 1, 3, 6, and 12 months within a range of up to 36 months of follow-up from initial enrollment (Table 1). A two-sample t test was used to assess the significance when comparing 45 PROMS associated with the NOSE, SNOT-22, SCHNOS, and ESS scores at 12 months. There was no significant difference in the technique used. The aesthetic components of the SCHNOS score demonstrated cosmetic improvement at 12 months (Table 2).

Functional outcomes were measured using the NOSE and SNOT-22 forms. NOSE scores were collected in 71 patients. The average (range) preoperative NOSE score was 9.36 (0–20). NOSE scores were noted at the last 12-month follow-up mean (range) 3.22 (3–36) months. NOSE scores at the last follow-up showed 69% of all patients reporting an improvement in score for an overall mean improvement of −4.4 at 12 months (standard deviation [SD] 3.1, $p<0.0015$). There was no difference between the MSSM and the Z flap technique with 69% improvement in MSSM and 67% improvement in the Z flap technique at 12 months. SNOT-22 scores were collected in 67 patients. The average (range) preoperative SNOT-22 score was 23.9 (0–67). SNOT-22 scores were noted at last follow-up mean (range) 12 (3–36) months. SNOT-22 scores at last follow-up (12 months) showed that 86% of all patients reported an improvement in the score for an overall mean improvement of −16.4 (SD 10.2, $p<0.0002$). There was no difference in the functional or cosmetic components of the SCHNOS when comparing the MSSM with the Z flap technique.

An overall improvement of 77% and 100% in total SCHNOS scores, respectively, at 12 months.

The ESS was used to evaluate sleep symptomatology. ESS scores were collected in 60 patients. The average (range) preoperative ESS score was 6.2 (0–20). ESS scores were noted at last follow-up mean (range) 12 (3–36) months. ESS scores at last follow-up showed 72.0% of all patients reported an improvement in score for an overall mean improvement of −1.6 (SD 3.2, $p=0.01$) at 12 months and mean improvement of −2.7 (SD 4, $p<0.0001$) at 6 months. There was no difference in the functional or cosmetic components of the ESS when comparing the MSSM with the Z flap technique.

SCHNOS scores were employed to evaluate functional and psychosocial outcomes in 37 patients. The average (range) preoperative SCHNOS total, functional, and

Fig. 2. (A–L) Fourteen-month follow-up after modified Z flap technique. Overall percent improvement and average change in patient reported NOSE (13–2), SNOT-22 (43–7), and SCHNOS (37–0) and ESS (10–7) scores.

Table 1. Patient demographics and concurrent surgical procedures

Patients (n)	*71*
Age years (range)	23 (17–64)
Male (n)	9
Female (n)	62
Follow-up months mean (range)	12 (36)
Surgical procedures n (%)	
MSSM	35
Z flap	36
Complications n (%)	
Residual hump	2 (2.8)
Axis deviation	1 (1.4)
Tip deviation	1 (1.4)
Warping of grafts	0 (0)
Loss of midvault height	0 (0)
Radix drop	0 (0)

MSSM, modified subdorsal strip method.

cosmetic scores were 27.6 (6–47), 8.2 (0–20), and 18.7 (0–37), respectively. SCHNOS scores were noted at last follow-up mean (range) 5.7 at 12 months (3–36). SCHNOS scores for the total, functional, and cosmetic domains at last follow-up showed an improvement that reported to be 93%. For total, functional, and cosmetic SCHNOS scores an overall mean improvement of −5.7 (SD 8.2, $p<0.001$), −5.73 (SD 6.24, $p<0.001$), and −18.1 (SD 9.7, $p<0.001$) (Table 2). There was no difference in the functional or cosmetic components of the SCHNOS when comparing the MSSM with the Z flap technique with an overall improvement of 92% and 100% in total SCHNOS scores, respectively, at 12 months.

Discussion

In a consecutive series of dorsal preservation rhinoplasty patients, those treated with a high-strip Z flap compared to those treated with an MSSM showed similar results as measured by NOSE, SNOT-22, ESS, and SCHNOS. The ordinal and paired cohort evaluated the septal strip excision using these two techniques. The data demonstrate an improvement in PROMS for NOSE, SNOT-22, ESS, and SCHNOS scores with 12-month median (36 month range). The surgical techniques employed had similar results. Patients demonstrated even greater improvement in aesthetic result as noted by the SCHNOS cosmetic score having a greater delta drop (−18 points) versus functional (−5.7), $p<0.001$.

Table 2. Pre- and postoperative patient reported outcome measures

	n	*Follow-up (range) months*	*Mean score (SD) pre-op*	*Mean score (SD) delta*	*p*
NOSE	71	12 (3–36)	9.36 (0–20)	−4.4 (3.1)	<0.001
SNOT-22	67	12 (3–36)	23.9 (0–67)	−16.4 (10.2)	<0.001
ESS	60	12 (3–36)	6.2 (0–20)	−1.6 (3.2)	= 0.01
SCHNOS	64	12 (3–36)	27.6 (6–47)	−5.73 (8.2)	<0.001
SCHNOS-O			8.2 (0–20)	−5.73 (6.24)	<0.001
SCHNOS-C			18.7 (0–37)	−18.1 (9.7)	<0.001

ESS, Epworth Sleepiness Scale; NOSE, Nose Obstruction Symptom Evaluation; SCHNOS, Standardized Cosmesis and Health Nasal Outcomes Survey; SNOT-22, Sinonasal Outcome Test; SD, standard deviation.

When compared to other reports in the literature, similar findings were achieved in a smaller cohort of dorsal preservation rhinoplasty patients.[19,20] These findings are consistent with and extend those from prior reports.

The implication of this study shows that subdorsal strip techniques are effective in improving functional and aesthetic outcomes. In this study, the let-down boney technique was used in all patients. However, when comparing push-down versus let-down osseous techniques, it has been postulated that impacting nasal bones into the pyriform aperture could lead to increased airway obstruction.[21] It would be useful to evaluate surface techniques with similar methodology.[22]

NOSE and SNOT 22 scores showed reduction in patient's overall symptom burden at last follow-up. Patients often report to us how their nose affects their overall sleep quality, and we applied the ESS to help measure sleepiness and not as a measure of obstructive sleep apnea. Sleepiness is a measure of across multiple PROMS and is a common symptom of patients presenting for rhinoplasty. Functional and psychosocial outcomes were measured using the SCHNOS scale.

The authors recognize the average 12-month follow-up as a limitation. It is widely held that 12-month follow-up is an evaluation point for rhinoplasty and not the end point. Given the improvement of PROM scores and the difficulty obtaining an ordinal cohort for comparison, 71 patients met inclusion criteria (35 in the MSSM and 36 in the Z flap group). Complications were limited to residual hump in two patients (2.8%) with only one patient requiring revision, axis deviation in one patient (1.4%) which did not completely resolve with the technique and tip deviation (1.4%) in a patient with preexisting tip deviation. Additionally, this represents a relatively small cohort and a single surgeon's experience. Larger investigations across multiple institutions and varied surgical practices would yield more robust results. Allergy, inferior turbinate hypertrophy, and sleep apnea were not assessed during this study. Patients presenting with concomitant septal deviations and nasal valve incompetence were evaluated using nasal endoscopy and modified Cottle maneuver and treated as part of their rhinoplasty surgery. Finally, there was attrition due to loss of follow-up with a follow-up range of 36 months. The 12 months minimum postoperative follow-up was felt to be sufficient to report these data.

Conclusion

PROMS related to aesthetic and functional results after dorsal preservation rhinoplasty are a critical next step in reporting the outcomes. Among patients undergoing preservation rhinoplasty, those having an MSSM compared to Z flap subdorsal septal cartilage technique demonstrated improvement in nasal obstruction outcomes, sinonasal outcome measures, ESS, and SCHNOS scores.

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Authors' Contributions

J.E.B. was the primary surgeon for all of the surgeries. J.E.B. collected and analyzed the data, and wrote the material in this submission. The senior author has reviewed and approved the final submission content.

Author Disclosure Statement

No competing financial interests exist.

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Featured Operative Technique

Surface Aesthetics in Tip Rhinoplasty: A Step-by-Step Guide

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Abstract
Tip rhinoplasty is a key component of aesthetic rhinoplasty. An understanding of the correlation between tip surface aesthetics and the underlying anatomic structures enables proper identification and correction of tip abnormalities. Surface aesthetics of the attractive nose are created by certain lines, shadows, and highlights with specific proportions and breakpoints. In this Featured Operative Technique, the authors describe a stepwise process for tip rhinoplasty that conceptualizes aesthetic subunits as geometric polygons to define the existing deformity, the operative plan, and the aesthetic goals. Tip rhinoplasty is described in detail, from initial markings through incisions and dissection. The autorim graft concept is explained, and lateral crural steal and footplate setback techniques are described for the attainment of symmetric domes with correct lateral crural resting angles. Methods in columellar reconstruction are described, including creating the columella (C′) breakpoint and the infralobular caudal contour graft. The principal author (B.Ç.) has applied these techniques to 257 consecutive "polygon rhinoplasties" over the past 3 years.

Keywords
rhinoplasty, nasal surface aesthetics, nasal aesthetic polygon, lateral crural resting angle, cephalic dome suture, autorim graft, infralobule caudal contour graft

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Nasal tip surgery is a critical step in aesthetic rhinoplasty. A disfigured nasal tip results in a poor surgical result, even in an otherwise attractive nose. Therefore, an understanding of aesthetic tip procedures and the correlation between tip surface aesthetics and underlying anatomic structures is mandatory for any rhinoplasty surgeon. The aesthetically pleasing nasal tip is a composite of lines, shadows, and highlights with specific proportions and breakpoints that can be conceptualized as a series of geometric forms. Specifically, the nasal tip includes the dome triangles, the lateral crus polygons, the interdomal triangle, the facet polygons, the infralobular polygon, the columellar polygon, and the footplate polygons (Figure 1).[1] In this Featured Operative Technique, we describe "polygon rhinoplasty," in which precise nasal tip proportions and breakpoints are considered to define an operative plan and create the desired aesthetic result.[1]

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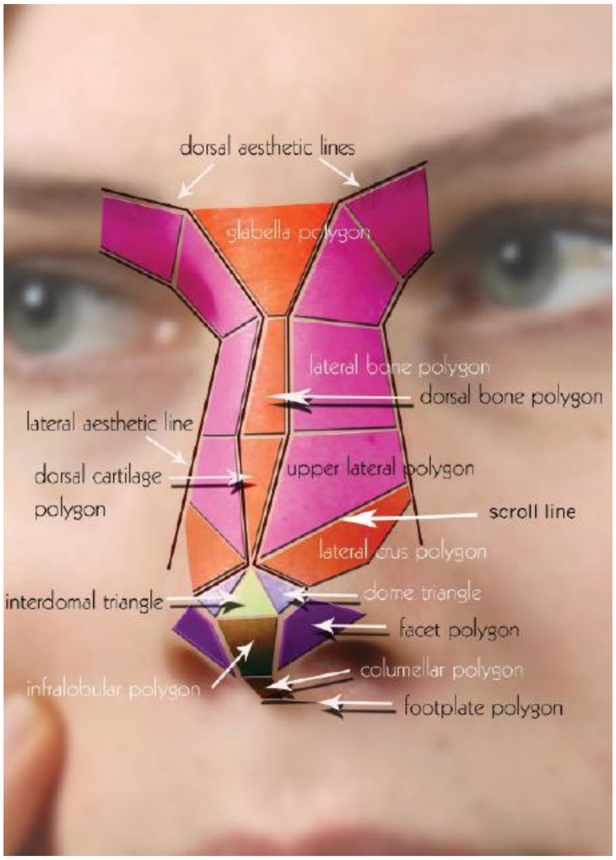

Figure 1. Nasal surface aesthetics can be analyzed in terms of these geometric shapes: glabella polygon, dorsal bone polygon, dorsal cartilage triangle, lateral bone polygons, upper lateral polygons, dome triangles, lateral crus polygons, interdomal triangle, facet polygons, infralobular polygon, columellar polygon, and footplate polygons. From Çakır et al.[1] Reprinted with permission from Sage Publications.

GEOMETRIC FORMS COMPRISING THE NASAL TIP

The aesthetic nasal tip can be conceptualized as a series of polygons delineated by precise breakpoints. An understanding of the relative sizes and proportions of these aesthetic subunits in the attractive nose enables the surgeon to define an operative plan for any rhinoplasty case.

The Lateral Crus Resting Angle

The scroll line is a groove indicating the transition from the upper lateral polygon to the lateral crus polygon (Figure 1).[1] The scroll junction between the upper lateral cartilage and the lateral crus marks the transition from the static nasal body to the dynamic nasal tip.[2] The grooves over the scroll area should meet in the center to create a supratip breakpoint corresponding to the common apices of the dome triangles and the interdomal triangle.

The positions of the lateral crura can be defined in 2 planes.[1] The first is the longitudinal axis of the lateral crus, which represents the divergence of the lateral crus relative to the contralateral lateral crus, that is, the intercrural angle. In its correct position, the longitudinal axis of the lateral crus intersects the lateral canthus of the ipsilateral eye. The second plane is the axial rotational position of the lateral crus, which gives rise to the lateral crural resting angle (Figure 2).[1] With the normal lateral crural resting angle, the lateral crus lies almost in a horizontal plane, with the cephalic margin slightly superior to the caudal margin. When the cephalic edge is considerably more superior than the caudal edge, structure and aesthetics may be negatively affected.[3] The resting angle of the lateral crura must be considered in tip surface aesthetics. A resting angle of 100° or less creates a well-defined scroll groove. Lateral crura with an abnormal resting angle (> 100°) lack a scroll groove and present with excessive fullness in the supratip region, suggesting cephalic malpositioning of the lower lateral cartilages (LLC). This phenomenon is described as pseudocephalic malposition of the lateral crura.[1] A resting angle of 180° or more results in medialization of the cephalic border of the lateral crus vs the upper lateral cartilage, creating a "pinched nose" appearance (Figure 2).

The Nasal Tip Diamond

Our concept of tip surface aesthetics involves 2 dome triangles, an interdomal triangle, a pair of facet polygons, and an infralobular polygon. Together, these components create a diamond-shaped highlight effect when photographed by a standard 2-flash technique on frontal view (Figure 3).[1] Proper creation of this diamond-shaped reflection is characteristic of an aesthetic result following tip surgery.

Defining Breakpoints of the Nasal Tip

The oblique and lateral views of the nose reveal important break points at the tip surface that precisely define the tip polygons. These include the superior tip (T_s), the inferior tip (T_i), the medial rim (R_m), and the lateral rim (R_l) (Figure 4).[1] T_s corresponds to the combined vertices of the dome triangles. The T_i points correspond to the inferomedial corners of the dome triangles, hence the 2 inferolateral vertices of the interdomal triangle. These points should be positioned in the same vertical plane in the lateral profile view to create an aesthetically pleasingly shaped tip. The R_m and R_l points represent the medial and lateral ends of the lateral crura at the caudal border, respectively (Figure 4).

The Dome and Interdomal Triangles

The dome triangles are a pair of isosceles triangles between the T_s, T_i, and R_m points, and the base of each triangle is in contact with the facet polygons.[1] The

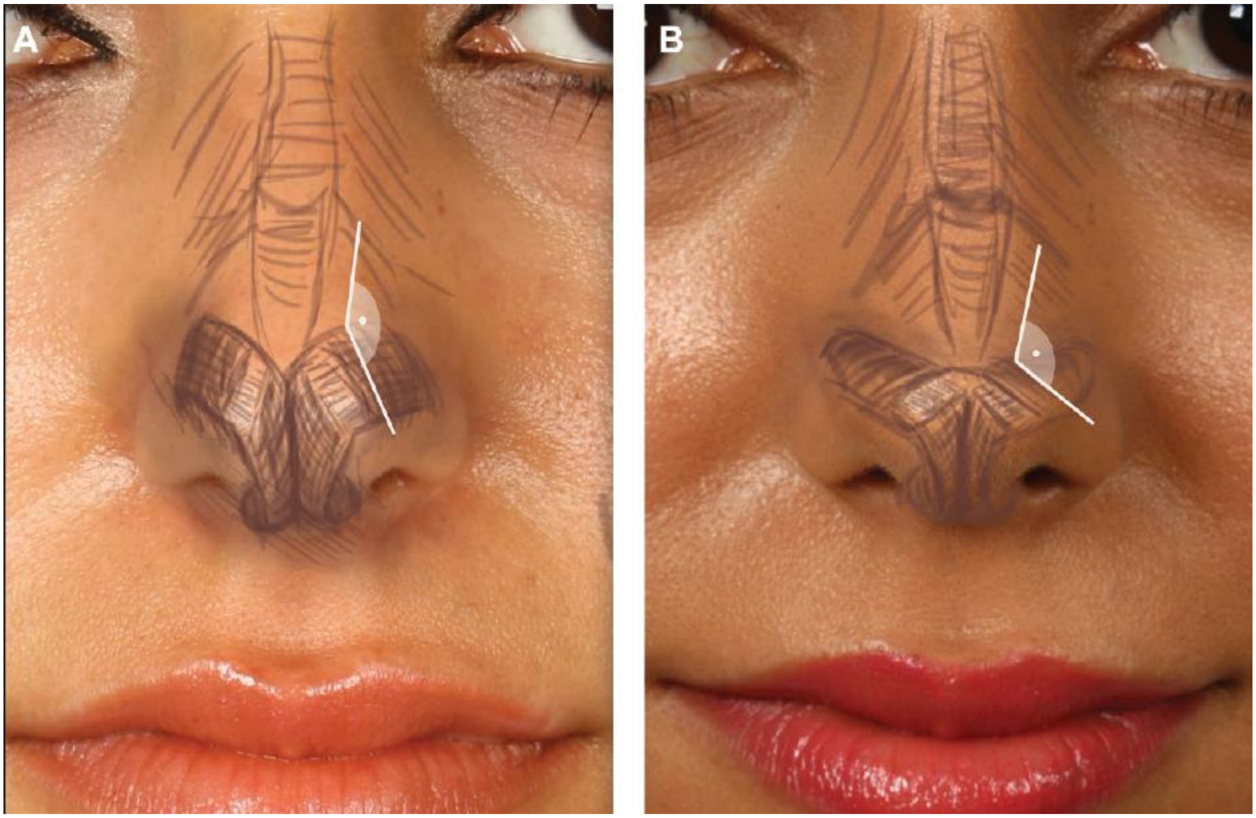

Figure 2. The lateral crural resting angle determines the position of the lateral crus rotational angle to the upper lateral cartilage. Ideally, this angle should be 100° between the lateral crus and the upper lateral cartilage. (A) This 26-year-old woman presented with an abnormal lateral crural resting angle of 150° that manifested as excessive fullness in the supratip region and apparent cephalic malpositioning of the lower lateral cartilages. (B) One month after rhinoplasty with reduction of the lateral crural resting angle to 100°. Note the well-defined scroll groove and the aesthetically appealing supratip region. From Çakır et al.[1] Reprinted with permission from Sage Publications.

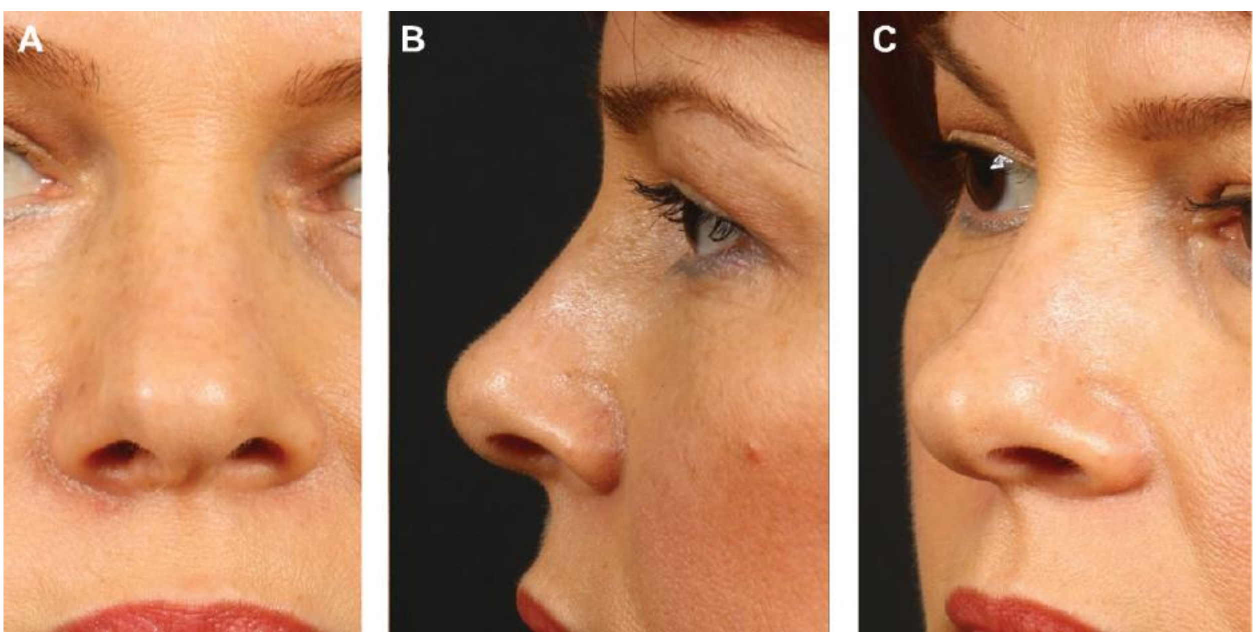

Figure 3. (A-C) The aesthetically pleasing natural nose of a 34-year-old woman. (A) Note the paired light reflections at the nasal tip when imaged using paraflash photography. From Çakır et al.[1] Reprinted with permission from Sage Publications.

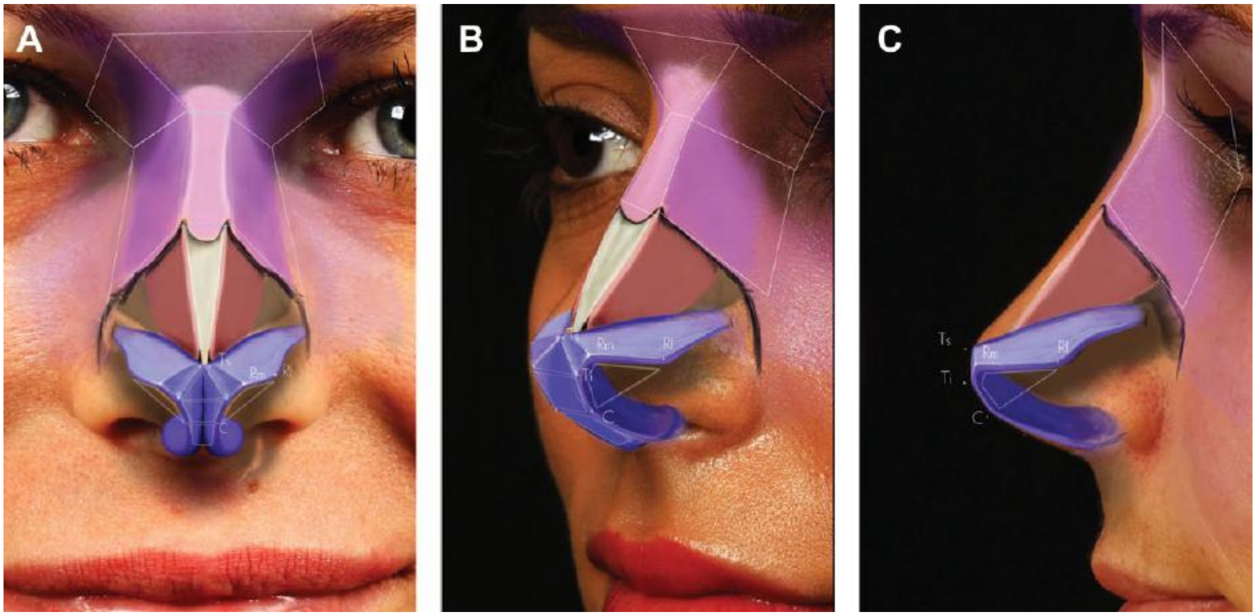

Figure 4. Structural anatomy of the tip surface of this 28-year-old woman. C, columellar breakpoint; T_s, superior tip; T_i, inferior tip; R_m, medial rim; R_l, lateral rim. T_s corresponds to the combined vertices of the dome triangles. The T_i points correspond to the inferomedial corners of the dome triangles and the inferolateral vertices of the interdomal triangle. The R_m and R_l points represent the medial and lateral ends, respectively, of the lateral crural caudal border. (A) Frontal, (B) oblique, and (C) lateral views. From Çakır et al.[1] Reprinted with permission from Sage Publications.

interdomal triangle is between the dome triangles created by T_s and the bilateral T_i points (Figures 1 and 4). The base of the interdomal triangle is the widest area of the tip and connects the 2 T_i points (Figures 1 and 4). The medial edge of each dome triangle corresponds to the lateral edge of the interdomal triangle.[1] The relative ratio of tip width to nasal width at the keystone area is wider in females than in males.[1]

The Facet and Infralobular Polygons

The facet polygon lies between the T_i, R_m, and R_l and C′ points (Figure 4) and is a critical surface structure in the nasal tip that must be taken into account to optimize the overall tip aesthetic result (Figure 1).[1]

The infralobular polygon is formed between the interdomal triangle and the columellar polygon (Figure 1).[1] The superior edge of this polygon corresponds to the interconnection of the T_i points. The base of the infralobular polygon is at the columella breakpoint and connects the C′ points (Figure 4). This breakpoint is ideally 1 mm anterior to the apical edge of the nostrils. A lower columellar breakpoint would present as a more exposed nostril from a frontal view. The superior edge of the infralobular polygon is wider in females.

The Columellar and the Footplate Polygons

The columellar polygon is located between the infralobular polygon and the footplate polygon (Figure 1).[1] It begins at the columellar breakpoint and extends to the divergence of the medial crura. The footplate polygon begins at the divergence of the medial crura footplates and ends just above the lip junction. These polygons reflect the underlying division of the medial crura into a columellar segment and a footplate segment.[2,4]

CORRELATION OF SURFACE GEOMETRY WITH UNDERLYING STRUCTURE

The rhinoplasty surgeon must consider how the underlying tip infrastructure relates to polygonal aesthetic subunits on the surface. A precise understanding of dome shape and position enables correct management of aberrant structures to create an aesthetically pleasing external surface. What we see preoperatively as the “dome” typically is the middle crura of the LLC, which are guided into position by septal growth.

The key to nasal tip reshaping is establishing proper length and symmetry of the lateral crura. The total length of the LLC (lateral, middle, and medial portions) is adequate in most patients, obviating the need for an onlay tip graft (eg, Peck or shield). The lateral crural steal procedure can increase tip rotation as well as tip projection, especially when combined with repositioning and setback of the footplate.[5] The ratio of lateral to medial crura, the position of footplates, and the lateral crural resting angle provide the underlying structure responsible for the aesthetic subunits of the nasal tip surface.[1]

During the past 3 years, 257 consecutive polygon rhinoplasties, including primary and secondary cases, have been performed by the principal author (B.Ç.) according to the concepts and techniques described herein. Eighty percent were women and 20% were men; the age range was 19 to 56 years (average, 27 years). The average follow-up period was 1.5 years. Two cases of bleeding (0.78%) and no cases of infection were observed. The rate of revision for the entire series was 5%.

SURGICAL TECHNIQUE

A video that demonstrates polygon rhinoplasty may be viewed at www.aestheticsurgeryjournal.com or www.surgery.org/videos.

Step 1: Preoperative Markings and Simulation

Preoperatively, points corresponding to the existing and planned nasal tip are marked on the lateral cheek skin, and the expected surgical result is simulated with Photoshop CS6 (Adobe Systems, San Jose, California) (Figure 5).

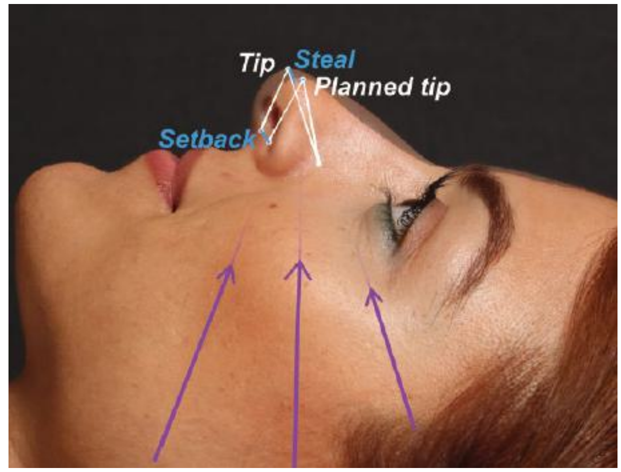

Figure 5. Before surgery, the lateral profile view of this 30-year-old woman is used to simulate the final result. Semitransparent images are superimposed, and the plan is brought to the operating room. Points corresponding to the current and planned nasal tips are marked on the lateral cheek before surgery begins.

Step 2: Incisions

The open approach is performed through a transcolumellar V-shaped incision that is extended with bilateral infracartilaginous incisions. It is important to retain the superficial musculoaponeurotic system (SMAS) in the nasal flap while performing an open-approach incision. This tissue fills the infralobular polygon and prevents a depression when the incision is closed. Alternately, the closed approach is performed through posterior transfixion incisions combined with intercartilaginous and infracartilaginous incisions targeted for dome delivery (Figure 6A).

If the lateral crura are wide and extend cephalically and caudally, the nasal tip will have a bulbous appearance. Caudal excess narrows the facet polygon, and its resection can cause notching of the nostril. If excessive caudal lateral crus is noted before the incision is made, an autorim graft can be performed. In this case, the infracartilaginous incision (ie, the intracartilaginous incision within the cartilage) is placed 1 to 3 mm cephalically, leaving the caudal portion of the lateral crus behind on the nostril side (Figure 6B,C). Resecting the caudal portion corrects the bulbous tip deformity, increasing the facet polygon size, reinforcing the rim margin, and preventing notching of the nostril. Given the in situ attachment of the cartilage that is left behind, the autorim graft is a more effective and symmetric option than a classic rim cartilage graft placed into a prepared pocket. The autorim graft also is softer and more natural looking than the rim graft, without compromising strength. This maneuver, performed at the beginning of the operation, enables manipulation of the facet polygon, narrowing the lateral crus polygon while directly increasing the facet polygon size.

Step 3: Footplate Setback

Management of the footplates is an important step, especially in cases of tension tip noses. This deformity involves an enlarged high pedestal upon which the nasal septum and LLC are positioned that manifests as an overprojected nose.[6] Correct management of this pedestal and the anterior nasal spine should precede any maneuver dedicated to tip reshaping.

Once the septal position is stabilized and the enlarged pedestal is reduced, the LLC footplates are dissected and set back, resulting in deprojection of the nasal tip. The setback amount for each footplate is calculated according to the extent of pedestal reduction and the relationship between the infralobular and columellar polygons. Dome positioning via the lateral crural steal procedure can compensate for reduced projection and can increase the rotation. In fact, footplate

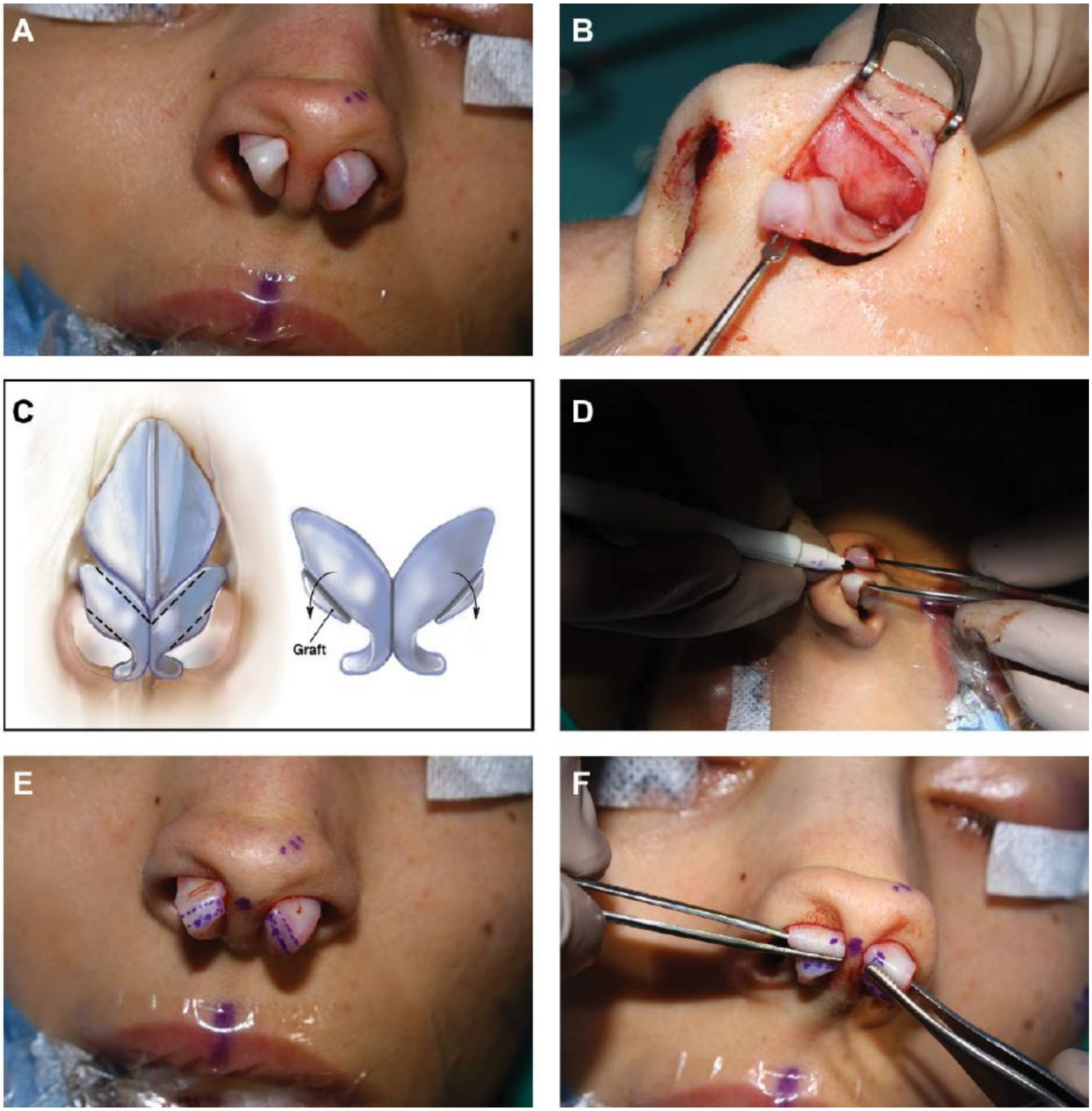

Figure 6. (A) The dome delivery technique is utilized to access the nasal tip of this 24-year-old woman. A total subperichondrial/subperiosteal dissection enables controlled management of Pitanguy's midline ligament and the scroll ligaments. Skeletonization of thinner, more pliable cartilage requires thinner and more delicate sutures for cartilage shaping. (B) The infracartilaginous incision (ie, an intracartilaginous incision made within the cartilage) is made 1 to 3 mm cephalically, leaving the caudal portion of the lateral crus on the nostril side and creating the autorim graft. (C) Design and effect of the autorim graft. Resection of the caudal portion corrects the bulbous tip deformity, increasing the facet polygon size while enhancing rim margin reinforcement and preventing notching of the nostril. This technique should be planned and attempted before any cephalic resection. (D, E) The medial crura are pulled and held under tension, and the middle crura symmetry mark is made for reference. (F) The new dome position is determined by simulating the lateral crural steal procedure on 1 side and marking the new dome such that it aligns with the planned tip marking on the cheek.

setback enables the lateral crural steal procedure to increase projection further than if no setback was performed.[5]

Step 4: Dissection

Dissection should be performed in the total subperichondrial/subperiosteal plane[7] for 2 reasons: (1) control and management of Pitanguy's midline ligament and scroll ligaments and (2) skeletonization of thinner, more pliable cartilage requiring thinner and more delicate sutures for cartilage shaping (Figure 6A). Pitanguy's midline ligament is marked with sutures, and an incision is made in the open approach to enable repair and to control the supratip region at the end of the operation. Note that the closed approach does not require transection of the ligament.

Nasal dissection is initiated at the lateral crura completely in the subperichondrial plane. This enables the analysis of asymmetries between the 2 crura and the nasal tip as a whole. Wide dissection is performed. The LLC (medial and lateral portions) are excised via the nostrils in the closed approach (Figure 6A), whereas extended visibility is achieved via the open approach. The interdomal and Pitanguy's midline ligaments are split longitudinally for 3 to 5 mm, enabling the lateral crural steal procedure. These ligaments then are sutured immediately before the dome-equalizing suture is placed (step 9).

Step 5: Cartilage Marking

The LLC are marked to ensure correct manipulation. The medial crura are pulled and kept under tension, and symmetric reference markings are made on the middle crura of the cartilages (ie, the middle crura symmetry mark; Figure 6D). This is especially important for asymmetric tips in which the domes are not aligned. The middle crura symmetry mark must divide the lateral crura into equal lengths.

Step 6: Cartilage Resections and the Autorim Graft

Resection of the LLC consists of caudal and/or cephalic resections that should target defects of the surface polygons, especially the facet polygon (Figures 1 and 4). Cephalic resections of the LLC should be conservative and should enable proper eversion of the lateral crura by means of cephalic dome sutures (CDS; step 8). Overresection of the cephalic portion introduces a structural defect in the scroll area. For this reason, we try to maintain contact of the upper lateral and lateral crural cartilages by reconstructing the scroll ligament.[7]

Caudal resection must account for the facet polygon. Correct planning and utilization of the autorim graft at the incision step is mandatory for proper management of this polygon (Figure 6B,C). In the case of narrow facet polygons, caudal resection of the LLC, either at this step or earlier as part of the autorim graft, enables their enlargement and correction. Lateral crural caudal edges often are wide, with a tendency to bend inward, resulting in contour deformity and narrow facet polygons. Excision of these curved edges increases the facet polygon but may result in notching in the soft triangle area. Retaining the resected part in the rim as an autorim graft eliminates the potential for this deformity and stabilizes the rim. The autorim graft provides structural support and increased safety if subsequent resections are made from the caudal portion. A 3-mm autorim graft enables an extra caudal resection of 1 to 2 mm. Caudal resections are made, leaving a 5-mm-wide strip of cartilage in the dome region. The lateral crura should be trimmed midlength, leaving cartilage that is 5 to 7 mm wide. With a strong autorim graft in place, caudal excisions and mucosa repair also help define the scroll line, reducing the appearance of cephalic malpositioning. Planning is necessary to ensure that cephalic resections can compensate for the caudal counterparts and to determine whether caudal trimming will be performed. Caudal resections are indicated only in combination with the CDS, which repositions the lateral crura at the correct resting angle.[1]

Step 7: Marking the Dome-Defining Point

Proper reshaping of the dome, especially in cases of asymmetric tip, requires precise identification of the dome-defining point. It is at this point where tip projection and rotation are determined and where the lateral crural steal amount for each LLC is planned. As described in step 5, the lateral crura must be symmetrical and of equal lengths, and the middle crural symmetry mark provides a point of reference to achieve this symmetry (Figure 6D,E). To determine the new dome position, the lateral crural steal procedure is simulated on 1 side, and the new dome is marked to align with the planned tip marking on the cheek (step 1). To ensure symmetry, the distance between the new dome marking and the middle crural symmetry mark is measured, and the same distance is marked on the contralateral lateral crus. By marking the planned positions of the new domes on the lateral crura, symmetry is ensured even in the previously asymmetric tip (Figure 6E,F).

Step 8: Cephalic Dome Sutures

With the planned dome positions marked on the lateral crura, the lateral crural steal can be performed to create new domes via CDS. When placed properly, CDS function as lateral crus angling sutures that stabilize the middle and lateral crura in different planes, correct the resting angles of the lateral crura, and everting them onto the appropriate surface polygons. The lateral crural steal is performed to increase tip rotation and to define the position of the dome. If the footplate has not been repositioned, the lateral crural

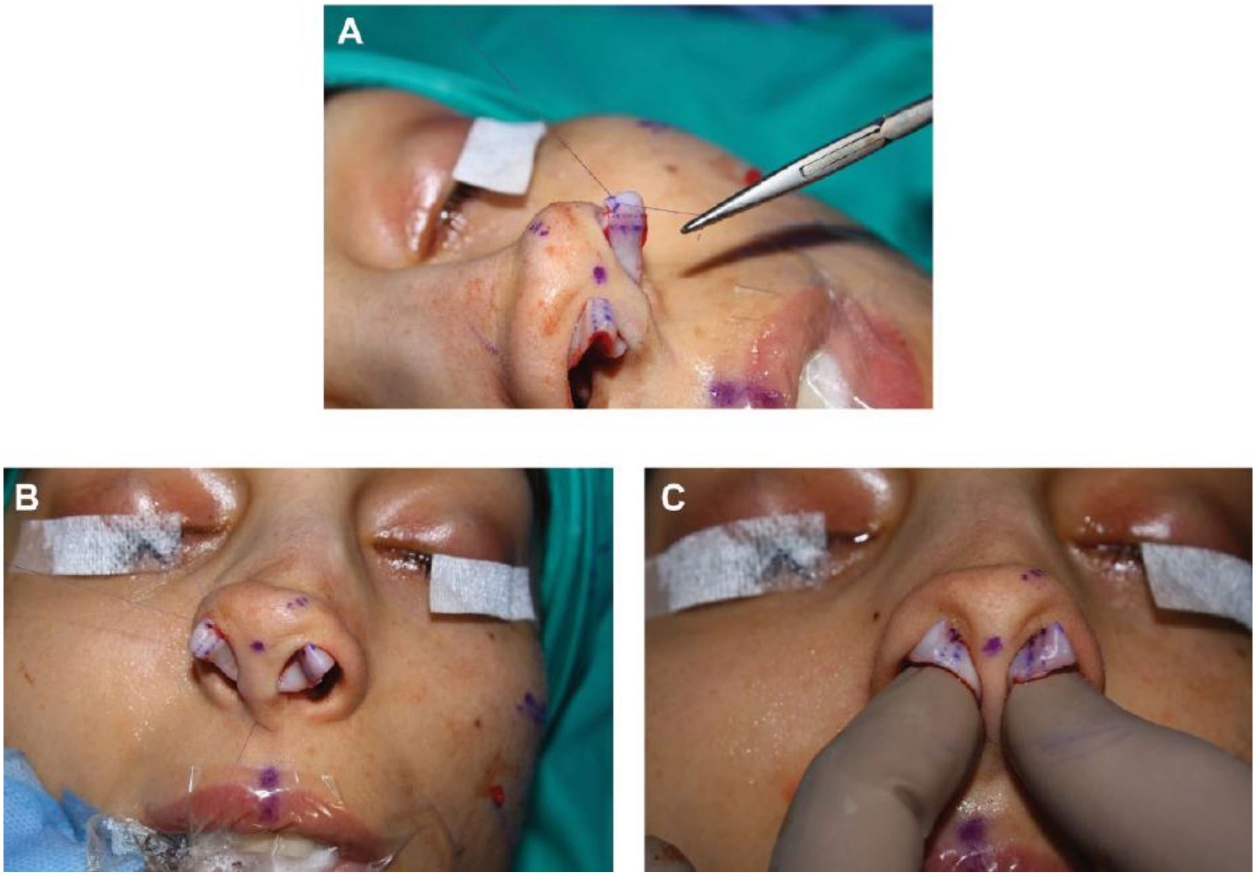

Figure 7. (A-C) The cephalic dome sutures are placed 3 mm from the cephalic edge of the cartilage on both sides, as marked previously.

steal typically will not increase tip projection. However, when footplate setback is planned at the beginning of the operation, the lateral crural steal procedure can be used to compensate for the lost projection caused by footplate setback.[5] CDS are placed 3 mm from the cephalic edge of the cartilage on both sides, as marked previously (Figure 7). Additional CDS are placed as needed, including when the medial and lateral crura remain far apart, for a hanging columella, and to correct the lateral crural resting angle.[1]

The lateral crural steal controls rotation and projection of the tip and enables elongation of the infralobular and facet polygons. Approximately 70% of our patients present with a short infralobular polygon; the lateral crural steal maneuver corrects this deformity automatically. For the remaining 30% of patients, the infralobule-to-nostril ratio is normal, or the tip is already overprojected. Lateral crural steal in these patients would undesirably increase the infralobular polygon and could introduce a hanging columella. Instead, the middle crura are transected and an overlap procedure is performed. The overlap procedure involves transection of the medial crura such that the medial end is moved beneath its domal end counterpart, resulting in overlapping of the middle crus on top of the medial crus (Figure 8A). If indicated, this technique can be modified to correct a hanging columella deformity while maintaining the correct infralobule-to-nostril ratio. Specifically, the anterior overlap procedure incorporates posterior rotation of both ends, leaving a triangular overlap of the anterior medial crura (Figure 8B).

The rhinoplasty surgeon must be able to anticipate the overall effects of the various maneuvers described here for proper tip surgery. Footplate setback, the lateral crural steal maneuver, and the medial crural overlap procedure all contribute to tip projection and rotation. The surgeon must ensure balance of the infralobular, facet, columellar, and footplate polygons by combining these techniques, to different extents, as needed for each patient.

Step 9: The Dome-Equalizing Suture

Once the domes are stabilized, the skin is redraped (or reduced in place in the closed approach), and tip rotation is inspected. If tip rotation is adequate, the domes are exposed, and dog-ears created by the CDS are resected.[1]

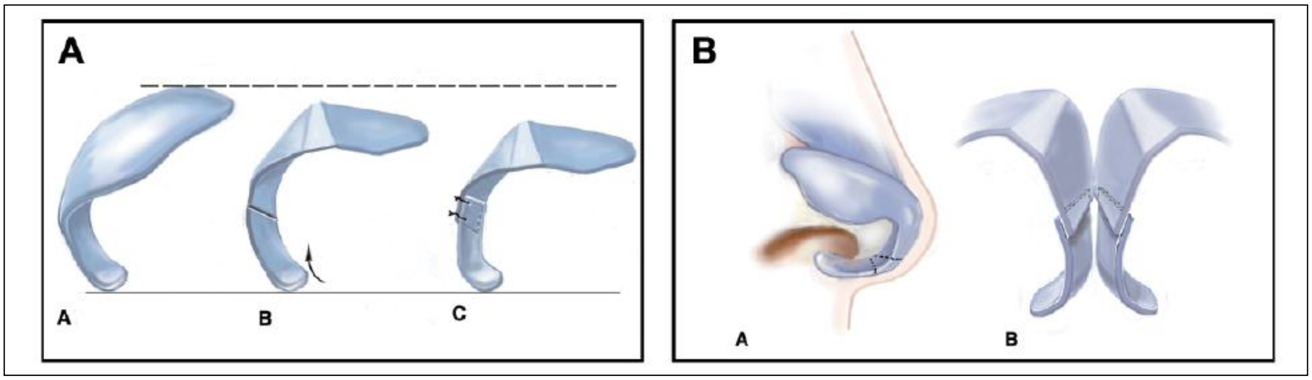

Figure 8. (A) The overlap procedure employs transection of the medial crura, where the medial end is moved beneath its domal end counterpart to overlap the middle crus on top of the medial crus. (B) A hanging columella deformity can be handled while maintaining the correct infralobule-to-nostril ratio via the anterior overlap procedure. In this case, posterior rotation of both ends leaves a triangular overlap of the anterior medial crura.

Because this step is irreversible, it should be performed only when the surgeon is certain that the new domes have been positioned appropriately. Both domes are then exposed (from 1 side in the closed approach), and the dome-equalizing figure-of-8 suture is placed (Figure 9) while the split interdomal and Pitanguy's midline ligaments are repaired. The less-skilled surgeon is advised to perform the dog-ear excision step after the columellar strut graft (step 10) to verify the correct position of the tip.

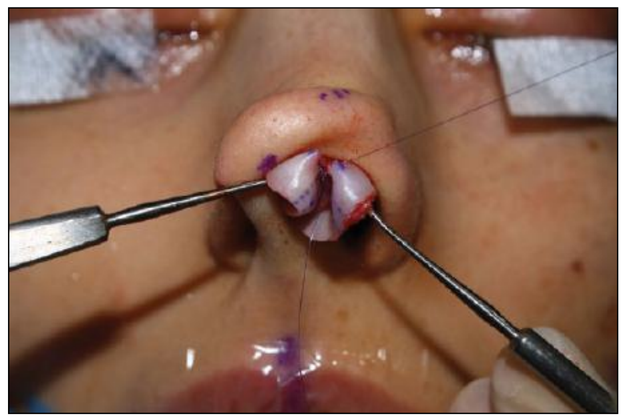

Figure 9. The dome-equalizing figure-of-8 suture is placed.

Step 10: Columellar Strut Graft

A curved columellar strut graft can be placed as long as the inferior edge is posterior (cephalic) to the medial crura caudal edges (Figure 10A). The columellar strut graft is set into a pocket between the medial crura. The tip point of the graft is secured with a figure-of-8 suture. Positioning the strut cephalically in relation to the medial crura prevents its visibility and creates the empty space that is required for proper reconstruction of the polygons, specifically the transition from the infralobular polygon to the columellar polygon via the C′ breakpoint.[1]

Step 11: C′ Breakpoint Remodeling

The C′ breakpoint is a key feature of the nasal tip surface that exists at the transition line from the infralobular polygon to the columellar polygon (Figures 1 and 4).[1] Reshaping of this breakpoint is performed using a suture placed 5 to 7 mm inferior to the dome triangle apex and 1 mm anterior to the apical edge of the nostrils. The C′ breakpoint suture is placed from 1 side through the columellar strut, passing close to the cephalic edge of the medial crus. It is then passed back through the medial crus, this time close to the caudal edge and in front of the strut (without going through it) and through the contralateral crus close to the caudal edge. Finally, the suture is passed backward, close to the cephalic edge and medially toward the strut, and the knot is tied (Figure 10B,C).

Step 12: The Infralobule Caudal Contour Graft

Approximately 5% of our patients present with very pliable cartilages. The lateral crural steal procedure transfers these pliable domes to the C′ breakpoint area. This approach would yield a poorly defined infralobular polygon. To overcome this deformity, a mini-contour graft (4-5 mm long; 1 mm thick) is placed and secured over the caudal edge of the middle crura (Figure 10D,E). Tip projection is increased in these patients only if the tip of the graft is extended to the dome. Extension to the T_i point facilitates definition of the dome triangles. Extension to the R_m point increases tip projection by 1 to 2 mm (Figure 4) and helps distinguish the border between the infralobular and facet polygons.

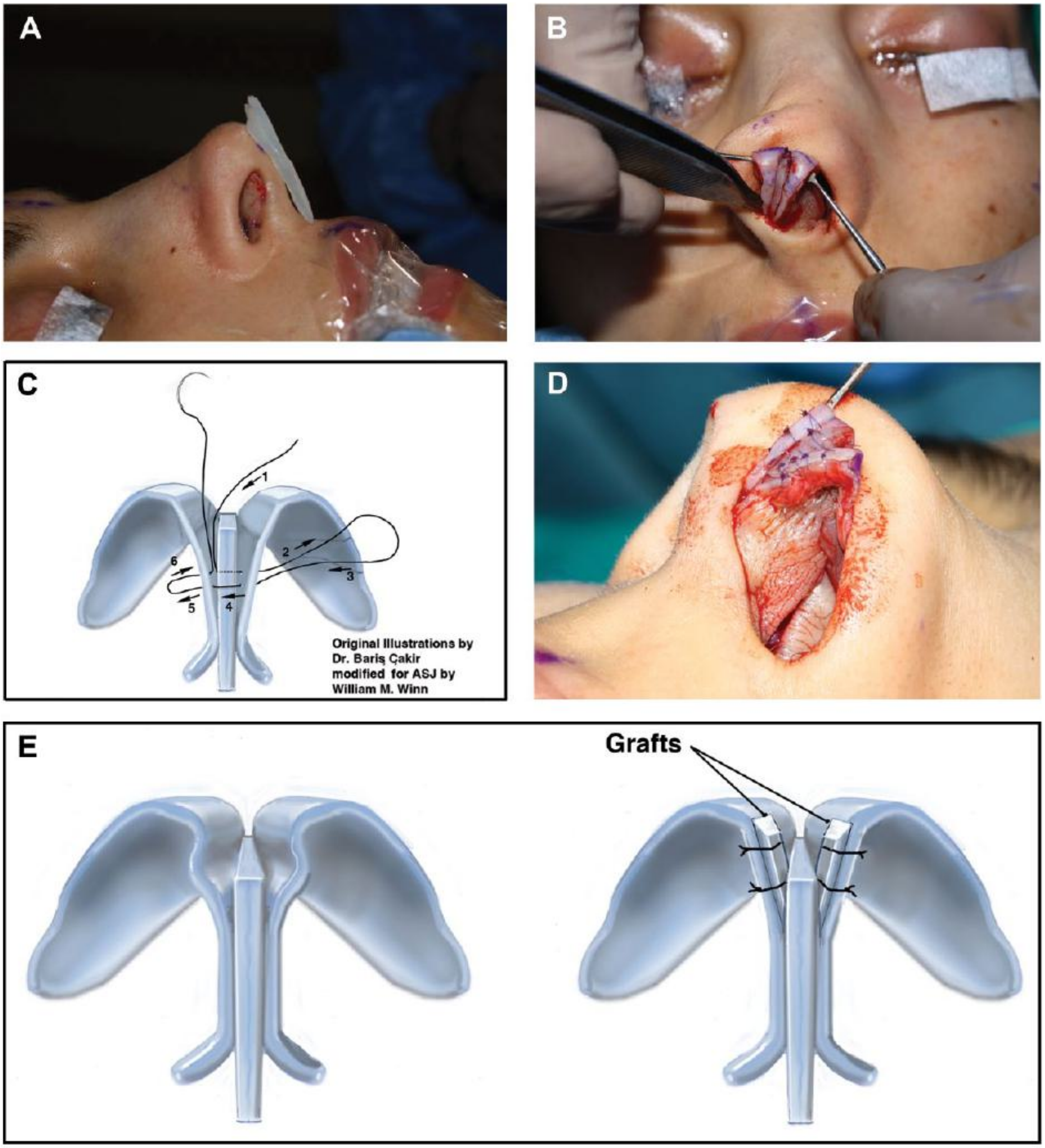

Figure 10. (A) A curved columellar strut graft can be placed as long as the inferior edge is posterior (cephalic) to the medial crural caudal edges. (B) The columella (C′) breakpoint suture is placed from 1 side through the columellar strut, passing close to the cephalic edge of the medial crus. It then is passed back through the medial crus, this time close to the caudal edge in front of the strut (without going through it) and through the contralateral crus close to the caudal edge. Finally, the suture is passed backward, close to the cephalic edge and medially toward the strut, and the knot is tied. (C) C′ breakpoint reconstruction is performed by placing a suture 5 to 7 mm inferior to the dome triangle apex and 1 mm anterior to the apical edge of the nostrils. This suture creates the C′ breakpoint, defining a distinct border between the infralobular polygon and the columellar polygon. (D, E) In cases of pliable and soft domes (middle crura), a mini-contour graft (ie, infralobule caudal contour graft; 4-5 mm long and 1 mm thick) is placed and secured over the caudal edge of the middle crura to add definition to the infralobular polygon.

Figure 11. This 24-year-old woman presented with an asymmetric bulbous and deprojected nasal tip, bony and cartilaginous hump, right septal deviation, right deviation of the nasal axis, left inferior conchal hypertrophy, and thick skin. (A) Frontal, (C) lateral, (E) oblique, and (G) basal preoperative views. Closed dome delivery was performed in the subperichondrial/subperiosteal dissection plane. The left concha was reduced by submucosal resection, the hump was reduced, and septoplasty was performed. The lateral crura were trimmed cephalically, and both domes were elevated 3 mm. The medial crura were overlapped 2 mm with anterior modification, and a columellar strut graft was placed. The lateral crura resting angles were corrected using 3 cephalically positioned dome sutures. The dorsum was reconstructed by means of autospreader flaps in combination with diced cartilage. (B) Frontal, (D) lateral, (F) oblique, and (H) basal views of the patient 1 year postoperatively.

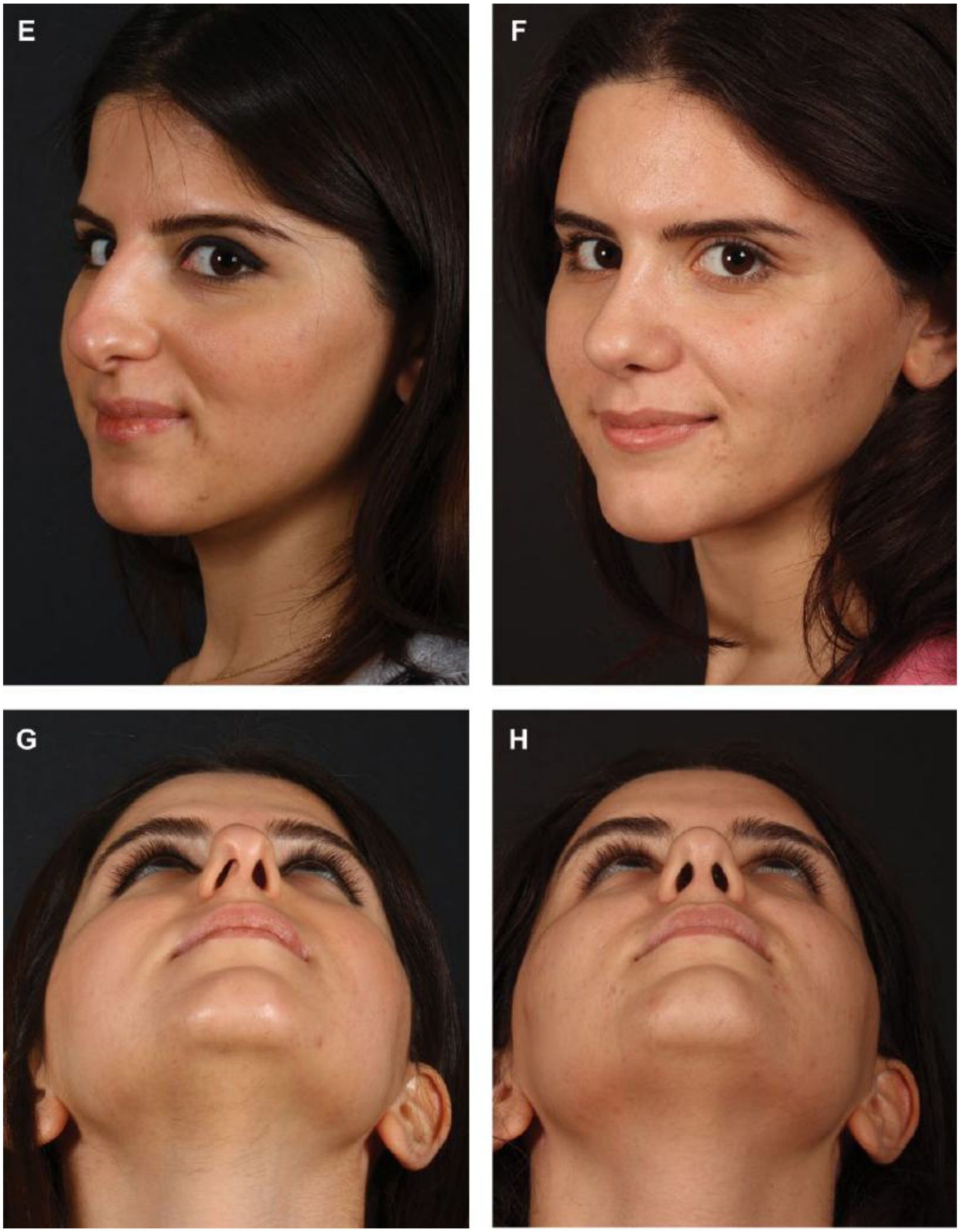

Figure 11. (continued) This 24-year-old woman presented with an asymmetric bulbous and deprojected nasal tip, bony and cartilaginous hump, right septal deviation, right deviation of the nasal axis, left inferior conchal hypertrophy, and thick skin. (A) Frontal, (C) lateral, (E) oblique, and (G) basal preoperative views. Closed dome delivery was performed in the subperichondrial/subperiosteal dissection plane. The left concha was reduced by submucosal resection, the hump was reduced, and septoplasty was performed. The lateral crura were trimmed cephalically, and both domes were elevated 3 mm. The medial crura were overlapped 2 mm with anterior modification, and a columellar strut graft was placed. The lateral crura resting angles were corrected using 3 cephalically positioned dome sutures. The dorsum was reconstructed by means of autospreader flaps in combination with diced cartilage. (B) Frontal, (D) lateral, (F) oblique, and (H) basal views of the patient 1 year postoperatively.

Figure 12. This 28-year-old woman presented with a long nose, right septal deviation, dorsal hump, cephalically malpositioned lateral crura, short columella, and thin skin. (A) Frontal, (C) lateral, (E) oblique, and (G) basal preoperative views. Closed dome delivery was performed in the subperichondrial/subperiosteal dissection plane. The hump was reduced, internal valve mucosa were repaired, and septoplasty was performed. The lateral crura were trimmed 3 mm cephalically and 2 mm caudally. Both domes were elevated 3 mm. A columellar strut graft was placed. The lateral crura resting angles were corrected using 3 cephalic dome sutures. The dorsum was reconstructed by means of modified Libra spreader grafts and diced cartilage. (B) Frontal, (D) lateral, (F) oblique, and (H) basal views of the patient 1 year postoperatively.

Figure 12. (continued) This 28-year-old woman presented with a long nose, right septal deviation, dorsal hump, cephalically malpositioned lateral crura, short columella, and thin skin. (A) Frontal, (C) lateral, (E) oblique, and (G) basal preoperative views. Closed dome delivery was performed in the subperichondrial/subperiosteal dissection plane. The hump was reduced, internal valve mucosa were repaired, and septoplasty was performed. The lateral crura were trimmed 3 mm cephalically and 2 mm caudally. Both domes were elevated 3 mm. A columellar strut graft was placed. The lateral crura resting angles were corrected using 3 cephalic dome sutures. The dorsum was reconstructed by means of modified Libra spreader grafts and diced cartilage. (B) Frontal, (D) lateral, (F) oblique, and (H) basal views of the patient 1 year postoperatively.

Step 13: Columellar Polygon Reshaping

The C′ suture sets the superior edge of the columellar polygon. The remaining medial crura are sutured to the columellar strut in continuous fashion to create the remainder of the columellar polygon from the C′ breakpoint to the footplate. For patients with a short columellar polygon and a long footplate polygon, the footplates cartilages are sutured together (ie, stealing from the footplate polygon to the columellar polygon) to increase the size of the columellar polygon and reduce the footplate polygon size.

Step 14: Redraping

To complete the procedure, the skin is redraped (or in the closed approach, the cartilages are replaced). Care should be taken at this step to ensure correct reduction and settling of Pitanguy's midline ligament and the SMAS between the medial crura.[7] Pitanguy's midline ligament and the scroll ligaments help control the supratip and lateral supratip skin, while stabilizing the lateral crural cephalic edges.[7] Misplacement of these soft-tissue components would introduce asymmetries and deformities to the tip, disrupting efforts to improve surface aesthetics.

Clinical results utilizing the aforementioned techniques with respect to nasal tip surface aesthetics appear in Figures 11 and 12.

DISCUSSION

The aesthetic concepts and stepwise surgical techniques described here enable the rhinoplasty surgeon to properly rearrange the underlying anatomic structures and achieve an aesthetically pleasing nasal tip surface. Several techniques associated with polygon rhinoplasty require preoperative analysis to maximize their combined utilization and address each patient's specific needs. For instance, the choice to perform an autorim graft must be made at the beginning of the operation because it alters the course of the surgery from the first incisions. Inclusion of the autorim graft also affects subsequent caudal and cephalic resections of the lateral crura and maneuvers to adjust the facet polygon. The concepts of lateral crural steal, footplate setback, and medial crura overlap require thorough preoperative planning and combined utilization to achieve desired aesthetic results. Together, these techniques enable correction of tip rotation, tip projection, the infralobule-to-nostril ratio, and facet polygon size in a single strategical maneuver without the need for onlay cartilage grafts. The columella-related aesthetic concepts discussed in this article also can have dramatic effects on tip aesthetics and nasal shape. Proper reconstruction of the C′ breakpoint should be a primary goal for all rhinoplasty procedures.

CONCLUSIONS

To achieve desired nasal tip aesthetics, the surgeon must prepare a detailed preoperative plan for each patient. Incorporating the techniques we have outlined will help ensure that the polygonal aesthetic subunits of the tip surface are manipulated in the correct manner and proportions.

Disclosures

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A Complete Subperichondrial Dissection Technique for Rhinoplasty With Management of the Nasal Ligaments

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A Complete Subperichondrial Dissection Technique for Rhinoplasty With Management of the Nasal Ligaments

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Abstract

Background: A complete subperichondrial and subperiosteal dissection technique during rhinoplasty may minimize soft tissue disruption, resulting in less scar tissue formation and preservation of ligamentous structures.

Objectives: The authors describe their results with subperichondrial dissection of the nasal framework and manipulation of the preserved nasal ligaments.

Methods: The charts of 228 consecutive patients who underwent rhinoplasty with complete subperichondrial dissection via an open or closed approach between May 2008 and April 2011 with the senior author (BÇ) were retrospectively reviewed. Intraoperatively, the scroll ligament and Pitanguy's midline ligament were repaired to stabilize the internal valve and tip position, respectively.

Results: Patients in this series (182 women, 46 men) ranged in age from 18 to 54 years (mean, 24.3 years). A total of 203 procedures were primary rhinoplasties; 14 were secondary, and 11 were revisions. The open approach was used in 92 patients, whereas a closed dome delivery was used in the remaining 136 patients. Follow-up ranged from 9 months to 3 years. A complete subperichondrial dissection technique resulted in relatively limited edema and more rapid patient recovery compared with the authors' previous experience with the sub-superficial musculoaponeurotic system (SMAS) approach. Repeat elevation in the subperichondrial plane was easier and less traumatic in revision cases compared with secondary rhinoplasty cases.

Conclusions: Subperichondrial dissection of the nasal framework allows reshaping and redraping of the nasal tip and controlled manipulation and repair of ligaments without disturbing the overlying soft tissue.

Level of Evidence: 4

Keywords

rhinoplasty, nasal tip, subperichondrial dissection, dermocartilaginous ligament, nasal ligaments

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Rhinoplasty has traditionally involved elevating the soft tissue envelope in either the subcutaneous or sub-superficial musculoaponeurotic system (SMAS) plane. The associated soft tissue disruption leads to significant swelling, with prolonged scar remodeling before the final results are achieved 12 to 18 months postoperatively. Destruction of various ligaments and muscles with the subcutaneous or sub-SMAS approach can also compromise nasal function, especially in the internal valve area.

The soft tissue envelope that overlies the osseocartilaginous framework of the nose consists of 5 distinct layers: (1) the skin, (2) the superficial areolar layer, (3) the fibromuscular or SMAS layer, (4) the deep areolar layer, and (5) the perichondrial/periosteal layer.[1-3] The ligamentous connections within the SMAS layer play a critical role in the dynamic interplay of compression and dilation of the nose. Letourneau and Daniel[4] provided the original description of the nasal SMAS; others have confirmed the presence of this structure.[1,2,5] Recently, Saban et al[2] published an in-depth analysis of the nasal SMAS based on cadaver dissections. They described the nasal SMAS as a

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continuous fibromuscular layer extending from the frontalis SMAS to the nostril rim and composed of the transverse nasalis muscle, the procerus, and the compressor naris major and minor. In Saban et al's description, the SMAS layer is substantial above the level of the internal valve but becomes quite thin more caudally over the lower lateral cartilages. In addition, they consider the levator labii alaeque nasi and the dilator nasi muscles as "links" to the facial SMAS, a concept with which other authors are in agreement.[5-7] They also demonstrated that the nasal SMAS divides into a superficial and a deep layer at the level of the internal valve, with each layer having a lateral and medial portion. The superficial medial layer identified by Saban et al runs caudally above the interdomal ligament into the columella. The deep medial layer of the SMAS runs beneath the interdomal ligament but above the anterior septal angle into the membranous septum and then downward toward the anterior nasal spine. These new findings have profound functional and surgical implications with regard to the scroll ligament.

When performing sub-SMAS dissections, Saban et al[2] found a distinct connection between the deep layer of the SMAS and the internal valve present at the scroll junction of the upper lateral cartilages (ULC) and the lower lateral cartilages (LLC). They postulated that the nasal muscles stabilize and help to open the internal valve via this ligamentous attachment. In this article, we will refer to the deep lateral portion of the nasal SMAS described by Saban et al as the "scroll ligament." The scroll ligament is usually excised in a routine rhinoplasty procedure while performing the LLC cephalic resections. We recommend that the scroll ligament be preserved during elevation of the soft tissue envelope and repaired at closure to stabilize the internal valve. Suturing the scroll ligament to the mucosa of the ULC and LLC prevents inward collapse of the internal nasal valves and minimizes the tendency for superior retraction of the lateral supratip skin (Figure 1).

In 1965, Pitanguy[8] described a "dermocartilaginous ligament" occurring in the noses of blacks and in bulbous noses. He stated that he had found "the presence of a ligament, uniting the derma of the upper third of the nose to the junction of the crux medialis, penetrating anteroposteriorly to help the formation of the fibrous septum." In 1995, Pitanguy et al[9] stressed the influence of the ligament on the equilibrium of the dorsal-tip relationship and even offered a classification of the ligament based on its thickness. In 2001, Pitanguy[10] again emphasized the role of the "dermocartilaginous ligament" and recommended transecting the ligament to eliminate tip dependency, thereby improving tip rotation, and/or resecting it to eliminate bulbosity.

Saban et al[2] concluded that the deep medial SMAS they identified in their dissections could correspond to Pitanguy's ligament. We agree with Saban et al that this ligament is a continuation of the deep medial SMAS layer, rather than a true dermocartilaginous ligament with a dermis origin and a cartilaginous insertion. However, to acknowledge the contributions of Pitanguy, we will use the term *Pitanguy's midline ligament* to describe the deep medial portion of the SMAS. It is our opinion that Pitanguy's midline ligament and the interdomal ligament maintain a soft tissue cushion between the domes and the anterior septal angle, as well as a 2- to 3-mm "septal extension effect" on the tip projection. Reconstruction of this ligamentous system helps stabilize the supratip skin and prevents the formation of a fluid-collecting dead space. Further, repair of the cut ligaments helps maintain the desired tip projection and rotation as required by the newly shaped nasal structure (Figure 1).

In this article, we describe our technique for rhinoplasty performed completely in the subperichondrial and subperiosteal plane, instead of the classical sub-SMAS plane. Used routinely for septal surgery, subperichondrial dissection facilitates exposure in a bloodless surgical field[1,2] and may provide distinct aesthetic and functional benefits over subcutaneous or sub-SMAS dissection for rhinoplasty surgery. Aesthetically, patients experience less morbidity in the immediate postoperative period. In addition, the final result in the tip area is seen much earlier. Functionally, the essential scroll ligaments and Pitanguy's midline ligament are preserved during the subperichondrial elevation and can be repaired prior to closure, which stabilizes the internal valve and tip position, respectively.

METHODS

Complete subperichondrial/subperiosteal dissection plane (SSD) rhinoplasties were performed in 228 consecutive patients performed between May 2008 and April 2011, and their charts were retrospectively reviewed. All surgeries were performed by the senior author (BÇ) in a hospital setting. Both an open and closed approach were employed.

Open Approach

The open-approach technique, which is initially demanding, was performed beginning with a transcolumellar "V" incision extending through the subcutaneous tissue until the medial crura was reached. Care was taken to preserve the tissues filling the space between the medial crura and to keep the soft tissue in the columellar flap. A pair of sharp-tip scissors was used to incise the perichondrium of the middle crura and allow elevation in the subperichondrial plane with the septal mucosal elevator. (It should be noted here that a "clean white" alar cartilage does not indicate a subperichondrial dissection plane. To ensure that dissection is proceeding under the perichonrdium, the surgeon should look for the inferior side of the elevated flap…., where the perichondrium is visible. In addition, marking the nude cartilage with an ink marker enables distinguishing nude cartilage from overlying perichondrium, where the ink diffuses after a few minutes in the latter.) The dissection was extended into the interdomal area, keeping the perichondrium of the two middle crura in the flap. The perichondrium was then cut at the caudal edge of the LLC and included in the skin flap. Following dissection of the lateral crura, the central fibromuscular

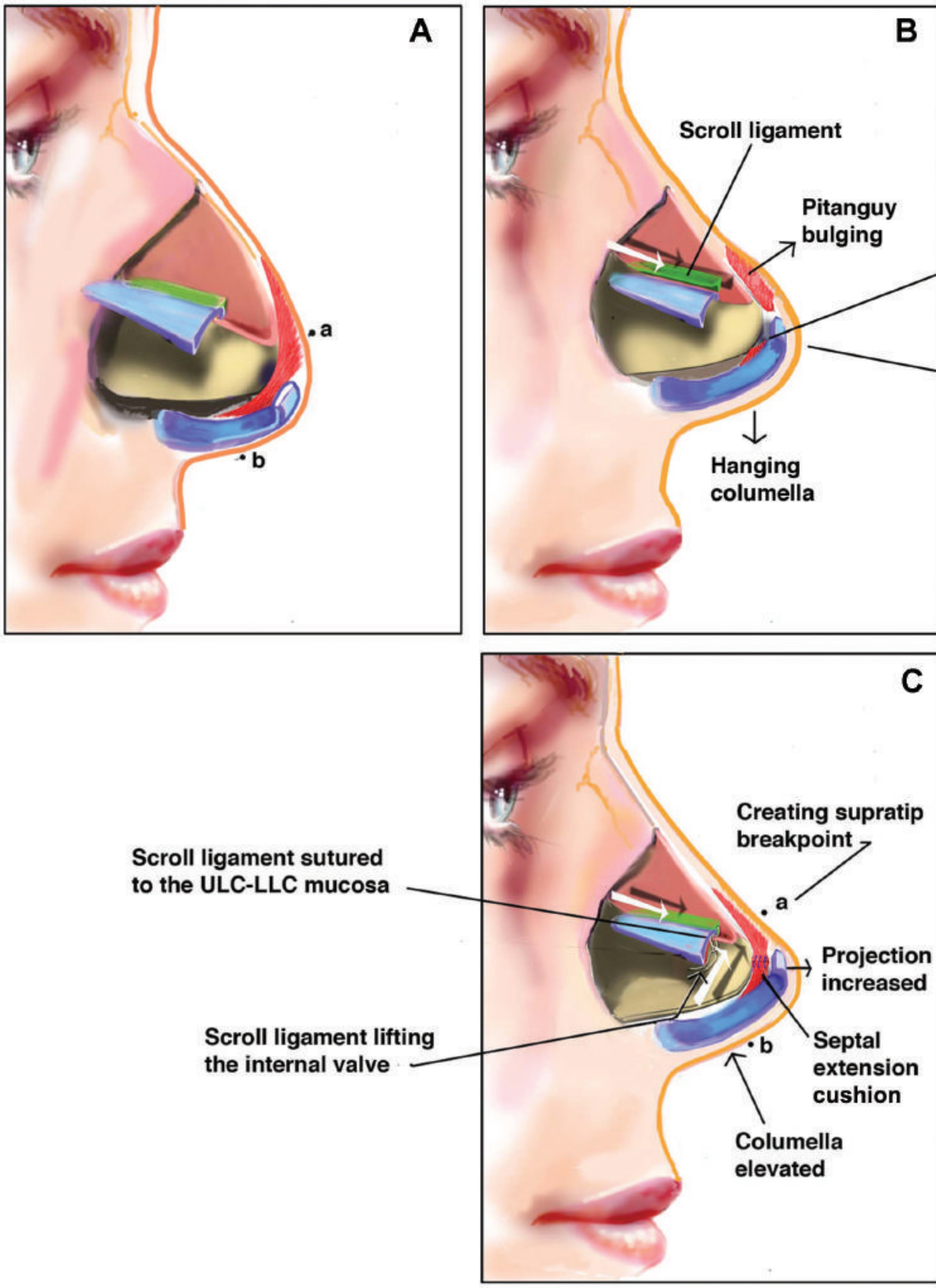

Figure 1. Ligament sketch. (A) Lateral sketch of Pitanguy's midline ligament and the scroll ligament in relation to the nasal framework structures. The distance between Points A and B shows the axis of Pitanguy's midline ligament. Reducing this distance will require shortening the ligament. (B) Disruption and resection of Pitanguy's midline ligament and the scroll ligaments will result in bulging of the supratip area, loss of tip projection, hanging of the columella, loss of the scroll junction groove, and narrowing of the internal nasal valve. (C) The effect of repair of Pitanguy's midline ligament and the scroll ligaments on the nasal skin. Note the increase in tip projection, creation of the supratip breakpoint, elevation of the columella, and stabilization of the scroll area. LLC, lower lateral cartilage; ULC, upper lateral cartilage.

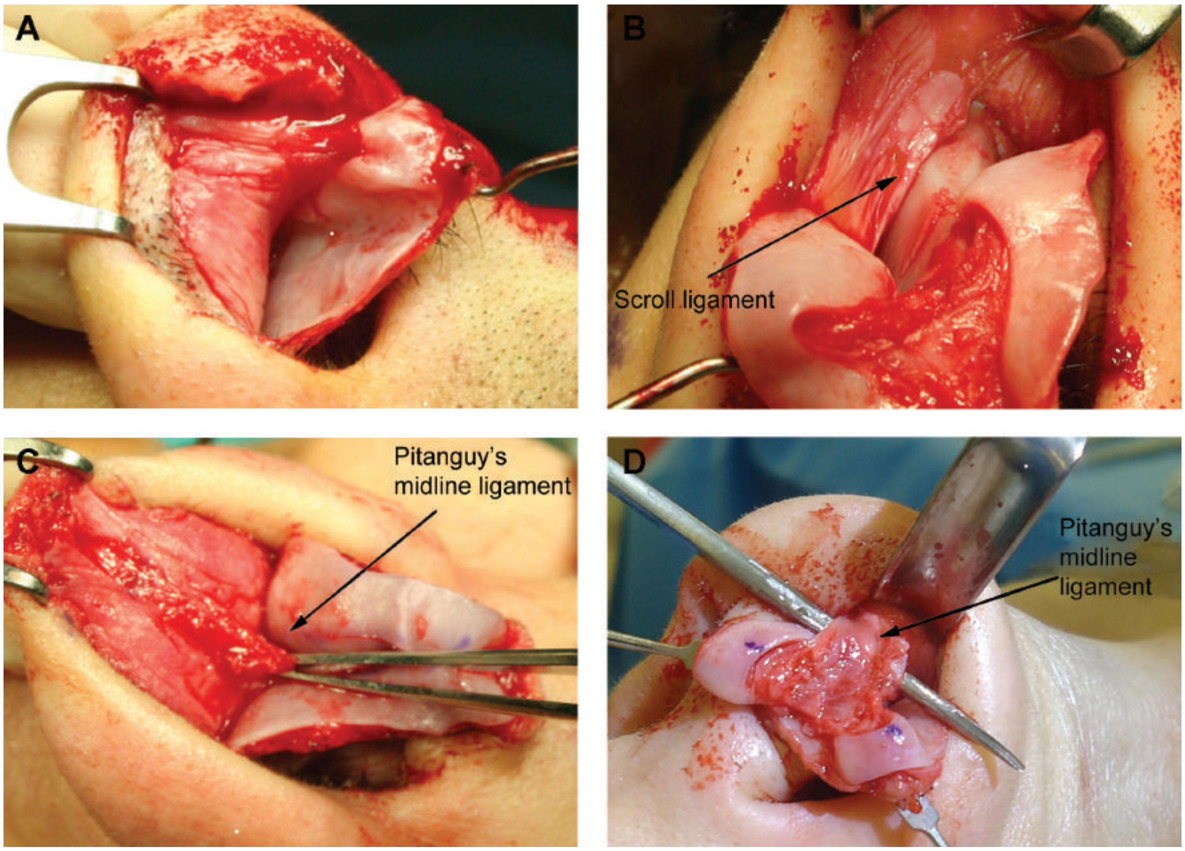

Figure 2. Dissection. (A) Subperichondrial dissection of the lower lateral cartilage (LLC) via the open approach. (B) The right scroll ligament. (C) The transected Pitanguy's midline ligament. (D) Subperichondrial dissection of the LLC via the closed approach, showing the intact Pitanguy's midline ligament before plication.

tissue underlying the skin flap was marked and identified as Pitanguy's midline ligament (Figure 2). Small 6-0 sutures were placed to identify the ends of the ligament once its attachment to the septum was cut. The cephalic end of the ligament was elevated with the skin flap, and the SSD was extended to the junction between the ULC and the LLC. A subperichondrial tunnel was then dissected from the septum on top of the ULC to the nasal bones and extended laterally over the ULC. This maneuver unified the subperichondrial plane of the ULC and the LLC, creating a single bloodless subperichondrial space and preserving the scroll ligament intact on the undersurface of the skin flap, which is strikingly similar to Saban et al's cadaver dissections done in the subperichondrial plane[2] (Figure 2). At the keystone area, the periosteum was sharply penetrated. The caudal subperichondrial dissection was continued in the subperiosteal plane over the nasal bones, rather than in the subperichondrial plane under the nasal bones, since the latter can lead to separation of the cartilages from the bones.

To complete the procedure, Pitanguy's midline ligament was repaired with No. 6-0 polypropylene sutures. The distal free end of the ligament, with the cephalic portion attached to the skin envelope in the supratip area, was sutured to the caudal portion of the ligament between the medial crura. The scroll ligaments, which were not damaged during dissection, were repaired at closure to stabilize the internal valve. A video of the authors' open surgical technique is available at www.aestheticsurgeryjournal.com. You may also use any smartphone to scan the code on the first page of this article to be taken directly to the video on www.YouTube.com.

Closed Approach

The closed-approach SSD procedure began with bilateral transfixion incisions made 4 mm cephalic to the caudal septum. The perichondrium was incised and a subperichondrial dissection was performed caudally in a retrograde direction up to the caudal edge of the septum. Standard intercartilaginous incisions were made and continued into the transfixion incisions. Next, the septal dissection was continued upward 2 to 3 mm until the ULC became visible. A subperichondrial tunnel was created on top of the ULC, using an elevator, from the anterior septal angle until the bony junction was reached. Elevation of the ULC perichondrium was easily completed through a sweeping action with the elevator. Next, a standard infracartilaginous incision was made at the caudal border of the LLC. The perichondrium of the lateral crus was carefully incised with a No. 15 blade, and the subperichondrial plane was entered with a pair of sharp-point scissors. The subperichondrial dissection of the lateral crura continued to the domes and around the middle crura onto the medial crura, at which point Pitanguy's midline ligament was isolated, preserved, and tagged. (Most surgeons believe that they are definitely dissecting in the subperichondrial plane over the lateral crura. This, however, is not usually true; in fact, they are sub-SMAS.) Once the skin envelope was elevated, dorsal vault reshaping and nasal tip modification were performed. Pitanguy's midline ligament was repaired using No. 6-0 polypropylene sutures, with the goal of achieving a projection gain of 2 to 3 mm and helping create a supratip breakpoint.

We recommend determining whether there is a need to reduce the distance between the supratip and the columella breakpoint prior to suturing the ligament, as the ligament should only be shortened if this distance is to be reduced (Figure 1). Shortening the ligament can be achieved either by plication or overlap suturing of the ligament. Extra reduction of the supratip fullness requires a 1- to 3-mm resection of the ligament before repair. If no reduction in this distance is required, the ligament should be left intact or repaired without overlap.

The ligament repair sutures were placed in three points on the ligament in the same plane to stabilize the domes and prevent asymmetry of the tip, since single suture repair can result in a right or left shift in the tip axis when compared with the dorsum. The septocolumellar relationship was then reestablished by suturing the septal perichondrium back to the septum in its original position with two or three No. 6-0 polypropylene sutures. Sutures were inserted on an angle in patients for whom the goal was modification of tip projection. The transfixion incision was closed once the deeper perichondrial suturing was completed. This maneuver stabilized the columella to the septum, maintaining tip projection and rotation as required. Finally, the scroll ligament was repaired. Three No. 5-0 poliglecaprone-25 sutures were inserted in the intercartilaginous incision as follows: the needle first passed 2 mm from the caudal mucosa on the ULC, then through the scroll ligament preserved on the undersurface of the skin flap, and then exited 2 mm back from the cephalic mucosa of the LLC. Upon tying the knot, the intercartilaginous incision was closed and the scroll ligament was placed between the lateral crus and the ULC, thereby stabilizing the internal nasal valve. This single-step maneuver is intended to prevent inward collapse of the internal nasal valves and minimize the tendency for superior retraction of the lateral supratip skin.

A video of the authors' open surgical technique is available at www.aestheticsurgeryjournal.com. You may also use any smartphone to scan the code on the first page of this article to be taken directly to the video on www.YouTube.com.

RESULTS

Patients in this series (182 women, 46 men) ranged in age from 18 to 54 years (mean, 24.3 years). A total of 203 procedures were primary rhinoplasties; 14 were secondary rhinoplasties, and 11 were personal revisions of previous cases. The open approach was employed in 92 patients, whereas a closed dome delivery technique was employed in 136 patients. Follow-up of the 228 cases in this series ranged from 9 months to 3 years.

Postoperatively, supratip deformity was noted in 17 patients, of whom 5 required revision. Overprojection of the tip was observed in 5 patients, with revision planned for 1. The other patients with supratip deformity or tip overprojection have reported that they are pleased with their results and have not requested any revisions. Six other cases were revised: 2 for axis deviations, 2 for dorsal surface irregularities, and 2 for saddle nose deformity.

Surprisingly, we found that SSD through the subperichondrial plane was easier in revision patients who had undergone a previous SSD procedure compared with primary or other secondary cases in this series. We found the ease of secondary dissection in the subperichondrial space to be comparable to the majority of secondary septoplasties, provided the cartilage was not damaged by scoring or cross-hatching. The soft tissue envelope was easily elevated in the revision cases, which was not possible when a classical sub-SMAS dissection had been previously performed. In addition, we noted a lower incidence of bruising, swelling, and numbness in our SSD series compared with cases we had performed previously with the classical sub-SMAS dissection technique.

Clinical results are shown in Figures 3 and 4.

DISCUSSION

During rhinoplasty, the soft tissue envelope can be elevated in the subcutaneous, sub-SMAS, or subperichondrial plane. The majority of surgeons use the sub-SMAS dissection plane, which results in transitory edema, numbness, and subcutaneous scar remodeling, all of which delay the appearance of the final result. Interestingly, septal surgery is performed in the subperichondrial plane, which leads to minimal bleeding and rapid healing. In our experience, dissecting in an SSD plane over the tip and osseocartilaginous vaults is desirable, as it preserves the integrity of the soft tissue envelope. This minimally traumatic approach reduced the incidence of bruising, swelling, and numbness in the present series compared with our experience with the classical sub-SMAS dissection technique. It is our impression that repair or plication of Pitanguy's midline ligament helped control shaping of the supratip area and minimized postoperative loss of tip projection. Further, reconstruction

Figure 3. (A, C, E, G) This 23-year-old woman presented with a long nose and high tip projection. Nasal examination revealed a thin skin envelope, dorsal hump, and lateral crura deformity. (B, D, F, H) One year after primary rhinoplasty with the authors' complete subperichondrial technique, performed through a closed approach. To prevent a supratip deformity, Pitanguy's midline ligament was sutured using the overlap procedure. The scroll ligaments were repaired and a supratip breakpoint was created. An onlay tip graft was not used. The patient reported being happy with her result.

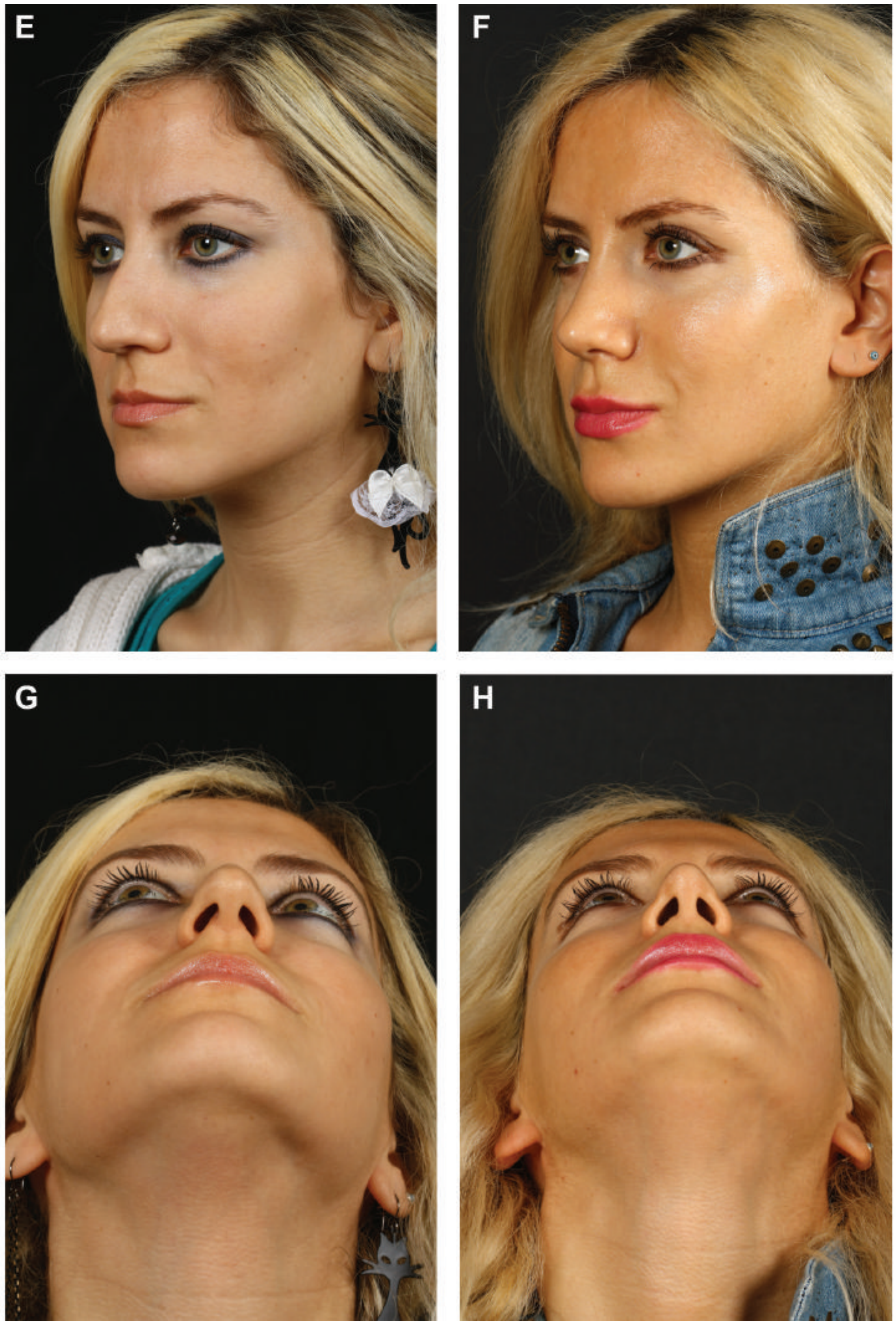

Figure 3. (continued) (A, C, E, G) This 23-year-old woman presented with a long nose and high tip projection. Nasal examination revealed a thin skin envelope, dorsal hump, and lateral crura deformity. (B, D, F, H) One year after primary rhinoplasty with the authors' complete subperichondrial technique, performed through a closed approach. To prevent a supratip deformity, Pitanguy's midline ligament was sutured using the overlap procedure. The scroll ligaments were repaired and a supratip breakpoint was created. An onlay tip graft was not used. The patient reported being happy with her result.

Figure 4. (A, C, E, G) This 24-year-old woman presented with a long nose, high tip projection, wide keystone area, and bulbous tip. (B, D, F, H) One year after primary rhinoplasty with the authors' complete subperichondrial technique, performed through a closed approach. The patient's dorsal hump was reduced, the tip rotated, and the infralobule elongated via the lateral crural steal procedure. The tip projection was decreased. Pitanguy's midline ligament was sutured using the overlap procedure to prevent a supratip deformity. The scroll ligaments were repaired and a supratip breakpoint created. An onlay tip graft was not placed in this patient.

Figure 4. (continued) (A, C, E, G) This 24-year-old woman presented with a long nose, high tip projection, wide keystone area, and bulbous tip. (B, D, F, H) One year after primary rhinoplasty with the authors' complete subperichondrial technique, performed through a closed approach. The patient's dorsal hump was reduced, the tip rotated, and the infralobule elongated via the lateral crural steal procedure. The tip projection was decreased. Pitanguy's midline ligament was sutured using the overlap procedure to prevent a supratip deformity. The scroll ligaments were repaired and a supratip breakpoint created. An onlay tip graft was not placed in this patient.

of the scroll ligament provided stability for the internal nasal valve while eliminating dead space that could fill with blood and lead to postoperative swelling. Although not discussed in detail in this series, we have also found that cartilage grafts placed in the subperichondrial pockets show less irregularity under the thicker skin envelope preserved with an SSD technique.

Surgeons consider the primary determinants of nasal tip support to be the rigidity of the alar cartilages and their relationship to the abutting cartilaginous framework. Dissection through the nasal soft tissue and the associated damage to the structural components responsible for tip support can result in loss of tip height and projection, loss of tip rotation, changes in the silhouettes of the nasal cartilages, supratip deformity, and a hanging columella.[11,12]

Soft Tissue Envelope

The musculoaponeurotic layer of the nose is a critical structure, with the nasal vasculature lying primarily within or above this plane. Dissection through the areolar sub-SMAS plane with preservation of the major vascular supply to the nasal tip has been shown to reduce postoperative tip edema and protect against skin necrosis, especially in secondary procedures.[1] However, we have found that SSD better preserves the structures overlying the perichondrium, including the SMAS and its associated ligaments, and maintains the dynamic tension of the nasal muscles, a major factor affecting nasal valves, airway patency, and breathing dynamics.[5]

Following a rhinoplasty procedure, healing and scar remodeling occur for a minimum of 12 months and continue with gradual changes in the soft tissue envelope for many years. Tardy and Schwartz[13] illustrate that continued thinning of the subcutaneous envelope occurs after a sub-SMAS approach, which can lead to downgrading of the final result seven to 10 years postoperatively, especially for patients with thin skin. Interdomal fat pads have been described in noses of all nasal skin thicknesses.[7,14] SSD eliminates unwanted injury to the interdomal fat pad.

Additional advantages of this minimally traumatic technique are the surgeon's ability to "see" the final result on the table, maintain the structural integrity of the surgical result by repair of the ligamentous structures, and minimize the amount of scar formation. Furthermore, numbness of the nasal tip due to injury of the external nasal nerve—located in most patients directly under the nasal SMAS, beginning at the nasal bone-cartilage vault junction and continuing down to the alar cartilages—is a morbidity reported in many postoperative patients.[12] This nerve is vulnerable to injury when dissection is performed through the soft tissues but is protected in an SSD.

The Nasal Lobule

The vast majority of rhinoplasty surgeons divide the nasal lobule into its component parts, both for analytical and surgical reasons. The skin, subcutaneous tissue, and alar cartilages are analyzed and then manipulated by dissection, resection, suturing, or grafting. In contrast, the SSD approach requires the surgeon to think of these structures as one entity that should be manipulated as little as possible. With our technique, it is essential to have a clear understanding of the integrated anatomy of the nasal lobule, to preserve structures at the time of exposure, and to manipulate them surgically by suturing, rather than resection. When elevating the soft tissue envelope for exposure, the SMAS layer is often disrupted in the midline, either distally at the interdomal area or above the anterior septal angle. Surgeons generally have little reluctance to resect this soft tissue, especially in patients with broad tips or thick skin. However, what many surgeons consider a mass or "blob" of soft tissue is, in reality, a very intricate SMAS system that functionally influences dilatation and compression of the nares while aesthetically influencing tip rotation directly and tip projection indirectly.

If one accepts the 5-layer laminate composition of the nasal skin,[1,2,13] then Pitanguy's ligament should not be considered a "dermocartilaginous" structure. The name implies that the ligament originates from the dermis, then transverses tangentially through the other 4 layers to insert on the cartilage, when, in contrast, Saban et al[2] have demonstrated that the medial SMAS divides into a superficial and deep layer at the level of the internal valve. In addition, Molnar et al[15] have shown that the superficial layer runs in the subcutaneous layer above the alar cartilages down into the columellar base, where it joins the superficial orbicularis oris nasalis. The deep layer runs beneath the interdomal ligament through the membranous septum with insertions onto the medial crura and the anterior nasal spine, then continues to join the depressor septi nasalis.

On the basis of these findings, we believe it is obvious that Pitanguy's midline ligament is part of the dynamic nasal SMAS layer and not a fixed dermocartilaginous ligament. It is important to identify and preserve this structure during exposure, divide it early in the procedure for subsequent reconstruction, and then repair or modify it at the time of closure. Disruption of the midline structures during elevation of the soft tissues can lead postoperatively to excessive scar tissue formation, supratip fullness, and a hanging columella. In some ways, Pitanguy's midline ligament can be viewed as similar to the reins used to raise and rotate a horse's head upward. If we destroy this midline ligament, we lose this technique for controlling tip position.

Further, by repairing or modifying the midline ligament, the tip is stabilized, allowing the surgeon to maintain or change tip projection and rotation. For major changes in tip position, many surgeons favor a combination of dorsal reduction, columellar strut placement, and tip graft insertion to achieve the desired tip projection and supratip break. In contrast, repair of this ligamentous system significantly reduces the need for these grafts. In addition, it provides the flexibility of either a direct repair to maintain tip position or a shortening of the ligament to rotate the tip upward and achieve a supratip break.

Internal Valve Area

The anatomical relationship between the ULC and the LLC (the scroll area) is of great importance when it comes to internal nasal valve anatomy and its postoperative patency. The natural anatomy of this area reveals an interlocking position maintained by the ULC and the LLC, which is reinforced by the ligament in between. This relationship is greatly disrupted by classical dissection techniques. In contrast, muscles responsible for maintaining structure and tone of the internal nasal valve, including the anterior and posterior dilators, are preserved during an SSD procedure, and reconstruction of the internal nasal valve area can only be performed when dissection is made subperichondrially, which allows both preservation of the ligaments and their subsequent repair.

CONCLUSIONS

During rhinoplasty, a complete SSD technique can be employed with either an open or closed approach to minimize disruption of the soft tissue envelope. Preservation of the dynamic musculoaponeurotic system with its ligamentous connections permits their repair at the time of closure. Repair of Pitanguy's midline ligament allows the surgeon to control tip rotation, enhance projection, and emphasize a supratip break, while reconstruction of the scroll ligament provides stability of the internal nasal valve. In addition, as compared with our previous experience using the sub-SMAS approach, we have found that a complete SSD technique is associated with a lower incidence of bruising, edema, and numbness.

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Disclosures

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CHAPTER 1.3

THE PRESERVATION TECHNIQUE: THEORETICAL MOTIVATION AND PRACTICAL DEVELOPMENTS

Valerio Finocchi

”First do no harm” is one of the first principles taught in medical faculties, especially with regard to iatrogenesis: most of the precepts underpinning the philosophy of preservation are based precisely on this phrase. This approach allows us to modify the shape and size of the primary nose while minimizing surgical invasiveness and the need to reconstruct the anatomy of the nasal pyramid.

There are three key principles to be respected: the preservation of the soft tissues of the dorsum and the cartilages of the tip. Although this is a concept that is now more than a century old, only in the last four years has great progress been made from the point of view of surgical techniques.

As far back as 1889, Goodale wrote an article entitled “A new method for the operative correction of exaggerated Roman nose” in which he described the preservation of the back and impaction by means of the removal of a high septal strip.

In subsequent years, similar methods were described before Joseph’s technique, which involved gibbotomy, took hold. But because of the mark left by this technique, this demolition approach gave way to a more structural one, in which, following the demolition of the hump and ligaments, the reconstruction of a solid anatomical structure was envisaged that would be capable of resisting the cicatricial forces during the healing phases (3).

Although excellent results were obtained with this approach, the number of secondary rhinoplasties was unfortunately not reduced, often forcing surgeons to implement reconstruction techniques using rib cartilage, also not free of complications.

The nose is a very complex structure, consisting of bones, cartilages, ligaments, muscles, aponeurosis, fat, mucosa and skin. These formations, finely connected and interconnected with each other, form a three-dimensional structure made up of various surfaces, angles, depressions and curves. What makes the anatomy of the nose even more fascinating is the fact that each nose is unique, precisely because of the infinite combinations in terms of qualitative and quantitative characteristics of the tissues and the shapes.

It follows that the surgeon who dedicates himself to a structured philosophy must not only know anatomy "like the back of his hand" but also have great reconstruction skills, since each piece removed must be reconstructed with great caution and precision, every corner recreated and every empty space closed.
Therefore, from these general considerations, the need arises in primary reductive rhinoplasty to consider less invasive techniques that can be used by a wide range of surgeons and are able to offer results with rapid healing, stable over time, and a lesser risk of leaving significative post-operative deformities, seeking a balance between aesthetic correction and the functionality of the nose that must never be neglected in the search for shape.
This is precisely why Daniel RK in a 2018 editorial entitled: "Preservation rhinoplasty, the next revolution in rhinoplasty", stated the need to replace resection with preservation, excision with manipulation and secondary reconstructions with rib cartilage with simple, minimal revisions.

Micro and macroanatomy static and dynamic

Understanding the microanatomy of the nose has become fundamental today. The various tissues are articulated not only in a static way but also dynamically. We are used to breaking down the areas of the nose into units for educational reasons, although these are structures that are dynamically related to each other.
It is now known that the growth of the septum plays a role in nasal development and in the formation of the hump. By remodelling it and changing its position in space, it is possible, for example, to modify the profile of the back. This is because the keystone area, often considered simply a passageway between bone and cartilage, is actually a flexible and extendable synchondrosis (chondro-osseous joint) that can be mobilized if the structures that hold it in place are remodelled. It therefore has a specific "range of motion" (Rom) that can be released with specific manoeuvres, making it possible for us to modify the curvature of the profile.
Nasal ligaments are equally important: they divide the nose into compartments (for example, tip and back); they have functional roles such as the support of the nasal valves and the tip; aesthetic roles, since they create definition in some important areas (*supratip break point, supratip alar crease*); their anatomical repositioning avoids the formation of deformities (for example *polly beak deformity, supratip deformity*).

The stages of preservation rhinoplasty

Preservation rhinoplasty is divided into the following stages:
- preservation of the cutaneous-subcutaneous envelope (dissected or not);
- preservation, remodelling and impaction of the dorsal-septal unit;
- preservation, minimal excision and remodelling of the alar cartilages through the use of sutures.

If applied correctly, these stages allow us to obtain stable and substantial aesthetic-structural changes without compromising anatomy and function, minimizing reparative processes and therefore recovery times and patient discomfort. This type of approach reduces complications and, if they occur, they can be corrected with minimal revisions.

Preservation of the cutaneous-subcutaneous envelope

The cutaneous-subcutaneous envelope, if preserved, makes it possible to avoid excessive

post-operative oedema, numbness, prolonged scar remodelling and progressive thinning.
Subperichondrial-subperiosteal dissection, if access to a specific structure is necessary: this type of dissection requires good dexterity and ad hoc microsurgical instruments and must be mastered. This avascular plane permits a practically bloodless field (fig. 1), with an excellent view of the structures, and the cartilages are more easily modelled because they have no envelope. Furthermore, histological studies have shown that the activity of fibroblasts is markedly reduced and this translates into a faster recovery with greater stability of the result.

Maximum preservation of soft tissues: in some selected cases, keeping firmly in mind the concepts of dynamic anatomy, we can afford the luxury of avoiding the detachment of the external soft tissues (TM). For example, as will be seen in the chapter dedicated to the SPQR (Simplified Preservation Quick Rhinoplasty) technique, it is possible to avoid detachment of the back in a wide range of cases. A back that is not detached is a back “not operated upon”, without any type of regenerative activity and therefore can easily be operated on in case of technical errors or impaired healing, a back free from certain types of complications (fibrosis, callus).

Figure 1 Subperichondrial-subperiosteal dissection. This avascular plane makes it possible to have a bloodless field with an excellent view of the structures; the cartilages are more easily modelled because they have no perichondrial envelope

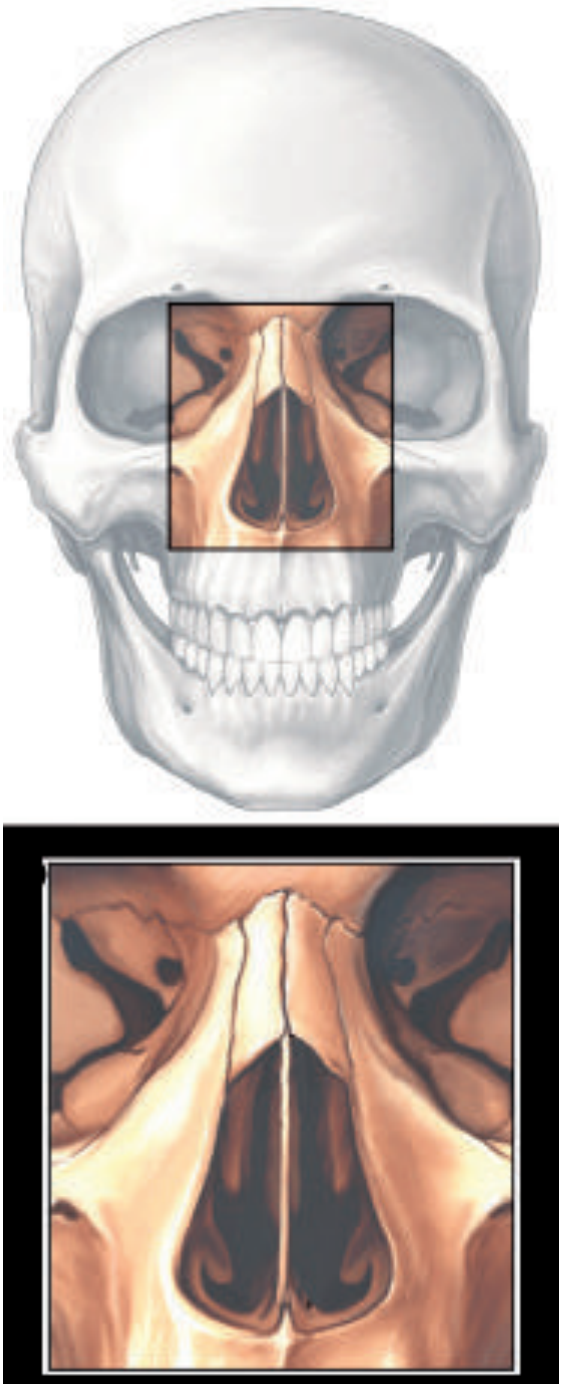

Figure 2 The nasal spine rests on three pillars: the nasal bones and the upright branch of the maxillary bone constitute the lateral pillars, while the nasal septum provides the central pillar

Preservation, remodelling and impaction of the dorsal-septal unit

Two fundamental points must be considered:

- the keystone area is a flexible joint held in place in a given position by tissue. Joint release techniques will be fully explained in the chapters on preservation rhinoplasty. The dorsal-septal unit is modified to allow the keystone area to flex and modify the dorsal profile;
- the nasal spine rests on three pillars (fig. 2), the two bony walls and the nasal septum.

The bony walls can be treated with three different methods:

1. through the *push down technique*, that is, circumferential osteotomies (low to low, transverse and root). In this case, the bony portion slides into the pyriform aperture;
2. through the *let down technique*, that is, an osteoectomy of the base of the bony vault associated with transverse and root osteotomy. In this case, no internal sliding takes place but it is as if the foundations were removed from a building;
3. through the *hybrid technique* which involves the osteotomy of Webster's triangle which then continues with a low to low osteotomy up to the medial canthus and the completion of the circumference with transverse and root osteotomy.

Each technique has pros and cons, which will be covered in depth in the respective chapters.

The septal pillar can be treated at various levels: high, medium and low.

Preservation, minimal excision and remodelling of the alar cartilages through the use of sutures

The tip is reshaped by modifying the angles of incidence between the alar and triangular cartilages (resting angles) (see chapter 20, "Lateral crural steal and medial crural overlay by Salvatore Taglialatela) and avoiding aggressive resections that may cause valvular retraction or incompetence. Once the position of the structures is changed, they are stabilized so that they cannot be altered during the healing phases.

Conclusions

This philosophy deserves to be included in the technical armoury of today's rhinology surgeon. Despite the wide range of its application, this approach is not *per se* the gold standard of primary rhinoplasty but has precise indications that must be considered and respected.
Indeed, the future of rhinoplasty lies in combining the principles of preservation with the structural approach in order to exploit the merits and benefits of both and give rise to effective techniques, with reduced discomfort and rapid recovery, a lower number of complications, however easy they may be to correct, but above all with excellent aesthetic and functional results that are stable over time.

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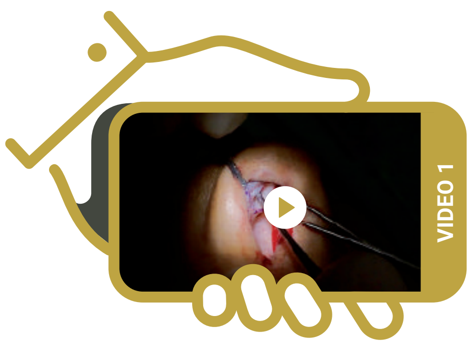

Subperiosteal subperichondrial dissection

CHAPTER 3.3

THE CROOKED NOSE

Pisa Tower Concept and Swinging door septoplasty: a winning combination in the most complex dorso-septal deviations


Valerio Finocchi


Valentino Vellone

The crooked nose – that is, the deviation of the nasal pyramid from the median line of the frontal plane – is a constant challenge for rhinosurgeons.
The types of dorsal deviation can be many and often also involve the nasal tip.
There are multiple causes of the deviation of the nasal pyramid and include, in the first instance, traumas, followed by iatrogenic or congenital factors.
All faces present an asymmetry but most people do not notice this if it is less than 3-4 mm.
However, it is very important to show the patient their facial asymmetry before performing the operation since the level of attention to each little detail will increase the post-operative period.
A careful analysis becomes essential for planning the operation. Each of the anatomical components (upper lateral cartilages and alars, the septum, the osseous vault, the nasal spine, the soft tissues and the ligament must be assessed since each can contribute to creating this deformity.
Even though, in structured rhinoplasty, various nasal osteotomy techniques have been described for the correction of osseous nasal deformities, so far surgical strategies have not been described that would be compatible with the dorsal preservation philosophy.
The three main pillars of the dorsum are made up of the nasal bones (in conjunction with the upright branch of the maxillary bone) and the nasal septum. Therefore, the correction of a crooked pyramid must involve the evaluation and, where necessary, management of one or more pillars.

The correction of the septum is essential for surgical success since, in these cases, a major septal deviation is usually present but the nasal bones are equally important, which are often asymmetrical (Rhinion distance-pyriform aperture asymmetric between the two sides) (figures 1 and 4).
Various techniques are available to correct the septodorsal junction (scoring, crossbar graft, asymmetric spreader graft, spreader flap with asymmetric tension) (1-4).
Although these techniques are relatively minimally invasive and generally produce favourable outcomes, all are based on an L (L-structure) septoplasty. This technique, however, does not take account of the influence of the perpendicular plate of the ethmoid (PPE) on the quadrangular cartilage (QC). Therefore, in the case of high septal deviation, it becomes very difficult to correct a septal deviation and the surgeon is forced to use camouflage grafts (only unilateral or double-side spreader grafts from the concave side) or even an extracorporeal septoplasty (2,3).

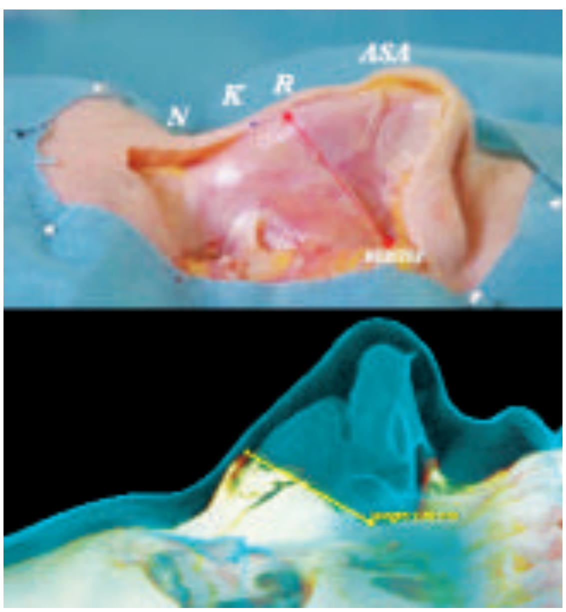

Figure 1 R-web distance. The distance between Rhinion and the most lateral and caudal portion of Webster's triangle. This distance in a symmetrical nose is bilaterally equal while it is different in some types of crooked nose (N= nasion, K = khipion, R = rhinion, ASA= anterior septal angle)

On the other hand, for the nasal bones, many osteotomy techniques have been proposed in the literature for the correction of a deviated nose: double lateral osteotomy in the longer nasal wall or, as described by Uygar Levent Demir (5), a low to low osteotomy combined with transversal osteotomy of the root on the long side and a low to high osteotomy on the short side with the addition of a spreader graft from the long side.
Until today, the deviation of the nose seemed to be a criterion of exclusion of the dorsal preservation technique.
Authors, underlining the versatility of the dorsal preservation technique, have also applied this concept in the correction of a crooked nose, introducing the combination of the "Pisa Tower Concept" (fig. 2) with the "swinging door" septoplasty (fig. 3) from the perspective of specifically correcting the three dorsal pillars. In our case studies, 60% of crooked noses present a deviation of the central pillar (osteocartilaginous septum) associated with a deviation of the nasal bones (lateral pillars). The remain 40%, on the other hand, present only the deviation of the cartilaginous vault (and so only of the central pillar) and this group is not involved in the technical combination proposed by us.
Deviated and asymmetric nasal bones have been compared to the walls of the famous Tower of Pisa.
One side of the "tower" appears longer, so the aim is to make the lengths of the two sides equal through an ostectomy of the upright branch of the maxillary from the "longer" side of the nasal pyramid. Once the distances between Rhinion and pyriform aperture have been made bilaterally equal and the septum centred again on the medial line, an asymmetric impaction will be obtained of the osteocartilaginous vault with its complete recentring.

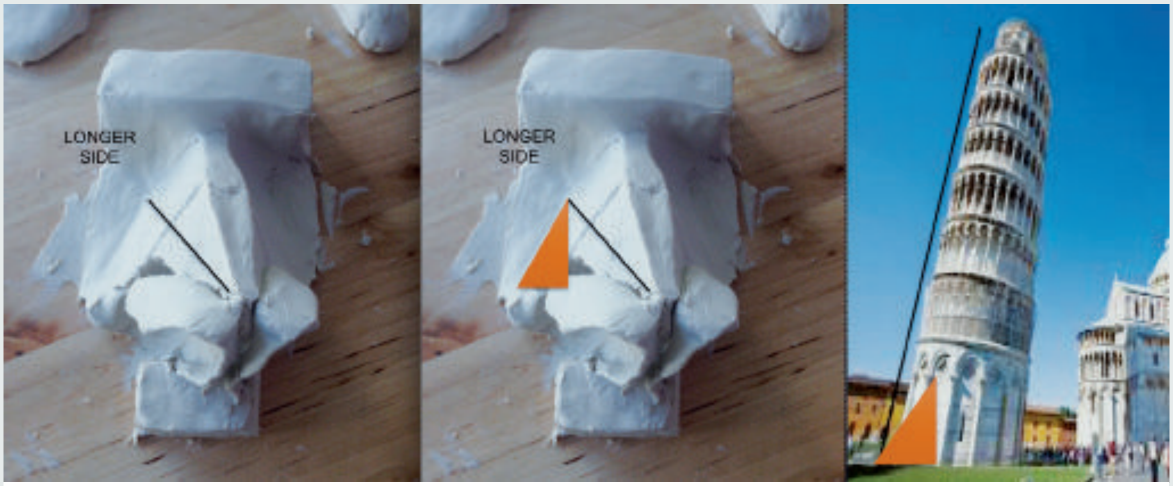

Figure 2 Deviated and asymmetric nasal bones have been compared to the walls of the famous Tower of Pisa. One side of the "tower" appears longer, so the aim is to make the lengths of the two sides equal through an ostectomy of the upright branch of the maxillary from the "longer" side of the nasal pyramid.

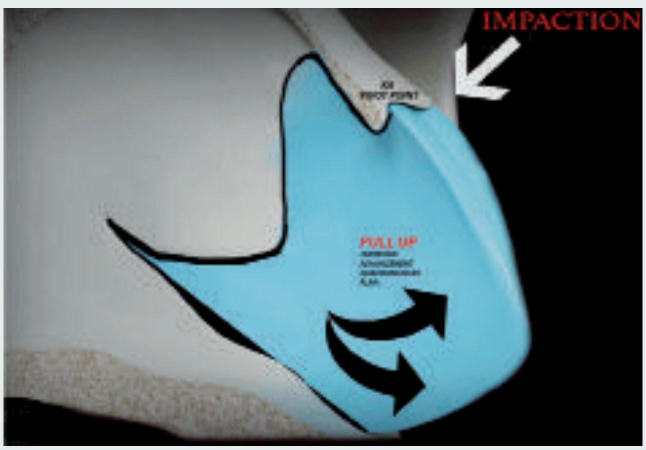

Figure 3 Swinging door septoplasty. The quadrangular cartilage is detached from the perpendicular plate of the ethmoid and remains attached only to the dorsum by the rhinion up to the anterior septal angle. Since it is detached, it can be easily mobilised both on the sagittal plane (thereby being recentred on the median line) and the coronal (that is, rotating anteriorly)

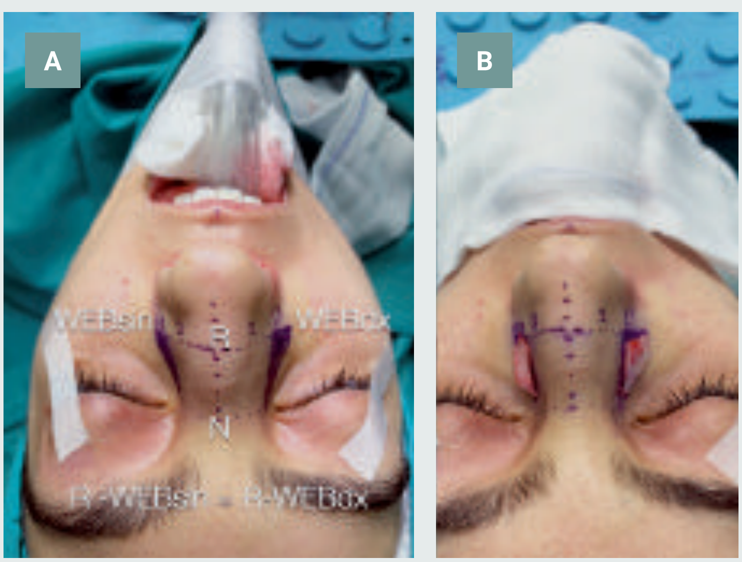

Figure 4 A-B Clinical case where it is shown how to regulate the quantity of bone to remove. The R-web distance in Caucasian women should on average be 20 mm. In this case, it is 3.5 cm on the right and 2.5 cm on the left. Therefore, the osseous triangle to remove for the let down must have a caudal base of 1.5 cm on the right and 0.5 cm on the left.

Surgical technique

- The first step consists of a swinging door septoplasty, slightly modified compared to Wright's description (6). The cartilaginous septum is elevated at the base, in an anteroposterior direction, starting from the anterior maxillary spine to the chondro-vomerine joint and, from there, the quadrangular cartilage is completely disarticulated from the perpendicular plate of the ethmoid up to point E. This enables the QC to lose all influence on the part of the osseous septum because it is totally disengaged. Generally, point E is cephalic with regard to the Rhinion (R) and it may be necessary to also free the R-E segment to completely free the synchondrosis of the keystone in order to allow a correct mobilisation of this joint. Once free, the quadrangular can be considered as a flap that can be shifted both on the sagittal and coronal planes (see chapter 7 on the SPQR technique). At this point, the posterior septum can be corrected. Should the quadrangular also be deviated (usually in post-traumatic cases) it is possible to carry out a scoring on the concave side and then, if that is not enough, to graft a multi-perforated portion of PPE with stitches in PDS 5/0.
- The second step consists of the performance of transversal osteotomies using an intranasal approach with a Tastan-Cakir hand saw or through the percutaneous route with a 2 mm osteotome. The osteotomy of the root can vary depending on the case (oblique or sagittal depending on the need or otherwise to modify the height of the root). Now is the time to complete the disarticulation of the nasal pyramid from the cranium by performing either a let down (LDO = let down operation) or an asymmetric push down (PDO = push down operation) or two asymmetrical let downs. A bony wedge is removed from the ascending maxillary process to obtain a greater impaction of one side compared to the other, based on the pre-operative measurements (figures 1-4). The normal average distance between Rhinion and pyriform aperture (known as R-web, where web indicates Webster's triangle) in the Caucasian population is 20 mm (in females) and 25-30 mm (in men). The bony wedge to be removed is triangular in shape with caudal base and cephalic vertex. The final goal is to obtain two lateral osseous walls of equal length. Therefore, the osseous tissue that is found beyond the correct distance of the lateral wall must be removed up to the pyriform aperture. If only a straightening of the pyramid is planned, a let down is performed from the longest side and a contralateral push down (a simple low to low osteotomy) from the shortest side, which will make the impaction a pivot point of the pyramid. If, as well as the deviation, it is necessary to reduce the height of the profile, a bilateral but asymmetric let down will be carried out. The Rongeur is the ideal instrument (especially for those still inexperienced) to perform an osseous resection (fig. 5) of the wedge after a wide internal and external periosteal dissection but it can also be performed with a protected osteotome (the anterior osteotomy must be performed first in order to ensure good resistance and stability of the bone during the more basal osteotomy). Following the circumferential mobilisation of the dorsum, it may be necessary to correct a slight "rocker deformity" on the side contralateral to the deviation. By removing the osseous wedge, moreover, the narrowing of the inner nasal valve during the nasal impaction is avoided because Webster's triangle will not slip towards the head of the inferior turbinate (figures 6-7). In combination with the swinging door septoplasty, it is possible to correct complex crooked noses without the need for an extracorporeal septoplasty. The dissection of the lateral keystone area (LKA), also called the "Ballerina manoeuvre", has

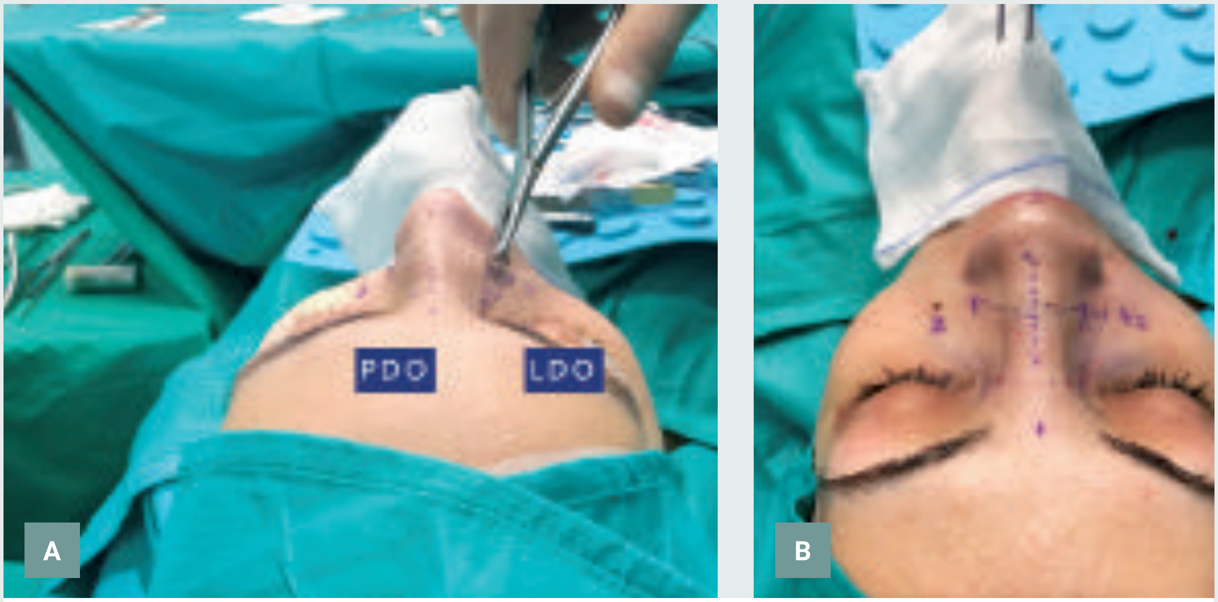

Figure 5 In this case, in the photo on the left, it is possible to note that the left R-web is correct and therefore the left osteotomy line (PDO) should only act as a pivot for the asymmetry impaction. On the right, however, the R-web distance is 3 cm and therefore an excess of 1 cm. The osseous triangle to remove will have a caudal base of 1 cm. In the photo on the right, it is possible to see that, once the osseous disarticulation has been carried out, the osteocartilaginous vault is realigned

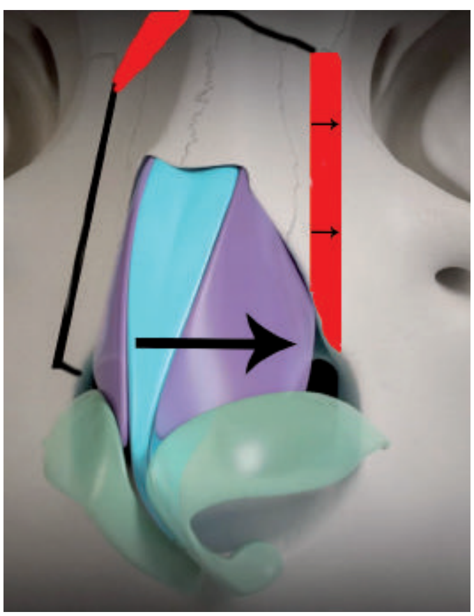

Figure 6 3D Image. Usually in cases of crooked nose, after performing the disarticulation, a Rocker deformity may be noted along the transverse osteotomy line of the ipsilateral side to the deviation. Therefore, a second external osteotomy may be necessary with a 1 mm scalpel to lower the osseous spur

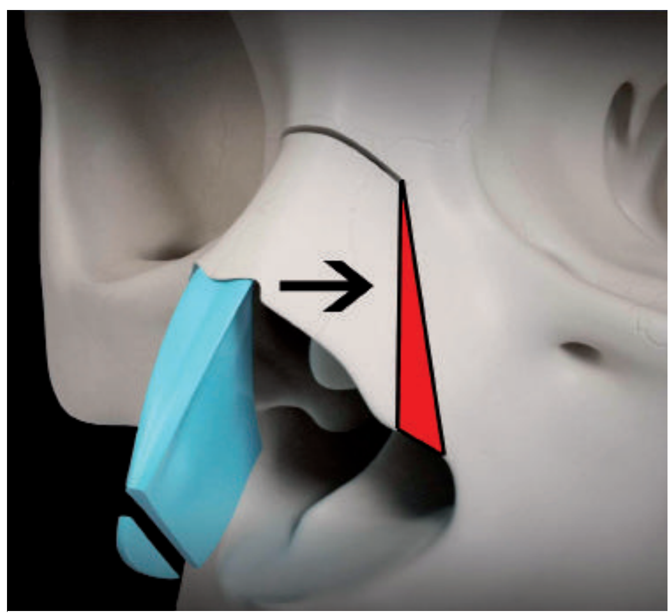

Figure 7 3D image that shows the triangular shape of the osseous portion to be removed. In this case, the longest side is on the left and so the axial deviation of the nose is to the right. By detaching the quadrangular cartilage from the PPE, removing the osseous triangle and disarticulating the remaining osseous part, it will be possible to obtain a frontal dorsal realignment recently been popularised by Abdulkadir Goksel as an ancillary manoeuvre in the liberation of the dorsal joint for the purpose of flattening the profile. In reality, based on our experience, it is an optional manoeuvre that is not always necessary since we believe that the dissection of the pyriform ligament is more effective in contributing to the mobilisation of the keystone. On the contrary, it is fundamental for us in the realignment of the upper lateral cartilages beneath the bones when one is longer than the other (fig. 8). The upper lateral cartilages (ULC) are free to be correctly repositioned with the longer side, which slips internally, while the shorter one moves outwards. Furthermore, at the end of the operation, it is necessary to check that the caudal portion of the upper lateral cartilages does not overlap the scroll area or the respective lateral crus. In that case, a triangle of caudal portion must be resected in such a way that there is a space between ULC and LLC where the longitudinal component of the scroll ligament will be repositioned at the end of the operation.

As can be seen in the following clinical cases, the association of the Tower of Pisa concept with the swinging door septoplasty enormously facilitates the correction of difficult deviations. Obviously, once recentred, an excessive height of the QC flap will be clear and its height will therefore be corrected by removing a low strip and refixing the cartilage to the anterior maxillary spin with a stitch in PDS 5/0.

CLINICAL CASES

To simplify these complex cases, we have divided them into two groups that will be discussed below.

Type 1. The nasal cavity is decentred, asymmetric osteocartilaginous vault with a septal deviation (Tower of Pisa concept).

It is possible to compare the anatomy of these cases with the Tower of Pisa.

One side of the tower appears longer: to straighten the tower, the longest side must be made equal to the shorter one.

Removing a wedge of bone (orange triangle), the osseous nasal wall becomes the same length as the contralateral and the nasal "Tower" can be impacted in the right position.

For these cases, the following is performed:

- swinging door septoplasty;
- Tower of Pisa concept. The asymmetric osseous resection of the wedge (LDO) performed on the side of the nasal pyramid
- the treatment of the contralateral osseous wall depends on the quantity of reduction of

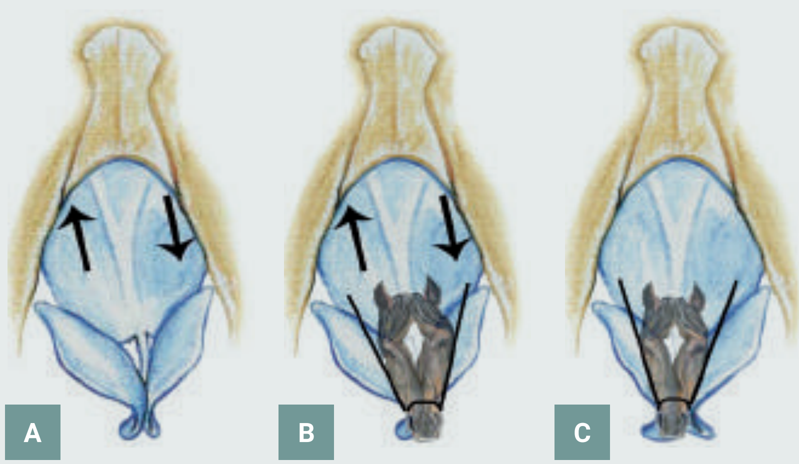

Figure 8 A-B-C The LKA dissection enables the upper lateral cartilages to slip beneath the nasal bones and to realign them in their correct position. This movement can be thought of as if the septum were the head of a horse and the upper lateral cartilages its reins. Once the forces that retain these structures in that position have been released, we will obtain a realignment of the dorsal cartilaginous components

the nose planned; if minimal, an osteotomy is obligatory from low to low without periosteal dissection (this side acts as a pivot and is not impacted); in the case of a greater reduction, a minimal LDO may be necessary since a simple PDO would not be sufficient to allow a reduction of the profile.

Clinical case 1

Analysis and technique. This patient was operated on by us in live surgery during the National Congress of the Aiceff Society (the Italian Association of Aesthetic and Functional Surgery of the Face). Note how it can be seen that the decentred/deviated left nasal cavity presents a longer right nasal bone, a shorter contralateral nasal osseous wall and a septal deviation with deviated nasal tip. For the dorsum, I used the SPQR V2 technique (therefore without dissection of the dorsal soft tissues) associated with a swinging door septoplasty + osteotomies/ostectomies according to the Tower of Pisa concept + low strip resection and recentring the septum to the anterior maxillary spine + tip in accordance with Cakir. This deformity can be corrected by acting on three pillars, so first of all the septoplasty, then an asymmetric disarticulation of the nasal pyramid with the following order of manoeuvres: external transversal osteotomies + osseous wedge resection on the right + low to low osteotomy on the left + osteotomy of the root. Then, on the right, I performed an LDO while, on the opposite side, a PDO. If a greater reduction should be necessary, an LDO on the left side would have been necessary (with a minor resection).

Type 2. The osseous components, the cartilaginous vault/nasal septum complex is deviated and the ULCs present a different cranial-caudal length.

Therefore, it is clear from the analysis that the upper lateral cartilages (ULC) are positioned asymmetrically under the Lateral Keystone Area (LKA). Usually, the ULCs are brought ventrally to the nasal bones by around 1 cm. However, in these cases, the ULCs on the long side are less extended under the nasal bones compared to the contralateral.

Surgical technique. In these cases, in addition to the osteotomies/ostectomies already described must be associated with the dissection of the LKA since it allows the ULC to be stabilised in the correct position. The aim is to make the UCL slide from the long side cranially and that of the short side caudally. The swinging door septoplasty alone would not allow an optimal recentring of the cartilaginous vault since the triangulars, unless released, would have no way of being repositioned. Conceptually, the septum can be considered as the head of a horse and the ULC as the reins (fig. 8). After the dissection, the ULCs are free to slide beneath the nasal bones cephalically on the long side and caudally on the short side and the septum is positioned on the median line.

CLINICAL CASE 1 page 185

Clinical case 2

Analysis. The osteocartilaginous vault is deviated with asymmetry of the ULCs. The profile displays a deep root with a slight hump. It can be classified as a V-shaped dorsum.

Surgical technique. The following order of manoeuvres was carried out: a swinging door septoplasty + SPQR V1 dissection + LKA dissection + osteotomies/ostectomies with the Tower of Pisa concept (LDO on the left and PDO on the right) + low strip resection and recentring of the septum + tip in accordance with Cakir. The SPQR V1 approach enables the dorsum remodelling, then, once the soft tissues of the dorsum were dissected, I first flattened the bony cap with a rasp, then I performed the LKA dissection. After asymmetrically disarticulating the dorsum and removing the low septal strip, dorsal recentring is immediately seen. Now the tip, if it does not retract on its own, can be remodelled by performing asymmetric lateral crura steal.

CLINICAL CASE 2 page 186

Clinical case 3

Analysis and technique. All the structural components of the nasal pyramid are deviated to the left, therefore the long side is the left one and the short one is the right. Nasal bones, septum, triangulars, scroll ligament insertion, alar cartilages. Despite this, the patient has a dorsum with good aesthetic lines. The dorsum profile is V-shaped and so has a flat bony cap. We can say that the hump is practically absent. In my experience, it becomes more complex to realign it with a structural technique than a preservation technique. In my opinion, the preservation philosophy offers a faster and more elegant way out in the realignment. Figure 5 is the intraoperative photograph showing how the right ostectomy was set up to ensure that the right lateral side would become of a equal size to the left. Summarising, the order of the manoeuvres was the following:

- swinging door septoplasty;
- tip elevation, scroll ligament and cartilaginous dorsum;
- LKA dissection;
- transverse osteotomies;
- right ostectomy;
- left low to low osteotomy;
- inside-out oblique root osteotomy;
- low septal strip resection and fixing QC to the anterior nasal spine;
- tip recentring with asymmetric lateral crural steal and subsequent asymmetric medial overlay (more to the right and less to the left);
- repositioning the scroll ligament in its orthotopic position;
- closure of mucosa breaks.

CLINICAL CASE 3 page 187

Complications

Pre-analysis: patient with an S-shaped dorsum and slight deviation of the nasal pyramid to the left in the frontal view. The septum presented a high septal deviation with perpendicular plate of the ethmoid on the left. This led to an indirect deviation of the quadrangular cartilage.

Operation: a swinging door septoplasty was performed to free the quadrangular cartilage – SPQR V1 technique (dorsal elevation) + asymmetric bilateral LDO (with greater removal of bone on the left) + resection of low septal strip and recentring of the septum on the anterior maxillary spine + remodelling of tip in accordance with Cakir. The elevation of the dorsum enabled the keystone area to be remodelled both with a rasp and by resection of the paraseptal clefts, which were very prominent.

Post-analysis: dorsal aesthetic lines not perfectly parallel. In particular, at the level of the left lateral side, it can be seen that there is an enlargement of the middle third. The causes of this are to be sought in two possible points:

- in a septum that has probably not been well detached from the perpendicular plate of the ethmoid and that therefore continues to exert pressure to the left on the left ULC, which therefore extends slightly to the left;
- the length of the ULC could not be corrected and, as a consequence, was compressed between the ligament scroll and the osseous nasal dorsum, altering its flattening and causing its curvature.

Despite the fact that the level of precision required has risen enormously in recent years due to the fashion for selfies, the patient was satisfied with the work carried out and did not request a correction. But should that have been necessary, what would we have done?

- First step: a new septoplasty making sure to properly detach the perpendicular plate of the ethmoid from the quadrangular cartilage and checking that the distance from the dorsum to the anterior septal spine was correct. In the case of cartilaginous curvature, removal of a low septal strip.
- Second step: should the previous manoeuvre not be successful through an intercartilagi-

nous incision, a caudal portion of triangular cartilage should be removed so that it can be opened out.

This case (fig. 9) makes it clear that there must be great precision in the management of the three dorsal pillars and that nothing must be neglected. The cases have often multifactorial causes that can depend on the combination of many structures. Therefore, at the end of the operation, it is necessary to be maniacal in re-checking and, in the event a slight asymmetry is seen, it must not be assumed that "it will adjust itself" because the truth is that it can only worsen. Therefore, it is necessary to recheck the bony stumps, the septum, the length of the ULCs and review all the steps in reverse order.

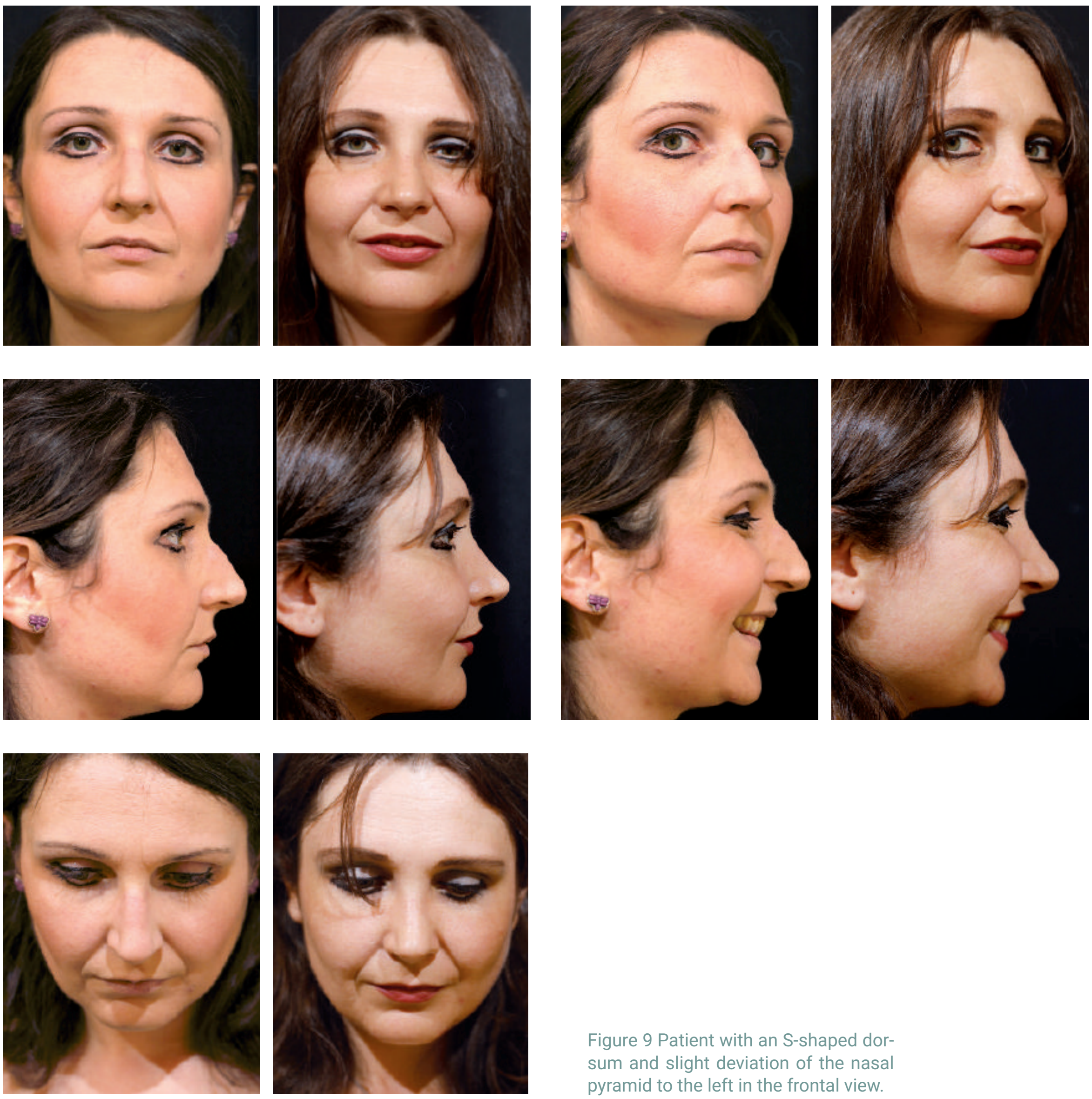

Figure 9 Patient with an S-shaped dorsum and slight deviation of the nasal pyramid to the left in the frontal view.

Conclusions

Cases of crooked nose represent a real nightmare for the rhinosurgeon. It is of fundamental importance to analyse the external (photo and palpation) and interior (rhinoscopy and CT cone beam) structures. Once the aetiology underlying the deviation is understood, it is possible to apply either structural techniques (which however, in most cases, require asymmetric grafts) or preservation techniques (that involve acting on dorsal pillars). As the title of this book says, the ways of rhinoplasty are infinite. It is possible to obtain excellent results following both philosophies.

In our experience, the combination of swinging door septoplasty and the Tower of Pisa concept has greatly facilitated things at the technical level since it has enabled us to create a rapid routine (especially if compared to extracorporeal septoplasty), capable of obtaining excellent aesthetic and functional results, with a rapid recovery (especially when it is possible to avoid dorsal dissections) and a proper dorsal realignment.

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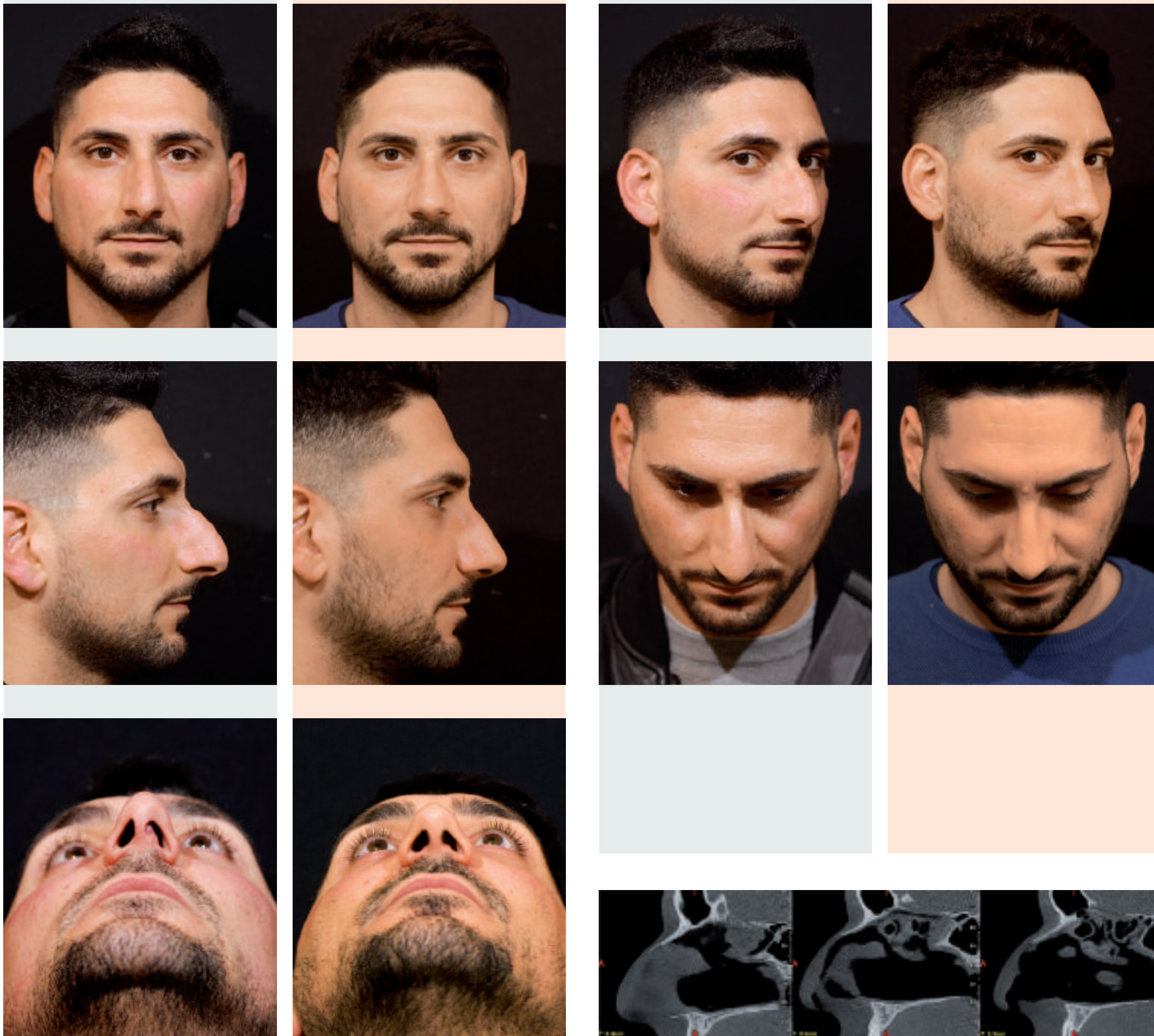
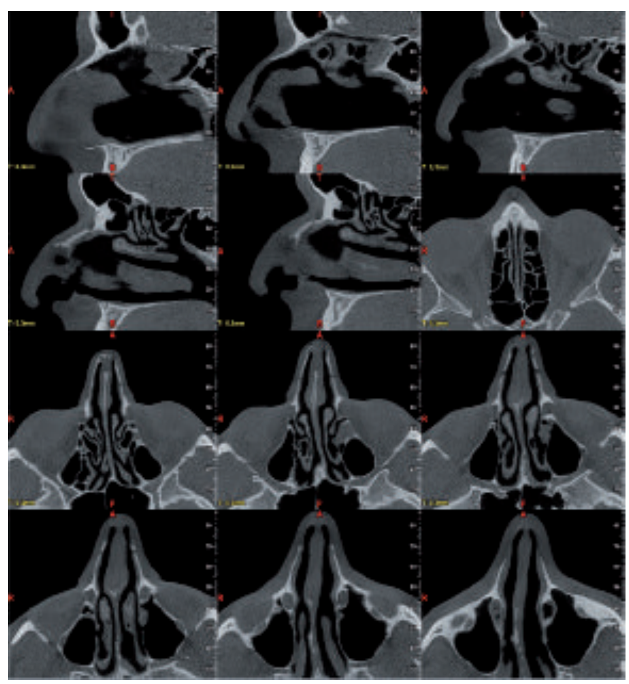
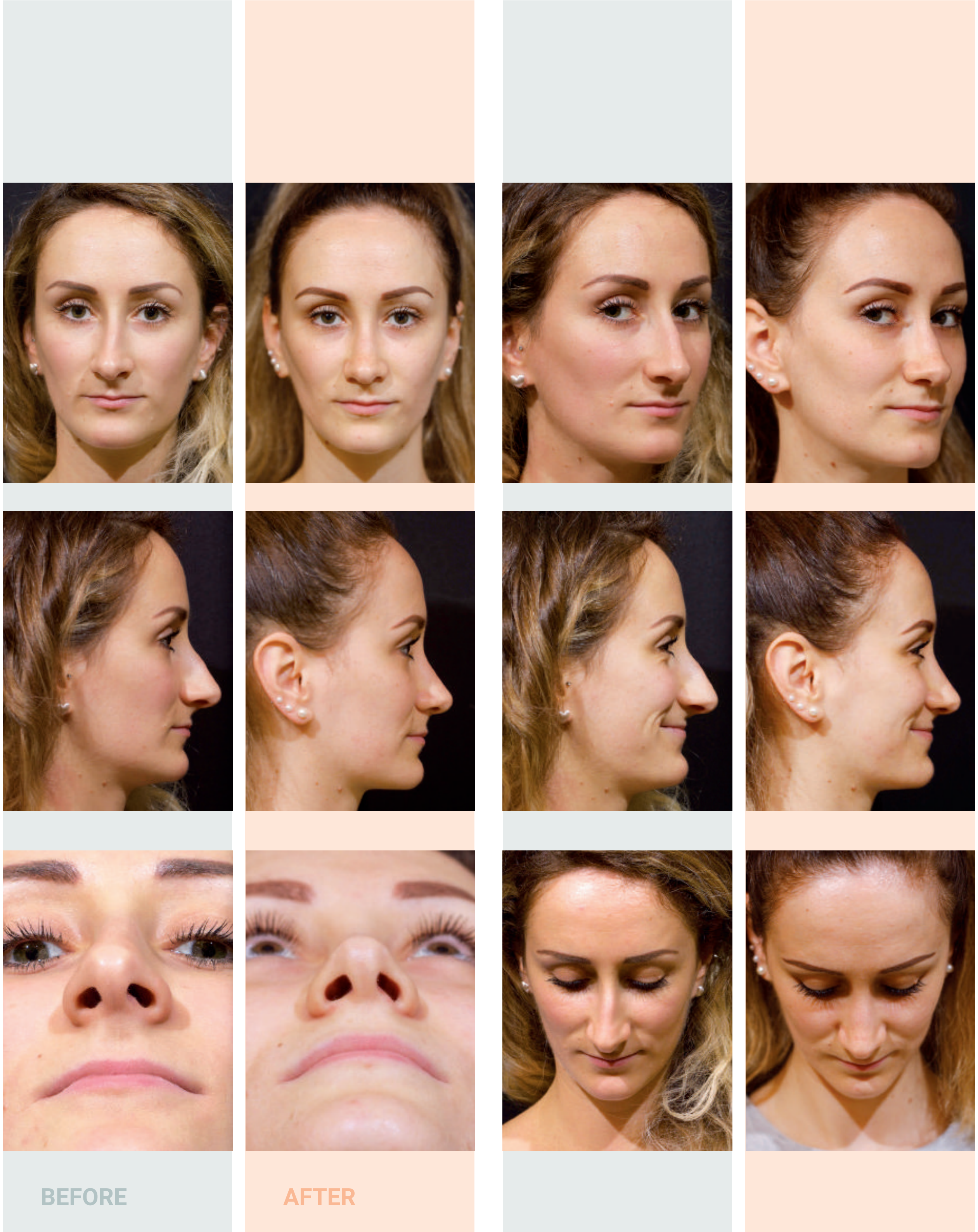
Combination of the Tower of Pisa Concept – Swinging Door septoplasty in the correction of the deviation of the septodorsal complex





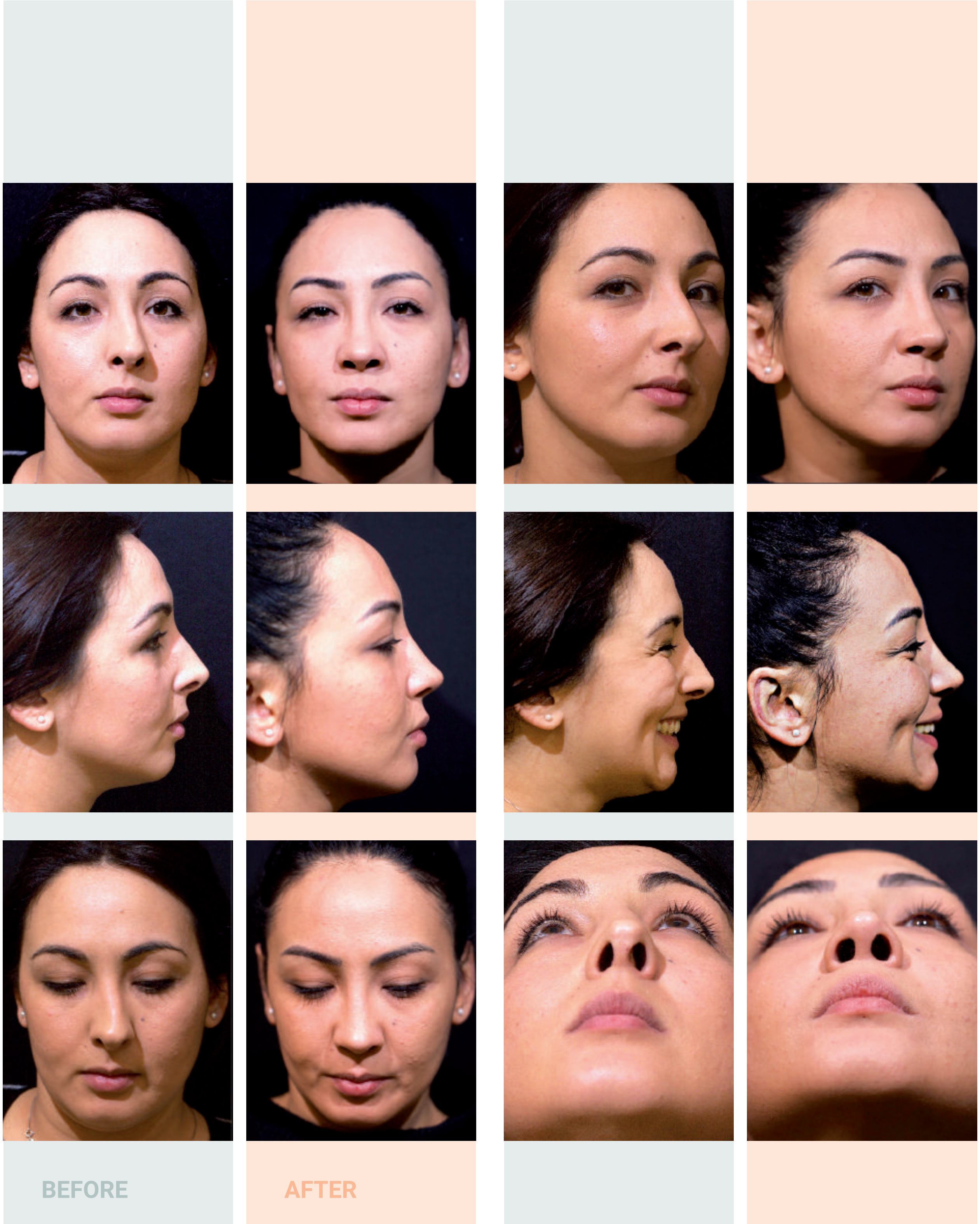
CLINICAL CASE 1

The patient was operated on by us in live surgery during the National Congress of the Aiceff Company. The decentred/deviated left nasal cavity presents a longer right nasal bone, a shorter contralateral nasal osseous wall and a septal deviation with deviated nasal tip.



CLINICAL CASE 2

The osteocartilaginous vault is deviated with asymmetry of the ULCs. The profile displays a deep root with a slight hump. It can be classified as a V-shaped dorsum.



CLINICAL CASE 3

All the structural components of the nasal pyramid are deviated to the left. Therefore, the long side is on the left and the short one is on the right. Nasal bones, septum, triangulars, scroll ligament insertion, alar cartilages. Despite this, the patient has a dorsum with good aesthetic lines.

Expanding Indications for Dorsal Preservation Rhinoplasty With Cartilage Conversion Techniques

Aaron M Kosins, MD

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Abstract

Background: Preservation rhinoplasty (PR) is a new and evolving philosophy in rhinoplasty surgery. As a surgeon becomes more experienced with preservation concepts, he/she begins to look for new ways to apply PR to an increasing percentage of primary cases.

Objectives: This article presents a series of 100 primary rhinoplasties that underwent dorsal preservation with an emphasis on the cartilage-only dorsal preservation.

Methods: A total of 226 primary rhinoplasty cases were studied retrospectively between July 2017 and August 2018. One hundred cases of dorsal preservation were included in the study. Data was collected in all cases regarding age, gender, ethnicity, and technical details of the operation. These 100 cases fall into the following 3 categories: (1) dorsal preservation employing a subdorsal strip; (2) dorsal preservation utilizing a cartilage-only pushdown with separate bony pyramid modification; and (3) dorsal preservation employing a cartilage reduction method with separate bony pyramid modification.

Results: Fifty-seven patients underwent subdorsal strip technique, 39 underwent cartilage-only pushdown technique, and 4 underwent cartilage modification. The average lowering was 4.5 mm (range, 2-10 mm), 2.5 mm (range, 1-3.5 mm), and 2 mm (range, 1-2.5 mm) for the subdorsal strip, cartilage-only pushdown techniques, and cartilage modification technique, respectively. No patients required revision surgery of their dorsum.

Conclusions: PR is a paradigm shift in rhinoplasty. With time, surgeons will find themselves asking in every situation whether they can preserve structures. Dorsal preservation is a reliable technique if patients are chosen properly. With bony cap modification, more dorsums can be preserved and dorsal aesthetics can be improved.

Level of Evidence: 4

4
Therapeutic

Editorial Decision date: March 10, 2020; online publish-ahead-of-print March 18, 2020.

Preservation rhinoplasty (PR) is a new and evolving philosophy in rhinoplasty surgery. As a surgeon becomes more experienced with preservation concepts and techniques, he/she begins to look for new ways to apply PR to an increasing percentage of primary cases. This article presents a series of 100 primary rhinoplasties that underwent dorsal preservation with an emphasis on the different types of dorsal preservation, including the cartilage-only dorsal preservation. The cartilage-only dorsal preservation technique is an easy way for surgeons to incorporate PR, and specifically dorsal preservation, into their rhinoplasty practice.

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For review, PR is composed of 3 distinct parts, including (1) preservation of the soft tissue nasal envelope by dissecting in a subperichondrial-subperiosteal plane and preserving the nasal ligaments; (2) preservation of the osseocartilaginous dorsum by maintaining the integrity of the middle third; and (3) preservation of the alar cartilages with tensioning and suturing techniques as opposed to excisional techniques. Dorsal preservation (number 2) is just 1 component of PR that avoids the creation of an "open roof" via traditional en-bloc or split hump reduction techniques. On the contrary, dorsal preservation maintains the osseocartilaginous structures while eliminating the dorsal hump utilizing septal resection to reduce the height of the dorsal profile. By modifying the dorsum without separation of the upper lateral cartilages from the dorsal septum, midvault reconstruction is unnecessary.

Currently, 2 forms of traditional dorsal preservation are being performed with either a high or low septal strip removed from the septum followed by mobilization of the bony pyramid via osteotomies and either a pushdown or letdown procedure. In the cartilage-only pushdown, the osseocartilaginous hump is converted into a cartilage-only hump, and pushdown of the cartilaginous hump only is performed with the bones modified separately. This article will review 100 dorsal preservation primary rhinoplasties, including the techniques employed and expanding indications for each.

METHODS

These 226 primary rhinoplasty cases were studied retrospectively between July 2017 and August 2018. Informed consent was obtained from all patients, and guiding principles from the Declaration of Helsinki were followed. One hundred cases of dorsal preservation were included in the study. No secondary rhinoplasty or secondary septoplasty cases were included. Asian patients were excluded because their dorsums are rarely reduced and are thus not usually candidates for dorsal PR. Any patient not having at least 1 year of follow-up was also excluded. All patients included had no previous nasal surgery whatsoever. Data were collected in all cases regarding age, gender, ethnicity, and technical details of the operation. Technical details were recorded with a focus on dorsal preservation, including amount of reduction, straightening maneuvers, nasal bone surgery including types of piezoelectric osteotomies and piezoelectric rhinosculpture, and fixation. These 100 cases fall into the following 3 categories: (1) dorsal preservation utilizing a subdorsal strip, (2) dorsal preservation employing a cartilage-only pushdown with separate bony pyramid modification, and (3) dorsal preservation utilizing a cartilage reduction method with separate bony pyramid modification.

Surgical Techniques

Rhinoplasty surgery of the nasal dorsum is variable and includes multiple well-studied surgical techniques. The following description reflects the author's current techniques of conventional subdorsal strip dorsal preservation as well as the cartilage-only pushdown and cartilage reduction methods.

Preservation of the Dorsum (Subdorsal Strip)

The following provides a review of the current subdorsal strip technique. After elevating the soft tissue envelope (STE), a wide submucosal dissection of the subdorsal septum is performed as well as dissecting for at least 5 mm under the upper lateral cartilages. Two anatomical points must be clearly delineated: the anterior septal angle (ASA) and W-point. The W-point may be defined as the point of the separation caudally of the upper lateral cartilages from the dorsal septum. The intervening area between the ASA and W-point is called the W-ASA segment. Subdorsal strip (also called high septal strip) dorsal preservation consists of 2 parts: (1) septal strip resection to flatten the dorsal hump and separate the dorsum from the septum; and (2) osteotomies to mobilize the bony pyramid, separate the dorsum from the face, and lower the dorsal profile via impaction into the pyriform aperture. Thus, this is an impaction technique whereby the entire osseocartilaginous vault is lowered.

Septal Strip Removal

The initial strip resection starts approximately 8 to 10 mm cephalic to the ASA at the W-point. The W-ASA segment will be modified at the time of tip surgery.[1] Initially 2 to 3 mm of septum is resected directly under the dorsum. This is done to test how the dorsum will move. Curved scissors are used for the anterior cut to stay immediately under the dorsum and straight scissors for the posterior cut to ensure a straight cut. Once the cartilage strip is removed, a portion of the perpendicular plate of ethmoid can be resected incrementally employing piezoelectric instrumentation and/or a narrow, long rongeur only if its presence will prevent impaction of the dorsum. Any remaining septum on the undersurface of the osseocartilaginous vault is scored with scissors to help break the tension of the chondro-osseous joint.[2]

Osteotomies to Release the Bony Pyramid

After the initial 2- to 3-mm strip of septum is removed, a portion of Webster's triangle is removed bilaterally to help with dorsal impaction. First, a low-to low-osteotomy is started on the patient's left nasal bone with a curved saw from the edge of the pyriform aperture along the base of the nose. Once the low osteotomy is made, the saw is curved to begin the transverse osteotomy to the midline. This is repeated on the right nasal bone meeting in the transverse midline where the "radix osteotomy" is completed and connected down to the perpendicular plate resection. The nasal bony pyramid is released, and the nose can be mobilized with side-to-side movement to push down into the pyriform aperture. At times, areas of bony contact need to be released further, and they can be checked utilizing the full open approach. Once the bony pyramid is released, the surgeon checks the movement of the dorsum to determine if further septal resections are necessary. Further resections are conducted in 1- to 2-mm increments while watching the movement of the dorsum. Final touches on the dorsum are conducted caudally near the ASA where the septum proper is removed. Only after lowering is septal work performed to harvest cartilage or to mobilize/reset the caudal septum. It should be noted that submucosal resections of the septal body are safe utilizing the high subdorsal strip procedure.

Fixation

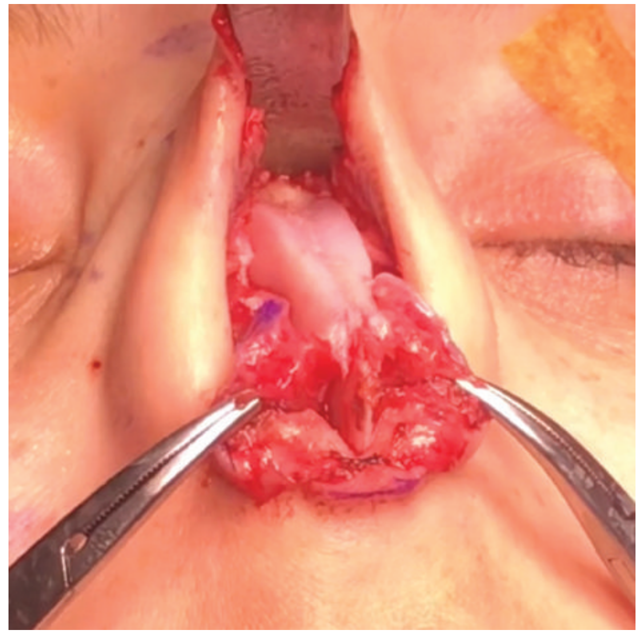
Fixation is an important step to prevent the dorsum from "popping up" postoperatively, which would lead to revision surgery. Suture fixation of the dorsum is performed at 3 points if needed as previously described.[3]

Preservation of the Cartilaginous Dorsum (Cartilage-Only Pushdown)

The following describes the author's technique for a cartilage-only pushdown. After elevating the STE, a wide submucosal dissection of the subdorsal septum is performed as well as dissecting for at least 5 mm under the upper lateral cartilages. Two anatomical points must again clearly be delineated: the ASA and W-point. Cartilage-only dorsal preservation is a hybrid technique that consists of 4 parts: (1) modification and ostectomy of the bony cap, including the lateral keystone area to convert the bony dorsum to cartilage for a cartilage-only pushdown; (2) septal strip resection to flatten the dorsal hump; (3) precise fixation of the cartilaginous vault to the underlying septum; and (4) piezoelectric rhinosculpture and osteotomies to narrow and sculpt the bony pyramid. Thus, this is a surface technique whereby only the cartilaginous vault is lowered. The bones are dealt with separately (as in a component reduction), and no impaction of the osseocartilaginous vault into the pyriform aperture is performed (see the Video accompanying this paper, available online as Supplemental Material).

Bony Cap Removal

As previously described, there is no bony hump on the dorsum.[4] A bony cap exists that overlaps the cartilaginous vault. This bone is removed incrementally with a piezoelectric scraper, exposing the underlying cartilaginous vault.



Video 1. Watch now at http://academic.oup.com/asj/article-lookup/doi/10.1093/asj/sjaa071

This effectively changes the proportions of the dorsum by increasing the amount of exposed cartilage while removing excess bone. This maneuver helps to decrease the convexity/kyphosis of the nasal profile, create a more flexible osseocartilaginous joint, and widen the bony dorsal aesthetic lines. Bone is removed until the cephalic profile (area above the caudal end of the nasal bones) fits the desired postoperative profile. After incremental cap removal, only the cartilage must be lowered.

Septal Strip Removal

Just as in traditional dorsal preservation, the initial strip resection starts approximately 8 to 10 mm cephalic to the ASA at the W-point. Initially, only 1.5 to 2 mm of septum is resected directly under the dorsum to break the tension of the osseocartilaginous joint so it can easily be flattened. Curved scissors are employed for the anterior cut to stay immediately under the dorsum and straight scissors for the posterior cut to ensure a straight cut. Any remaining septum on the undersurface of the osseocartilaginous vault is scored with scissors to help further break the tension of the chondro-osseous joint.[2] No perpendicular plate of ethmoid is removed because bony impaction is not part of this technique.

Precise Fixation

The cartilaginous vault is now sewn down to the underlying septum. Two 25-gauge needles are utilized to pin the cartilaginous vault in place, and sutures secure the natural dorsum down into its new desired position. Sutures are placed from each shoulder of the upper lateral cartilage down to the underlying septum independently. In this way, the cartilaginous vault width and shape can be modified incrementally. If more than 2 mm of reduction is required, the cartilaginous vault must sometimes be partially released from the lateral keystone area to allow fixation. At no time is the cartilaginous vault disarticulated completely from the bone. Only enough release is done to allow fixation. The upper lateral cartilages are assessed for stiffness, because stiffer cartilage requires more release from the lateral keystone area. Humps larger than 3.5 mm are not suitable for this technique because a large amount of release/disarticulation is required, which can be destabilizing.

Osteotomies

After the cartilaginous profile is lowered to the point of harmony with the bony vault, as in traditional reduction methods, piezoelectric osteotomies are performed.[5] Although this will create the dorsal and lateral aesthetic lines, no open roof deformity needs to be closed because the middle vault has been maintained. In this way, the bone is treated separately from the entire cartilaginous vault that remains intact. It should be noted that this technique can be easily conducted with traditional instruments, but piezoelectric instrumentation and the full open approach makes uncapping and osteotomies easier and more predictable in the author's opinion.

Preservation of the Cartilaginous Dorsum (Cartilage Modification)

The following describes the author's technique for preservation of the cartilaginous dorsum via modification. After elevating the STE, a wide submucosal dissection of the subdorsal septum is performed as well as dissecting for at least 5 mm under the upper lateral cartilages. Cartilage dorsal preservation utilizing modification is also a hybrid technique that consists of 3 parts: (1) incremental modification and ostectomy of the bony cap, including the lateral keystone area to convert the bony dorsum to cartilage; (2) shaving the upper lateral cartilage shoulders and dorsal septum WITHOUT opening the mucosa; (3) piezoelectric rhinosculpture and osteotomies to narrow and sculpt the bony pyramid; and (4) closing any cartilage defect over the underlying mucosa and shaping the upper lateral cartilages. Thus, this is also a surface technique whereby only the cartilaginous vault is modified/lowered. The bones are dealt with separately (as in a component reduction), and no impaction of the osseocartilaginous vault into the pyriform aperture is performed.

RESULTS

Patients were seen for follow-up at 1 week, 1 month, 3 months, and 1 year after surgery. Of the patients who underwent dorsal preservation, 57 underwent subdorsal strip technique, 39 underwent cartilage-only pushdown technique, and 4 underwent cartilage modification. Eighty-three patients were female and 17 were male, and the average age was 29 years (range, 15-62 years). All patients received open rhinoplasty. The average lowering was 4.5 mm (range, 2-10 mm), 2.5 mm (range, 1-3.5 mm), and 2 mm (range, 1-2.5 mm) for the subdorsal strip, cartilage-only pushdown technique, and cartilage modification technique, respectively.

For patients who received the traditional subdorsal strip technique, the bony cap was partially removed in 41 of 57 patients to help with flattening of the dorsum. The undersurface was scored in 52 of 57 patients; in the 5 patients who did not need scoring, the dorsum was straight and overprojected so flattening was not necessary. Six patients had radix grafts of diced cartilage in fascia to maintain an ideal radix position. One patient had a supratip graft because the W-ASA segment was inadvertently lowered too much. Only 45 of 57 patients required fixation of the dorsum to the underlying septum. No patients required revision surgery of their dorsum, and no patients had the dorsum dislocate anteriorly after surgery. Two patients were felt to have small, residual humps but did not request revision surgery. One of these had a kyphotic hump and would have needed small rasping to the nasal bone for a straight profile, and the other would have required another 2 to 3 mm of septal strip resection.

For patients who had the cartilage-only pushdown, the bony cap was partially removed in 39 of 39 patients to align the bony profile. The undersurface was scored in all patients. Fixation was also performed in all patients. Three patients had radix grafts of diced-cartilage in fascia to maintain an ideal radix position. Piezoelectric osteotomies and rhinosculpture were performed as previously described in 36 of 39 patients to optimize the dorsal and lateral aesthetic lines.[6] Particularly if any lateral keystone area release was done, drill holes were placed in the nasal bones as well as a 4-0 PDS suture to assure no bony splay would occur postoperatively. Importantly, no patients had dorsal camouflage placed. No patients required revision surgery of their dorsum for a residual hump; however, 1 patient did require formal osteotomies because she felt her nose was still too wide. Osteotomies had not been performed at her initial surgery.

For patients who received the cartilage modification, the bony cap was partially removed in 4 of 4 patients to align the bony profile. No patients required radix grafts. Piezoelectric osteotomies and rhinosculpture were performed as previously described in 4 of 4 patients to optimize the dorsal and lateral aesthetic lines. No patients required revision surgery of their dorsum for a residual hump.

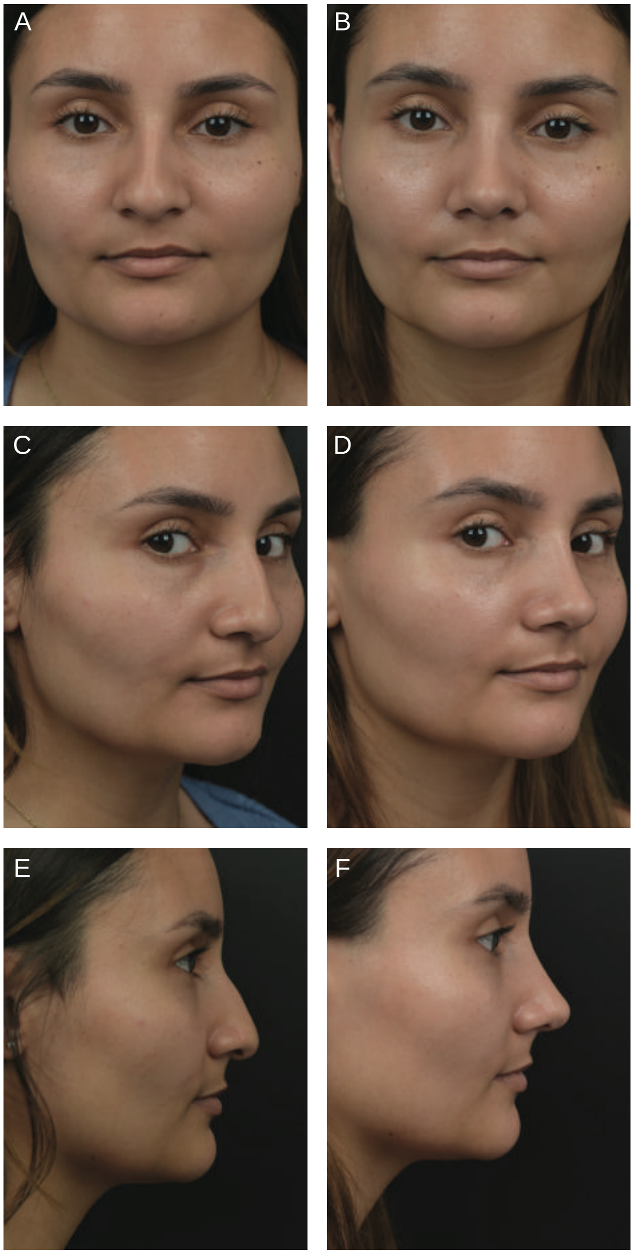


Figure 1. This 22-year-old female of Hispanic descent (A, C, E, G, I) is shown preoperatively and (B, D, F, H, J) 12 months postoperatively after removal of the bony cap with piezoelectric surgery and modification of the cartilaginous vault. The upper lateral cartilages and a small amount of the dorsum are shaved with a 15-blade without opening the middle vault mucosa. Medial oblique, low-to-low, and transverse osteotomies were performed with piezoelectric instruments, and a left endonasal spreader graft was placed to widen the left side of the middle vault. A septal extension graft was utilized to support the nasal tip in a side-to-side fashion on the left side of the caudal septum. The preoperative photographs demonstrate a 2.5-mm dorsal hump as well as a bulbous tip and plunging tip on smiling. There is axis deviation to the right. The postoperative photographs demonstrate improved dorsal aesthetic lines, relief of the dorsal hump, and excellent tip contour.

Figure 1. Continued.

Morbidity

There was no incidence of surgical bleeding requiring operative intervention. One patient presented a nasal tip infection requiring antibiotics. No septal perforations were found on postoperative speculum examination.

Figures 1-4 demonstrate the 3 different techniques.

DISCUSSION

The concept of traditional dorsal preservation is enticing, because the nose is lowered while maintaining the natural osseocartilaginous vault. In this way, mid-vault reconstruction is avoided, the keystone area is preserved, and septal cartilage grafting largely avoided. In previous publications, patient selection has been stressed to ensure a good aesthetic result. Many patients are not good candidates for traditional dorsal preservation, and the author's experience was limited to only 31% of patients being suitable for this foundation (impaction) technique.[7] With experience, the question of "Can I preserve the dorsum?" becomes important with every initial primary rhinoplasty consultation.

Patient Selection

When selecting patients for a dorsal preservation technique, the initial decision is made by inspecting the natural dorsum in terms of width and shape of the dorsal aesthetic

Figure 2. This 22-year-old female of Middle Eastern descent (Persian) who underwent a cartilage pushdown is shown after bony cap modification (A, C, E, G, I, K, M) preoperatively and (B, D, F, H, J, L, N) 12 months postoperatively. The patient has an ideal cartilaginous vault with wide nasal bones and a hump of approximately 3.5 mm. After removal of the bony cap with piezoelectric surgery, a 3-mm strip of subdorsal septum is removed. The cartilage vault is conservatively disarticulated at the lateral keystone area from the nasal bones. Once mobilization has occurred, 5-0 PDS sutures are utilized at multiple points to sew the preserved cartilaginous vault down to the underlying septum. Piezoelectric medial oblique, transverse, and low-to-low osteotomies were performed to narrow the bony dorsum and bone base. In this way, the cartilage vault is preserved and the bones are narrowed. The tip was supported with a columellar strut. The patient is shown preoperatively with a dorsal hump, a wide bony vault, and plunging tip on smiling. The same patient is shown 12 months postoperatively with improved dorsal aesthetic lines and a narrow and symmetric bony vault. The profile line is improved without opening the middle vault.

lines on frontal view. Selection will be different for each surgeon depending on his/her tolerance for asymmetries, deviation, and width. Initially in the author's experience in dorsal preservation, if the dorsum was not totally ideal in terms of width and the shape of dorsal aesthetic lines, a traditional reduction method was chosen. However, it became apparent that the critical factor was the cartilaginous vault. If the cartilaginous vault was ideal, the bones could be dealt with separately. Bones can be narrowed, lowered, removed, and/or sculpted. If a nasal dorsum could be converted to cartilage by incremental bony cap removal (which is conducted in every reduction surgery as an initial step), the surgeon can examine the cartilaginous vault and decide if he/she wants to preserve it. It is apparent that the cartilaginous vault is a key to dorsal PR. When bone is modified, it is unlikely to move after 4 to 6 weeks. Bony pyramid position is fixed at this point. However, once the cartilaginous vault is opened (with or without structural reconstruction), it becomes part of the postoperative healing process. The attachments of the upper lateral cartilages to the dorsal septum and the underlying mucosa are the most important part of the dorsum to preserve. Figure 5 details the 4 types of dorsal preservation in increasing order of complexity.

When choosing between dorsal preservation techniques, it is important to examine the profile. The following should be assessed.

Position of Radix

With subdorsal stirp dorsal preservation, the radix can lengthen in the vertical plane, and the starting point of the nose (nasion or radix point) can move caudally. Ideal patients have a normally positioned or slightly high radix. Patients with a low radix, strong glabella, and/or a prominent premaxilla must be approached more carefully and a radix graft considered. Dorsal preservation in these patients may result in a short nose.

On the other hand, the position of the radix does not change with the cartilage-only pushdown technique or modification technique. Bone is only removed to align the bony profile, and no osteotomies are performed at the radix. Therefore, no hinge or drop occurs at the site of the cephalic osteotomies. If the postoperative result would be negatively impacted by lowering of the radix, a cartilage-only pushdown technique or modification technique should

Figure 2. Continued.

be considered. Also, if the patient has a pseudohump because of a low radix and an underprojected tip, a cartilage-only pushdown technique or modification technique can be utilized with a radix graft and increase in tip projection. This has been especially useful in the Hispanic nose.

Type and Size of Hump

Ideal patients for subdorsal strip dorsal preservation have beautiful dorsal aesthetic lines and a straight, overprojected dorsum. In these cases, one can lower/impact the whole dorsum without worrying about flattening the osseocartilaginous joint. However, most patients have a V or S-shaped hump. Understanding these humps is critical to choosing patients for dorsal preservation.[8] It is technically easier to "flatten" the osseocartilaginous vault in patients with a V-shaped hump because they have only 1 locus of angulation. S-shaped humps are more difficult because they tend to have an acute takeoff of the hump from the sellion, resulting in a high kyphion point and a second locus of angulation. S-shaped humps are much harder to flatten because they have anterior convexity of the nasal bones, and bone will not flatten like cartilage. Initial dorsal preservation patients for traditional subdorsal strip dorsal preservation should be chosen that have an overprojected and straight dorsum, small humps, or V-shaped nasal bones (humps). With good selection and experience with the technique, humps greater than 3 mm are good candidates for subdorsal strip preservation and humps greater than 10 mm can be removed without issue.

The cartilage-only pushdown technique, as well as the cartilage modification technique, work well in both V- and S-shaped humps because the bony cap is removed. By converting these humps to mostly cartilage, flexion of the osseocartilaginous vault is simplified. In fact, removing bone can convert many S-shaped humps into V-shaped humps, and subsequently only the cartilage must be lowered. This greatly simplifies the reduction. As stated above, the cartilage-only pushdown technique does not work well in humps over 3.5 mm and is best in humps smaller than 3 mm. Smaller humps require less removal of bone and less release of the cartilage from the bony vault and therefore involve little chance of a step-deformity at the keystone area. Bigger reductions require a large amount of disarticulation that is destabilizing and then requires fixation. The idea of PR is to preserve structures and simplify surgery, not to take more apart. The cartilage modification technique works well in humps 1 to 2 mm or humps where the "shoulders" of the upper lateral cartilage appear prominent after bony cap removal.

Figure 3. This 23-year-old female of European descent who underwent a cartilage pushdown is shown after bony cap modification (A, C, E, G, I) preoperatively and (B, D, F, H, J) 12 months postoperatively. The patient has an ideal cartilaginous vault with wide nasal bones and a hump of approximately 3 mm. After removal of the bony cap with piezoelectric surgery, a 3-mm strip of subdorsal septum is removed incrementally. The cartilage vault is conservatively disarticulated at the lateral keystone area from the nasal bones. Once mobilization has occurred, 5-0 PDS sutures are utilized at multiple points to sew the preserved cartilaginous vault down to the underlying septum. Piezoelectric medial oblique and low-to-high osteotomies were performed to narrow the bony dorsum and bone base. In this way, the cartilage vault is preserved and the bones are narrowed.

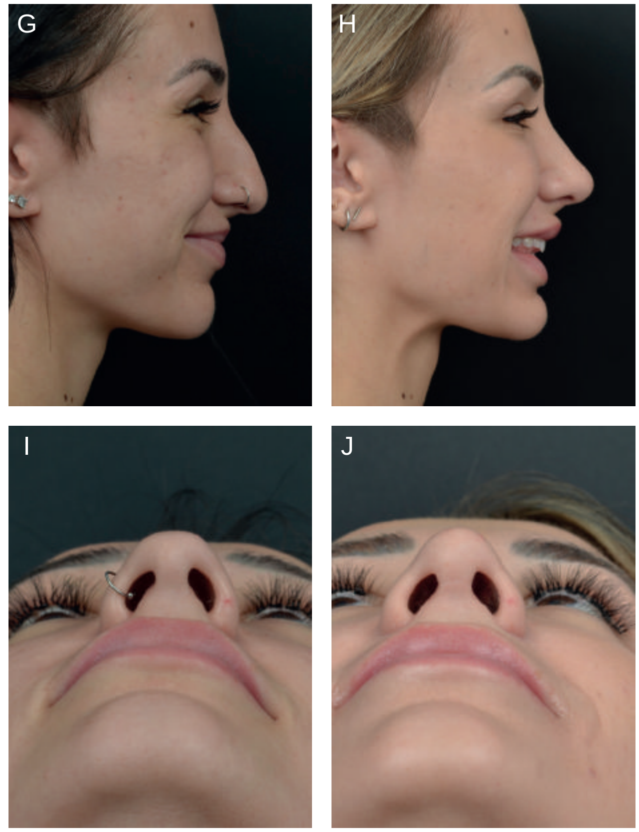


Figure 3. Continued.

Length of Bony Vault

With subdorsal strip dorsal preservation, bony vaults (nasal bones) are more difficult to flatten because cartilage is easier to flex than bone. Initial dorsal preservation patients should be chosen who have primarily cartilaginous noses.

Alternatively, the bony cap can be removed in long bony vaults, which transforms the dorsum into one that is more cartilaginous. This aids in reduction utilizing both the subdorsal strip as well as the cartilage-only techniques.

Width of Bony Vault

Wide bony vaults are unsuitable for subdorsal strip dorsal preservation. If the bony dorsal aesthetic lines are not good, they should not be preserved. However, with the cartilage-only preservation techniques, the bones are treated separate

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The tip was supported with a septal extension graft. The patient is shown preoperatively with a dorsal hump, a wide bony dorsum, and plunging tip on smiling with a bulbous tip. The same patient is shown 12 months postoperatively with improved dorsal aesthetic lines and a narrow and symmetric bony vault. The profile line is improved without opening the middle vault.

Figure 4. This 19-year-old female of Middle Eastern descent (Palestinian) who underwent a high septal strip pushdown procedure is shown (A, C, E, G, I, K, M) preoperatively and (B, D, F, H, J, L, N) 22 months postoperatively. The patient had a large osseocartilaginous hump but excellent dorsal aesthetic lines on front view. A high septal strip was chosen because the patient's septum was straight, and widening of the middle vault occurs with a high septal strip procedure. After weakening of the bony cap with a piezoelectric scraper, incremental subdorsal strips were removed from under the dorsum measuring 5.5 mm in total. Bilateral low-to-low, transverse, and radix osteotomies were performed with piezoelectric saws to release the osseocartilaginous pyramid from the face. The nose was impacted into the pyriform aperture. Dorsal fixation was conducted with three 5-0 PDS sutures as previously described. A columellar strut was employed to support the tip, and contour was improved with a lateral steal procedure. The patient is shown preoperatively with a dorsal hump, a narrow dorsum, and plunging tip on smiling with a bulbous tip. The patient is shown 22 months postoperatively with improved dorsal aesthetic lines and a narrow and symmetric bony vault. The profile line is improved without opening the middle vault.

from the cartilage. While the cartilage is preserved, the bony vault can be treated as in traditional reduction methods with osteotomies, piezoelectric rhinosculpture, etc.

Width/Symmetry of Cartilaginous Vault

If the cartilaginous dorsal aesthetic lines are not good, they should not be preserved. Wide cartilaginous vaults are traditionally unsuitable for subdorsal strip dorsal preservation because often the cartilaginous vault widens and lengthens as it is flattened. Thus, in subdorsal strip dorsal preservation, it can happen that the middle vault widens. In some patients, this is aesthetically pleasing, but not if the dorsal aesthetic lines in the middle vault are already wide. However, with the cartilage-only pushdown, the cartilage vault is incrementally resutured to the septum. Fine-tuning and narrowing can be easily performed with sutures. Alternatively, with the cartilage modification procedure, the profile has been lowered but the septum remains intact. If an asymmetry is present in the middle vault, an endonasal spreader graft can easily be placed. Narrow dorsums can likewise be treated well with this technique.

The inclusion of these surface techniques to the traditional foundation techniques has expanded the indications for dorsal preservation. Utilizing the above analysis, the dorsum was preserved in 43% of patients who the author felt had a dorsum and characteristics suitable for dorsal preservation. This percentage was increased by the 31% previously published when only foundation techniques were employed.[7] Incremental removal of the bony cap allows for the separate treatment of the bony and cartilaginous vaults while keeping them structurally intact. In effect, the indications of dorsal preservation have been expanded to more patients and types of dorsal deformities. The cartilage-only pushdown is a hybrid technique that is a modification of both the subdorsal strip technique as advocated by Saban and the SPARE roof technique described by Ferreira.[9] Unlike the subdorsal strip technique, the osseocartilaginous pyramid does not have to be separated from the face, nor is the osseocartilaginous vault completely separated from the septum (no perpendicular plate of ethmoid is resected). This maximizes stability, allows for large and safe submucous resections of the septum for structural tip surgery if required, and is an easy procedure for surgeons looking to add dorsal PR to their practice.

Figure 4. Continued.

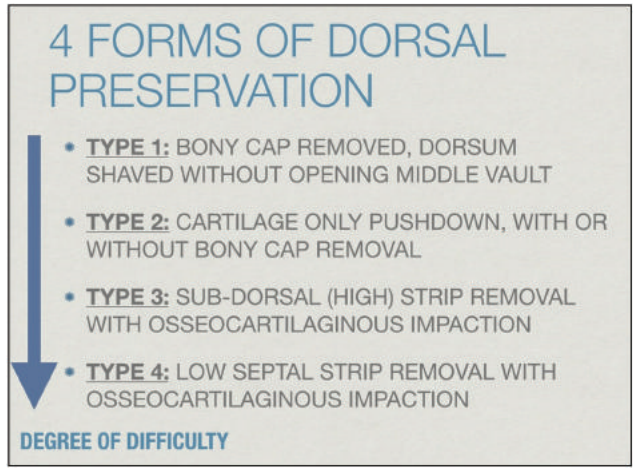

Figure 5. Classification of the different dorsal preservation procedures in order of increasing complexity. Types 1 and 2 are surface techniques whereby the cartilage is lowered and the bones are treated separately without impaction of the osseocartilaginous vault. Types 3 and 4 are foundation techniques. A septal strip is either removed directly under the septum (type 3) or from the floor of the septum (type 4), and the nose is then impacted into the pyriform aperture.

In the SPARE roof technique, the subdorsal strip is removed first followed by ostectomy of the bony cap and lateral keystone area with a drill. However, a large lateral release of the periosteal-perichondrial junction is undertaken to allow the cartilaginous vault to descend as humps up to 5 mm are treated. Suture fixation is not always part of the described procedure. Unlike the SPARE roof technique, in the cartilage-only pushdown, the bony cap is incrementally removed first to visualize the cartilaginous vault and to assess its suitability for preservation. Only then is a septal strip removed, and it is only removed as high as the new keystone junction. Minimal dissection is performed at the lateral keystone area (and only if necessary) to sew down the cartilaginous vault to the septum at multiple points. This allows for maximum stability of the osseocartilaginous vault. Bone dust or camouflage of the keystone area is not required. Both the SPARE roof technique and cartilage-only pushdown are reliable techniques designed to preserve the natural cartilaginous dorsum. Ferreira should be congratulated for his extensive experience with this technique as well as his functional studies that validate its airway preservation.[10] Although this technique can be applied to larger humps, the author does not because of the potential step deformities at the new keystone area. In larger humps, the primary author prefers subdorsal strip pushdown or letdown maneuvers. Ishida has described a technique similar to the cartilage-only pushdown, where the bony cap is preserved along with the cartilage vault and lowering is conducted with either high or low septal strip removal.[11] In theory, this is ideal because the whole osseocartilaginous keystone area is preserved. However, if the bone is curved, osteoplasty must be performed. Also, bone is more difficult to flex than cartilage. Removing the bony cap facilitates flattening, which is advantageous in all dorsal preservation techniques. If the bone is flat, the Ishida technique is a great option. However, the primary author would caution that a cartilage-only pushdown utilizing low strip removal requires a large (and sometimes complete) release of the upper lateral cartilages from the nasal bones. This can be quite destabilizing.

To summarize, the cartilage-only preservation techniques (pushdown and modification) described here allow the surgeon to preserve the cartilaginous structure of the dorsum without separating the upper lateral cartilages from the dorsum. In addition, bony deformities can be treated separately with piezoelectric surgery and fine tuning of the cartilaginous vault can be performed with sutures. If the surgeon does not like the result intraoperatively, it is easy to convert to a traditional reduction technique. This represents an easy bridge for surgeons wishing to incorporate dorsal preservation. In addition, impaction of the bony vault into the pyriform aperture is not performed in these surface techniques. Unsuitable candidates for cartilage-only dorsal preservation are patients with major mid-vault asymmetries, C-shaped dorsal deviations, high septal deviations, humps larger than 3.5 mm, and cephalically based humps.

Study Limitations

The limitations of this study include its retrospective nature. The learning curve is ongoing. One-year follow-up is adequate for an article but inadequate in terms of long-term longevity of dorsal preservation in particular. For the reader interested in larger studies with long-term follow-up, one should see articles by Saban et al.[12] Finally, no formal airway obstruction measurement tool was employed although no dorsal preservation patients subjectively complained of airway obstruction. When septal strips larger than 6 mm are removed, the surgeon must inspect carefully the airway to ensure the pyriform has not been narrowed too much.

CONCLUSIONS

PR is a paradigm shift in rhinoplasty. With time, the techniques become more comfortable, and surgeons will find themselves asking in every situation whether they can preserve structures. In the majority of patients, the dorsal soft tissue envelope as well as the nasal ligaments and lateral crura can be preserved. Dorsal preservation is a reliable technique if patients are chosen properly. With bony cap modification, more dorsums can be preserved and dorsal aesthetics improved. No dorsum looks as good as a natural dorsum, and long-term issues with the middle vault and keystone area can hopefully be avoided.

Disclosures

Dr Kosins is an instrument designer for Micrins (Lake Forest, IL; the Kosins Preservation Rhinoplasty set) and is a shareholder and consultant for ZO Skin Health (Irvine, CA).

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Rhinoplasty

Dorsal Modification: Practical Applications in Rhinoplasty

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Abstract

Background: Management of the dorsum continues to present challenges for rhinoplasty surgeons, especially regarding the inherent asymmetry of the bony and cartilaginous vaults and the need for a highly individualized approach for each case.
Objectives: The aim of this study was to assess the efficiency of superficial dorsal modification to improve the shape and symmetry of the dorsum, without resecting/reconstructing the main parts that maintain dorsal stability.
Methods: A total of 147 patients who underwent superficial dorsal modification between October 2020 and March 2024 were retrospectively reviewed. A step-by-step algorithm was applied to achieve the required dorsal improvement.
Results: The average postoperative follow-up period was 27 months (range, 12-41 months). No patients required revision surgery of their dorsum. No complications were reported. A retrospective analysis of the 147 patients demonstrated aesthetic and functional improvement.
Conclusions: Dorsal modification as a separate philosophy is a very conservative, fast, and reliable approach. In cases where there is no need to significantly change dorsal dimensions (height and width), dorsal modification improves the dorsum quickly and efficiently without significant resection and no reconstruction, while maintaining stability and maximum predictability.

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Management of the dorsum continues to present challenges for rhinoplasty surgeons, especially regarding the inherent asymmetry of the bony and cartilaginous vaults and the need for a highly individualized approach for each case.[1-3] Currently, both dorsal structural rhinoplasty and preservation rhinoplasty techniques are used to optimize patient outcomes for the nasal dorsum. In some cases, structural grafting is also used in combination with dorsal preservation. When performing techniques according to either philosophy, additional maneuvers aimed at improving the symmetry of the nasal dorsum are applied. Dorsal modification was first described by the senior author in 2017 in the first edition of *Preservation Rhinoplasty* as a way to expand the indications for dorsal preservation (bony cap removal, rasping, trimming upper lateral cartilages [ULCs], etc), and these modifications are well known and have been repeatedly described as additional elements of existing techniques.[4-9]

Over time, it became clear that these dorsal modification maneuvers, performed independently, without the use of dorsal reconstruction or preservation techniques, could be applied to certain patients (see Supplemental Figure 1). This approach requires only superficial work to the dorsum, without resecting/reconstructing the main parts that support and ensure dorsal stability. Dorsal modification can be

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effectively used to improve the shape of the dorsum and improve its symmetry in cases where there is no need to significantly change dorsal dimensions (height and width). With experience and improvement in instrumentation the authors now use this technique to reduce nasal humps up to 3 mm in size. An important feature of this technique is that there is no need to use spreader grafts or flaps unless there is severe lateral wall asymmetry/concavity that may need additional treatment with grafts. However, endonasal grafts can still be used with dorsal modification without violating the mucosa of the midvault.

Dorsal modification can be conveniently divided into bony modification and cartilage modification. Bony modification involves working with the bony pyramid to maintain its stability without significant lateral wall mobility. Bony modification is based on: (1) rhinosculpture, (2) bony cap removal/reshaping/release, which can be performed with ultrasonic piezoelectric instruments (PEIs), burrs or rasps, and (3) partial osteotomies with intact bony bridges to ensure stability of the side walls while permitting limited movement medially.[1]

Cartilage modification is based on: (1) shaving the ULC shoulders and dorsal septum without opening the mucosa using a No. 15 blade or electrocautery (Colorado needle) or partial incision of the ULCs along the septum in cases of wide dorsum without opening the mucosa; (2) keeping the W-point intact; (3) smoothing the keystone and shaving the ULCs with a diamond burr or PEI; and (4) closing the cartilaginous defect over the underlying mucosa if necessary (see Supplemental Figure 2).[3,6]

The dorsal modification philosophy greatly facilitates the ease and the speed for the rhinoplasty surgeon who needs to reduce small humps even with excessive bony and/or cartilaginous width, and address asymmetries of the bony pyramid and cartilaginous vault. This allows for an easy and reliable procedure that largely avoids the problems and complications associated with excessive mobilization of the side walls and middle vault reconstruction.

This study is based on the extensive experience of both authors (V.Z. and A.K.) as well as a retrospective review of 147 primary rhinoplasty cases performed over a 3.5-year period by the primary author (V.Z), in which dorsal modification techniques are utilized as a separate philosophy.

METHODS

A total of 311 primary rhinoplasty cases were studied retrospectively between October 2020 and March 2024. Written informed consent was obtained from all patients, and guiding principles from the Declaration of Helsinki were followed. One hundred forty-seven cases of dorsal modification were included in the study. No secondary rhinoplasty or secondary septoplasty cases were included. Patients with a hump >3 mm and patients with a significantly deviated (axis deviation) or significantly crooked dorsum (posttraumatic) were excluded because they are not good candidates for dorsal modification; these patients were operated with dorsal preservation and reconstruction techniques. Any patient not having at least 1 year of follow-up was also excluded. Data were collected in all cases regarding age, gender, ethnicity, and technical details of the operation.

These cases can be broken down into the following 2 types based on the surgery performed on the bony pyramid (bony modification): Type 1, rhinosculpture only; Type 2, rhinosculpture + osteotomies.

The cases also can be broken down into the following 2 types based on the surgery performed on the cartilaginous part of the dorsum (cartilage modification): Type 1, ULC shoulder shaving; Type 2, partial incision of the ULCs along the septum.

Photographs of all 147 patients were taken before and after surgery. All patients included in this study also were examined with Standardized Cosmesis and Health Nasal Outcomes Survey (SCHNOS).[10,11]

This 10-item questionnaire is designed to evaluate both perceived nasal obstruction and cosmetic disadvantage on a 0 to 5 scale ("no problem" to "extreme problem"). SCHNOS in fact consists of 2 domains: SCHNOS-O (the first 4 items) which evaluates nasal obstruction; and SCHNOS-C (the last 6 items) which evaluates cosmesis.[12] All patients completed the questionnaire preoperatively and at 12 months postoperatively.

Statistical analysis was performed with IBM SPSS Statistics for Windows (IBM Corp., Armonk, NY) and Excel after deidentification of patient data. Continuous variables are shown as means and standard deviations (SDs); here, the SD represents the degree of variation of the mean SCHNOS, SCHNOS-O, and SCHNOS-C scores. Normal distribution of variables was verified by the Shapiro-Wilk test or by means of skewness and kurtosis values. Differences among paired groups were evaluated by the paired *t*-test for normally distributed data (accompanied by the Cohen's *d* to show the effect size with the following cut-offs: $d = 0.2$, "small" effect size; $d = 0.5$, "medium" effect size; $d = 0.8$, "large" effect size). Statistical significance was defined as $P < .05$ setting the α-error probability at 5%.

Surgical Techniques

Exposure

The open rhinoplasty technique was performed in all patients by the first author, although it should be noted that rhinoplasty is also regularly performed using a closed approach by the senior author (A.K.). The nasal dorsal skin flap was elevated through a transcolumellar V-shaped incision plus infracartilaginous incisions along the caudal edge of the lower lateral cartilages. The skin and soft tissue envelope were elevated over the lower lateral cartilages in the supra-superficial muscular aponeurotic system plane,

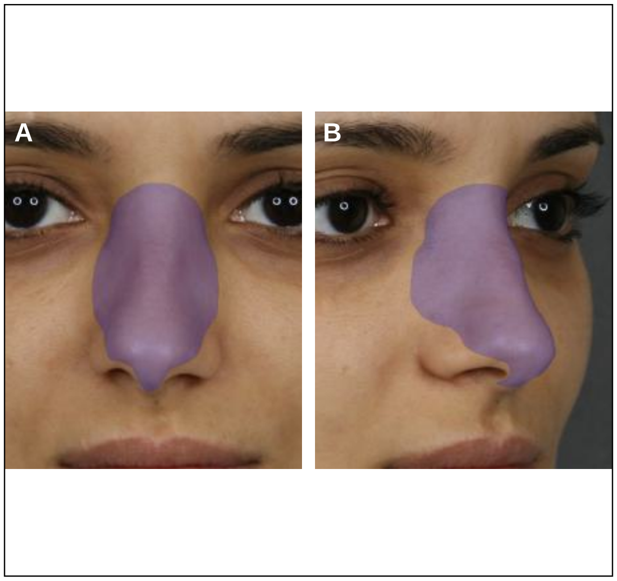

Figure 1. A 25-year-old female patient with the area for extended dissection of the skin-soft tissue envelope over the nasal skeleton marked in purple. (A) Frontal view. (B) Side view.

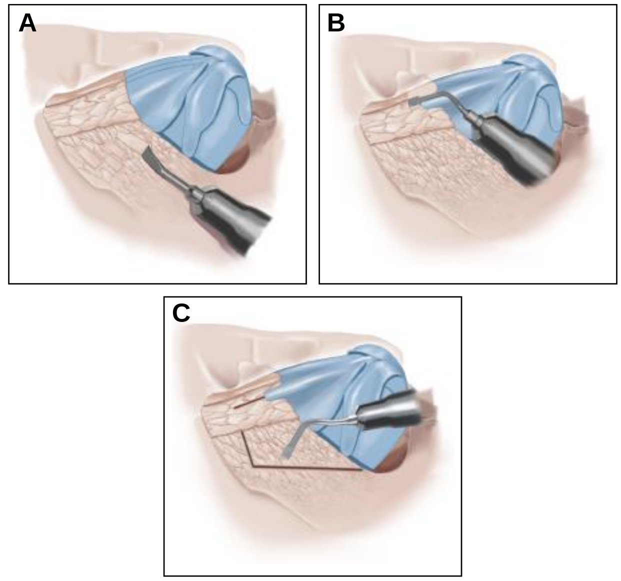

Figure 2. Rhinosculpture technique and partial osteotomies. (A) Sculpting the lateral bony wall with a piezo scraper head. (B) Sculpting the central bony dorsum. Removal of the bony cap with the use of a piezo rasp head. (C) A low-to-low lateral osteotomy, a partial length transverse osteotomy, and a paramedial osteotomy. An intact bony segment remains between the anterior transverse and paramedial osteotomies.

over the ULCs in the supraperichondrial plane, and over the bony pyramid in the subperiosteal plane. A fully open approach using a subperiosteal dissection of the bony vault was performed longitudinally from the keystone junction up to the cephalic part of the radix, and transversely from one ascending frontal process of the maxilla to the other side. In addition, it is necessary to undermine the periosteum beyond the nasofacial groove to achieve the requisite exposure. Usually, the lateral pyriform aperture ligaments are stretched or cut depending on their strength to allow complete access to the nasal bony wall along the pyriform aperture (Figure 1).[1]

Bony Modification

Sculpting the Lateral Bony Wall

For sculpting the bony pyramid, we mainly used ultrasonic PEIs over the entire surface as well as diamond burrs if significant bone thickness needed to be removed, usually with severe asymmetries at the base of the bone pyramid. Different piezo inserts, including scrapers and rasps of various shapes and gradations, are used for sculpting. Initially, we started with a rough surface and then progressed to a more delicate surface before performing the final sculpting with an ultrafine diamond-coated head. The rhinosculpture began at the base of the pyramid just beyond the nasofacial groove, because this is the widest point of the bony vault (base bony width, *x*-point) where the ascending process of the frontal process of the maxilla is thinned and any irregularities removed.[1] The aim of this rhinosculpture is to achieve the best possible symmetry between the 2 sides regarding the shape, size, and angulation of the lateral bony walls and to reduce the width of the base of the bony pyramid. As one moves medially along the lateral bony wall, any convexities are removed. The rasping continues over the nasal bones, including the lateral keystone area, to achieve maximal symmetry of the shape and size of the 2 sides (Figure 2A). The new bony dorsal aesthetic lines are directly sculpted on the bones by tilting the angle of the rasp or the scraper. Both bony walls can be sculpted until the inner cortical layer is observed by a change in the shade of bone color to red. When the bone changes to this color, the rhinosculpture is stopped.

Sculpting the Central Bony Dorsum (Bony Dorsal Platform)

The next step is a very delicate partial or complete removal of the bony cap, which is performed with the use of piezo scraper heads and rasps. The wider the hump, the more lateral the extent of the bone removal. Bone is removed until the cephalic profile (the area above the caudal end of the nasal bones) fits the desired postoperative profile. Whatever the instrument used, an open roof never occurs because the underlying cartilages and mucosa are unharmed by the piezoelectric device (Figure 2B). Preservation of the cephalic portion of the ULC allows it to be utilized for cartilage modification.

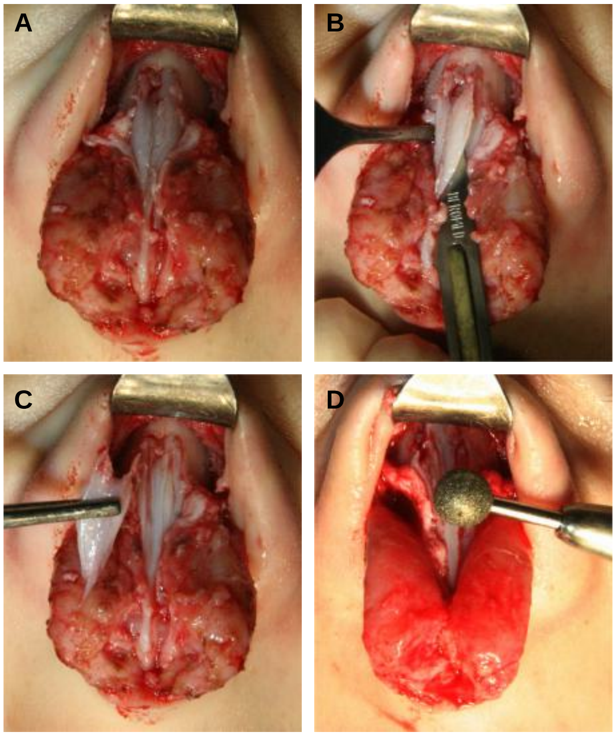

Figure 3. A 28-year-old female patient with ULC shoulder shaving. (A) The ULC shoulders protrude upward after removal of the bony cap. (B) Shaving the ULC shoulders and dorsal septum with a No. 11 blade without opening the mucosa and keeping intact the W-point. (C) View of the shaved middle third surface. (D) Smoothing the shaved surface and keystone with a diamond burr. ULC, upper lateral cartilage.

Osteotomies

If excessive width of the bony pyramid persists or asymmetry of the lateral walls occurs, then osteotomies are considered and performed unilaterally or bilaterally if necessary. We use a sequential approach for osteotomies.[1] In this way, osteotomies are performed with ultrasonic PIEs, and in the vast majority of cases a bony bridge is left cephalically at the junction of the medial and lateral osteotomies, which ensures maximal stability of the entire nasal pyramid (Figure 2C). Wedges of cartilage or bone can be used in the lateral osteotomy sites to increase lateral stability.

Cartilage Modification

For this particular subset of patients, the main complaints include a small dorsal hump in profile view as well as a wide and asymmetric middle third of the dorsum in anterior view. To solve these problems after bony modification, we used ULC shoulder shaving or partial incision of the ULCs along the septum, or both. If this was not enough, we used submucosal spreader grafts, more often unilateral,

Video. Watch now at http://academic.oup.com/asj/article-lookup/doi/10.1093/asj/sjae148

to eliminate the visible concavity of the ULCs as described by the senior author.[9]

ULC Shoulder Shaving

After removal of the bony cap the ULC shoulders protrude upward, recreating a hump or causing irregularities in thin-skinned patients.[6] To remove this cartilaginous hump, we perform a hydrodissection and shave the ULC shoulders and dorsal septum very precisely with a No. 11 blade or by electrocautery (Colorado needle), without opening the mucosa and keeping intact the W-point. (Figure 3). In the vast majority of cases, the thickness of cartilage in the area of the shoulders allows us to remove only their external part including the internal perichondrium, which together with intact mucosa and W-point preservation supports and prevents deformity of the ULCs. This preserves their original width and shape. The next step is to smooth the shaved surface and keystone with a diamond burr or electrocautery, which allows us to remove even very small irregularities on the cartilage surface and make the transition from the bony to the cartilaginous part into one smooth line (Video). Sometimes, to create a better contour we place one or more 6-0 PDS sutures to close the small cartilaginous defects, but in most cases this was not necessary.

Partial Incision of the ULCs Along the Septum

In cases with a wide hump and/or flat dorsum with an asymmetric middle vault, it was often unnecessary to lower the dorsal projection. In such cases, partial incision of the ULCs along the septum without opening the mucosa and keeping intact the W-point was performed using a No. 11 blade. In this case, the removed section of the ULCs usually did not exceed 20 to 25 mm in length and 2 mm in width (Figure 4). In cases of asymmetry, this maneuver was unilateral or asymmetric. We then placed 6-0 PDS sutures to close the small cartilaginous defect. This was usually sufficient to reduce the lateral hump and the width of the middle

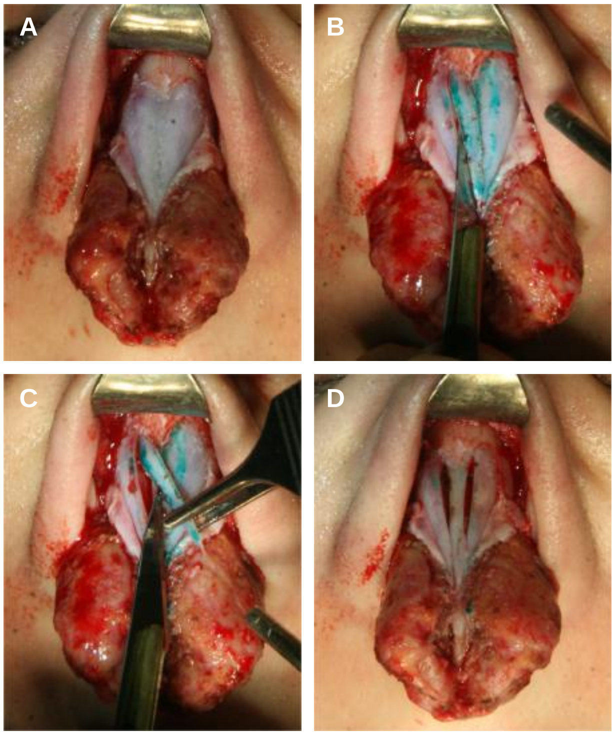

Figure 4. A 36-year-old female patient with partial incision of the ULC along the septum. (A) The wide cartilaginous middle third after removal of the bony cap. (B) Partial incision of the ULC along the septum without opening the mucosa and keeping the W-point intact was performed. (C) The removed section of the ULC did not exceed 20 mm in length and 2 mm in width. (D) View on the middle third surface after removal sections of cartilage. ULC, upper lateral cartilage.

vault on one or both sides especially with osteotomies because the ULCs follow the bone.

In cases with visible concavity of the ULCs after bony and cartilage modification, we used submucosal spreader grafts that are positioned under the mucosa in a tunnel along the superior aspect of the septum, most often unilaterally.[13] In all other cases spreader grafts were not used.

In cases with low radix we placed segmental diced cartilage-fascia (DC-F) grafts for radix augmentation.[14] The use of such a graft, well fixed on the dorsum, made it possible not only to augment the radix, but also highlighted dorsal aesthetic lines. Elevation of the radix also decreases the prominence of the hump, which enabled us to remove less bone and cartilage tissue from the dorsal surface in such cases.

RESULTS

This study was conducted over 41 months from October 2020 to March 2024. All patients underwent bony modification followed by cartilage modification. As shown in Table 1, of the 147 patients who underwent bony modification, 44 underwent rhinosculpture only and 103 underwent rhinosculpture plus osteotomies. Of the 147 patients who underwent cartilage modification, 133 underwent ULC shaving and 14 underwent partial incision of the ULCs along the septum. The age of the patients varied from 16 to 62 years (average, 38 years); 143 of the patients were women and 4 were men. The average postoperative follow-up period was 27 months (range, 12-41 months). Patients were seen for follow-up at 1 week, 2 weeks, 1 month, 3 months, 6 months, and 1 year, 2 years, and 3 to 3.5 years after surgery.

For patients who received ULC shaving, rhinosculpture without osteotomies was performed in 38 of 133 patients, and rhinosculpture plus osteotomies was performed in 95 of 133 patients; the bony cap was partially removed in 133 of 133 patients to align the bony profile and to modify the bony pyramid. Twelve patients with visible concavity of the ULCs after cartilage modification had submucosal spreader grafts, 8 from which were placed unilaterally. Thirty patients had radix grafts of segmental DC-F to maintain an ideal radix position. No patients required revision surgery of their dorsum. One patient with very thin skin had small irregularities on the central dorsum but did not request revision surgery. Two patients had small residual concavities of the ULCs but did not request revision surgery.

For patients who received partial incision of the ULCs along the septum, rhinosculpture without osteotomies was performed in 6 of 14 patients and rhinosculpture plus osteotomies was performed in 8 of 14 patients; the bony cap was partially removed in 11 of 14 patients to align the bony profile and to modify the bony pyramid. Two patients with visible concavity of the ULCs after cartilage modification had submucosal spreader grafts, both of which were placed unilaterally. Four patients had radix grafts of segmental DC-F to maintain an ideal radix position. No patients required revision surgery of their dorsum.

Subjective Aesthetic and Functional Outcome Analyses With SCHNOS

Preoperatively, the mean SCHNOS-O score for nose obstruction was 1.37. Postoperatively, the mean score significantly improved to 0.41. Nose breathing during exercise showed a significant improvement from 1.44 preoperatively to 0.26 postoperatively. After analysis of mean score before and after rhinoplasty (from 1.40 to 0.26), we note that nasal congestion has been reduced. Nose breathing during sleep was also improved. The mean score dropped from 1.52 preoperatively to 0.25 postoperatively.

Mood and self-esteem due to the patient's nose was improved 12 months after rhinoplasty. The mean SCHNOS-C score fell from 2.58 to 0.25. Nasal tip shape was significantly enhanced according to the patients; the mean score was 3.13 preoperatively and 0.30 postoperatively. Nose

Table 1. Numbers of Patients Who Underwent Bony and Cartilage Modification

		Cartilage modification		Dorsal modification (bony + ULC)
		ULC shoulder shaving	Partial incision of the ULCs along the septum	
Bony modification	Rhinosculpture	38	6	44
	Rhinosculpture plus partial osteotomies	95	8	103
All cases		133	14	147

ULC, upper lateral cartilage.

Table 2. Mean SCHNOS Scores Before and After Rhinoplasty (n = 147)

	Mean score before rhinoplasty	Mean score after rhinoplasty (at 12 months)
SCHNOS-O		
1. Having a blocked or obstructed Nose	1.37	0.41
2. Getting air through my nose during exercise	1.44	0.26
3. Having a congested nose	1.40	0.26
4. Breathing through my nose during sleep	1.52	0.25
SCHNOS-C		
5. Decreased mood and self-esteem due to my nose	2.58	0.25
6. The shape of my nasal tip	3.13	0.30
7. The straightness of my nose	3.04	0.34
8. The shape of my nose from the side	3.50	0.29
9. How well my nose suits my face	3.06	0.37
10. The overall symmetry of my nose	3.02	0.22

SCHNOS, Standardized Cosmesis and Health Nasal Outcomes Survey (O, nasal obstruction; C, cosmesis).

straightness was ameliorated; the mean score dropped from 3.04 preoperatively to 0.34 postoperatively. Nose profile was improved substantially from 3.50 preoperatively to 0.29 postoperatively. Harmony between the nose and the face was better 12 months after rhinoplasty; the mean score fell from 3.06 to 0.37. Finally, patients reported an improvement in the overall symmetry of their nose from 3.02 to 0.22 (Table 2).

The mean [SD] preoperative SCHNOS score was 24 [9.1], SCHNOS-O was 5.7 [5.3], and SCHNOS-C was 18.2 [6.6]. At 12 months postoperatively, the SCHNOS score was 3 [2], SCHNOS-O was 1.2 [1.3], and SCHNOS-C was 1.8 [1.3]. Preoperatively, the mean SCHNOS-O and SCHNOS-C scores were 5.7 [5.3] and 18.2 [6.6], respectively. Postoperatively, the scores significantly improved to 1.2 [1.3] and 1.8 [1.3], respectively (Table 3).

The mean difference in scores at 12 months postoperatively (compared with the preoperative condition) for SCHNOS, SCHNOS-O, and SCHNOS-C was −20.9 [8.9] (large), −4.5 [4.9] (large), and −16.4 [6.5] (large), respectively (Table 4).

The mean score changes at 12 months postoperatively compared to preoperative scores were statistically significant. The positive impact on both aesthetic and functional outcomes for our patients is also demonstrated by a Cohen's *d* effect size greater than 0.8. Cohen's *d* scores were 3.1, 1.1, and 3.4 for SCHNOS, SCHNOS-O, and SCHNOS-C, respectively. According to the SCHNOS scores, patient satisfaction appears to be closely linked to stable surgical outcomes. We presume that nose breathing without or during exercise, nasal congestion, or nose breathing during sleep did not get worse due to the dorsal surface modifications and obviously improved due to the tipplasty.

Table 3. Preoperative and 12 Months Postoperative Mean Scores for SCHNOS, SCHNOS-O, and SCHNOS-C

Preoperative			12-month postoperative		
SCHNOS	SCHNOS-O	SCHNOS-C	SCHNOS	SCHNOS-O	SCHNOS-C
24 [9.1]	5.7 [5.3]	18.2 [6.6]	3 [2]	1.2 [1.3]	1.8 [1.3]

Values are mean [standard deviation]. SCHNOS, Standardized Cosmesis and Health Nasal Outcomes Survey (O, nasal obstruction; C, cosmesis).

Table 4. Mean Changes in SCHNOS, SCHNOS-O, and SCHNOS-C Scores at 12 Months Postoperatively

Δ 0-12 months		
SCHNOS	SCHNOS-O	SCHNOS-C
−20.9 [8.9] (large)	−4.5[4.9] (large)	−16.4 [6.5] (large)

Values are mean [standard deviation]. SCHNOS, Standardized Cosmesis and Health Nasal Outcomes Survey (O, nasal obstruction; C, cosmesis).

Case Examples

Figure 5 shows a 42-year-old female patient who presented for a primary rhinoplasty. She complained of having an asymmetric dorsum, a hump on oblique view, plus an asymmetric, underprojected tip. Through an open approach, the skin and soft tissue envelope was elevated. A full subperiosteal dissection of the bony vault was then done, and ultrasonic rhinosculpture was performed on both sides of the bony pyramid. Bony thickness and all bony irregularities were removed from the lateral parts on both sides and the bony cap was removed from the central part of the bony pyramid with a Piezotome. There were no osteotomies. Partial incision of the ULCs along the septum without opening the mucosa and keeping the W-point intact was performed using a No. 11 blade. A 1-mm-wide section of ULC was resected on the right side and a 2-mm-wide section of ULC was resected on the left side along the septum. No sutures, spreader grafts, or flaps were used in the middle third. A septal extension graft was fixed between small bony grafts caudally. Tip modification was achieved with lateral crura transposition plus lateral crura strut grafts and tip sutures.

Figure 6 depicts a 28-year-old female patient who presented for a primary rhinoplasty. She complained of having a wide, deviated dorsum with a hump as well as an asymmetric overdroopy tip with hanging columella and tension nasolabial angle. Through an open approach, the skin and soft tissue envelope was elevated. Ultrasonic rhinosculpture of both sides of the bony pyramid was then performed. The bony cap was removed with a piezo rasp and the cartilaginous vault was exposed cephalically for approximately 5 mm. Then, a low-to-low lateral osteotomy was performed in combination with partial length transverse and paramedial osteotomies with intact bony bridges on both sides. Protruded ULC shoulders and dorsal septum were shaved with a No. 11 blade without opening the mucosa and keeping the W-point intact. The shaved surface and keystone were smoothed with a diamond burr. No sutures, spreader grafts, or flaps were used in the middle third. A septal extension graft was fixed between small cartilaginous grafts caudally. The medial crura were fixed to the septal extension graft more cranially and posteriorly to treat the hanging columella and tension nasolabial angle. Tip modification was achieved with lateral crura transposition plus lateral crura strut grafts and tip sutures.

Figure 7 illustrates a 22-year-old Hispanic male who presented with an S-shaped kyphotic dorsal hump, a slightly deviated nose, and a bulbous and underprojected, plunging tip on smiling. An open approach was used to augment the tip and gain access to the kyphotic nasal bones which required significant remodeling. Dorsal modification of the nasal bony cap and ULCs was performed with piezoelectric rhinosculpture and electrocautery sculpting of the cartilaginous vault. Asymmetric piezoelectric osteotomies were performed, including bilateral low to low, a left medial oblique, and right transverse to straighten the bony pyramid. A septoplasty was performed to relocate the deviated septum. No cephalic trim was performed, and a lateral crural steal of 2.5 mm was performed bilaterally. The tip was supported in a tongue-in-groove manner on the caudal septum. The vertical scroll ligaments were reattached at the end of the case to close the dead space, and Pitanguy's ligament was also reattached.

DISCUSSION

The following 4 areas warrant in-depth discussion: (1) dorsal modification—an independent philosophy for a subset of patients; (2) choice of technique for hump reduction and dorsal improvement; (3) avoiding technical problems; and (4) indications/contraindications.

Dorsal Modification—An Independent Philosophy for a Subset of Patients

In rhinoplasty, there is no universal technique and it is clear that certain patients benefit from preservation, certain patients benefit from structure, and certain patients benefit from a hybrid approach.[7,15] Theoretically, one technique

Figure 5. In an open rhinoplasty approach performed on a 42-year-old female patient, subperiosteal dissection of the bony vault and ultrasonic rhinosculpture on both sides of the bony pyramid were performed. Bony thickness and all bony irregularities were

(continued)

Figure 5. (Continued)
removed from the lateral parts on both sides, and the bony cap was removed from central part of the bony pyramid. Partial incision of the ULC along the septum without opening the mucosa and keeping the W-point intact was performed. A 1-mm-wide section of ULC was resected on the right side and 2-mm-wide section of ULC was resected on the left side along the septum. A septal extension graft was fixed between small bony grafts caudally. Tip modification was achieved with lateral crura transposition plus lateral crura strut grafts and tip sutures. (A, C, E, G, I, K, M) Preoperative images. (B, D, F, H, J, L, N) Postoperative images showing the results after 17 months. ULC, upper lateral cartilage.

could be used in all patients, but this is not always the best, easiest, and/or safest approach.

Dorsal modification as a separate philosophy is also a hybrid approach, but remains very conservative, fast, and reliable. This reliability is strengthened by the finding that no patients in this subset required a dorsal revision. Although not studied directly here, the senior author has also never had to revise a dorsum where dorsal modification was done as a separate philosophy. In cases where there is no need to significantly change dorsal dimensions (height and width), dorsal modification improves the dorsum as quickly and efficiently without significant structural resection and no reconstruction, while maintaining stability and maximum predictability.

Dorsal reconstruction and preservation techniques have different philosophies regarding the stability of the new dorsum. In dorsal reconstruction the predictability of the result is ensured by an even and well-fixed nasal septum (the central support, which is also the foundation of the future bridge of the nose) and mobile side walls of the nose. Thus, the lateral walls of the bony pyramid are mobilized and displaced by osteotomies (lateral, transverse, medial) to close the open roof after removal of the hump during resection and reconstruction of the dorsum. The final result, and its longevity, is based on how well the septum is strengthened, and how good is the final reconstruction including osteotomies and middle vault reconstruction.[16] Dorsal preservation techniques are inherently very different, because the nasal dorsum is separated by septal strip removal from the underlying septum. Unlike in dorsal reconstruction, the dorsum no longer depends on foundational issues. In an impaction procedure, the osseocartilaginous vault must be fully mobile by lateral, transverse, and radix osteotomies, so that it is possible to make impaction of the bony vault downward into or toward the pyriform aperture.[17] With surface procedures, the bony cap is modified or removed, and only the central platform is lowered with or without formal osteotomies. The final result depends on the aesthetics of the original dorsum and the fixation in its new position. The aesthetics are unlikely to change with time because no reconstruction of the dorsum has been performed and the underlying septal tension has been released.

The main elements of dorsal modification were first described by the senior author (A.K.) as follows: (1) incremental modification and ostectomy of the bony cap, including the lateral keystone area, to convert the bony dorsum to cartilage; (2) shaving the ULC shoulders and dorsal septum without opening the mucosa; (3) piezoelectric rhinosculpture and osteotomies to narrow and sculpt the bony pyramid; and (4) closing any cartilage defect over the underlying mucosa and shaping the ULCs.[5] These elements, in our opinion, make dorsal modification a separate philosophy, because shaving the ULC shoulders and dorsal septum even without opening the mucosa results in partial disruption of the cartilaginous dorsal platform and partial opening of the middle vault, but according to most authors, dorsal preservation may be any technique of dorsal dehumping that does not open the cartilaginous middle vault.[15,17] In contrast, reductive dehumping typically involves opening the middle vault, which requires reconstruction with sutures, grafts, or flaps. Reconstruction is never required in dorsal modification because there is no complete opening of the cartilaginous middle vault, which remains stable because of the intact mucosa and W-point. No grafts or flaps are required for reconstruction and, very importantly, the tension of the ULCs remains. As soon as the ULC is divided from the dorsal septum, the cartilage retracts caudally and tension is lost in the dorsum. By maintaining this tension, the dorsum remains stable.

When dorsal modification is used as an independent procedure, the philosophy is inherently separate from dorsal reconstruction and preservation techniques. Stable and well-fixed lateral bony walls, as well as tensioned ULCs that are not taken apart, make the underlying septal foundation issues less relevant. In addition, preserving structures of the dorsum and maintaining the stability of the side walls allows for maximum predictability of the result. Thus, dorsal modification, in our opinion, when performed as a stand-alone procedure, is a separate philosophy that differs from dorsal preservation and reconstruction concepts. It allows for reshaping of the dorsum as in structural rhinoplasty, but also allows for preservation of the important structures while decreasing the reliance of an absolutely straight septum that is required in dorsal structural rhinoplasty.

Choice of Technique for Hump Reduction and Dorsal Improvement

Many well-known surgeons who perform dorsal preservation note that final reshaping by osteoplasty with burrs or PEIs is often required.[3,8,12] This raises the question: if it is necessary to perform dorsal modification as an additional procedure

Figure 6. This 28-year-old female patient underwent an open rhinoplasty, including ultrasonic rhinosculpture of both sides of the bony pyramid. The bony cap was removed and 5 mm of the cartilaginous vault was exposed. Then, a low-to-low lateral osteotomy was performed in combination with partial length transverse and paramedial osteotomies with intact bony bridges on both sides. (A, C, E, G, I, K) Preoperative images. (B, D, F, H, J, L) Postoperative images showing the results at 15 months.

with dorsal preservation, for example, when reducing S-shaped nasal bones where the hump is ≤3 mm and/or treating a wide and asymmetric middle vault, can this be achieved with dorsal modification as a separate technique only, which is faster and also gives good results? In suitable patients, it is possible to perform only dorsal modification by sculpting the bones and cartilages while maintaining the stability of the bony pyramid, mucosa, and W-point. In such cases, where there is no need to significantly change dorsal dimensions (height and width), our approach used to be to reduce hump height up to 3 mm, especially in patients with S-shaped nasal bones, low radix, low supratip, lateral hump, wide and asymmetric middle vault, etc. This avoids the problems and complications associated with excessive lateral wall mobilization,

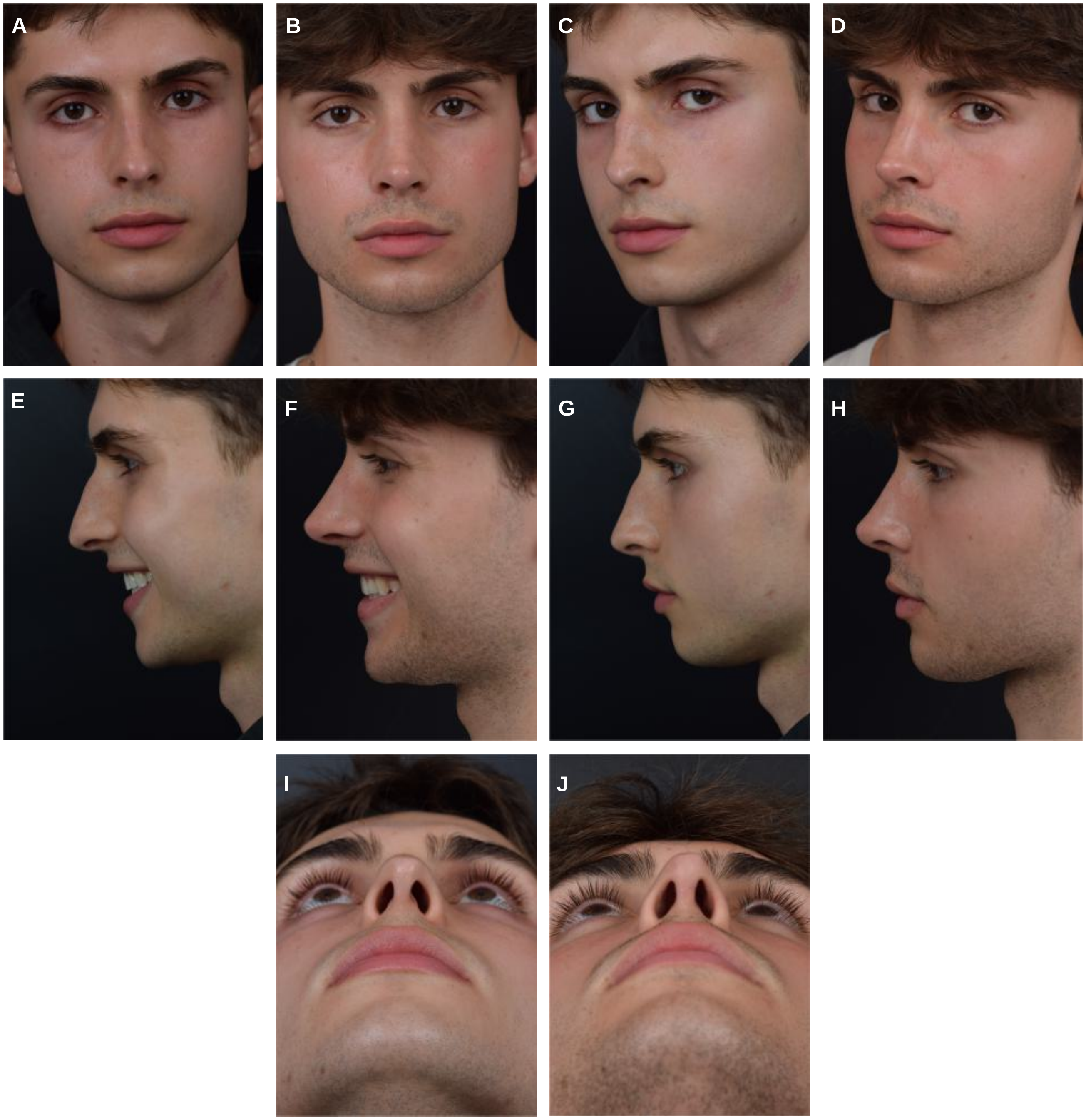

Figure 7. An open rhinoplasty approach was used on this 22-year-old male patient to augment the tip and gain access to the kyphotic nasal bones. Dorsal modification of the nasal bony cap and upper lateral cartilages was performed with piezoelectric rhinosculpture and electrocautery sculpting of the cartilaginous vault. Asymmetric piezoelectric osteotomies were performed including bilateral low-to-low, a left medial oblique, and right transverse to straighten the bony pyramid. A septoplasty was performed to relocate the deviated septum. No cephalic trim was performed, and a lateral crural steal was performed 2.5 mm bilaterally. The tip was supported in a tongue-in-groove manner on the caudal septum. The vertical scroll ligaments were reattached at the end of the case to close the dead space, and Pitanguy's ligament was also reattached. (A, C, E, G, I) Preoperative images. (B, D, F, H, J) Postoperative images showing the results at 12 months.

preserves perioperative structural stability, and ensures long-term nasal symmetry. A number of authors have noted in their papers that a more conservative approach often produces more predictable results and significantly reduces the number of their own revisions.[18,19] Each individual surgeon will apply this technique depending on his/her patient population.

Having performed dorsal modification in more than 50% of primary rhinoplasties during the last 3.5 years, the primary author has encountered a significant reduction in his own revisions on the dorsum, and we attribute this to our frequent use of the dorsal modification technique. Of course, other techniques for the dorsum are used when necessary to significantly change dorsal dimensions (height and width), in particular dorsal preservation with a hump >3 mm, or in case of a significant lowering of the dorsal projection >3 mm, or in the presence of a severe dorsal deviation, especially axial, which in our opinion is well treated by the asymmetric let-down technique. We also perform dorsal reconstruction for patients with significantly crooked dorsum (posttraumatic) and in almost all cases of secondary rhinoplasty. And in many of these cases, we had to use the dorsal modification technique, not as a separate procedure, but as an addition to other techniques to achieve better results.

Avoiding Technical Problems

Dorsal and surface modifications (bony cap removal, rasping, trimming upper lateral cartilages, etc) have been well known for many years and have been repeatedly described as additional procedures of existing techniques.[4-8] However, the use of dorsal modification as a separate technique is a new approach.[5]

The critical feature of dorsal modification is the preservation and competence of the internal valve with the absence of irregularities or discontinuity of the dorsum. Normal functioning of the internal valve is achieved by maintaining the stability of the entire nasal pyramid without excessive mobility, with 2 points of tight fixation of the ULCs. This fixation is both cranial in the keystone area and caudal at the W-point. This tension and the intact mucosa prevent displacement inward and obviate the need for expanding flaps or grafts. Therefore, it is important to avoid excessive mobilization of the bony pyramid when performing bony modification by utilizing a sequential approach, first performing rhinosculpture and partial bony cap reduction, and then, if necessary, performing osteotomies, leaving bone bridges to ensure the stability of the cranial point (keystone).[1] It is equally important to maintain stable fixation of the ULCs at the caudal point (W-point). If a small reduction of the dorsum at this W-point is necessary, then after shaving it should be restored by fixing the ULCs to the septum with a mattress suture without dissection of the mucosa.

To keep the mucosa intact, hydrodissection between the ULCs and the mucosa should be performed before starting cartilage modification, and when shaving the shoulders and septum or performing partial incision of ULC, always shave very little at first and then remove more step by step, controlling the depth of removal.

To avoid small irregularities or discontinuity, especially in the keystone area, after bony modification and cartilage shaving or partial incision of ULC along the septum we use a diamond burr, which smooths the transition of the bony pyramid to cartilage and enables us to achieve excellent results without camouflage on the dorsum.

Indications and Contraindications

The primary indications for dorsal modification are primary rhinoplasty cases where there is no need to significantly change dorsal dimensions (height and width), when the bony vault has excessive width, and when a dorsal reduction <3 mm is indicated. The contraindications are cases in which it is necessary to significantly change dorsal dimensions (height and width), and when the bony vault has a severe excessive width and a dorsal reduction >3 mm is indicated, and cases with severe dorsal deviation, a significantly crooked dorsum (posttraumatic) dorsum, and secondary rhinoplasty cases.

Limitations

The primary limitation of this study is not the number of patients (147 cases) but rather the limited follow-up time of 41 months; however, the conclusions reached in this paper have been confirmed in subsequent months following termination of the study. Another limitation of this study is its retrospective nature. A specific limitation of the method is the lack of access to PEIs and electric burrs.

CONCLUSIONS

Dorsal modification is a separate philosophy in rhinoplasty, and can be considered as the first choice of technique when the surgeon needs to perform minor changes in the dorsal region. Because this procedure is quick, simple, and superficial, while keeping all structures stable and well fixed to each other, it is reliable. By not requiring mobilization of the entire nasal pyramid and the use of spreader flaps and grafts in most cases, the long-term stability of the dorsum is maintained. Using dorsal modification for a dorsum with a small hump, mild excessive width, and when a dorsal reduction of <3 mm is required avoids the problems and complications associated with excessive lateral wall or ULC mobilization, preserves perioperative structural stability, and ensures long-term nasal symmetry. At the same time, the use of dorsal modification as an additional procedure remains not just desirable but necessary in many cases when performing both dorsal preservation and dorsal reconstruction.

Supplemental Material

This article contains supplemental material located online at www.aestheticsurgeryjournal.com.

Disclosures

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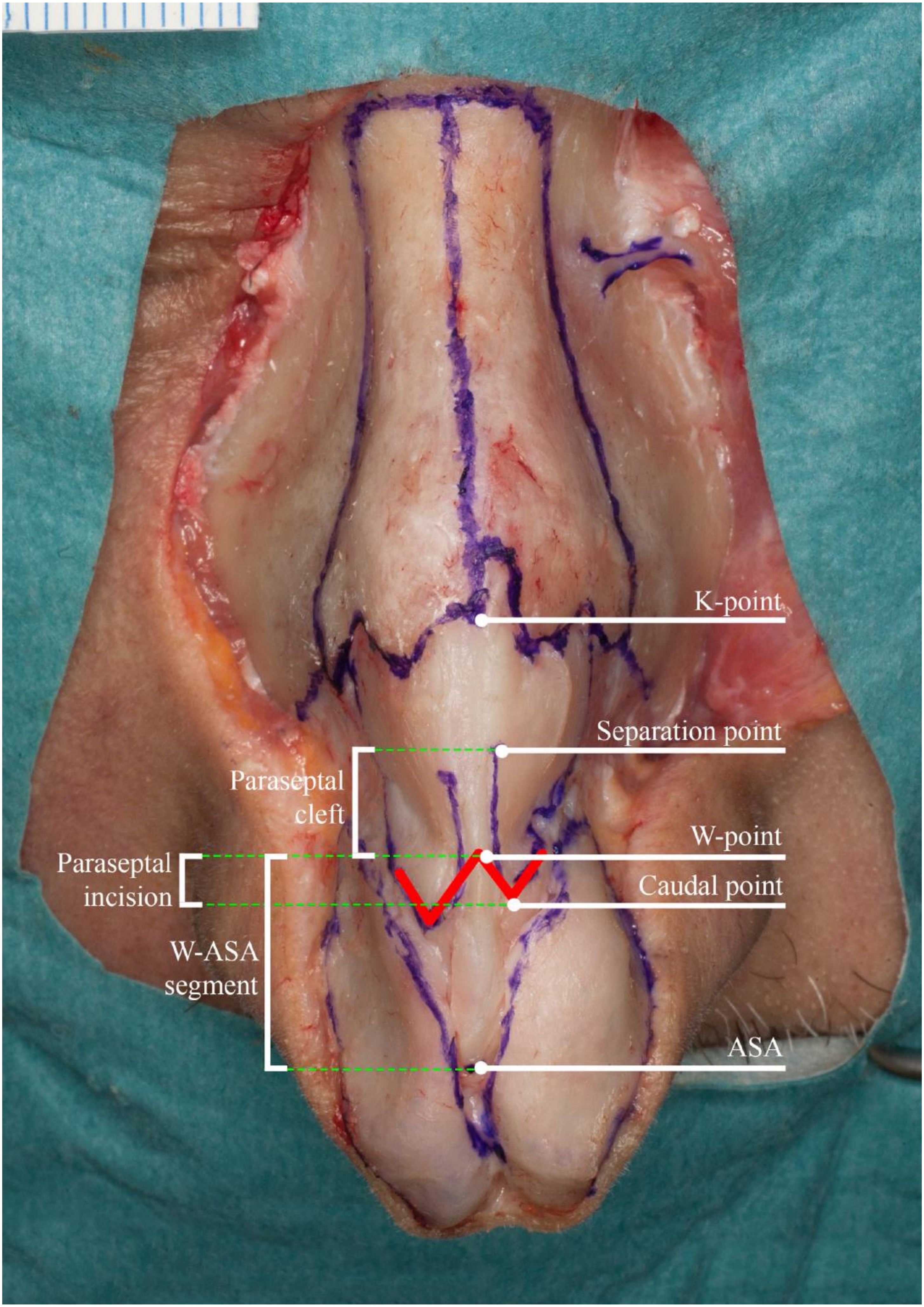
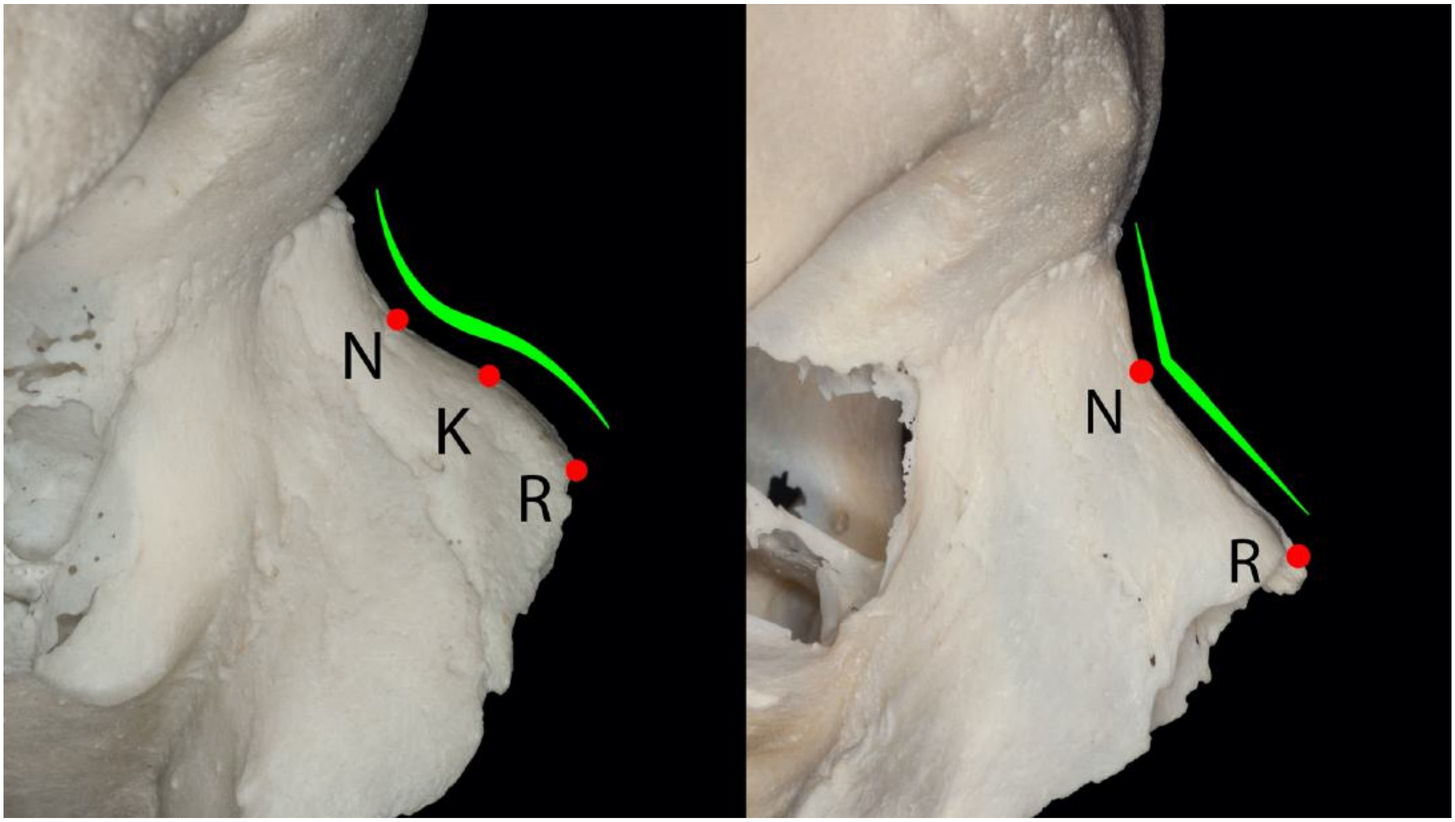

K-point
Separation point
Paraseptal cleft
W-point
Paraseptal incision
Caudal point
W-ASA segment
ASA



Operative Anatomy
for Preservation Rhinoplasty

Peter Palhazi, Rollin K Daniel

As with all surgery, Preservation Rhinoplasty (PR) requires an in-depth knowledge of anatomy in order to understand and perform the essential operative steps. A detailed knowledge of surgical anatomy is crucial for PR for two reasons. First, there has been a dramatic expansion in our understanding of nasal anatomy over the past decade (Daniel, Palhazi, 2018). Second, surgical techniques have evolved based on this new anatomical knowledge. For example, the current techniques for Dorsal Preservation are based on the concept of the osseocartilaginous junction being a semi-flexible chondro-osseous joint which can be changed from convex to straight while retaining a natural dorsum. Another example is the elevation of an intact soft tissue envelope in a continuous subperichondrial-subperiosteal plane. To elevate the skin envelope without damaging it requires advanced technical skills as well as a sophisticated understanding of the nasal anatomy, especially tissue planes and nasal ligaments. The present chapter will discuss and illustrate both the essential anatomy and surgical techniques required for Preservation Rhinoplasty in a step-by-step fashion.

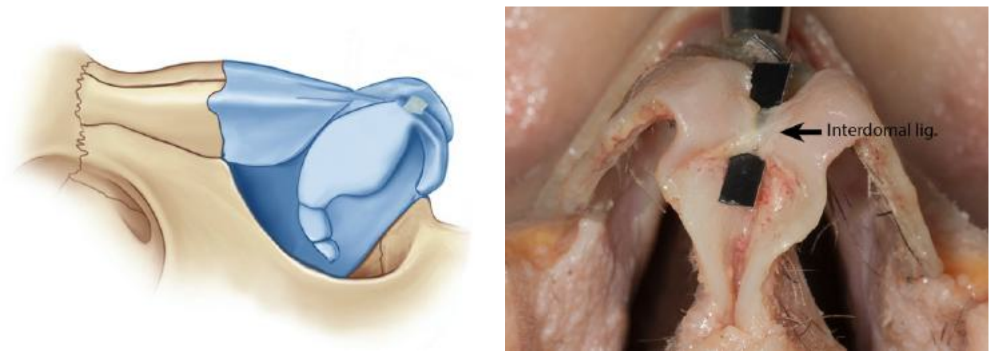
ANATOMICAL CONCEPTS OF THE SOFT TISSUE ENVELOPE FOR PR

The majority of rhinoplasty surgeons have familiarity with nasal anatomy and a relatively routine surgical technique for most noses. However, the transition to Preservation Rhinoplasty requires greater in-depth knowledge of nasal anatomy and new surgical approaches based on that anatomy. In this section, we will emphasize the anatomy of the nasal ligaments and their importance in the surgical techniques for elevating an intact soft tissue envelope.

Interdomal Ligament

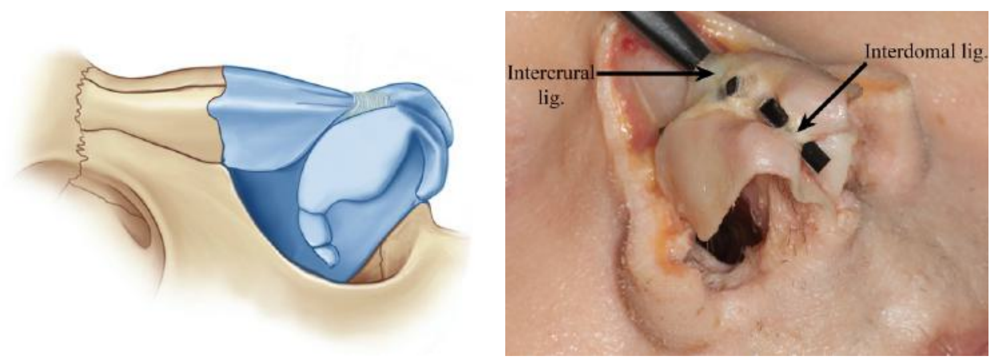
The interdomal ligament connects the two middle crura at the cephalic junction of the infralobular segment. Technically, the ligament does not run between the domes, but rather between the middle crura in a more posterior and cephalic location. It is easily found in all noses and is often quite rigid.

Although many surgeons cut the interdomal ligament during insertion of a columellar strut, the interdomal ligament can easily be preserved due to its cephalic position away from the caudal border of the middle crura. Obviously, this preservation is not possible if a tip split procedure is performed. Many surgeons routinely insert an interdomal suture to narrow the interdomal distance, which in reality merely represents reestablishment of the previously cut interdomal ligament.

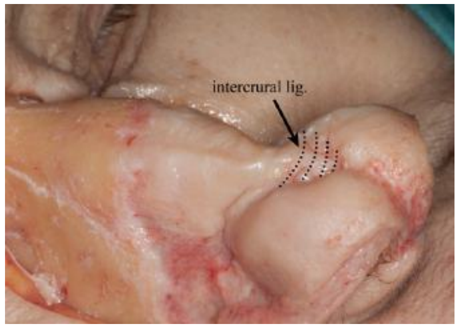


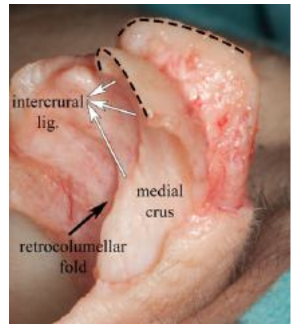
Intercrural Ligament

The intercrural ligament connects the cephalic border of the entire alar cartilages, including the lateral, middle, and medial crura. It passes just above the mucosa and holds the alar cartilages together.



In its cephalic portion along the lateral crus, it acts as the suspensory ligament of Converse passing just above the anterior septal angle. In its mid-portion, it is posterior to both the interdomal ligament and the deep portion of Pitanguy's midline ligament. Its caudal component effectively restrains the medial crus and footplate, pulling them towards the caudal septum. The intercrural ligament unifies the two alar cartilages and acts as a suspensory sling over the anterior septum.

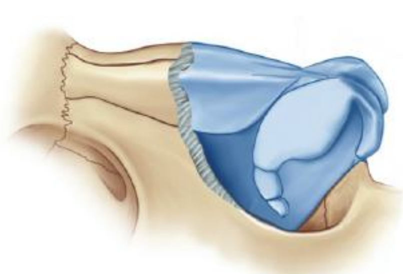


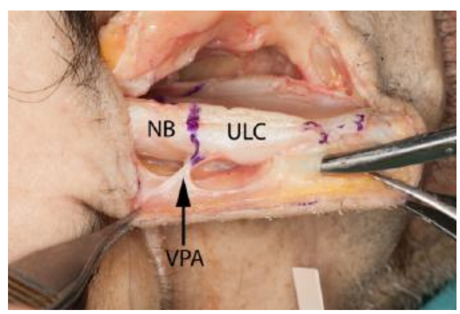


During rhinoplasty surgery, this ligament can either be preserved or disrupted. In an open approach, a "tip split" procedure will divide the ligament and require the surgeon to restore support, usually with a columellar strut. However, downward traction on the alar cartilage followed by a "dorsal split" allows one to maintain the intercrural ligament. A bilateral transfixion incision through the membranous septum will disrupt the intercrural ligament support between the footplates. Alternatively, one can perform a low septal transfixion incision. Essentially. one makes the transfixion incision through the caudal septum approximately 2-3 mm back from the caudal border, thereby ensuring total preservation of this ligament.

Vertical Pyriform Attachments

Saban noted distinct superior and inferior lateral nasal ligaments along the pyriform aperture, which he designated ligamentum laterale superius and inferius nasi. We have found these ligaments to be inconsistent as distinct entities, but have detected a consistent vertical attachment between the entire pyriform aperture and the overlying soft tissue envelope, which we have designated as the Vertical Pyriform Attachments (VPA). It is particularly dense at the keystone area and on occasion along the lateral border. Release of this VPA becomes important in the total dorsal exposure associated with complete lateral osteotomies done with a piezo-electric saw.

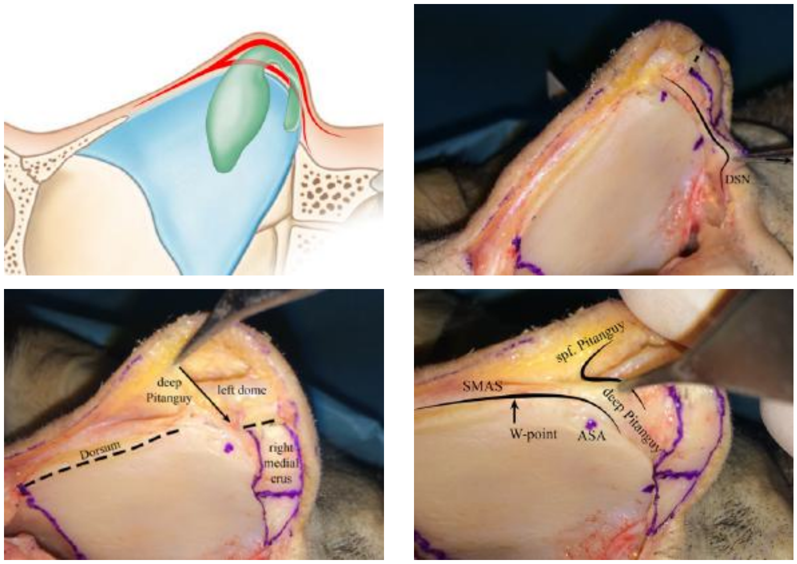




Pitanguy's Midline Ligament

Pitanguy described a ligament originating on the undersurface of the dermis and running tangentially down to and in between the alar cartilages. He reported a connection between this ligament and the depressor septi nasi (DSN), which was later confirmed by de Souza Pinto. Recently, Saban has demonstrated that the medial SMAS at the level of the internal nasal valve divides into a superficial and a deep layer. The superficial medial layer runs caudally below the interdomal fat pad, but *above* the interdomal ligament into the columella. The deep medial layer of the SMAS runs *beneath* the interdomal ligament, but above the anterior septal angle into the membranous septum and then downward toward the anterior nasal spine. Saban concluded that the deep medial SMAS could correspond to Pitanguy's ligament.

Based on the accepted five-layer laminate concept of the nasal soft tissue envelope, Pitanguy's ligament cannot be a true dermocartilaginous ligament, as it would have to run tangentially from the dermis across and through the SMAS to reach the cartilaginous structures in the tip. We have modified the original terminology and advocate the use of the term "Pitanguy's midline ligament," which reflects its origin as part of the midline SMAS layer. (Daniel, Palhazi, 2018)

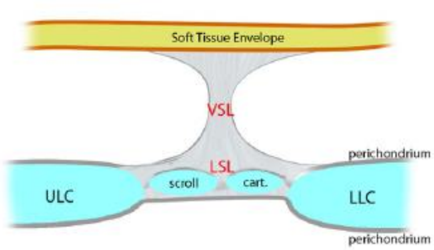


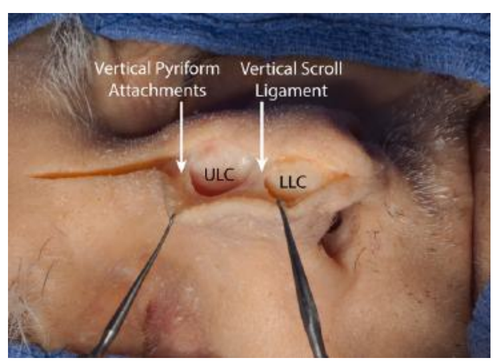
We emphasize that Pitanguy's midline ligament divides into a *superficial portion* which passes above the interdomal ligament and becomes continuous with the superficial orbicularis oris muscle (SOON) and a *deep portion* which passes below the interdomal ligament and becomes continuous with the depressor superficial nasalis muscle (DSN).

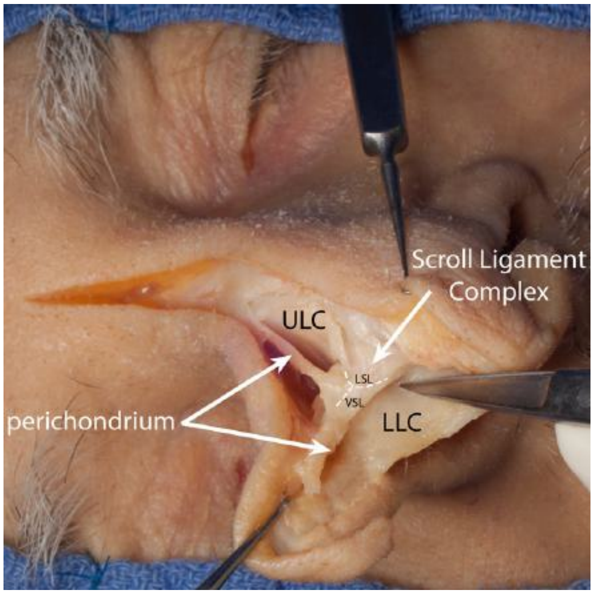
Surgically, division and repair of Pitanguy's midline ligament has become an important method of supporting the nasal tip. Utilizing a closed approach, Çakır identifies the ligament and preserves it in approximately 90% of cases. Surgeons using an open approach often mark, divide, and then repair Pitanguy's midline ligament at the end of the case.

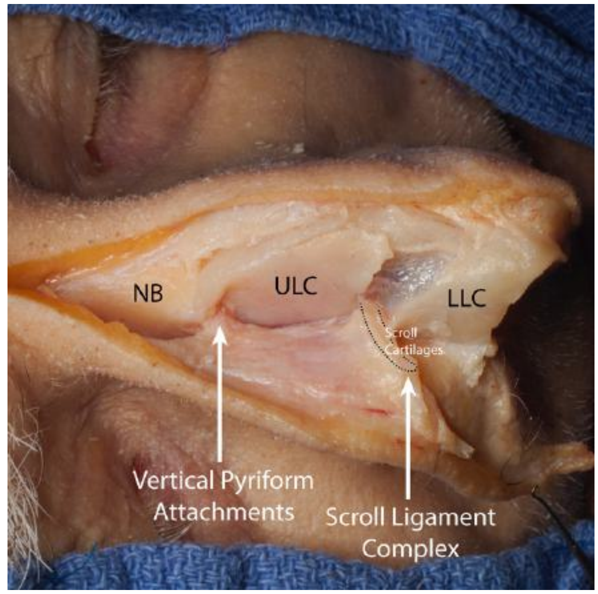
Scroll Ligament Complex (SLC): Vertical & Longitudinal Scroll Ligament

A longitudinal fibrous attachment has long been recognized in the scroll area between the cephalic border of the lower lateral cartilages (LLC) and the caudal border of the upper lateral cartilages (ULC). Recently, Saban has identified a distinct fibrous attachment from the undersurface of the transversalis muscles to the scroll junction. Thus, a Longitudinal (LSL) and a Vertical Scroll Ligament (VSL) can be collectively referred to as the Scroll Ligament Complex.

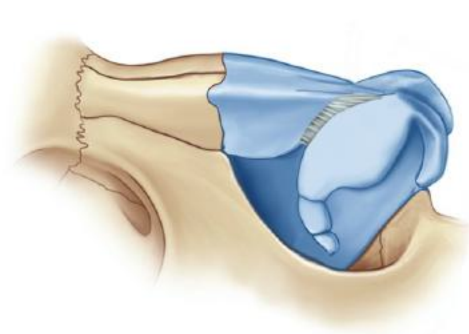


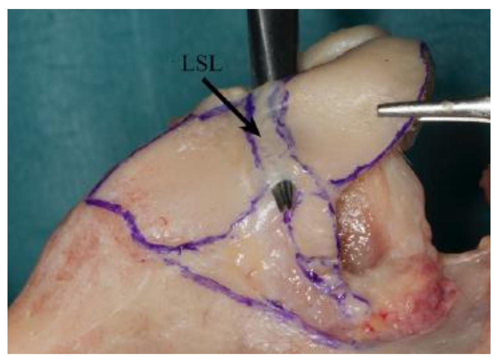


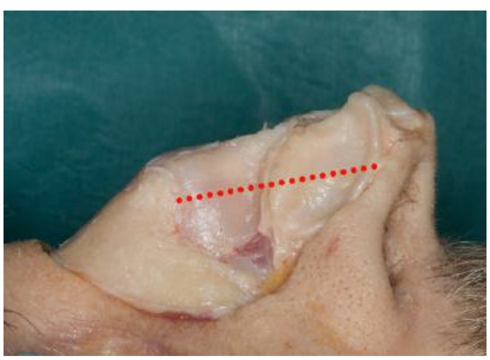


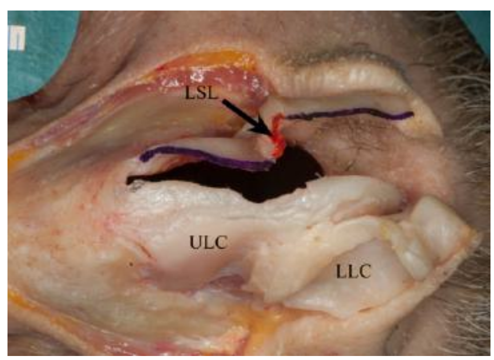


The *Longitudinal Scroll Ligament* (LSL) occurs at the junction between the LLC and ULC. It is basically a perichondrium-derived fibrous tissue in the scroll area that contains multiple interspersed sesamoid (scroll) cartilages. On the mucosal surface, it is the internal valve area. It acts like a swinging door. This ligament is a strong connection between the cartilages, whose lateral counterpart is the pyriform ligament (Rohrich et al. 2006).

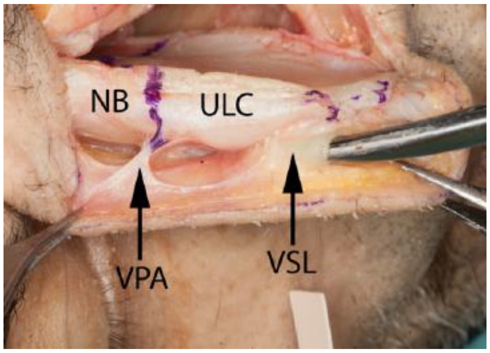


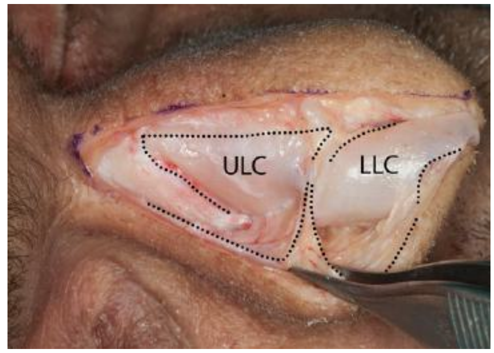




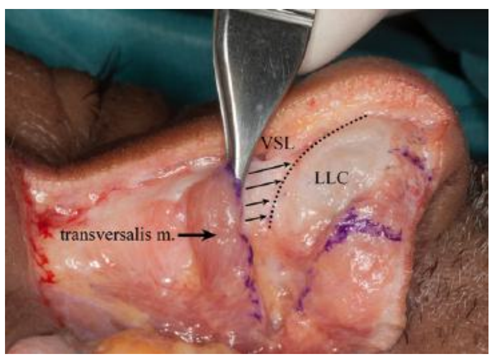


Saban introduced the concept of a *Vertical Scroll Ligament* (VSL) that emerges from the undersurface of the deep SMAS layer and inserts into the internal nasal valve area. These vertically oriented ligaments are always problematic to understand, because they are not as distinct as the longitudinal ones between the cartilages. The VSL is actually a line of adherence along the scroll area, between the overlying soft tissue envelope (SMAS) and the underlying LSL as seen below.





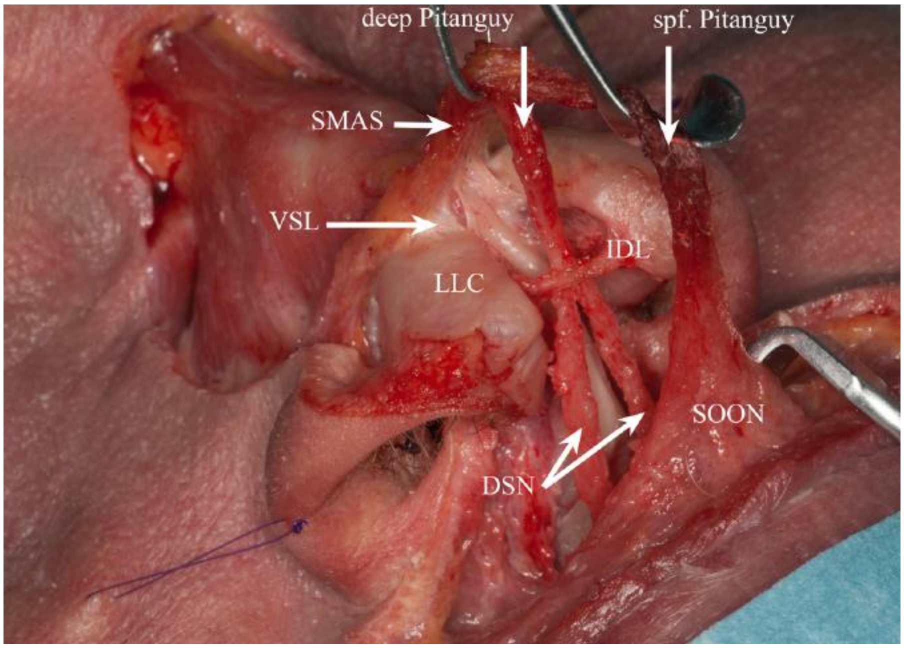
One can clearly see in the following figure the SMAS and scroll area connections. The VSL appears from the caudal edge of the perimysium of the transversalis muscle, thus transmitting the muscle contraction onto the scroll area and finally onto the internal valve. However, the transversalis muscle is a paradoxical muscle. During inspiration, it contracts to narrow the airway, exaggerates the internal valve, and hence redirects the airflow towards the upper meatuses.



The scroll ligament complex (SLC) has become extremely important in PR and demonstrates the linkage between surface aesthetics-anatomy-surgical technique. New analysis and terminology of this area are now required. As seen in the photograph below, it is important that the surface aesthetics of this area be carefully analyzed pre-operatively.

The classic term "*alar groove*" often denoted a C-shape line which arises in the alar crease, runs vertically through the "alar dimple" before turning toward the alar rim along the caudal border of the lateral crus, and ending at the turning point (TP). However, we now conceptualize the alar groove as splitting at the A-1/lateral crus junction point into a scroll line and a lobular line. The line along the cephalic border of the lateral crus is called *the scroll line*. It is significant as it is both the cephalic border of the lateral crus polygon and the location of the resting angle, both important aesthetic considerations. The *lobular line* overlies the caudal border of the lateral crus and terminates at the turning point, thereby separating the tip lobule from the alar base. These concepts have a dramatic impact on surgical technique as demonstrated in the patient below, treated by Dr. Çakır. As seen in the pre-operative photo on the left, the alar groove is very pronounced, and the scroll line is angulated upward and far from the rim. Surgically, one can elevate the scroll ligament complex intact and then reattach it closer to the alar rim, thereby creating a more aesthetic tip, as seen post-operatively.

In conclusion, this photograph shows the relationship of all of the important ligaments in the lower third.



SOFT TISSUE ELEVATION OVER THE OSSEOCARTILAGINOUS VAULT

Elevation of the entire soft tissue envelope (STE) in a continuous subperichondrial -subperiosteal plane (SSP) is a critical first step in performing a complete PR.

Step #1 – A Low Septal Transfixion Incision

The first incision is a low septal transfixion incision. Most surgeons are familiar with the transmucosal transfixion incision with its half- and full-length extent, plus unilateral or bilateral configurations. Essentially, the columellar is separated from the caudal septum via an incision through the membranous septum.

The disadvantage of these incisions is that they cut many of the nasal ligaments including the deep layer of the Pitanguy ligament, and it disrupts many of the attachments of the alar cartilages, including the intercrural ligaments. In contrast, the low unilateral septal transfixion incision placed 2 mm cephalic to the caudal border of the septum preserves all of these ligaments while providing access to the septum. The cartilage retained in the columellar complex is called the posterior strut by Çakır, in contrast to the columellar struts utilized for tip shaping.

Step #2 – Intercartilaginous Incisions

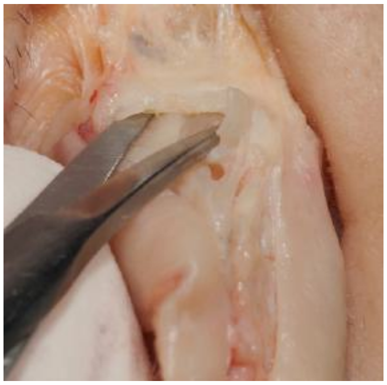
The intercartilaginous incision is placed at the junction between the upper (ULC) and lower lateral (LLC) cartilages. After infiltration with local anesthesia, a 10-15 mm long incision is made, just penetrating the mucosa. The incision passes from lateral to medial where it joins with the septal transfixion incision bilaterally.

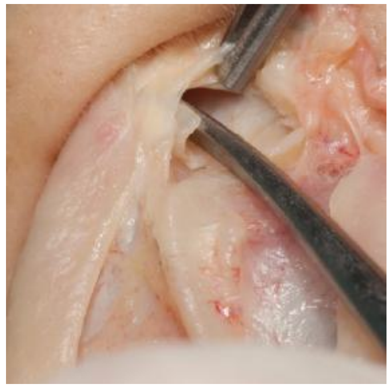
Step #3 – Subperichondrial Dissection over the Cartilaginous Vault

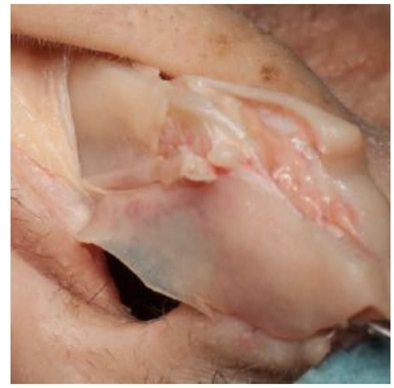
Sharp pointed scissors are then used to expose the upper lateral cartilages along their caudal border. Technically, it is important to facilitate clear demonstration of the dissection planes.

The perichondrium is easily swept off the dorsal aspect of the cartilaginous vault in a lateral to medial direction and then progressing upward to the bony cartilaginous junction. The Daniel-Çakır elevator is particularly useful for this maneuver. Resistance will be encountered as one approaches the cartilaginous-bony junction.

In the photos below, one can see the central and lateral subperichondrial dissection over the cartilaginous vault.

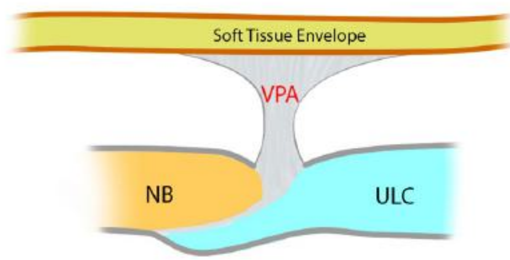






Step #4 – Division of the Vertical Pyriform Attachments

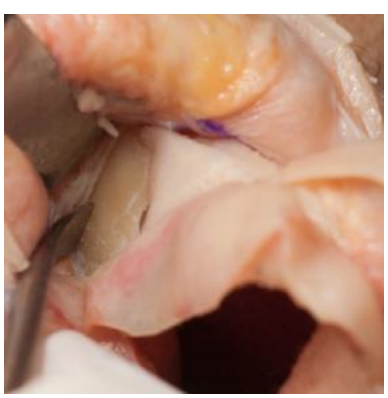
Significant resistance is encountered as one passes from the cartilage vault to the bony vault, due to the vertical pyriform attachments (VPA) which are vertical attachments between the pyriform aperture and the overlying soft tissue envelope. These may provide significant resistance and require sharp dissection to enter the subperiosteal plane.

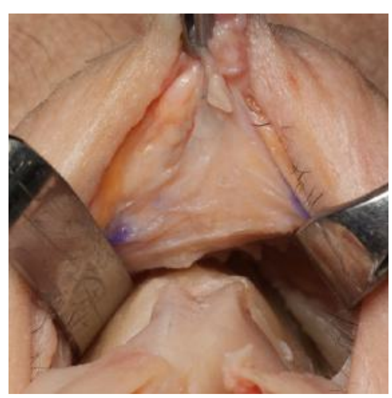


Step #5 – Lateral Dissection into the Subperiosteal Plane

It may be necessary to use a #15 blade to scratch along the caudal border of the nasal bone in order to enter the subperiosteal plane. It is often best to find the plane laterally over the nasal bones and then connect medially over the dorsum.

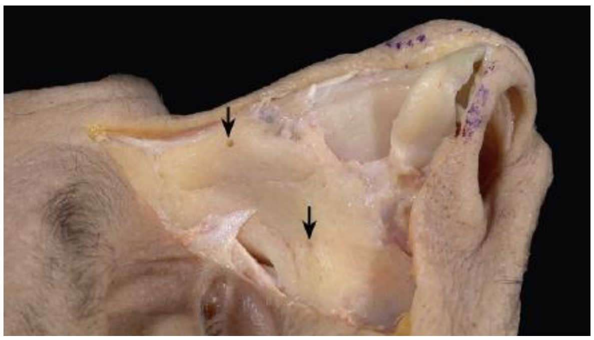
However, once this plane is entered, the dissection is easily done with an elevator. The extent of the subperiosteal dissection cephalically and laterally will depend upon the surgeon's preferred method of osteotomies. For conventional osteotomes or hand saws, the dissection cephalically will extend to the radix area and laterally midway down the lateral bony wall. For those surgeons using power or piezo-electric instruments, a total degloving of the bony vault is preferred.

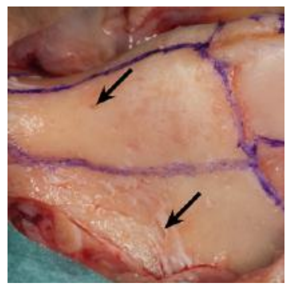




Step #6 – Lateral Dissection and Bleeding Points

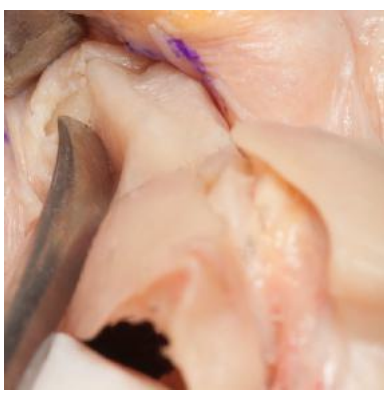
As the lateral dissection continues cephalically in a subperiosteal plane, one tends to encounter several bleeding points at consistent locations. One group of perforating vessels are usually slightly caudal to the sellion, in the radix area. The bleeding is due to severing the small communicating vessels. These vessels are small (< 0.5 mm) branches from the anterior ethmoidal vessels below the bone, which pass through holes to reach the angular vessels. Cauterization is usually sufficient to achieve hemostasis, but bone wax can be applied in cases of persistent bleeding. A second group of vessels are found in a more lateral location at the cephalic end of the nasofacial groove. There are also bleeding vessels through the mucosal space (see figure on the right). These vessels are usually 0.5-1.0 mm in diameter and consist of communicating vessels between the external and intranasal vessels. They are usually damaged when a lateral osteotomy is done or an incision made through the mucosa internally.





Step #7 – Medial Dissection: Central Subperichondrial/Subperiosteal Fusion Area

Dissection in the central area to unite the upper subperiosteal and lower subperichondrial pocket can be difficult.



The reason for this challenging dissection is based on embryology. During fetal development, the nose is made up of a cartilaginous capsule which is covered with perichondrium. Then the nasal bones with their periosteum are laid down on top, which results in an overlapping fusion of perichondrium and periosteum. In some ways, this challenging dissection is similar to dividing the conjoined fibers between the anterior and posterior pockets of the septum. Again, judicious scraping with the #15 blade may be of value.

SOFT TISSUE ELEVATION OVER THE LOBULE

Soft tissue elevation over the lobule via a subperichondrial-subperiosteal plane (SSP) is a demanding technique that must be mastered.

Step #1 – Auto-Rim Flaps and Entering Subperichondrial Plane at the Turning Point

As advocated by Çakır (Çakır et al., 2015), an auto-rim flap is an important method for achieving the desired alar highlight line advocated by Toriumi, as well as for preventing alar rim retraction. In addition, it minimizes the need to add alar rim contour grafts at the end of the case. The figures below show a closed approach.

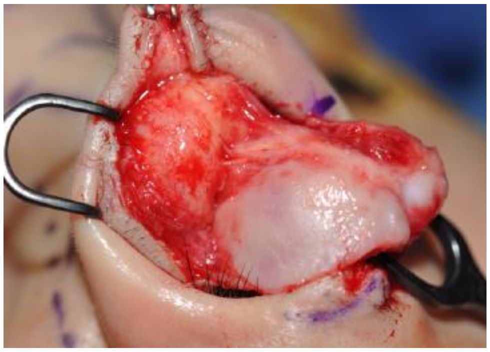
After careful palpation of the caudal border of the lower lateral cartilage, an intracartilaginous incision is made 2-3 mm back from the caudal margin. It begins at the lateral genu of the domal notch or 2-3 mm lateral to the dome, and then passes laterally to the turning point (TP) of the lateral crus, where it ends. This long narrow sliver of cartilage is retained within the skin sleeve.

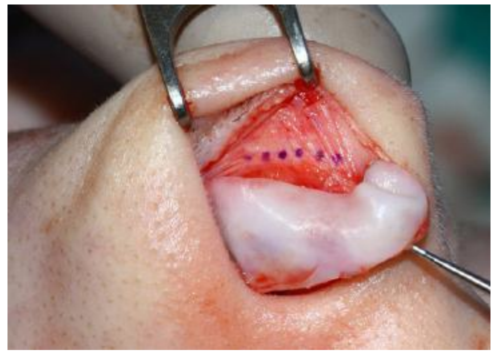
It is easiest to begin the subperichondrial dissection laterally using a #15 blade held vertically and then scarping along the cartilage. The lateral crus is held under tension with a fine hook pulling the lateral crus downward, while a narrow ribbon retractor pulls the skin upward to increase exposure.

Step #2 – Develop a Full Subperichondrial Plane over the Lateral Crus

It cannot be over-emphasized that the lateral crus must be absolutely clean, with no soft tissue fragments.

As seen in the clinical photographs below, the vast majority of surgeons who think they are dissecting subperichondrially are not in the correct plane. If one sees muscles or bleeding points on the elevated skin, then the dissection is sub-SMAS, no matter how "clean" the cartilage appears. Gaining access to this plane is the most tedious and technically challenging aspect of this operation. On the left side below, one can see a clean dissection over the cartilage, but it is sub-SMAS as the muscles and bleeding soft tissues are obvious. On the right side, one can see a true subperichondrial dissection with visible perichondrial fibers on the elevated soft tissue, while the dots indicate the scroll ligament complex.





Step #3 – Continue Dissection over the Dome, Down the Middle Crus, and onto the Medial Crus

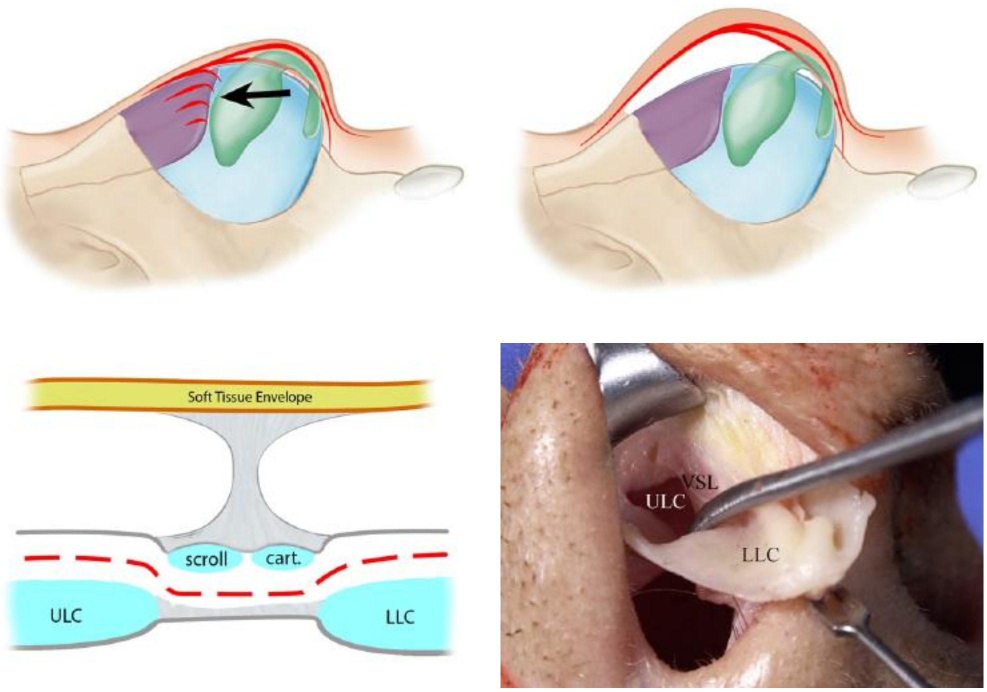
Once the lateral crus has been exposed, the dissection continues over the dome, then down the middle crus and onto the medial crus below the columellar breakpoint. The goal of this dissection is to achieve sufficient mobility of the crus to allow delivery of them into one nostril. It is essential that the alars be sufficiently mobile to be in approximation without tension when delivered through one nostril, thus allowing accurate suturing. In the figures below one can see a closed approach on the left, an open approach on the right.

Step #4 Release of the Interdomal Ligament

At this point, additional mobilization is achieved by releasing the interdomal ligament. Again, the dissection must be meticulous, and the ligament released from the posterior border of the middle crus. Note that the appositional approximation of the interdomal ligament is restored with sutures, including various "loop sutures" between the interdomal soft tissues and cephalic border of the middle crura.

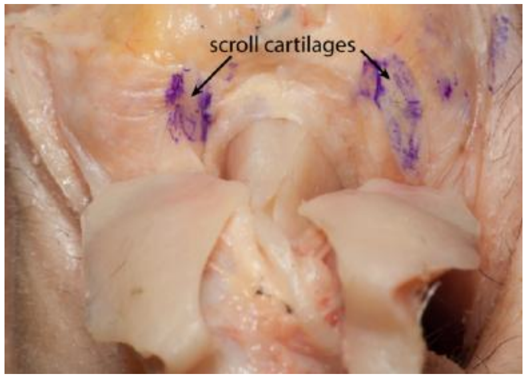
Step #6 – Cephalic Dissection across the Scroll Junction pushing up the Scroll Cartilages and the Vertical Scroll Ligament

Although conceptually simple, this step is ultimately the joining of two preexisting subperichondrial pockets: one over the lateral crus, and the other over the cartilaginous vault (see figure below). Connecting the pockets starts at the dorsum and progresses laterally.



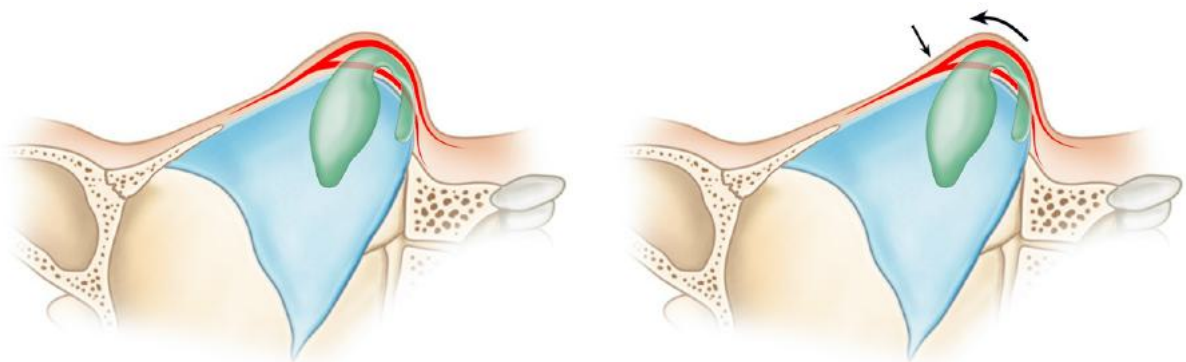
The figure below demonstrates the preservation of the Pitanguy's ligament. Note: The transcolumellar incision was done to show the deep Pitanguy's ligament.

Success is noted by visualization of the white sesamoid cartilages in the overlying soft tissue envelope (see figure below; note: dissection was performed to show the scroll cartilages in the perichondrium/VSL—the Pitanguy's ligament is not preserved).



Dividing Pitanguy's ligament, with the option of suturing it back together, gives greater access to the dorsum, if there is a need for any dorsal modification. In most cases Pitanguy's ligament is kept intact. The obvious question is: "Why bother to preserve the ligament?" There are 3 reasons to keep it intact:

1) it elevates the tip,
2) it compresses the infralobular curve, and
3) it pulls the soft tissue envelope downward, thereby accentuating the supratip break.



Cutting Pitanguy's ligament has three negative consequences:

1) derotation of the tip with loss of projection,
2) it lengthens the infralobule and causes it to round out, and
3) it creates a soft tissue poly-beak. *Preservation leads to predictability*.

Why is this step so important? Functionally, it means that the scroll ligament complex between the longitudinal and vertical components is maintained and neither disrupted nor scarred. In many ways, it is the equivalent of preserving the internal valve angle by doing submucosal tunnels. Aesthetically, the suture reattachment of the sesamoid area to the ULC will set the aesthetic scroll line on the surface and define the upper border of the lateral crus polygon.

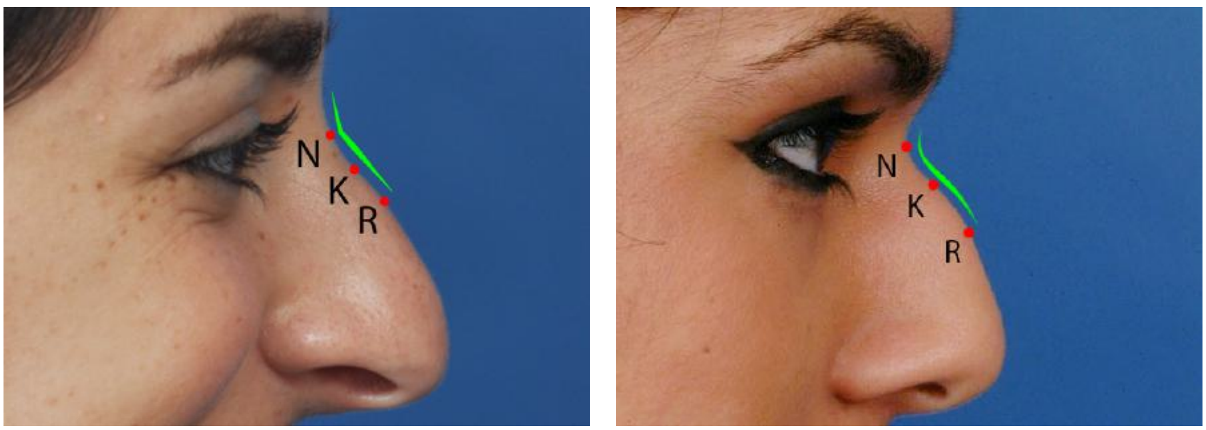
ANATOMICAL CONCEPTS OF DORSAL PRESERVATION

Preserving the osseocartilaginous dorsum is a major advance in rhinoplasty surgery. Instead of excising the dorsum, one lowers it by removing a subdorsal septal strip, followed by lateral, transverse, and radix osteotomies.

Step #1 – Understanding the Aesthetic Points of the Dorsal Profile (N-K-R)

Very few surgeons analyze the nasal hump. Rather, they connect the dots between the nasion (N) and ideal tip projection to set the ideal dorsal line and thereby determine the amount of reduction. In PR, it is important to recognize the three aesthetic points: N, K, R.

The clinical *Nasion (N),* as opposed to the anthropometric nasion, is the deepest point in the radix area on profile view, which is usually the deepest point on the nasal bones. The *Kyphion (K)* is the most prominent point on the nasal dorsum. The *Rhinion (R)* is most caudal point of the paired nasal bone and marks the midline junction between the bony and cartilaginous vaults. One needs to realize that the rhinion denotes the keystone junction (do not confuse K & R).

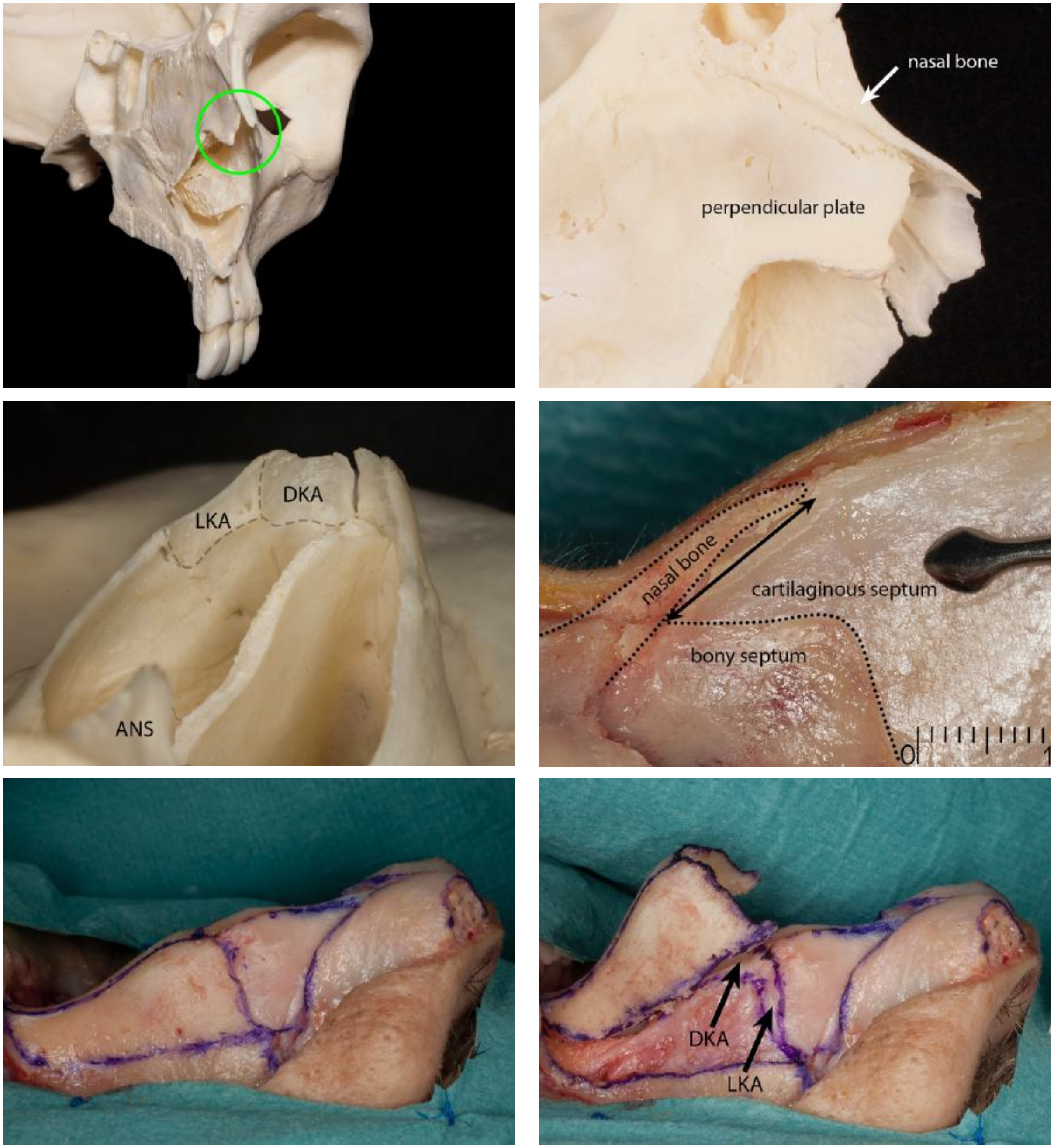


Step #2 – Anatomy of Humps and Nasal Bones

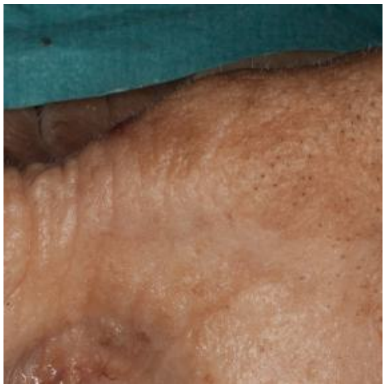
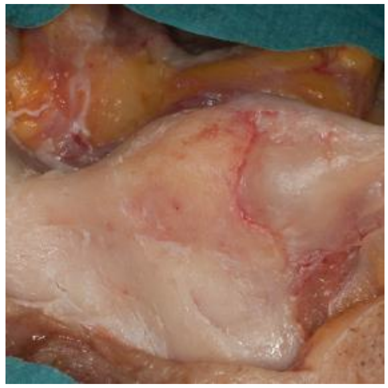
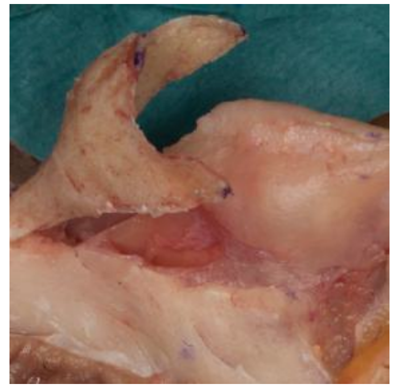
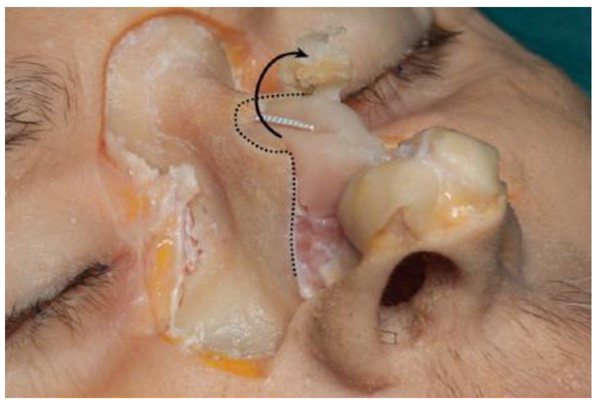
After marking these three points, one can classify dorsal humps into V- and S-shape (Lazovic et al. 2015). The V-shape dorsum has a straight-line configuration from Nasion to Rhinion, with one point of angulation. The S-shape dorsum has a distinct angulation from Nasion to Kyphion and then a plateau from Kyphion to Rhinion. In PR, the more severe the S-shape kyphotic dorsum, the more difficult it is to flatten.

Step #3 – The Keystone Area

It is important to define the keystone area as that portion of the nose where the bony vault overlaps the cartilaginous vault both dorsally (dorsal keystone area—DKA) and laterally (lateral keystone area—LKA).

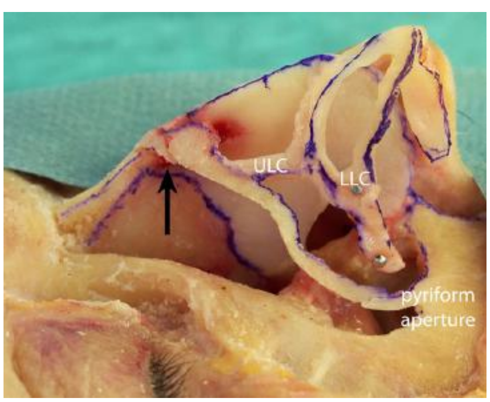


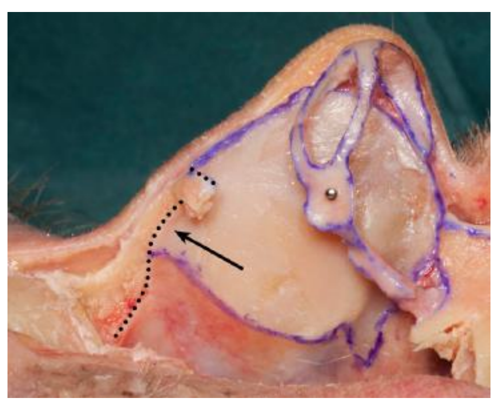
The nasal bones serve as a “bony cap” whose position is largely determined by growth of the cartilaginous septum. The nasal bones vary in size and dimension but form a thin “bony cap” contour overlaying the cartilaginous structures. Thus, the nasal hump is a reflection of the underlying cartilaginous vault with a thin bony cap overlay, rather than a large osseocartilaginous structure comprised of 50% cartilage and 50% bone.

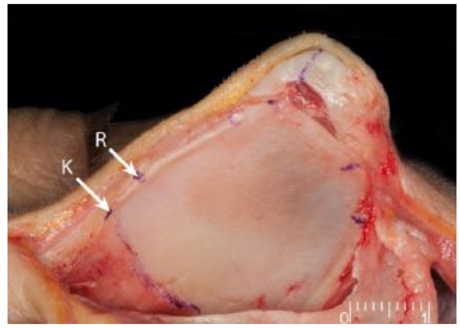





Step #4 – Anatomy of Septal Cartilage/PPE Junction and Relationship to N and R

One of the most important anatomical findings is the variation between the location of the keystone point (R) and the dorsal junction between the cartilaginous septum and the perpendicular plate of ethmoid (E point). In most cases, the dorsal cartilaginous septum will extend 8-10 mm beneath the nasal bones.



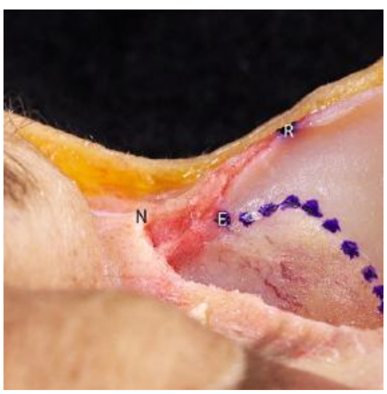


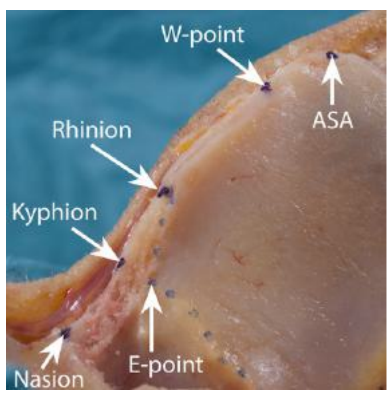


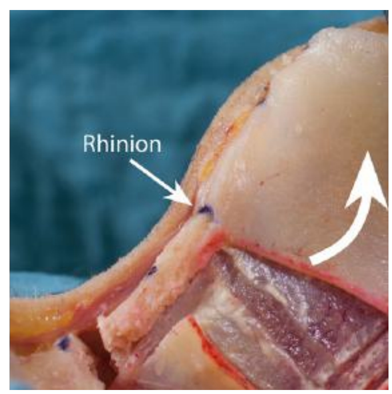
However, one must be aware that significant anatomical variations exist as to the location of the junction point. The ability to know the junction point between the subdorsal cartilaginous septum and the perpendicular plate of ethmoid prior to surgery is yet another indication to do a cone-beam CT-scans prior to rhinoplasty surgery.

Step #5 – Concept of the "Chondro-Osseous" Joint

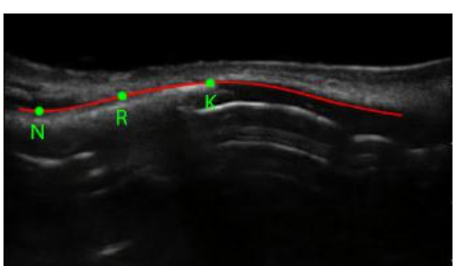
The periosteum on the deep surface of the bony cap fuses with the perichondrium on the superficial aspect of the cartilaginous vault (below on the left). The result is a flexible dorsum which allows the convexity of the dorsum to be eliminated by reducing the underlying cartilaginous septal support. Thus, the vault can be modified from convex to concave without losing its continuity by either a high strip or Cottle septal resection. The two photos below on the right are sequential photos, demonstrating the flattening that appears at the Rhinion during Cottle-type resection. The skull is kept in a fixed position.

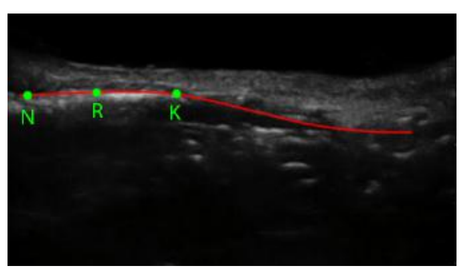






As shown in the sonograms below, provided by Dr. Kosins, a very distinct flattening of the osseocartilaginous junction is observed between pre-op (left) and one-week post-op (right) following a Dorsal Preservation procedure.



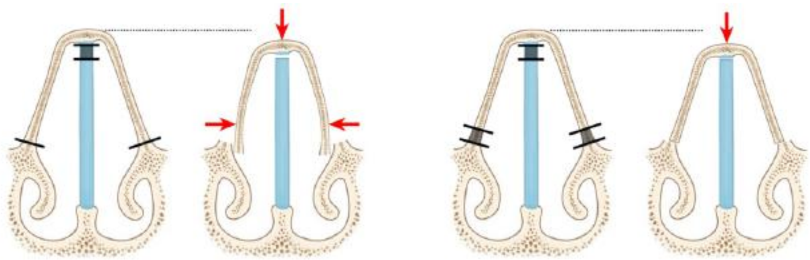


OPERATIVE STEPS OF DORSAL PRESERVATION

Dorsal Preservation (DP) is done using the following three steps: (1) excision of a septal strip, (2) total mobilization of the bony vault with osteotomies, and (3) downward impaction of the osseocartilaginous vault. It is important to realize that the sequence of these steps vary based on the surgeon's preference. Additionally, surgical preference extends to the method of mobilization (push-down vs let-down), which in turn determines the types of lateral osteotomies.

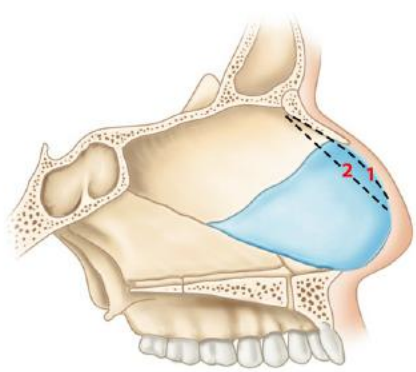
Step #1 – Push-Down vs Let-Down: Concepts

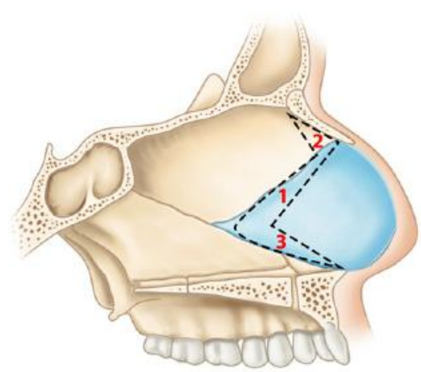
The classic DP techniques require a Push Down or Let Down bony lateral wall lowering. Push Down includes low-to-low osteotomies followed by pinching of the completely mobilized osseocartilaginous vault and impacting it downward into the nasal cavity. In contrast, the Let Down involves excision of a tapered triangle of the frontal process of the maxilla, which provides space for the mobilized vault to be lowered into. Most experienced surgeons develop a distinct preference for one technique or the other, while others have specific indications for each.



Step #2 – Anatomy of the Septal Strip Excision

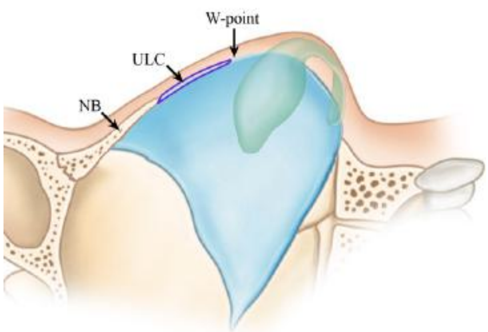
Historically, the septal strip excision has varied extensively as to amount, shape and location. There are 2 basic type of septal excisions: high septal strip – subdorsal (below left) and the Cottle-type septal excisions (below right). Currently, the majority of surgeons prefer the following: high septal strip – immediately subdorsal and tapered in shape.



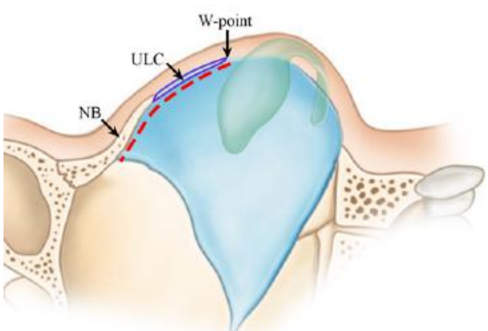


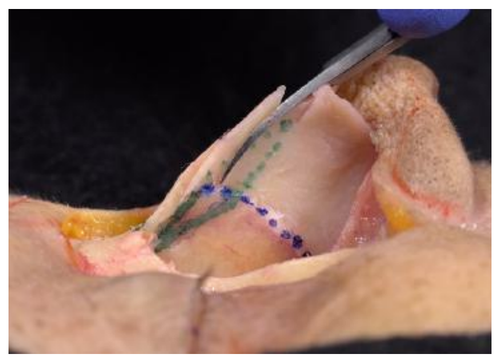
Step #3 – Septal Strip Excision: Cartilaginous Component

The cartilaginous strip excision consists of an incisional curved subdorsal cut first and then a straight excisional cut through the septum for removal of the intervening cartilaginous strip. It is important that the cartilaginous cut NOT start at the ASA point, but rather at the W-point. The W-point represents the point of separation of the ULCs from the septum. From the surgeon's viewpoint looking from caudal to cephalic, it resembles the letter W. Anatomically, the W-point will be 4.4 mm (range: 1-8 mm) (Palhazi et al. 2015) from the ASA. However, we recommend clinically to place the incision at the actual W-point, which should be at least 6-8 mm cephalic to the ASA.

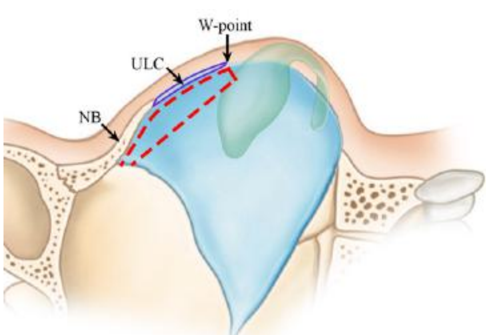


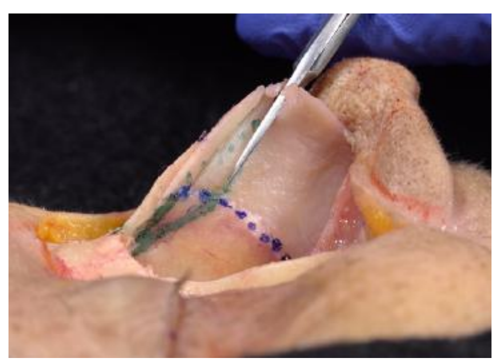
The *incisional cut* then continues subdorsal, keeping intimate contact between the scissor tips and the undersurface of the dorsum. The incision passes cephalically until bone is encountered at the junction of cartilaginous septum and the perpendicular plate of ethmoid (PPE).





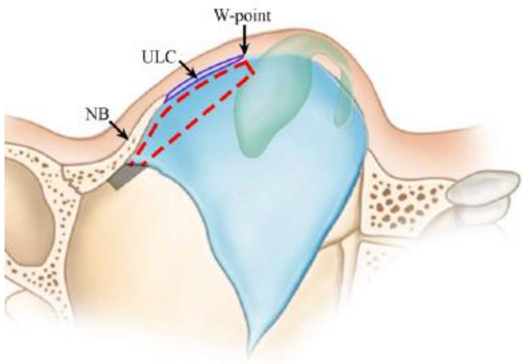
The *excisional cut* is a straight cut using straight scissors, and it begins 2-4 mm below the W-point. It then continues until the bony septum is encountered. One should conceive of this as an incremental strip excision and not a definitive setting of the profile line. Remove half of what you think you need initially, then add incremental excisions.

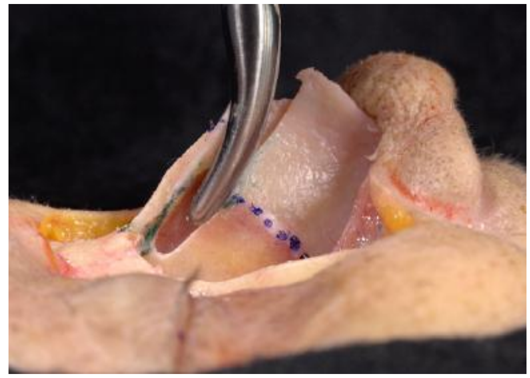




Step #4 – Septal Strip Excision: Bone (PPE) Component

Once the initial cartilage strip has been excised, one must obtain mobility at the bony PPE component of the septum and provide space for the dorsum to descend. As previously stated, pre-operative cone-beam CT scans are extremely helpful in estimating the extent of bone removal that will be required, as well as the method.

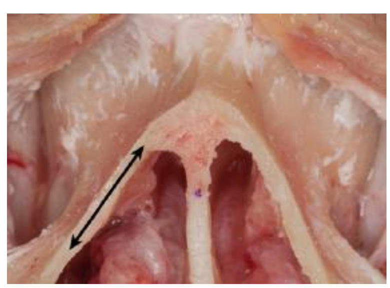




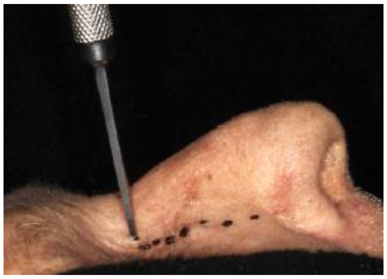
Saban takes a progressive approach to mobilizing the bony septum, depending on the amount to be excised: no excision, simple fracture, triangular excision, or quadrangular excision. Çakir prefers to use a micro-tip Rongeur (Medicon Instruments). It is important to remove the bony PPE with multiple small cuts and to avoid any twisting motion. At this point, one can begin the osteotomies to mobilize the entire osseocartilaginous vault. Please note that the above seen cadaver case is only for demonstration purposes. Also, the Rongeur is usually smaller.

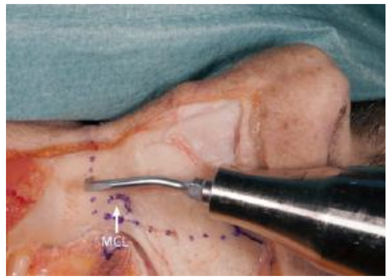
Step #5 – Anatomy of the Transverse Osteotomy

By definition, a transverse osteotomy extends from the level of the lateral osteotomy across the frontal process of the maxilla and nasal bone into the radix area, terminating at the ipsilateral dorsal aesthetic line. It is usually a straight line. Its location may vary depending on the location of the new nasion (N), which in turn corresponds to the location of the radix osteotomy. The transverse and also the lateral osteotomy can affect the medial canthal ligament. This clinically does not cause tarsal instability, because it is only its anterior limb. The medial canthal ligament (MCL) has three limbs. The superior and posterior ones are responsible for stabilization of the tarsus. The anterior limb mainly originates from the orbicularis oculi muscle. When one performs a total subperiosteal elevation, then the anterior MCL can be elevated, and it will reattach. Also, bleeding is minimized because the angular artery and vein are superficial to the MCL, as seen below.

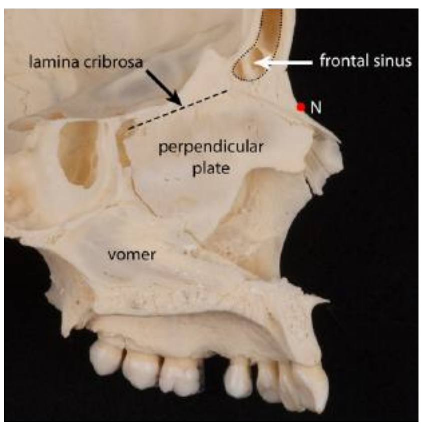

The transverse cut is made first, as the bones are stable; a clean cut can be made, either with a hand saw or a piezo blade. Alternatively, a percutaneous osteotomy can be done with a 2-3 mm osteotome.

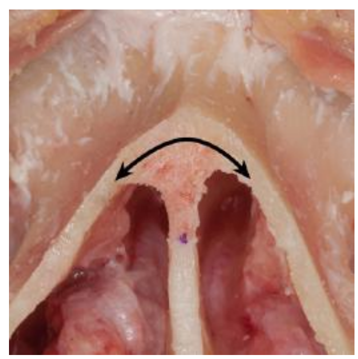




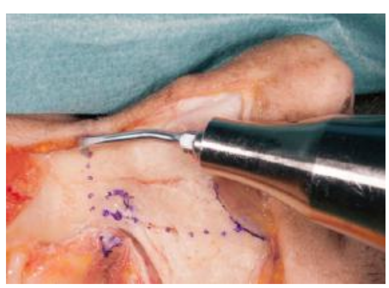
Step #6 – Anatomy of the Radix Osteotomy

The radix osteotomy may be called the nasion, or even the nasofrontal osteotomy. Its purpose is simple: (1) to unite the two transverse osteotomies, and (2) to fracture downward through the fused nasal bones and then the nasal spine of the frontal bone in order to enter the previously resected area of the bony septum. This osteotomy must be approached carefully yet firmly to cut through the fused syndesmosis of the nasal bones. When using percutaneous osteotomes, it is important to stand at the head of the table and angle the osteotome at a 45-degree angle downward away from the cribriform plate.



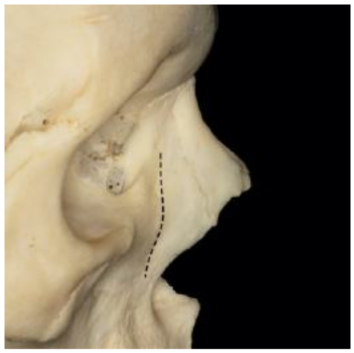


The location of the radix osteotomy is critical: at the desired nasion point (N) within the radix area. In the majority of patients, there will be no desire to change N, and this site will be selected. It should be noted that the nasion or soft tissue sellion is often 4-5 mm above the medial canthal ligament. As one moves the site of the radix osteotomy caudally, one tends to create a deepening of the radix and caudal displacement of N, leading to an infantilization of the nose (Kosins). The orientation of the percutaneous osteotome is also highly important in producing a step (perpendicular) or a hinge (oblique) in the radix. When no lowering of the radix is planned, creation of a hinge is preferable.



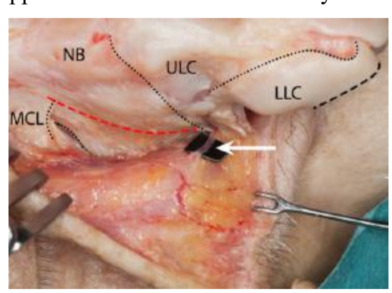
Step #7 – Lateral Osteotomy and Webster's Triangle

A traditional low-to-low osteotomy is performed beginning at the caudal border of the pyriform aperture, then straight across the ascending process of the maxilla, before terminating at the level of the transverse osteotomy. Once completed bilaterally, the entire osseocartilaginous vault should be mobile. This traditional lateral osteotomy is done a couple of millimeters higher than our preferred low-to-low osteotomy during DP, especially if it is done by Piezoelectric saw. It has to be done along the *Nasofacial Groove* (see below) which is where the frontal process of maxilla shapes and creates the bony nasal pyramid. During Piezoelectric rhinoplasty one has no other landmarks but this.



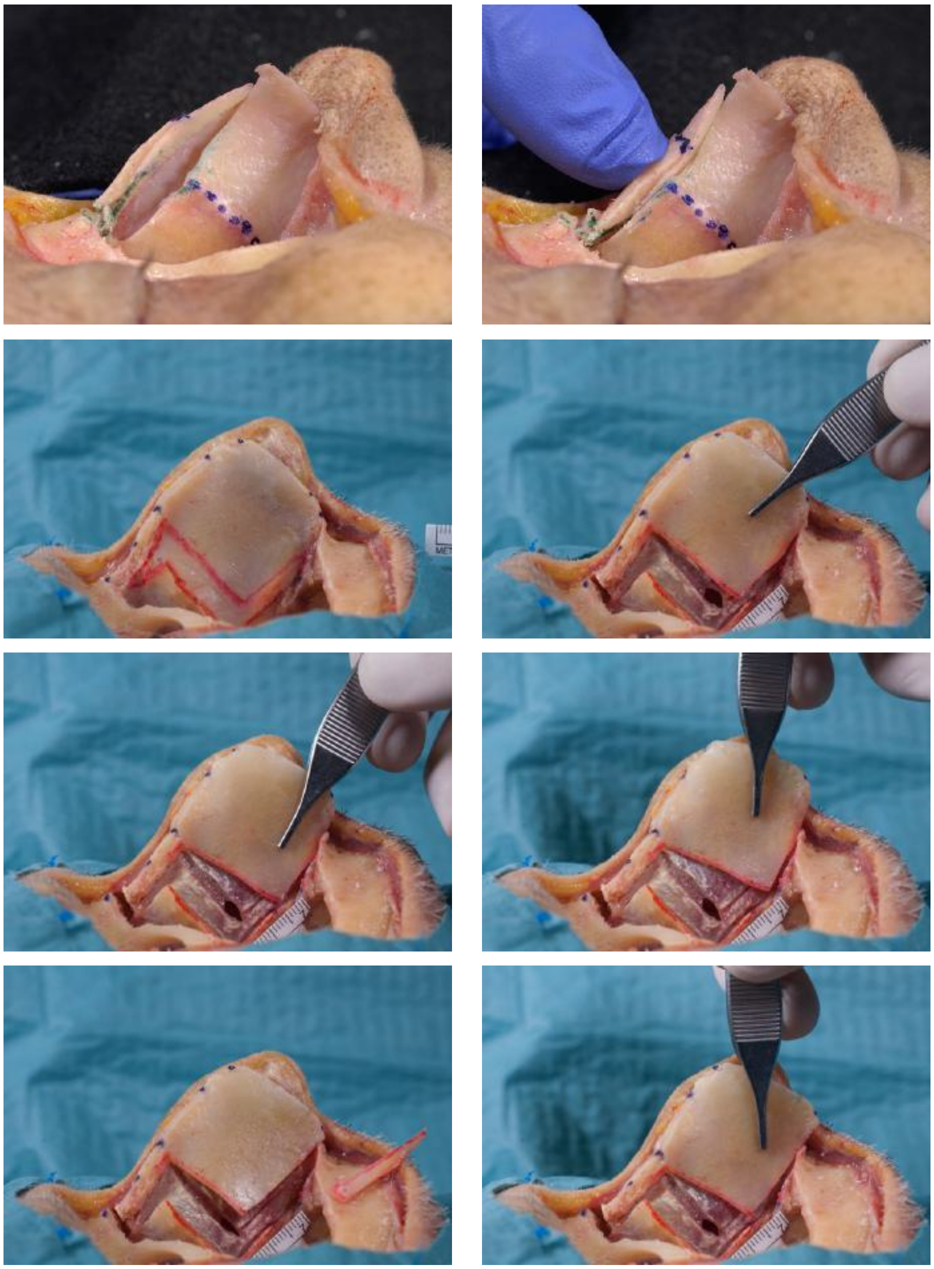

Many surgeons excise the Webster's triangle area using a small tip Rongeur. This is done prior to the lateral osteotomy. In many ways, this is simply resecting the same area as one would in a let-down procedure. Also, it prevents any potential medial bony displacement toward the head of the inferior turbinate. Conceptually, this approach can be considered a type of hybrid Let Down / Push Down lateral bony wall lowering.


There are veins just on the top of the periosteum; these can bleed during lateral osteotomy if one is not subperiosteal. These veins also connect to the internal nasal vessels through the Mucosal Space. This anastomosis usually bleeds when one does the mucosal cut along the pyriform aperture to create the approach for the lateral osteotomy.

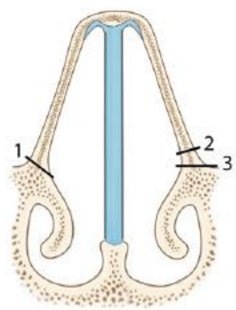



Step #8 – Mobility

Once the bony osteotomies are completed, it is important to check that the bony cuts are all connected to each other and deep enough through the bone to allow complete mobilization. The bony vault can be grasped between thumb and index finger, and then totally moved from one side to the other. Alternatively, a 90-degree chisel can be placed in the cuts to ensure their adequacy. Most often, there will need to be additional mobility achieved at the radix cut (often just minor mobility, or fracturing with the 90-degree chisel) and along the lateral osteotomy line. The latter problem has been minimized by resection in the Webster triangle area, but this excision may need to be extended cephalically.



As seen in the drawings below, the lateral bony wall is thick along the Nasofacial Groove. It is extremely important to understand the differences between the traditional osteotomy cuts, piezoelectric cuts, and the osteotomies for Push Down or Let Down. During classical osteotomies with conventional instruments, the osteotome will automatically follow the line of least resistance, which results in higher osteotomy lines (#2). When performing classical bony wall medialization for example during a cartilage only DP, sinking of the lateral wall into the nasal cavity is not desired, so the orientation of the cut is more horizontal (#3). In contrast, during Push Down mobilization, to enhance the impaction, it is advisable to cut more sagittally (#1), which is easily achievable using Piezo saws. During a pure Let Down lateral bony wall lowering, these considerations have no significance, since a bony strip is always removed.



Step #9 – Adjustments Including the W-ASA Segment

Once the osseocartilaginous pyramid has been lowered to the desired position, then the profile line should be evaluated, both for height and alignment. The W-ASA Segment (the area between the W and ASA points) must be checked, as it was deliberately kept high initially to avoid any potential saddling. Frequently, a straight-line cut from ASA to W is sufficient. Additional adjustments may include the following: (1) minor septal strips excised, (2) the undersurface of the dorsum released with partial vertical cuts, or (3) the dorsum shifted to one side or the other.

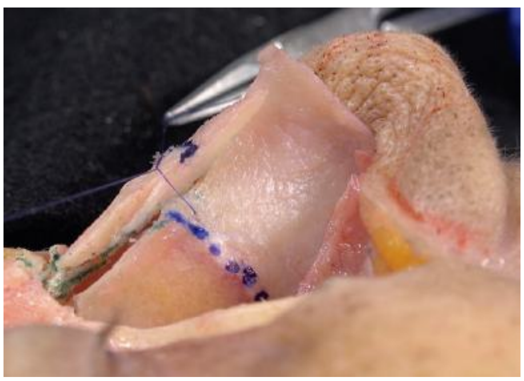
Step #10 – Three-Point Suture Fixation/Stabilization

Once the surgeon is satisfied with the dorsal profile, then the dorsum is fixed to the underlying structures. Kosins has developed a three-point suture fixation technique which allows for minor adjustments, rigid stabilization, and reduction of post-operative problems.

Suture #1 is placed at the original K-point of the hump. Small drill holes are made through the bone on either side (most often these holes are placed at the start of the case). A 4-0 PDS suture is passed through one hole, then across the dorsal septum, out the opposite bone hole and then tied in a cerclage fashion. The goal is to keep the dorsum flat and resting against the septum, thereby minimizing the chance of a recurrent hump.

Suture #2 is placed at the W-point with 5-0 PDS. Since the distal cartilage vault is still mobile, certain adjustments can be made. The steps are as follows: (1) the vault is moved from side to side until the best location is found, (2) the vault is then fixed to the underlying septum with a #25 needle, and (3) the suture is then inserted to stabilize the structures in the correct position.

Suture #3 is inserted midway between the other two sutures using a 4-0 PDS suture passed in a cerclage fashion. Essentially, one has locked down the dorsum in the desired position and fixed it at three points.



CONCLUSIONS

Anatomy is at the critical center of the rhinoplasty triad of aesthetics-anatomy-surgical techniques. Anatomy determines the surface aesthetics and is the structure upon which we operate. Yet, for surgeons wanting to master Preservation Rhinoplasty (PR), there are the problems of having to learn new techniques based on a new anatomy and also the limited visibility that occurs in most clinical cases. Thus, the surgeon must understand the anatomy and surgical techniques which have been illustrated in this chapter in detail. Elevation of the soft tissue envelope in a complete subperichondrial-subperiosteal plane will minimize post-operative morbidity and the need for revision surgery. Understanding the anatomy of the keystone area enables dorsal reduction with retention of the natural dorsum, without the need for intraoperative mid-vault reconstruction or secondary rib graft procedures. Thus, a new era in Rhinoplasty Surgery is evolving, based on an appreciation of recent advances in our anatomical knowledge.

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Lateral Crural Tensioning for Refinement of the Wide and Underprojected Nasal Tip: Rethinking the Lateral Crural Steal

Q2Q3 Richard E. Davis, MD[a,b,*]
Q4

KEYWORDS

• Wide nasal tip • Lateral crural steal • Caudal septal extension graft • Tongue-in-groove setback • Alar rim graft

KEY POINTS

- Excisional rhinoplasty techniques, such as the cephalic trim maneuver, often alter nasal tip size at the expense of structural stability.
- Effective refinement of the wide nasal tip does not mandate aggressive excision of the cephalic margin.
- The septal extension graft (SEG) creates a sturdy and stationary platform to allow precise positioning and suspension of the tip cartilage complex.
- The lateral crural steal (LCS) borrows from the overly long lateral crura to elongate the foreshortened medial crura to correct the alar cartilage length imbalance typical of the wide and underprojected nasal tip.
- In addition to cosmetic benefits of the traditional LCS, lateral crural tensioning (LCT) improves lower nasal sidewall tone and increases the threshold for dynamic nasal valve collapse by preserving the lateral crus and the nasal scroll and by stretching and tensioning the lateral crus.

Q6Q7

BACKGROUND

Refining the overly wide nasal tip is among the most common, yet also among the most difficult, challenges in cosmetic rhinoplasty. Until recently, surgical strategies to reduce tip width have been largely dependent on cartilage excision for alterations in lobular size and shape. Despite the immediate and discernable reduction in nasal tip size, aggressive cartilage excision often fails to enhance tip contour in a controlled and predictable manner. As a consequence, aggressive excision-based techniques are increasingly recognized as haphazard, unpredictable, and disproportionately prone to undesirable postoperative contour deformities.[1–11] The outcome is frequently a nasal tip that is both unattractive and dysfunctional and one that usually deteriorates significantly over time (**Fig. 1**).

In response to the unacceptably high morbidity of aggressive excisional rhinoplasty techniques, most accomplished rhinoplasty surgeons have adopted strategies that preserve tip cartilage and/or augment skeletal tip support, thereby improving

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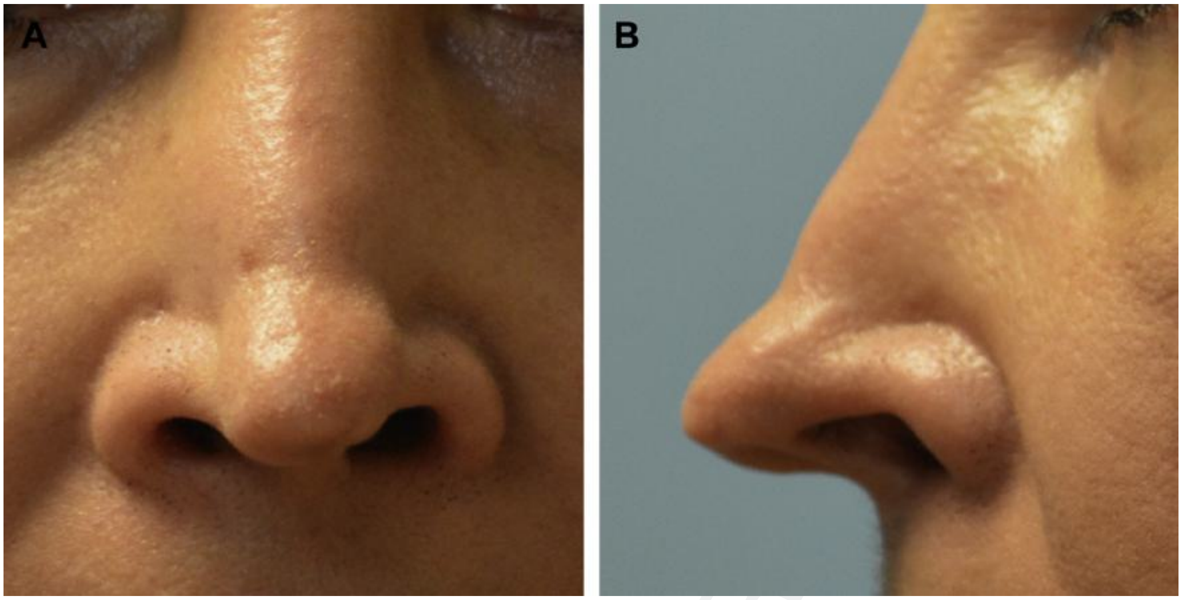

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Fig. 1. Nasal tip deformity from lateral crural over-resection. Frontal (*A*) and left profile (*B*) views of a severely over-resected nasal tip with compromised skeletal support. Note lobular pinching, tip bossae, supra-alar pinching, alar retraction, and tip asymmetry.

long-term contour stability and airway patency.[1–15] Although this trend is rapidly spreading among rhinoplasty enthusiasts, the number of failed rhinoplasty outcomes stemming from cartilage over-resection seems to be growing rapidly, suggesting that aggressive excisional techniques are still practiced widely even today.[1] Nonetheless, there are now safe and effective alternatives to excisional rhinoplasty in which little if any tip cartilage excision is required. These techniques seek to preserve the existing tip cartilage and to alter tip contour via suture techniques, cartilage repositioning, and/or augmentation grafting to achieve an elegant and stable tip contour. And because the overly wide nasal tip is perhaps the most common morphology prompting cosmetic tip surgery, mastery of nonexcisional/structurally based rhinoplasty techniques is essential for the contemporary rhinoplasty surgeon.

The LCS is the pejorative name given to an effective and tissue-conservative technique of nasal tip refinement. Resurrected in the contemporary rhinoplasty literature by Kridel and colleagues in 1989,[16] the traditional LCS achieves several cosmetic improvements with one comparatively simple surgical maneuver: relocation of the domal apices. Moreover, unlike excisional rhinoplasty techniques, the traditional LCS is not contingent on aggressive cartilage excision to achieve tip refinement. Instead, the LCS uses redistribution and/or repositioning of the existing skeletal elements to derive a more attractive, stable, and functional tip configuration. Although a modest amount of cartilage must be excised from the nasal dome when performing an aggressive LCS, cartilage removal is confined to the medial-most aspect of the lateral crus in an area of comparatively minimal structural consequence,[11] thereby preserving virtually all of the naturally derived skeletal support. And, when the traditional LCS is used in combination with an SEG, the LCS/SEG combination—herein referred to as LCT—becomes a far more potent and versatile surgical workhorse for tip refinement.[1–3] With skillful execution, LCT not only achieves contour elegance with reliable long-term contour stability but also can serve to protect or improve nasal valve patency.

The overly wide nasal tip is perhaps the most common tip malformation encountered in cosmetic nasal surgery. Although excess tip width may occur in isolation, it more commonly occurs in combination with inadequate tip projection and/or tip ptosis (ie, inadequate tip rotation). Historically, treatment of the wide, underprojected, and ptotic nasal tip—herein referred to as the compound tip deformity (CTD)—has been directed at volume reduction of the nasal tip cartilages. The CTD stems from more than just oversized tip cartilages, however, and volumetric reduction alone seldom achieves a satisfactory tip contour. Optimal refinement of the CTD necessitates correction of each anatomic malformation contributing to the unsightly tip morphology, not just volume reduction.

For the CTD, excessive rounding of the nasal domes, excessive divergence of the nasal domes, and a length imbalance between the medial and lateral crura must all be corrected to achieve an elegant and natural-appearing tip contour. Rounding of the domal arches and excessive separation of the nasal domal apices have both long been recognized as a major source of excessive lobular width,[17] even when alar cartilage length is normal. And when the transverse (vertical) height of the lateral crura is also excessive, additional lateral crural deformity, characterized by increased convexity of the entire crural span, exacerbates the CTD by creating a wide supratip and occasionally an unsightly polly beak fullness of the supratip (**Fig. 2**). A less commonly recognized abnormality of the CTD, however, is the length imbalance between the medial and lateral crura created by medial displacement of the domal apices (ie, the tip defining points [TDPs]). Length discrepancies between the medial and lateral crura and their effects on positioning of the TDPs have been previously described by Adamson and colleagues[7] in their delineation of the M-Arch model of tip

Fig. 2. CTD and polly beak fullness from convex cupping of wide lateral crura. Frontal (*A*), right profile (*B*), and intraoperative right profile (*C*) views. Note the cupped and overly wide lateral crura (*C*) contributing to excessive supratip width (*A*) and polly beak supratip fullness (*B*).

dynamics. In the healthy and attractive nasal tip, longitudinal stiffness of the lateral crura thrusts the tip anteriorly and inferiorly. This is counterbalanced by the opposing anterior and superior thrust of the medial crura to create both equilibrium and stability within the lower lateral cartilage (LLC) arch. The equilibrium is further stabilized by the surrounding soft tissues. In the CTD, however, these relationships are anomalous. Although the overall length of the widened LLC arch is often normal or near normal, in the CTD, the nasal domes (and thus the TDPs) are skewed medially, resulting in abnormally long lateral crura and disproportionately short medial crura (**Fig. 3**). Overly long lateral crura bow outward and exaggerate the downward tip displacement creating a ptotic tip configuration and excessive width in the tip and supratip. In a review of 500 consecutive cases of nasal tip ptosis, Foda[18] found inferiorly oriented alar cartilages were the main cause of tip ptosis in 85% of patients presenting with a drooping tip. The CTD is also frequently exacerbated by pronounced convex cupping (ie, bulbosity) of the lateral crura, both longitudinally and transversely, which not only adds to lobular width but also dramatically increases supratip fullness (**Fig. 4**). Ironically, although bulbous cupping of the lateral crura increases crural stiffness and, therefore, enhances lower nasal sidewall support, bulbosity also creates a highly objectionable cosmetic deformity that frequently prompts over-resection of the lateral crura and subsequent destabilization of the tip architecture. The anatomic counterpart to overly long lateral crura is overly short medial crura. Medial displacement of the domal breakpoint results in medial crura that are abnormally short and stubby, exacerbating the CTD with inadequate projection of the nasal tip (see **Fig. 3**). Moreover, inadequate tip projection is compounded by secondary splaying of the alar base, which further exacerbates the unsightly width deformity. Perhaps the most extreme example of alar cartilage maldistribution is the unilateral cleft-lip nasal deformity. In the unilateral cleft-lip nose, a severe ipsilateral length disparity between the foreshortened medial crus and the elongated lateral crus results from lateral, inferior, and posterior displacement of the ipsilateral alar base. This developmental deformity is best corrected by repositioning the ectopic alar base and redistributing the malformed LLC with a unilateral LCS-type domal repositioning.[19]

THE CEPHALIC TRIM

Historically, a variety of surgical techniques have been advocated for refinement of the overly wide nasal tip. Perhaps the least effective technique for tip refinement is the cephalic trim maneuver. The cephalic trim maneuver seeks to simultaneously narrow, refine, and rotate the ptotic and overly wide nasal tip simply by resecting the cephalic margin of both lateral crural cartilages. In theory, precise and judicious trimming of the cephalic margin strategically weakens the lateral crura leading to a refined and slightly rotated nasal tip,[20] but only if the volume and location of the excised crural cartilage correspond perfectly to the required distribution and degree of structural weakening. In reality, determining how much cartilage can be safely excised without triggering secondary crural deformities is virtually impossible, and over-resections are commonplace. Because the average lateral crus measures only approximately 12 mm in (vertical) width,[21,22] even the generally accepted residual crural width of 6.0 mm preserves only approximately half of the original crural height. Furthermore, because lateral crural thickness averages only 0.7 mm,[22] resecting half of the crural height often results in a narrow and flimsy crural remnant that is incapable of supporting either the nasal tip or the lower nasal sidewall. Because LLC stiffness is a primary component of tip contour and support,[23] an overaggressive cephalic resection can destabilize the tip architecture with disastrous consequences. The eventual result is often severe distortion of the nasal tip leading to lobular pinching, alar retraction, bossae formation, asymmetry, excessive tip rotation, unwanted loss of tip projection, and/or symptomatic nasal valve collapse.[1–12,20,24,25] Patients with naturally weak tip cartilage are at disproportionally high risk for morbidity after the cephalic trim maneuver because the tip is already at or near the threshold for collapse, and these patients often develop unsightly tip deformities despite comparatively modest cephalic resections.[1–3,24] Moreover, tip width does not correlate with cartilage stiffness, and overly pliable, weak tip cartilages are often encountered in ultrawide bulbous noses.[1–3] Ironically, the combination of a weak tip cartilage and a comparatively severe cosmetic deformity often prompts overzealous treatment and subsequent tip deformity. Similarly, over-resection of the cephalic margin is also more likely to distort the tip architecture in noses with extremes of skin thickness. In the thin-skinned nose, shrink-wrap contracture is often forceful and sustained, leading to a higher incidence of bossae, buckling, and alar retraction. The morbidity of over-resection is also exacerbated, however, by ultrathick skin that adds additional weight to the frail and surgically dilapidated tip framework (**Fig. 5**).[4,7,11,26]

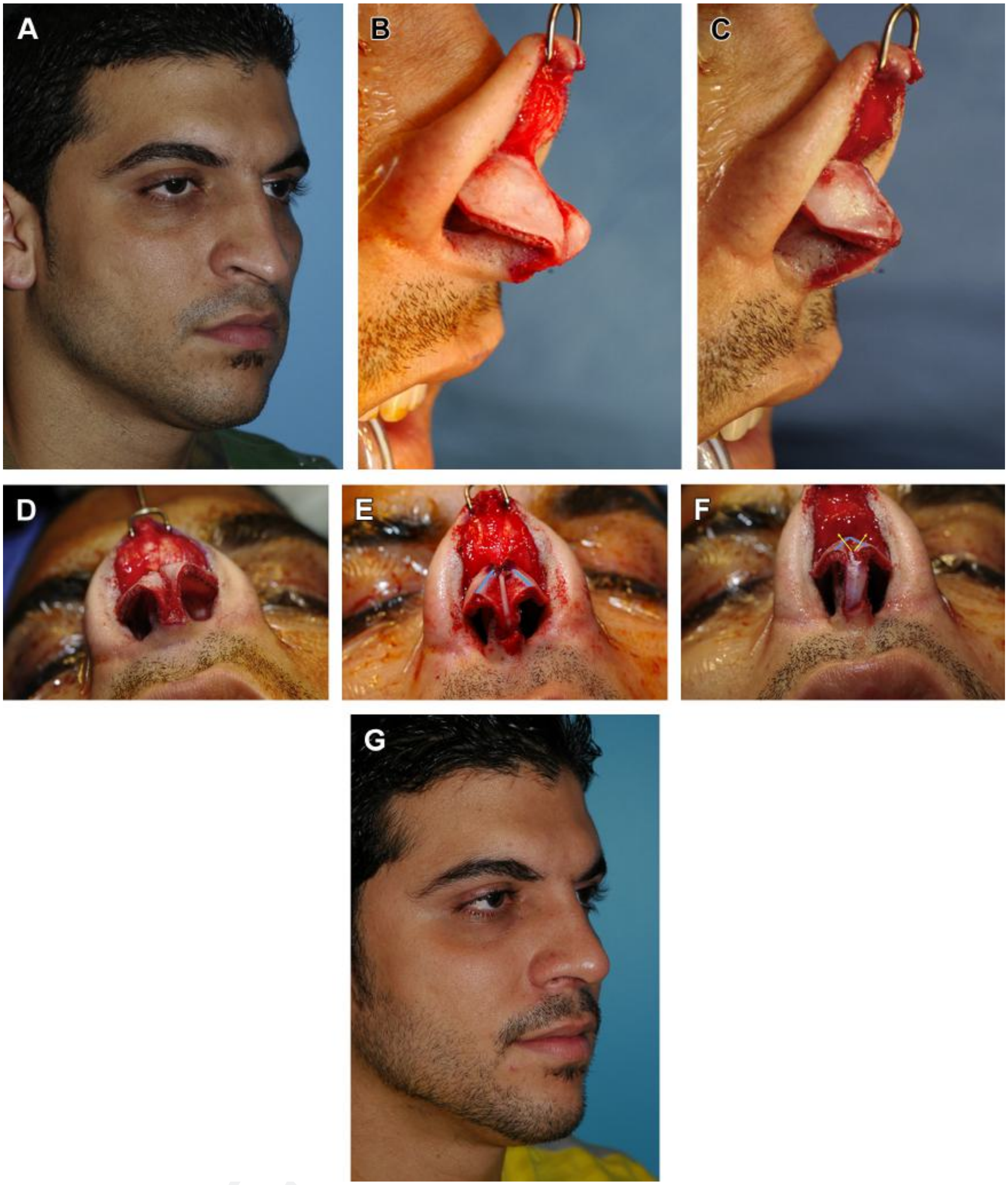

Fig. 3. Medial and lateral crural length discrepancy from malposition of the domal apex. Preoperative right oblique view (*A*) demonstrating overly long lateral crura with severe tip ptosis, and overly short medial crura with inadequate tip projection. Intraoperative right oblique view (*B*) demonstrating the crural length discrepancy. Intraoperative right oblique view (*C*) after LCS to correct crural length imbalance. Note alteration in length of the lateral and medial crura. Intraoperative base views demonstrating underprojected alar cartilages before treatment (*D*), formation of the neodomes with domal folds (*blue lines*) oriented perpendicular to the long axis of the lateral crus to preserve infratip divergence (*E*), and completed LCS after suture approximation of the neodomes to conceal the SEG (*F*). Note persistent divergence of the domal folds (*blue lines*) at completion of the LCS, and the oblique direction of suture passage (*yellow arrows*). Postoperative right oblique view (*G*) demonstrating a natural and attractive tip contour using the LCS technique.

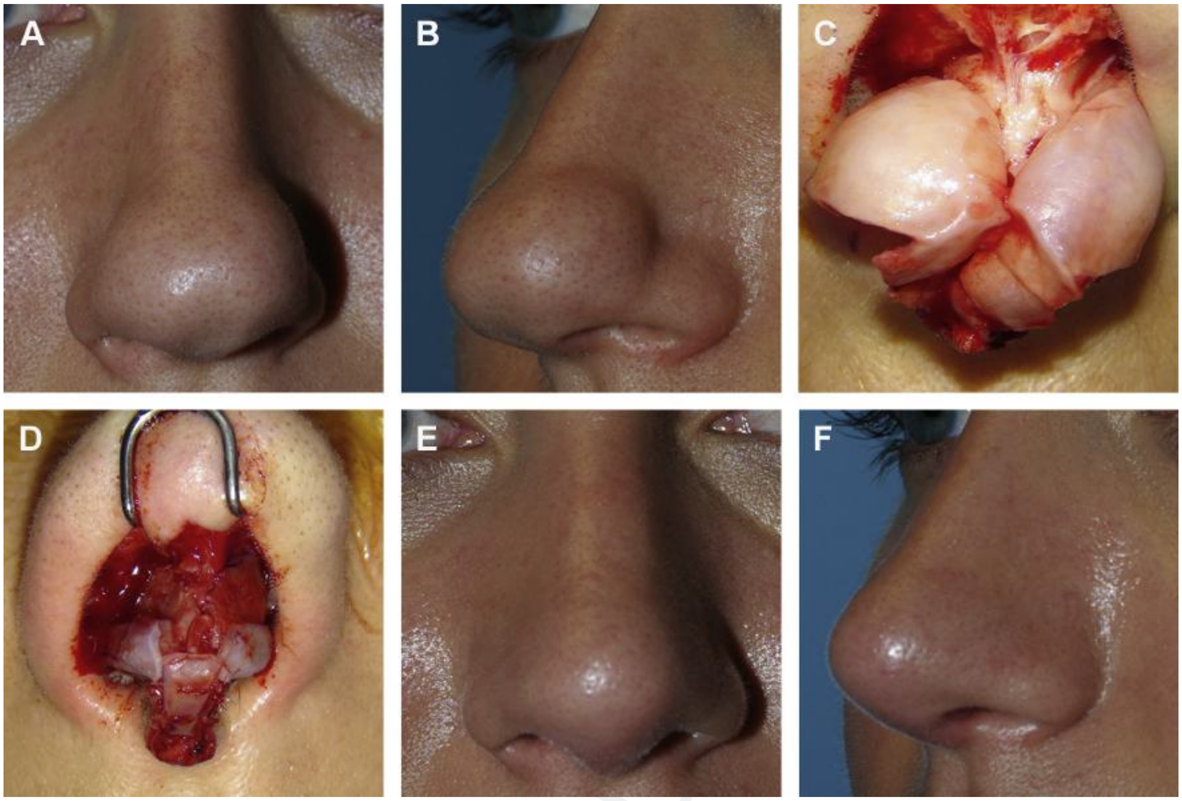

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Fig. 4. Longitudinal and transverse cupping (bulbosity) of the lateral crura. Preoperative frontal (*A*) and left oblique views (*B*) demonstrating pronounced bulbosity of the alar cartilages, intraoperative frontal views revealing bulbous and asymmetric tip cartilages (*C*) reconfigured tip cartilages after LCT, cephalic turn-in flaps, bilateral AARGs (double on right side), and shield graft placement (*D*), and postoperative frontal (*E*) left oblique views (*F*) demonstrating elimination of tip bulbosity. Q16

Q8 Ironically, severe crural over-resection may not become immediately evident in the thick-skinned nose because postoperative swelling—which is typically more severe and longer lasting in thick nasal skin—may conceal the initial tip deformity for many months. As the swelling subsides, however, and the surgically weakened tip framework is subjected to the sustained and potent forces of fibrosis combined with the repetitive inward sidewall flexion generated during nasal inspiration, stigmatic tip deformities and/or functional impairment eventually become evident. Finally, even when the cephalic trim fails to initially exceed the threshold for skeletal collapse, age or disease-related deterioration in crural stiffness may also lead to eventual tip deformities, particularly because many surgeons fail to account for future losses in cartilage strength when planning crural resections. Although tip suturing techniques are now commonly used in combination with the cephalic trim for tip refinement, the inappropriate or overzealous use of tip sutures can themselves cause postsurgical tip deformities, and aggressive resections of the cephalic margin usually serve to increase the likelihood of such problems.[1–3,6–8] Owing to the synergistic and destabilizing triad of (1) surgically compromised structural support, (2) chronic deformational forces of wound healing, and (3) age-related losses in cartilage strength, the adverse effects of crural over-resection frequently worsen for decades, making the cephalic trim a risky undertaking associated with considerable long-term morbidity in susceptible patients. And when crural over-resection is combined with over-resection of the anterior nasal septum, which undergirds and supports the tip complex, virtually all of the adverse consequences of the cephalic trim are intensified.[1–4,27]

OVERLY LONG LATERAL CRURA—A FREQUENTLY NEGLECTED DEFORMITY

Treating the constellation of LLC deformities that characterizes the CTD—in particular, the overly wide tip cartilages and the abnormalities of domal shape and spacing—has improved greatly in the past 3 decades. Structural techniques that enhance skeletal support for improved contour

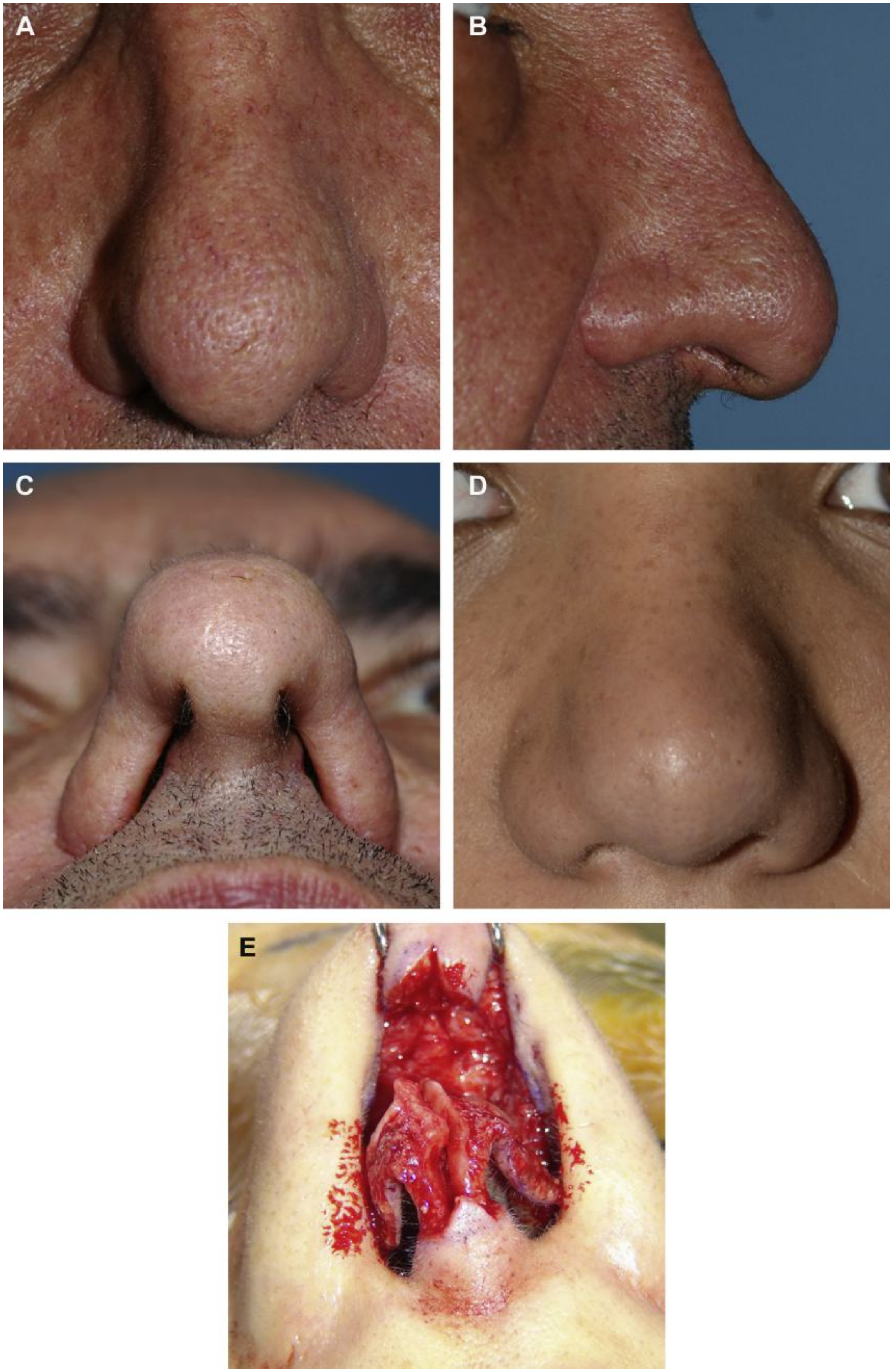

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Fig. 5. Over-resection of the lateral crura in an ultrathick skinned nose. Frontal (*A*), profile (*B*), and base views (*C*) after subtotal resection of the lateral crura (performed elsewhere) in a middle-aged man with ultrathick nasal skin. Note severe external valve collapse and tip ptosis from compromised skeletal support. According to the patient, the collapse developed gradually several months after surgery.

Q17

stability and nondestructive suture-based techniques that reshape and reposition malformed or malpositioned tip cartilages have transformed the quality and long-term predictability of tip rhinoplasty.[1–10,12–18] Over this same time period, however, comparatively little attention has been directed at another important anatomic deformity common to the CTD: the crural length disparity that results from malposition of the nasal domes. Despite the adverse impact on tip aesthetics, maldistribution of tip cartilage is a critical aberration of tip architecture that can dramatically affect lobular contour, supratip contour, tip support, sidewall aesthetics, and nasal valve function, yet one that is often overlooked, undertreated, and/or mismanaged. And although placement of a columellar strut graft or an SEG enhances central tip support by augmenting medial crural length, such techniques alone fail to treat the corresponding excess in lateral crural length that results from malposition of the apical fold. The persistent excess length of the lateral crura coupled with their caudally directed forces of tip displacement may explain the failure of columellar strut grafts to consistently maintain tip projection.[28] Similarly, the unrecognized crural length surplus may also explain the continued use of overaggressive cephalic resections in a misguided and ill-fated attempt to eliminate unwanted supratip fullness. And when over-resection of the oversized lateral crus does occur, a flail segment usually ensues because the excess crural length remains unreconciled. Although some surgeons have advocated lateral crural overlap (LCO) techniques, in which the lateral crura are divided vertically overlapped by several millimeters to reduce crural length and then reattached with mattress sutures,[7,18,29,30] vertical sectioning of the alar cartilage, although effective at truncating crural length, reduces tip projection and potentially destabilizes the lateral crural span—bothconsequences that can be avoided entirely with the use of the LSC. Moreover, in a 500-patient (consecutive) series comparing the standard LCS and the LCO technique for treatment of the ptotic and underprojected nasal tip, the LCS was deemed preferable because tip projection and rotation were both increased simultaneously.[18] This confirmed findings of previous work in which the LCS was preferred over the LCO for simultaneous increases in tip projection and tip rotation.[30] Regardless of the preferred treatment method, excessive lateral crural length is an often-ignored yet fundamental anomaly of the CTD that has a profound impact on form and function of the nasal base; and failure to shorten the overly long lateral crus while maintaining the structural integrity of the lateral crural span inevitably taints an otherwise satisfactory surgical outcome.

SIDEWALL TENSION—THE UNRECOGNIZED BENEFIT OF THE LATERAL CRURAL STEAL

Unlike the cephalic trim technique, which sacrifices natural skeletal support and ignores the crural length discrepancy, thereby converting a wide and overly prominent lateral crural span into a collapsed and flail segment vulnerable to distortion from scar contracture, the traditional LCS restores balanced and aesthetically pleasing crural proportions by lengthening the undersized medial crura at the expense of the overly long lateral crura (**Fig. 6**). The redistribution of tip cartilage is accomplished without excising large segments of the cephalic margin or vertically dividing the LLC but simply by relocating the natural domal fold (or apex) that establishes the breakpoint between the medial and lateral crus and which delineates the TDP. Relocating the domal fold and creating a neodome results in several simultaneous functional and cosmetic benefits.[1–3,16,18,30] First, as the relocated nasal domes are approximated in the midline, tip width is substantially reduced. Spacing of the neodomes and acuity of the domal angles can also be independently adjusted with tip sutures to fine-tune lobular width according to variations in skin thickness and cosmetic preferences. Second, neodomal approximation also simultaneously increases both tip rotation and tip projection as the length imbalance between the medial and lateral crura is eliminated. Thus, with a single nondestructive maneuver, the traditional LCS addresses all 3 major cosmetic abnomalities of the CTD—excessive lobular width, tip ptosis, and inadequate tip projection. And because each neodome is constructed independently, modest preexisting asymmetries in domal arch projection and/or tip rotation can be offset with differential dome positioning. Finally, when the LCS is used for aggressive increases in tip projection, a secondary reduction in nasal base width often occurs as an additional cosmetic benefit of alar cartilage redistribution.

One of the most important but unrecognized benefits, however, of an aggressive LCS involves secondary improvements in nasal tip dynamics. As the neodomes are suture approximated in the midline, longitudinal tensioning forces are generated that stretch and tighten both lateral crura. Unlike many other contemporary tip refinement strategies that rely on bulky structural grafts, such as the lateral crural strut graft (LCSG)[31] or the crural batten graft,[32] to contour and support the lax lower nasal sidewall (with or

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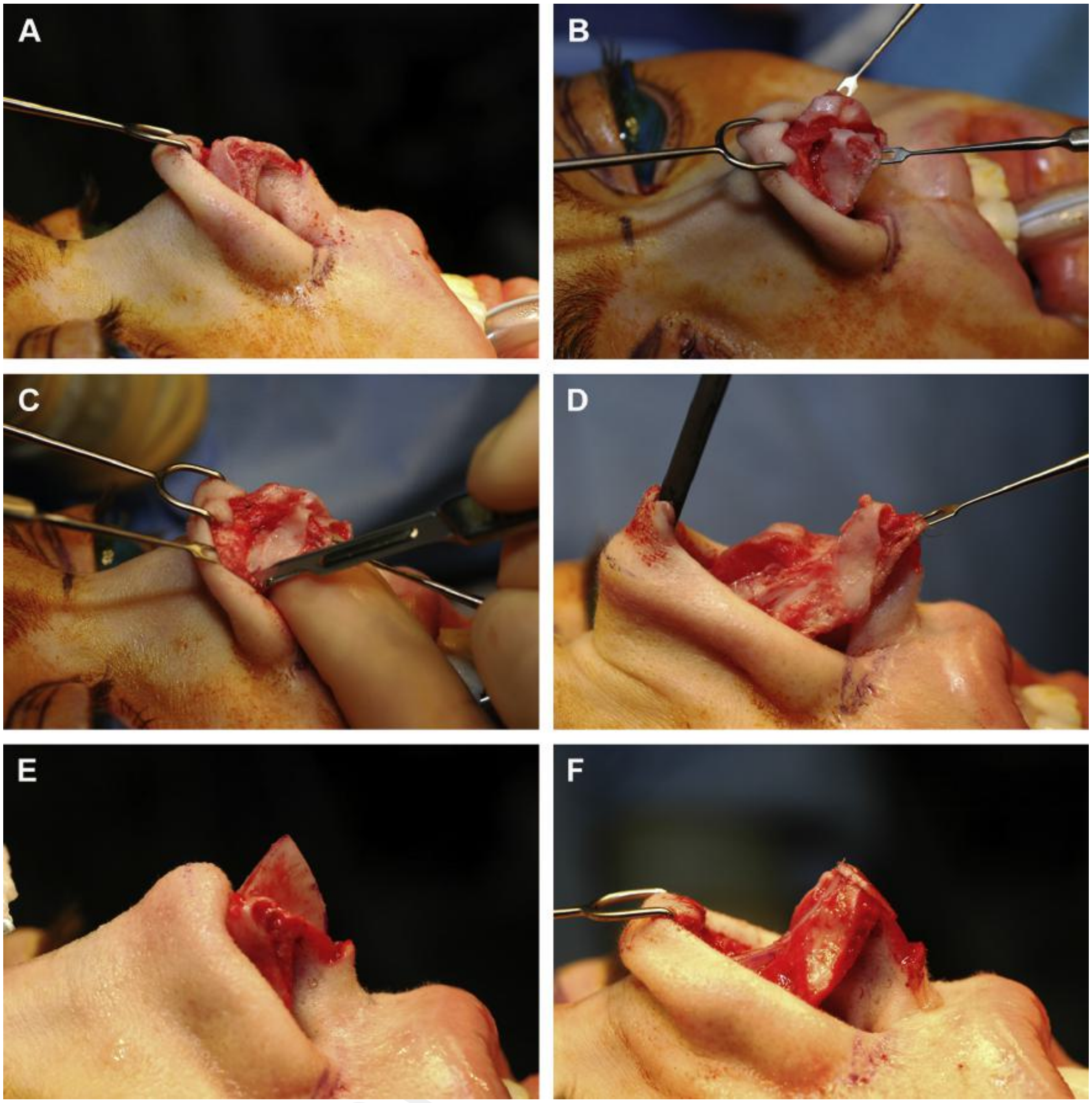
Fig. 6. Cosmetic benefits of the LCT technique. Preoperative frontal (*A*) and profile (*B*) views demonstrating a wide and underprojected tip with congenital alar retraction. Postoperative frontal (*C*) and profile (*D*) views demonstrating an improved columellar-alar relationship with simultaneous improvements in lobular width, tip projection, and tip rotation.

without cephalic resection), the LCT approach to tip refinement exploits the tensioning forces generated from tip refinement to increase crural rigidity and subsequently to strengthen and contour the lower nasal sidewall.[1–3] And because lateral crural augmentation grafts are frequently obviated, limited graft materials are conserved, and the additional weight and mass effect of structural grafts can be avoided. Because LCT also shortens and tightens the lateral crura without the need for cephalic resection, the entire nasal scroll and its sizable contribution to sidewall support are also preserved. And because the nasal scroll lies at the epicenter of the internal nasal valve—a dynamic flow-regulating apparatus that is sensitive to even minor reductions in cross-sectional area resulting from bulky sidewall grafts or crural over-resection—the nondestructive LCT maneuver is far less likely to disrupt nasal airflow. Moreover, additional cosmetic enhancements are also derived from LCT. Because the lateral crura are tethered laterally at the piriform aperture, tensioning forces created by LCT also stretch and flatten the lateral crura with a noticeable reduction in crural convexity and bulbosity, particularly in patients with weak tip cartilage.[1–3] The result of this sidewall tensioning effect is a more slender and elegant supra-tip contour, accompanied by a concomitant increase in resting sidewall tone and a corresponding increase in the threshold for dynamic nasal valve collapse. Hence, unlike most other contemporary strategies for treating the CTD, the LCT approach also simultaneously enhances nasal valve physiology by (1) preserving virtually all of the existing natural skeletal support, (2) eliminating laxity derived from excess lateral crural length, and (3) increasing lower nasal sidewall tone with tensioning forces—all without the use of lateral crural augmentation grafts. In previously operated noses presenting with concave sagging of the lower nasal sidewall from lateral crural over-resection, the tensioning forces generated by LCT also serve to lift and tighten flail crural segments, thereby minimizing unsightly sidewall pinching while dramatically enlarging internal nasal valve dimensions.[1–3] Similarly, sidewall tensioning can also be used to prevent and/or minimize alar retraction. In primary rhinoplasty, stretching and tightening of the lateral crura with LCT not only flattens the crura but also creates a piano string effect that opposes upward displacement from scar contracture. And because sidewall tensioning generally obviates a traditional cephalic trim, preservation of the full vertical height of the lateral crus further buttresses the alar rim against vertical scar contracture. In the over-resected tip presenting with iatrogenic alar retraction, sidewall tensioning, combined with lysis of cephalic adhesions and unfurling of the contractured internal lining, can stabilize the repositioned crural remnant against recurrent retraction (**Fig. 7**), particularly if the crural remnant is also further supported with modified alar rim grafts.[1–3] Although severe alar retraction may require more-aggressive techniques to stabilize the alar rim, such as the LCSG,[31] with or without lateral crural repositioning,[33] aggressive sidewall tensioning alone is sufficient in a large percentage of cases. The use of LCT, however, does not preclude the combined use of the LCSG for the treatment of severe alar retraction, and because the mechanisms of alar rim stabilization are compatible with LCT, the combined use of LCT and LCSG is likely to be more effective, albeit with a greater risk of internal nasal valve impingement from LCSG bulk. In summary, LCT mimics the natural dynamics of an attractive and fully functional nasal sidewall by stiffening the existing crural cartilage and raising the threshold for dynamic internal valve collapse, all while maintaining a thin, lightweight, and flexible nasal sidewall—a particularly useful benefit when treating the long, ultraslender nose where LCSGs may compromise internal valve patency, efface the supra-alar crease, and/or partially restrict mimetic movement.[1–3,34] LCT also expands the already potent cosmetic benefits of the traditional LCS by flattening the entire lateral crus to eliminate unsightly fullness of the supratip. Hence, by reallocating and reshaping the LLC using almost entirely reversible suture techniques, LCT can custom-contour the CTD while enhancing or preserving airway function and reducing the dependence on large structural grafts.

INCREASING POTENCY OF THE LATERAL CRURAL STEAL WITH THE SEPTAL EXTENSION GRAFT

Although the classic LCS can simultaneously narrow, project, and rotate a wide, underprojected, and ptotic nasal tip, recruiting more than a few millimeters of the lateral crura usually results in over-rotation of the nasal tip and excessive nostril show. To prevent tip over-rotation and excessive nostril show, the newly configured tip complex must be firmly stabilized against unwanted cephalic and/or posterior displacement.[1–3] Although the conventional columellar strut graft is effective at stabilizing the tip against unwanted deprojection, it does little to



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Q18 **Fig. 7.** Sidewall tensioning to correct alar retraction in the short and over-resected nose. (*From* Davis RE. Revision rhinoplasty. In: Johnson JT, Rosen CA, editors. Bailey's Head and Neck Surgery – Otolaryngology. 5th edition. Wolters Kluwer/Lippincott; Williams, & Wilkins; 2014. p. 2989–3052; with permission.) Q19

prevent over-rotation after an aggressive LCS. Because recruiting large amounts of lateral crural cartilage inevitably leads to increasingly powerful forces of tip rotation,[35] these forces can easily displace an unsupported tip/columellar strut complex in an upward (cephalad) direction. Consequently, it is essential to combine an aggressive LCS with an SEG to prevent unwanted tip rotation and stabilize tip positioning. The SEG is a modified columellar strut graft that is sutured to the caudal septum to enhance stability of the tip complex and is especially useful after large increases in nasal length and/or tip projection.[28,36–40] By securing the SEG to the caudal L strut, a stationary and invisible support column—buttressed indirectly from above by the bony facial skeleton—is created to suspend and immobilize the newly configured tip cartilages and to prevent excessive rotation triggered by aggressive lateral crural recruitment.[1–3] In essence, the SEG creates a tent pole effect that projects the skin envelope outward while opposing the upward pull generated by aggressive sidewall tensioning. Without the stationary fixation point generated by SEG placement, LCT is ill advised, and nearly all the cosmetic

Fig. 7. (*continued*)

and functional benefits of nasal sidewall tensioning rendered impossible. By fabricating an SEG of appropriate dimension and shape, however, precise 3-D positioning of the tip complex is limited only by availability of donor graft material and distensibility of the skin envelope. A properly crafted and sturdy SEG not only counters the forces of tip displacement generated by an aggressive LCT but also stretches a thick, fibrotic, and noncompliant skin envelope and resist distortion generated by excessive postoperative swelling. Although stabilization grafts, such as extended spreader grafts or splinting grafts, are occasionally necessary to prevent rudder-like deflection of the SEG and/or flexion of the dorsal L strut in cases of high closing tension,[38–40] in noses with a readily distensible skin envelope, a properly secured SEG—further stabilized by suture fixation of the medial crura—facilitates significant increases in tip projection and/or nasal lengthening without the need for stabilization grafts (**Fig. 8**). In cases that do require stabilization grafts, encroachment of the internal nasal valve is more likely with bilateral extended spreader grafts—particularly in an ultraslender nose where even modest valve impingement can lead to symptomatic airway dysfunction—and stabilization is often best achieved using thin (unilateral) osseous splinting grafts fabricated from perforated segments of ethmoid or vomerine bone (**Fig. 9**). Extended spreader grafts, however, which are usually fashioned from rib cartilage, are well suited to the wide nose where nasal valve impingement is unlikely, and they are sometimes the only effective means for distending rigid and nondistensible nasal skin when re-expanding the severely over-resected nose. Although comparatively little donor cartilage is required to create an SEG, a stiff, flat, and slender graft is mandatory, and septal cartilage is preferred owing to its ideal shape and rigidity. When septal donor tissue is depleted or rendered unsuitable, however, a double-layered conchal cartilage graft or a rib cartilage graft can also be used effectively, albeit with additional graft thickness. Finally, in exchange for the unparalleled benefits of the SEG, a permanently stiff and rigid tip complex is inevitable. Although the fully healed tip still flexes easily from side to side, the ability to compress the tip complex is permanently lost. Although tip rigidity is sometimes cited as a

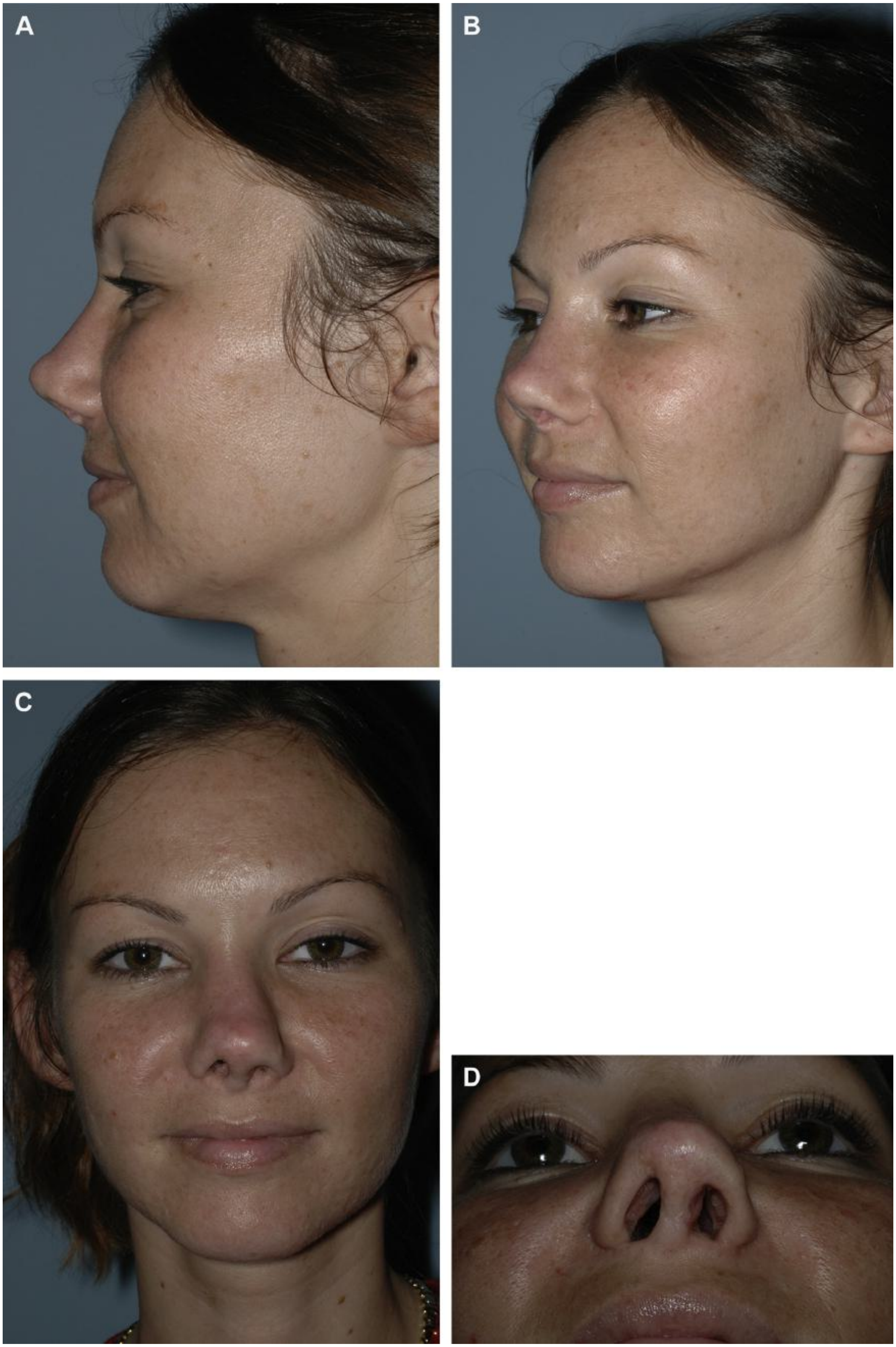

Fig. 8. Aggressive nasal lengthening (without extended spreader grafts) using SEG. Preoperative left profile (*A*), left oblique (*B*), frontal (*C*), and base (*D*) views of over-resected nose after multiple previous attempts at surgical correction.

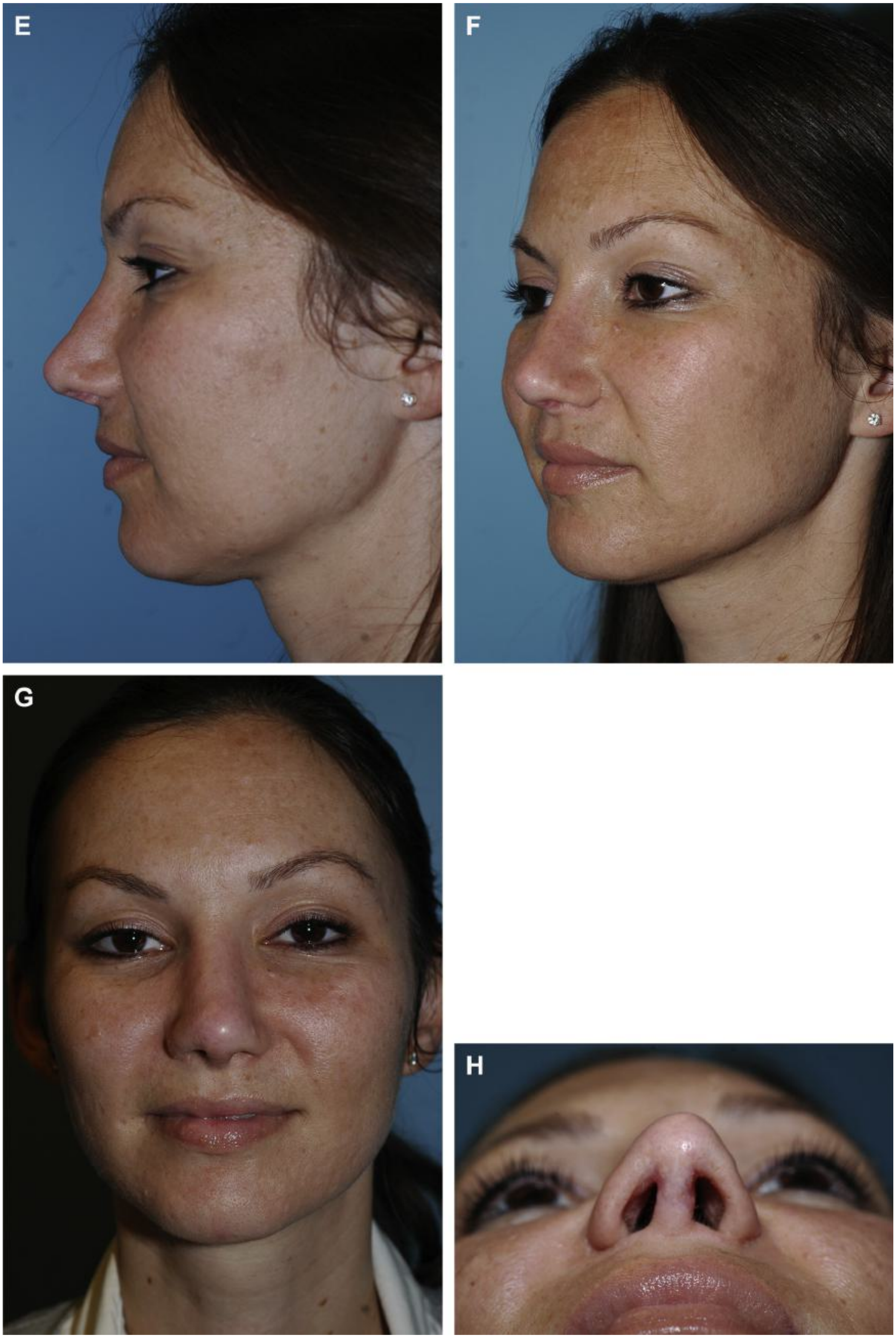

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Fig. 8. (*continued*) Aggressive nasal lengthening (without extended spreader grafts) using SEG. Corresponding postoperative views (*E–H*) after nasal elongation with SEG fashioned from rib cartilage and secured with side-to-side fixation. Note significant nasal lengthening without the use of extended spreader grafts or splinting grafts.

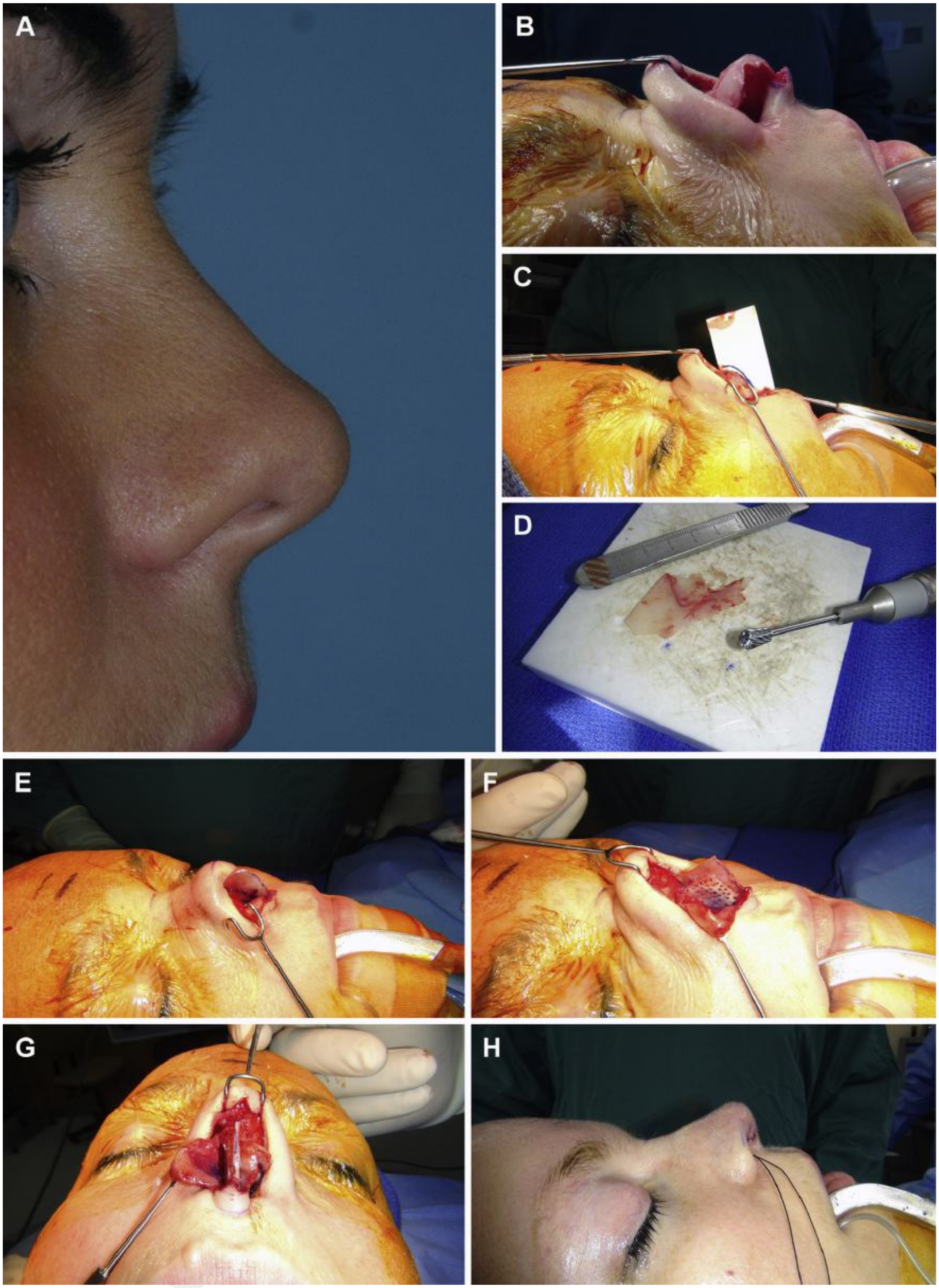

Fig. 9. Stabilization of SEG using osseous splinting graft. Preoperative profile (*A*) and frontal (*B*) views of a congenitally short nose with excessive nostril show. Intraoperative views of untreated cartilage (*C*), tracing of caudal septum for template creation (*D*), septal graft and cutting bur to thin septal bone during splinting graft fabrication (*E*), cartilaginous SEG secured in end-to-end alignment using figure-of-8 sutures (*F*), perforated vomerine splinting graft bridging the SEG and caudal septum from profile (*G*) and base (*H*) views (note thin graft profile on base view), and immediate postoperative views showing tip counter-rotation and decreased nostril show.

contraindication to SEG use owing to patient nonacceptance, after nearly 2 decades of SEG use, the author has found nearly all patients readily accepting of this minor side effect of tip refinement.

PREOPERATIVE PREPARATIONS

All patients undergo a detailed preoperative medical screening history. Comorbidities, medications, or behaviors that may have an impact on safe and effective general anesthesia or that may impair wound healing are specifically sought. Details of any previous nasal surgery are also elicited. Physical examination is used to assess the nasal tissue characteristics, such as skin thickness and elasticity, cartilage stiffness, tip and sidewall support, septal alignment, previous septal cartilage excision, nasal valve patency and function, turbinate size, and the extent of previous surgical scarring. A careful elucidation of a patient's cosmetic objectives and standard preoperative photographs are also obtained. Computer imaging is also performed to determine optimal changes in tip projection, rotation, and width. Platelet inhibitors, such as aspirin-containing medications, nonsteroidal anti-inflammatory drugs, herbal supplements, vitamin E, and omega fish oils, are discontinued at least 10 days prior to surgical treatment, and all smokers are advised to discontinue all forms of nicotine use at least 6 weeks prior to surgery. When appropriate, preoperative laboratory testing is also conducted based on previously established medical guidelines for preanesthesia testing.[41,42] In patients working as health care providers and in patients with a past history of methicillin-resistant *Staphylococcus aureus* infection, mupirocin ointment is applied to the vestibular skin twice daily for 5 days immediately prior to surgical treatment.

SURGICAL TECHNIQUE

Use of the LCT technique requires the open (external) rhinoplasty approach. Careful en bloc degloving of the skin/soft tissue envelope is performed in a subperichondrial/subperiosteal dissection plane to prevent unnecessary trauma to the overlying subdermal vascular plexus. Controlled hypotension in young and healthy rhinoplasty patients (with a target mean arterial pressure of 60–65 mm Hg) is also used to minimize intraoperative bleeding, swelling, and ecchymosis and is most easily accomplished using general endotracheal anesthesia. Local anesthesia is initiated with the topical anesthetization of the nasal mucosa using cotton pledgets saturated with 4% cocaine solution. Topical anesthetization of the nasal cavity improves visualization for local anesthetic infiltration and simultaneously eliminates most of the painful stimuli associated with subsequent injections. After approximately 10 minutes, topical anesthetization is followed by soft tissue infiltration of the outer nose and nasal airway using 1% lidocaine containing 1:100,000 epinephrine. In addition to muting painful stimuli, local anesthetic infiltration with epinephrine-containing solution is used to create a comparatively bloodless surgical field frequently obviating electrocautery. A total of approximately 3.0 mL of local anesthetic is first used to infiltrate the columella, tip, and the nasal sidewalls at the nasofacial groove. Direct infiltration of the dorsum is avoided to minimize contour distortion. Approximately, 4.0 to 9.0 mL of additional local anesthesia is then used to infiltrate the septum (and inferior turbinates when appropriate). Care is taken to administer local anesthesia gradually to prevent hemodynamic instability. Because local anesthesia eliminates nearly all intraoperative pain, narcotics are withheld throughout the entire procedure to reduce the risk of postoperative nausea and vomiting (PONV). To further reduce the risk of emesis, 4 mg of intravenous (IV) dexamethasone sodium phosphate (APP Pharmaceuticals, Schaumburg, Illinois) is administered immediately after induction of general anesthesia and 4 mg of IV ondansetron (Baxter, Deerfield, Illinois) is administered approximately 30 minutes prior to extubation.[43,44]

Prior to infiltration with local anesthesia, reference marks are made on the facial skin at the radix, at the TDPs (ie, the point of maximum tip projection), and at the columellar-labial junction. Preoperative baseline measurements of tip projection (at the TDP) (**Fig. 10**A) and nasal length (as determined by the distance between the radix and the TDP) (see **Fig. 10**B) are obtained prior to anesthetic infiltration and the values are recorded for later comparison. Tip projection is measured using a projectometer (Anthony Products, Indianapolis, Indiana) placed on the upper central incisor teeth and the forehead (see **Fig. 10**A). Positioning of the projectometer on the forehead skin is also marked for the consistency of subsequent measurements.

After complete degloving of the LLC (from the medial crural footpods to the sesamoid cartilages), the membranous septum is separated with sharp dissection to expose the caudal margin of the quadrangular cartilage. Complete (bilateral) exposure of the caudal septum and nasal spine (in the subperichondrial/subperiosteal plane) is performed to facilitate SEG placement, particularly if a tongue-in-groove (TIG) setback is also planned. The upper lateral cartilages (ULCs) are then degloved laterally to the piriform aperture for

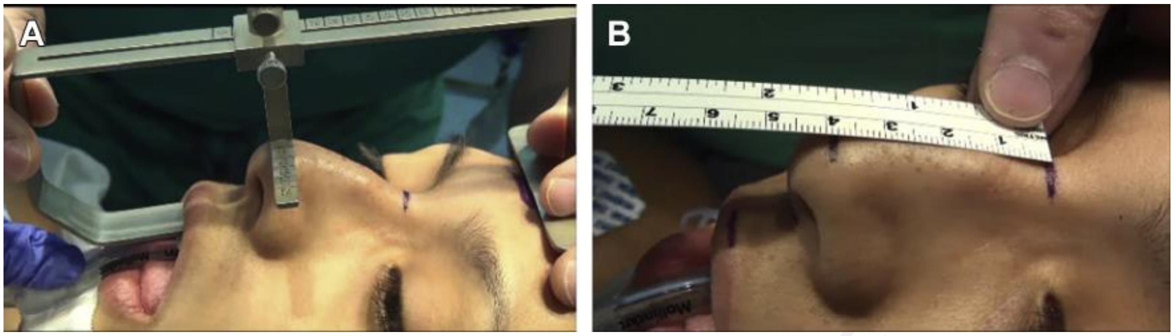

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Fig. 10. Preoperative baseline tip measurements. (*A*) Measurement of preoperative tip projection using projectometer. (*B*) Measurement of preoperative TDP position relative to radix reference mark.

complete exposure of the cartilaginous nasal framework. Wide-field exposure is particularly important when performing LCT to optimize lateral crural mobilization and recruitment (**Fig. 11**).

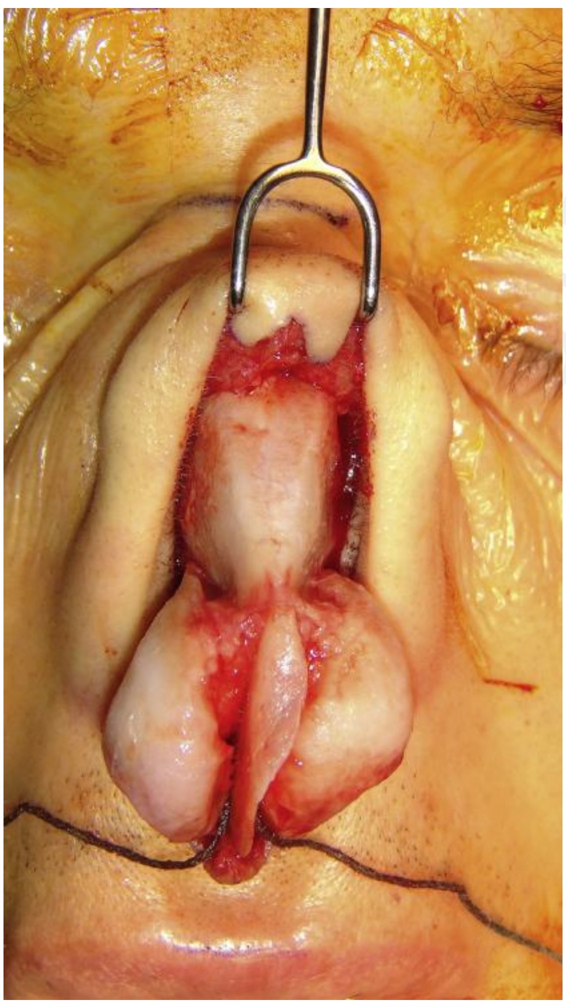

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Fig. 11. Wide-field nasal dissection for complete release of the outer nasal soft tissue/skin envelope. Note full degloving of the cartilaginous framework just medial to the piriform aperture.

Although the extent of lateral crural recruitment varies from patient to patient, up to 7 to 8 mm of LCS can be achieved in some noses after the wide-field release of the skin/soft tissue envelope. Care is taken to elevate the outer soft tissue envelope in a symmetric fashion to minimize asymmetries derived from wound healing. In contrast to the outer skin envelope, however, the internal nasal lining is usually not dissected from the lateral crura because the benefits of LCT are derived in part by concomitant tightening of the vestibular lining.

After soft tissue degloving of the outer nose, septal cartilage is harvested for SEG fabrication. Care is taken to preserve a sturdy L-strut remnant because a rigid and flat L strut is essential for structural stability and effectiveness of the SEG bulwark. Hence, only cartilage essential to grafting objectives (or for treatment of nasal airway obstruction) is removed. Septal cartilage is reserved for the fabrication of the SEG and alar rim grafts, whereas alternative cartilage graft materials from the concha or rib cage are used for spreader grafting or for dorsal augmentation when sufficient amounts of septal cartilage are unavailable. In those patients needing large amounts of septal graft tissue, the natural stiffness of dorsal septum must be taken into consideration when determining residual L-strut size. A much wider L strut should be retained in patients with weak septal cartilage unless compensatory techniques, such as spreader graft placement and/or osseous splinting of the dorsal L strut, are also performed. In patients with unacceptably weak septal cartilage, it is often necessary to harvest secondary sources of donor cartilage or autologous septal bone to augment L-strut rigidity and support. Perforated ethmoid or vomerine bone is an effective (autologous) alternative to septal cartilage for strengthening a weak or distorted L strut when septal cartilage is unavailable. When using osseous splinting grafts, a pear-shaped cutting bur (Stryker, Kalamazoo, Michigan) is usually needed to create a thin and flat bony plate. The graft is then carefully perforated with numerous 1.0-mm drill holes to facilitate suture fixation and vascular in-growth (see **Fig. 9**). Regardless of the source of donor graft tissue, a straight and rigid dorsal septum is paramount.

In patients presenting with an ultrawide nasal tip and normal (or increased) tip projection, using the LCT approach to tip refinement inevitably results in lobular overprojection from aggressive lateral crural recruitment. Even traditional tip-narrowing sutures can alone produce modest degrees of overprojection in this circumstance.[1–3,6,7] Consequently, to prevent excess tip projection, LCT is preceded by a variation of the classic TIG setback, as previously described by Kridel and colleagues.[45] Unlike the classic technique in which the medial crura are moved in a mostly cephalad direction to shorten the nose, however, the modified TIG setback is used to initially underproject the tip/columellar complex by moving the medial crura inferiorly. The repositioned medial crura are then secured to the anterior nasal spine using percutaneous transfixion sutures of 4-0 poliglecaprone (Ethicon) passed through (transverse) osseous drill holes. In addition to immobilizing the medial crura, suture fixation permits narrowing of the columellar pedestal when desired. Initial underprojection of the ultrawide nasal tip complex is uniquely advantageous because it opens the door for a more aggressive LCT and thus better tip refinement, while simultaneously restoring tip projection to an acceptable level. And in overly long noses, or noses with an overly obtuse nasolabial angle or a hanging columella, the TIG setback can also be used to simultaneously shorten a long nose, deepen an obtuse nasolabial angle, and/or correct a hanging columella for further improvements in nasal base profile aesthetics (**Fig. 12**).[45,46] Because the combined TIG/LCS/SEG technique works to reposition and reconfigure the entire length of the LLC arch, tip refinement and nasal base profile aesthetics are both optimized, and unwanted increases in tip projection are avoided without negating the benefits of LCT. Although the TIG setback is indispensable for reducing tip projection and/or enhancing nasal base profile aesthetics, it should be used judiciously when the nasolabial angle is normal to prevent hyperacuity of the columellar-labial junction.

After the TIG setback is complete, placement of the SEG begins. By contouring the caudal edge of the SEG to reflect the desired columellar profile, and by trimming the cephalic edge to reciprocate the caudal septal contour, the SEG is fabricated to create a lock-and-key relationship

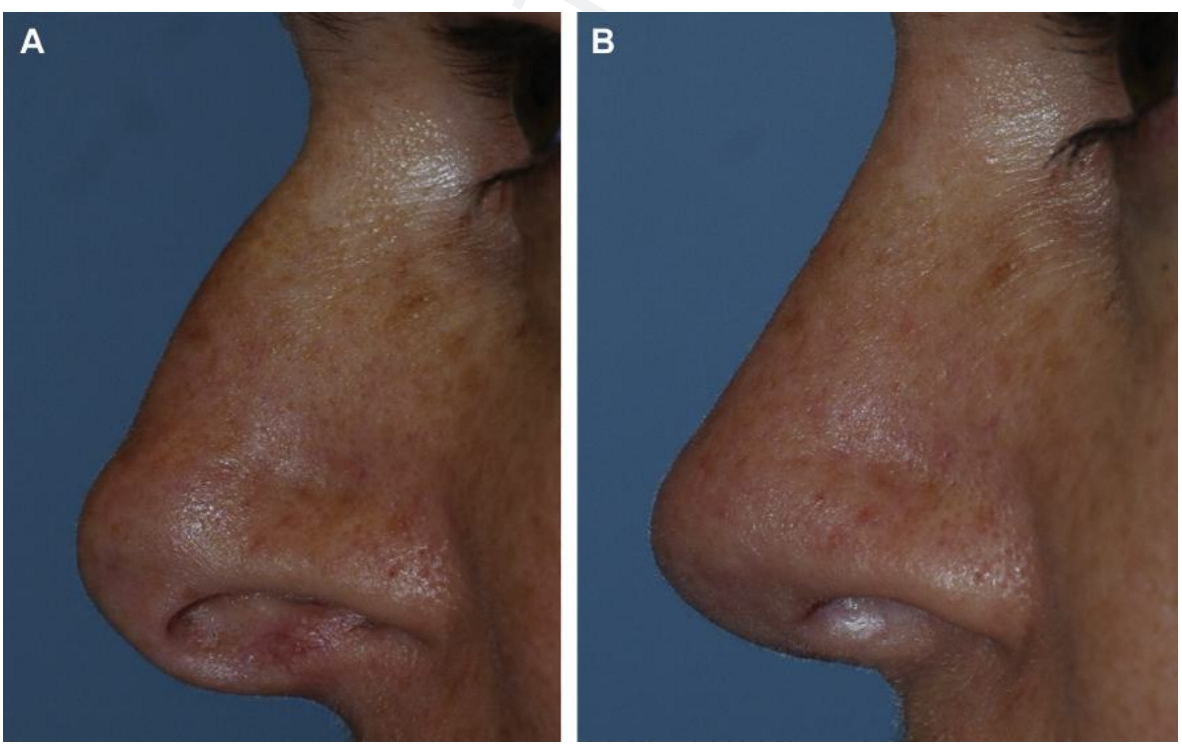

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Fig. 12. Concomitant use of TIG setback to eliminate caudal excess and improve nasal base profile aesthetics. (*A*) Preoperative profile view demonstrating caudal excess nasal base deformity. (*B*) Postoperative profile view demonstrating improved nasal base contour after TIG setback combined with LCT technique.

to the caudal septum that permits precise end-to-end fixation of the graft (see **Fig. 9**F). Figure-of-8 sutures are placed between the caudal septum and SEG from bottom to top to create a stable end-to-end graft alignment. Further stabilization is achieved when the medial crura are then individually sutured to the caudal margin of the SEG. Unless skin closing tension is high, further stabilization of the SEG is generally unnecessary, especially when the LCT forces are also equally balanced. If closing tension and/or tensioning forces are excessive, however, additional stability is required to prevent rudder-like displacement of the SEG from the midline or bowing of the dorsal L strut. This is accomplished using cartilaginous or osseous splinting grafts in the slender nose (**Fig. 13**), or with extended spreader grafts in the wide nose or in the undersized and severely contractured nose. Alternatively, in select cases, side-to-side fixation can also be used for effective SEG fixation.[1–3,36] The stronger side-to-side fixation technique uses mattress sutures to secure the overlapping cartilage segments and is preferred in noses with minor deviations of the caudal septum because placement of the SEG on the side opposite the deviation results in stable midline fixation (**Fig. 14**).[36] In addition to concealing the modest caudal septal deviation, the sturdier side-to-side fixation method also obviates splinting grafts or extended spreader grafts in most cases. Graft overlap and graft thickness, however, should both be used judiciously because airway obstruction may result from impingement of the internal nasal valve. Additionally, in slender noses, airway impingement and/or visible deviation of the columella may result from side-to-side fixation when the caudal septum is located in the midline. And, as with all other structural grafts used in close proximity to the internal nasal valve, circumspect graft positioning and modest graft thickness help to prevent inadvertent nasal valve obstruction.

After placement of the SEG, which is intentionally overprojected to permit in situ refinements in graft contour, the SEG is sequentially trimmed until the ideal position of the new TDP is established. Optimal positioning of the TDP is determined using a quantitative comparison of the preoperative profile photograph and the corresponding computer-optimized profile simulation (**Fig. 15**). This in turn yields the approximate change in tip projection and/or dorsal length (relative to baseline measurements) to generate coordinates for ideal positioning of the TDP. Once the SEG is properly contoured and secured, a stable and stationary platform is then created for suspension of the reconfigured alar cartilages. When creating the new domal fold, care is taken to fold the lateral crus perpendicular to its longitudinal axis to maintain divergence of the paired TDPs and to prevent inversion of the lateral crus at its caudal margin (see **Fig. 3**E). Conversely, as each neodome is then sutured flush with the SEG, care is taken to align the suture parallel to the longitudinal axis of the lateral crus and to place the suture near the cephalic edge of the fold (see **Fig. 3**F). Finally, although some surgeons opt to forego closure of the marginal incisions when using the external rhinoplasty approach, careful closure of the marginal incision is paramount with the LCT procedure. Unless the marginal skin incisions are closed carefully and without bias, the full benefits of LCT go unrealized because enhancements in nostril size and shape will be incomplete.

POSTOPERATIVE CARE

Postoperative care begins immediately after placement of a cinch dressing followed by an aluminum splint. A circumferential wrap of 1.0-inch Coban (3M, St. Paul, Minnesota) is temporarily placed over the dorsum for temporary compression of the skin to minimize bleeding within the subcutaneous dead space during extubation. The pressure wrap is then removed immediately after extubation. An IV infusion of nicardipine hydrochloride (Chiese USA, Cary, North Carolina) is also begun at the time of bandage placement to maintain the systolic blood-pressure between 85 mm Hg and 90 mm Hg throughout emergence and extubation to minimize ecchymosis and swelling. After extubation, the head is raised to a 45° angle and kept elevated for at least 4 weeks. A damp washcloth is then placed over the upper face, and nonlatex gloves partially filled with crushed ice are placed over the orbits and medial cheeks. Iced gloves are maintained continuously for 36 hours and changed every 45 to 60 minutes for constant cooling. Intermittent ice application is then continued for the remainder of the first week after surgery. PONV risk is minimized with a clear liquid diet, non-narcotic analgesia, and supplemental ondansetron antiemetic. Prophylactic IV antibiotics are continued overnight and oral prophylaxis is continued for 1 week postdischarge. Nasal packing is removed on the first postoperative day and sterile saline nasal irrigations are used liberally to minimize nasal crusting. The aluminum splint and outer cinch dressing are removed after approximately 7 days and bacitracin ointment is applied twice daily to the nasal

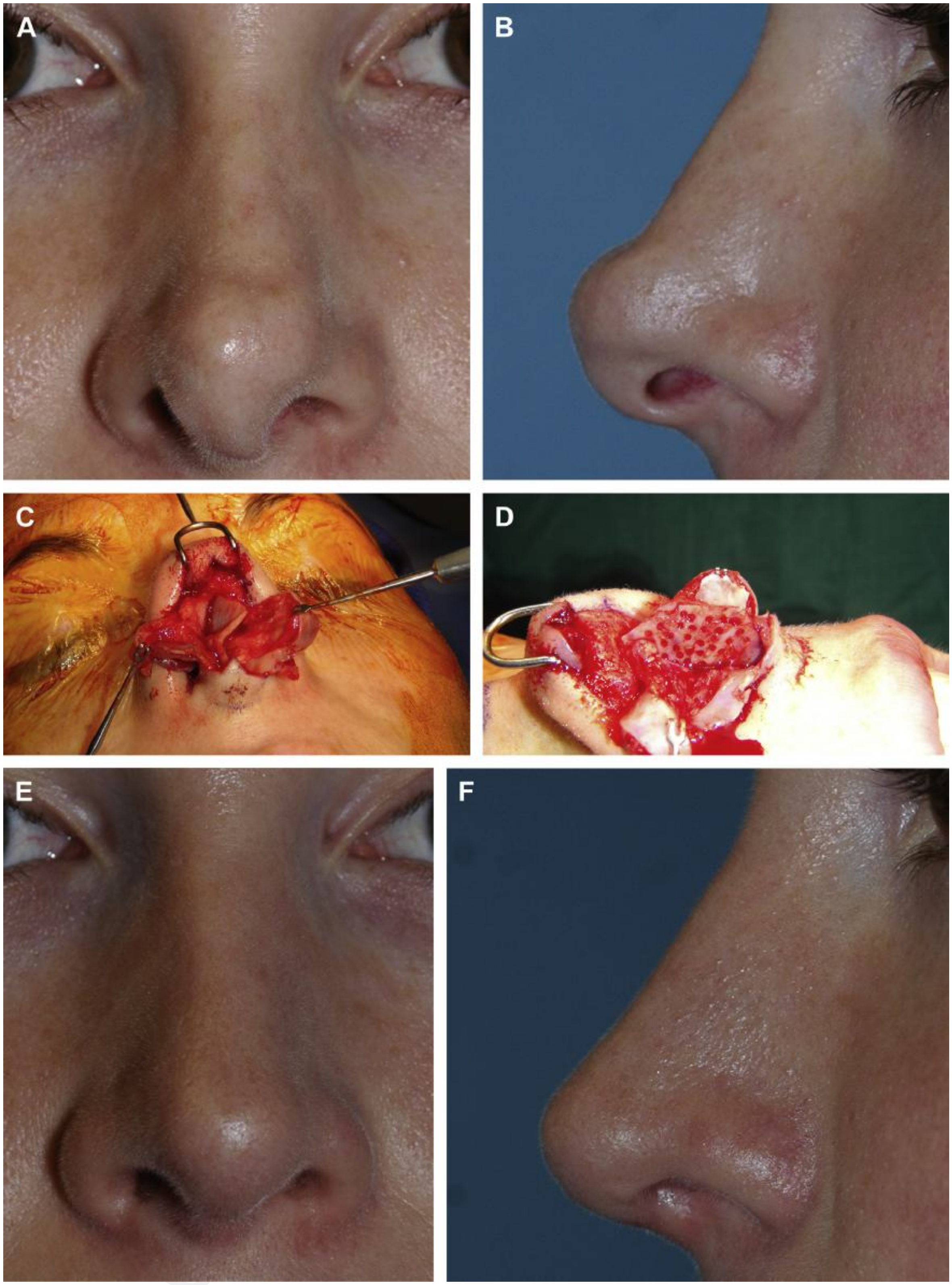

Fig. 13. Splinting of L-strut/SEG complex using perforated septal bone in the narrow nose. Preoperative frontal (*A*) and profile (*B*) views after over-resection of the nasal tip. Note twisting, foreshortening, and tip over-rotation. (*C*) Intraoperative view of deformed L strut. (*D*) Placement of perforated (vomerine) graft for splinting of L-strut/SEG complex. Postoperative frontal (*E*) and profile (*F*) views demonstrating improved nasal contour. Q20

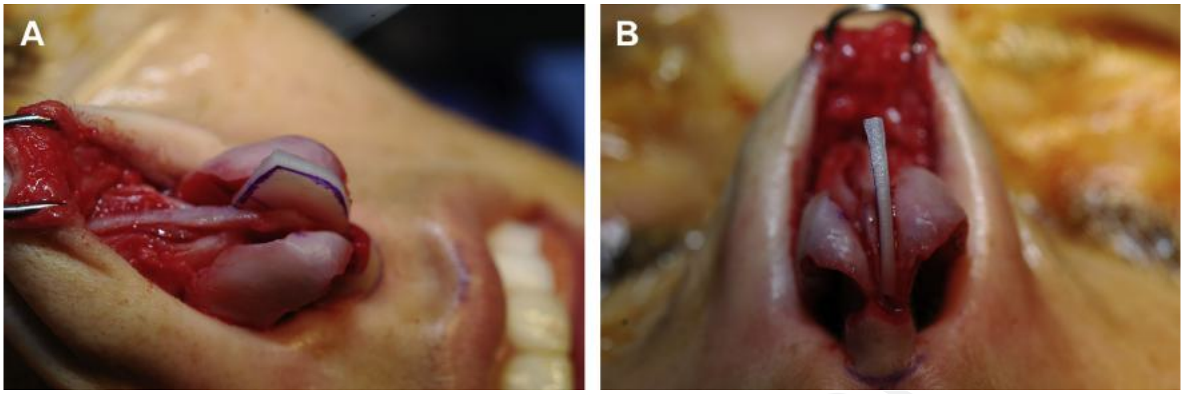

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Fig. 14. Placement of SEG using overlapping (side-to-side) fixation. Intraoperative oblique (*A*) and base (*B*) views of large SEG sutured to the left caudal septum in (overlapping) side-to-side fixation technique.

vestibule for the week after bandage removal. Topical nasal steroids are initiated 2 weeks post-surgery and are continued daily until acute swelling and inflammation subside.

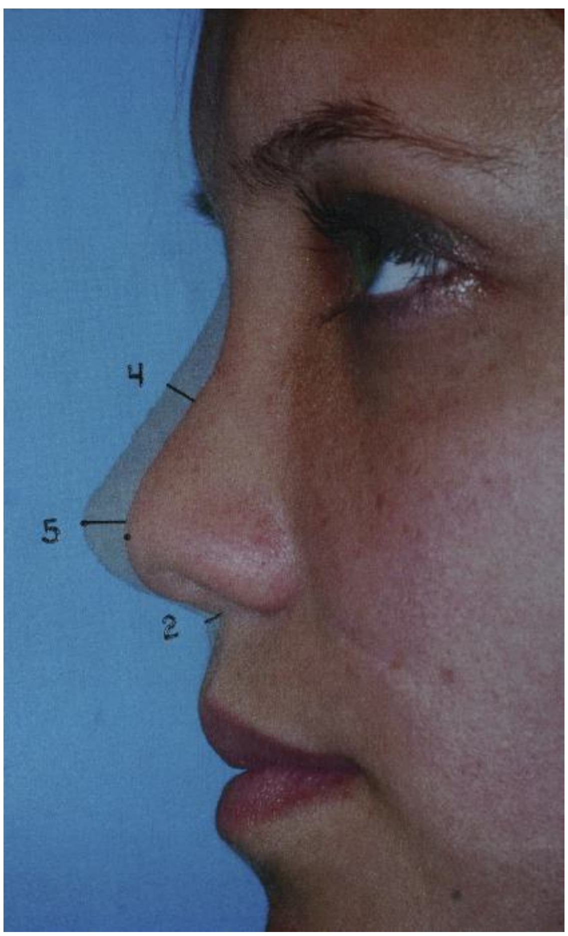

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Fig. 15. Superimposed photographic comparison of preoperative profile with corresponding computer-simulated profile morph. Note measurements for planned changes in nasal profile parameters.

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MINIMIZING POTENTIAL COMPLICATIONS OF LATERAL CRURAL TENSIONING

Stabilization of the Nasal Tip—Balancing Tip Forces

When performing an LCT using an SEG to suspend the modified alar cartilages, considerable tension can be generated at the point of suture fixation. Unless this tension is equally balanced, tip deviation inevitably occurs. To ensure a stable and properly aligned neotip complex, a flat, rigid, and stationary SEG/L-strut complex is paramount. When necessary, splinting grafts or extended spreader grafts fashioned from either cartilage or bone are used to straighten and strengthen the SEG/L-strut complex to maintain a straight sagittal axis and adequate longitudinal rigidity. In addition to resisting the forces of retrodisplacement generated by increased tip projection, a straight and rigid SEG/L-strut complex also serves to counter the superiorly directed forces of rotation generated by LCT. Laterally directed force vectors, however, which are also generated by sidewall tensioning, must be perfectly balanced because even a rigid SEG/L-strut complex is highly susceptible to lateral displacement from modest asymmetries in sidewall tension. To avoid tip deflection, the SEG must be pulled equally in opposite directions. Balancing the laterally directed sidewall tension of the tip complex is analogous to a radio transmission tower that is stabilized by opposing guy wires stretched with equal intensity. Although there is significant tension within the tip complex, balancing the lateral force components creates steady-state tip dynamic that ensures long-term stability of the central support column. Secure suture fixation of the neodomes, however, is equally important to ensure stability of the alar cartilage suspension until wound-healing processes stabilize the tip complex. This is accomplished with individual 4-0 or

5-0 polydioxone mattress sutures to suspend each dome independently from the distal SEG and augmented with transdomal polydioxone sutures to further consolidate the fixation. Although tensioning is a necessary requirement for a successful LCT procedure, sidewall tension should nevertheless be applied judiciously, because even carefully balanced forces can still destabilize the tip complex when tension is excessive. When the following requirements are met, however, a stable and symmetric tip tripod with taut nasal sidewalls is created, and long-term contour stability is generally assured: (1) suture fixation of the neodomes is secure, (2) the SEG/L-strut complex is rigid and unyielding, and (3) the laterally directed forces created by lateral crural recruitment are applied equally.

Although achieving balanced sidewall tension is straightforward in the symmetric nasal tip, in some noses, a preexisting alar cartilage length discrepancy may cause a corresponding asymmetry in domal projection. To establish symmetric domes in the final tip construct without introducing imbalanced sidewall tension, a unilateral segmental excision of the oversized alar cartilage is required to equalize cartilage length. To optimize structural stability of the tip tripod, the author prefers to perform cartilage excision at the neodome and to avoid lateral crural or medial crural overlap techniques, which may weaken the crural span. Because the entire tip suspension is already dependent on suture fixation at the domes, this seems the most logical anatomic location for crural reattachment after vertical transection of the alar cartilage arch. Unilateral segmental dome excision is accomplished by first performing suture suspension of the smaller (normal-sized) tip cartilage and then down-sizing the oversized tip cartilage to match. After vertical transection of the oversized tip cartilage at a point 1 to 2 mm below the contralateral TDP, both medial crura are then sutured to the leading edge of the SEG. The stump of the transected lateral crus is then elevated off the vestibular skin, trimmed when necessary, folded on itself to create a lateral crural segment of the appropriate length, and then sutured to the medial crural stump/SEG complex to reconstitute the tip tripod. The end result is symmetric length of both the medial and lateral crural segments, symmetry in domal projection and rotation, and balanced tensions between the right and left lateral crura (**Fig. 16**).

SUPRATIP FULLNESS

Another inadvertent consequence of an aggressive LCS is a polly beak–type profile deformity of the supratip. Because the LCS recreates each dome from a wider portion of the lateral crus (**Fig. 17**A), the neodomal fold projects much further above the dorsal line (at its cephalic edge), producing unsightly fullness in the supratip profile (see **Fig. 17**B; **Fig. 18**C–E). Consequently, to restore the domal folds to normal length and subsequently to eliminate the unwanted supratip fullness, the elongated neodomal folds must be trimmed along their cephalic edges (see **Fig. 17**C). Unlike the traditional cephalic trim, which resects the entire cephalic margin to produce a complete rim strip, however, the paradomal trim (PDT) removes only a narrow 3-mm × 7-mm strip centered around the domal fold (see **Fig. 18**D, E). The trim begins medial to the nasal scroll, crosses the domal fold, and terminates on the cephalic portion of the middle crus. Care is taken to create a smooth transition from the TDP to the adjacent dorsal septum (as seen on profile view) and to achieve a final fold length of approximately 3.0 mm (see **Fig. 18**F, G). Although the PDT is primarily used to eliminate unsightly supratip fullness and thereby enhance the profile contour, the slope of the PDT and the degree of separation between the TDP and the nasal dorsum can be customized to accentuate, minimize, or eliminate the supratip break according to individual cosmetic preferences. Additionally, the PDT preserves the entire nasal scroll and, by preserving nearly the entire vertical and horizontal span of the lateral crus, structural support of the lower nasal sidewall (including the nasal scroll) is almost entirely preserved. Moreover, any slight reduction in structural support produced by the PDT is more than offset by a substantial increase in sidewall tone generated from sidewall tensioning.

SPANNING SUTURES

One of the more common failures in tip surgery is inadequate treatment of supratip width and/or supratip bulbosity. Although the root cause of excessive supratip width is convexity of the lateral crura (sometimes exacerbated by excessive middle vault width), convexity and cupping of the lateral crura may persist even after an aggressive LCT. Persistent and stubborn crural convexity is most common in bulbous noses with thick and abnormally stiff tip cartilage. In this circumstance, lateral crural spanning sutures can be used to flatten and contour the lateral crura and to eliminate residual supratip width deformities after a PDT.[2,3,6] In addition to treating residual convexity of the lateral crura, spanning sutures are also used to further narrow the supratip, stabilize the

Fig. 16. Refinement of asymmetric boxy nasal tip with LCT and segmental excision of right neodome. (*A–C*) Preoperative front, profile, and base views.

tip complex, evert the lateral crura, and/or restore lateral crural symmetry after LCT. Spanning sutures may be applied unilaterally or bilaterally, as simple sutures or mattress sutures, and placed between the cut border of the LLC and either the septum, the SEG, and/or the contralateral lateral crus to sculpt the supratip to the desired contour. Care must be taken, however, to place the spanning sutures high in the middle vault to prevent unwanted constriction of the underlying internal nasal valves.

INVERSION OF THE LATERAL CRURA

Another potential drawback to the LCT technique is the potential for unsightly inversion of the lateral crus. Inversion (ie, inward rotation of the lateral crus around its longitudinal axis) can result from improper placement of tip sutures, overtightening of tip sutures, excessive tensioning of the lateral crura, or combinations therein. Externally, inversion of the lateral crus results in unsightly pinching of the tip lobule with conspicuous vertical shadows

Fig. 16. (*continued*) Refinement of asymmetric boxy nasal tip with LCT and segmental excision of right neodome. (*D–E*) Corresponding postoperative views demonstrating improved tip symmetry after vertical lobular division. (*From* Davis RE. Revision of the over-resected tip/alar cartilage complex. Facial Plast Surg 2012;28(4):427–39; with permission.)

separating the alar and tip lobules.[8,33,47] Treatment options for inverted lateral crura vary, but rotating (or everting) the lateral crus around its long axis using spanning sutures (placed between the medial and/or cephalic border of the lateral crus and the dorsal septum and/or SEG) often successfully lateralizes (or everts) the caudal border of the crus. Externally, proper eversion of the lateral crus creates a smooth and comparatively flat contour between the tip and alar lobules, thereby eliminating the pinched appearance. Alternatively, alar rim grafts can also be used to lateralize the caudal margin and camouflage mild pinching of the lobule.

ARTICULATED ALAR RIM GRAFTS

Although LCT preserves the lateral crura and increases sidewall tone to stabilize the alar rim against vertical scar retraction, poor skeletal support to the alar rim may lead to postoperative external valve collapse despite successful LCT. Postoperative collapse of the external valve is

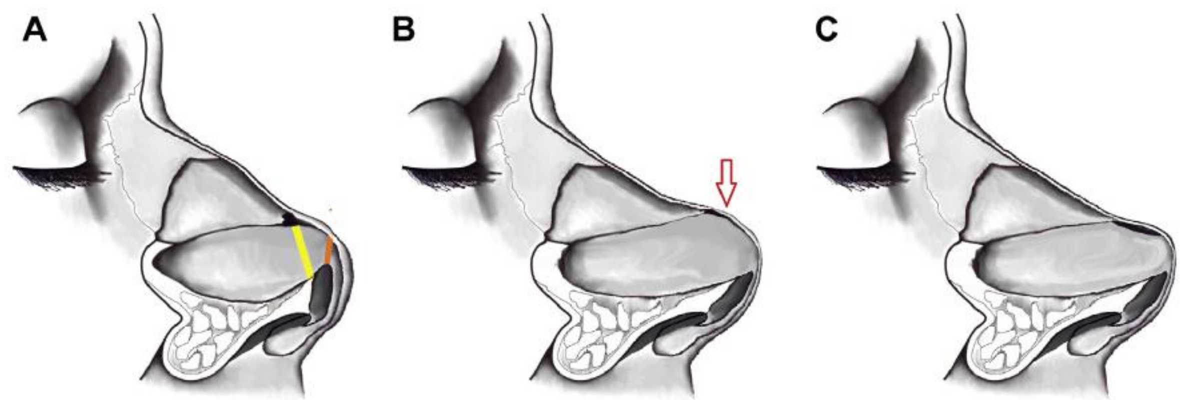

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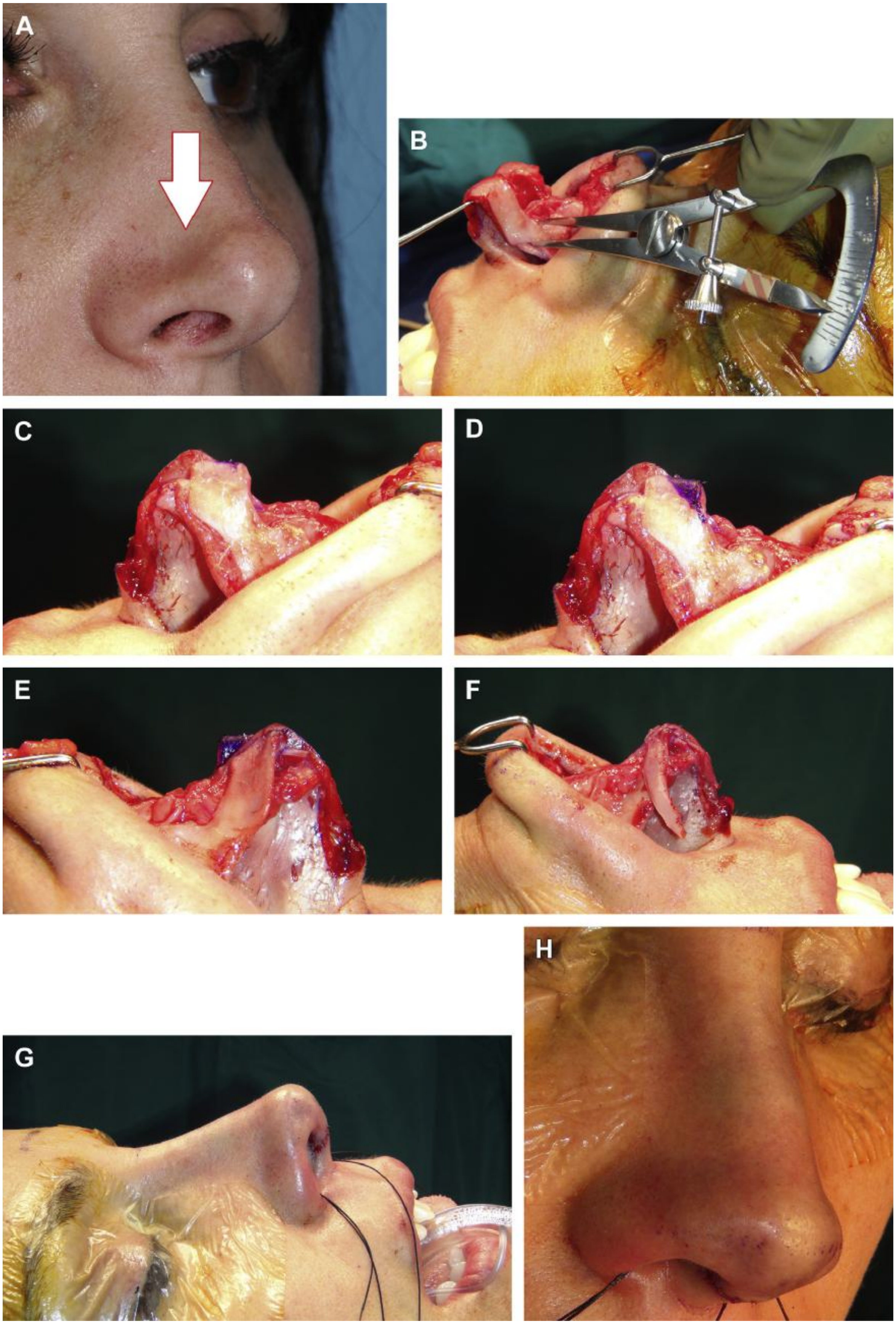
Fig. 17. Schematic illustration of the PDT. (*A*) Wide-tip cartilage with convex (bulbous) cupping of the lateral crus. Note location of natural domal fold (*red*) and neodomal fold (*yellow*) with corresponding differences in fold height. (*B*) Appearance of right lateral crus after LCT. Note stretching and flattening of the crus and supratip profile fullness (*arrow*) resulting from increased neofold height. (*C*) Appearance of right lateral crus after PDT. Note improved supratip profile after elimination of supratip fullness with PDT.

most likely to affect patients with naturally weak tip cartilage and preexisting alar rim laxity, but robust wound-healing phenomena may occasionally distort comparatively strong nostril rims. LCT may also lead to aggressive tensioning of the lateral crus with unwanted inversion of the caudal margin and subtle lobular pinching. Although a reduction in tensioning forces to eliminate inversion is preferable, in some instances a reduction in sidewall tension proves detrimental to airway patency or supratip contour making slight lobular pinching the lesser of two evils. Moreover, in most patients with unsightly alar collapse or retraction, or in noses deemed to be at increased risk for external valve collapse or alar retraction, successful correction/prophylaxis can be achieved with small but effective alar contour grafts[48]—now commonly referred to as *alar rim grafts*. Originally described as long narrow cartilage grafts placed within a nonanatomic skin pocket dissected along the nostril rim, these floating grafts have become very effective and treating various contour disturbances of the alar rim.[48,49] The author has modified the traditional alar rim graft to increase graft stability and thus to increase effectiveness of these small and inconspicuous structural grafts. The modified alar rim graft—which the author has dubbed the *articulated alar rim graft (AARG)*—is a long and narrow batten graft, which, unlike the traditional alar rim graft, is sutured to the tip framework with multipoint fixation to enhance both contour and structural support. As such, the AARG can be used to stabilize the alar rim against primary or secondary retraction, to camouflage mild lobular pinching produced from lateral crural inversion, to augment the poorly supported alar rim against collapse, and to selectively widen the tip along its caudal-most border.[2,3] These thin, narrow, and inconspicuous grafts span the tip and alar lobules and are placed approximately 2 to 3 mm above the nostril rim. In cases of secondary alar retraction resulting from over-resection of the cephalic margin, vestibular adhesions must first be lysed to unfurl the vestibular mucosa and recreate the gap between the ULC and LLC and thus permit caudal repositioning and stabilization of the lateral crural remnant. In all cases, the AARG should be tapered laterally and beveled peripherally for camouflage. Proper positioning and secure fixation of the graft are essential because graft immobilization is critical to a favorable outcome (**Fig. 19**O–R). Medially, the graft is sutured on top of the lateral crus such that the tapered medial end is flanking (and flush with) the domal fold (see **Fig. 19**O). The graft is also angled at approximately 90° to the sagittal midline as seen from the frontal view (see **Fig. 19**Q). Care is taken to avoid an overly acute angle between the AARG and the columella (as seen on basal view) (see **Fig. 19**P) so as to create a gentle springlike lifting effect of the alar rim. Two-point fixation—at the medial-most end of the graft and at the point of divergence from the lateral crus—is critical to resist upward displacement of the alar margin. Typically an intracutaneous skin pocket is created to house any portion of the AARG extending beyond the marginal excision. For cases of severe alar retraction, however, the pocket is dissected 1 to 2 mm further away from the nostril rim. Although the AARG may add a total lobular width increase of approximately 2 to 3 mm, this typically offsets the width reduction from crural inversion and is seldom aesthetically objectionable. When alar rim support is essential but additional width increases are undesirable,



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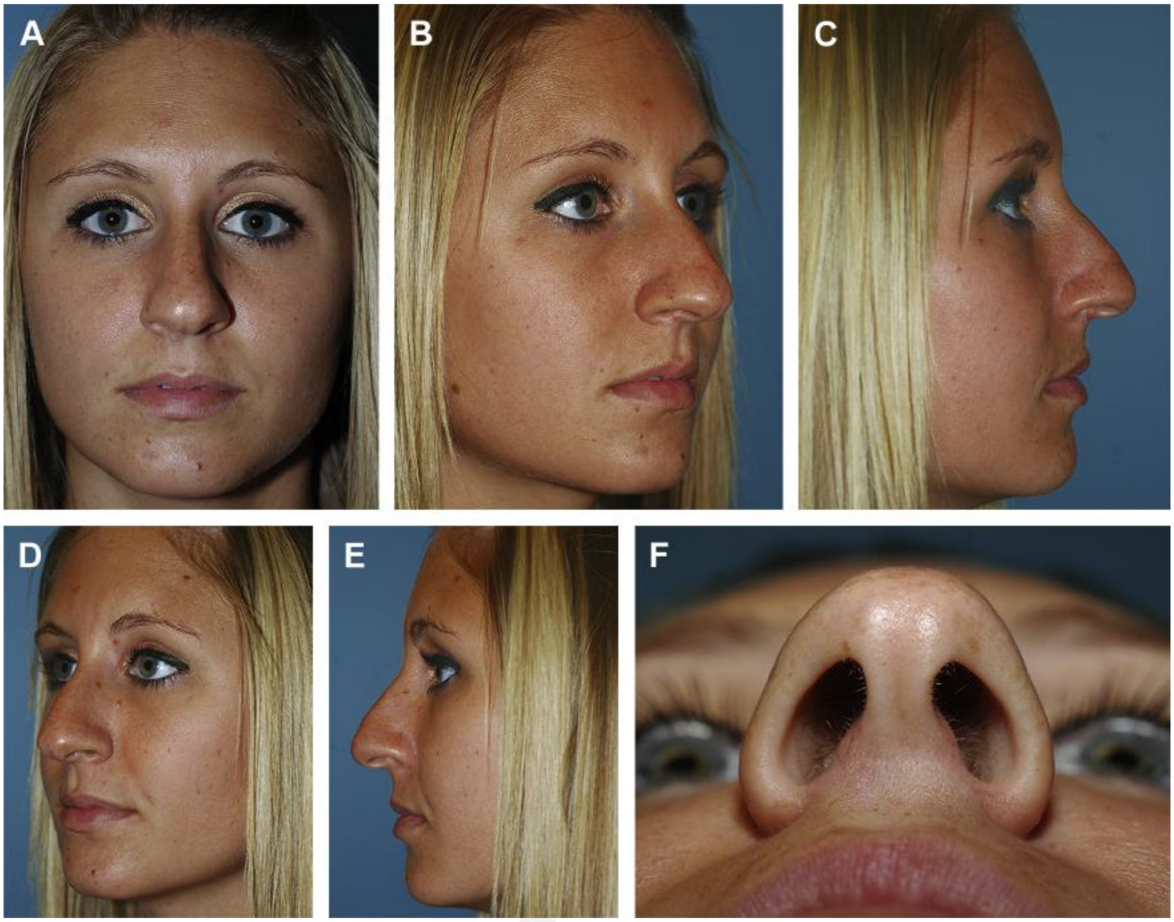

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Fig. 19. Surgical refinement of the CTD using LCT, TIG setback, and AARG combined techniques. (*A–F*) Preoperative views.

the AARGs may also be placed as underlayment grafts to negate width increases. Owing to the diminutive graft size, the economy of donor graft utilization use makes the AARG an attractive alternative to large support grafts that use large amounts of donor graft material and that may add bulk to the scroll region of the nose. In patients highly prone to scar contracture, however, additional support grafts are often necessary to prevent recurrent retraction. Nevertheless, alar rim graft/AARG placement has little downside and the author frequently uses both the traditional and the modified (articulated) graft for prophylaxis.

CASE PRESENTATION

A healthy woman presented for cosmetic rhinoplasty complaining of a large nose with a wide drooping tip. No functional complaints were elicited.

Nasal examination revealed a CTD with intermediate tip skin thickness and exceptionally weak and pliable tip cartilages (see **Fig. 19**A–F). Tip support was poor with inferiorly oriented tip cartilages and bulbous cupping of the lateral crura (in both the longitudinal and transverse planes), along with mild tip asymmetry and infratip bifidity. The

Fig. 18. PDT in over-resected nose with bilateral collapsed lateral crura. (*A*) Preoperative oblique view demonstrating supra-alar concavity (*arrow*) from lateral crural cartilage collapse. (*B*) Intraoperative view of left lateral crural remnant measuring only 4 mm wide. (*C*) Intraoperative view of left lateral crural remnant after LCT maneuver. Note cephalic protrusion of the neodomal fold. (*D*) Intraoperative left and (*E*) right profile views of overprojecting left neodomal fold marked for PDT (*blue ink*). (*F*) Right intraoperative profile view after LCT, PDT, and AARG placement. Note smooth transition from the TDP to the dorsal profile line. (*G*) Immediate postoperative right profile view demonstrating elimination of supratip fullness. (*H*) Immediate postoperative right oblique view demonstrating absence of supratip concavity.

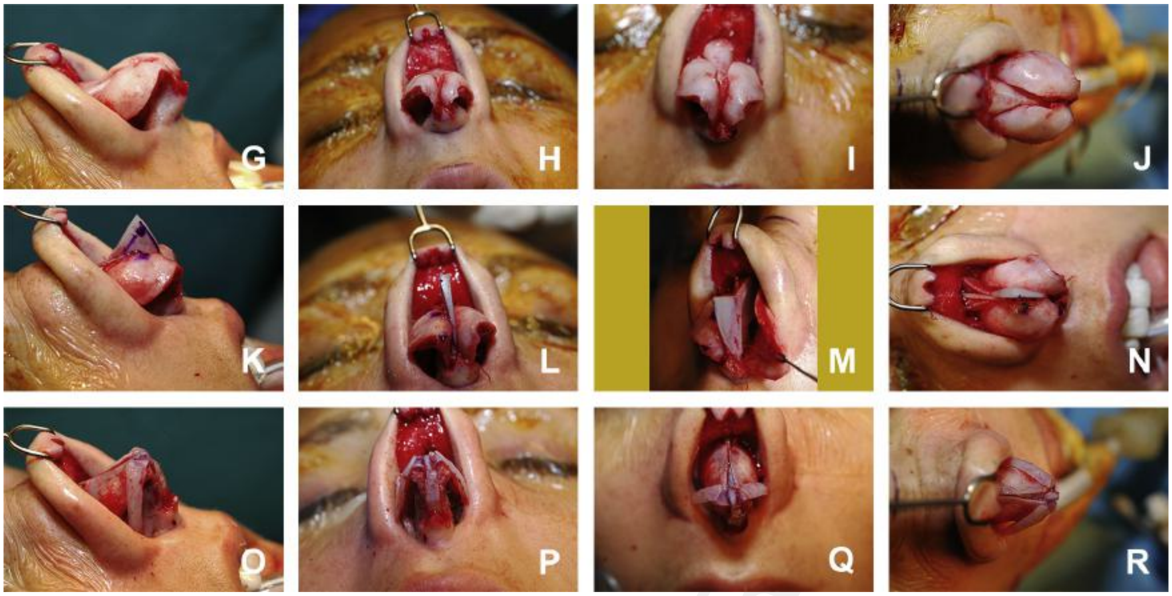

Fig. 19. (*continued*) Surgical refinement of the CTD using LCT, TIG setback, and AARG combined techniques. (*G–J*) Intraoperative views of untreated tip cartilages, (*K–N*) intraoperative views after TIG setback and SEG placement. Note difference in positioning of the columellar-labial junction before and after TIG setback. (*O–R*) Intraoperative views after TIG setback, LCT with bilateral PDT and spanning suture placement, and AARG placement.

dorsum was symmetric, slender, and straight, but progressive widening of the middle vault resulted from overly prominent lateral crura. On profile view, the nose appeared ptotic and slightly unprojected. Long nostrils with overly arched alar rims were present bilaterally, and the columellar-labial junction was displaced anteriorly creating fullness of the nasolabial angle. A convex dorsum with a polly beak fullness was also seen on profile view. The basal view revealed a boxy tip with columellar bifidity and thin infratip skin. Endonasal examination revealed an unremarkable nasal airway with a midline nasal septum.

Primary cosmetic rhinoplasty was performed using the open (external) rhinoplasty approach. After wide-field degloving of the skeletal framework, inspection revealed overly long, large, and convex lateral crura protruding well above the dorsal line (see **Fig. 19**G–J). The lateral crural deformity accounted for much of the dorsal convexity and for the nasal tip ptosis (see **Fig. 19**G). Round and divergent nasal domes were medially displaced resulting in foreshortened medial crura and long, inferiorly oriented lateral crura (see **Fig. 19**G, H). The lateral crura also protruded laterally at the tip and supratip (see **Fig. 19**H–J). After dissection of the caudal septum and nasal spine, septal cartilage was harvested for graft fabrication with preservation of a sturdy residual L strut. A TIG setback was then performed to retrodisplace the columellar-labial junction and simultaneously underproject the tip cartilages. An intentionally oversized SEG was then placed using a (left) side-to-side fixation technique for stabilization (see **Fig. 19**K–N). After component reduction of the cartilaginous and bony hump, the SEG was sequentially trimmed to the desired projection and nasal length as determined by computer-generated 2-D simulations. An LCS with 8.0-mm recruitment of both lateral crura was performed to reposition the nasal domes laterally, thereby reducing tip width and simultaneously increasing tip rotation and projection. Domal folds were created perpendicular to the long axis of the lateral crura to maintain tip divergence and then sutured flush with the SEG. Small paradomal cephalic excisions were performed bilaterally on either side of the domal fold, and spanning sutures were placed bilaterally to flatten and stabilize the lateral crura. A small augmentation graft was placed to accentuate the columellar double-break on profile view, and bilateral AARGs were then sutured to the lobule with multipoint fixation. At the conclusion of the TIG/SEG/LCS procedure, the tip complex was narrowed extensively at the supratip and more conservatively at the tip lobule (see **Fig. 19**I, S, M, and R). Tip projection and rotation were both increased, but the SEG prevented over-rotation of the tip complex (see **Fig. 19**G, P). The medial crura were also lengthened by shortening the lateral crura (see **Fig. 19**G, P) and the round and divergent domal folds were converted to angular and closely approximated TDPs (see **Fig. 19**H, O). Postoperative photos

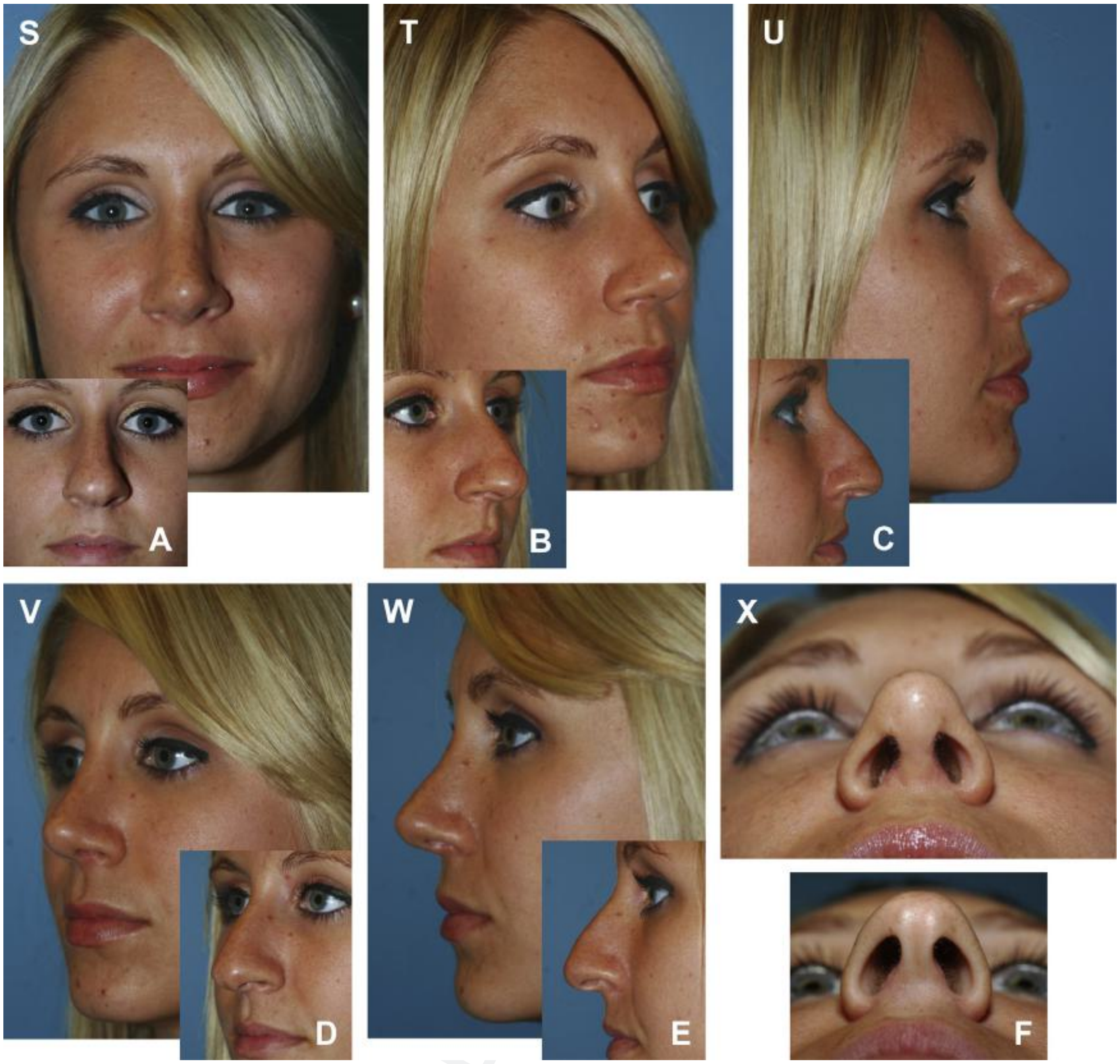

Fig. 19. (*continued*) Surgical refinement of the CTD using LCT, TIG setback, and AARG combined techniques. (*S–X*) Postoperative views demonstrating improved tip contour at long-term follow-up.

taken at long-term follow-up reveal a natural-appearing nose with an attractive and feminine contour (see **Fig. 19**S–X). Postoperative examination also revealed good sidewall and alar rim support, a sturdy and noncompressible tip complex, and widely patent nasal passages.

SUMMARY

LCT—the combination of an aggressive LCS and a sturdy SEG (with or without TIG setback)—is a powerful and versatile technique for treating the CTD, in part because it addresses width, projection, and rotation all through a single nondestructive modification of the tip cartilage. LCT is also a radical departure from traditional excisional rhinoplasty techniques that rely on haphazard cartilage resections to achieve reductions in tip volume and shape. LCT removes little if any tip cartilage and preserves virtually all the natural skeletal support, whereas tensioning of the lateral crura, made possible through the addition of a strong and stationary SEG, serves to profoundly strengthen the lateral cartilages well beyond their baseline rigidity—a stark contrast to the flail rim strip resulting from over-resection of the cephalic margin. And although LCT increases sidewall tone and raises the threshold for internal nasal valve collapse, the nasal sidewall remains thin, lightweight, and flexible because lateral crural augmentation grafts are generally unnecessary. LCT also supplants the columellar strut graft, which lacks the stability and precision of the SEG in controlling tip position. When executed correctly, LCT fundamentally restructures the nasal tip framework by redistributing and reshaping the alar cartilage arches to produce a more attractive (and more functional) nasal tip complex. The change in skeletal architecture also creates a durable tip framework that more effectively resists deformation by the processes of wound healing. And when combined with the TIG technique, LCT readily adapts to virtually any tip morphology (including the overprojected tip) and is equally suited to both primary and secondary rhinoplasty applications. Finally, the author has been using this approach to tip refinement exclusively for well over a decade with uniformly favorable results.

As with any rhinoplasty technique, however, LCT must be applied prudently with continual reassessment of the secondary and tertiary effects of each structural modification. Proper application of the LCT technique requires prior mastery of rhinoplasty fundamentals (eg, SEG placement) and sound clinical judgment, especially with regard to positioning and contouring of the tip complex. Although LCT can create a stable and more attractive tip contour in most noses, care must be taken to avoid excessive and/or imbalanced skeletal tension because large structural loads may eventually cause destabilization and structural failure, particularly when the loads are asymmetric and skeletal support is weak. Consequently, despite the overall versatility and efficacy of LCT, it is not a remedy for all ills. LCT alone may not be effective with extremely bulbous and rigid lateral crura because LCT is best suited to noses with weak tip cartilage and strong septal graft material. Similarly, LCT may not adequately restore extreme deficits in tip projection or nasal length especially when combined with a stiff and nondistensible skin envelope. In these situations, additional techniques may be needed to alter tip projection, contour the lower nasal sidewall, and/or reposition retracted alar rims. A graduated and stepwise approach to tip refinement, beginning with the LCT algorithm and increasing in complexity (as needed) to include ancillary techniques, such as cephalic turn-in flaps, LCSGs, Gruber-type horizontal mattress sutures,[50] lateral crural repositioning, and other techniques, will ultimately provide the best outcome for these more difficult cases. Moreover, even when LCT fails to fully correct existing tip abnormalities, it seldom precludes the successful application of adjuvant rhinoplasty techniques. Although LCT alone is not fully applicable to all noses, the wide and amorphous nasal tip with poor tip projection, inadequate tip rotation, and weak tip cartilage is particularly amenable to this treatment algorithm; and predictable, safe, and durable cosmetic refinement with satisfactory airway function can be achieved in the overwhelming majority of these patients with LCT.

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Dorsal Modification: Practical Applications in Rhinoplasty

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Abstract
Background: Management of the dorsum continues to present challenges for rhinoplasty surgeons, especially regarding the inherent asymmetry of the bony and cartilaginous vaults and the need for a highly individualized approach for each case.
Objectives: The aim of this study was to assess the efficiency of superficial dorsal modification to improve the shape and symmetry of the dorsum, without resecting/reconstructing the main parts that maintain dorsal stability.
Methods: A total of 147 patients who underwent superficial dorsal modification between October 2020 and March 2024 were retrospectively reviewed. A step-by-step algorithm was applied to achieve the required dorsal improvement.
Results: The average postoperative follow-up period was 27 months (range, 12-41 months). No patients required revision surgery of their dorsum. No complications were reported. A retrospective analysis of the 147 patients demonstrated aesthetic and functional improvement.
Conclusions: Dorsal modification as a separate philosophy is a very conservative, fast, and reliable approach. In cases where there is no need to significantly change dorsal dimensions (height and width), dorsal modification improves the dorsum quickly and efficiently without significant resection and no reconstruction, while maintaining stability and maximum predictability.

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Management of the dorsum continues to present challenges for rhinoplasty surgeons, especially regarding the inherent asymmetry of the bony and cartilaginous vaults and the need for a highly individualized approach for each case.[1-3] Currently, both dorsal structural rhinoplasty and preservation rhinoplasty techniques are used to optimize patient outcomes for the nasal dorsum. In some cases, structural grafting is also used in combination with dorsal preservation. When performing techniques according to either philosophy, additional maneuvers aimed at improving the symmetry of the nasal dorsum are applied. Dorsal modification was first described by the senior author in 2017 in the first edition of *Preservation Rhinoplasty* as a way to expand the indications for dorsal preservation (bony cap removal, rasping, trimming upper lateral cartilages [ULCs], etc), and these modifications are well known and have been repeatedly described as additional elements of existing techniques.[4-9]

Over time, it became clear that these dorsal modification maneuvers, performed independently, without the use of dorsal reconstruction or preservation techniques, could be applied to certain patients (see Supplemental Figure 1). This approach requires only superficial work to the dorsum, without resecting/reconstructing the main parts that support and ensure dorsal stability. Dorsal modification can be

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effectively used to improve the shape of the dorsum and improve its symmetry in cases where there is no need to significantly change dorsal dimensions (height and width). With experience and improvement in instrumentation the authors now use this technique to reduce nasal humps up to 3 mm in size. An important feature of this technique is that there is no need to use spreader grafts or flaps unless there is severe lateral wall asymmetry/concavity that may need additional treatment with grafts. However, endonasal grafts can still be used with dorsal modification without violating the mucosa of the midvault.

Dorsal modification can be conveniently divided into bony modification and cartilage modification. Bony modification involves working with the bony pyramid to maintain its stability without significant lateral wall mobility. Bony modification is based on: (1) rhinosculpture, (2) bony cap removal/reshaping/release, which can be performed with ultrasonic piezoelectric instruments (PEIs), burrs or rasps, and (3) partial osteotomies with intact bony bridges to ensure stability of the side walls while permitting limited movement medially.[1]

Cartilage modification is based on: (1) shaving the ULC shoulders and dorsal septum without opening the mucosa using a No. 15 blade or electrocautery (Colorado needle) or partial incision of the ULCs along the septum in cases of wide dorsum without opening the mucosa; (2) keeping the W-point intact; (3) smoothing the keystone and shaving the ULCs with a diamond burr or PEI; and (4) closing the cartilaginous defect over the underlying mucosa if necessary (see Supplemental Figure 2).[3,6]

The dorsal modification philosophy greatly facilitates the ease and the speed for the rhinoplasty surgeon who needs to reduce small humps even with excessive bony and/or cartilaginous width, and address asymmetries of the bony pyramid and cartilaginous vault. This allows for an easy and reliable procedure that largely avoids the problems and complications associated with excessive mobilization of the side walls and middle vault reconstruction.

This study is based on the extensive experience of both authors (V.Z. and A.K.) as well as a retrospective review of 147 primary rhinoplasty cases performed over a 3.5-year period by the primary author (V.Z), in which dorsal modification techniques are utilized as a separate philosophy.

METHODS

A total of 311 primary rhinoplasty cases were studied retrospectively between October 2020 and March 2024. Written informed consent was obtained from all patients, and guiding principles from the Declaration of Helsinki were followed. One hundred forty-seven cases of dorsal modification were included in the study. No secondary rhinoplasty or secondary septoplasty cases were included. Patients with a hump >3 mm and patients with a significantly deviated (axis deviation) or significantly crooked dorsum (posttraumatic) were excluded because they are not good candidates for dorsal modification; these patients were operated with dorsal preservation and reconstruction techniques. Any patient not having at least 1 year of follow-up was also excluded. Data were collected in all cases regarding age, gender, ethnicity, and technical details of the operation.

These cases can be broken down into the following 2 types based on the surgery performed on the bony pyramid (bony modification): Type 1, rhinosculpture only; Type 2, rhinosculpture + osteotomies.

The cases also can be broken down into the following 2 types based on the surgery performed on the cartilaginous part of the dorsum (cartilage modification): Type 1, ULC shoulder shaving; Type 2, partial incision of the ULCs along the septum.

Photographs of all 147 patients were taken before and after surgery. All patients included in this study also were examined with Standardized Cosmesis and Health Nasal Outcomes Survey (SCHNOS).[10,11]

This 10-item questionnaire is designed to evaluate both perceived nasal obstruction and cosmetic disadvantage on a 0 to 5 scale ("no problem" to "extreme problem"). SCHNOS in fact consists of 2 domains: SCHNOS-O (the first 4 items) which evaluates nasal obstruction; and SCHNOS-C (the last 6 items) which evaluates cosmesis.[12] All patients completed the questionnaire preoperatively and at 12 months postoperatively.

Statistical analysis was performed with IBM SPSS Statistics for Windows (IBM Corp., Armonk, NY) and Excel after deidentification of patient data. Continuous variables are shown as means and standard deviations (SDs); here, the SD represents the degree of variation of the mean SCHNOS, SCHNOS-O, and SCHNOS-C scores. Normal distribution of variables was verified by the Shapiro-Wilk test or by means of skewness and kurtosis values. Differences among paired groups were evaluated by the paired t-test for normally distributed data (accompanied by the Cohen's d to show the effect size with the following cut-offs: $d = 0.2$, "small" effect size; $d = 0.5$, "medium" effect size; $d = 0.8$, "large" effect size). Statistical significance was defined as $P < .05$ setting the α-error probability at 5%.

Surgical Techniques

Exposure

The open rhinoplasty technique was performed in all patients by the first author, although it should be noted that rhinoplasty is also regularly performed using a closed approach by the senior author (A.K.). The nasal dorsal skin flap was elevated through a transcolumellar V-shaped incision plus infracartilaginous incisions along the caudal edge of the lower lateral cartilages. The skin and soft tissue envelope were elevated over the lower lateral cartilages in the supra-superficial muscular aponeurotic system plane,

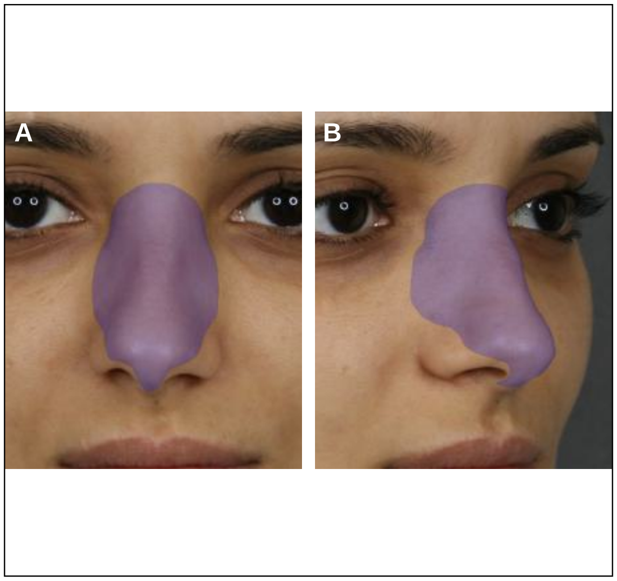

Figure 1. A 25-year-old female patient with the area for extended dissection of the skin-soft tissue envelope over the nasal skeleton marked in purple. (A) Frontal view. (B) Side view.

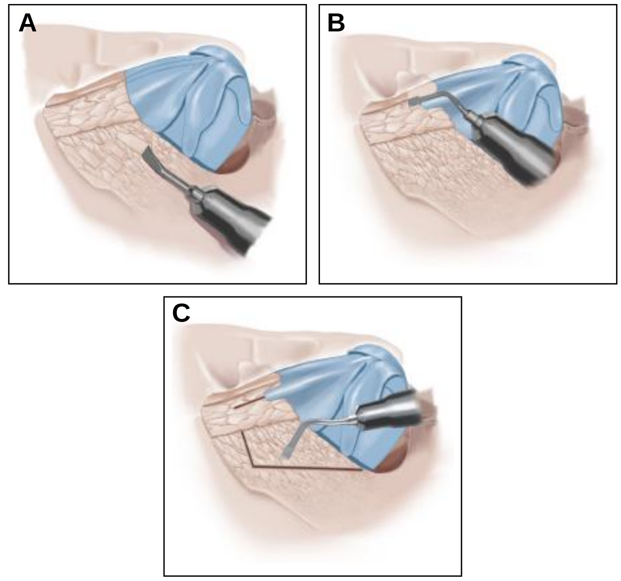

Figure 2. Rhinosculpture technique and partial osteotomies. (A) Sculpting the lateral bony wall with a piezo scraper head. (B) Sculpting the central bony dorsum. Removal of the bony cap with the use of a piezo rasp head. (C) A low-to-low lateral osteotomy, a partial length transverse osteotomy, and a paramedial osteotomy. An intact bony segment remains between the anterior transverse and paramedial osteotomies.

over the ULCs in the supraperichondrial plane, and over the bony pyramid in the subperiosteal plane. A fully open approach using a subperiosteal dissection of the bony vault was performed longitudinally from the keystone junction up to the cephalic part of the radix, and transversely from one ascending frontal process of the maxilla to the other side. In addition, it is necessary to undermine the periosteum beyond the nasofacial groove to achieve the requisite exposure. Usually, the lateral pyriform aperture ligaments are stretched or cut depending on their strength to allow complete access to the nasal bony wall along the pyriform aperture (Figure 1).[1]

Bony Modification

Sculpting the Lateral Bony Wall

For sculpting the bony pyramid, we mainly used ultrasonic PEIs over the entire surface as well as diamond burrs if significant bone thickness needed to be removed, usually with severe asymmetries at the base of the bone pyramid. Different piezo inserts, including scrapers and rasps of various shapes and gradations, are used for sculpting. Initially, we started with a rough surface and then progressed to a more delicate surface before performing the final sculpting with an ultrafine diamond-coated head. The rhinosculpture began at the base of the pyramid just beyond the nasofacial groove, because this is the widest point of the bony vault (base bony width, *x*-point) where the ascending process of the frontal process of the maxilla is thinned and any irregularities removed.[1] The aim of this rhinosculpture is to achieve the best possible symmetry between the 2 sides regarding the shape, size, and angulation of the lateral bony walls and to reduce the width of the base of the bony pyramid. As one moves medially along the lateral bony wall, any convexities are removed. The rasping continues over the nasal bones, including the lateral keystone area, to achieve maximal symmetry of the shape and size of the 2 sides (Figure 2A). The new bony dorsal aesthetic lines are directly sculpted on the bones by tilting the angle of the rasp or the scraper. Both bony walls can be sculpted until the inner cortical layer is observed by a change in the shade of bone color to red. When the bone changes to this color, the rhinosculpture is stopped.

Sculpting the Central Bony Dorsum (Bony Dorsal Platform)

The next step is a very delicate partial or complete removal of the bony cap, which is performed with the use of piezo scraper heads and rasps. The wider the hump, the more lateral the extent of the bone removal. Bone is removed until the cephalic profile (the area above the caudal end of the nasal bones) fits the desired postoperative profile. Whatever the instrument used, an open roof never occurs because the underlying cartilages and mucosa are unharmed by the piezoelectric device (Figure 2B). Preservation of the cephalic portion of the ULC allows it to be utilized for cartilage modification.

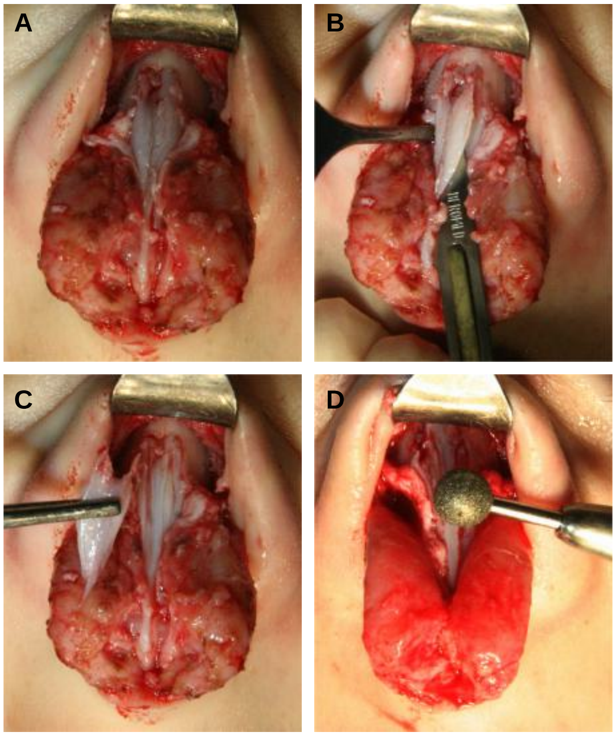

Figure 3. A 28-year-old female patient with ULC shoulder shaving. (A) The ULC shoulders protrude upward after removal of the bony cap. (B) Shaving the ULC shoulders and dorsal septum with a No. 11 blade without opening the mucosa and keeping intact the W-point. (C) View of the shaved middle third surface. (D) Smoothing the shaved surface and keystone with a diamond burr. ULC, upper lateral cartilage.

Osteotomies

If excessive width of the bony pyramid persists or asymmetry of the lateral walls occurs, then osteotomies are considered and performed unilaterally or bilaterally if necessary. We use a sequential approach for osteotomies.[1] In this way, osteotomies are performed with ultrasonic PIEs, and in the vast majority of cases a bony bridge is left cephalically at the junction of the medial and lateral osteotomies, which ensures maximal stability of the entire nasal pyramid (Figure 2C). Wedges of cartilage or bone can be used in the lateral osteotomy sites to increase lateral stability.

Cartilage Modification

For this particular subset of patients, the main complaints include a small dorsal hump in profile view as well as a wide and asymmetric middle third of the dorsum in anterior view. To solve these problems after bony modification, we used ULC shoulder shaving or partial incision of the ULCs along the septum, or both. If this was not enough, we used submucosal spreader grafts, more often unilateral,

Video. Watch now at http://academic.oup.com/asj/article-lookup/doi/10.1093/asj/sjae148

to eliminate the visible concavity of the ULCs as described by the senior author.[9]

ULC Shoulder Shaving

After removal of the bony cap the ULC shoulders protrude upward, recreating a hump or causing irregularities in thin-skinned patients.[6] To remove this cartilaginous hump, we perform a hydrodissection and shave the ULC shoulders and dorsal septum very precisely with a No. 11 blade or by electrocautery (Colorado needle), without opening the mucosa and keeping intact the W-point. (Figure 3). In the vast majority of cases, the thickness of cartilage in the area of the shoulders allows us to remove only their external part including the internal perichondrium, which together with intact mucosa and W-point preservation supports and prevents deformity of the ULCs. This preserves their original width and shape. The next step is to smooth the shaved surface and keystone with a diamond burr or electrocautery, which allows us to remove even very small irregularities on the cartilage surface and make the transition from the bony to the cartilaginous part into one smooth line (Video). Sometimes, to create a better contour we place one or more 6-0 PDS sutures to close the small cartilaginous defects, but in most cases this was not necessary.

Partial Incision of the ULCs Along the Septum

In cases with a wide hump and/or flat dorsum with an asymmetric middle vault, it was often unnecessary to lower the dorsal projection. In such cases, partial incision of the ULCs along the septum without opening the mucosa and keeping intact the W-point was performed using a No. 11 blade. In this case, the removed section of the ULCs usually did not exceed 20 to 25 mm in length and 2 mm in width (Figure 4). In cases of asymmetry, this maneuver was unilateral or asymmetric. We then placed 6-0 PDS sutures to close the small cartilaginous defect. This was usually sufficient to reduce the lateral hump and the width of the middle

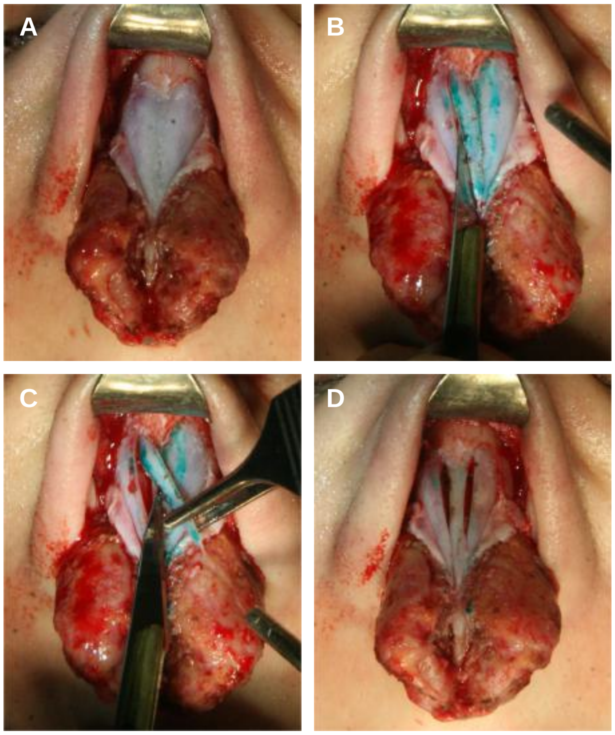

Figure 4. A 36-year-old female patient with partial incision of the ULC along the septum. (A) The wide cartilaginous middle third after removal of the bony cap. (B) Partial incision of the ULC along the septum without opening the mucosa and keeping the W-point intact was performed. (C) The removed section of the ULC did not exceed 20 mm in length and 2 mm in width. (D) View on the middle third surface after removal sections of cartilage. ULC, upper lateral cartilage.

vault on one or both sides especially with osteotomies because the ULCs follow the bone.

In cases with visible concavity of the ULCs after bony and cartilage modification, we used submucosal spreader grafts that are positioned under the mucosa in a tunnel along the superior aspect of the septum, most often unilaterally.[13] In all other cases spreader grafts were not used.

In cases with low radix we placed segmental diced cartilage-fascia (DC-F) grafts for radix augmentation.[14] The use of such a graft, well fixed on the dorsum, made it possible not only to augment the radix, but also highlighted dorsal aesthetic lines. Elevation of the radix also decreases the prominence of the hump, which enabled us to remove less bone and cartilage tissue from the dorsal surface in such cases.

RESULTS

This study was conducted over 41 months from October 2020 to March 2024. All patients underwent bony modification followed by cartilage modification. As shown in Table 1, of the 147 patients who underwent bony modification, 44 underwent rhinosculpture only and 103 underwent rhinosculpture plus osteotomies. Of the 147 patients who underwent cartilage modification, 133 underwent ULC shaving and 14 underwent partial incision of the ULCs along the septum. The age of the patients varied from 16 to 62 years (average, 38 years); 143 of the patients were women and 4 were men. The average postoperative follow-up period was 27 months (range, 12-41 months). Patients were seen for follow-up at 1 week, 2 weeks, 1 month, 3 months, 6 months, and 1 year, 2 years, and 3 to 3.5 years after surgery.

For patients who received ULC shaving, rhinosculpture without osteotomies was performed in 38 of 133 patients, and rhinosculpture plus osteotomies was performed in 95 of 133 patients; the bony cap was partially removed in 133 of 133 patients to align the bony profile and to modify the bony pyramid. Twelve patients with visible concavity of the ULCs after cartilage modification had submucosal spreader grafts, 8 from which were placed unilaterally. Thirty patients had radix grafts of segmental DC-F to maintain an ideal radix position. No patients required revision surgery of their dorsum. One patient with very thin skin had small irregularities on the central dorsum but did not request revision surgery. Two patients had small residual concavities of the ULCs but did not request revision surgery.

For patients who received partial incision of the ULCs along the septum, rhinosculpture without osteotomies was performed in 6 of 14 patients and rhinosculpture plus osteotomies was performed in 8 of 14 patients; the bony cap was partially removed in 11 of 14 patients to align the bony profile and to modify the bony pyramid. Two patients with visible concavity of the ULCs after cartilage modification had submucosal spreader grafts, both of which were placed unilaterally. Four patients had radix grafts of segmental DC-F to maintain an ideal radix position. No patients required revision surgery of their dorsum.

Subjective Aesthetic and Functional Outcome Analyses With SCHNOS

Preoperatively, the mean SCHNOS-O score for nose obstruction was 1.37. Postoperatively, the mean score significantly improved to 0.41. Nose breathing during exercise showed a significant improvement from 1.44 preoperatively to 0.26 postoperatively. After analysis of mean score before and after rhinoplasty (from 1.40 to 0.26), we note that nasal congestion has been reduced. Nose breathing during sleep was also improved. The mean score dropped from 1.52 preoperatively to 0.25 postoperatively.

Mood and self-esteem due to the patient's nose was improved 12 months after rhinoplasty. The mean SCHNOS-C score fell from 2.58 to 0.25. Nasal tip shape was significantly enhanced according to the patients; the mean score was 3.13 preoperatively and 0.30 postoperatively. Nose

Table 1. Numbers of Patients Who Underwent Bony and Cartilage Modification

		Cartilage modification		Dorsal modification (bony + ULC)
		ULC shoulder shaving	Partial incision of the ULCs along the septum	
Bony modification	Rhinosculpture	38	6	44
	Rhinosculpture plus partial osteotomies	95	8	103
All cases		133	14	147

ULC, upper lateral cartilage.

Table 2. Mean SCHNOS Scores Before and After Rhinoplasty (n = 147)

	Mean score before rhinoplasty	Mean score after rhinoplasty (at 12 months)
SCHNOS-O		
1. Having a blocked or obstructed Nose	1.37	0.41
2. Getting air through my nose during exercise	1.44	0.26
3. Having a congested nose	1.40	0.26
4. Breathing through my nose during sleep	1.52	0.25
SCHNOS-C		
5. Decreased mood and self-esteem due to my nose	2.58	0.25
6. The shape of my nasal tip	3.13	0.30
7. The straightness of my nose	3.04	0.34
8. The shape of my nose from the side	3.50	0.29
9. How well my nose suits my face	3.06	0.37
10. The overall symmetry of my nose	3.02	0.22

SCHNOS, Standardized Cosmesis and Health Nasal Outcomes Survey (O, nasal obstruction; C, cosmesis).

straightness was ameliorated; the mean score dropped from 3.04 preoperatively to 0.34 postoperatively. Nose profile was improved substantially from 3.50 preoperatively to 0.29 postoperatively. Harmony between the nose and the face was better 12 months after rhinoplasty; the mean score fell from 3.06 to 0.37. Finally, patients reported an improvement in the overall symmetry of their nose from 3.02 to 0.22 (Table 2).

The mean [SD] preoperative SCHNOS score was 24 [9.1], SCHNOS-O was 5.7 [5.3], and SCHNOS-C was 18.2 [6.6]. At 12 months postoperatively, the SCHNOS score was 3 [2], SCHNOS-O was 1.2 [1.3], and SCHNOS-C was 1.8 [1.3]. Preoperatively, the mean SCHNOS-O and SCHNOS-C scores were 5.7 [5.3] and 18.2 [6.6], respectively. Postoperatively, the scores significantly improved to 1.2 [1.3] and 1.8 [1.3], respectively (Table 3).

The mean difference in scores at 12 months postoperatively (compared with the preoperative condition) for SCHNOS, SCHNOS-O, and SCHNOS-C was −20.9 [8.9] (large), −4.5 [4.9] (large), and −16.4 [6.5] (large), respectively (Table 4).

The mean score changes at 12 months postoperatively compared to preoperative scores were statistically significant. The positive impact on both aesthetic and functional outcomes for our patients is also demonstrated by a Cohen's *d* effect size greater than 0.8. Cohen's *d* scores were 3.1, 1.1, and 3.4 for SCHNOS, SCHNOS-O, and SCHNOS-C, respectively. According to the SCHNOS scores, patient satisfaction appears to be closely linked to stable surgical outcomes. We presume that nose breathing without or during exercise, nasal congestion, or nose breathing during sleep did not get worse due to the dorsal surface modifications and obviously improved due to the tipplasty.

Table 3. Preoperative and 12 Months Postoperative Mean Scores for SCHNOS, SCHNOS-O, and SCHNOS-C

Preoperative			12-month postoperative		
SCHNOS	SCHNOS-O	SCHNOS-C	SCHNOS	SCHNOS-O	SCHNOS-C
24 [9.1]	5.7 [5.3]	18.2 [6.6]	3 [2]	1.2 [1.3]	1.8 [1.3]

Values are mean [standard deviation]. SCHNOS, Standardized Cosmesis and Health Nasal Outcomes Survey (O, nasal obstruction; C, cosmesis).

Table 4. Mean Changes in SCHNOS, SCHNOS-O, and SCHNOS-C Scores at 12 Months Postoperatively

Δ 0-12 months		
SCHNOS	SCHNOS-O	SCHNOS-C
−20.9 [8.9] (large)	−4.5[4.9] (large)	−16.4 [6.5] (large)

Values are mean [standard deviation]. SCHNOS, Standardized Cosmesis and Health Nasal Outcomes Survey (O, nasal obstruction; C, cosmesis).

Case Examples

Figure 5 shows a 42-year-old female patient who presented for a primary rhinoplasty. She complained of having an asymmetric dorsum, a hump on oblique view, plus an asymmetric, underprojected tip. Through an open approach, the skin and soft tissue envelope was elevated. A full subperiosteal dissection of the bony vault was then done, and ultrasonic rhinosculpture was performed on both sides of the bony pyramid. Bony thickness and all bony irregularities were removed from the lateral parts on both sides and the bony cap was removed from the central part of the bony pyramid with a Piezotome. There were no osteotomies. Partial incision of the ULCs along the septum without opening the mucosa and keeping the W-point intact was performed using a No. 11 blade. A 1-mm-wide section of ULC was resected on the right side and a 2-mm-wide section of ULC was resected on the left side along the septum. No sutures, spreader grafts, or flaps were used in the middle third. A septal extension graft was fixed between small bony grafts caudally. Tip modification was achieved with lateral crura transposition plus lateral crura strut grafts and tip sutures.

Figure 6 depicts a 28-year-old female patient who presented for a primary rhinoplasty. She complained of having a wide, deviated dorsum with a hump as well as an asymmetric overdroopy tip with hanging columella and tension nasolabial angle. Through an open approach, the skin and soft tissue envelope was elevated. Ultrasonic rhinosculpture of both sides of the bony pyramid was then performed. The bony cap was removed with a piezo rasp and the cartilaginous vault was exposed cephalically for approximately 5 mm. Then, a low-to-low lateral osteotomy was performed in combination with partial length transverse and paramedial osteotomies with intact bony bridges on both sides. Protruded ULC shoulders and dorsal septum were shaved with a No. 11 blade without opening the mucosa and keeping the W-point intact. The shaved surface and keystone were smoothed with a diamond burr. No sutures, spreader grafts, or flaps were used in the middle third. A septal extension graft was fixed between small cartilaginous grafts caudally. The medial crura were fixed to the septal extension graft more cranially and posteriorly to treat the hanging columella and tension nasolabial angle. Tip modification was achieved with lateral crura transposition plus lateral crura strut grafts and tip sutures.

Figure 7 illustrates a 22-year-old Hispanic male who presented with an S-shaped kyphotic dorsal hump, a slightly deviated nose, and a bulbous and underprojected, plunging tip on smiling. An open approach was used to augment the tip and gain access to the kyphotic nasal bones which required significant remodeling. Dorsal modification of the nasal bony cap and ULCs was performed with piezoelectric rhinosculpture and electrocautery sculpting of the cartilaginous vault. Asymmetric piezoelectric osteotomies were performed, including bilateral low to low, a left medial oblique, and right transverse to straighten the bony pyramid. A septoplasty was performed to relocate the deviated septum. No cephalic trim was performed, and a lateral crural steal of 2.5 mm was performed bilaterally. The tip was supported in a tongue-in-groove manner on the caudal septum. The vertical scroll ligaments were reattached at the end of the case to close the dead space, and Pitanguy's ligament was also reattached.

DISCUSSION

The following 4 areas warrant in-depth discussion: (1) dorsal modification—an independent philosophy for a subset of patients; (2) choice of technique for hump reduction and dorsal improvement; (3) avoiding technical problems; and (4) indications/contraindications.

Dorsal Modification—An Independent Philosophy for a Subset of Patients

In rhinoplasty, there is no universal technique and it is clear that certain patients benefit from preservation, certain patients benefit from structure, and certain patients benefit from a hybrid approach.[7,15] Theoretically, one technique

Figure 5. In an open rhinoplasty approach performed on a 42-year-old female patient, subperiosteal dissection of the bony vault and ultrasonic rhinosculpture on both sides of the bony pyramid were performed. Bony thickness and all bony irregularities were

(continued)

Figure 5. (Continued)
removed from the lateral parts on both sides, and the bony cap was removed from central part of the bony pyramid. Partial incision of the ULC along the septum without opening the mucosa and keeping the W-point intact was performed. A 1-mm-wide section of ULC was resected on the right side and 2-mm-wide section of ULC was resected on the left side along the septum. A septal extension graft was fixed between small bony grafts caudally. Tip modification was achieved with lateral crura transposition plus lateral crura strut grafts and tip sutures. (A, C, E, G, I, K, M) Preoperative images. (B, D, F, H, J, L, N) Postoperative images showing the results after 17 months. ULC, upper lateral cartilage.

could be used in all patients, but this is not always the best, easiest, and/or safest approach.

Dorsal modification as a separate philosophy is also a hybrid approach, but remains very conservative, fast, and reliable. This reliability is strengthened by the finding that no patients in this subset required a dorsal revision. Although not studied directly here, the senior author has also never had to revise a dorsum where dorsal modification was done as a separate philosophy. In cases where there is no need to significantly change dorsal dimensions (height and width), dorsal modification improves the dorsum as quickly and efficiently without significant structural resection and no reconstruction, while maintaining stability and maximum predictability.

Dorsal reconstruction and preservation techniques have different philosophies regarding the stability of the new dorsum. In dorsal reconstruction the predictability of the result is ensured by an even and well-fixed nasal septum (the central support, which is also the foundation of the future bridge of the nose) and mobile side walls of the nose. Thus, the lateral walls of the bony pyramid are mobilized and displaced by osteotomies (lateral, transverse, medial) to close the open roof after removal of the hump during resection and reconstruction of the dorsum. The final result, and its longevity, is based on how well the septum is strengthened, and how good is the final reconstruction including osteotomies and middle vault reconstruction.[16] Dorsal preservation techniques are inherently very different, because the nasal dorsum is separated by septal strip removal from the underlying septum. Unlike in dorsal reconstruction, the dorsum no longer depends on foundational issues. In an impaction procedure, the osseocartilaginous vault must be fully mobile by lateral, transverse, and radix osteotomies, so that it is possible to make impaction of the bony vault downward into or toward the pyriform aperture.[17] With surface procedures, the bony cap is modified or removed, and only the central platform is lowered with or without formal osteotomies. The final result depends on the aesthetics of the original dorsum and the fixation in its new position. The aesthetics are unlikely to change with time because no reconstruction of the dorsum has been performed and the underlying septal tension has been released.

The main elements of dorsal modification were first described by the senior author (A.K.) as follows: (1) incremental modification and ostectomy of the bony cap, including the lateral keystone area, to convert the bony dorsum to cartilage; (2) shaving the ULC shoulders and dorsal septum without opening the mucosa; (3) piezoelectric rhinosculpture and osteotomies to narrow and sculpt the bony pyramid; and (4) closing any cartilage defect over the underlying mucosa and shaping the ULCs.[5] These elements, in our opinion, make dorsal modification a separate philosophy, because shaving the ULC shoulders and dorsal septum even without opening the mucosa results in partial disruption of the cartilaginous dorsal platform and partial opening of the middle vault, but according to most authors, dorsal preservation may be any technique of dorsal dehumping that does not open the cartilaginous middle vault.[15,17] In contrast, reductive dehumping typically involves opening the middle vault, which requires reconstruction with sutures, grafts, or flaps. Reconstruction is never required in dorsal modification because there is no complete opening of the cartilaginous middle vault, which remains stable because of the intact mucosa and W-point. No grafts or flaps are required for reconstruction and, very importantly, the tension of the ULCs remains. As soon as the ULC is divided from the dorsal septum, the cartilage retracts caudally and tension is lost in the dorsum. By maintaining this tension, the dorsum remains stable.

When dorsal modification is used as an independent procedure, the philosophy is inherently separate from dorsal reconstruction and preservation techniques. Stable and well-fixed lateral bony walls, as well as tensioned ULCs that are not taken apart, make the underlying septal foundation issues less relevant. In addition, preserving structures of the dorsum and maintaining the stability of the side walls allows for maximum predictability of the result. Thus, dorsal modification, in our opinion, when performed as a stand-alone procedure, is a separate philosophy that differs from dorsal preservation and reconstruction concepts. It allows for reshaping of the dorsum as in structural rhinoplasty, but also allows for preservation of the important structures while decreasing the reliance of an absolutely straight septum that is required in dorsal structural rhinoplasty.

Choice of Technique for Hump Reduction and Dorsal Improvement

Many well-known surgeons who perform dorsal preservation note that final reshaping by osteoplasty with burrs or PEIs is often required.[3,8,12] This raises the question: if it is necessary to perform dorsal modification as an additional procedure

Figure 6. This 28-year-old female patient underwent an open rhinoplasty, including ultrasonic rhinosculpture of both sides of the bony pyramid. The bony cap was removed and 5 mm of the cartilaginous vault was exposed. Then, a low-to-low lateral osteotomy was performed in combination with partial length transverse and paramedial osteotomies with intact bony bridges on both sides. (A, C, E, G, I, K) Preoperative images. (B, D, F, H, J, L) Postoperative images showing the results at 15 months.

with dorsal preservation, for example, when reducing S-shaped nasal bones where the hump is ≤3 mm and/or treating a wide and asymmetric middle vault, can this be achieved with dorsal modification as a separate technique only, which is faster and also gives good results? In suitable patients, it is possible to perform only dorsal modification by sculpting the bones and cartilages while maintaining the stability of the bony pyramid, mucosa, and W-point. In such cases, where there is no need to significantly change dorsal dimensions (height and width), our approach used to be to reduce hump height up to 3 mm, especially in patients with S-shaped nasal bones, low radix, low supratip, lateral hump, wide and asymmetric middle vault, etc. This avoids the problems and complications associated with excessive lateral wall mobilization,

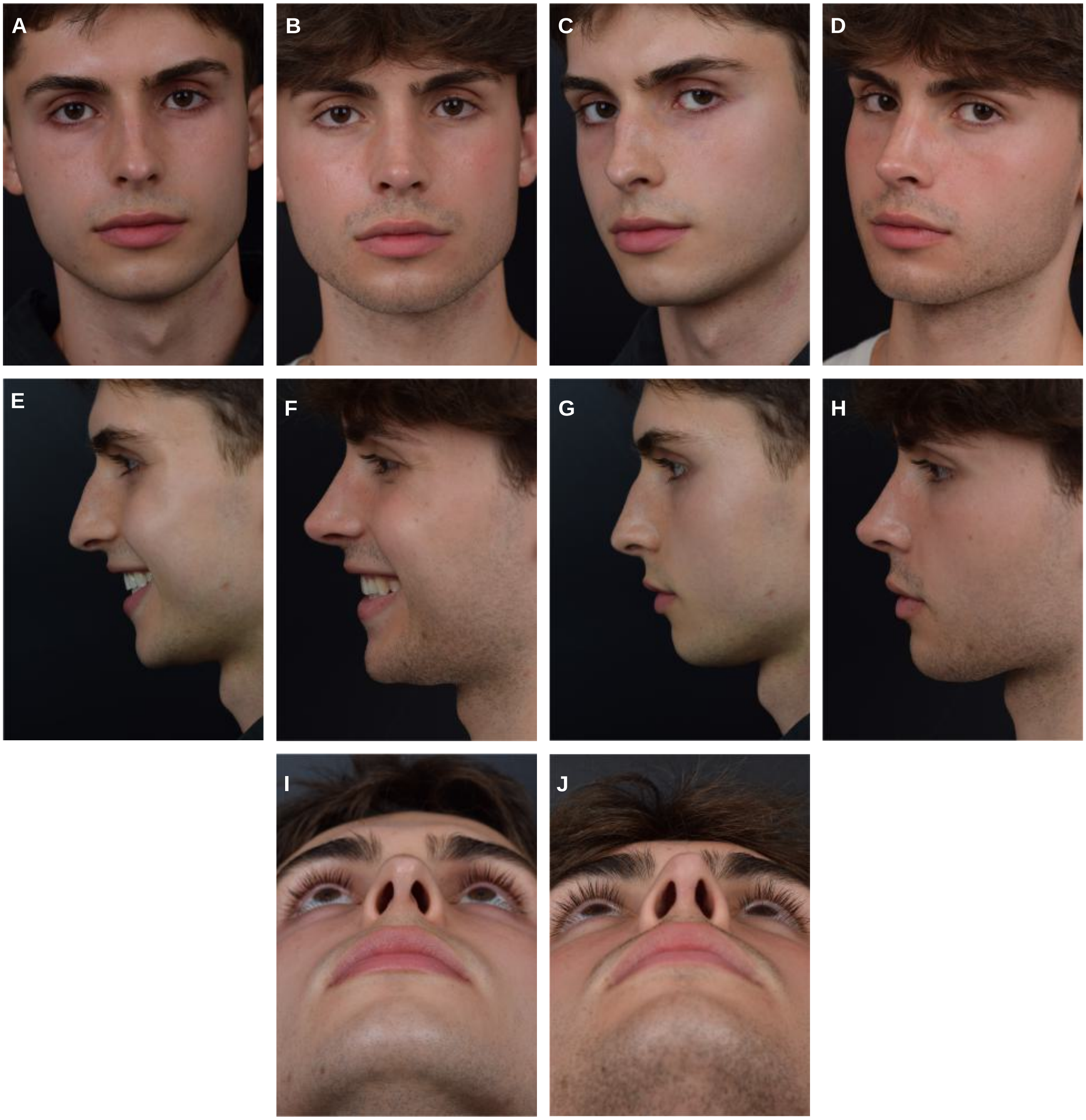

Figure 7. An open rhinoplasty approach was used on this 22-year-old male patient to augment the tip and gain access to the kyphotic nasal bones. Dorsal modification of the nasal bony cap and upper lateral cartilages was performed with piezoelectric rhinosculpture and electrocautery sculpting of the cartilaginous vault. Asymmetric piezoelectric osteotomies were performed including bilateral low-to-low, a left medial oblique, and right transverse to straighten the bony pyramid. A septoplasty was performed to relocate the deviated septum. No cephalic trim was performed, and a lateral crural steal was performed 2.5 mm bilaterally. The tip was supported in a tongue-in-groove manner on the caudal septum. The vertical scroll ligaments were reattached at the end of the case to close the dead space, and Pitanguy's ligament was also reattached. (A, C, E, G, I) Preoperative images. (B, D, F, H, J) Postoperative images showing the results at 12 months.

preserves perioperative structural stability, and ensures long-term nasal symmetry. A number of authors have noted in their papers that a more conservative approach often produces more predictable results and significantly reduces the number of their own revisions.[18,19] Each individual surgeon will apply this technique depending on his/her patient population.

Having performed dorsal modification in more than 50% of primary rhinoplasties during the last 3.5 years, the primary author has encountered a significant reduction in his own revisions on the dorsum, and we attribute this to our frequent use of the dorsal modification technique. Of course, other techniques for the dorsum are used when necessary to significantly change dorsal dimensions (height and width), in particular dorsal preservation with a hump >3 mm, or in case of a significant lowering of the dorsal projection >3 mm, or in the presence of a severe dorsal deviation, especially axial, which in our opinion is well treated by the asymmetric let-down technique. We also perform dorsal reconstruction for patients with significantly crooked dorsum (posttraumatic) and in almost all cases of secondary rhinoplasty. And in many of these cases, we had to use the dorsal modification technique, not as a separate procedure, but as an addition to other techniques to achieve better results.

Avoiding Technical Problems

Dorsal and surface modifications (bony cap removal, rasping, trimming upper lateral cartilages, etc) have been well known for many years and have been repeatedly described as additional procedures of existing techniques.[4-8] However, the use of dorsal modification as a separate technique is a new approach.[5]

The critical feature of dorsal modification is the preservation and competence of the internal valve with the absence of irregularities or discontinuity of the dorsum. Normal functioning of the internal valve is achieved by maintaining the stability of the entire nasal pyramid without excessive mobility, with 2 points of tight fixation of the ULCs. This fixation is both cranial in the keystone area and caudal at the W-point. This tension and the intact mucosa prevent displacement inward and obviate the need for expanding flaps or grafts. Therefore, it is important to avoid excessive mobilization of the bony pyramid when performing bony modification by utilizing a sequential approach, first performing rhinosculpture and partial bony cap reduction, and then, if necessary, performing osteotomies, leaving bone bridges to ensure the stability of the cranial point (keystone).[1] It is equally important to maintain stable fixation of the ULCs at the caudal point (W-point). If a small reduction of the dorsum at this W-point is necessary, then after shaving it should be restored by fixing the ULCs to the septum with a mattress suture without dissection of the mucosa.

To keep the mucosa intact, hydrodissection between the ULCs and the mucosa should be performed before starting cartilage modification, and when shaving the shoulders and septum or performing partial incision of ULC, always shave very little at first and then remove more step by step, controlling the depth of removal.

To avoid small irregularities or discontinuity, especially in the keystone area, after bony modification and cartilage shaving or partial incision of ULC along the septum we use a diamond burr, which smooths the transition of the bony pyramid to cartilage and enables us to achieve excellent results without camouflage on the dorsum.

Indications and Contraindications

The primary indications for dorsal modification are primary rhinoplasty cases where there is no need to significantly change dorsal dimensions (height and width), when the bony vault has excessive width, and when a dorsal reduction <3 mm is indicated. The contraindications are cases in which it is necessary to significantly change dorsal dimensions (height and width), and when the bony vault has a severe excessive width and a dorsal reduction >3 mm is indicated, and cases with severe dorsal deviation, a significantly crooked dorsum (posttraumatic) dorsum, and secondary rhinoplasty cases.

Limitations

The primary limitation of this study is not the number of patients (147 cases) but rather the limited follow-up time of 41 months; however, the conclusions reached in this paper have been confirmed in subsequent months following termination of the study. Another limitation of this study is its retrospective nature. A specific limitation of the method is the lack of access to PEIs and electric burrs.

CONCLUSIONS

Dorsal modification is a separate philosophy in rhinoplasty, and can be considered as the first choice of technique when the surgeon needs to perform minor changes in the dorsal region. Because this procedure is quick, simple, and superficial, while keeping all structures stable and well fixed to each other, it is reliable. By not requiring mobilization of the entire nasal pyramid and the use of spreader flaps and grafts in most cases, the long-term stability of the dorsum is maintained. Using dorsal modification for a dorsum with a small hump, mild excessive width, and when a dorsal reduction of <3 mm is required avoids the problems and complications associated with excessive lateral wall or ULC mobilization, preserves perioperative structural stability, and ensures long-term nasal symmetry. At the same time, the use of dorsal modification as an additional procedure remains not just desirable but necessary in many cases when performing both dorsal preservation and dorsal reconstruction.

Supplemental Material

This article contains supplemental material located online at www.aestheticsurgeryjournal.com.

Disclosures

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Dorsal Preservation Rhinoplasty: Core Beam Computed Tomography Analysis of the Nasal Vault, Septum, and Skull Base—Its Role in Surgical Planning

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Abstract

Dorsal preservation rhinoplasty in cases of a convex or overprojected noses has significant advantages over resection and reconstruction of the dorsum. Analysis of the subdorsal septum in relation to the radix osteotomy to achieve a drop or hinge of the natural dorsum is important in avoiding possible complications involving the skull base, frontal sinus, and subsequent radix position. In the majority of patients, simple cut release of the perpendicular plate rather than resection superiorly may be necessary where the quadrangular cartilage junction with the perpendicular plate is caudal to the radix osteotomy. Computed tomography is helpful in delineating this position as well as providing information on the frontal sinus and position of the cribriform plate prerhinoplasty.

Keywords

- rhinoplasty
- dorsal preservation
- nasal septum
- computed tomography

Dorsal preservation (DP) has many advantages in primary rhinoplasty. This preserves the patient's natural dorsum including at least part of the bone cap and the continuity of the cartilaginous vault, thereby minimizing the risks associated with monobloc hump reduction, consequent middle third collapse, and airway dysfunction. The operation is cartilage sparing, meaning less need for septal grafts.

DP invariably involves a reduction in the height of the nasal septum, either cartilaginous or bony or both. In both high-strip and low-strip septal reduction, a release has to be made underneath the dorsal vault. The lateral bony pyramid is released from the maxilla and this is combined with transverse and radix cuts to free the osseocartilaginous vault as a whole.

Alternatively, the bony cap can be removed and the cartilaginous vault pushed down combining with faded paramedian and lateral osteotomies to medialize the bony walls.

Complete DP consists of two principle techniques: the dorsal push down (PDO) and the let down (LDO). The main difference between the two is that a PDO requires a lateral osteotomy of the bony vault with the base of the nasal pyramid medialized and pushed inside the bony pyriform aperture, whereas the LDO involves an ostectomy—a segment of bone is removed from the ascending process of the maxilla and the lateral vault rests on the cut surface of the maxilla bone rather than inside it. Common with all DP techniques is a subdorsal septal excision. This involves the cartilaginous septum and in some cases a strip of the perpendicular plate of the ethmoid (PPE). These maneuvers can prove hazardous particularly with regard to fracture propagation into the cribriform plate and ultimately a cerebrospinal fluid leak.

An important point to realize is that with DP, the more cartilaginous the bridge, the easier it is to flex and to push or let down.

One difficult area to control is the radix—in many instances the question that needs to be asked is should the radix be dropped down toward the face or maintained with a hinge effect created to lower the more caudal dorsum leaving the radix height. Excessive resection under the radix potentially will allow the dorsum to drop, resulting in infantilization of the nose with an excessively low radix and a step deformity.

Understanding the anatomy of the subdorsal septum is therefore crucial, in particular, the position of the quadrangular cartilage/perpendicular plate junction. Where the radix needs to be preserved, it is postulated that perpendicular plate resection is not required, but merely a cut to release it.

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It is important therefore to understand the structures that make up the bone of the nasion and bone cap.

The aim of this study was to analyze computed tomography (CT) images of the midline bony vault and the anatomical relations of the dorsal septum and key structures of the anterior cranial base.

Methods

Patients who had cone beam CT (CBCT) studies with 1-mm slices performed either for preoperative planning for rhinoplasty or for other pathology were identified from electronic patient records (EPRs). The images were exported for analysis using a commercially available triplanar DICOM reader software (Cavendish Imaging) and the following measurements were taken.

The anatomical points were identified on each image:

- Radix: the soft tissue center-point of transition from the glabella to the nasal dorsum (the nasion is the deepest bony depression at the root of the nose corresponding to the nasofrontal suture).
- Nasal bone/frontal spine at the radix.
- Antero-caudal frontal sinus: the most anterior and caudal point of the frontal sinus.
- point: the most anterior part of the cribriform plate.
- J point: the junction between the PPE and the quadrangular cartilage at its most cranial aspect.

The coronal plane view of each image was inspected to identify the midline using a vertical marker. The corresponding sagittal image was then used to view and a vertical line drawn mimicking the transverse radix osteotomy plane (TROP; ►**Fig. 1**). From the TROP the following measurements were taken (a positive value indicating that the point is in front of the TROP and a negative value demonstrating the point is posterior to the TROP).

- Nasal bone cap thickness (nasal bone, spine of the frontal bone).
- Distance from TROP to frontal sinus.
- Distance from TROP to O point.
- Distance from TROP to E point.

All the data were exported to Excel (Microsoft) for analysis. The population as a whole was considered with regard to the aforementioned measurement. A subgroup analysis was undertaken to determine variability with age. Patients were categorized into the following groups: < 10, 10 to 15, 16 to 20, 21 to 30, 31 to 40, 41 to 50, 51 to 60, and > 60 years. The narrower age groups within the pediatric population were chosen as growth is accelerated during this period, and hence we hypothesized that larger differences may occur during skeletal maturity.

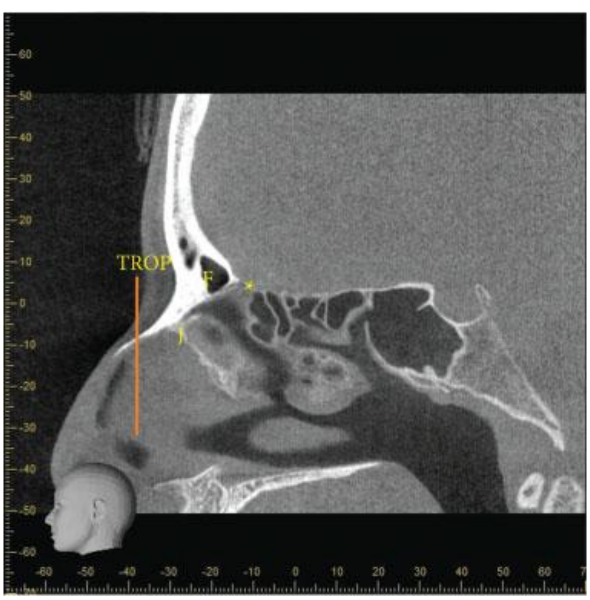

Fig. 1 The “J” point, the radix line (in orange; TROP), and the frontal sinus (F). The star marks the cribriform plate.

Results

A total of 89 patients were identified from the EPR. Sixty-four CBCT image series were available that demonstrated the entirety of the anatomical region of interest. The mean age of the patients was 33.5 years (range: 2–62 years). The study cohort was evenly split with regard to gender (51.5% female, 48.5% male).

Nasal Bone Thickness

Across the entire cohort, the mean nasal bone thickness was 2.59 mm (range: 0.8–4.56 mm). Dependent on the length of the spine of the frontal bone, there was considerable variation in the thickness of bone at the osteotomy point; in some patients there was only the thin nasal bone, in others the spine contributed to the width. A subanalysis of the mean nasal bone thickness according to age categories demonstrated no correlation with age (►**Fig. 2**).

Distance from TROP to Frontal Sinus

The mean distance from the TROP to the frontal sinus was 13.58 mm (range: 7.7–21.2 mm) across the entire cohort. A subanalysis according to age is shown in ►**Fig. 3**.

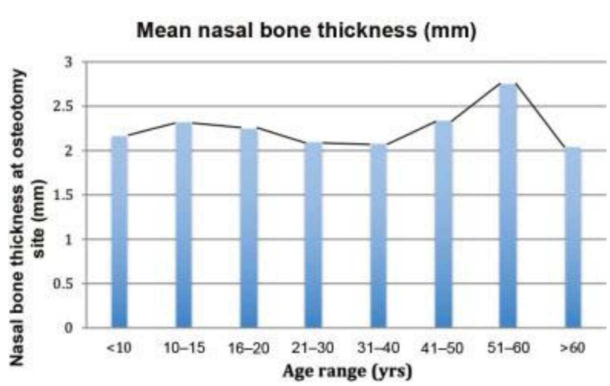

Fig. 2 Mean nasal bone thickness at the site of transverse radix osteotomy across different age categories.

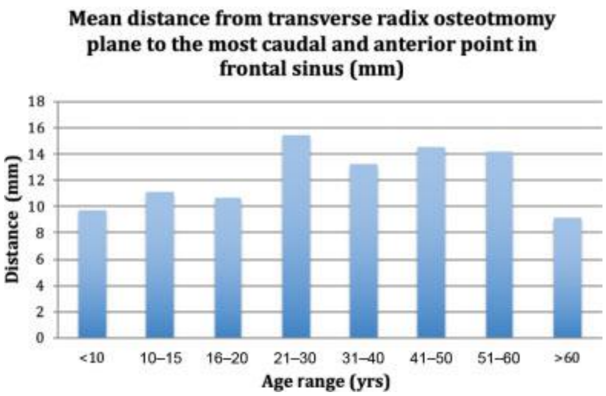

Fig. 3 Mean distance from the transverse nasal osteotomy plane to frontal sinus across different age categories.

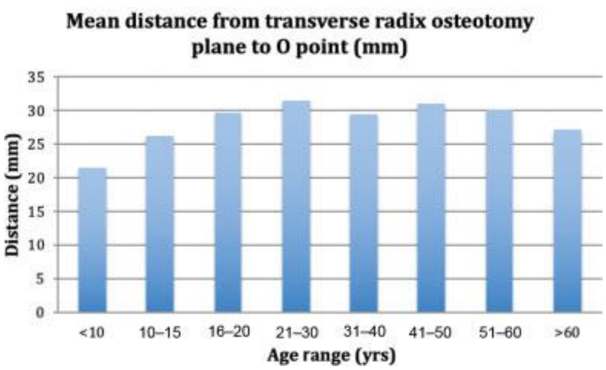

Fig. 4 Mean distance from the transverse nasal osteotomy plane to the O point across different age categories.

Distance from TROP to O Point

The mean distance from the TROP to the O point was 28.67 mm (range: 7.7–21.2 mm) across the entire cohort. A subanalysis according to age is shown in ►**Fig. 4**.

Distance from TROP to J Point

The mean distance from the TROP to the J point was −7.25 mm (range: −19.2 to 5.22 mm) across the entire cohort. A negative value denotes that the J point is located posterior to the TROP. A positive value indicates the J point is located anterior to the TROP. There were only five adult patients for whom the J point was anterior to the TROP; in all the pediatric studies and the remainder of the adults, the junction was behind the TROP, i.e., the septum was cartilaginous below where the osteotomy would be made.

A subanalysis according to age is shown in ►**Fig. 5**

Discussion

DP rhinoplasty is a reappraisal of the structures making up the radix; a review of the biomechanics of how the movement of a preserved dorsum can change a patient's profile. In complete DP, instead of paramedian osteotomies and an infracture, there are transverse bone cuts connecting a low lateral and a transverse radix osteotomy.[1]

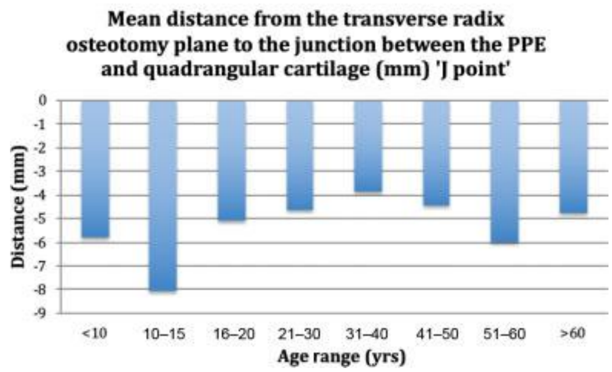

Fig. 5 Mean distance from the transverse nasal osteotomy plane to the "J point" across different age categories.

It is important to understand the anatomy at the radix. Very often three bones are present—the nasal bone which is often quite thin but is fused on top of the spine of the frontal bone (a joint called a gomphosis); underneath this there is either a cranial extension of the cartilaginous septum or the thin PPE.

The dorsal septum determines the support of a new dorsum in preservation rhinoplasty by lowering the septal height, allowing flexion at the central keystone producing a flatter bridge from a previously convex shape.

In determining the ideal profile, the surgeon has to judge where the starting point of the nose will be, whether this is adequately projected or needs to be augmented or set back.

The more subdorsal tissue that is resected particularly in the cranial part of the septum, the greater the liability of the radix to drop down, therefore deepening and lowering the starting point of the nose. This may produce a step deformity that needs a graft or a further more cranially performed

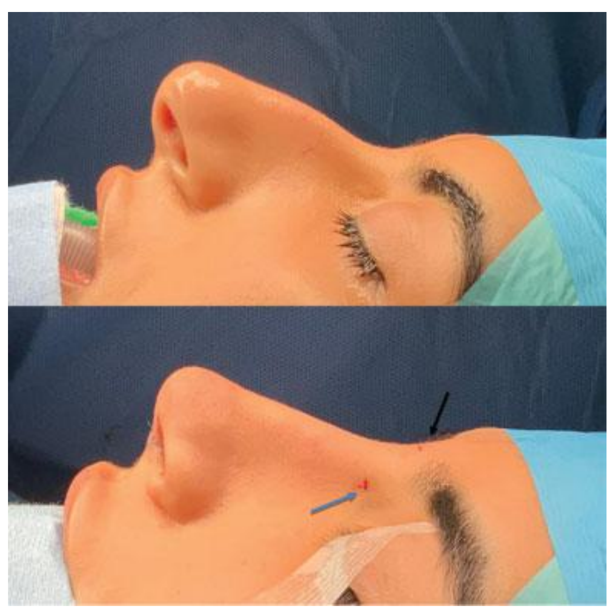

Fig. 6 In this low strip dorsal preservation, note the oblique radix cut (*black arrow*) 10 mm above the percutaneous lateral osteotomy (*blue arrow*) to allow a hinge at the radix.

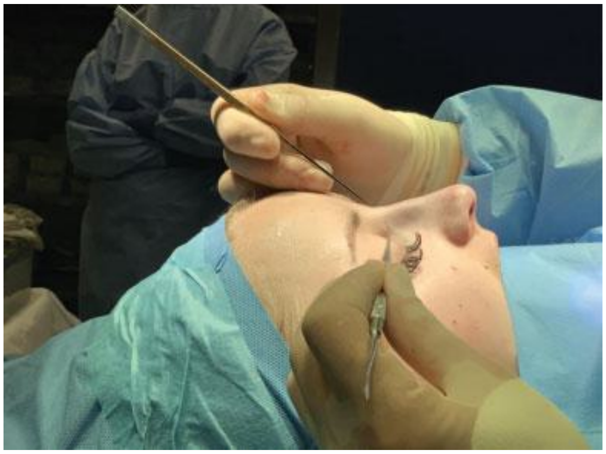

Fig. 7 An oblique cut at the radix 5–10 mm above the transverse osteotomy; this allows more of a radix "hinge."

osteotomy to produce a triangular fragment of bone that drops to fill the gap.

This anatomical study using CBCT has demonstrated several important points which should guide surgeons during DP rhinoplasty. At the site of the transverse osteotomy, the nasal bone is on average 2.59 mm. Contrary to what was previously thought, there was no significant correlation found between the nasal bone thickness and age in our study.

This is not the case for the junction between the PPE and quadrangular cartilage, denoted as the "J point."

There is frequently a tongue of cartilage extending cranially underneath the bone cap, and this junction point was seen to be on average 7.25 mm posterior to the transverse osteotomy plane. In the small number of pediatric scans studied, all of them showed extensive cartilage extension cranially, i.e., the junction point was situated much higher compared to that in the adult population. This correlates with the embryological development where the nose starts entirely as a cartilaginous capsule and then ossification extending from the skull base downwards seeming to progress with age. This has significant implications for flexion at the K area as the movement between the bone and the underlying cartilaginous vault is easier to achieve when the nasal bone is short, or the hump/bridge is entirely cartilaginous.

Therefore, in older patients with a relatively ossified nasal pyramid and septum, preservation rhinoplasty to flex the K area may not be as easily achieved and an alternative method of removing the bone first may be indicated.

In choosing whether to drop the radix or to hinge it keeping the radix position, a key determinant is the amount of subdorsal septum that needs resecting (►**Fig. 6**).

From this study, it was found that in the majority of patients it is not necessary for high resection of the perpendicular plate, but merely a simple cut to allow overlap if a hinge is required, or resection with a narrow rongeur if it is felt that the radix needs to drop.

Moreover, the position of the transverse radix osteotomy also has an important bearing on whether the radix drops

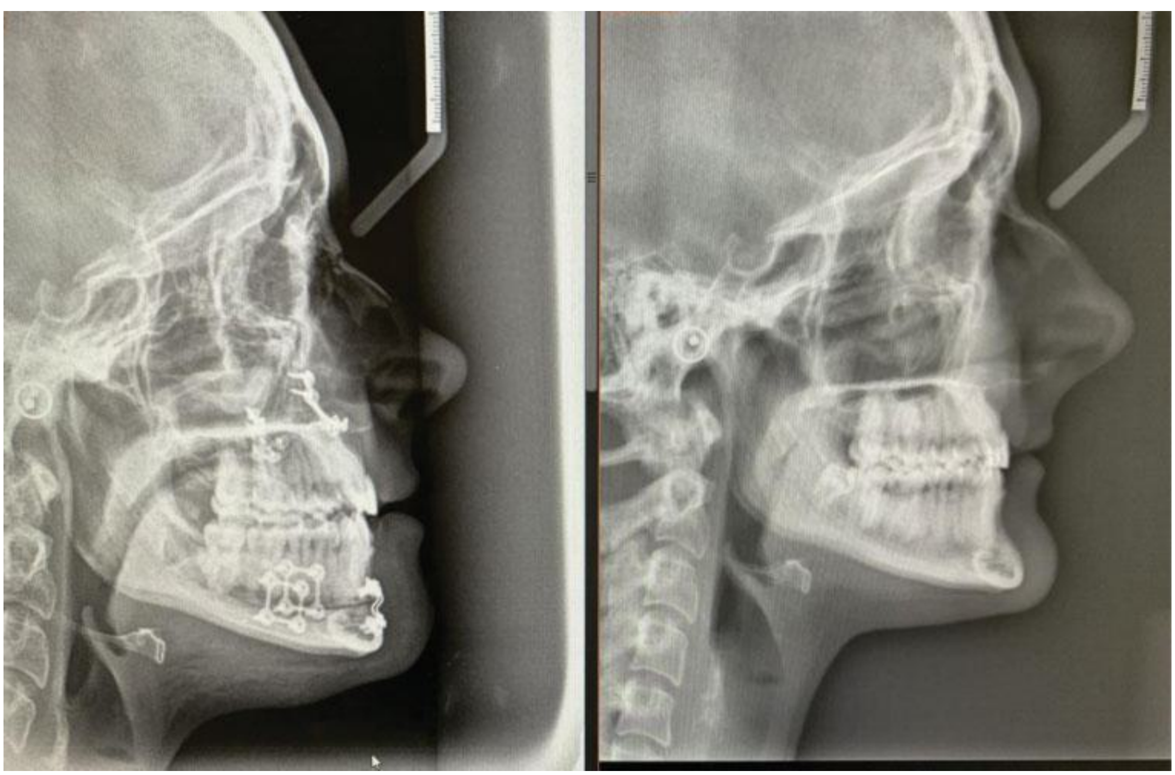

Fig. 8 The transverse radix cut is clearly seen on the left image where the perpendicular plate was resected to allow the dorsum to drop in the combined rhinoplasty and orthognathic surgery case.

Fig. 9 Radix preservation in high strip preservation rhinoplasty.

and produces a step or whether there is an oblique cut from superior to inferior allowing a slide or a hinge of bone on bone (see ►**Figs. 7–9**).

The frontal sinus is on average 13.58 mm posterior to the osteotomy plane. This distance seems to increase with skeletal maturity into the second to the fourth decade of adult life and then decreases with advancing age. This is consistent with facial bony resorption with advancing age.[2,3]

Therefore, it is unlikely for a fracture line to propagate into the sinus with a careful technique—narrow, sharp 2-mm osteotomes. When the frontal sinus does encroach into the radix, the radix is often excessively high (eagle profile; ►**Fig. 10**) and resection of the frontal wall may be necessary.

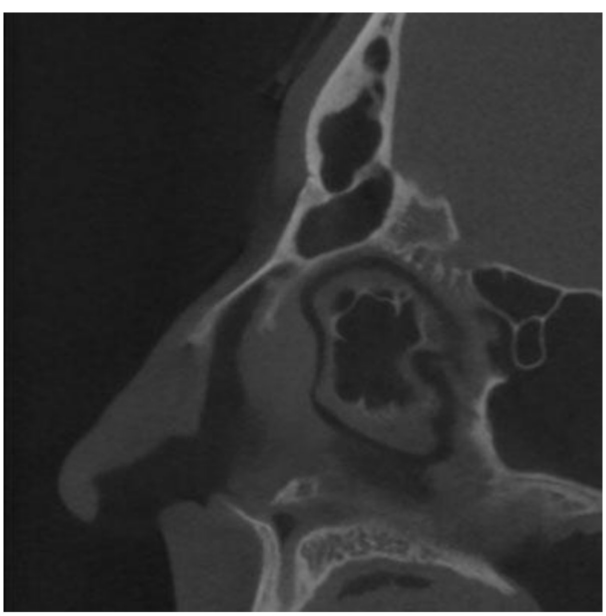

Fig. 10 Frontal sinus pneumatization into the radix.

It is important to place a small graft usually of cartilage onto the mucosal defect to prevent direct contact of the frontal sinus mucosa to nasal soft tissues.

Fracture propagation into the cribriform plate is possible during septoplasty and rhinoplasty and is a concern with manipulations of the high perpendicular plate. We defined the anterior cribriform plate as the O point. This study demonstrated that it lies a mean distance of 28.67 mm behind the transverse osteotomy plane. Again, this distance gradually increased into the second and third decades of life before decreasing, although this change was not significant (►**Fig. 4**). This finding should prove reassuring for surgeons and the clinical advice is to minimize the risk of a radiating fracture to the skull base by avoiding any twisting actions with rongeurs on the perpendicular plate. Direct cuts with narrow-bladed double action scissors, piezo, or the use of a 2-mm narrow bladed rongeur to nibble small pieces of the thin bone will reduce the risk inadvertent damage. An essential step is to release the subdorsal septum from the bony and cartilaginous vault before the transverse radix osteotomy.

CBCT is now inexpensive and readily available so we would recommend its routine use in rhinoplasty. Nowadays, nasal sidewall anatomy, pyriform aperture dimensions, and dorsal and septal anatomy are readily assessed, as well as any disease more posteriorly involving the turbinates and paranasal sinuses.

This study confirms previous cadaver reports on the anatomy of the osseocartilaginous vault.[4,5]

Conclusion

CBCT can readily elucidate the nasal dorsal, septal, and sidewall anatomy and is helpful to the surgeon in planning the most appropriate modification of the dorsum in modern rhinoplasty. The need for routine resection of the perpendicular plate in preservation rhinoplasty may not be necessary but it is advised that the dorsum is separated from the cartilage or perpendicular plate before any osteotomy to release the radix.

Conflicts of Interest
None declared.

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Editorial

The Preservation Rhinoplasty: A New Rhinoplasty Revolution

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Rollin K. Daniel, MD

Editorial Decision date: December 4, 2017.

Rhinoplasty surgery tends to evolve in generational epochs often associated with landmark publications and the simultaneous popularization of revolutionary surgical techniques. In 1978, Sheen published his monumental text *Aesthetic Rhinoplasty* which confirmed his status as the greatest rhinoplasty surgeon since Joseph.[1] Three critical concepts were summarized. First, rhinoplasty became a truly aesthetic operation which included preoperative analysis, operative planning, and surgical execution. Second, the reduction-only concept of Joseph was replaced with a balanced approach combining reduction and grafting in primary rhinoplasty. Third, the previously dismal results for secondary rhinoplasty were dramatically improved. Suddenly, the mark of a great rhinoplasty surgeon was no longer how quickly one could do a "nose job," but rather the achievement of an attractive natural nose with normal function.

As the closed approach for rhinoplasty reached its apogee of influence, the open approach gained sudden popularity. Building on the work of Goodman,[2] Anderson,[3] Daniel,[4,5] Gunter,[6] and others, rhinoplasty surgeons quickly adopted the open approach. This revolution occurred for three reasons. First, the open approach offered better visualization for analysis, surgery, and teaching. Second, new operations were developed including tip suturing, advanced septal reconstruction, and midvault reconstruction which were either impossible or technically challenging via a closed approach. Third, the open approach shortened the learning curve for the less experienced surgeon and could be applied to a wider range of ethnic groups with good results. Rhinoplasty surgery enjoyed a wave of popularity and became one of the most frequently performed aesthetic surgical procedures.

Despite the improved aesthetic and functional results, minor revisions and major secondary rhinoplasties persisted. Recently, Toriumi has summarized his experience with open structure rhinoplasty in his monumental text *Structure Rhinoplasty: Lessons Learned in 30 Years*.[7] This summary of 3 decades of passionate obsession with rhinoplasty surgery reveals the changes which occur with time and compromise even excellent early results using reduction techniques. The critical need for structure to resist the forces of contracture and provide essential support is undeniable. Equally, the use of multiple grafts derived from rib is illustrated in numerous difficult cases always stabilizing the base first and building outwards. Numerous refinements and new techniques are illustrated with superb documentation and follow up.

Despite this tour de force, one troubling question remains—why are we doing an operation that can produce such a destructive result that a rib graft reconstruction becomes necessary following a primary case performed by an experienced surgeon? My conclusion is that we must fundamentally change how we perform rhinoplasty surgery which leads to the next revolution—the preservation rhinoplasty. The fundamental goal is to replace resection with preservation, excision with manipulation, and secondary rib reconstruction with minimal revisions. The foundation of this preservation rhinoplasty rests on new anatomical studies, advanced tip suture techniques, and refinement of surgical techniques.

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During the last decade, major advances have occurred in our understanding of nasal anatomy and how it relates to nasal aesthetics and surgical techniques. Two of the most interesting are the composition of the soft tissue envelope, including the nasal ligaments and the osseocartilaginous vault. The nasal ligaments have long been overlooked yet they are critical for both functional and aesthetic reasons.[8] For example, the vertical scroll ligament helps to stabilize the internal valve via the transversalis muscle while its surgical reattachment can accentuate the alar groove and maintain function.[9] Anatomical dissections have shown convincingly that the bony hump is in reality a thin "bony cap" which can be easily rasped away while preserving the underlying cartilaginous vault.[9] In addition, the keystone area is in reality a semimobile chondrosseous "joint" which can be converted from convex to straight by resecting its underlying cartilaginous septal support.[10]

As open tip suture techniques reached their apogee, Cakir[11] realized that he could achieve comparable results with greater control and less morbidity if he used a closed approach. The goal was to preserve the nasal ligaments and manipulate the cartilages with minimal resection. He has found that the subperichondrial approach has less postoperative morbidity (swelling, numbness) and revisions are far simpler (less scar tissue) when compared to conventional techniques.[12] Two additional examples of this fundamental change in tip surgery are cephalic alar preservation and alar tensioning. Traditionally, excision of the cephalic lateral crus was an automatic step in rhinoplasty surgery. Yet, Ozmen et al[13] and Gruber et al[14] have demonstrated the benefits of preserving the entire lateral crus, which leads to less alar notching and a reduce need for alar rim grafts. Alar malpoisition has long been considered one of the most difficult tip deformities with the treatment of choice being alar transposition with lateral crural strut grafts. However, Cakir[11] and Davis[15] have shown convincingly that alar transposition is not necessary and that medial tensioning will suffice without any alar resection or additional grafts.

The most fundamental component of traditional rhinoplasty is dorsal resection, which destroys the keystone area and requires some immediate combination of osteotomies and midvault reconstruction. Currently, it is dorsal reconstruction in secondary cases that leads to the majority of rib graft reconstructions. Similar to Goodman's[2] popularization of Rethi's open approach, Saban[16] has updated the push down operation leading to dorsal preservation. His technique of dorsal preservation minimizes the need for immediate midvault repair in primary cases and permits minor revisions rather than major rib graft secondaries.

Since we are only at the beginning of this revolution, time will be required to expand the indications, refine new surgical techniques, and solve the inevitable problems. The beneficiaries of this advancement will be our patients who will be given greater predictability with less risk. Since the primary reason that patients do not seek rhinoplasty surgery is the fear of a bad result ("nose job" look), it will behoove surgeons to learn the preservation rhinoplasty as it reduces this risk and will lead to simple revisions rather than major secondary procedures.

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VIEWPOINT Rhinoplasty

A Practical Classification System for Dorsal Preservation Rhinoplasty Techniques

Miguel Gonçalves Ferreira, MD, PhD,[1,*,†] and Dean M. Toriumi, MD[2,3]

Abstract

Preservation rhinoplasty in general and dorsal preservation in particular are for sure one of the most attractive topics in modern rhinoplasty and probably the most puzzling concept in this field. Recent major meetings and many other publications have led to an increased interest in these old/new techniques. New strategies for preservation have been developed in recent years, with a broader range of indications than the older push/let down. A simple classification urges to clarify this puzzled semantic concept of "preservation". Is it possible to systematize all new preservation variations in a simple classification? Yes, in this viewpoint, we propose a simple classification that systematizes all kinds of preservation techniques—the old and the new techniques. Classifying preservation will clarify the relative position of all techniques. It will allow comparing procedures from similar families there so to compare outcomes and indications from each technique.

Relevant Historical Background

The concept of preservation rhinoplasty (PR) has emerged as an evolving approach to primary rhinoplasty (Table 1). The earliest descriptions of dorsal preservation (DP) appeared in 1899, by Goodale.[1] Jacques Joseph published his book on ''reductive'' techniques in 1904, which contrasted the preservation methods.[2] Preservation of the nasal dorsum came about as a logical ''primum non nocere'' technique, to avoid complications related to violation of the middle nasal vault and bony vault.

In 1917, Lothrop published a remarkable article with the first description of what would later be called ''surface preservation techniques.''[3] Maurice Cottle appeared 30 years later and has been coined as the father of ''preservation rhinoplasty'' due to his consistent and thorough work in the famous push down operation.[4]

From the 50s moving forward, a few surgeons performed and improved PR in a surgical world dominated by reduction techniques. Some of these surgeons were Skoog, E. Huizing, R. Daniel, R. Gola, Lopéz-Ulloa, W. Dewes, Y. Saban, and J. Ishida among others.[5] In the past decade, new concepts of nasal anatomy have emerged due to cadaver studies,[6] and more recently, due to accurate radiological studies.[7] These new findings/concepts have allowed surgeons to develop and apply a rational basis on many different variations in modern PR.

Why Did PR Lose Popularity After the 60s?

The concept of preserving the good features of the dorsum and middle vault is clearly superior to reduction and would have been universally accepted if not for some issues of surgical imprecision/loss of control and medium–long-term structural unpredictability. These factors drove surgeons to structure rhinoplasty (SR) as it presented more precise and predictable results. Despite all the subsequent improvements of middle vault reconstruction, with new grafts and flaps developed by eminent worldwide surgeons, the ''preservers'' continued to believe that PR would achieve better dorsal outcomes. At that time, PR was believed to avoid the major problems created by the ''traumatic'' opening/avulsion of the middle vault noted with ''dehumping'' using reductive and SR techniques.

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Table 1. Common terms and abbreviations used in preservation rhinoplasty

Expression	*Acronym*
Preservation rhinoplasty	PR
Structure rhinoplasty	SR
Dorsal preservation	DP or PR-D
Tip preservation	PR-A
Soft tissue preservation	PR-S
Dorsal key stone area	DKA
Lateral key stone area	LKA
Foundation techniques	FT
Surface techniques	ST

Increasing Popularity in Recent Years

In the past decade, the persistent educational efforts of R. Daniel, Y. Saban, and others have worked as a trigger to the recent explosion of PR as an irrefutable part of the modern rhinoplasty surgery. PR has gained popularity among surgeons and this has led to some great achievements and development of new modifications of the early push down/let down techniques. The necessity of preserving structures is intrinsic to rhinoplasty as a science. This has led to some recent innovations from surgeons who may have been less aware of the history behind PR and, therefore, were not influenced by the rich history in this area.

What Is PR/DP?

The abstract concept of ''preservation rhinoplasty'' is a scientific legacy with an important history behind it—a surgical philosophy that does not belong to anyone but closely relates to the science of anatomy.

Even though the technique was first described around 1900, the expression ''preservation rhinoplasty'' was coined by Daniel,[8] who recently divided this into three different kinds of preservation—dorsal, alar (tip), and soft tissue preservation.

Historically, the almost unanimous definition of DP may be any technique of dorsal dehumping that does not open the cartilaginous middle vault—in opposition to reductive dehumping that typically involves opening the middle vault. The idea of lowering the entire humped dorsum from the roof often resulted in a problem—in the end, surgeons got a lower but still humped dorsum.

The convexity of the humped middle vault has two main structural problems—the bony convexity and the cartilaginous convexity. These two main problems do not allow a simple push down (without extra maneuvers) in the vast majority of the cases. The bony convexity was initially solved by rasping (still preserving the cartilaginous middle vault), and the cartilaginous convexity was solved by smaller or larger release of the lateral keystone area with some additional maneuvers.

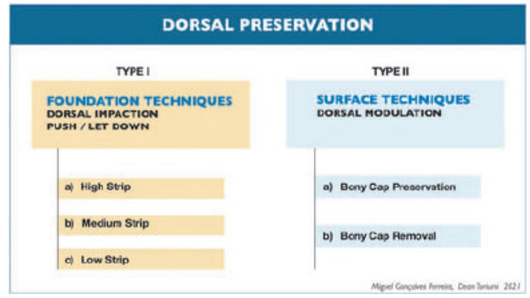

Fig. 1. Practical classification for dorsal preservation rhinoplasty. Type I—a, b, and c are addressed to septal cartilage main incision level.

Classification of DP—Two Different Types of Preservation

Popularized by Cottle's push down, DP today is a complex area of rhinoplasty due to the number of new techniques and modifications that have been developed in recent years. The authors propose a simple classification system that aims to clarify future scientific works on DP, helping to better categorize future studies and indications for each technique.

Conceptually and structurally there are two different groups in DP: the foundation techniques (FTs) and the surface techniques (STs) (Figs. 1 and 2).

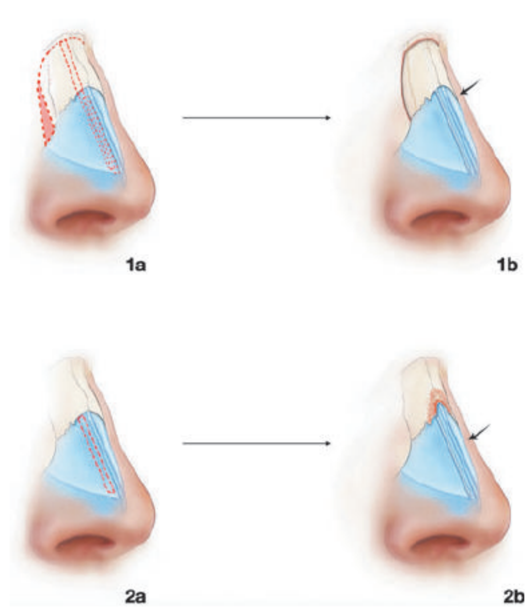

Fig. 2. **(1a, 1b)** Foundation techniques (Type I) involve osteotomies and impaction (push down/let down) of the nasal pyramid into the face (top row). **(2a, b)** Surface techniques (Type II) involve treating the hump superficially without impaction.

FTs or Type I is based on dorsal impaction, which involves impaction of the nasal pyramid into the face, requiring impaction osteotomies—lateral, transverse, and radix—thus, the nasal pyramid sinks and impacts into the face—push or let down.

ST or Type II is based on dorsal modulation, the hump is treated superficially with modulation of the middle vault, without impaction osteotomies—there is no impaction osteotomies—no bony push or let down.

FTs can be performed with high, medium, or low septal strips and with some relevant new techniques to solve the cartilaginous convexity of the hump. STs can be performed with or without preservation of the bony cap, but always with preservation of the cartilaginous middle vault and with no need to impact the bony dorsum.

Conclusions

Dorsal PR represents a huge number of different techniques with the same aim—get a straight and smooth dorsum without the necessity of reconstruction with flaps or grafts. These techniques must be appropriately classified to allow for a sound scientific approach with respect to indications and intended outcomes. The authors purpose this simple classification as a suitable means to help all surgeons interested in this emergent form of rhinoplasty.

Ethical Approval

All opinions are in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Author Disclosure Statement

No competing financial interests exist.

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Special Topic

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Advanced Preservation Rhinoplasty in the Era of Osteoplasty and Chondroplasty: How Have We Moved Beyond the Cottle Technique?

Miguel Gonçalves Ferreira, MD, PhD; Dean M. Toriumi, MD; Bart Stubenitsky, MD, PhD; and Aaron M. Kosins, MD

Abstract

Background: Over the last 10 years, many new papers on innovative strategies from different surgeons worldwide have elevated the philosophy of preservation rhinoplasty (PR) to a different level: advanced preservation rhinoplasty.

Objectives: The goal of this article was to illustrate how 4 experienced surgeons approach important anatomical and functional issues related to PR.

Methods: M.G.F., A.M.K., B.S., and D.M.T. were asked about how they approach classical problems and relative contraindications for dorsal PR with different modern advanced preservation rhinoplasty techniques.

Results: The answers of each surgeon make clear a new reality in dorsal PR that did not exist in the recent past. These advances in dorsal PR techniques are due to many surgeons' contributions, leading this practice to a different level: advanced preservation rhinoplasty.

Conclusions: Dorsal preservation is making a dramatic resurgence and is fueled by the many very talented surgeons who are demonstrating outstanding outcomes with preservation techniques. The authors believe that this trend will continue, and a mutual collaboration between structuralists and preservationists going forward will continue to advance rhinoplasty as a specialty.

Editorial Decision date: June 15, 2023.

In 1899, Goodale introduced dorsal preservation (DP), and this was followed by Lothrop in 1914 and Cottle in 1946.[1-3] Moving forward from the 1950s, a select group of innovative surgeons performed and improved DP in a surgical world dominated by reduction techniques. The concept of preserving the good features of the dorsum and the middle vault is theoretically superior to reduction. This strategy may have been universally accepted if not for some issues

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of surgical imprecision, loss of control, and structural unpredictability. These factors, along with the advent of the open approach, influenced surgeons to turn to structure rhinoplasty (SR), because it presented more precise and predictable results. Despite all the subsequent improvements of middle vault reconstruction, with new grafts and flaps developed by eminent worldwide surgeons, the "preservers" continued to believe that preservation rhinoplasty (PR) could achieve better dorsal outcomes in a select group of patients.

In the past decade, new concepts of nasal anatomy have emerged due to cadaver studies and, more recently, accurate radiological studies.[4,5] These ideas and findings have allowed new modifications of the early push-down/let-down techniques. Daniel recently coined the descriptive title "preservation rhinoplasty" (PR), and it has become a rather popular movement in recent years.[6]

PR is rapidly gaining popularity among surgeons. Due to the expansion of techniques and a new understanding of anatomy, we are now in the era of advanced preservation rhinoplasty (APR). Patients who in the Cottle era were not considered ideal candidates for DP may now be suitable. The main objective of this article is to provide an overview of surgical solutions to common problems and unique perspectives that allow expansion of the indications for DP. To achieve this, 4 renowned surgeons with experience in APR provided answers regarding how they expand the use of DP techniques in their own practices. As described herein, the concepts of osteoplasty and chondroplasty in rhinoplasty have changed the paradigm and broadened the indications for PR.

METHODS

Eleven questions regarding new aspects in advanced DP were answered, individually and independently, by 4 experienced surgeons: M.G.F., A.M.K., B.S., and D.M.T. The answers were limited to 100 to 150 words each.

RESULTS: QUESTIONS AND ANSWERS

How Do You Manage the Medium/Severe S-Shaped Nasal Bones?

M.G.F.

Big humps are more likely to have a bony kyphosis. The S-shaped nasal bones (Figure 1) will impact surface anatomy and must be diagnosed before surgery, if possible, with a computed tomography scan. If the kyphosis is significant, one must perform ostectomy or osteoplasty—in this case, I uncap the hump as far as needed with a diamond drill (preferable) or piezoelectric (PEI) system. I dissect the bony dorsal compartment. I use a superficial preservation approach to dehump a nose with S-shaped nasal bones: spare roof technique A.[7-9]

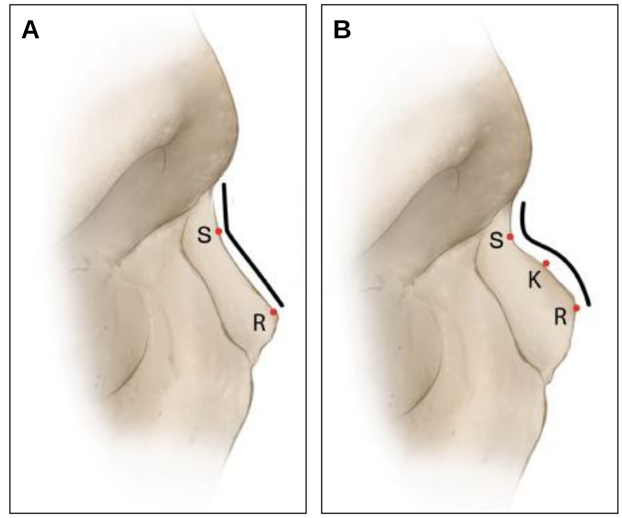

Figure 1. (A, B) V- and S-shaped nasal bones. K, kyphosis; R, rhinion; S, sellion.

A.M.K.

Although moderate S-shaped humps can be managed with bony cap modification and DP, severe S-shaped nasal bones are managed with SR. When the nasal bones have a very high kyphion point, the bone must be excessively modified or removed, and the underlying cartilaginous vault becomes exposed. The cartilage vault under the nasal bones is often denuded of perichondrium and has irregularities on the dorsum where the skin is the thinnest. Although these dorsums can be treated with DP, SR is easier, and the outcomes are more consistent. In addition, patients with severe S-shaped nasal bones often have a low radix and/or a low anterior septal angle. These anatomic characteristics make flattening maneuvers even more difficult.

B.S.

S-shaped nasal bones are a relative contraindication for preservation of the bony vault. In slightly S-shaped nasal bones, I try to change the S-shape to a V-shape by rasping. If successful, I proceed with a let-down or push-down as usual. In severe S-shaped nasal bones, I revert to structural techniques for the bone. This can be done by extensive rasping or removal of the bony cap followed by osteotomies.

D.M.T.

My method of management of the severe S-shaped nasal bones depends on the status of the radix. The S-shaped dorsal hump has an S-shaped angulation from the nasion to rhinion, whereas the V-shaped hump has a straight-line configuration from nasion to rhinion. If the radix is low and requires augmentation, I place a radix graft to a level that is appropriate for the patient. Elevation of

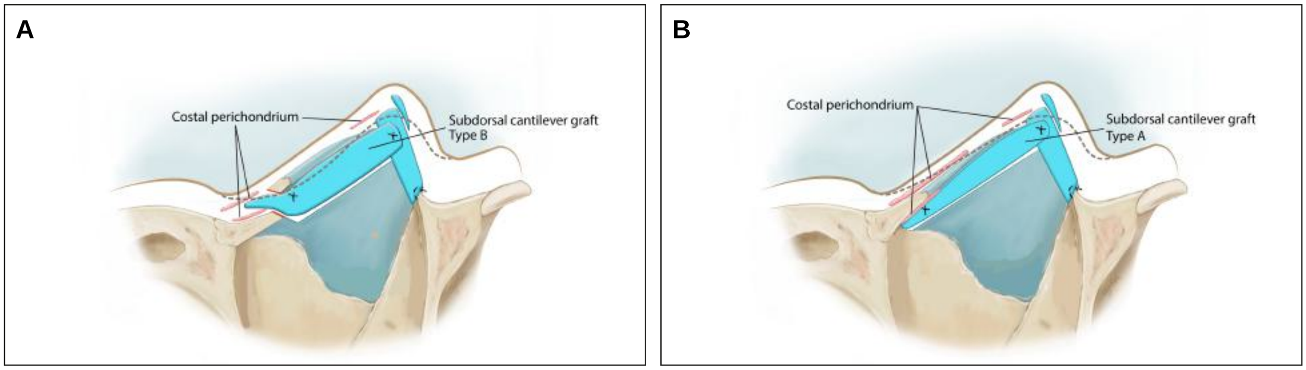

Figure 2. (A, B) Subdorsal cantilever graft types A and B.

the radix will decrease the prominence of the S-shaped deformity. Then the remaining hump can be managed with the PEI or a rasp to take down the bony cap. Once the bony cap is reduced, the cartilaginous dorsum can be reduced with an intermediate level flap such as the subdorsal Z-flap or Tetris.[10] I take out bilateral bone strips (let-down) through subperiosteal tunnels, bilateral transverse bone cuts through small stab incisions, and the radix osteotomy from below. If the radix is not low and does not require augmentation, I utilize the spare roof type B technique of Ferreira and Ishida and use a PEI to take out triangular segments bilaterally to allow the projecting component of the S-shaped hump to be collapsed on itself and sutured into a flattened position.[11] This will convert the S-shaped hump to a straight profile line. Even in these cases, I may use a small, crushed cartilage radix graft. I prefer to place radix grafts into a narrow subperiosteal tunnel and then fix them into place with a 6-0 Monocryl (Ethicon, Raritan, NJ) transcutaneous fixation suture.

How Do You Manage the Low Radix?

M.G.F.

A low radix is a very important entity in nasal aesthetics. Due to long-term issues with visibility, I usually avoid putting grafts in the radix area. When the deepness is relevant, I use diced cartilage in a subperiosteal tunnel that I create specifically for this purpose. In extreme cases, I still utilize the “diced cartilage in fascia” proposed by Daniel et al.[12]

A.M.K.

The low radix is a relative contraindication for an impaction technique. Even if a hinge is created at the radix, some amount of radix lowering often occurs. Most often, a surface technique is performed in which the bony cap and cartilaginous vault are lowered with high septal strip removal. This has been the most consistent and reliable way to manage the low radix, in addition to radix grafts of diced cartilage in fascia. An open technique is more often employed for surface techniques because of the large exposure and ability to sculpt the bones with PEI.

B.S.

A low radix can be a presurgical finding or an iatrogenic result of the surgery when using bony vault lowering techniques. In both cases, I solve the issue by augmenting the depressed area with minced cartilage. A narrow subperiosteal tunnel (4-mm wide) is made cranially beyond the deepest point without dissection of lateral walls. The minced cartilage is then applied with an applicator syringe.

D.M.T.

I manage the low radix with a radix graft placed into a narrow subperiosteal pocket and then fixated with a transcutaneous 6-0 Monocryl suture that is removed on the seventh postoperative day when the cast is removed. I can also place the radix graft through the lateral wall stab incisions. If the dorsum and radix are low and both require augmentation, I use a push-up technique incorporating a subdorsal cantilever graft (SDCG) type B (Figure 2A).[13,14] This graft is carved from autologous costal cartilage and is specifically designed for the patient’s needs. After performing bilateral lateral osteotomies, bilateral transverse osteotomies, and a radix osteotomy, the SDCG type B is extended through the radix osteotomy to raise the entire dorsum, including the radix. Complete release of the lateral keystone and piriform ligament is also required to allow the middle vault to be pushed up. The SDCG type B is then fixed to a caudal septal extension graft to create a new L-shaped support structure.

How Do You Manage the Supratip Area?

M.G.F.

In PR, the supratip area is critical whether one performs high, low, or intermediate strip strategies. Recently I`ve introduced the septal advancement flap (SAF) in all primary cases (Figure 3), so I have a smooth continuity between

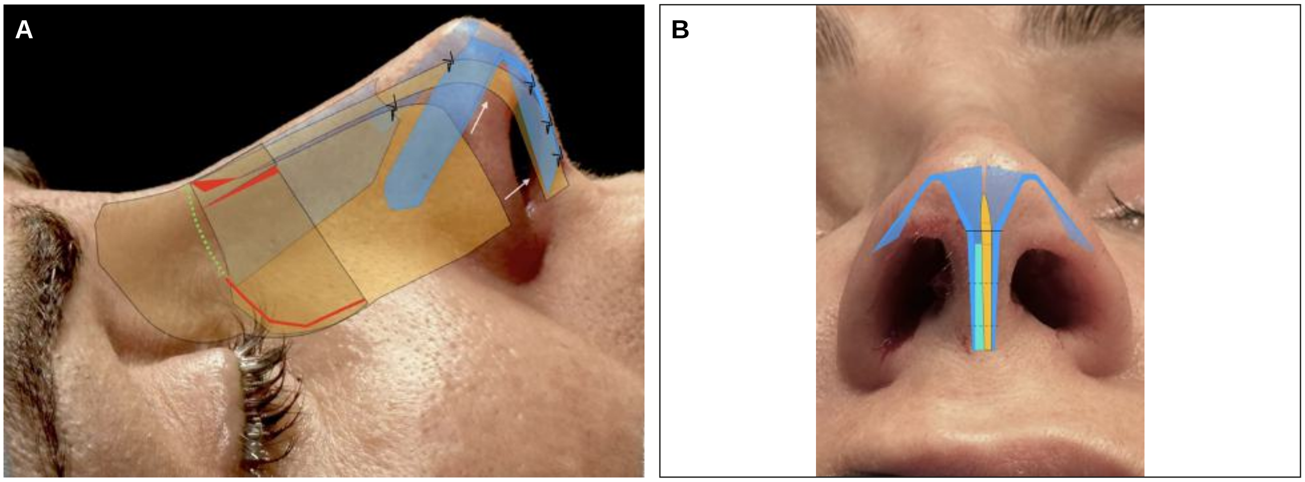

Figure 3. (A, B) Septal advancement flap applied to the spare roof technique in a 44-year-old female patient.

W-point, tip, and upper lip.[15] With the SAF, it is critical to double-check that the "supratip suture" is in the correct position to have a stable relationship in the complex septum/lower lateral cartilages/domal area.

A.M.K.

The supratip area is managed last in a high strip technique, whether with a surface or impaction technique, by preserving the W-ASA segment (the W point is the caudal point of separation of the upper lateral cartilages from the septum, and the ASA point is the anterior septal angle). If the supratip is low preoperatively, this is a relative contraindication for DP, and a low strip technique should only be employed if the caudal septum is strong and if the surgeon can rely on the flap to rotate and push up the anterior septal angle. If a strong supratip break point is present preoperatively, structural dorsal rhinoplasty should be considered to retain complete control of the dorsal profile.

B.S.

Often, this issue can be anticipated by preoperative examination when palpating a downward curvature of the dorsum caudally. There are several options to correct a supratip depression, depending on the severity. If there is a slight depression, the issue can be solved by either the placement of a thin cartilage graft (ideally a thin cephalic trim graft) or releasing the caudal upper lateral cartilages and suturing them together above the septum. A second, more caudal vertical cut can be made in more severe cases. This creates 2 QC flaps with 2 pivot points, enabling the elevation of the supratip area.

D.M.T.

The supratip area is managed based on the desired position after the tip projection is set. If the supratip requires lowering, such as in a tension nose deformity, I use a Tetris flap with the vertical incision of the caudal segment of the flap extending through the W point.[16] This will allow precise control of the supratip position by advancing or lowering the connection of the Tetris flap to the caudal strut. If the supratip is in proper position, I use a subdorsal Z-flap, without extending the caudal cut through the W-point to preserve the supratip position.[17,18] If the supratip is too low, I place a small soft tissue onlay graft into the depressed area. If a saddle nose deformity is noted, I raise the saddled area with an SDCG type A that elevates the supratip/saddle and is fixed to a caudal septal extension graft (Figure 2B).[13]

How Do You Manage the Upper Lateral Cartilage (ULC) Shoulders?

M.G.F.

ULC shoulders might be a problem in surface anatomy if they are prominent, asymmetric, or both. In these cases, I dissect only the dorsum's cartilaginous segment and use a Colorado needle (Stryker, Kalamazoo, MI) to burn the shoulders (chondroplasty). I utilize it with the lowest potency that is efficient. The concept of chondroplasty has emerged with the use of electromedicine—Colorado tip, laser, etc. After doing so, I do interpose some kind of absorbable material (Spongostan; Johnson & Johnson Medtech, New Brunswick, NJ) between the roof and the envelope to avoid any kind of skin fibrosis or retraction during the first healing period.

A.M.K.

If the ULC shoulders are prominent or asymmetric, they are best treated by shaving with a blade or electrocautery. At times a lateral keystone release can help to treat these

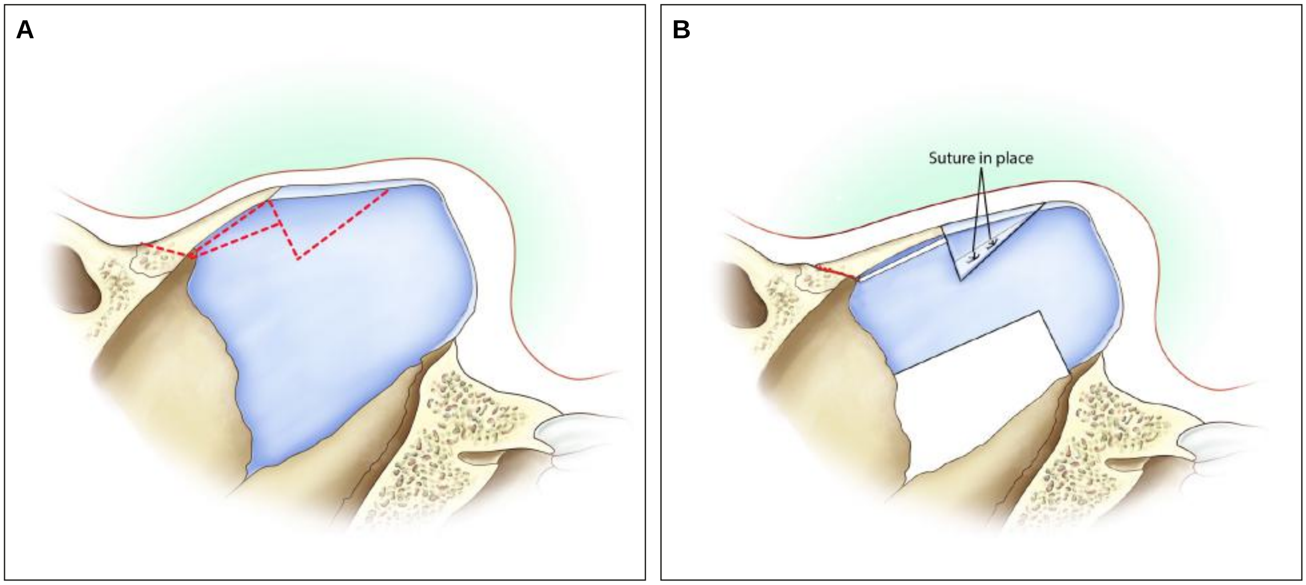

Figure 4. (A, B) Subdorsal Z-flap.

asymmetries, but after the dorsal preservation has been completed, the ULC shoulders can be modified to smooth the profile. Surgeons will find that the left ULC shoulder often sits higher than the right, and this can easily be modified.

B.S.

This challenge often justifies structural rhinoplasty techniques. If, like me, you want to use preservation, there are a couple of solutions. For broad ULC shoulders, I partially incise the cartilage of the dorsum on the new desired dorsal lines. This takes off the tension and narrows the ULCs. If the shoulders are sharp or elevated, careful sculpting of the edges can be performed with electrocautery to soften them. Finally, if there is serious bulging or broadness of the ULCs, the release of the ULCs from the septal T with trimming of the excess is an efficient solution.

D.M.T.

I manage the ULC shoulders by trimming with a 15 blade, preserving the underlying mucosal lining. The lining preserves support and prevents deformity. To create the proper contour, I may place a 6-0 Monocryl suture to close the small cartilaginous defect. Another option is to employ gentle electrocautery (Colorado needle) to sculpt the high upper lateral cartilage shoulder.

How Do You Manage the Crooked Nose?

M.G.F.

In PR, the crooked nose is always managed with the following rational basis: tension on the cartilaginous middle vault is solved with the releasing of the septum at any level (high, intermediate, or low). Structurally the final result will be similar because the remaining attached septum will be tilted to the contralateral side of the deviation with high and medium strip (side to side), or will be tilted to the same side in low strip in a swinging door fashion. The crooked nose is managed with my standard surface technique—spare roof technique B.[19] Once the roof is released from the septum (high strip), the nose tends to immediately become straight, and the septum remains crooked. For nonsevere septal deviations, I perform a regular L-shape septoplasty and suture the upper part asymmetrically to the roof. If the septal deviation is severe, I do an extracorporeal septoplasty (preserving the roof).

A.M.K.

If the crooked nose is secondary to axis deviation, the best way to manage the nose is with an asymmetric, let-down technique (impaction). Moderate deviations are addressed with a subdorsal Z-flap technique (Figure 4), in which the flap is locked to the contralateral side of the septal deviation, and a septoplasty is performed separately to release the tension. For severe deviations, a low strip technique is used to move the entire osseocartilaginous vault and septum as 1 flap. If the patient has intracorporeal damage or distortion (usually from trauma), often a subtotal septoplasty is necessary.

B.S.

By far, the most efficient technique for managing crooked noses in PR is a cartilaginous low strip combined with an asymmetric bony vault let-down, or SPQR (Figures 5, 6).

Figure 5. Low septal strips shown in a 23-year-old female patient.

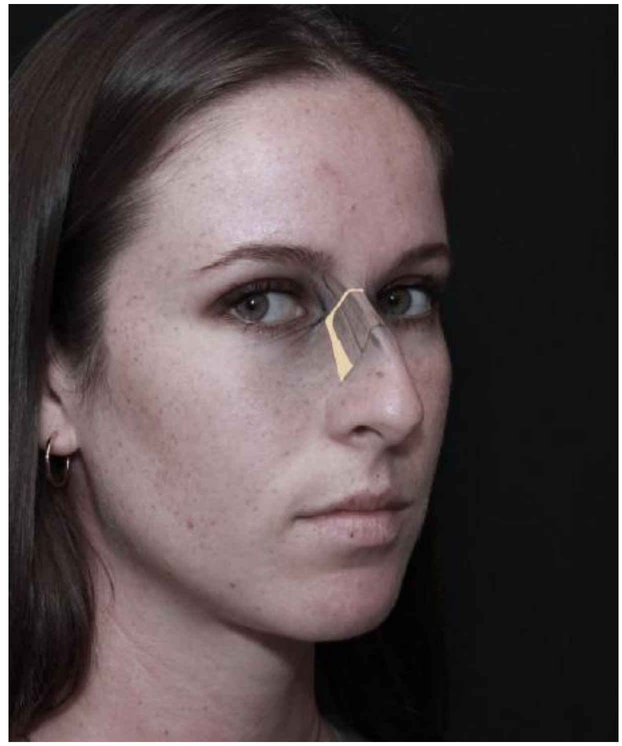

Figure 6. Let-down shown in a 23-year-old female patient.

The septum's vertical release from the ethmoid's perpendicular plate swings the septum tensionless into the midline. The complete release of the bony vault then lets it follow the cartilaginous vault.

D.M.T.

I manage the deviated nose with axis deviation based on the status of the nasal septum. If the nasal septum is not severely deviated in absence of a high septal deviation at the ethmoid bone, I release the bones and middle vault from the septum with an intermediate level flap (subdorsal Z-flap, Tetris, or Ishida) and then perform bilateral bone strips (let-down), taking out a larger strip on the side opposite the deviation. I also perform bilateral transverse bone cuts and a radix bone cut from below. Then the intermediate level flap is overlapped on the side opposite the deviation to shift the dorsum to the midline. If the nasal septum is severely deviated and/or if there is a high septal deviation involving the ethmoid bone, I employ a low strip (SPQR, Cottle, SPAR [septum pyramidal adjustment and repositioning] type B) by releasing the entire septum from the bony attachments.[20-22] This allows the overly large quadrangular cartilage flap to be trimmed and rotated caudally and then fixed to the nasal spine. In the absence of a dorsal hump, a septal flap is created, and minimal rotation avoids dropping the dorsum. This is a type of swinging door septal flap. The deviated ethmoid bone can be removed to allow straightening of the bony septum. Care must be taken to create an angled oblique radix bone cut leaving the external periosteum attached to the bone to avoid dropping the radix. I prefer a "no dorsal skin elevation" method to preserve nasal bone integrity and support. In most cases, I utilize osteotomes and a rongeur for the bone cuts with no dorsal skin elevation over the dorsum. For the severely deviated nose with an S-shaped deformity, I use structure methods. If there is deviation and saddling of the middle vault, I employ a subdorsal cantilever graft type A to straighten the dorsum and raise the middle vault.

I do not believe the low strip (Cottle, SPQR, SPAR type B) has fallen out of favor. To the contrary, I believe improvements made in the technique (SPQR) have increased the utility of the low strip.[23] The technique demonstrates superior benefit for the deviated nose and deviated septum with high septal deviation.

How Do You Prevent the Hump Recurrence and Manage the Lateral Keystone Area (LKA)?

M.G.F.

Probably the most important structural movement in DP is the release of the LKA. The 3-dimensional (3D) structural

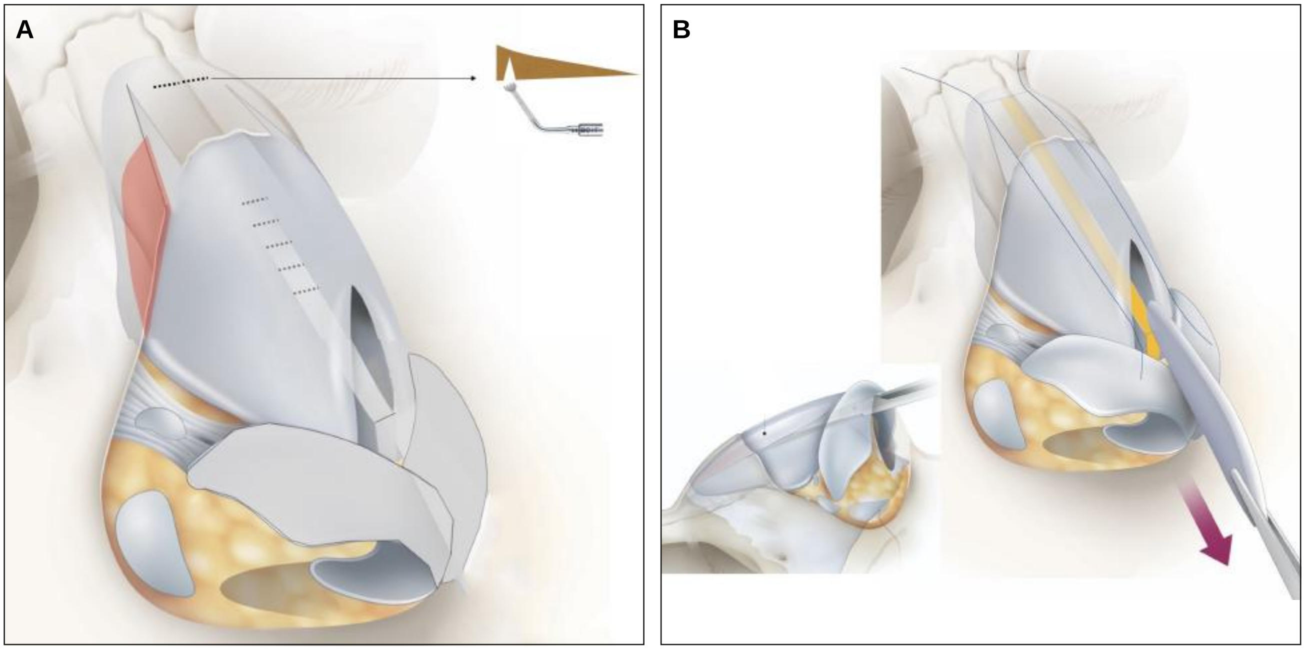

Figure 7. Spare roof technique B. (A) Lateral wall and subdorsal ostectomy. (B) High strip and central compartment.

architecture of the cartilaginous middle vault is very important to understanding how safe it is to release the LKA in DP. Once the integrity of the middle vault is maintained, one can release the LKA, and the 3D architecture will be the same. Splitting the bony and cartilaginous part of the middle vault in the lateral wall is the key to pushing the roof down and flattening the dorsum. In big humps or severe S-shaped nasal bones the roof should be sutured to the septum as described by Ferreira (Figure 7).[11]

A.M.K.

When utilizing a surface technique, a high strip is almost always done. Hump recurrence is prevented with a 3-suture fixation technique as previously described. With an impaction technique, the surgeon must check all possible blocking points, including Webster's triangle, bony contact at the lateral osteotomy lines, internal periosteal dissection at the lateral osteotomy lines, lateral keystone release, and full bony mobilization. For a high strip impaction, the surgeon must also check to make sure that the subdorsal keel has been removed. For a low strip impaction, the surgeon must make sure the osseocartilaginous joint is completely released and that the posterior septal angle of the caudal septum rests on the anterior nasal spine without tension (which can cause the flap to migrate cephalically postoperatively) and without excessive caudal septal length (which can deviate the nose postoperatively).

B.S.

The most frustrating complication in PR is hump recurrence. It is caused by an insufficient release of blocking points and inadequate fixation of the cartilaginous vault. Blocking points can be bony (under the bony cap, at the middle keystone area [MKA], or at osteotomy sites) or cartilaginous (LKA or septum underneath pivot point). By removing sufficient bone under the vault, rasping the MKA, banana-shaped ostectomies, and by releasing the LKA (ballerina move) and incising the septum under the pivot point, recurrence can be prevented.

Good fixation of the cartilaginous vault by 2 sutures in the high strip and reliable fixation of the septum to the anterior nasal spine is essential to keeping the dorsum in place.

D.M.T.

I prevent hump recurrence by managing all the potential blocking points and with suture fixation methods. I perform a lateral keystone release for larger dorsal humps and more severely deviated noses. I release the LKA and piriform ligament on the side opposite the deviation in the deviated nose. I do a banana-shaped lateral bone strip removal to make sure there is no blocking point near the medial canthal ligament. I make sure I take out a generous bone or cartilage segment below the bony hump. I also release the periosteum around the lateral bone strip removal to prevent a blocking point at the maxilla. I check the subdorsal area at the rhinion to make sure there is no residual cartilage spanning the bone cartilage junction. Vertical cuts can be made through any remnant cartilage below the rhinion to allow flexing of the K-area to "stretch and flatten the hump." I place a fixation suture (4-0 PDS) to fixate the dorsum into the reduced position on the septal flap (subdorsal

Z-flap, Tetris, etc.) and/or a transmucosal suture through the middle vault and septum.

How Do You Manage Bony Dorsal Irregularities?

M.G.F.

Bony dorsal irregularities have to be diagnosed before surgery because they change the strategy. Once irregularities have an impact on surface anatomy, I have to dissect the dorsum (which I do not do routinely), and typically they are fixed before any maneuver, by ostectomy/osteoplasty with a diamond burr or (if not possible) with PEI. Care must be taken to avoid any soft tissue envelope or skin injuries. The most frequent "irregularity" is kyphosis of the S-shaped nasal bones.

A.M.K.

All bony dorsal irregularities are managed with piezoelectric rhinosculpture. This can be done before or after DP, and the bones can be modified as you proceed throughout the operative sequence. The use of rasps and osteotomes is often too aggressive and causes radiating fracture lines, loss of the bony cap, and irregularities, especially if the dorsal preservation has been completed and further modification is necessary.

B.S.

Rasping is the easiest and most effective solution for bony vault irregularities. Let-down or push-down can be performed following reshaping into the desired form.

D.M.T.

Intraoperatively, I manage dorsal irregularities with a piezotome, narrow rasp, or trimming of the cartilage. If I note an irregularity postoperatively, I correct it with a narrow rasp if it is bony. If it is cartilage, I may consider an in-office "needle shave," in which I place local anesthetic over the area and with a 16-gauge needle shave down the cartilage deformity.[24] I do not use filler in the nose.

How Do You Manage ULC Irregularities and Asymmetries?

M.G.F.

As with bony irregularities, cartilage asymmetries or irregularities must be diagnosed before surgery, and the dorsum is dissected in that specific area. Asymmetries are frequent in the crooked nose and are solved with bilateral dissection of the LKA (excess of ULCs sink in the dissected LKA). Irregularities, including ULC shoulders, are typically treated with Colorado tip cautery in vaporization mode at the lowest potency possible. After doing so, one should interpose

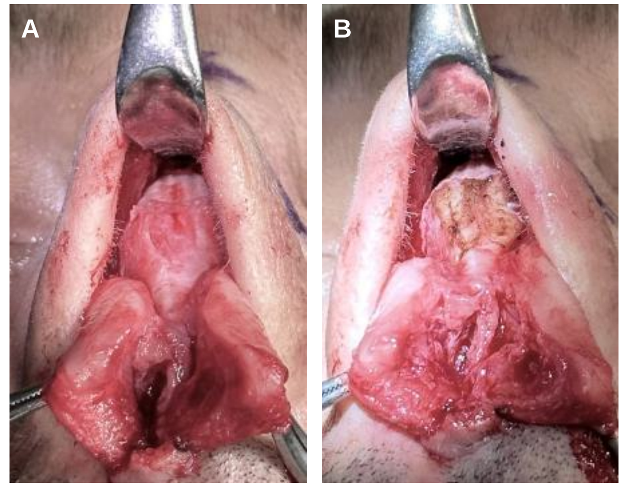

Figure 8. Chondroplasty with electrocautery (Colorado needle) of the upper lateral cartilage shoulders in a 38-year-old male patient.

some material (Spongostan) in between the burned area and the soft tissue envelope (Figure 8).

A.M.K.

See previous response. For severe concavities, I often add submucosal spreader grafts in predissected pockets. This is very common in axis deviation, in which a submucosal spreader is added opposite the side of the deviation. Small onlay lateral wall grafts are placed caudally as necessary.

B.S.

For cartilaginous vault irregularities or asymmetries, structural rhinoplasty techniques are justified and probably easiest. For preservation, the irregularities or asymmetries can be carefully sculpted with electrocautery or a blade. But again, the threshold to convert to structural should be low.

D.M.T.

ULC asymmetries or irregularities can be managed with a shave of the prominent shoulder. If the upper lateral cartilages are asymmetric and 1 side is too narrow or medialized, I place a submucosal spreader graft, in which the rectangular-shaped graft is placed into a narrow subperichondrial pocket (Figure 9).[18,24] This lateralizes the medialized upper lateral cartilage. If the middle vault is too wide, I perform bilateral segmental spreader flaps. In this case, the upper lateral cartilages are freed from the dorsal septum, and then spreader flaps are created and sutured with a 5-0 PDS suture to set a narrower middle vault. This is not a preservation technique.

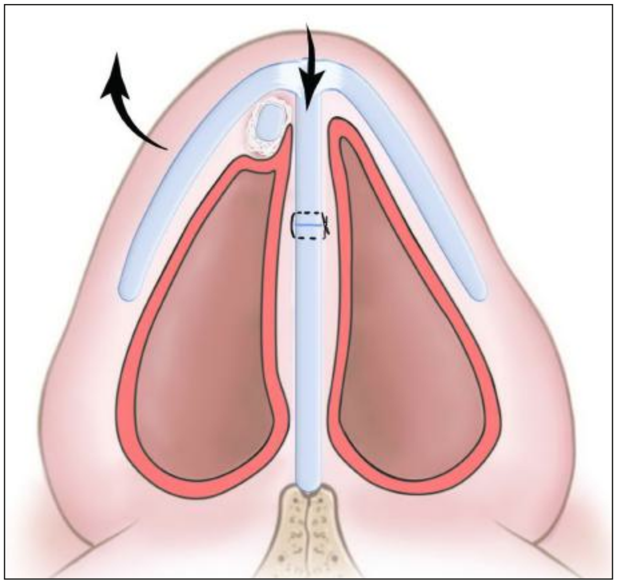

Figure 9. Unilateral spreader graft to correct upper lateral cartilage asymmetries.

How Do You Manage Dorsal Aesthetic Lines (DALs)?

M.G.F.

DALs are the most important aspect of spare roof technique B. The triangular ostectomy is always done immediately in the exterior aspect of the desired DALs. After this maneuver, the traditional lateral osteotomies are done in a greenstick fashion, closing the "greenstick ring" of this technique—the barn doors greenstick fracture.[25] The cartilaginous part of the DALs is treated, when needed, with Colorado tip cautery, as mentioned previously.

A.M.K.

When doing dorsal preservation, it is optimal to have excellent dorsal aesthetic lines, and an impaction technique can be employed without skin dissection. However, most dorsums require modification. If an impaction technique is employed, the bony dorsum is sculpted to achieve optimal DALs before impaction. Maximum modification can be done with a surface technique, in which the surgeon can combine bony modification and sequential piezoelectric osteotomies for maximum control of the bony vault.

B.S.

If the dorsal aesthetic lines are good preoperatively, they will look even better after use of a low septal strip. With a high septal strip broadness might occur, with extensive lowering or shortening. For this unwanted effect, there are a couple of solutions. If the dorsum is too broad, the cartilage of the dorsum can be partially incised on the new desired dorsal lines. This takes off the tension and narrows the ULC. Finally, if there is serious bulging or broadness of the ULC, release of the ULC from the septal T with trimming of the excess is an efficient solution.

D.M.T.

I manage the dorsal aesthetic lines by preserving them when they are favorable. This is the major upside of the dorsal preservation techniques. If the dorsal aesthetic lines are unfavorable, I use surface modification techniques to reset the DALs. If the bones are asymmetric or too wide, I perform a wide subperiosteal dissection and use PEI to sculpt the bones to a proper width and contour. If the middle vault is too wide, I utilize segmental spreader flaps as previously described. If there are small depressions at the end of the case, I place small soft tissue grafts into the depressions and fixate the grafts transcutaneously with a 6-0 Monocryl suture. If the DALs are too wide or asymmetric in the augmentation rhinoplasty patient or secondary rhinoplasty patient, I use a narrow asymmetrically carved subdorsal cantilever graft to contour the DALs into a straight and symmetric contour.

How Do You Manage Big Humps (>5 mm)?

M.G.F.

Big humps are always a problem per se; most of the time, they are part of a "big nose." The outcomes might be suboptimal with traditional maneuvers, even with a structured approach. In these cases, and with PR, the possible spring effect tends to be bigger, and the final position of the roof is less predictable. The technique is the same but with 2 extra measures: be sure to complete LKA dissection and suture the roof to the remaining septum (only after feeling no resistance)—the "hump apex suture," with 1 or 2 sutures.

A.M.K.

With humps bigger than 5 mm, surface techniques are not employed. The lateral keystone release is extensive with complete or near complete disarticulation of the bones from the cartilaginous vault. Large humps are treated with impaction techniques or SR.

B.S.

For me, the most eloquent technique to manage big humps is a cartilaginous low strip combined with a bony vault letdown (SPQR). With a low strip, one not only lowers but also lengthens the midvault, enabling significant descent of the dorsum without it looking unnatural or broad.

D.M.T.

For larger dorsal humps, I utilize a Tetris or low strip to allow maximal subdorsal control and stability. If there is an S-shaped component to the hump, I take down the bony cap with a rasp or piezotome or use a spare roof type B with a radix graft (if the radix is low). With bigger dorsal humps, managing the potential blocking points is critical to preventing hump recurrence (LKA release, banana osteotomy, subdorsal cartilage/bone removal, periosteal elevation, etc.). I place 1 or 2 transmucosal sutures to help fix the hump in a reduced position. In larger humps, I also place lateral bone sutures that go through holes in the bones along the ascending process of the maxilla to hold the hump down. Another key is to make sure one has excellent stable tip projection and radix position to help camouflage a residual dorsal convexity. In most cases, I employ structure techniques in the tip such as a caudal septal extension graft to maximize tip support and preserve tip projection.[24] This concept is very helpful with larger dorsal humps.

In Primaries, What Are Currently Your Main Contraindications for Dorsal Preservation Rhinoplasty?

M.G.F.

The spare roof technique, like most surface techniques, has no absolute contraindications in primary rhinoplasties. Grossly I apply this technique in all primary rhinoplasties. Exceptionally, extremely difficult primaries demand exceptional adjuvant maneuvers—less than 2% of all primaries, such as severe deformities due to closed trauma and/or severe asymmetric dysmorphias, demand some hybrid procedures in the dorsum or at maximum, a classical structured strategy.

A.M.K.

The main contraindications for DP are severe S-shaped nasal bones, a low radix combined with a low supratip region, severe middle vault asymmetries, complex septal deviations, a preoperative appearance of an inverted V, and any patient for whom I think a structural surgery will be easier and faster to get the same result.

B.S.

I try to do all my primary rhinoplasties with preservation techniques. In 85% I do complete preservation of the dorsum (cartilaginous and bony) and the tip. In the remaining primaries, I use a hybrid approach depending on the anatomy of the nose. Relative contraindications to preservation rhinoplasty are:

- bony vault: S-shaped dorsum, extremely broad dorsum
- cartilaginous vault: severe broadness

Tip: I use a septal extension graft if the tip has very thick skin, if the tip cartilages are very weak, if the desired up rotation of the tip is significant, or if I employ a high strip.

D.M.T.

My indications for dorsal preservation in primaries are very liberal. I use dorsal preservation in greater than 90% of primary rhinoplasties. I utilize dorsal preservation in patients with dorsal humps, deviations, and low dorsums requiring augmentation. I employ structure in primary cases where there are complex bone or middle vault deformities that require structural grafting for complete correction. In the wide nose, I use a hybrid approach, employing rhinosculpture for narrowing the wide nasal bones and segmental spreader flaps for the wide middle vault. I believe dorsal preservation rhinoplasty is contraindicated in cases in which the septum has been previously resected, leaving less than 15 mm of dorsal strut, and cases in which there is disruption of the keystone in the midline due to previous trauma, surgery, or iatrogenic disruption.

When Do You Perform Dorsal Non-Dissection?

M.G.F.

Dorsal non-dissection was first described by Goodale in 1899 in “a new method for the operative correction of exaggerated roman nose”; later it was popularized by Maurel (1940), Gola, and Saban, among others.[1] The dorsal non-dissection is a common step of the spare roof technique B, with exceptions: medium/big bony kyphosis, ULC shoulders or other middle vault irregularities with impact on surface anatomy, big reductions in which redraping of the skin is necessary. The subdorsal osteotomy (radix greenstick fracture) allows complete dorsal preservation without any dissection or perforation of the skin in selected patients.

A.M.K.

When doing dorsal preservation, only with impaction techniques do I not dissect the skin. I do no dorsal skin dissection when the patient has V-shaped nasal bones that do not require any bony modification or rhinosculpture. Osteotomies are performed internally for the low osteotomies and through small stab incisions with ice cold water and a small piezoelectric saw through the transverse nasal incision. The healing is very rapid and the surgeon does not need to worry about damage to the soft tissue envelope (Figure 10).

B.S.

Over the years I have moved toward minimal dorsal skin dissection. In the majority of cases (>95%) the scroll ligament is not opened. Through the hemitransfixion incision, a narrow (3-4 mm) midline tunnel over the dorsum is made, starting at the caudal septal border, extending to the K-area or the sellion if needed. Through this tunnel I then can:

Figure 10. Utilizing the piezoelectric device through the skin of a 35-year-old female patient.

- resect the caudal border of the ULC if shortening the nose by an up rotation of the tip
- rasp the K-area to weaken the hinge or transform an S-shape into a V-shape
- perform the ballerina maneuver (release of LKA) to facilitate flattening of the hump
- add a graft to the sellion or K-area (minced cartilage or bone dust)

Lateral banana-shaped osteotomies are performed through an internal incision on the piriform rim; transverse and radix osteotomies (1-2 mm) are done transcutaneously, eliminating the need for lateral dorsal skin dissection. In cases in which the dorsum is straight and just has to be lowered, no skin dissection at all is done.

D.M.T.
I try to use a "no dorsal skin elevation" approach in all primary rhinoplasties with a V-shaped dorsal hump that do not require rhinosculpture or modifications of the upper lateral cartilages (upper lateral cartilage shoulders, etc.). In these cases, I dissect up to the W-point and leave the dorsal nasal skin intact and undissected. I perform the radix osteotomy from below, the transverse bone cuts through small lateral wall stab incisions, and removal of lateral bone strips through subperiosteal tunnels. The no dorsal skin elevation techniques provide rapid healing and excellent short-term and long-term outcomes. I also frequently employ no dorsal skin elevation techniques when I use a subdorsal cantilever graft to raise the dorsum of the nose.

In Primary Rhinoplasty, What Is Your Percentage of Dorsal Preservation Rhinoplasty?

M.G.F.
>98%.

A.M.K.
70%.

B.S.
85% to 98% (sometimes hybrid).

D.M.T.
>90%.

DISCUSSION

During the last 5 to 10 years, PR has evolved into the current era of advanced preservation rhinoplasty. The vast majority of the problems with traditional PR have been solved due to the persistence of well-known and talented surgeons, turning this practice into a comprehensive set of solutions and strategies that are much more accurate and predictable.[7,10,26-35]

In addition, the "marriage" between 2 iconic and seemingly opposite philosophies—structure and preservation—has become synergistic, improving and merging the best solutions, and now many surgeons use structural preservation rhinoplasty (SPR).[18] Whether a surgeon employs structural techniques, preservation techniques, or a fusion of both depends on the surgeon's comfort as well as their patient population.

A main theme throughout this question and answer session was that the possibility of changing the bone and cartilage shape has expanded the indications for DP. The new concepts of osteoplasty (PEI or burr) and chondroplasty (Colorado needle, laser, or permanent sutures) have entered the era of advanced preservation rhinoplasty.

CONCLUSIONS

Dorsal preservation is making a dramatic resurgence and is fueled by the many talented surgeons who are demonstrating outstanding results with preservation techniques. This group of surgeons has, in many ways, lead the revival and inspires many.[7,10,26-35] We are strong believers that this trend will continue, and that a mutual collaboration between structuralists and preservationists going forward will continue to advance rhinoplasty as a specialty.

Disclosures

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Special Topic

Reassessing Surgical Management of the Bony Vault in Rhinoplasty

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Abstract

Management of the nasal bony vault is an integral part of rhinoplasty surgery, whether reducing the dorsal profile line or narrowing the base bony width. Since 2013, dramatic changes have occurred because of new insights into our understanding of nasal anatomy, how we analyze bony vault deformities, and the introduction of new surgical techniques and technologies including piezosurgery. Therefore, a reassessment and overview of bony vault surgery appears justified. With wide exposure and visualization of the bony vault, we have concluded that all bony vaults are asymmetrical and that the lateral bony wall may be analyzed in 3 axes: longitudinal, sagittal, and transverse. The longitudinal and sagittal axes may be judged as convex, straight, or concave. The transverse axis can be precisely rotated or translated depending on the design of ultrasonic osteotomies. We review this nasal anatomy as well as treatment including sculpting of the nasal bones, as well as different osteotomy patterns. Piezosurgery is certainly a disruptive technology in rhinoplasty that allows bony reshaping with precise osteotomies and sculpting. This versatility allows treatment of any type of bone (thin, brittle, short), mobile bones, and fractured bones. This enables the surgeon to achieve better symmetry with greater accuracy and precision.

Level of Evidence: 5

5
Therapeutic

Editorial Decision date: September 20, 2017.

Management of the nasal bony vault is an integral part of rhinoplasty surgery, whether reducing the dorsal profile line or narrowing the base bony width. During the past 5 years, dramatic changes have occurred because of new insights into our understanding of nasal anatomy,[1,2] how we analyze bony vault deformities,[3] and the introduction of new surgical techniques.[4] Therefore, a reassessment and overview of bony vault surgery appears justified. It should be noted that extensive discussion of the historical evolution of bony vault surgery and the use of piezoelectric instrumentation (PEI) have been previously published by the authors in this journal.[4]

SURGICAL ANATOMY

Anatomically, one must reconcile skull-based anthropometric terminology with surface-based surgical descriptions. The bony vault is comprised of the fused radix area (nasal bones with frontal bone), the paired nasal bones, and the bilateral frontal processes of the maxilla. Throughout this article, we will emphasize surgical terminology. From a

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surgical perspective, we will focus on three components: the radix area, the bony cap, and the lateral bony wall.

Radix Area

The bony vault can be divided at the nasion (N) into a cephalic (radix area) and caudal portion (bony cap). The cephalic radix area is comprised of three distinct bones: nasal bone, frontal bone, and nasal spine of the frontal bone. These three bones fuse in a solid syndesmosis obliterating the original midline suture lines. This solid triangular bony mass is reduced with difficulty, and osteotomies that extend into this area risk development of "rocker formations." Surgically, the vast majority of dorsal humps do not extend above the nasion. Alternatively, there are certain cases where deepening of the nasion in an anterior-posterior plane is necessary, and one must distinguish between muscle mass and bony fullness.

Bony Cap/Keystone Area

The caudal portion of the bony vault is a much thinner *bony cap* covering the cartilaginous vault and the underlying nasal airway. Palhazi et al[2] demonstrated that the nasal bones form a thin *bony cap* over the underlying cartilaginous vault. The cap measures 0.7 mm (range, 0.5-1.0 mm) in thickness at the keystone junction, and clinically, the bony cap extends 10-14 mm cephalically. This anatomical concept of a bony cap, as opposed to the surgical entity of a bony hump, can be explained embryologically. Growth of the nose occurs from the anterior-posterior expansion of the septum rather than from growth of the nasal bones themselves. During puberty, the cartilaginous nasal septum functions as the dominant growth center of the midface. The nasal hump results from the upward thrust of the underlying cartilaginous vault rather than an equal contribution from the nasal bones and cartilage. Thus, *there is no bony hump, only a bony cap* that covers a cartilaginous hump.

The keystone area can be divided into a dorsal and lateral keystone area. The dorsal keystone area (DKA) measures 9 mm in the midline (range, 4-14 mm).[2] The lateral keystone area (LKA) is created by the overlap of the upper lateral cartilages (ULCs) and nasal bones. The degree of overlap is highly variable. However, the amount of longitudinal overlap is greatest along the dorsum. In most dorsal reductions, the osseocartilaginous junction is permanently removed in the midline, and the new osseocartilaginous junction is moved cephalically toward the nasion. Clinically, the mucosa cephalic to the cartilage vault is rarely exposed after the removal of the bony cap. Laterally, the bony-cartilaginous junction moves caudally and posteriorly after hump reduction due to the slope of the pyriform aperture. The management of the LKA is paramount to creating smooth dorsal aesthetic lines (DALs) and must be blended smoothly with the middle vault.

Lateral Bony Wall

The term *lateral bony wall* encompasses both the frontal process of the maxilla and the lateral portion of the nasal bones. Surgically, bony cap reduction is confined to the nasal bones, but lateral osteotomies pass within the frontal process of the maxilla. Anatomically, there is a reciprocal size relationship between the frontal process of the maxilla and the nasal bones: the larger the frontal process, the smaller the nasal bones (Figure 1). Likewise, the lateral extent of the ULC closely corresponds to the nasal bone-frontal process of the maxilla suture line.

The configuration of the lateral bony wall is 3-dimensional (3D) and is crucial in planning lateral osteotomies. There can be distinct variations in the contour of the nasal bones and the frontal process of the maxilla—straight, convex, or concave configurations (Figure 2). Equally variable is the shape and width of the pyriform aperture. The length of the lateral bony wall (distance from the medial canthal ligament to the pyriform aperture on the frontal process of the maxilla irrespective of the nasal bones) must also be considered.

AESTHETICS AND ANALYSIS

Skin-surface DALs as seen on the anterior view help define the aesthetics of the nasal dorsum. Our understanding of the DAL has been advanced in recent years for two reasons: (1) the polygon concept of Çakir; and (2) direct intraoperative evaluation made possible by wide surgical exposure.

Surface Aesthetics

Sheen described the dorsal lines as "two divergent concave lines that are unbroken extensions of the superciliary ridges…which connects the radix with the lateral projection of the crura."[5] Recently, Çakir introduced the concept of polygons for analyzing the aesthetics of the nose.[6] Nasal polygons are geometric forms derived from a composite of lines, shadows, and highlights with specific proportions and breakpoints with variations in males and females. The osseocartilaginous vault is comprised of four polygons: two bony (dorsal and lateral) and 2 cartilaginous (dorsal and lateral) polygons. Importantly, he notes that DAL are not straight, but rather "fusiform"—narrow in the radix, wider at the keystone, and narrow again at the supratip. In addition, there is a lateral aesthetic line that demonstrates the nasofacial groove, which

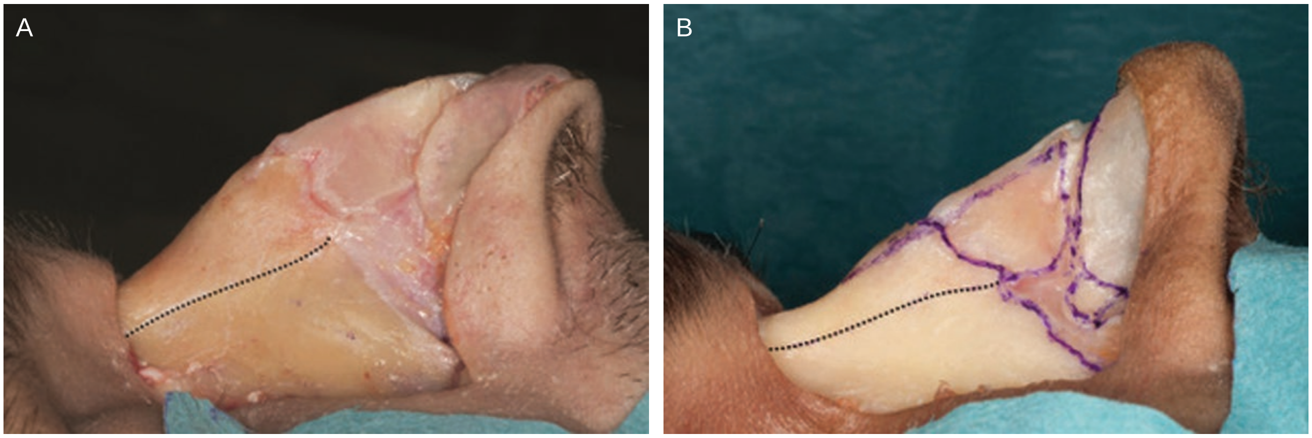


Figure 1. (A, B) There exists a reciprocal relationship between the sagittal length of the lateral bony wall and the frontal process of the maxilla. The longer the frontal process, the shorter the length of the nasal bone.

is the junction between the angulated frontal process of the maxilla and the maxilla itself. The polygon concept of nasal analysis can be expanded to the interface between the nose, radix, and central brow.[7] Essentially, there are three polygons: glabellar, medial orbit, and superomedial orbit.

Clinically, the DAL and lateral aesthetic lines are connected by the lateral bony wall, with its corresponding shadowing. As noted in the anatomy section, the lateral bony wall can be thought of as having three axes: longitudinal (cephalic to caudal), sagittal (anteroposterior), and transverse (lateral to medial). The longitudinal and sagittal axes can vary from straight to convex to concave. Importantly, the transverse axis can be translated or rotated (Figure 3).

Clinical examination of the nose preoperatively is paramount for analysis. First, the skin thickness must be assessed, because the skin is frequently thinner in the keystone area and also near the medial canthus.[8] Nasal bone characteristics are assessed through palpation to estimate the length and width of the bony vault, as well as the shape of the bone segments (straight, convex, concave). In the case of secondary rhinoplasty, palpation can demonstrate irregularities, osteotomy level and type, residual bone width, etc.

Radiography

Nasal bone thickness and angulation can be assessed through preoperative radiological examination. The cone beam is preferred to the CT scan, because it requires less radiation and is less expensive. This test allows a very precise bone thickness measurement on any computer. This thickness can be especially important in the LKA, because it will help in deciding between sculpting down this area or doing a medial oblique osteotomy.

Surgical Observations

The complete bony vault was rarely visualized by surgeons until the introduction of the "wide exposure" necessary for piezoelectric osteotomies.[4] After elevation of the periosteum, we gain exposure from one maxilla to the other, and the following observations can be made:

1) The bony vault is always asymmetric in shape and frequently there is a more pronounced convexity at the LKA on one side
2) The shape of the medial component in terms of width and the lateral component in terms of straight, convex, or concave can be perfectly analyzed. This analysis will dictate the type of osteotomy and/or sculpturing performed, but also sometimes the need for concavity concealment with diced cartilage, bone dust, or other graft material
3) The exact location of the bony cap removal can be assessed not only on the dorsal segment, but also on the lateral segment. Asymmetric sculpting and removal avoids length discrepancies after medial oblique osteotomies.

OPERATIVE SEQUENCE FOR MANAGING THE BONY VAULT

Traditional management of the bony vault has evolved to avoid overresection and to conserve cartilage. First, the dorsum is reduced using an en bloc, split, or component technique followed by osteotomies. Although one can achieve good results with traditional instruments, problems still occur, including overresection, asymmetries, and unreliable movement of the nasal bones. These issues are related to the inability to visualize the bony vault and to the inherent disadvantage of traditional instrumentation. With the advent of PEI, greater precision has become possible. Although wide

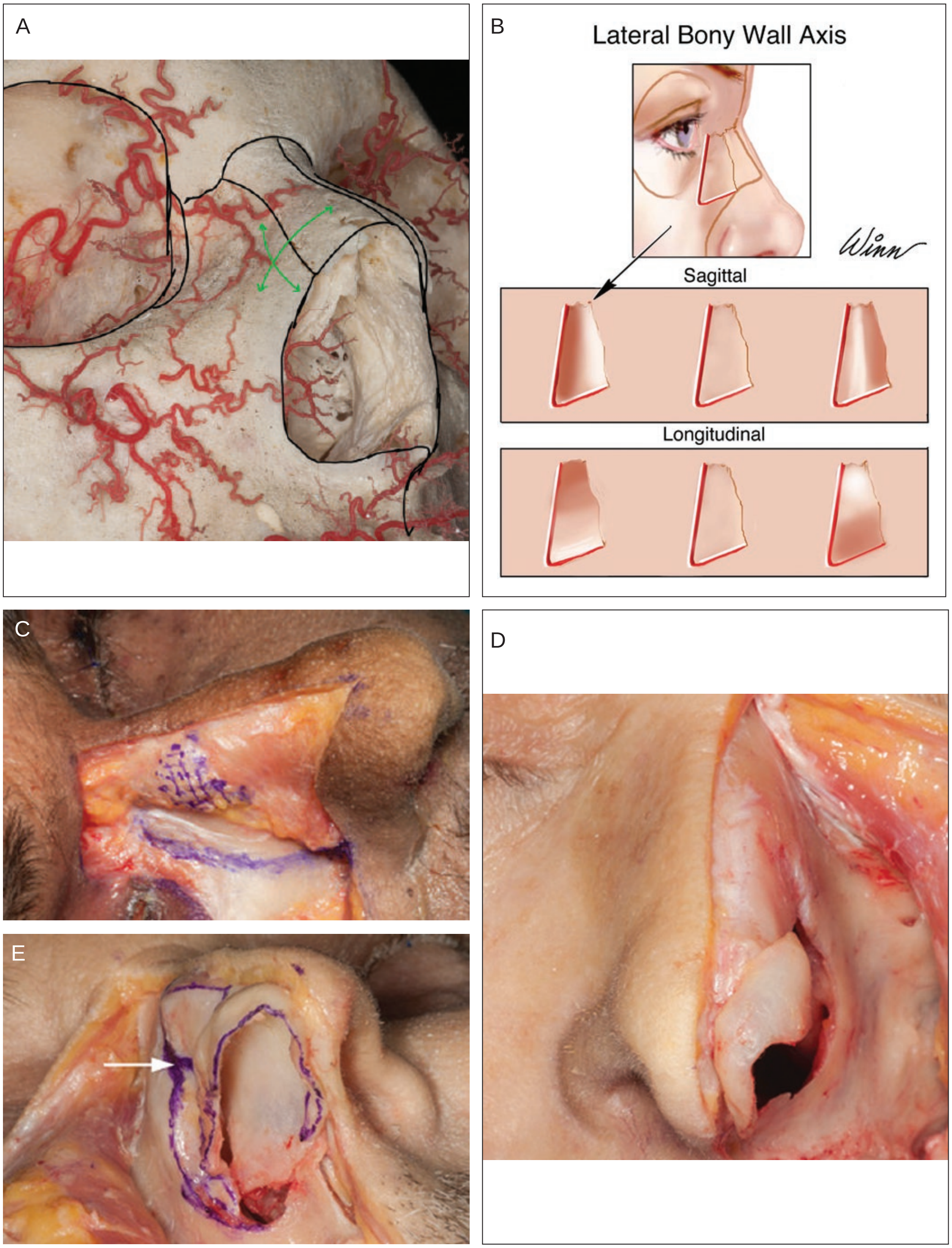


Figure 2. (A) The longitudinal and sagittal axes of the lateral bony wall are shown. (B) The longitudinal and sagittal axes may be convex, straight or concave. Cadaver dissections demonstrate sagittal axes that are (C) convex, (D) straight, or (E) concave.

variations are possible to accommodate the anatomical variations encountered, a standard operative sequence is as follows: (1) wide subperiosteal undermining; (2) bony cap removal; (3) osteotomies; and (4) midvault reconstruction.

Wide Subperiosteal Exposure

Since 2014, an extended bony vault degloving has been used for all primary and secondary rhinoplasties performed

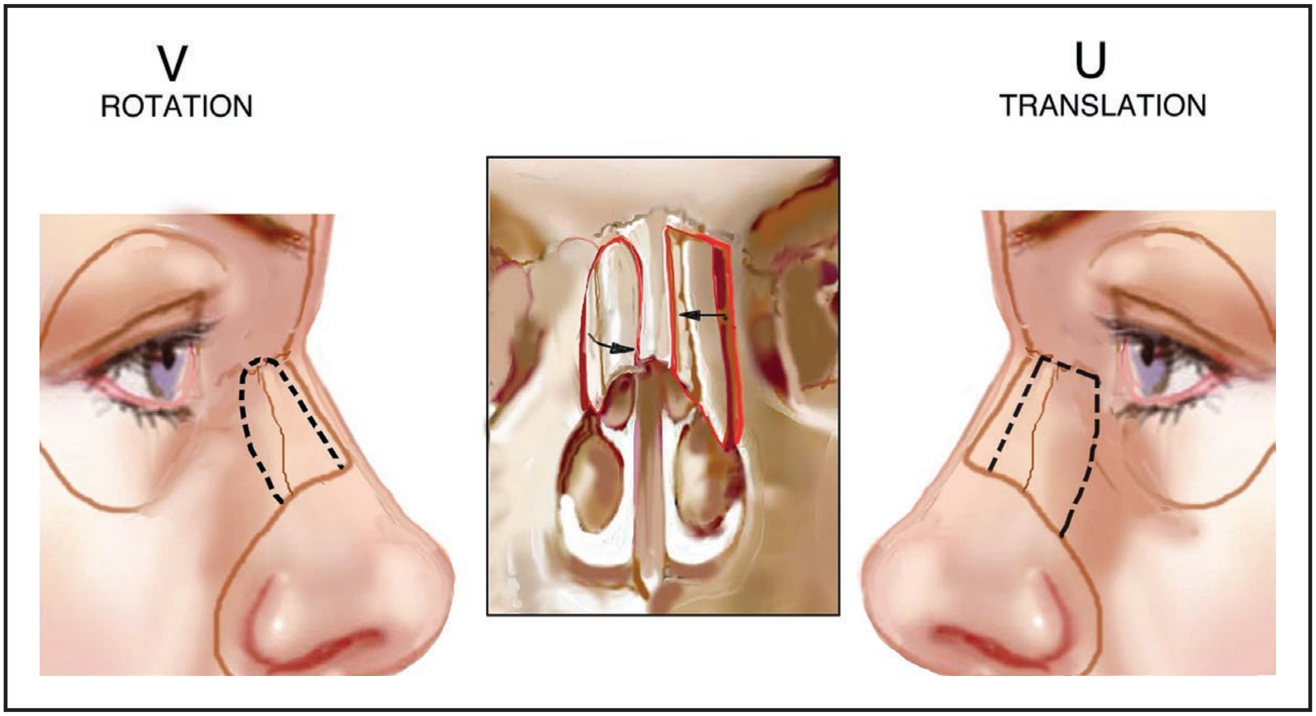


Figure 3. The transverse axis of the lateral bony wall can be rotated with V-shape osteotomies, and translated with U-shape osteotomies.

by the primary (O.G.) and junior authors (A.K.), except when no bone modification was planned. The dissection is initiated at the level of the anterior septal angle in a supraperichondrial or subperichondrial plane and continued above the cartilaginous dorsum until the bony junction. Then, using a sharp Daniel-Çakir elevator, the subperiosteal plane is entered in each LKA for ease of dissection and then connected in the midline that is much more adherent. The subperiosteal undermining is extensive. Beginning at the keystone junction, it extends dorsally up to and beyond the nasion, then laterally toward the medial canthal ligament, and then caudally along the frontal process of the maxilla. Any perforating vessels are cauterized in the bony foramen with a curved Colorado needle. As one approaches the pyriform aperture, it is often necessary to cut the *vertical* pyriform attachments and stretch the *transverse* pyriform ligaments to gain adequate exposure (Figure 4).[9] Next, the dissection is extended approximately 1cm lateral to the nasofacial groove out onto the horizontal anterior surface of the maxilla. With this exposure, it is possible to totally analyze the bony vault deformity and to gain access for surgical instrumentation.

Management of the Dorsal Hump

Once the extensive subperiosteal dissection and a "dorsal time out" to reassess the planned dorsal surgery are completed, then the bony cap is removed in the medial and lateral keystone areas. Traditionally, this is followed by splitting the ULCs from the dorsum and an anterior dorsal resection. However, only the bony cap removal is done initially, and the actual reduction of the cartilaginous vault is performed after the osteotomies, and this is a major change from traditional rhinoplasty surgery.

Bony Cap Removal

As shown in previous anatomical studies, the osseocartilaginous dorsal hump consists of a thin bony cap overlying an arched cartilaginous vault.[2] Rather than use an osteotome, incremental bone removal not only is limited to the central area of the hump but also extends to the LKA if it is too convex. The bone is removed with a coarse PEI rasp first (RHS2H) and then with a finer rasp (RHS2F). The bony DALs can be sculpted by tilting the rasp horizontally on the medial keystone and obliquely on the lateral keystone. When the dorsal hump extends to the nasion or if the radix must be significantly reduced, then a scraper (RHS1) is used followed by a rasp (RHS2F) for refinement. Because PEI does not harm soft cartilaginous tissues, the bony cap can be removed without affecting the underlying ULC or even the mucosa in cases of very significant and cephalic humps. Thus, in contrast to the use of osteotomes or chisels, there is never an open roof with PEI. The roof is only opened if necessary when the ULCs are split off, and then it is closed with the subsequent midvault reconstruction. Moreover,

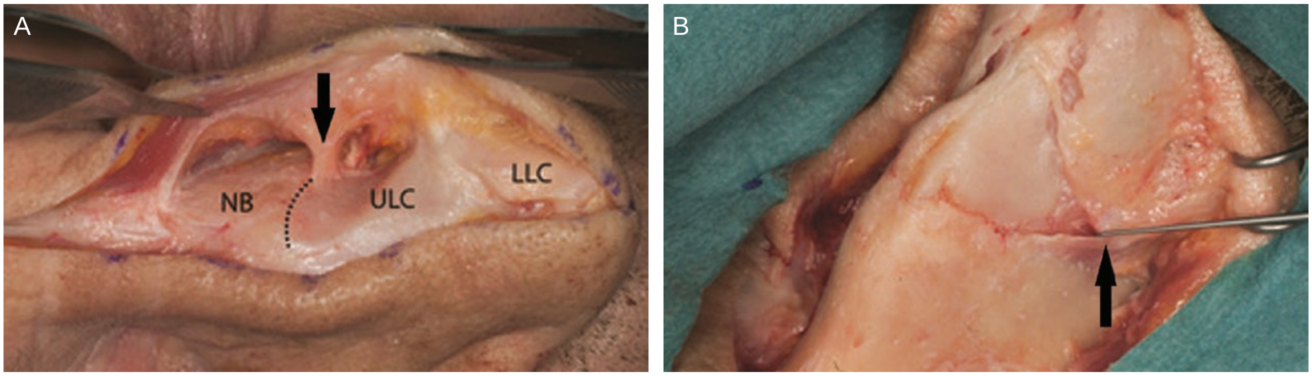
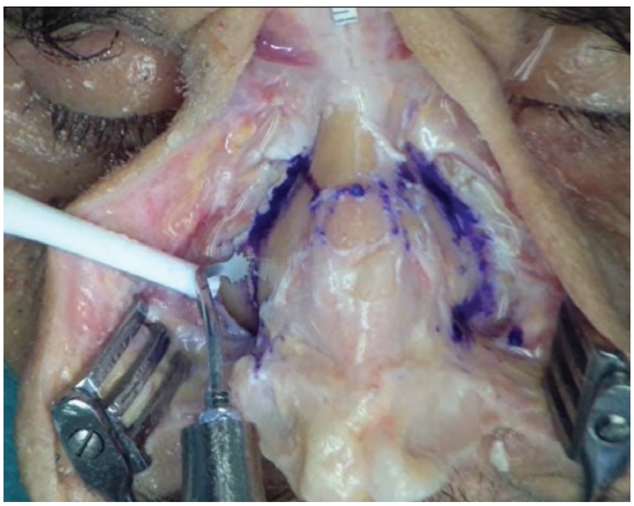


Figure 4. To accurately perform piezo osteotomies, good visualization and exposure are paramount. After subperiosteal dissection of the entire bony vault, release of the (A) vertical pyriform attachments and (B) transverse pyriform ligaments is often necessary. NB, nasal bone; LLC, lower lateral cartilage; ULC, upper lateral cartilage.



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the attachments between the posterior periosteum of the remaining nasal bones and the anterior perichondrium of the ULC are preserved, favoring the middle third for stability and a smooth osseocartilaginous transition.

Osteotomy Sequence

Historical Perspective

To understand the current osteotomy sequence, one must review the historical progression of how modern osteotomy techniques evolved. Since the time of Joseph, lateral osteotomies have been done to narrow the broad nose following hump reduction.[10] Initially, osteotomies were performed with saws placed in the nasofacial groove and continued from the pyriform aperture to above the medial canthal ligament. Once the osteotomies were completed, digital pressure was used to move the bones medially. Millard added medial osteotomies to all his rhinoplasties to facilitate bony movement.[11] Once both osteotomies were done, the nasal bones were "outfractured" followed by "infracturing" to achieve complete movement of the lateral bony wall. Ultimately, surgeons switched to chisels and osteotomes, because they were less traumatic, so the surgeons did infracturing only. Limited skin undermining was emphasized to promote stability of the mobilized bones. Tardy used 2 mm micro-osteotomes for medial oblique osteotomies followed by low lateral osteotomies.[12] Sheen advanced the concept of the *low to high osteotomy* that begins low on the pyriform aperture and ascends across the frontal process of maxilla ending at the nasal bone.[5] Narrowing of the nose and closure of the open roof is accomplished with a transverse greenstick fracture. In contrast, the *low to low osteotomy* remains within the frontal process of the maxilla and requires another osteotomy to pass from its cephalic termination into the open roof, either through a previous medial oblique osteotomy coming down from the open roof or a transverse osteotomy.

The longitudinal extent and location of lateral osteotomies has changed dramatically from Joseph's original design. First, surgeons realized that there was rarely a need to go above the medical canthal ligament and that doing so risked significant bony irregularities. In the vast majority of cases, the bony vault is "narrow-waisted" at the level of the medial canthal ligament and the bone above is fused and prone to visible rocker formation. Next, surgeons began to place the lateral osteotomy significantly more anterior away from the nasofacial groove and the face of the maxilla. Also, the goal was no longer complete mobilization of the lateral nasal wall, but rather inward tilt and stabilization. In 1977, Webster proposed that a triangle of bone be preserved at the pyriform aperture to maintain an intact airway below the level of the inferior turbinates.[13] He advocated use of a curved lateral osteotome placed more anteriorly and superiorly. This dictum led to the concept of a "high-low-high"

Figure 5. (A, C, E, G) Preoperative views of a 31-year-old woman who complained of a wide nose who was found to have a convex left nasal bone. (B, D, F, H) Following bony cap removal, bilateral U-shape piezo osteotomies, and additional rasping on the left lateral bony wall, better symmetry and contour of the bony dorsum can be seen at 1 year postoperatively. Spreader flaps were used for midvault reconstruction as well as a septal extension graft and tip suturing.

lateral osteotomy. Surgeons disagree on whether this triangle needs to be kept intact to maintain airway patency.

Lateral Osteotomy

The first osteotomy cut is done very caudally on the frontal process of the maxilla with a thin saw (RHS5) or with the fan-shape lateral saw (RHS3 L and R). This low initiation point is in direct contrast to the high starting point used by those who favor the preservation of Webster's triangle. The reasons for not preserving a Webster's triangle are two possible aesthetic deformities: (1) excessive base bony width near the alar crease; and (2) palpable bone excess. If endonasal assessment after completion of the full osteotomy sequence shows that the inferior turbinate moves significantly inward, then a mucosal reduction with radiofrequency and/or a bone reduction (inferior nasal concha) with a long piezo saw or outfracture could be performed. If this endonasal assessment shows that the pyriform aperture edge moves too much inward, then it can be reduced with a rasp or a scraper. Since 2013, we (O.G. and A.K.) have not found a need for these refinements.

Next, the lateral osteotomy is continued in the nasofacial groove using a fan-shape piezo saw (RHS3R for the left side and RHS3L for the right side). This cut follows the nasofacial groove in a cephalic direction until the point where the width of the bony vault is aesthetically correct. If the radix is narrow, there is no need for the lateral osteotomy to go above the medial canthal ligament (MCL). Conversely, if the radix is wide, the lateral osteotomy follows the groove above the MCL. After the lateral osteotomy is completed, the amount of bone movement is checked with an elevator. Most surgeons are surprised that 2 to 5 mm of transverse medial bony movement along the frontal process of the maxilla can and does occur following only a lateral osteotomy. Significant narrowing of the base bony width occurs with just a lateral osteotomy in many cases. If the movement is sufficient without a significant spring effect and the bone orientation is correct, then the osteotomy sequence is stopped. However, if the lateral osteotomy did not achieve sufficient narrowing, then the following options are considered: (1) if the dorsum is wide, a medial oblique osteotomy is done; and (2) if the dorsum is ideal, then a transverse osteotomy is done.

Transverse Osteotomy

The transverse osteotomy is performed with an angulated, thin piezo saw (RHS4L for the right side and RHS4R for the left side). It begins at the cephalic termination of the lateral osteotomy and continues horizontally until the point where this line would meet a theoretical medial oblique osteotomy (even if this osteotomy is not performed). At this point, bony movement is again checked with an elevator. If the mobilization and orientation of bones are correct, then the osteotomy sequence is ended. If not, then a medial oblique osteotomy is added.

Medial Oblique Osteotomy

This osteotomy is performed with the same thin saw (RHS5) used for the initial osteotomy. It begins on the LKA at the point where the ideal DAL should be. It is usually oriented toward the medial eyebrow, and there are two possibilities regarding how this osteotomy is used to effect nasal bone movement. First, when the medial oblique osteotomy is combined with only a lateral osteotomy, an intact bony hinge remains. This results in a V-shape osteotomy. This combination is done to narrow the dorsal lines, to increase medial movement of the lateral bony wall, and to allow slight verticalization of the bone. This combination is favored when the bones are thin or fragile and less movement is needed. The second option is to do a complete continuous osteotomy composed of lateral + transverse + medial oblique osteotomies to "translate" the nasal bone medially in its original orientation. This results in a U-shape osteotomy. After this complete fracture, drill holes and sutures can be used to precisely fine-tune the nasal bones if needed.

Finishing Touch

Smoothing of the osteotomy edges and bony dorsal edges are done with a fine piezo rasp (SL1). Palpation of the nose with wet gloves should find no rough areas; otherwise, they should be smoothed out. This assessment can even be done at the end of the procedure, when the columella is sutured, allowing a final touch through the infracartilaginous access.

It should be noted that there is not any bleeding from the nostrils during the procedure, because the mucosa is intact with PEI. Infiltrating the lining before the osteotomies helps to prevent any rare mucosal tears that occur from pushing too hard on the instruments.

MOVEMENT OF LATERAL BONY WALL AND OSTEOTOMIES

Nasal bone movement depends on the path of the osteotomies. With classic osteotomies, bones are supposed to fracture on the path of least resistance, or to have a greenstick fracture. If these maneuvers are insufficient, more digital pressure is applied and osteotomies can be added.

Most frequently, the osteotomy pattern has either a V- or U-shape pattern (Video, available online as Supplementary Material at www.aestheticsurgeryjournal.com). The V-shape osteotomy consists of a lateral low to high and a medial oblique osteotomy with an intact bony hinge. The U-shape osteotomy consists of a lateral low to low osteotomy plus a transverse and medial oblique osteotomy. When V-shape osteotomies are done, there is a hinge at the junction of the two osteotomies that prevents the translation of the bone inwards. In this case, the bone medializes by rotation. This rotation makes the bone more vertical and can alter aesthetics of the sidewall. The result is a tubular appearance of the dorsum, with a vertical shadow laterally and a vertical light area in the middle of the dorsum. When U-shape osteotomies are performed, the lateral bony wall can translate medially without restriction. The two edges of the bone stay end to end on the medial oblique fracture line with minimal angulation on the osteotomy line. Osteotomies are more commonly performed with a U-shape pattern, to narrow the bony vault without altering the aesthetic features of the nasal sidewalls (Figure 5). The bones are moved inward but remain stable, even if complete osteotomies are performed. The primary indication we have for V-shape osteotomies is when the bony vault is wide and flat, and/or bone verticalization must be done. This happens often for "ethnic noses."

Overall, the ability to change the shape and orientation of osteotomies under direct visualization is the biggest advantage we have seen with piezosurgery that makes it truly a disruptive technology. Because all bony vaults are asymmetric, it is not uncommon to do a V-shape osteotomy on one side and U-shape osteotomy on the other. Likewise, at times, an osteotomy is done on one side and ultrasonic rhinosculpture is done on the other.

ULTRASONIC RHINOSCULPTURE

When the bony vault has minimally excessive width and minimal dorsal reduction is indicated, then a thinning of the entire bony vault can be performed with a PEI rasp. This means that no osteotomy is performed, but rather a rasping of the entire bony pyramid, especially the more convex areas, is done. The advantages are that the bones remain perfectly stable and there is very little bruising after the surgery. The new bony dorsal aesthetic lines can be sculpted (Figure 6). Care must be taken not to use rhinosculpture when a significant narrowing of the bones is indicated. At the beginning of his experience with rhinosculpture (2013-2015), the primary and junior authors (O.G. and A.K.) "pushed" the indications of rhinosculpture to cases where osteotomies would have been indicated. In some cases, the bony vault remained too wide. After a minimum of 6 months, a second operation was successfully performed with osteotomies (Supplemental Figure 1).

BONE MANAGEMENT IN ETHNIC RHINOPLASTY

Many people from African or Asian descent have a flat dorsum and wide nasal bones. Likewise, ethnic rhinoplasties usually include dorsal augmentation, tip refinement, and alar base modification. Usually, the nasal bones are left untouched. However, the bony vault may remain too wide in many cases, even though the width is more balanced with a new profile line. Moreover, a step deformity can occur at the junction of the overlay dorsal graft and the underlying bony vault, because there may be a width discrepancy between both if the bony vault is not narrowed.

When the bony vault is very wide, we do not hesitate to do lateral osteotomies. These osteotomies are more difficult, because the bones are very dense and further from the midline. In most cases, a low and sometimes transverse osteotomy are enough to narrow the bony vault significantly. In these cases, any verticalization is beneficial. In the treatment of ethnic noses, incorporating narrowing of the bony vault has improved the overall result (Figure 7 and Supplemental Figure 2). The risk of unwanted fractures, bone instability, and bone collapse has also been reduced with PEI.

BONE MANAGEMENT IN SECONDARY RHINOPLASTY

Until the introduction of widespread subperiosteal exposure, the bony deformities found in secondary rhinoplasty cases were difficult to understand and treat. One should consider previous osteotomy location, direction, and completeness as well as the stability and comminution of the lateral bony wall. One can divide secondary bony deformities into the following categories: surface irregularities, contour defects, and lateral bony wall deformities.

Surface Irregularities

These bony irregularities most commonly occur in the following areas: (1) dorsally where the bony hump was removed; and (2) along the bony edges of greenstick fracture lines or previous osteotomy. The irregularities are much more frequently noticeable in thin-skinned patients. Treatment of surface irregularities is usually done with a piezo rasp.

Contour Deformities

One of the most common secondary bony vault problems is contour asymmetries. Previously, the solution was a combination of fine rasping and osteotomies done blindly. With wide exposure, the problem can actually be seen and treated directly often with ultrasonic rhinosculpture. With a fine rasp, one can sculpt a wide nasal bone down to match the narrower bone, whereas previously the surgeon was unaware of intrinsic thickness and tried to narrow the wide side with an osteotomy. The most frequent etiology of residual bony convexity is a failure to correct the original preoperative deformity with uneven osteotomies (ostoeotomies performed at different levels). The residual convexity is treated either by rasping if the bone is sufficiently thick or by criss-cross osteotomies if the bone is thin.

Figure 6. (A, D, G) Preoperative views of a 26-year-old woman who presented to the primary author (O.G.) and complained of a wide bony vault and wide nose overall. She was found to have a slightly wide dorsum amenable to ultrasonic rhinosculpture. Spreader flaps and tip suturing were done to reconstruct the middle vault and tip. (B, E, H) Six days and (C, F, I) 11 months postoperatively, the patient has aesthetic and appropriately narrow dorsal aesthetic lines.

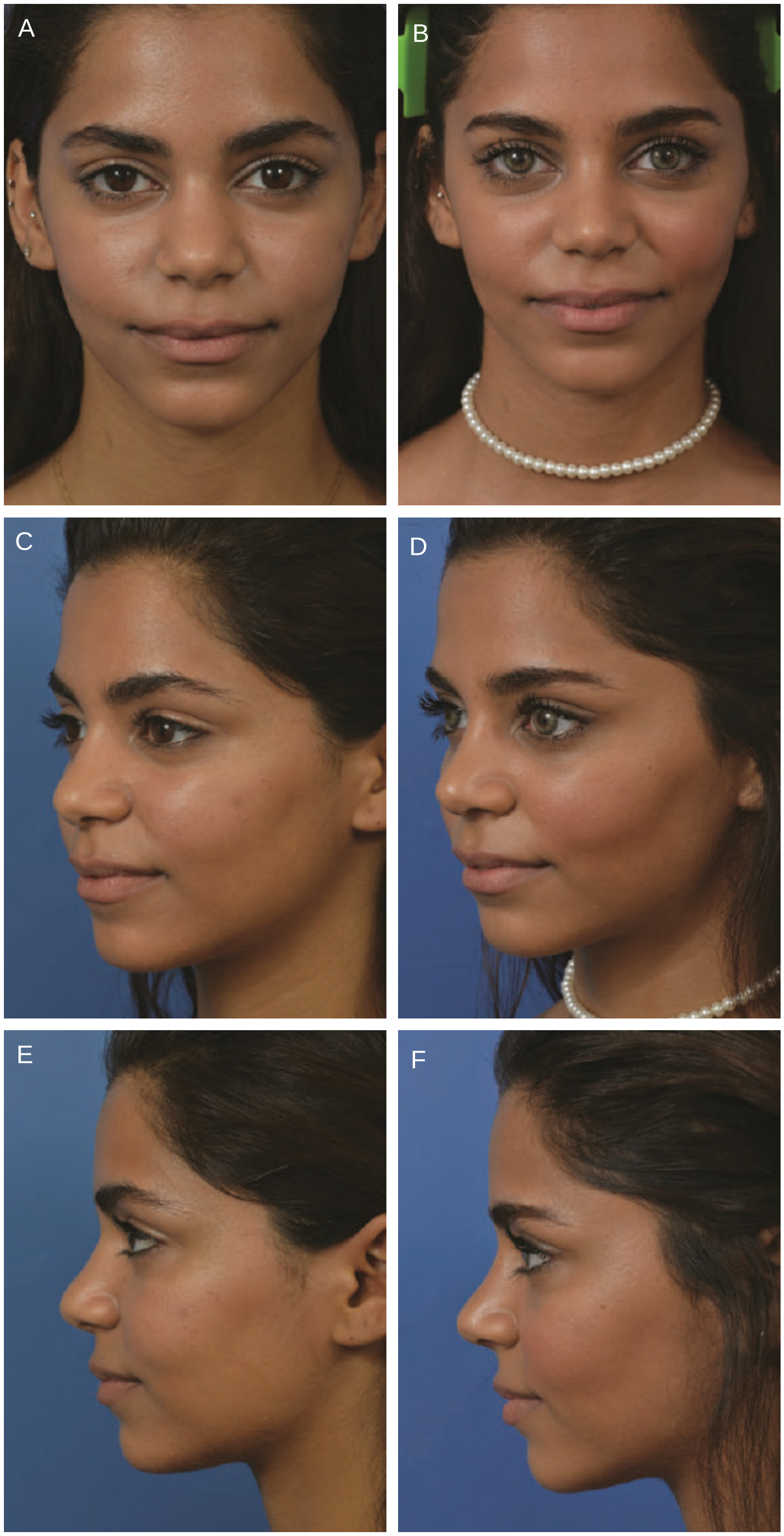

Figure 7. (A, C, E) Preoperative and (B, D, F) 13-month postoperative result of a 19-year-old woman from Qatar who presented to the junior author (A.K.) with a wide, flat dorsum and extreme convexity of the lateral bony walls. Piezo saws were used to harvest ethmoid bone in continuity with septal cartilage. The tip was supported on a septal extension graft, and a radix graft was done. V-shape osteotomies were done to verticalize the lateral bony walls and to narrow the dorsum from 18 to 6 millimeters.

Lateral Wall Problems

Challenges in the lateral bony wall include "step deformities" associated with previous osteotomies and the position of the wall with either inadequate or excessive movement. Step deformities can have moderate palpable separations and major level discrepancies. If a redo osteotomy is not indicated for positional or rotational reasons, then the bony edges can be smoothed with a fine rasp and/or filled with very finely diced cartilage to eliminate palpability. If there is a significant level discrepancy between the two sides of an osteotomy, multiple drill holes are placed through both bones, the lower side is raised, and one to three sutures are inserted with 4/0 PDS on a P3 needle. If there is still a gap after the fracture osteosynthesis, it is filled with a cartilage paste obtained by scratching a piece of cartilage with a number 15 blade or with diced cartilage.

If there was a failure to medialize the lateral bony wall and the bony vault remains too wide, then the lateral osteotomies are repeated, but in a more lateral position. When the lateral osteotomy is correctly located but inadequate movement is achieved, then a transverse osteotomy and/or a medial osteotomy are adequate to allow complete mobilization.

If excessive bony movement is present, it is usually associated with verticalization of the bony wall. Verticalization is related to bone rotation, with the thick lower posterior base moving medially and the thin anterior portion moving laterally. This rotation results either from the osteotomy design, or from excess narrowing. Excessive movement is usually treated by grafting the lateral aspect of the bone with diced cartilage or other camouflage. Another option is to do a paramedian and transverse osteotomy to outfracture the bone and to place a long spreader graft to stent the bone in the correct position.

REFINEMENTS/COMPLICATIONS IN PIEZOSURGERY

With any new technology or technique, there are refinements and complications that occur during initial adoption. Pushing the indications for ultrasonic rhinosculpture when osteotomies are indicated has already been discussed above. Since the adoption of piezosurgery by the authors, over 750 rhinoplasties have been performed, with few complications. Because this is the combined work of four authors over a multiyear period, detailed demographic data about the patients treated were not available. The following is a list of issues and refinements that have been made over the last years:

- The piezo device requires water to assist in ultrasonic vibration and to prevent heating. If water flow is too low, the device can get hot, and a few burns to the skin were observed near the nostrils. At the time of surgery, these were seen and excised without issue to prevent untoward healing. Water flow is paramount to preventing this issue. The waterflow should be at least 50 ml/min to avoid any skin or bone burning.
- Suction retractor and suction speculum are very useful to ease the procedure and overflooding by the water outflow.
- It has been demonstrated that bruising and swelling are decreased with piezo osteotomies as compared with conventional instrumentation.[14,15] After the osteotomies are completed, dilute steroid is injected next to the bone cuts, and a small drain hole is made in the intra-nasal mucosa to allow for drainage. Subjectively, this has further decreased swelling/bruising after surgery but has not formally been studied. We have found no contraindications to the wide subperiosteal exposure.
- To avoid favoring fluid collection in the lateral area of the bony vault dissection, large splints must be used. A narrow preshaped splint may compress only the median part of the undermining, favoring a lateral fluid collection.
- In a few patients over a 4-year period, the primary and junior authors (O.G. and A.K.) have had noticed a buildup of soft tissue callus in lateral osteotomy sites 3-4 weeks after surgery in 3 patients. Dilute steroid has been injected into the callus (under ultrasonic guidance in the senior author's practice), and this has resolved. In one case, a second injection was necessary. This is not due to the wider area of dissection, but rather secondary to the bone emulsification along the osteotomy lines.
- The cost of the piezo device and disposable inserts is different in every country. The cost of the device can be up to $10,000, and inserts can each cost over $100. Currently, we are hopeful that reusable inserts are on the horizon. Although this technology is more expensive than osteotomes, all of the advantages described above certainly make it worth it.

CONCLUSIONS

Since the origins of rhinoplasty, wide exposure of the nose was taboo, even with the "open" approach to prevent bone collapse. With the accuracy of bone reshaping and mobilization with PEI, extending the bone dissection to the whole nose, including the bony vault, is safe and allows full visualization of the nasal bones before and after osteotomy.

Piezo surgery is a disruptive technology in rhinoplasty that allows bony reshaping with precise osteotomies and sculpting. This versatility allows the treatment of any type of bone (thin, brittle, short), mobile bones, and fractured bones. This enables the surgeon to achieve better symmetry with more accuracy and precision. Piezo surgery may reduce significantly defects of the bony vault and the keystone area in rhinoplasty, and it adds new options in bone reshaping and in the treatment of bony defects.

Supplementary Material

This article contains supplementary material located online at www.aestheticsurgeryjournal.com.

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My First Twenty Rhinoplasties Using Dorsal Preservation Techniques

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KEYWORDS

• Preservation rhinoplasty • Dorsal preservation • Dorsal hump reduction • Profile alignment • Subdorsal Z- flap • Tetris flap • Foundation techniques • Push down

KEY POINTS

- Dorsal preservation preserves the native dorsal esthetic lines and avoids middle vault reconstruction.
- Surface techniques involve modification of the bony cap and foundation techniques involve bone cuts (push down or let down) with impaction of the bony nasal vault. Subdorsal modification acts to stretch the dorsal hump flat.
- Structure techniques can be used in the nasal tip with dorsal preservation for the upper two-thirds to execute a hybrid structural preservation rhinoplasty.

Video content accompanies this article at http://www.facialplastic.theclinics.com.

Preservation rhinoplasty is a philosophy of rhinoplasty that is based on the concept of "preserving" as much of the natural anatomy of the nose as possible. The term "preservation rhinoplasty" was coined by Rollin K. Daniel and has become a rather popular movement in recent years.[1] Preservation rhinoplasty can be broken down into 3 different components that include subperichondrial/subperiosteal dissection plane with preservation of the ligamentous structures, maintenance of the alar cartilages with reshaping performed primarily through suturing, and preserving the natural dorsum with possible minor surface modification without creating an "open roof deformity." I believe all these components have merit but the most intriguing to me is the concept of dorsal preservation, which will be referred as "DP" from here moving forward. Many would consider Yves Saban as the person most responsible for the resurgence of DP in recent years.[2] The history behind DP is quite lengthy dating back to Goodale in 1899 and Lothrop in 1914 and has been accurately chronicled by many.[3] DP fell out of favor with the introduction of reductive techniques and open structure rhinoplasty only to make a strong comeback in recent years.

I have always been bothered by the action of excising a pristine, nicely contoured nasal dorsum to reduce a dorsal hump, only to have to put it back together with spreader grafts and/or spreader flaps. The concept of leaving the nicely contoured nasal dorsum intact and reducing it from below, appeared to be such a sensible approach. Initially, I was intimidated by the concept of manipulating the upper dorsal septum below the hump and making bone cuts to "push down" and flatten the hump. However, I was attracted to the concept and set out to try it.

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In this article, I will take you through my first 20 DP cases to provide some insight into the nuances of such a dramatic change in my technique for profile alignment. I will focus on the earlier cases where I had problems to provide information to help surgeons potentially prevent issues early on in their own experience.

CASE #1

I searched for the ideal case to be my first attempt at DP. Listening to the experts, it was made clear to me that the ideal candidate would have a V-shaped dorsal hump with a straight-line contour from nasion to rhinion. A less favorable candidate would be a patient with an S-shaped hump who has a pronounced angulation from nasion to kyphion (most prominent point of the dorsal hump; **Fig. 1**).

I also wanted to choose a case where the patient was accepting of a residual dorsal convexity. In June of 2019, a patient presented who wanted a reduction of her dorsal hump but did not want to change her frontal view and desired to keep some of her dorsal convexity. The problem was that she had an S-shaped dorsal hump and a slightly low radix. However, I saw this as an opportunity to do a conservative DP procedure. I performed her case endonasally, and used the Saban style subdorsal high strip technique with rasping of the bony cap and placement of a small radix graft (**Fig. 2**). For the osteotomies, I performed bilateral lateral osteotomies and bilateral transverse osteotomies leaving a hinge (green-stick) at the radix to prevent

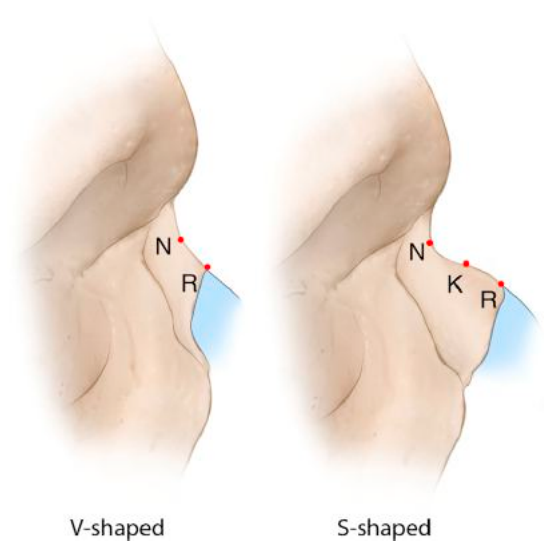


Fig. 1. The V-shaped and S-shaped dorsal humps. (Reprinted with permission from Toriumi DM, Davis RE. Marina Medical Rhinoplasty Cadaver Dissection Course Videos. St. Louis: Quality Medical Publishing; 2021.)

lowering the radix. The lateral osteotomies were performed intranasally and the transverse bone cuts were performed via small lateral wall stab incisions. Before the surgery, I consulted with both Yves Saban and Aaron Kosins who were both very helpful. The surgery went well, and she is happy with her outcome. Her hump is less prominent, and her frontal view is the same by her request. I believe my deficiencies were not extending my subdorsal strip to the W-point where the dorsal septum meets the upper lateral cartilages. This left the supratip too high (see **Fig. 2**C right). I was very conservative with the tip because she did not want it changed so I just placed an endonasal columellar strut. She probably would have benefited from a little more tip projection as well. In this case, I was very conservative to avoid any possible complications.

In retrospect, I thought it went well for my first case and she had no problems postoperatively, and more importantly, she is happy with her outcome. I learned a great deal from this first case. My take home points are as follows. Early on, try to pick cases where the patient would be acceptable of a small residual hump. Many male patients will look good with a small dorsal convexity and may be willing to have a small residual hump. Use an endoscope if you can to better visualize the upper dorsal area where you will be working. One of the more difficult aspects of your execution will be the osteotomies. If you have access to the Piezotome, that will simplify the bone cuts. With my first 20 cases, I did not have access to the Piezotome, so I used 2 mm and 3 mm osteotomes. Starting out it is tricky to make the bilateral lateral, bilateral transverse, and radix osteotomies (**Fig. 3**). In the early cases, it will make it easier if you dissect widely over the nasal dorsum so you can directly visualize the execution of the bone cuts. This wider dissection can result in some increased swelling and bruising so I would recommend a good injection of 1% lidocaine with 1:100,000 epinephrine and also inject tranexamic acid (1000 mg in a 10 mL vial diluted into 60 mL of normal saline) into the tissues around the osteotomy sites.

It is important to avoid placing excessive force on the ethmoid bone while manipulating the bony vault. You can help prevent disruption at the skull base by performing your subdorsal work and releasing the septum from the nasal bones before you make your external bone cuts.[4] This sequence will minimize movement of the bony vault until you have removed the subdorsal strip and extended the subdorsal cut to meet the radix osteotomy. The cartilaginous septum extends close to the radix osteotomy in most patients making the bony cut relatively short.[5] You can avoid a radix step-off by angulating your radix osteotomy, so the

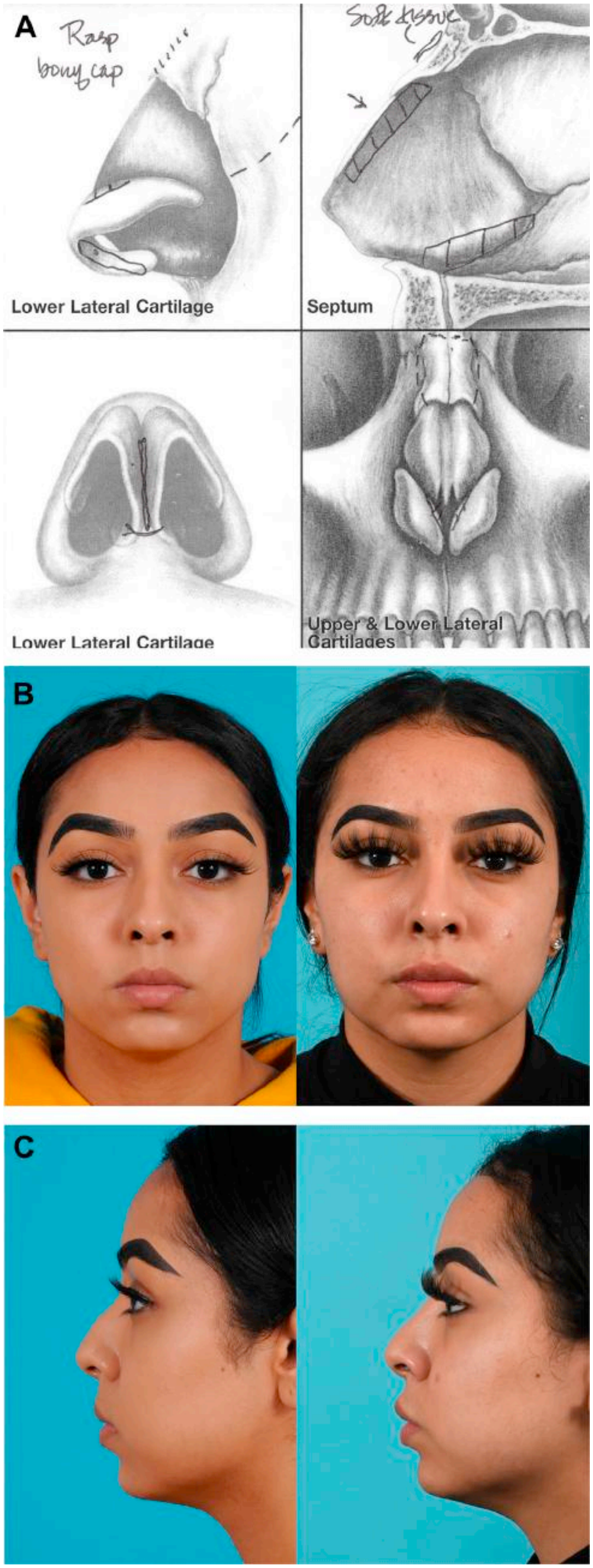


Fig. 2. Case #1. (*A*). Rhinoplasty worksheet showing Saban type subdorsal strip with bilateral lateral osteotomies, bilateral transverse osteotomies, and radix osteotomy. (*B*). Preoperative frontal view (*left*). Three-year postop frontal view (*right*). (*C*). Preoperative lateral view (*left*). Postoperative lateral view (*right*).

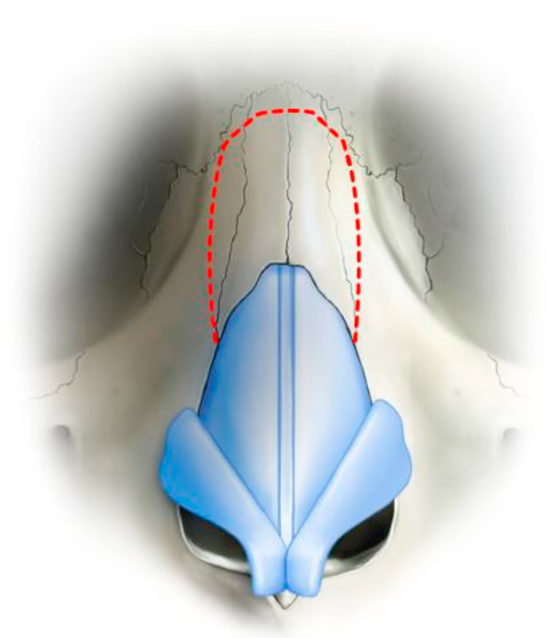


Fig. 3. Connecting lateral, transverse, and radix osteotomies. (Reprinted with permission from Toriumi DM, Davis RE. Marina Medical Rhinoplasty Cadaver Dissection Course Videos. St. Louis: Quality Medical Publishing; 2021.)

upper nasal bone will slide and not drop (**Fig. 4**). This was particularly important in this patient because she already had a low radix. When you are performing your septal work, you must be careful managing the bony septum because it is supporting the position of the bony vault. If you are aggressive and remove a significant amount of the lower bony septum (vomer), this could result in disruption of the ethmoid plate and you may be at higher risk of creating an infantile dorsum due to excessive lowering.

In your early cases, you are more likely to leave a residual dorsal convexity, so it may be a good idea to rasp the bony cap and place a radix graft to help camouflage any residual dorsal hump. I continue to do this in cases where there is an S-shaped component to the hump and elevation of the radix would improve the profile.

CASE #2

My second DP case was very straightforward. It was a patient with a small V-shaped dorsal hump (**Fig. 5**). I performed this case using an open approach to gain maximal access and to use structure techniques on the nasal tip. I used a Saban style high strip taking out a 2 mm strip of cartilage subdorsally. He had short nasal bones, so I did not perform any osteotomies. I performed a conservative surface modification by slightly rasping his bony cap. I also placed a small soft tissue radix graft. This patient's dorsal hump was small, and I could have just camouflaged it with a radix graft above and a supratip graft below with increasing tip projection. However, I saw this case as an opportunity to use a DP technique. The surgery went well, and the patient is happy with his outcome.

In this case, I realized that using the DP technique is extremely valuable in patients with small dorsal humps. To open the roof of such a patient using a Rubin osteotome or equivalent followed by reconstruction using spreader grafts or spreader flaps seems extreme. It is much more sensible to simply pull the hump down from below, preserving the dorsal esthetic lines and minimizing reconstruction. If his hump was primarily bony, one could have performed a push down by making lateral, transverse, and radix bone cuts or simply perform "surface modifications." His hump was mostly cartilaginous, so it made sense to use a Saban style high strip with slight reduction of the bony cap.

When you start out it is a good idea to work on small dorsal humps (less than 3 mm) with shorter straight nasal bones and a normal radix. Ideally,

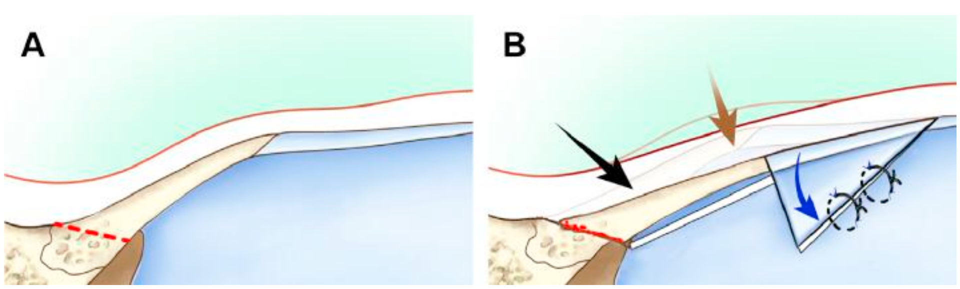


Fig. 4. The obliquely oriented radix osteotomy allows sliding of the bony dorsum. This will avoid an inferior drop and radix step-off. (*A*). Dotted line showing angle of the bone cut. (*B*). After hump reduced showing movement of the bone at the radix. (Reprinted with permission from Toriumi DM, Davis RE. Marina Medical Rhinoplasty Cadaver Dissection Course Videos. St. Louis: Quality Medical Publishing; 2021.)

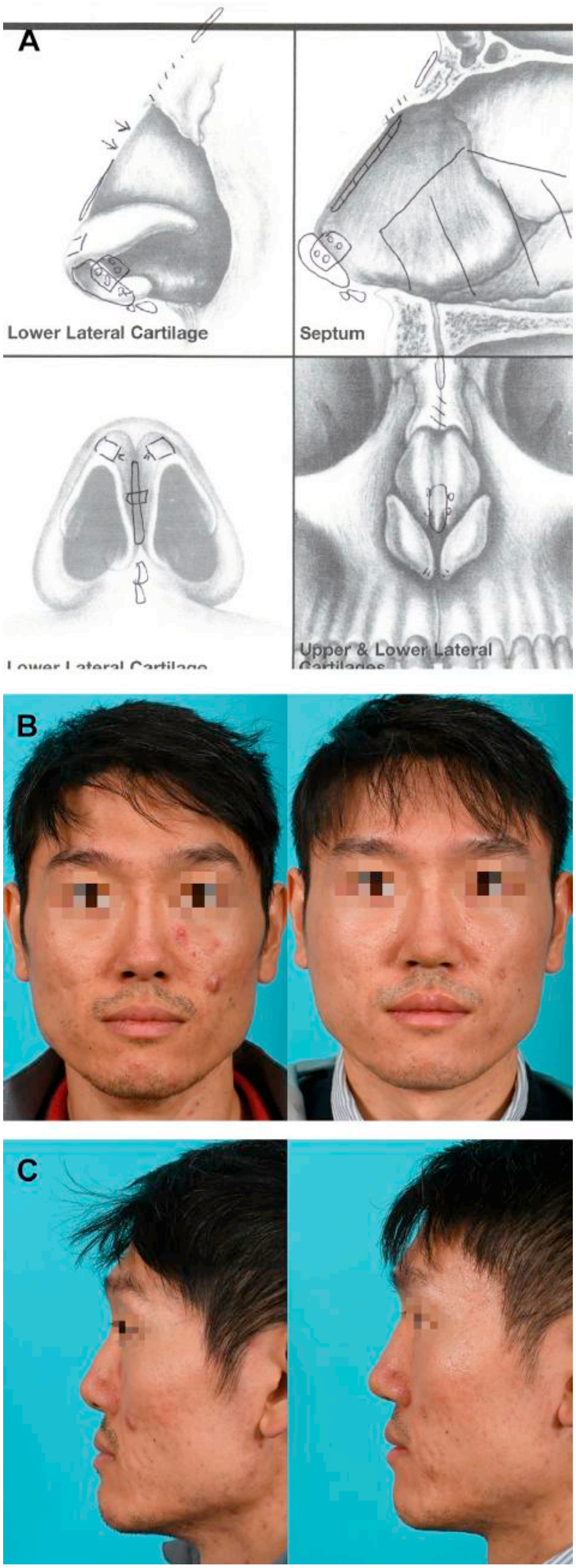


Fig. 5. Case #2. (*A*). Rhinoplasty worksheet showing Saban subdorsal strip, rasping of dorsal cap, radix and supratip graft. (*B*). Preoperative frontal view (*left*). Six-month postoperative frontal view (*right*). (*C*). Preoperative lateral view (*left*). Postoperative lateral view (*right*).

the nose should be relatively narrow in the upper two-thirds of the nose. In this type of patient, a high strip is an easy option and relatively safe. With shorter nasal bones, you may be able to limit most of the work to the cartilaginous middle vault and possibly only have to rasp the caudal aspect of the bony cap. If the nose is straight, you should make sure cartilage and or bone is removed from below the hump so there is no chance for a stump to lodge on one side of the septal strut and deviate the dorsum. The advantage of starting with the high strip is that if you should decide to abandon your attempt at DP you can simply open the middle vault and convert to a structure approach using place spreader grafts or spreader flaps.

CASE #3

This case was more challenging with a larger dorsal hump. I used Miquel Ferreira's spare roof technique type A.[6] I took off the bony cap and exposed the cartilaginous dorsal hump (**Fig. 6**). I performed bilateral lateral osteotomies to narrow her bony vault. Then I performed a Saban style high subdorsal strip and sutured the hump down to the remnant dorsal strut using two 5-0 polydioxanone (PDS) sutures. Critical analysis of the postop result reveals a supratip fullness and a slightly underprojected tip. In this case, I did not extend my subdorsal strip to the W-point, leaving no supratip break. Additionally, my septal extension graft was not as robust as it should be to support her weak tip, and she lost some tip projection postoperatively. Her septal cartilage was very thin and weak. The combination of these issues left her with a less than ideal lateral view and underprojected nasal tip. If her nasal tip was adequately projected, her outcome would have been better.

In overview, my hesitancy to extend my subdorsal strip excision to the W-point has proven to be problematic. My hesitancy to advance the subdorsal cut to the W-point is due to fear of creating a saddle deformity. If she did not want to keep a straight dorsum I probably would have been more aggressive and extended the subdorsal strip to the W-point and also would have taken a larger subdorsal strip. My assessment was that a major issue was the postoperative loss of tip projection due to placement of a smaller caudal septal extension graft.

During this period during coronavirus disease, many patients were frequently wearing masks that can compress the nasal tip. In some patients, I thought the compression of the mask on the tip could also contribute to postoperative loss of tip projection. In either case, robust support of the nasal base with a strong caudal septal extension graft is key to preserving good tip projection postoperatively.

The use of surface modification techniques is very effective and can be used in many patients. Patients with S-shaped humps benefit the most from surface modification such as rasping the bony cap. Reducing the prominence of the curvature of the hump with bony cap removal converts the S-shaped hump to a V-shaped hump that is more readily reduced with the subdorsal work.

CASE #4

The fourth DP case was relatively straightforward. She had a V-shaped dorsal hump and slightly underprojected bulbous nasal tip. I performed a Saban style high subdorsal strip with bilateral lateral osteotomies, bilateral transverse osteotomies, and a radix osteotomy (**Fig. 7**). I used a wide subperiosteal dissection over the dorsum and a Testan Cakir convex transverse radix saw (Marina Medical Inc., Davie, FL) to perform the transverse and radix bone cuts. I did not extend the subdorsal strip to the W-point again in this case. I placed two 5-0 PDS fixation sutures that passed through the dorsal septal strut and the roof of the middle vault. Postoperatively, the patient did well but she lost some of her supratip break over time. The good features of her frontal view were preserved with straightening of her nose. Her dorsal esthetic lines are straighter than preoperatively and her tip is less bulbous.

In retrospect, I could have lowered her dorsum a bit more. I did not extend the subdorsal strip to the W-point. I could have dropped her dorsum a little lower by taking a larger subdorsal strip that extended to the anterior septal angle (W-point). She has a strong chin, and I could have given her a bit more tip projection, which would have maximized her profile alignment.

In these earlier cases, I was acutely aware of the potential for excessive lowering of the supratip resulting in a saddle deformity. These patients did not want a low dorsum or pronounced supratip break. For this reason, I was very conservative when manipulating the supratip area, hence the hesitation to extend the subdorsal cut to the W-point. I do not use fillers in the nose, which eliminated the possibility of filling the supratip if there was a pronounced supratip break.

When starting out, it is advisable to use a wide subperiosteal dissection of the nasal dorsum and perform the bone cuts under direct visualization. If you do not have the piezotome then the Testan Cakir convex transverse radix saw (Marina Medical Inc., Davie, FL) is a very nice instrument to use to

Fig. 6. Case #3. (*A*). Rhinoplasty worksheet showing spare roof technique with rasping of dorsal cap and Saban subdorsal strip. (*B*). Preoperative frontal view (*left*). Two-year postoperative frontal view (*right*). (*C*). Preoperative lateral view (*left*). Postoperative lateral view (*right*).

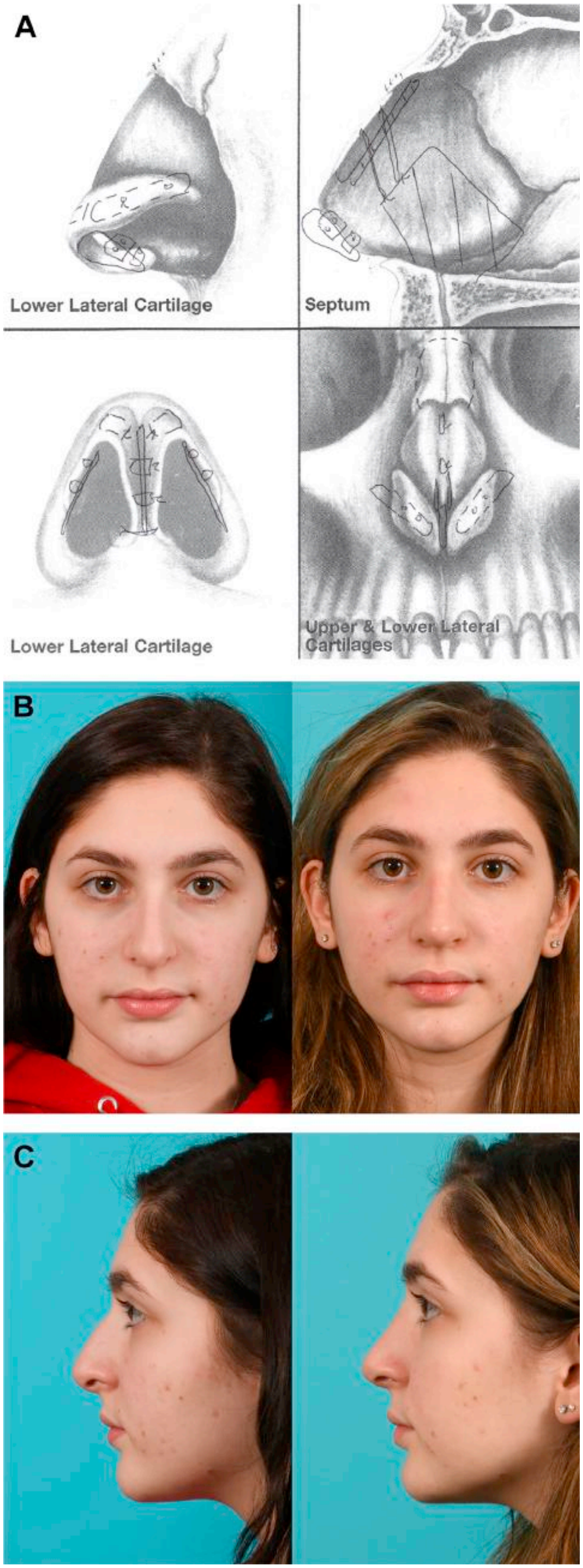


Fig. 7. Case #4. (*A*). Rhinoplasty worksheet showing rasping of bony cap, Saban subdorsal strip, bilateral lateral and transverse osteotomies, and radix osteotomy. (*B*). Preoperative frontal view (*left*). One-year postoperative frontal view (*right*). (*C*). Preoperative lateral view (*left*). Postoperative lateral view (*right*).

perform the radix and transverse bone cuts. The only problem is that this saw tends to create a more vertical radix bone cut that could encourage a drop of the radix area. If the patient already has a low radix, you may want to use a 2 mm osteotome to create an angled green stick radix bone cut to avoid this potential drop (see **Fig. 4**).

CASE #5

In this case, the patient had a V-shaped dorsal hump, deviated nose with a bulbous nasal tip. I used a modified intermediate level strip technique with overlap on the left side of the dorsal remnant to straighten her nose (**Fig. 8**A). The subdorsal cut left more cartilage at the supratip and narrowed as it approached the radix. I used two 5-0 PDS fixation sutures from upper lateral cartilage to remnant dorsal septum. I also performed bilateral lateral osteotomies with bilateral transverse osteotomies and a radix osteotomy. I used a wide subperiosteal dissection to gain access and then used a Testan Cakir convex transverse radix saw (Marina Medical Inc., Davie, FL) to perform the radix and transverse bone cuts.

Postoperatively, the upper dorsum shifted to the midline and the hump was reduced (**Fig. 8**B and 8C). She does not have a supratip break as I did not extend my subdorsal strip to the W-point. I also could have lowered her dorsum a little more and increased her tip projection by another millimeter or two. You can also see that her upper two-thirds is a bit wider postoperatively. This can occur after using DP techniques. That is why it is ideal if the patient has a slightly narrow upper two-thirds to start and a slight widening postoperatively would be desirable.

If you shift the upper two-thirds of the nose to the midline, it is critical to ensure that the lower third of the nose is also in alignment with the nasal bones and midvault. In this case, there is a slight twist of the tip to the right that likely reflects this misalignment. The advantage of the classic Cottle is that you are shifting the entire septum to the midline.[3] At this point, it was becoming apparent that if I wanted to achieve a supratip break, I would have to extend my subdorsal strip to the W-point and provide very good tip support.

Key Shift in Technique

After discussing DP with Milos Kovacevic, I decided to try his modification of the Cottle technique. In his subdorsal Z-flap technique, a subdorsal triangle is incised and the cephalic cut is extended to meet the radix osteotomy (**Fig. 9**). The triangle of cartilage is left attached to the cartilaginous vault (hump) and can be pulled down and caudally to flatten the dorsal hump (Video 1). This is a very powerful maneuver because it acts to flatten the dorsal hump, and more importantly, it leaves a triangular segment of cartilage to easily fixate the dorsum into position. Using the high strip, I was having some difficulty with the fixation. With the subdorsal Z-flap and Carlos Neves's Tetris concept, you are able to suture end to end after making strip excisions if the nose is straight, or overlap opposite a dorsal deviation and fixate to correct the deviated nose.[4,7] I found the subdorsal Z-flap technique to be easy to perform and very effective for correcting the deviated nose.

Up to this point in time, I was using a push down by making bilateral lateral osteotomies and pushing the nasal bones into the piriform aperture. Using the push down, there is the potential for hump recurrence because there are blocking points at Webster's triangle. This area of bone can act to limit the reduction of the dorsal hump and leave a residual hump. At this point, I shifted to performing a "let down," by taking out bone strips bilaterally to remove the blocking points and eliminate the potential push back in the area of Webster's triangle. Initially, I removed the bone strips by making a medial and then more lateral bone cut and removed the intervening strip of bone with a forceps. Eventually, I changed to removing the bone strip with a narrow Cerkes bone rongeur (Marina Medical Inc., Davie, FL).

CASE #6

In this case, I used the subdorsal Z-flap. The patient's nose was deviated to the left, so I overlapped the subdorsal triangle to the right side of the dorsal strut and fixed it into place with a 5-0 PDS suture. I performed a lateral osteotomy on the right and radix and bilateral transverse bone cuts. I also took out a bone strip on the side opposite the deviation (right side) to allow the bony dorsum to tilt back to the right (**Fig. 10**). Postoperatively, she still has a slight deviation of the tip to the left and the slightest dorsal convexity. Some of the asymmetries may be due to her significant facial asymmetries. She has a small disruption in her right dorsal esthetic line. There is a small prominence of her right upper lateral cartilage because it meets the nasal bones. This cartilage "horn" could have been trimmed to improve the dorsal esthetic lines. She is happy with her outcome despite these imperfections. I should have done more work to straighten her inferior septum and could have lowered her dorsum a bit more (**Fig. 11**). I also could have

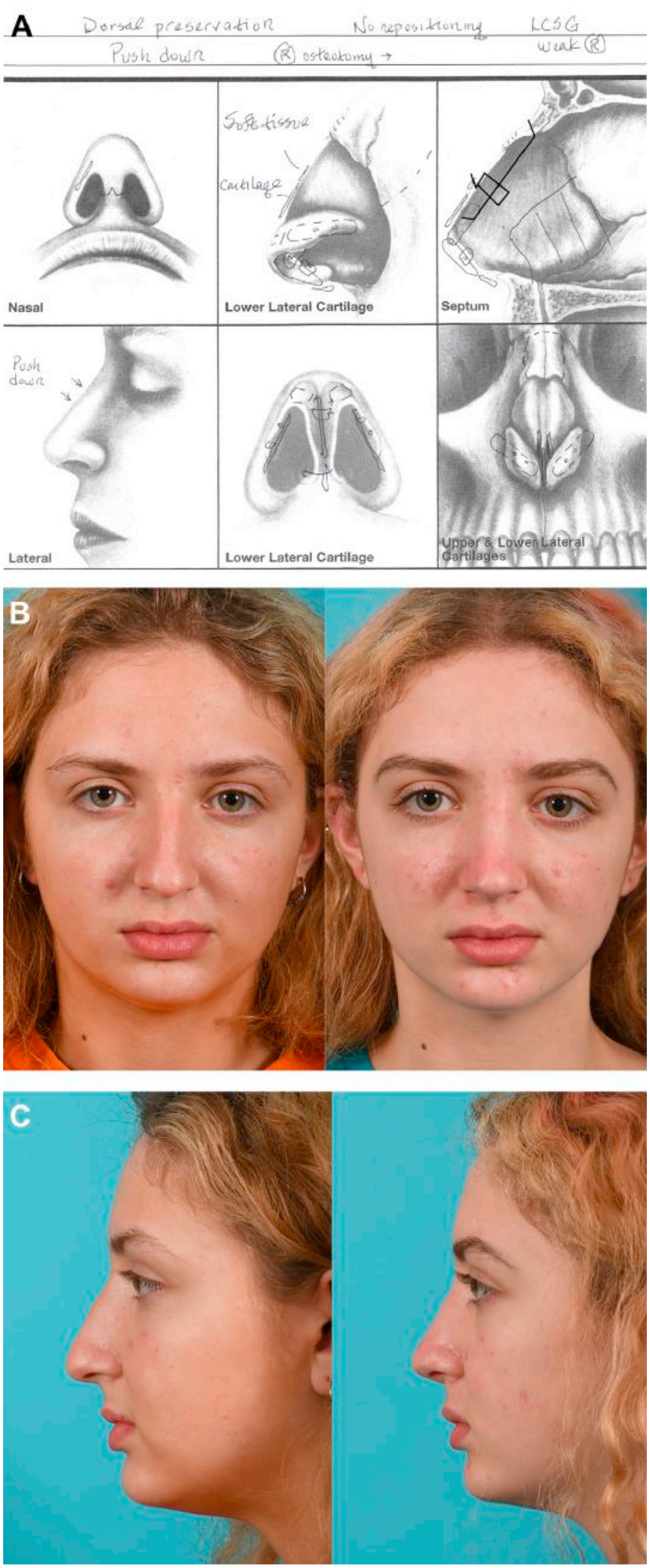


Fig. 8. Case #5. (*A*). Rhinoplasty diagram showing Saban subdorsal strip with rasping of dorsal cap and bilateral lateral, transverse, and radix osteotomy with 2 transdorsal fixation sutures. (*B*). Preoperative frontal view (*left*). One-year postoperative (*right*). (*C*). Preoperative lateral view (*left*). Postoperative (*right*).

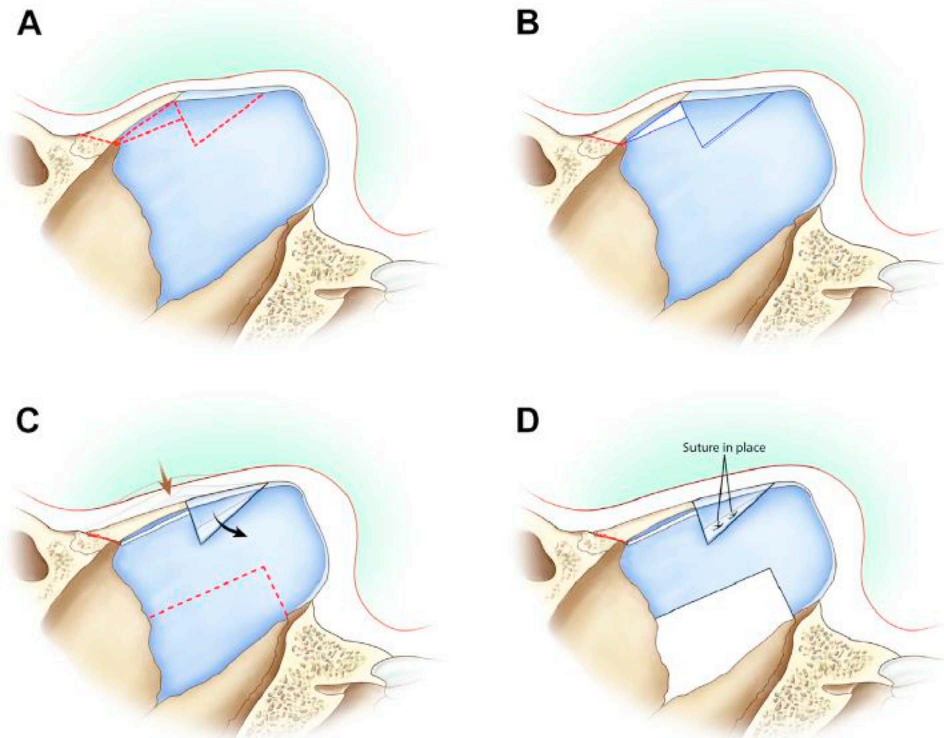


Fig. 9. Subdorsal Z-flap technique of Kovacevic with subdorsal triangular cartilage attachment to undersurface of the dorsal hump with the longer limb aligned with the apex of the dorsal hump. The incision extends under the hump to meet the radix osteotomy. Pulling the triangle caudally and inferiorly stretches and flattens the dorsal convexity. Note the overlap of the triangle on the right to correct a deviation to the left. This technique allows for harvesting septal cartilage for other grafting. This is one of the major advantages with this technique. (*A*). Position of cuts for Z flap and subdorsal work. (*B*). Strip of cartilage removed below the dorsal hump. (*C*). Subdorsal Z flap pulled posterior and caudal. (*D*). Subdorsal Z flap sutured overlapping on the right side of dorsal strut. (Reprinted with permission from Toriumi DM, Davis RE. Marina Medical Rhinoplasty Cadaver Dissection Course Videos. St. Louis: Quality Medical Publishing; 2021.)

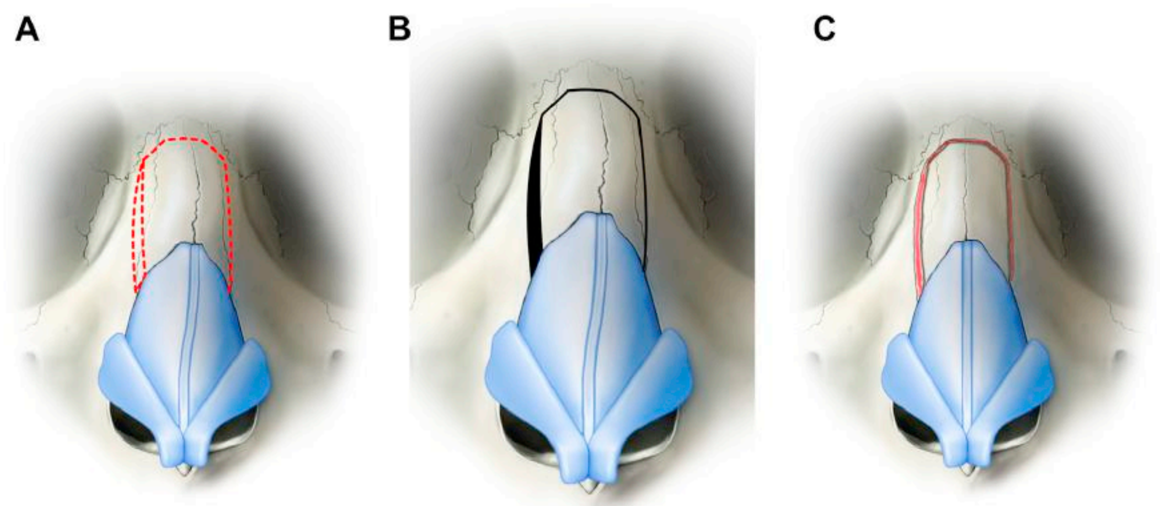
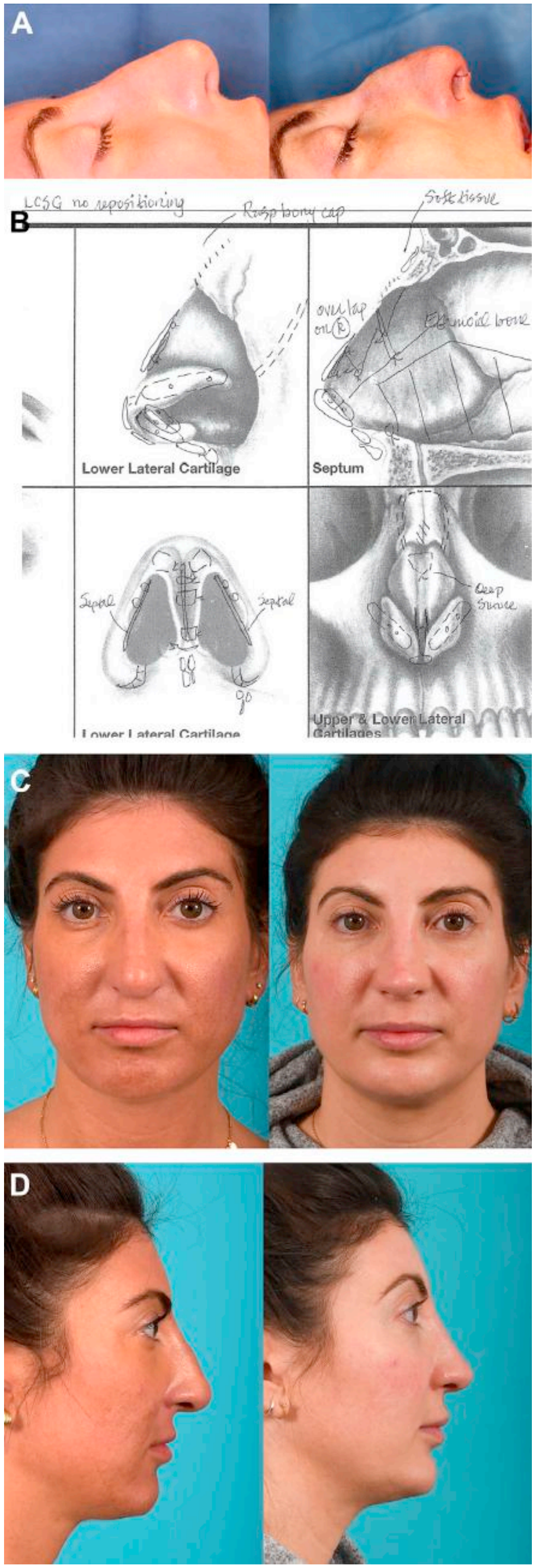


Fig. 10. Unilateral right-sided bone strip removal on the side opposite the deviation to allow the axis deviation to shift back to the midline. (*A*). Planned bone cuts noted in red broken line. (*B*). Bone cuts completed including bone strip removed on side opposite the deviation. (*C*). Bony hump let down and gaps in bone cuts closed. (Reprinted with permission from Toriumi DM, Davis RE. Marina Medical Rhinoplasty Cadaver Dissection Course Videos. St. Louis: Quality Medical Publishing; 2021.)

Fig. 11. Case #6. (*A*). Rhinoplasty worksheet showing rasping of dorsal cap, subdorsal Z flap (Kovacevic), left lateral osteotomy, left bone strip excision, bilateral transverse osteotomies, and radix osteotomy. (*B*). Preoperative frontal view (*left*). One-year postoperative frontal view (*right*). (*C*). Preoperative lateral view (*left*). Postoperative (*right*).


A
B
LCSG no repositioning
Rasp bony cap
Soft tissue
Ethmoid bone
Lower Lateral Cartilage
Septum
Septal
Septal
Deep Suture
Lower Lateral Cartilage
Upper & Lower Lateral Cartilages
C
D

placed a larger nasolabial angle plumping graft to augment her columella/upper lip junction.

This case demonstrates the importance of performing surface modifications to align the dorsal esthetic lines. If one encounters upper lateral cartilage “horns,” these prominences can be trimmed with a scalpel to flatten the prominence. In this case, her nasal bones and middle vault were going in different directions. In retrospect, this would have been a great case to use a low strip (Cottle or simplified preservation of quick rhinoplasty [SPQR]) to completely straighten the underlying septum and move the middle vault and tip to the midline.

At this point, I am beginning to get the feel for the operation doing better with the osteotomies and subdorsal work. Up to this point, I have been fairly conservative to avoid complications.

CASE #7

In this case, I was caught off guard because the patient had filler injected into her nose and what appeared to be a relatively straight forward V-shaped hump was transformed into an S-shaped hump once the filler was removed at the time of surgery. This proved to be a turning point where I realized that I could treat larger dorsal humps using DP techniques. I removed the filler to expose the true dorsal contour (**Fig. 12**A left and right). With this case going forward, I changed to using primarily the “let down” taking a bony strip out on both sides of the hump to eliminate Webster’s triangle and any bone that could push back on the dorsal hump. I found this very helpful in minimizing hump recurrence. In her case, I resected a bone strip on the left using a Cerkes bone rongeur and transverse and radix osteotomies using the Testan/Cakir saw. Then I performed the subdorsal Z-flap technique to stretch the hump flat and fixated with two 4-0 PDS sutures (**Fig. 12**). I also slightly rasped her bony cap and placed a soft tissue radix graft to camouflage any potential residual dorsal convexity. Postoperatively, the hump is flattened and her tip is projected. I probably could have rotated her more but she was concerned about too much rotation.

In overview, this case was important as I realized I could treat most dorsal humps (V-shaped or S-shaped, deviated), and I also transitioned to using the let down instead of the push down. A key maneuver to consider in S-shaped dorsal humps is to reduce the bony cap by rasping and place a radix graft (if indicated) to help establish a straight dorsal line. This combination of surface manipulation is very important to minimize the likelihood of a residual dorsal hump, particularly early on when you are potentially less “complete” in your execution of the DP techniques.

At this point in my transition, I am treating almost all primaries with DP techniques. I am also modifying my technique as I learn more about the nuances of execution.

CASE #8

This patient was an ideal candidate for a DP technique as she had a V-shaped dorsal hump and ptotic tip with a long nose. I performed a subdorsal Z-flap technique with the subdorsal triangle overlapping on the right side of the dorsal remnant (**Fig. 13**). I widely dissected subperiosteally over the dorsum and used the Testan Cakir convex transverse radix saw (Marina Medical Inc. Davie, FL) to execute the transverse and radix bone cuts. The lateral osteotomies were performed using a 3 mm straight osteotome. Suture fixation of the overlapping Z-flap allowed excellent stretching of the dorsal hump into the flattened position. She had a ptotic tip so I placed a larger caudal septal extension graft and repositioned her cephalically oriented lateral crura with lateral crural strut grafts. Her nose is straight and her hump is corrected postoperatively and her tip is rotated and projected. Her supratip may be a little too pronounced, and I could have placed a more substantial supratip graft to fill it a bit more. Looking back to her preoperative lateral view, one can see that her supratip was already slightly underprojected. Simply by projecting and rotating her nasal tip the supratip break became more pronounced and could have been augmented. She is also a little wider in the middle third, which is also a potential consequence of pulling the middle vault down from below. This can be managed by placing a suture through the upper lateral cartilages to create narrowing.

Her nasal tip was a more significant issue and required repositioning of her cephalically

Fig. 12. Case #7. (*A*). Initial intraoperative lateral view showing V-shaped dorsal convexity (*left*). After filler removed an S-shaped dorsal contour is noted (right). (*B*). Rhinoplasty worksheet showing subdorsal Z flap with rotation caudally and inferiorly with overlap on the right to correct the deviation. (*C*). Preoperative frontal view (left). Two-year postoperative frontal view (right). (*D*). Preoperative lateral view (left). Postoperative lateral view (right).

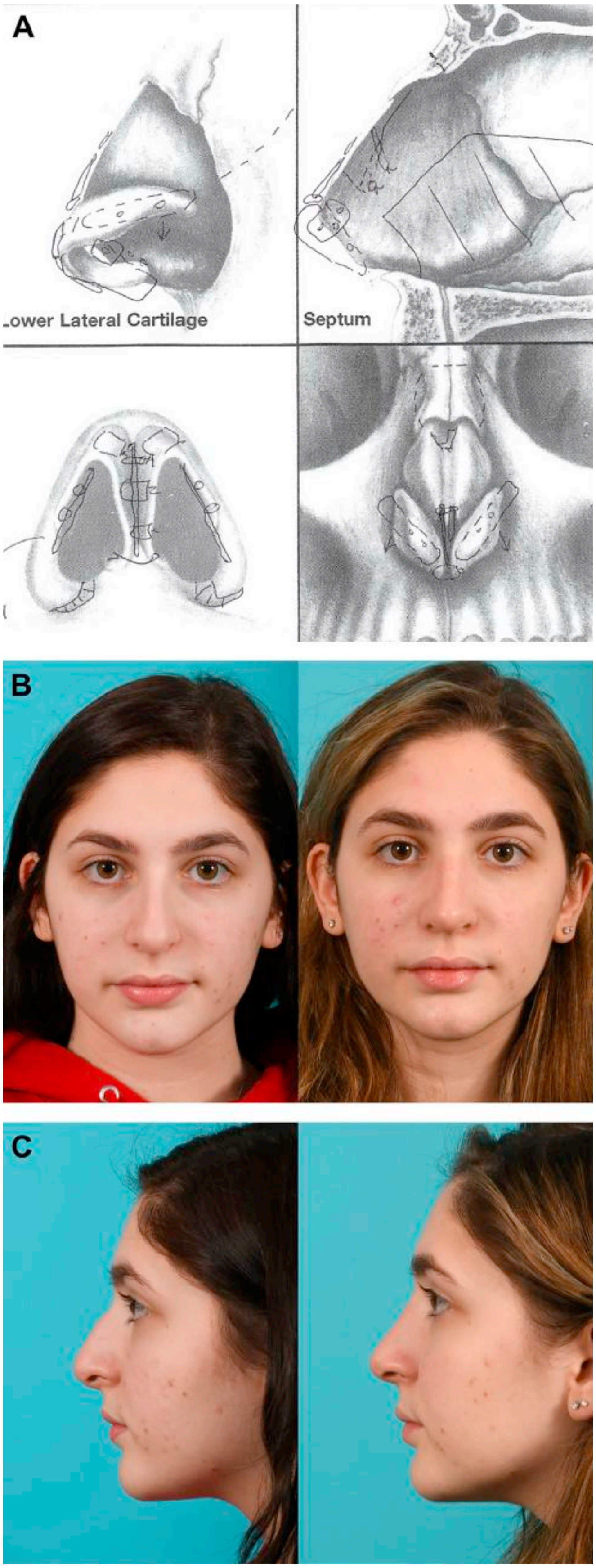


Fig. 13. Case #8. (*A*). Rhinoplasty worksheet showing subdorsal Z flap (Kovacevic) overlapping on the right to straighten the nose. (*B*). Preoperative frontal view (left). One-year postoperative frontal view (right). (*C*). Preoperative lateral view (left). Postoperative lateral view (right).

positioned lateral crura. The caudal septal extension graft was important to set her tip in a more projected and rotated position. With this combination of techniques, I was able to correct the downward orientation of her nostrils to a more appropriate configuration.

At this point, I am comfortable with the DP technique but have not been challenged with a more complex case. My next case was definitely challenging in many ways.

CASE #9

I went into this case convinced that I would perform a subtotal septal reconstruction due to his severe deviation and deviated caudal septum. His caudal septum was off to the right, and he had severe nasal airway obstruction. I consulted with Milos Kovacevic and he recommended a classic Cottle technique, which involves a reverse Z-cut that is made through the entire vertical axis of the cartilaginous septum, pulling the septum forward and fixing it to the nasal spine.[8] In this case, I anticipated that I would have to resect the caudal septum to straighten the deviation. At the time of surgery, I noted the fractured caudal septum, so I released the entire septum from the nasal spine, maxillary crest, ethmoid, and vomer and created a quadrangular cartilage flap (QCF) as described by Finocchi[9] (Video 2). The septal flap was left attached to the undersurface of the middle nasal vault. The QCF was then rotated caudally, and I resected the damaged/fractured caudal septum. To reestablish appropriate length and projection, I placed a large septal extension graft end to end to the rotated QCF to create an "extended Cottle septal rotation-advancement flap" (**Fig. 14**). The caudal septal extension graft was stabilized end to end using ethmoid bone grafts with holes drilled into it to allow passage of the sutures. This technique can be used for cases with a severe septal deviation or where the caudal septum would otherwise require excision and reconstruction. I also performed bilateral lateral bone strips with an osteotome, transverse and radix osteotomies with a Testan Cakir saw. In this case, I used a septal extension graft and shorter lateral crural strut grafts. I placed septal splints to splint the septum for 2 weeks postoperatively.

Early postop, his bones were slightly off to the right, so I had him do compression exercises on the right side of his nose and his bones have healed in the midline (**Fig. 15**).

There is significant debate as to the effectiveness of postoperative nasal compression exercises. I have been having patients do nasal compressions for years. In this case, I asked the patient to push on the right side of his nose for 60 seconds about 15 times a day. The duration of the compressions depends on the problem encountered. When performing DP there may be some slight shifting that occurs postoperatively. I find the compression exercises to be very helpful in setting the nose in the midline.

Key Observation

This case was very important in my progression as I realized the power of the Cottle technique (inferior strip). It is an intimidating technique as we are all taught to respect the keystone, and with this technique, we are dividing the keystone below the dorsum. The fixation of the QCF to the nasal spine is critical to avoid disruption of the dorsal septal support. In most of these cases, I will make a slight

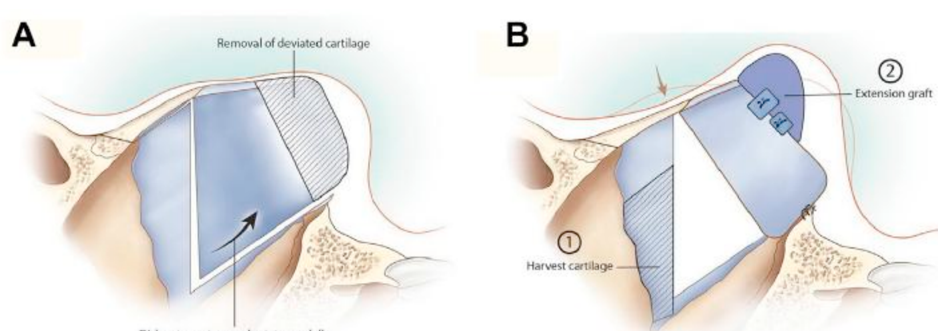
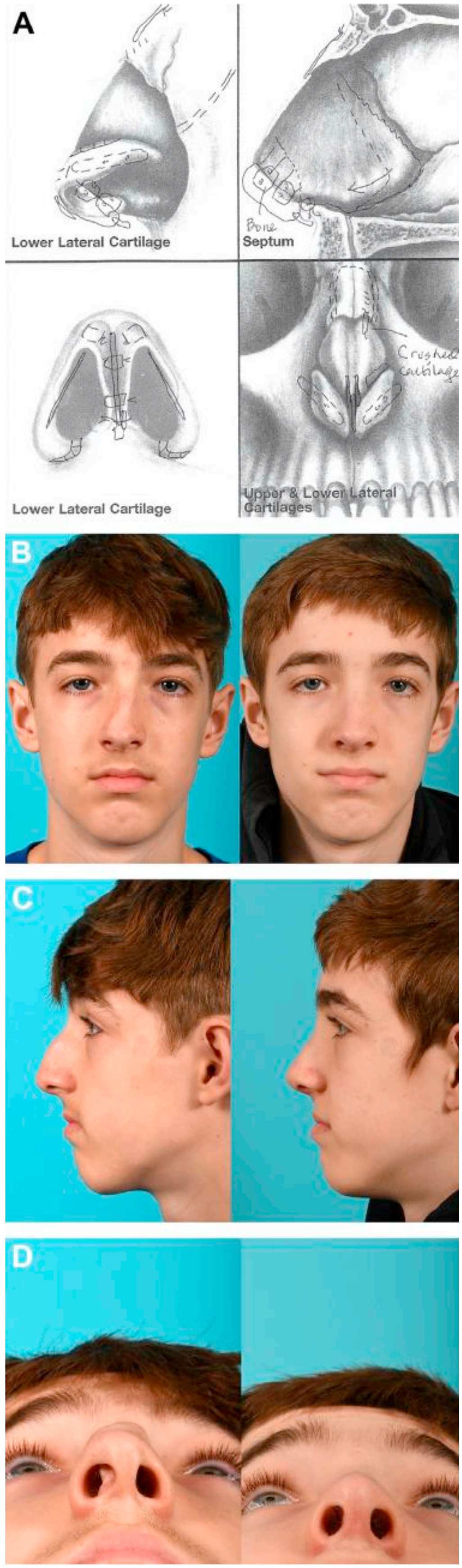


Fig. 14. Extended Cottle septal rotation advancement flap. (*A*). The deviated/fractured segment of the caudal septum is excised to allow reconstruction. Note the placement of the incisions creating a QCF. The crosshatched area represents the area of caudal septal fracture and proposed segment to be removed. (*B*). Note the rotation of the QCF flap caudally to stretch and flatten the dorsal hump with fixation to the nasal spine with two 4-0 PDS sutures. A caudal septal extension graft can be placed end to end and stabilized with slivers of cartilage or ethmoid bone. (*Reprinted with permission from* Toriumi DM, Davis RE. Marina Medical Rhinoplasty Cadaver Dissection Course Videos. St. Louis: Quality Medical Publishing; 2021.)


A
Lower Lateral Cartilage
Bone
Septum
Crushed cartilage
Lower Lateral Cartilage
Upper & Lower Lateral Cartilages
B
C
D

notch in the nasal spine and move it to the midline if needed, then fixate the QCF into the notch, and suture with two 4-0 PDS sutures incorporating surrounding soft tissue and periosteum. Additionally, you can place a notch along the infero-caudal margin of the QCF to prevent cranial displacement of the septal flap.

One of the drawbacks to the Cottle or SPQR technique is there is less potential cartilage to harvest for grafting. If you are planning on performing a good deal of structural grafting (caudal septal extension graft, lateral crural strut grafts), then you may need to harvest ear cartilage. You can harvest some septal cartilage from along the floor and posteriorly, however, typically this is not enough for longer lateral crural strut grafts and a caudal septal extension graft.

The fixation of the QFC to the nasal spine is a critical maneuver. For this reason, there should be no tension on this fixation point; otherwise, there may be a loss of support postoperatively.

CASE 10

At this point, I am very comfortable with DP and feel confident using the subdorsal Z-flap, Saban style high strip, and I have successfully tried the Cottle or SPQR technique.[9] The next case was a perfect case for the subdorsal Z-flap to correct the hump and straighten her nose. She had an axis deviation to the right and a V-shaped dorsal hump. This would be an ideal first case to do DP.

I performed a subdorsal Z-flap overlapping on the left side as well as a bone strip removal on the left and conventional lateral osteotomy on the right to tilt her nose to the midline. I used the Testan-Cakir convex transverse radix saw (Marina Medical Inc., Davie, FL) to perform the radix and transverse bone cuts. I slightly rasped her dorsal cap as well. I placed a septal extension graft and lateral crural strut grafts without repositioning her lateral crura.

At 1 year postoperative, her nose is straight and her dorsal hump was corrected. The amount of supratip break that I left her is subtle and what the patient desired (**Fig. 16**). One could have used a high strip (Saban) or intermediate strip as well. In this case, I did not extend her subdorsal excision to the W-point. The increased tip projection provided an appropriate supratip break.

With the subdorsal Z-flap, I seem to be able to better preserve the preoperative width compared with the high strip. This may be due to the "handle" effect created by the triangular cartilage attached to the undersurface of the middle vault.

In the interest of brevity, I selected 5 more cases out of the next 10 to illustrate due to their unique characteristics. Most of the remaining cases of the 20 are available for viewing online in the supplemental media.

CASE 12

This patient presented with a short, small nose with a dorsal hump. Her middle vault and tip were underprojected (**Fig. 17**). She had a history of prior septoplasty. The plan was to increase her tip projection and align her profile. After opening her nose and exposing her septum, it was evident that a large segment of her septal cartilage was previously harvested. She had enough dorsal septum to perform a subdorsal Z-flap to stretch her hump flat. However, her caudal septum was very weak and needed to be supported. I harvested costal cartilage from an 11 mm incision in her right chest. The rib cartilage was carved into a septal extension graft and other structural grafts.

I incised the subdorsal Z-flap and released the septum from under her nasal bones. I took out a bone strip on the left using a 3 mm osteotome and parallel cuts in the bone. Then I performed a right lateral osteotomy. The radix and transverse bone cuts were performed with a 2 mm osteotome via a small stab incision in the radix area. I overlapped the subdorsal Z-flap on the right side and fixated with a 5-0 PDS suture. This straightened her nose and reduced her dorsal hump.

After increasing her tip projection with a costal cartilage septal extension graft, she was left with a slight saddle deformity. This was anticipated due to the slight saddling effect noted preoperatively. To correct the saddle and stabilize the base of her nose, I performed a "push up" using bilateral spreader grafts that were fixed below her middle vault and sutured to the caudal septal extension graft (Video 3). The subdorsal spreader grafts acted to stabilize her caudal septum and correct the saddle nose deformity.

Postoperatively, the patient has done very well with straightening of her nose, removal of her

Fig. 15. Case #9. (*A*). Rhinoplasty worksheet showing rasping of left leading edge of nasal bone, classic Cottle technique with caudal rotation of the QCF with fixation to the nasal spine, bilateral bone strip excisions, bilateral transverse osteotomies, radix osteotomy, large caudal septal extension graft fixated with ethmoid bone. (*B*). Preoperative frontal view (left). Two-year postoperative frontal view (right). (*C*). Preoperative lateral view (left). Postoperative lateral view (right). (*D*). Preoperative base view (left). Postoperative base view (right).

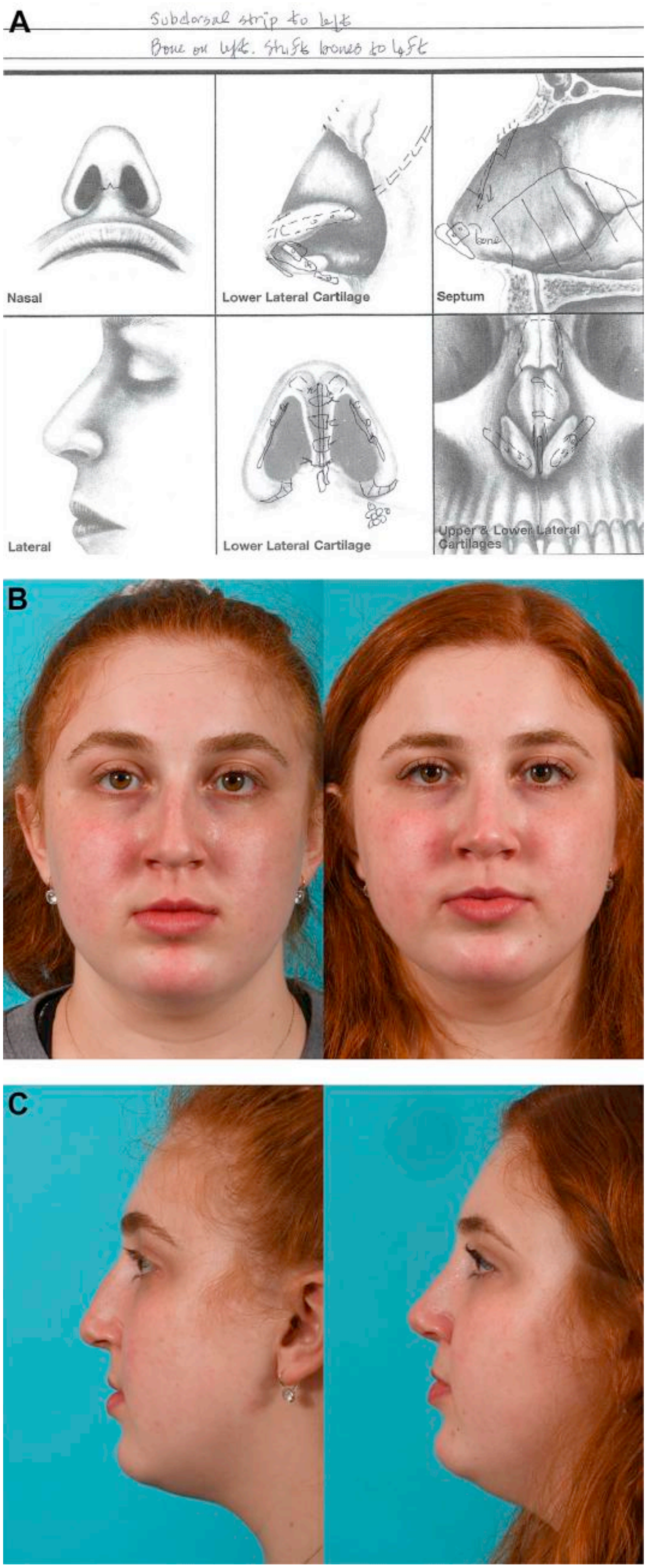


Fig. 16. Case #10. (*A*). Rhinoplasty worksheet showing subdorsal Z-flap overlapped on the left, rasping of the dorsal cap, let down, left-sided bone strip, and lateral osteotomy on the right. (*B*). Preoperative frontal view (left). One-year postoperative frontal view (right). (*C*). Preoperative lateral view (left). Postoperative lateral view (right).

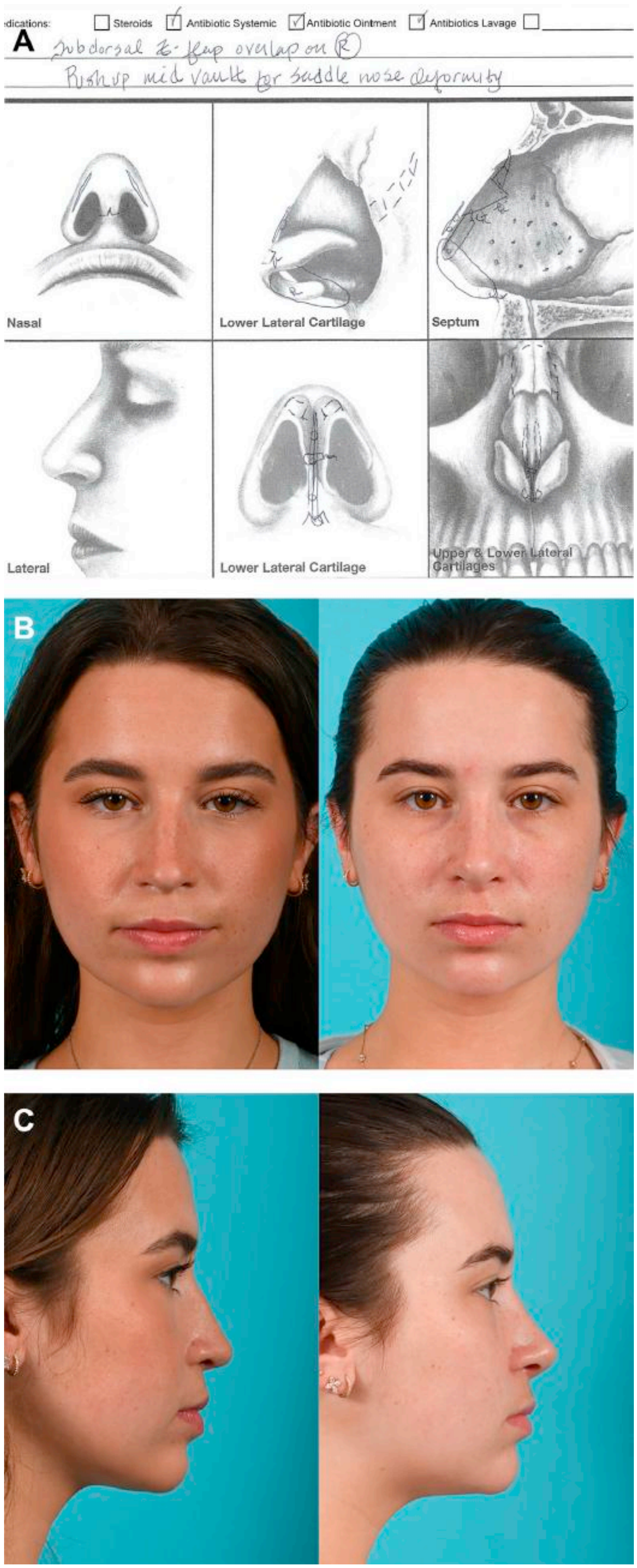


Fig. 17. Case #12. (*A*). Rhinoplasty worksheet showing the subdorsal Z-flap to flatten the hump and spreader grafts to "push up" the middle vault and correct the saddle nose deformity. (*B*). Preoperative frontal view (left). Two-year postoperative frontal view (right). (*C*). Preoperative lateral view (left). Postoperative lateral view (right).

dorsal hump, and correction of her saddle nose deformity. The concave left upper lateral cartilage was corrected as well. She has excellent nasal airway function, and she is happy with her esthetic outcome. Her nose remains on the smaller side but aligns with what we had imaged preoperatively.

In overview, this case was more complex due to the prior septoplasty. If one decides to perform DP after rhinoplasty with septoplasty, the surgeon should be prepared to harvest costal cartilage and use structure techniques to stabilize the reconstruction. The advantage of using DP in this case was the ability to reestablish her dorsal esthetic lines without reconstructing her middle vault and potentially creating an osseous deformity. The spreader grafts also helped to create a symmetric middle vault.

This case also shows how the middle vault can be “pushed up” to correct the saddle nose deformity. It is critical to use autologous costal cartilage to provide the support needed to preserve proper positioning of the upper lateral cartilages and prevent relapse.

CASE 13

This 15-year-old patient presented with a small dorsal convexity and requested a slightly lower dorsum and correction of her bulbous nasal tip. She also wanted to have her nose straightened. Her primary problem was her wide nose on frontal view.

I decided to perform an intermediate strip (Ishida) septal flap to straighten her nose and lower her dorsum. I chose the intermediate level option to have more purchase to pull her hump down. I overlapped on the left side to straighten her nose. I also did not elevate any of the dorsal nasal skin and left it completely intact. After I performed the overlap and fixation, I noted that her supratip was too low due to the extension to the W-point. This required placement of a supratip graft to avoid excessive lowering of her supratip.

I also performed a bone strip removal on the left and conventional lateral osteotomy on the right as well as the radix and transverse bone cuts. She shifted nicely to the midline. All the bony work was performed from an endonasal site with the radix osteotomy performed from below, and the lateral bone work through lateral subperiosteal tunnels and the transverse osteotomies via small stab incisions along the sidewall of the nose.

Postoperatively, she has done well at 2 years except she has some extra width in her supratip and tip area that fluctuates with swelling (**Fig. 18**). She is taping her supratip at night. I am confident the swelling will continue to subside with time.

This case demonstrates how DP can sometimes create widening of the nose. This is partially due to the compression of the middle vault downward and some splay of the upper lateral cartilages. This can treated with middle vault suturing or slight trimming of the upper lateral cartilages. One can also rasp the shoulders of the nasal bones to create a narrowing effect. Release of the lateral keystone and piriform ligament would likely have helped in this case as well.

This patient was 15 years old when I performed her rhinoplasty. I was always concerned about collapse of the middle vault over time when performing conventional component dorsal hump reduction because this would require reconstructing with spreader grafts or spreader flaps. This area can change dramatically over time with narrowing, asymmetries, and visible irregularities of the nasal bones. With the DP techniques, I am much more confident that she will heal well over her lifetime because the middle vault was not opened and the roof of the bony vault was not manipulated. This is a tremendous advantage of using DP, particularly in the younger patient who will undergo healing over many decades.

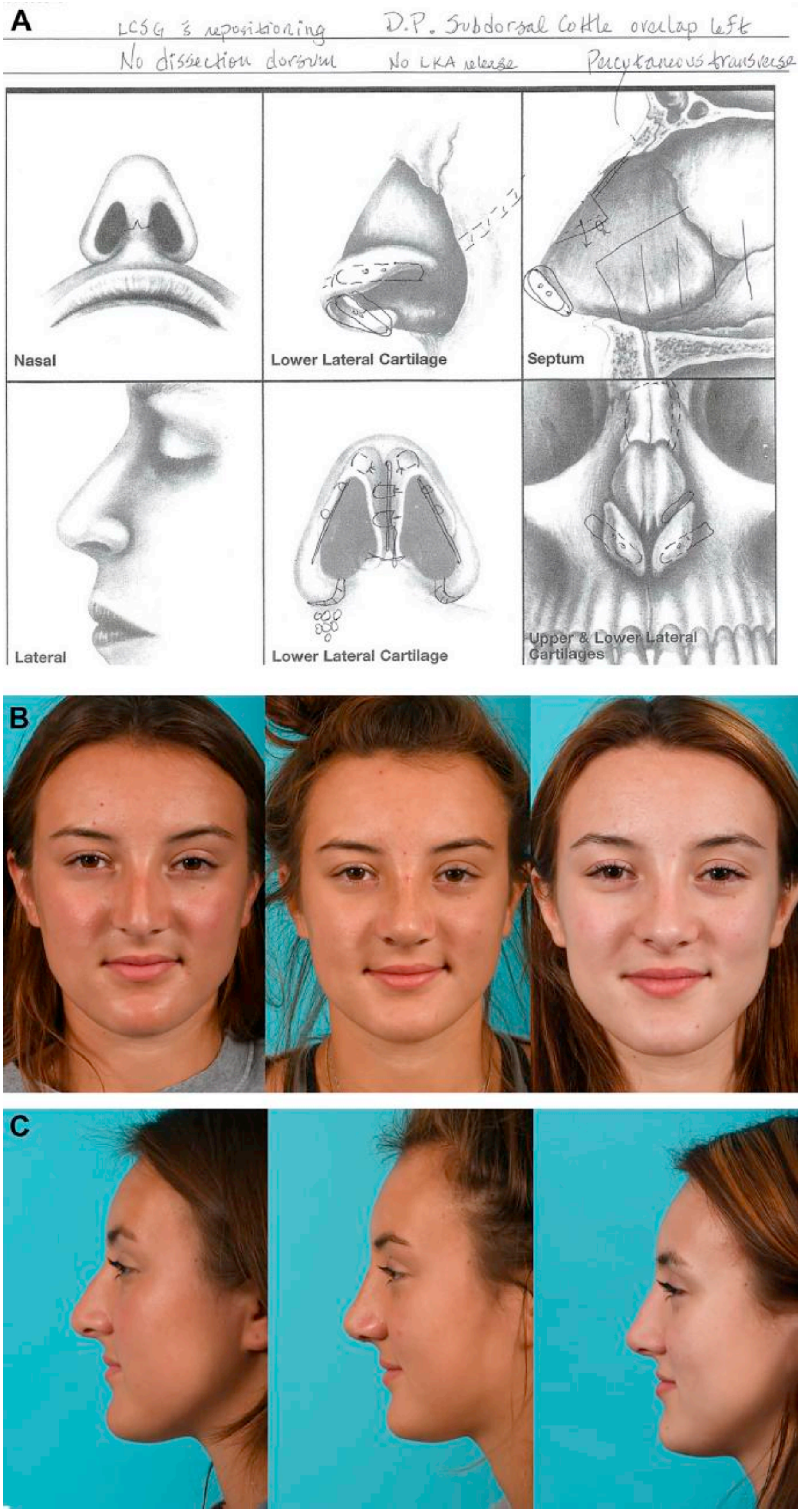
CASE 14

This 17-year-old patient presented with a deviated nose and dorsal hump. I performed DP using a subdorsal Z-flap. At this point, I am very comfortable with the subdorsal Z-flap and prefer it over the high strip technique. Because of her deviation to right, I overlapped her subdorsal Z-flap on the left side and sutured fixated with a 4-0 PDS suture. I performed a bone strip on the left and conventional lateral osteotomy on the right. I also performed the radix osteotomy and transverse osteotomies through small stab incisions. I did not raise any of the skin on her nasal dorsum. I also placed lateral crural strut grafts with no repositioning.

At 7 days postoperative when the cast was removed, she had very little edema over her nasal dorsum and her profile was aligned as desired (**Fig. 19**). At 2 years postoperative, she is doing very well with a straight nose and elimination of her dorsal hump. If you compare the 7-day postoperative frontal and lateral views and the 2-year postoperative views, one can see that there is little change during 2 years (see **Fig. 19**). This is likely due to the “no skin elevation” approach to the nasal dorsum. This “no skin dissection” method is particularly useful with V-shaped humps that do not require bony cap modification.

Some people argue that DP is not really “preservation.” This is based on the bone cuts and

Fig. 18. Case #13. (*A*). Rhinoplasty worksheet showing intermediate level Ishida flap overlapped on the left with bone strip on the left and conventional lateral osteotomy on the right. (*B*). Preoperative frontal view (left). 2 year postoperative frontal view (right). (*C*). Preoperative lateral view (left). Postoperative lateral view (right).


A
LCSG s̄ repositioning
D.P. Subdorsal Cottle overlap left
No dissection dorsum
No LKA release
Percutaneous transverse
Nasal
Lower Lateral Cartilage
Septum
Lateral
Lower Lateral Cartilage
Upper & Lower Lateral Cartilages
B
C

movement of the dorsum as well as the subdorsal work. In this patient, a lot was preserved. With no dorsal skin elevation, all the attachments of skin to bone were preserved. Additionally, the roof of the nasal dorsum was preserved. By performing the work posteriorly under the dorsum and along the maxilla, the entire roof of the dorsum of the nose is “preserved.” This is where the “preservation component” of DP affects the outcome by preserving the favorable dorsal esthetic lines and essentially freezing the contours in time.

CASE 15

This patient presented with a severely deviated caudal septum and deviated nose with a dorsal hump. I was planning on performing a Cottle technique/SPQR but on further assessment determined that I could perform a subdorsal Z-flap with a septal extension graft. I used some thin ethmoid bone with holes drilled into it to straighten her caudal septum. I performed a bone strip removal on the left side with a 3 mm osteotome and parallel bone cuts. A conventional lateral osteotomy was performed on the right. I performed the radix bone cut with transverse osteotomies via a small dorsal stab incision over the radix. I overlapped the Z-flap on the left side to shift her to the midline. I performed slight rasping of her bony cap to make it easier to straighten her profile. I used a septal extension graft and lateral crural strut grafts without repositioning for the lower third of her nose. I also fractured her nasal spine to the left to aid in straightening her nasal base.

She did well postoperatively with establishment of a straight nose and elimination of her dorsal hump (**Fig. 20**). I could have placed a larger nasolabial angle plumping graft to improve her columellar upper lip junction. She is very happy with her outcome at 20 months postoperatively.

This case shows that you can effectively combine structure and DP techniques to straighten a very deviated nose and to manage her tip issues. In most all of my primaries, I am combining structure and DP (structural preservation rhinoplasty). I believe this combination provides the surgeon with the absolute strengths of both philosophies.

Key Shift in Technique

At this point in time, I am varying how I dissect the dorsum based on whether I think I will need to perform any surface modifications. In the case where I do not have to reduce the bony cap or place a radix graft, I will leave the dorsal nasal skin intact with no elevation (case 14). In cases where I prefer to rasp the bony cap and/or place a radix graft, I only raise the dorsal nasal skin in the midline and leave the rest of the skin undissected. This approach minimizes dorsal skin elevation but allows access to the bony cap and radix area. I use a narrow rasp to reduce the bony cap, leaving most of the dorsal skin attached. If no bony cap reduction is needed and the skin is left attached, a radix graft can be placed via the small lateral wall stab incisions to avoid the dorsal skin elevation. The radix graft is fixed into position with a 6-0 transcutaneous fixation suture that is clipped when the cast is removed.

CASE 19

This patient presented with a deviated overprojected nose. In the past, I would have to open the middle vault and take down the septum and reconstruct the middle vault to accommodate the reduction in tip projection. This added a lot of time to the surgeries. Managing the overprojecting nose is difficult enough without having to perform spreader grafts and/or spreader flaps to reconstruct the middle vault.

In this case, I deprojected the nasal tip and then reduced the projection of the middle vault and nasal bones using DP. I performed a subdorsal Z-flap and overlapped on the right to straighten her nose. I performed a bone strip removal on the right and conventional lateral osteotomy on the left via intranasal tunnels. The transverse bone cuts were performed via small stab incisions along the lateral wall. In this case, the radix osteotomy was executed by angling the cut into the radix area from below the dorsum. A small dip formed near the keystone just caudal to the nasal bones that I filled with a very thin crushed cartilage graft. I also fractured her nasal spine to the right to shift the base of her columella to the midline.

She has done very well with a straight nose and less projected tip and dorsum (**Fig. 21**). Her thin skin has done well with the DP because there is no deformity of the upper lateral cartilages or bones to contend with.

I believe DP techniques will significantly reduce the complexity of managing the over projected

Fig. 19. Case #14. (*A*). Rhinoplasty diagram showing subdorsal Z-flap overlapped on the left with a bone strip taken out on the left and conventional lateral ostetomy on the right. (*B*). Preoperative frontal view (left). One week postoperative frontal view (middle). Two year postoperative frontal view (right). (*C*). Preoperative lateral view (left). One week postoperative lateral view (right). Two year postoperative lateral view (right).


A
LCSG ē repositioning
Suture septum to left perichondrium
Dorsal preservation
Rasp
Nasal
Lower Lateral Cartilage
Septum
Lateral
Lower Lateral Cartilage
Upper & Lower Lateral Cartilages
B
C
D

nose as you can avoid disrupting and then reconstructing the middle vault. This allows the surgeon to focus on the complex issues related to deprojecting the nasal tip and not expend time and cartilage on reconstructing an "open roof deformity."

CASE 20

This patient presented with a very overprojected nose and deviation. Whenever we deproject a nose, the middle vault and potentially the bony vault may become redundant. DP techniques are very effective in correcting the overprojecting component of the upper two-thirds of the nose.

In this patient, I deprojected her nasal tip and treated the overprojecting components of her dorsum using a subdorsal Z-flap. She had a high radix so I performed a vertical radix bone cut with a Testan-Cakir convex transverse radix saw to drop her radix. I removed more bone under the bony vault to allow the upper dorsum to drop posteriorly. I took out a bone strip on her left and performed a conventional lateral osteotomy on her right with transverse and the radix osteotomies. With the drop of her radix, there was a slight step off of her frontal bone above the radix osteotomy site. I removed this with an osteotome. There was a prominence of her left upper lateral cartilage (cartilage shoulder) that I trimmed to create symmetry. I used lateral crural release with lateral crural strut grafts and repositioning to decrease her tip projection and stabilize her nasal base.

Postoperatively she did well with straightening of her nose and significant deprojection. Her radix is slightly lower and her dorsal hump is no longer present (**Fig. 22**). To achieve more dramatic radix reduction, I would have had to perform the radix osteotomy more cranially and also perform a more aggressive subdorsal resection of her ethmoid bone. To be safe, I did not get too aggressive with the bone resection at the radix for fear of widening this area on the frontal view.

These last 2 cases clearly demonstrate how the overprojecting dorsum and middle vault can be corrected using DP techniques. Additionally, the cases further demonstrate the effectiveness for straightening the deviated nose. In my opinion, the ability to straighten the deviated nose is even more important than the hump reduction capability of DP.

SURFACE MODIFICATIONS TO ALLOW DP IN MOST PRIMARY CASES

Several of the subsequent cases presented with asymmetries in the middle vault and required some surface modifications to convert a non-DP case to a DP option. If the middle vault is asymmetric or deformed, surface adjustments can be performed to make the case a candidate for DP. Aaron Kosins was the one who popularized this approach.[3,10] He discusses using the piezotome to burr down the bony cap, trim the prominent edges of the upper lateral cartilages and place spreader grafts when the upper lateral cartilages are deformed. Robotti also talks about dividing the upper lateral cartilages and leaving the septal T, doing subdorsal work and reconstructing.[11] Placement of the spreader grafts with DP can be difficult as you are working in the space where the spreader grafts should be positioned. In order to get around this, I use "submucosal spreader grafts" that are placed into the soft tissue below the junction between the upper lateral cartilage and dorsal septum as performed in case #18[12] (Video 4). If a subdorsal Z-flap technique is used, the mucosa is dissected on the side opposite the spreader graft allowing placement into a submucosal tunnel. In cases where the middle vault needs to widened bilaterally, bilateral grafts may be needed and then spreader grafts are placed in the submucosal tunnels at the junction between the dorsal septum and upper lateral cartilage (**Figs. 23** and **24**). Then the subdorsal strip excision is performed lower on the septum similar to the modified Ishida septal strip at the intermediate level.[3,13] With the spreader grafts placed up high on the dorsal septum as it meets the upper lateral cartilages, and the septal strip is removed at a lower level just below a couple of millimeter cuff of attached mucosa, the dorsal hump can be stretched down and fixed into proper position. When performing a subdorsal Z-flap, the spreader graft can be placed along the Z-flap on the concave side of the deviation (**Fig. 25**). It may be necessary to make a vertical releasing incision in the dorsal remnant below the high point of the

Fig. 20. Case #15. (*A*). Rhinoplasty diagram showing subdorsal Z-flap with overlap on the left side with bone strip removed on the left and conventional lateral osteotomy on the right. Ethmoid bone was used to straighten the remainder of the caudal part of the septum. The nasal spine was fractured to the left and the caudal septum was resutured into the repositioned spine notch. Lateral crural strut grafts were placed with no repositioning. (*B*). Preoperative frontal view (left). Two-year postoperative frontal view (right). (*C*). Preoperative lateral view (left). Postoperative lateral view (right). (*D*). Preoperative base view (left). Postoperative base view (right).

Fig. 21. Case #19. (*A*). Rhinoplasty worksheet for the over projected nose showing subdorsal Z-flap overlapped on the right with bone strip on the right and conventional lateral osteotomy on the left. Nasal spine was fractured to the right. Lateral crural strut grafts with repositioning for the nasal tip. (*B*). Preoperative frontal view (left). A 1.5-year postoperative frontal view (right). (*C*). Preoperative lateral view (left). Postoperative lateral view (right).


A
Caudal septal extension graft overlap on left side
Nasal
Lower Lateral Cartilage
Septum
Lateral
Lower Lateral Cartilage
spine
fracture to left
Upper & Lower Lateral Cartilages
B
C
D

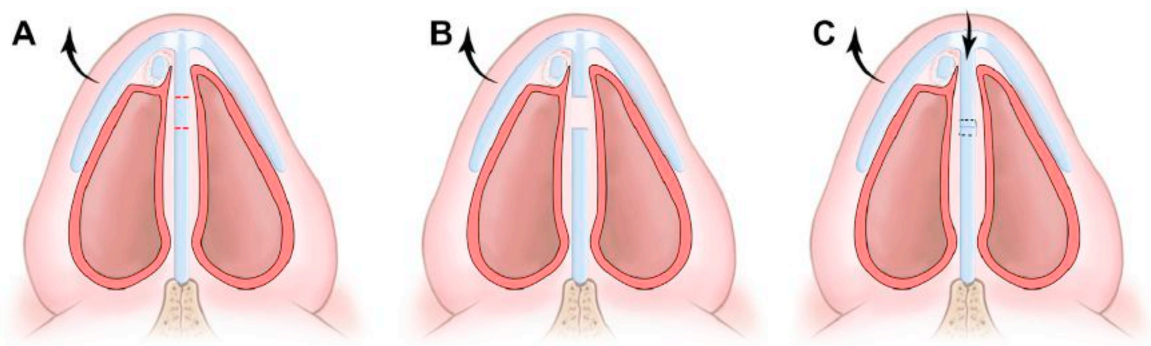


Fig. 23. Submucosal spreader graft. (*A*). Submucosal spreader graft placed into tunnel under the junction between the dorsal septum and upper lateral cartilage. (*B*). Note the lower intermediate level subdorsal strip below the spreader graft tunnels. (*C*). Dorsum flattened. (Reprinted with permission from Toriumi DM, Davis RE. Marina Medical Rhinoplasty Cadaver Dissection Course Videos. St. Louis: Quality Medical Publishing; 2021.)

dorsal hump to allow flexing and flattening of the dorsal hump. Submucosal spreader grafts will also act to tense the upper lateral cartilages to increase lateral wall support and potentially improve nasal function. In some cases, simply by leaving some of the mucosa attached up high on the dorsum on the concave side of the middle vault, the bulk of the mucosa can lateralize the concavity and correct the deformity.

CASES 10 THROUGH 20

In cases 12, 16, 17, and 18, I performed one Ishida intermediate level flap and the remainder were subdorsal Z-flaps. I had no complications, and the esthetic outcomes have been very good. I have 2 patients out of the 20 who have slight deviations of the nose due to correction of the upper two-thirds with inadequate correction of the lower third deviation (Case 6 and Case 7). I also have 1 patient with a prominent bony edge that is not visible but is palpable. There were no cases of saddling or excessive drop of the radix (infantile radix). To date, none of the patients who have undergone DP techniques has undergone revision surgery. The outcomes continue to improve with better profile alignment and fewer cases of residual dorsal convexity. I now also have better control of variations in dorsal height with the option to lower the radix, supratip, and dorsum to create a more curved dorsal line. I am not hesitant to extend my subdorsal incision to the W-point to set proper supratip position and place a small supratip graft if necessary. The intermediate level tetris flap allows for precise control of the supratip by adjusting the suturing of the tetris flap to the caudal strut.

I have continued to use the structure techniques for the lower third of the nose and nasal tip. In my hands, this involves the use of caudal septal extension grafts for tip support.[12,14,15] For the nasal tip, I use either dome sutures alone or with alar rim grafts, dome sutures with lateral crural strut grafts, or lateral crural repositioning with lateral crural strut grafts.[12–20] On occasion, I will use shield tip grafts in patients with thicker skin.[12] I have been using the structure techniques for the past 33 years with good success. The changes I have decided to make are related to the management of the upper two-thirds of the nose with the incorporation of DP techniques (structural preservation rhinoplasty).[21]

OVERVIEW OF MY EARLY EXPERIENCE TO DATE

It is apparent that there were some issues with the first 6 cases. During this period, I was trying to figure out the techniques and make adjustments based on the anatomy and deformities. The primary purpose of this article is to provide the newcomer to DP some insight into potential issues that could arise and how to prevent these problems. The most important observations that I have made to date are as follows.

1. The blocking points for moving the bony dorsum into position include Webster's triangle, the lateral keystone, and the underlying

Fig. 22. Case #20. (*A*). Rhinoplasty worksheet showing subdorsal Z-flap overlapped on the left with vertical radix osteotomy, bone strip on the left and conventional rhinoplasty on the right. Nasal spine fracture to the right. (*B*). Preoperative frontal view (left). A 1.5-year postoperative frontal view (right). (*C*). Preoperative lateral view (left). Postoperative lateral view (right). (*D*). Preoperative base view (left). Postoperative base view (right).

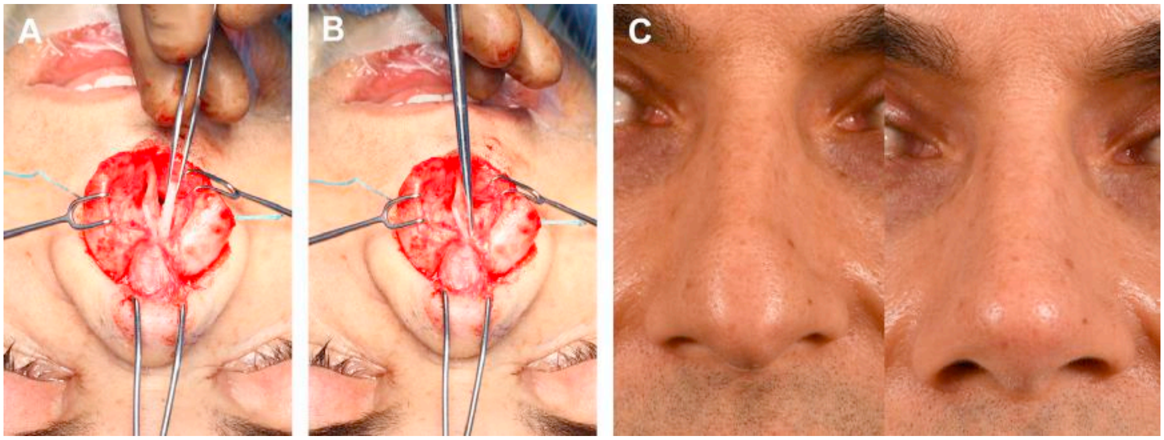


Fig. 24. Submucosal spreader grafts placed in Case #18. (*A*). Tunnels made under the junction between upper dorsal septum and upper lateral cartilages. (*B*). Spreader graft placed into the tunnel under the junction between the septum and the upper lateral cartilage. (*C*). Preoperative close-up frontal view showing narrow lower midvault (left). Two-year postoperative close-up frontal view showing more favorable width of the middle vault with spreader grafts in position (right).

septum. With removal of the subdorsal strip, the septum is no longer blocking. It is important to extend the strip excision under the bony dorsum to the radix osteotomy. In most cases, this is cartilage and can be easily resected. If there is bone under the nasal bones, this will need to be removed with a rongeur, piezotome, or osteotome. If you perform a push down using bilateral lateral osteotomies, bilateral transverse osteotomies, and a radix osteotomy, you will likely need to remove a segment of Webster's triangle. My preference is to take out a bony strip bilaterally in the straight nose and just on the side opposite the deviation in the deviated nose. In some deviated noses, I will take out bone strips bilaterally with a larger strip removed on the side opposite the deviation. I typically will raise a subperiosteal tunnel along the sidewall of the nose raising the periosteum on the internal and external surfaces of the bone. Then I use a Cerkes bone rongeur (Marina Medical Inc., Davie, FL) to take out the bone strips. The cranial 3 to 4 mm of the lateral bone cut is completed with a 3 mm osteotome to keep a blocking point at the level of the radix to minimize drop of the radix. The bone strip removal caudally removes any blocking points at Webster's triangle.

2. One of the key concepts of DP is the stretching and flattening of the cartilaginous portion of the dorsal hump by pulling the "handle" posteriorly and caudal (**Fig. 26**; Video 5). This can be effectively accomplished using most all of the DP techniques. However, I found that the subdorsal Z-flap, classic Cottle or modified SPQR Cottle rhinoplasty of Finocchi, Tetris of Neves provide the most powerful

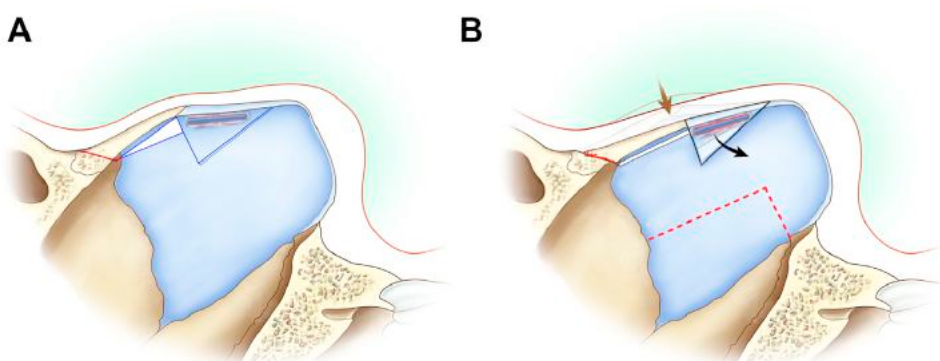


Fig. 25. Submucosal spreader graft with subdorsal Z-flap. (*A*). Note the spreader graft placed under mucosa at junction dorsal Z-flap and upper lateral cartilage. (*B*). Z-flap stretched with spreader graft in position. (Reprinted with permission from Toriumi DM, Davis RE. Marina Medical Rhinoplasty Cadaver Dissection Course Videos. St. Louis: Quality Medical Publishing; 2021.)

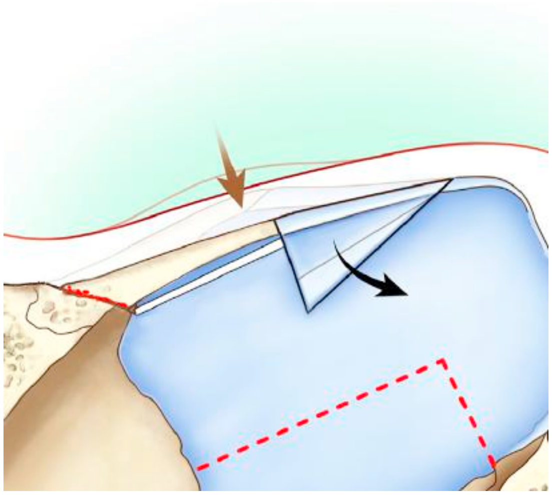


Fig. 26. Stretching flat the dorsal hump by pulling the subdorsal "handle" posteriorly and caudally. This action acts to stretch the hump down at the joint/junction between the bone and cartilage to flatten the hump.

stretching and flattening of the dorsal hump. This is due to the firm connection between the septal stump/triangle/rectangle to the undersurface of the upper lateral cartilages at the dorsal hump. This segment can be easily pulled caudally and posteriorly and fixed into proper position. This segment can be overlapped in the deviated nose as well. Care must be taken as one is placing the fixation sutures because it is easy to pull the suture through the cartilage. To minimize this "cheese wiring," one can leave the septal perichondrium on the upper dorsal septum where the septal flaps (subdorsal Z-flap or Tetris flap) are performed. This adds resistance to "pull through" when applying the fixation sutures (Jose Carlos Neves, personal communication, 2020).

3. One drawback to the action of stretching the hump flat is that the middle vault will tend to slightly widen from its preoperative width. For this reason, noses that start out narrow are ideal because they will likely become a little wider. With borderline wide dorsums, surface maneuvers may be needed to account for the increase in width. One can place a 5-0 PDS suture across the middle vault and bring the upper lateral cartilages in a millimeter or two or shave the upper lateral cartilages laterally to create narrowing. This must be done carefully to avoid creating deformity. For even wider dorsums, segmental spreader flaps can be performed to narrow the wide middle vault.[21]
4. The lateral keystone release (LKA) release or "ballerina maneuver" as described by Goksel is important particularly in larger dorsal humps because this can act as a blocking point. With smaller dorsal humps, I do not perform LKA release as is discussed by Kosins.[3] I did not perform any LKA releases in the first 20 cases of DP. I routinely use it now with the larger humps and prominent deviations. I think it can help to prevent hump recurrence with larger dorsal humps.
5. When performing DP techniques, you should recognize the potential compartmentalization that occurs with different techniques. When using the classic Cottle or the SPQR Cottle of Finocchi, the entire septum is managed and straightened by releasing and repositioning. With many of the other techniques the upper two-thirds of the nose is managed using the subdorsal maneuvers independent of what is done to the caudal septum and tip. This requires attention to the caudal septum to make sure it is in alignment with the upper two-thirds of the nose to avoid a disjointed outcome (Case #5). I refer to this as "disjointed compartmentalization." In many cases, I am using the overlapping caudal septal extension graft to correct any residual deviations of the lower third of the nose and to prevent disjointed compartmentalization. If the subdorsal Z-flap or Tetris is used but not extended to the W-point, torque can be placed on the caudal septum resulting in deviation or curvature. An overlapping caudal septal extension graft is used to correct these deviations or asymmetries. The side that is overlapped will depend on what is needed to ensure the tip is in the midline.
6. The ability to perform surface modifications of the bony dorsum in the form of bony cap removal, trimming of the shoulders of the upper lateral cartilages and placement of submucosal spreader grafts has been very important in converting questionable candidates for DP to good candidates for DP. Sculpting the bony cap and bony dorsum seems to be a big part of this. In most cases, I make a narrow subperiosteal tunnel and place a narrow rasp to take down a little of the bony cap. Through this same tunnel, you can place a small soft tissue radix graft above the dorsal hump to help camouflage a potential residual hump. Additionally, segmental spreader flaps can be used with the overly wide nasal dorsum.[22]
7. You must become very comfortable performing osteotomies in order to execute DP techniques. If you do not have access to the piezotome, then you will have to become

very efficient at making bone cuts either with wide exposure or with no skin elevation via small stab incisions. My preference is to do the latter in most cases to minimize trauma to the tissues and preserve stability of the bones. If you are inexperienced with osteotomies, your problems with DP will likely be related to these bone cuts (shattered bone, irregular bone cuts, incomplete bone cuts, displaced bone). Fortunately, we have rarely seen these problems in our series.

8. The axis deviation of the nose can be difficult to manage with spreader grafts and spreader flaps. DP techniques allow the axis of the nose to be tilted to the midline with great precision. Treatment of the deviated nose is one of the strengths of the DP techniques. You are able to shift the bony and cartilaginous vault (axis deviations) to the midline with asymmetric bone reduction and overlapping subdorsal segments. I think this is one of the most significant advantages of the DP techniques.
9. The combination of structure and DP (structural preservation rhinoplasty) is a very powerful combination that allows the surgeon to maximally structure the nasal tip and preserve the anatomy of the upper two-thirds of the nose while making adjustments in dorsal alignment.[21] The addition of spreader grafts can turn most primary rhinoplasties into good candidates for DP.
10. Early on, choose patients who have V-shaped dorsal humps and those who would be fine with a slight residual dorsal convexity. If the patient has a lower radix, use a radix graft to camouflage any residual dorsal hump.
11. Follow your patients long term to determine what the true outcome is and make adjustments in technique as needed.

Present Approach

At this point, after performing over 200 cases using DP, I have had the opportunity to use all the published techniques including high strip, intermediate strip (Z-flap, tetris), low strip, and surface techniques (spare roof types A and B). Many of these techniques can be mixed and many are interchangeable. I use the subdorsal Z flap in most V-shaped dorsal humps and mild-to-moderate deviations. Therefore, I use the subdorsal Z flap in the majority of primary rhinoplasties. I use the tetris for larger dorsal humps because it provides a larger subdorsal "handle" to manipulate. I also use the tetris in cases where I must reduce the supratip (tension nose). I can also use a "split tetris" in cases where the bones and middle vault are going in opposite directions. If I am planning on placing a submucosal spreader graft, I will use an intermediate level strip (Ishida or Most) leaving the mucosa A attached to one side of the flap. I use the spare roof type B for cases with a larger S-shaped hump because it allows me to reduce the bony cap and fix the bone into position. The Cottle/SPQR is reserved for patients with a severely deviated septum or severely deviated nose. I rarely need to perform a subtotal septal reconstruction as the Cottle/SPQR can correct most of these deformities. I have used all these techniques and find them all very effective.

In most cases, I try to keep the dorsal skin attached or undissected, and I perform most of the bone cuts from an intranasal approach (Video 6). I use primarily a 2 mm osteotome and a Cerkes bone rongeur (Marina Medical Inc., Davie, FL). The transverse osteotomies are typically performed via small lateral wall stab incisions. To prevent comminution of the transverse bone cuts, I use a Cerkes hand drill (Marina Medical Inc. Davie, FL) to etch a trough along the intended osteotomy line (Aaron Kosins, personal communication, 2020). Then a 2 mm osteotome can easily punch through the trough in a very controlled manner avoiding comminution.

With the transition to DP, I have actually changed my esthetics of the upper two-thirds of the nose. With conventional Joseph dorsal hump reduction (component hump reduction) and middle vault reconstruction with spreader graft or spreader flaps, I typically left the patient with a slightly overcorrected middle vault (wider). This wider construct was used in anticipation of narrowing that would occur over time due to scar contracture and healing. My conversion to DP has given me the confidence to keep the upper two-thirds of the nose (bones and middle vault) much narrower. I am confident that by not opening and reconstructing the middle vault, I can keep the nasal dorsum and middle vault much narrower as the contracture and healing effect is nullified. This change in esthetics has positively affected patient satisfaction without compromising nasal function. Additionally, because I rarely use spreader grafts, I have more cartilage for the structural grafting in the tip and I rarely go to the ear or rib in primary rhinoplasty cases. These are some of the significant advantages of incorporating DP into my practice.

I have also incorporated a subdorsal cantilever graft to "push up" the dorsum and treat the saddle nose deformity.[23] The subdorsal cantilever graft is also used to elevate the low dorsum in the ethnic rhinoplasty patient.[23] The subdorsal cantilever graft can also be used for elevating and supporting the nasal dorsum in cases of failed attempts at DP (infantile radix, saddle nose deformity). Secondary rhinoplasty patients with a residual dorsal hump and intact dorsal roof are also candidates for DP.

DP has become an integral part of my rhinoplasty armamentarium and has proven to be very reliable with minimal complications.

Final Comments

DP has come back with great popularity. In my assessment, there are distinct reasons for its resurgence. Having the capability to preserve the favorable anatomy of the upper two-thirds of the nose and minimize the need for spreader grafts and spreader flaps is significant. Component reduction of the dorsal hump requires amputating the top of the bony nasal vault and then needing closure of the open roof. This series of maneuvers results in potentially rough bony edges, irregularities, depressions or prominences that may require soft tissue camouflage in the form of temporalis fascia grafts, diced cartilage and fascia grafts, other soft tissue grafts, and so forth. Minimizing this potential site for irregularities is a significant advantage in the management of the dorsal profile. The cases above provide a good overview of one surgeon's early experience with DP. I focus on the teaching points to aid the reader in navigating through their early experience.

The impact on the esthetics of the upper two-thirds of the nose has been a positive change that has improved on patient satisfaction. The incorporation of DP into my practice has proven to be a major advancement in the treatment of primary rhinoplasty patients.

CLINICS CARE POINTS

- V-shaped dorsal humps are ideal for DP.
- S-shaped humps with a low radix are not good candidates for DP.
- Subdorsal Z-flap provides a "handle" to hold the dorsal hump in the reduced position.
- Overlapping Z-flap is ideal for correcting the axis deviation of the nose.
- Let down eliminates the blocking point at Webster's triangle.
- Oblique radix osteotomy helps to avoid radix drop and the "infantile radix."
- Caudal septal extension graft can stabilize and straighten a deviated caudal septum after the dorsal hump is reduced.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.fsc.2022.08.008.

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Original Article

Biomechanical Nasal Anatomy Applied to Open Preservation Rhinoplasty

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Facial Plast Surg

Abstract

Preservation rhinoplasty is a new way to reshape the nose by preserving the dorsum, nasal ligaments, soft tissue envelope, and muscles. This new concept provides the opportunity to achieve a more natural aesthetic and functional result. To achieve a good aesthetic and functional outcome while maintaining surgical safety, knowledge of the relevant anatomy is key. This is especially true for the preservation rhinoplasty technique, where a firm grasp of the anatomy of the nasal soft tissue and bony–cartilaginous framework is critical. The preservation technique is made more accessible by the open approach, which provides an opportunity for the deformity to be clearly visualized from the tip of the nose and the dorsum. Furthermore, tip plasty is easier to perform under direct vision, which is an advantage of the open approach. The goal of this article is therefore to make clear all the important anatomical structures and their relevance to the surgical steps taken when performing the open preservation rhinoplasty technique.

Keywords
- rhinoplasty
- preservation rhinoplasty
- nose anatomy
- open rhinoplasty
- piezosurgery

The most common step of reduction rhinoplasty is hump reduction. However, to create a more natural appearance and better functional result, the surgeon has to reconstruct the deformity that was iatrogenically created by the classical hump reduction technique. Preservation rhinoplasty is a new way to reshape the nose by preserving the dorsum, nasal ligaments, soft tissue envelope, and muscles. This new concept provides the opportunity to achieve a more natural aesthetic and functional result. Preservation rhinoplasty techniques keep the ligaments intact, and hence the operated nose can still retain its elasticity. Since the nasal ligaments are the main connection between the skin and the skeleton of the nose, by preserving them we reduce postoperative swelling and enable better and faster redraping of the nasal skin envelope, reducing the dead spaces created by the surgery. This point is particularly relevant for a thick-skinned rhinoplasty patient, in whom it is often difficult to get contours, especially in the early postoperative period. In our experience, preservation of the ligamentous and skin attachments will help create better contours in these patients.

To achieve a good aesthetic and functional outcome while maintaining surgical safety, knowledge of the relevant anatomy is key. This is especially true for the preservation rhinoplasty technique, where a firm grasp of the anatomy of the nasal soft tissue and bony–cartilaginous framework is critical. The preservation technique is made more accessible by the open approach, which provides an opportunity for the deformity to be clearly visualized from the tip of the nose and the dorsum. Furthermore, tip plasty is easier to perform under direct vision, which is an advantage of the open approach. The goal of this article is therefore to make clear all the important anatomical structures and their relevancy to the surgical steps taken when performing the open preservation rhinoplasty technique.

Surgical Anatomy

We use an inverted V incision on the narrowest part of the columella, which is the junction between the medial crural footplates and the medial crura of the lower lateral cartilages (LLCs). We prefer to use a no. 11 blade for the incision. The

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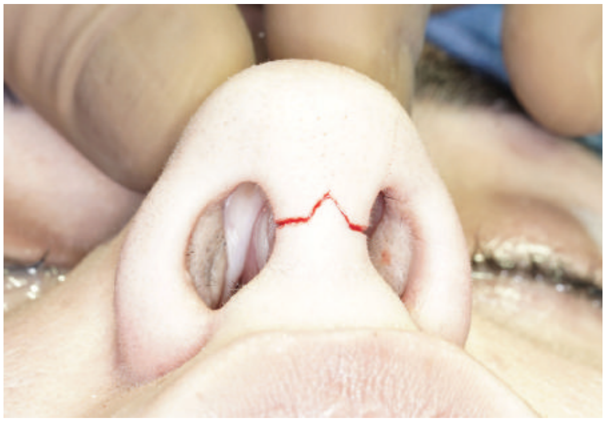

Fig. 1 Inverted V incision on the narrowest part of the columella, which is the junction between the medial crural footplates and the medial crura of the lower lateral cartilages.

medial crura of the LLC are located very superficially on the sides, and hence the incision should be performed very carefully and superficially on the columellar sides (►**Fig. 1**).

The superficial branch of the dermocutaneous ligament (called "Pitanguy") is located between the two medial crura of the LLCs, immediately beneath the skin.[1,2] While, in most cases, some fibers of the superficial Pitanguy ligament will inevitably be damaged by the transcolumellar incision, the essential bulk of the Pitanguy ligament can still be preserved when using this approach. Next, dissection of the LLC can be performed on either a sub- or supraperichondral plane. During the course of dissection, once the domes of the LLC appear, one can proceed in making the marginal rim incision by following the caudal edge of the LLC. The subperichondral plane is an absolutely bloodless plane, but the LLC becomes more fragile when placing tip sutures because of the absence of support from the perichondrium.[3] However, it is also important to note that the vertical scroll ligament attaches partly to the perichondrium of the cephalic border of the LLC mainly in the upper lateral cartilage (ULC) scroll; hence, dissection on the subperichondral plane would allow us to preserve the scroll ligament attachments. Therefore, for the aforementioned reasons, we typically perform supraperichondral dissection on the LLC but go under the perichondrium exactly at the border of the cephalic resection of the LLC. This modification enables us to put tip sutures through the perichondral layer, hence keeping the cartilages stronger and at the same time enabling us to preserve the attachments of scroll ligament onto the cranial LLC vertical scroll ligament (►**Fig. 2**).

If, however, the surgeon elects to dissect the LLC on an entirely subperichondral plane, the best starting point to cross through the perichondrium and enter the subperichondrial plane is at the turning point of the lateral crus. This is because the perichondrium tends to be thicker in this region and hence easier to identify. The vertical scroll ligament attachments can be seen clearly on the cephalic border of the LLC. When dissecting beneath the perichondrium, the vertical scroll ligament can be preserved. Dissection can be extended laterally following the LLC caudal border to reach to the pyriform aperture of the maxillary bone (►**Fig. 3**).

On the lateral nasal wall lie the horizontal and vertical pyriform ligaments. The horizontal pyriform ligament is a type of ligamentous barrier between the pyriform aperture of the maxillary bone and the accessory cartilages. The vertical pyriform ligament is a very strong connection between the lateral keystone area and the skin. This ligament becomes an important structure in piezosurgery since it needs to be dissected to create the requisite wide tunnel necessary to enable access for the piezo to be used to create low-to-low lateral osteotomies (►**Fig. 4**).

There is another ligament connecting the nasal bony pyramid to the skin on the lateral wall. It is located along the suture line between the nasal bones and the frontal process of the maxilla. We name it the nasomaxillary suture line ligament (NMSL). It is an important structure when it comes to lateral osteotomies, notably because if this ligament can be kept intact during the piezo osteotomies, skin redraping and healing will be faster. Preservation of the NMSL ligament can be achieved by creating a tunnel lateral to this ligament for the low-to-low osteotomies (►**Fig. 5**).

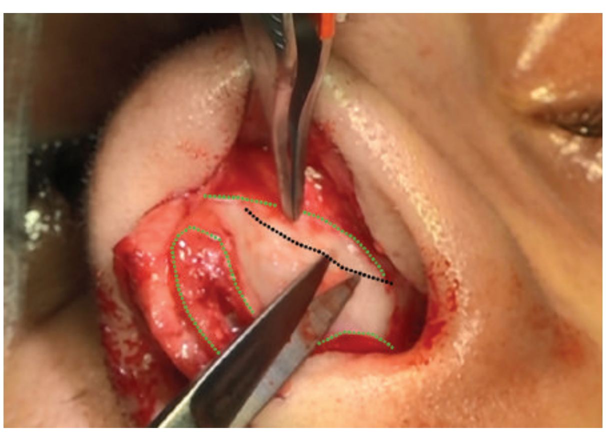

Fig. 2 The black line indicates the entry point and line for subperichondral dissection, which corresponds to the border of cephalic resection of the lateral crura.

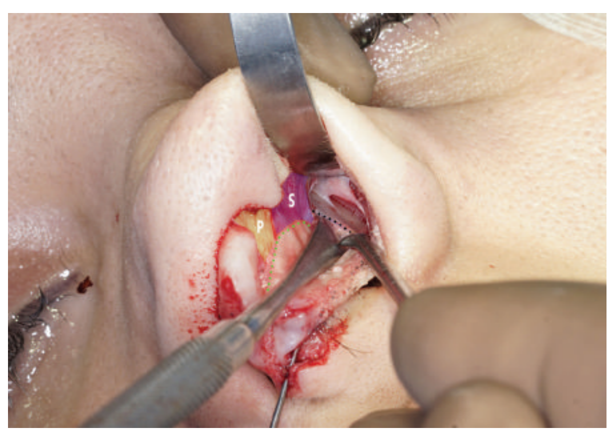

Fig. 3 Dissection extends up to the pyriform aperture. Note that the scroll (S) and "deep Pitanguy" (P) ligaments are intact.

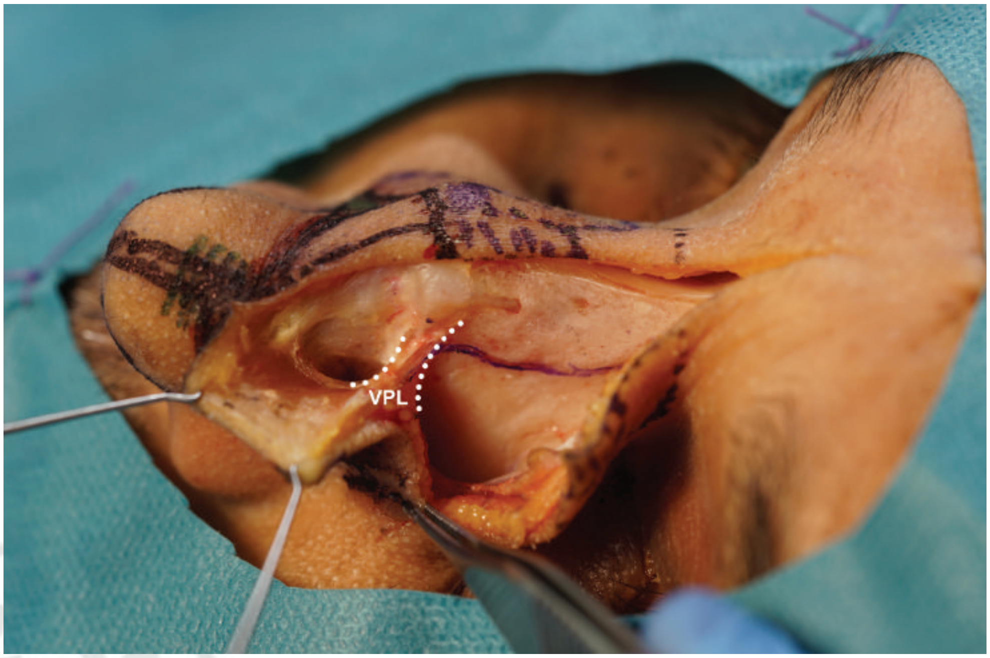

Fig. 4 VPL is a strong connection between the nasal bone and the skin. VPL, Vertical piriform ligament.

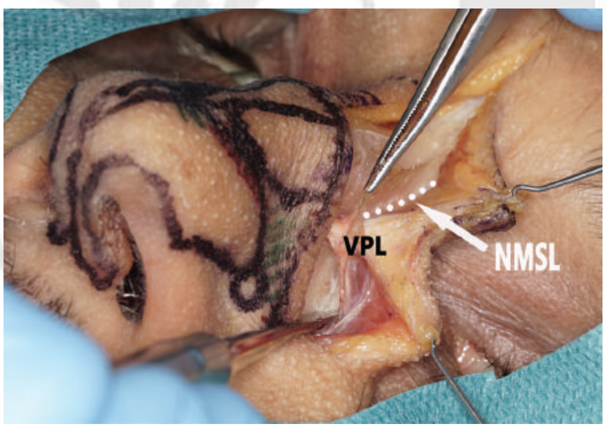

Fig. 5 The dotted line shows the NMSL ligament on the suture line between the frontal process of the maxillary bone and the nasal bone. NMSL, nasomaxillary suture line ligament; VPL, vertical pyriform ligament.

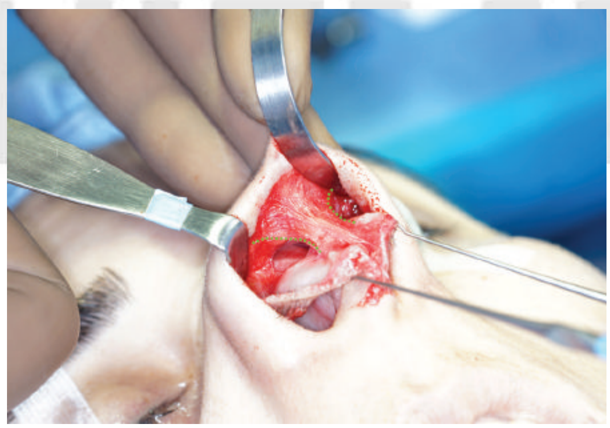

Fig. 6 Pitanguy midline ligament.

Approach to the Dorsum

When deciding upon whether or not to preserve the nasal dorsum, it is necessary to first evaluate if there is a deformity that makes preservation of the nasal dorsum not feasible. Naturally, when making this decision, one also needs to take into account other factors including the experience of the surgeon and the technique that he/she is accustomed to, as well as the individual demands of the patient and his/her expectations.

The second most important indicator for dorsal preservation is whether there is a convexity in the nasal bone that can be corrected by preserving the nasal dorsum.

We can either preserve the scroll and Pitanguy ligaments or refix them, depending on our chosen approach. The scroll ligament represents the attachment of the transversalis muscle. It attaches to the scroll cartilage between the ULC and LLC. The Pitanguy midline ligament is the elastic connection between the LLC medial crura cephalic portion and the supratip skin. It attaches to the orbicularis oris superficial pars and depressor septi nasi muscle (►**Fig. 6**).

During the patient selection process, we divided the patients into the following three groups according to the extent of soft tissue elevation and type of preservation surgery:

- Group 1: patients in whom, based on our initial assessment, we do not plan on making any other changes aside from dorsal hump resection. Such patients already possess otherwise well-shaped dorsal aesthetics and **V**-shaped nasal bones. In this group, it is possible to apply preservation rhinoplasty using an open structured

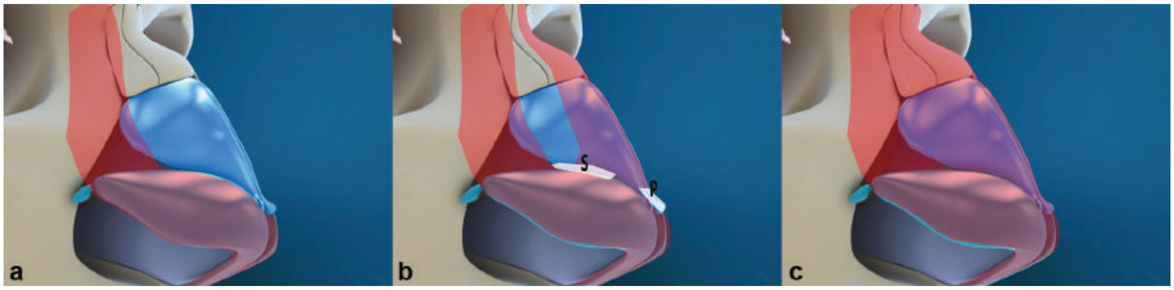

Fig. 7 (**a**) Group 1: preservation of the skin overlying the dorsum and most of the ligame:nts. (**b**) Group 2: approaching the dorsum between the scroll (S) and Pitanguy (P) ligaments. (**c**) Group 3 extended open approach. Red marked areas show the dissections.

approach characterized by no skin elevation over the dorsum and preservation of almost all the ligaments.

- Group 2: patients with correct dorsal aesthetic lines yet requiring osteoplasty due to the height and/or the shape of the nasal bone hump (i.e., **S**-shaped nasal bones). In this group, it is necessary to elevate the dorsal skin and partially dissect the ligaments while still preserving them.
- Group 3: despite the irregularities and asymmetries on the nasal dorsum, it is a group in whom we can still use dorsal preservation surgery. In this group, the dorsum is reshaped and preserved through total dissection of the skin. The Pitanguy ligament and scroll ligament can be fixed at the end of the procedure (►**Fig. 7**).

Approach to the Septum

The following discussion outlines the sequence of steps that are crucial when using the preservation rhinoplasty technique. We wish to emphasize that there is an important order of procedures that needs to be followed. The connection between the cartilaginous and bony septum with the dorsum should be separated before the low-to-low and transverse osteotomies are performed. Therefore, prior to performing osteotomies, we must first approach the septum.

There are several ways in which the septum can be approached, including caudal tip-split, dorsal split, transfixion, and hemitransfixion approach. For preserving the Pitanguy ligament attachments to the cephalic border of the medial crura of the LLC, we prefer to approach the septum through a hemitransfixion incision instead of approaching through the open approach. The hemitransfixion incision is performed on one side of the mucoperichondrium of the caudal portion of the quadrangular cartilage. The mucoperichondrium is usually thicker on the caudal portion of the septum, and the incision should extend through the full thickness of the mucoperichondrium to reach the proper septal cartilage. Following the incision, the next step is to create a subperichondral tunnel on the septum; the easiest way to reach the correct plane is by using the iris scissors to first tease the perichondral tissue fibers off the cartilage. If there is no need to harvest septal cartilage, then often elevation of only one side of the septal mucoperichondrium will suffice. The intact side of the mucoperichondrium will help to keep the septum stronger. Another difficult area of dissection is the connection between the maxillary bone and cartilaginous septum where perichondrium and periosteum intermingle their fibers. The periosteum of the maxillary bone should be incised and a subperiosteal tunnel be created if needed.

Depending on the approach that the surgeon chooses, we can classify the following three different methods to separate the connection between the septum and dorsum:

- High septal strip (HSS).
- Midseptal strip (MSS).
- Low septal strip.

It is important to note that the choice of the approach affects the septoplasty result, and hence the surgeon's decision will be largely influenced by the septal pathology.

High Septal Strip

The HSS excision should start exactly on the W point where the ULCs attach to the septal cartilage. The W-ASA segment of the septal cartilage refers to the area between the W point and the ASA (anterior septal angle). It should be kept intact until the end of the surgery, otherwise supratip saddle deformity can inadvertently occur (►**Fig. 8**).[4]

A no. 15 blade and scissors can be used to remove the high strip of septal cartilage. This resection includes both a strip of septal cartilage and a corresponding strip of the perpendicular plate of the ethmoid bone under the radix, if required, following preoperative cone-beam assessment and intraoperative findings. The high strip resection should be completed up to the radix osteotomy level, thus separating the connection between the nasal bones and the ethmoid perpendicular plate, to avoid creating any further unwanted irradiated fracture of the latter when performing mobilization of the bony pyramid. Septum is mainly cartilaginous during childhood and teenage, then the ossification process is extending caudally to the K-area. In the younger population, the septal cartilage usually lies beneath the bony hump, and therefore often resection of only a small amount of ethmoid bone is required. With age, however, larger amounts of ethmoid bone removal may therefore be necessary (►**Fig. 9**).

The septal strip excision should be performed incrementally by adding further strip resections to prevent unwanted overresection. After completing the osteotomies, if the height of the dorsum needs further reduction, then we can turn back to the previous step and carefully resect another strip of the cartilage. For resection of the ethmoid bone strip, the long inserts of the piezo electric device or baby rongeur

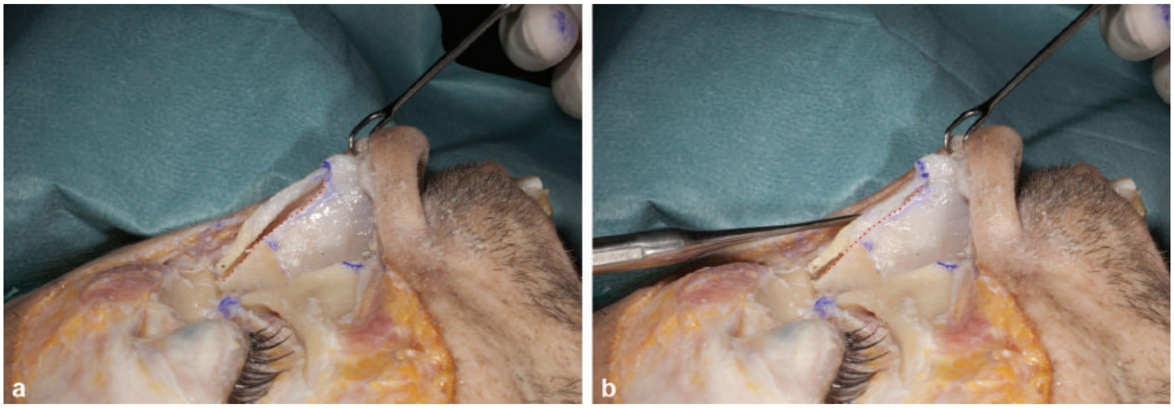

Fig. 8 (**a**) High septal strip excision along with the remnant part of the septum situated immediately under the dorsum. (**b**) The caudal portion of the septum remains intact and supports the supratip area.

Fig. 9 The cartilaginous septum is often larger in the younger population.

Fig. 10 A line is drawn for the septal harvesting in high septal strip.

can be used. If grafting material is needed, remnant septal cartilage can be harvested, taking care to leave behind an intact L-strut portion. The preferred L-strut thickness should not be less than 1 cm, and the corner of the excision at the anterior angle should be a round shape for better resistant force (►**Fig. 10**). Therefore, septal cartilage should be harvested after dorsum lowering—high strip resection—to check the precise height of intact L-strut shape at the end of the procedure.

The Best Indications for the High Septal Strip Approach

- Nice dorsal lines.
- Straight dorsum or tension noses including dorsal hump ≤ 4 mm.
- Hump is mostly cartilaginous.
- High septal deviation.
- Overprojected radix.
- Caudal septum is in the midline.
- **V**-shaped nasal bones[5] or short nasal bones.

Mid Septal Strip

The MSS approach gives us the opportunity to more easily fix the position of the new dorsal height. Instead of resecting the septal strip immediately beneath the hump, the strip is resected from the midportion of the septum. The MSS excision can be extended straight up to the level of the radix osteotomy, or a different design can be used to improve stabilization, such as the Tetris concept described by Dr Neves. Indications are similar to those for the HSS (►**Fig. 11**).

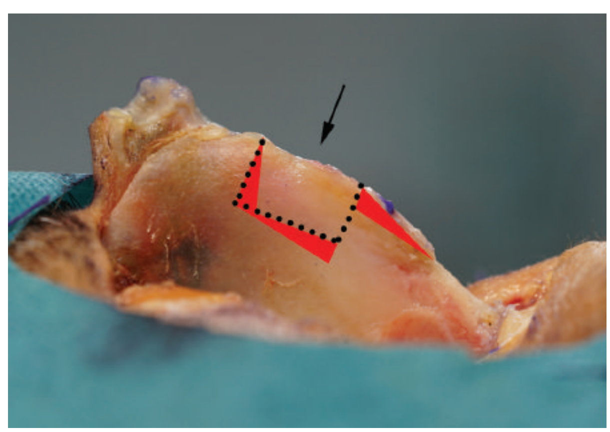

Fig. 11 Tetris concept (mini Cottle) described by Dr Neves.

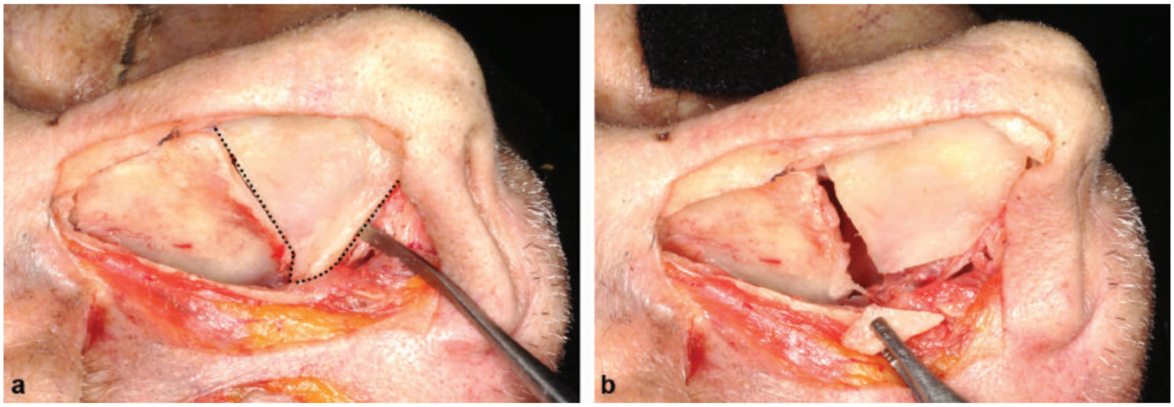

Fig. 12 (a,b) The septal quadrangular cartilage becomes free of tension after releasing its attachments from the adjacent bones. A vertical incision is made at the level of the most prominent point of the dorsal hump. A segment of the inferior edge is removed (low strip resection) allowing for lowering the dorsum.

Low Septal Strip and Cottle's Procedure

Cottle first described this septal approach in 1956.[6] There are many variations of this technique already described by Cottle, even though few papers have been published regarding these variations. It consists of a complete separation of the quadrangular cartilage from the surrounding bony framework. This procedure gives the opportunity to release the quadrangular cartilage from the tension arising from its connection to the surrounding bones. This procedure further helps to reestablish the correct relationship between the septum and the anterior nasal spine (ANS). LSS works better for cases of crooked nose correction and in those with caudal septal deviation.

In the majority of cases, ethmoid bone and septal cartilage connection is usually located more cephalic than the dorsal keystone area.

In the classical Cottle maneuver for LSS, the septal cartilage is separated from the ethmoid bone and the maxillary bony crest along its entire length vertically and horizontally. After marking the most prominent point of the convex K-area, then a vertical incision is made into the septal cartilage that is levelled with this "top" point of the dorsal hump. This level is always more caudal than the ethmoid bone connection. Once we have freed the septal cartilage from the aforementioned bony connections, it becomes flatter and straighter. The low septal excision amount depends on the extent of the hump reduction (►**Fig. 12**).

Another important point of this technique is refixing the caudal portion of the released septum to the ANS. This connection will be the main fixation point for the new shape of the dorsum and is critical for the support of the septum. If the caudal portion of the septum is not strong enough, the suture material may tear through the cartilage, making fixation very difficult. Therefore, patients with flimsy cartilages are not good candidates for the LSS.

There are different ways to fix the caudal septum to the ANS. This depends on the size and shape of the ANS. In most cases, we prefer to fix directly through the ANS bone using the "three-hole" method. After creating a **V**-shaped notch with a no. 15 blade on the middle portion of the ANS, we drill a hole from one side to the other with the piezo drill insert. Second and third holes are also carefully created on each side of the notch. 4–0 PDS suture (Ethicon Inc.) can be used to fix the septum to the ANS, passing through the three holes created. In our experience, this ANS fixation is the most strong and reliable method, just with one single suture (►**Fig. 13**).

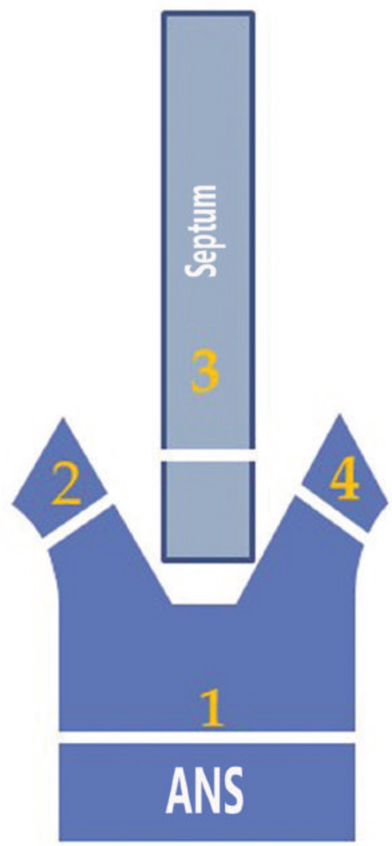

Fig. 13 Creating a notch on the anterior nasal spine and the three holes method fixation of the caudal septum

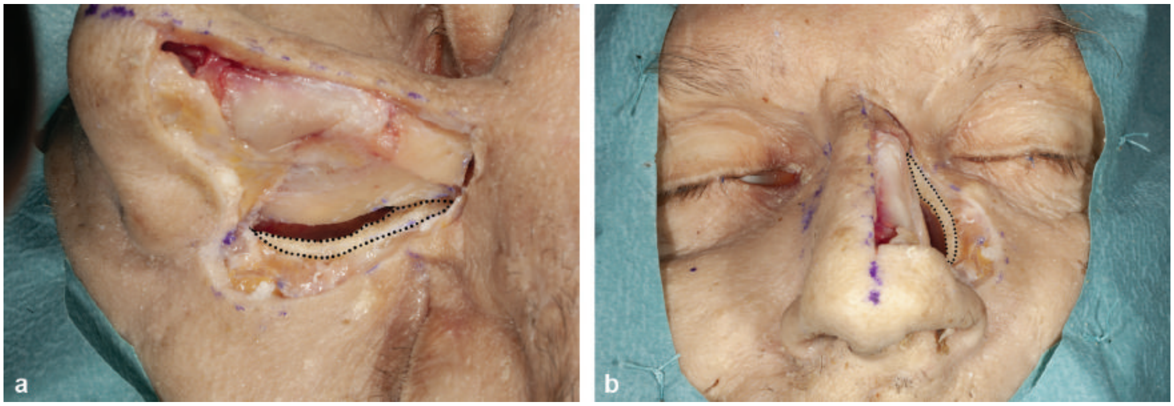

Fig. 14 (a,b) The medial canthal ligament area corresponds to the thickest part of the low-to-low osteotomy line.

Indications for the Low Septal Strip Approach Are Mainly Related to Challenging Septoplasties in Rhinoplasty Procedures

- Crooked nose indicated for dorsal preservations.
- Asymmetric face/noses.
- Dorsal hump ≥ 4 mm.
- If the caudal portion of the septum is not in the midline.
- Low septal deviation noses.

Approach for Osteotomies

If there is no need to work on the dorsum or radix, the skin over the dorsum can be preserved; hence, there is no need for dissection and elevation of the skin in this region. Osteotomies can be performed either endonasally through the pyriform aperture approach or externally. On the other hand, if we need to reshape the dorsum, then the skin overlying the dorsum is elevated and piezo osteotomies can be performed through the extended open approach.

We prefer to use the piezo electric powered instrument for osteotomy in preservation procedures. Piezo electric technology gives the opportunity to make precise osteotomies in the exact direction and depth that are needed. Additionally, because the soft tissues are not harmed, there is less bruising in the outcome. However, as a potential drawback, the piezo electric instruments create heat, and, if care is not taken, they can potentially cause burns on the skin with direct contact. For this reason, creating a sufficient wide tunnel will enable us to work with the Piezo device safely. Once the LLC accessory cartilage has been visualized, a pyriform aperture subperiosteal tunnel should be created using the sharp-edged periosteal elevator following the nasofacial groove up to the level of the medial canthal ligament. The superficial medial canthal ligament attaches onto the periosteum and will naturally be undermined in the process.

The level of the osteotomy should be placed on the nasofacial groove. Low-to-low osteotomy protects from having an undesirable lateral step on the osteotomy lines.

The direction of the osteotomy is important in preservation rhinoplasty. Once the dorsum has been preserved, in the foundation techniques we push down or “let the dorsum down” and consequently overlap the base of the nasal bony pyramid. If the osteotomies were to be performed horizontally, the thickness of the bone in the intercanthal area would block any downward impaction, thus either keeping the hump in place or leading to a recurrence of the hump in the early postoperative period (►Fig. 14).[7]

This is the key dilemma of horizontal osteotomies in the “pushdown” technique, and hence for this reason sagittal osteotomies are much desirable. They give the opportunity to slide the nasal bones down with less resistance, creating a better transition between the maxillary bone and the nasal pyramid (►Fig. 15). Sagittal low-to-low osteotomies extend up to the medial canthal ligament level.

The Webster triangle is another important anatomical landmark in low-to-low sagittal osteotomies (►Fig. 16).

The head of the inferior turbinate’s bony attachment is located immediately posterior to the Webster triangle.[8] When the whole dorsum is pushed down, the lateral bony wall of the nasal pyramid can overlap with the inferior turbinate bony attachment exactly on the Webster’s triangle. This has the potential to cause unwanted residual hump recurrence since the bony fragment of the inferior turbinate can block the intended downward movement of the nasal bone. Moreover, this overlap can produce pyriform aperture narrowing and breathing issues.[9] Therefore, to prevent this overlap and undesirable consequence from occurring, Webster’s triangle resection is recommended when using the preservation technique (►Fig. 17).

When using the piezo device, this resection can be easily and accurately performed. Because of the bone overlap providing bony support, resection of the Webster triangle does not result in breathing problems from the internal nasal valve’s lack of support and subsequent collapse in dorsal preservation techniques.

Transverse osteotomies can be performed using a Tastan–Cakir handsaw. In groups 1 and 2, the osteotomies were performed through the tunnels we created on the facial groove (►Fig. 18). We can easily perform transverse osteotomies with the piezo electric device in group 3.

Because of the limited space available in this region for access with the piezo device, there is a risk of unwanted skin damage secondary to the heat generated from the piezo

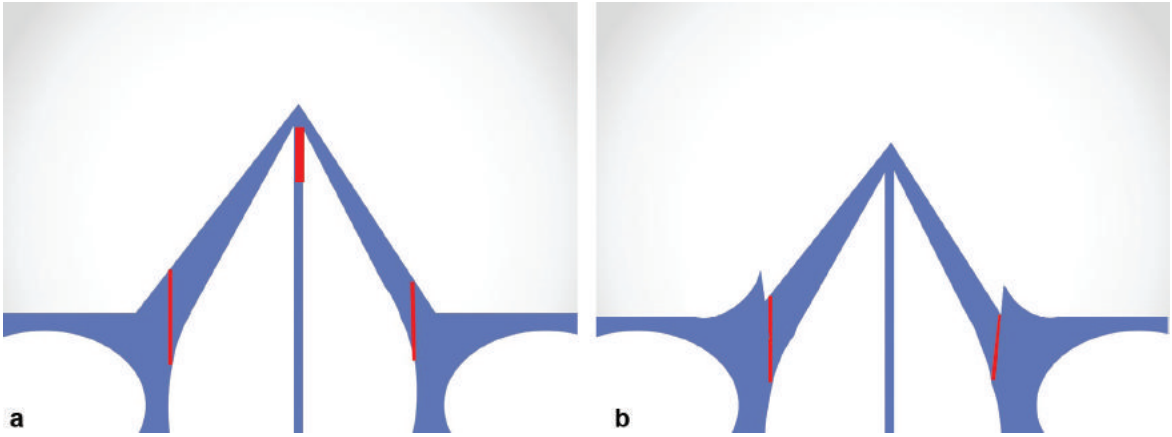

Fig. 15 (a,b) Sagittal low-to-low osteotomies allow for bony pyramid downward sliding with subsequent pushdown.

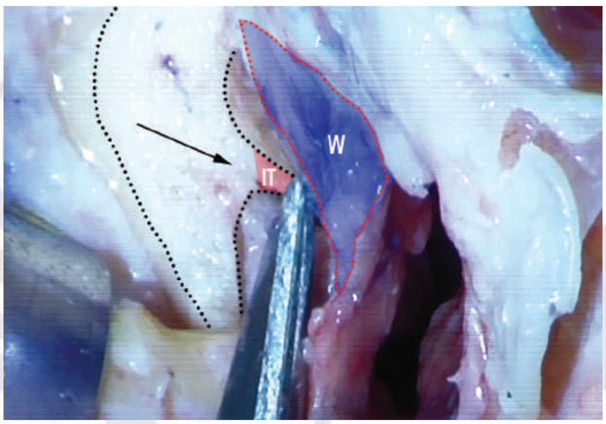

Fig. 16 Inferior turbinate's conchal bone insertion on the inner wall of the frontal process of the maxilla corresponding to Webster triangle.

inserts. Therefore, specifically when performing transverse osteotomies, we recommend using handsaws in these two groups instead of the piezo electric device.

Radix osteotomy is the last step to make the entire dorsum mobile and to enable it to be pushed down. In the dorsal skin preservation group (group 1), the periosteum and skin attachment of the radix area remain intact. The intact periosteum helps to avoid a step irregularity following radix osteotomy. A 2-mm-sharp osteotome is used externally for the radix osteotomy. The direction of the osteotomy is another important point that depends on the wishes of the surgeon. If the goal is deprojection of the radix, then the osteotomy should be performed in a direction perpendicular to the bone. However, if there is no wish to change the height of the radix, then it is safer to perform the radix osteotomy in an oblique manner (►**Fig. 19**).

Flattening Maneuvers

The most common complication of the dorsal preservation techniques is the presence of a residual hump. There are some common points of resistance, which can block the movement of the dorsum. These blocking points can cause the spring effect, and despite the efforts the surgeon can end up with a residual hump problem.

List of the blocking sites and the methods to correct or prevent them is as follows:

1. Osteotomy lines sagittal osteotomies.
2. Mucosal resistance on the areas of bone overlap. To prevent this, mucoperiostal elevation of the internal layer of the maxillary bone should be performed after the osteotomies and prior to pushdown (►**Fig. 20**).

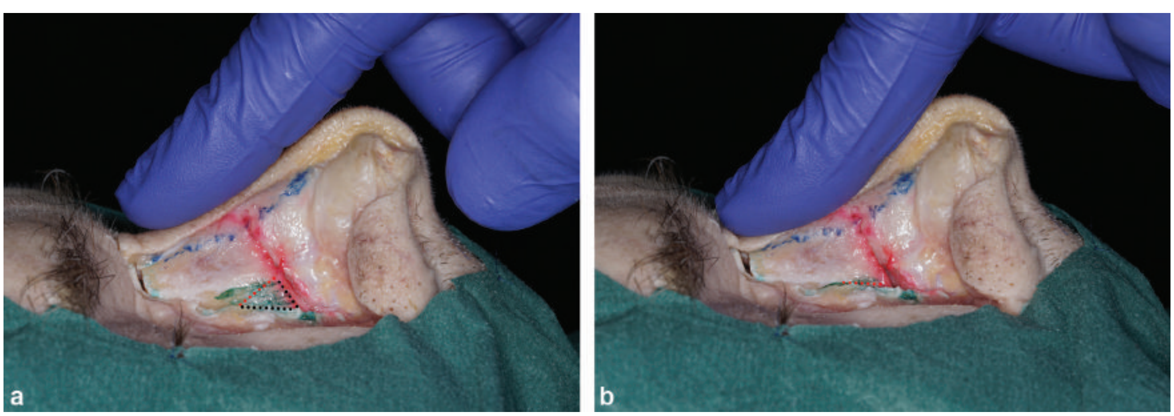

Fig. 17 (a,b) Webster's triangle resection is shown as the dotted marked area.

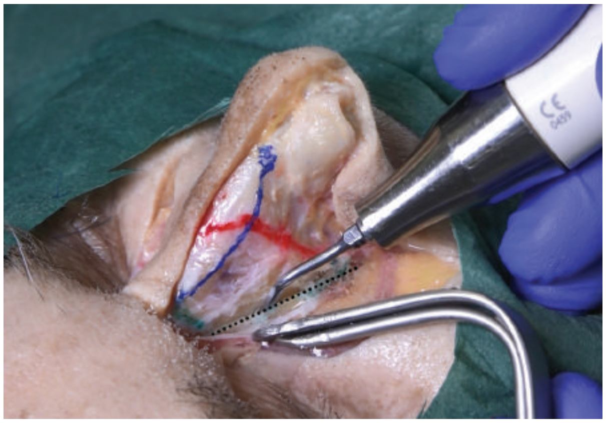

Fig. 18 Low-to-low piezo osteotomy is placed on the nasofacial groove.

Fig. 19 Using 2-mm radix osteotomy in an oblique manner to create a hinge effect.

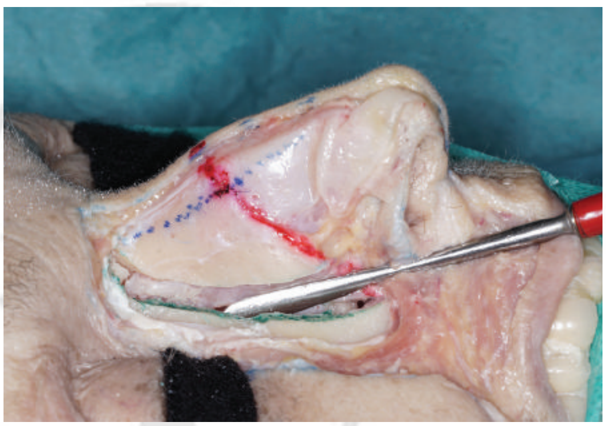

Fig. 20 Internal mucoperiostal elevation of the maxillary bone can be performed through the lateral osteotomy fracture line.

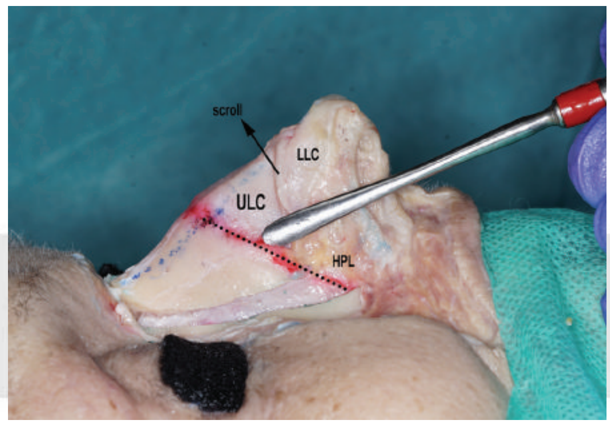

Fig. 21 Ballerina maneuver: in the LKA, blunt disarticulation between the ULC and nasal bone can be seen. LLC, lower lateral cartilage; HPL, horizontal pyriform ligament; ULC, upper lateral cartilage.

3. Webster triangle resection.
4. Septal strip immediately under the hump (in HSS). The preserved intact portion of the remnant septal cartilage immediately beneath the dorsal hump can block the movement of flattening the dorsum during the pushdown (coat-hanger effect). Therefore, if the remnant part is thick, it is better to remove or to score the cartilage under the K-area to make it mobile.
5. Lateral keystone area (Ballerina maneuver). This is one of the most important and tricky steps of the flattening process. The lateral connections of the dorsum consist anteriorly of the overlapping ULC and the nasal bones and posteriorly of the horizontal pyriform ligament and nasal bone connection. If these lateral wall connections are kept intact, they will prevent adequate flattening a humpy dorsum during the pushdown. To prevent this from occurring, a separation technique known as the "Ballerina maneuver" is recommended. This involves releasing the posterior connection and dissecting along the nasal bone up until the most dorsal aspect of the anterior connection that is between the ULC and nasal bone, which the surgeon keeps intact.

The Ballerina maneuver releases the lateral keystone area, hence allowing the dorsum to move and be straightened (►**Fig. 21**).

Repairing the Soft Tissue Envelope

Following rhinoplasty, there is always a degree of swelling due to redraping of the soft tissue envelope and dead spaces. Preservation rhinoplasty is partly built on the principle that if nasal ligaments are preserved, which are the most powerful connections between the skin and the skeleton, then the swelling will be less and healing will be faster. In groups 1 and 2 of the open preservation cases, there is no need for repair of the scroll and Pitanguy ligaments, as they would have been kept intact. However, it is important to note that in all open rhinoplasty cases, it is inevitable that the superficial layer of the Pitanguy midline ligament is cut. As the repair of this ligament would aid in improved redraping and wound healing, preference is given to do so using 6–0 PDS suture material.

If an extended open approach is performed (group 3) or the ligaments have inadvertently been damaged during the

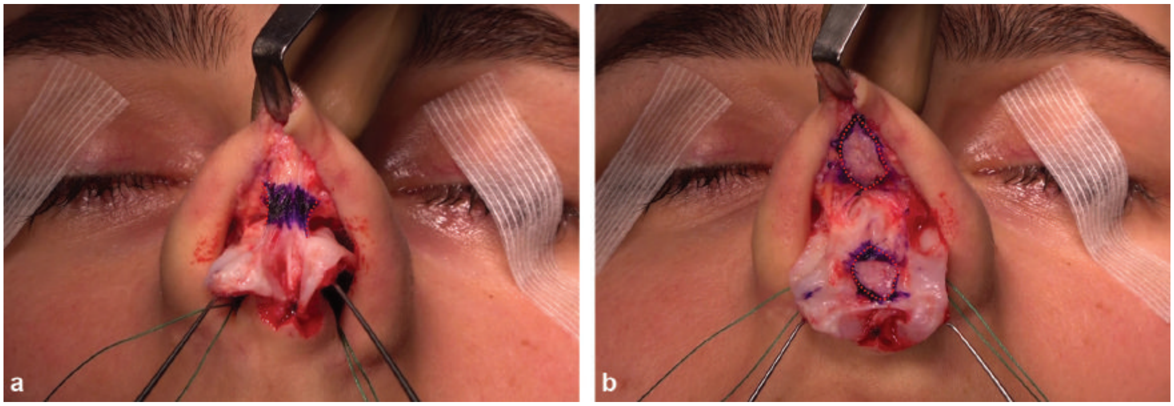

Fig. 22 The Pitanguy midline ligament can be ink-marked at the beginning of the surgery (**a**) and repaired at the end (**b**).

procedure, repairing them is the best option for better healing (►**Fig. 22**).

Conclusion

Preservation rhinoplasty is a biomechanical anatomy based combination of techniques applied with the aim of achieving a more natural result along with faster healing and less tissue edema. The surgeon who wishes to have a good result and minimal complications when using this approach needs to not only have a firm grasp of the anatomy of the nose but also embrace new perspectives on nasal anatomy since the steps, instrumentation, and philosophy of this approach differ in several respects from that of conventional rhinoplasty. In particular, the directions of the osteotomies and the potential blocking points that may impede the desired dorsal movement are key concepts, the understanding of which is critical for a successful outcome with lasting results in dorsal preservation surgery.

Conflict of Interest
None.

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Nasal Hump Treatment With Cartilaginous Push-Down and Preservation of the Bony Cap

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Abstract

Background: Classic nasal hump reduction based on partial resection of the cartilage and bones in the nose may lead to dorsum deformities such as an inverted-V deformity, irregularities, and an open roof. Techniques that preserve the nasal dorsum (namely the push-down and let-down) avoid these problems, but may not always be indicated for very large, broad, or deviated noses, whereas cartilaginous push-down is also indicated for large and deviated humps. Because only the cartilaginous portion of the hump is preserved in the cartilaginous push-down, a rough area may remain where the bony portion is resected.

Objectives: The aim of this study was to develop a variation of the cartilaginous push-down technique which includes a bony cap to preserve the smoothness of the keystone area during nasal hump treatment.

Methods: Forty-eight consecutive patients with indication for nasal hump treatment who underwent cartilaginous push-down procedures with bony cap preservation between August 2018 and October 2019 were studied.

Results: We observed related complications in 2 patients (4.2%); in 1 patient (2.1%) the bony cap was lost during the rasping of the nasal bones and the surgery was altered to utilize only the cartilaginous push-down. Another patient (2.1%) experienced a mild hump recurrence during the early weeks following the procedure. All of the remaining patients had their nasal humps treated adequately.

Conclusions: The nasal hump was adequately corrected in most of the study patients (95.8%). Preserving the bony cap while performing the cartilaginous push-down may prevent complications related to the osseous resection of the keystone area.

Level of Evidence: 4

4
Therapeutic

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Classic nasal hump reduction is based on partial resection of the bones and cartilage in the nose, as described more than a century ago by Joseph.[1] The cartilaginous portion of the hump is a single unit comprised of the 2 upper lateral cartilages (ULCs) and the septal cartilage. These 3 components fuse in their cephalic portions into a shape

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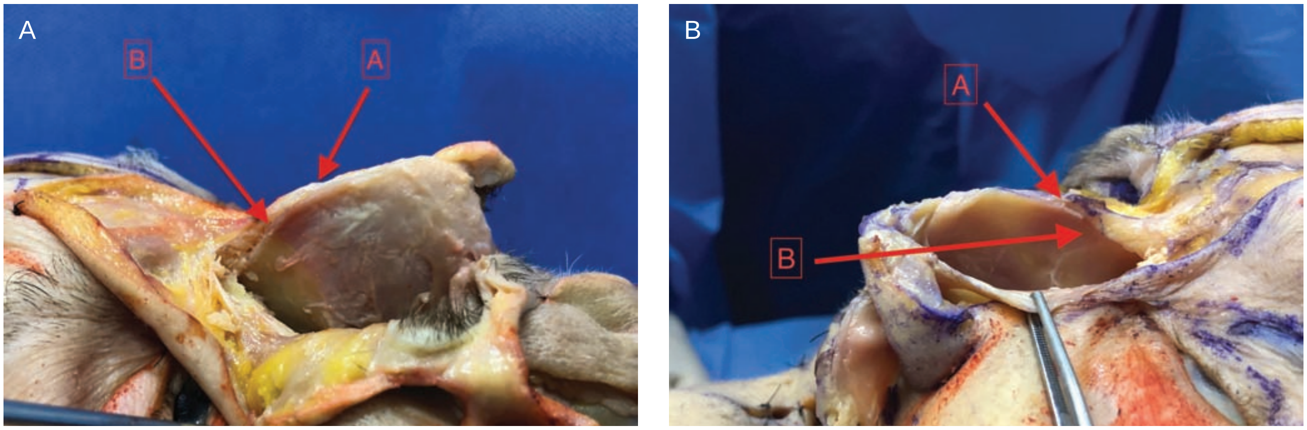


Figure 1. (A, B) Fresh cadaver dissections showing the caudal margin of the nasal bones (arrow in A) and the extension of the cartilaginous septum underneath the nasal bones (arrow in B).

resembling the letter M, a form that is unique in human anatomy.[2] During hump reduction in classic rhinoplasty, this structure is resected into 3 pieces, which is the main cause of irregularities, shadows, and pinching in the long term. Moreover, the angle and relation between the septal cartilage and the ULCs is reduced, which may compromise the function of the internal nasal valve.

To avoid these problems, various authors have described methods that preserve the integrity of the dorsum during nasal hump treatment. Three main approaches that preserve the dorsum are currently used in rhinoplasty: the push-down described by Cottle;[3] the let-down techniques described by Huizing[4] and Drumheller[5] (modifications of Cottle's method involving an osseous wedge resection); and the cartilaginous push-down described by Ishida.[6] The first 2 lower the hump as a whole, preserving the integrity of the dorsum and the keystone transition area. The main indications for these approaches are small humps, little or no nasal deviations, and a thin nose shape.[7-9] Large, angled, deviated, or broad humps can be treated with these techniques, but present additional difficulties as described by Cottle and Drumheller.

The treatment described by Ishida[6] preserves the cartilage. This technique was initially used only in thin, small to moderate humps with minimal or no deviations. However, once the anatomy of the keystone area was fully understood, the main indications for the cartilaginous preservation technique changed to include large and/or deviated humps.

The nasal hump is a unique structure with osseous and cartilaginous components. The main structure is the septal nasal cartilage,[10-16] comprised of the ULCs and the posterior septal cartilage, which are fused in the midline to form an M shape. This structure is responsible for the spring action which opens the internal valve. Fusion of the ULCs and the septal cartilage has been shown to occur at 4 months' gestation.[2]

The cephalic portion of the ULC (lateral process of the septal cartilage) is overlapped 4 to 9 mm by the nasal bones. Where it meets the perpendicular plate of the ethmoid bone, the septal cartilage extends cephalically 8 to 10 mm (50%-60%) under these overlying nasal bones (Figure 1).[10] The ULC adheres strongly to the nasal bones, and this adhesion is stronger towards the midline. The lateral borders of the ULC do not extend to the pyriform aperture, and are connected to the malar bones by fibrous connective tissue.

There are various advantages to keeping the cartilaginous dorsum intact, namely preserving the middle third of nose width, the dorsal aesthetic lines, and the internal nasal valve. On the other hand, this procedure can create a small open area where the overlaying nasal bone was removed and the underlying cartilage is not intact; irregularities and fibrous tissue may develop in this small area. In order to broaden the spectrum of the cartilaginous push-down technique and avoid these problems, we propose preserving the bone-cartilage connection (bony cap) in the upper keystone area during dorsum reduction.

METHODS

Forty-eight consecutive patients with indication for nasal hump treatment underwent cartilaginous push-down procedures with bony cap preservation. Patients who had previously undergone hump treatment were excluded

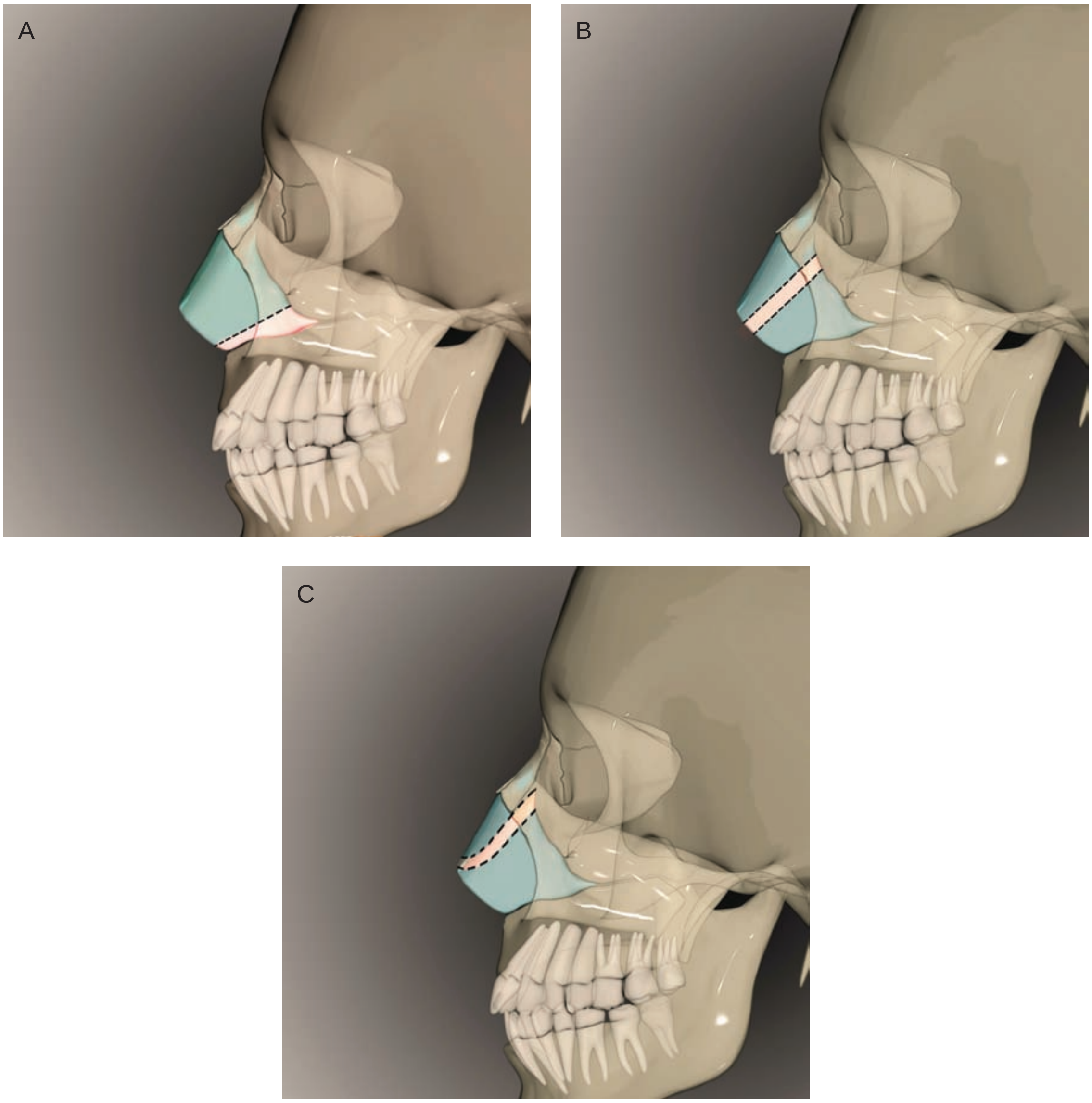


Figure 2. (A) Low septal strip resection, mostly used in low septal deviations and nasal deviations. (B) Mid-septal strip resection, when septal deviation is minimal or absent, facilitates stitching between upper and lower portions of the septum when necessary. (C) High septal strip resection, which leaves the caudal portion of the septal cartilage untouched.

from this study. This study was conducted between August 2018 and October 2019. This study was approved by the Committee of Ethics for Analysis in Projects of Research of the Faculty of Medicine of the University of São Paulo and all patients give written informed consent.

The cartilaginous push-down approach to nasal hump treatment is based on preserving and repositioning the septal cartilage as a single unit, without disrupting the M-shaped connection between the ULCs (lateral process) and the posterior septal cartilage.[6] Using an open or closed approach, the nasal dorsum is undermined in a sub-superficial musculoaponeurotic system plane and the posterior septum is undermined in a sub-perichondral plane on both sides. The undermining extends to the perpendicular plate of the ethmoid bone, and a strip of septal cartilage is resected parallel to the dorsum. This resection should occur on the more deviated portion of the septal cartilage; most deviations tend to occur at the base of the septal cartilage, near the palatal crest. When septal deviation is absent or minimal, the preferred spot for resection is approximately 3 to 4 mm below the dorsum (Figure 2). The high septal strip preserves the caudal portion of the

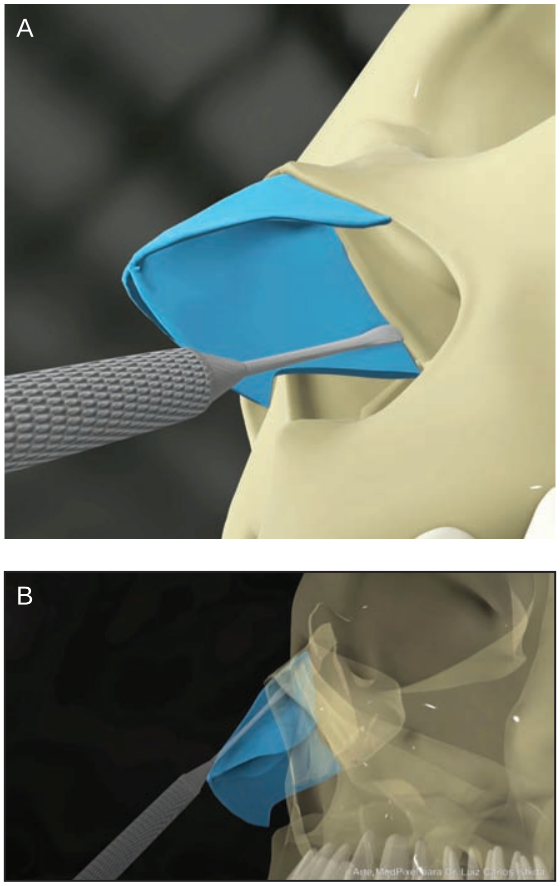


Figure 3. (A) Cartilaginous septum being released from the perpendicular plate of the ethmoid bone. (B) Upper lateral cartilages being dissected from the nasal bones near the keystone area.

septal cartilage, which may come in handy when treating difficult nasal tips.

The ULCs are freed from the nasal bones with a Freer dissector. Because this cartilage extends up to 9 mm under the nasal bones and is much softer than these overlying structures, special caution is required. The ULCs should be split from the nasal bones starting close to the keystone area, and the lateral extent of this dissection defines how far the dorsum will be lowered. The septal cartilage is then completely detached from the perpendicular plate of the ethmoid to mobilize the hump (Figure 3, Video 1).

Two osteotomies are performed on the nasal bones in the keystone; they begin just short of the widest point in the middle third of the nose (dorsal aesthetic lines) and converge to the midline at roughly 50% to 60% of the extent of the nasal bones (Figure 4). This bony cap in the keystone area will be lowered together with the cartilaginous portion of the hump.

The bony cap should not be extended past the midpoint of the nasal bones for 2 reasons: to avoid the thicker portion of the nasal bones; and to reduce the need for ethmoid osteotomies.

The lateral length of dissection between the ULCs and the osseous pyriform aperture determines how far the dorsum will be lowered; nasal deviations can be corrected without lowering the dorsum, if needed. The ULCs are released incrementally from midline to lateral; the more we advance the dissection, the more the cartilaginous dorsum is lowered. The remaining attachments of the ULCs and the nasal bones, the fibrous connective tissue that includes the sesamoids and the lateral osteotomies, stabilize and secure the middle third of the nose. The tip cartilages remain independent from the middle third of the nose.

The bony cap in larger noses just needs to be cut narrower; even in larger noses it articulates with the cartilage, straightening the osteocartilaginous transition. The residual lateral bony hump is then rasped to the desired level. The lateral osteotomies bring the bones closer to the midline and help stabilize the cartilaginous hump in place (Figures 5 and 6).

Surgery on the remaining tip is carried out according to the surgeon's preference. Gauze splinting is left in place for 24 hours as the inner dressing, and the cast is removed after 6 to 7 days. The specific postoperative restrictions for this procedure are no different from usual rhinoplasty.

RESULTS

Forty-eight patients were operated. Ten were male and 38 female, and ages ranged from 15 to 51 years old (median age, 27.6 years). In 46 patients, rhinoplasty was the primary procedure. Six surgeries were closed and 42 utilized an open approach. Nasal humps were considered small in 17 patients, medium in 24, and large in 7. Sixteen patients had nasal deviations. Twenty-nine patients underwent low cartilaginous septal strip resection, whereas the remaining 19 patients had high septal strip resection. Lateral osteotomies were performed in 40 patients, and 8 received both lateral and medial osteotomies (Figures 7- 9). The mean follow-up was 8.5 months (range, 6-14 months).

We observed related complications in 2 patients (4.2%); in 1 patient (2.1%) the bony cap was lost during the rasping of the nasal bones and the surgery was altered to utilize only the cartilaginous push-down. Another patient (2.1%) experienced a mild hump recurrence during the early

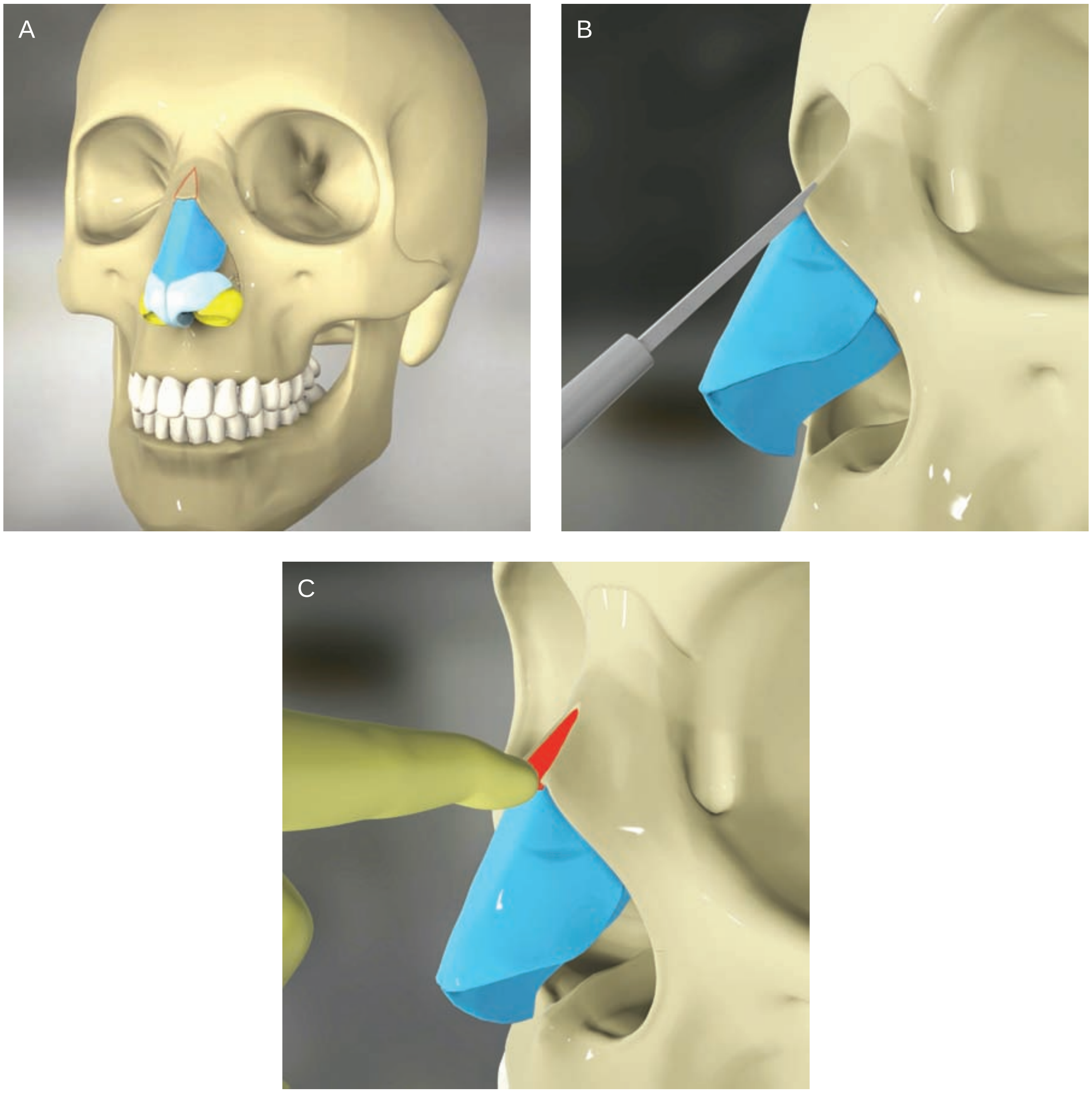


Figure 4. (A) Red lines on the nasal bones showing the path of the osteotomies. (B) Osteotomy with a small chisel. (C) Bony cap (red triangle) being lowered with the cartilaginous nasal dorsum.

weeks following the procedure. All of the remaining patients had their nasal humps treated adequately.

DISCUSSION

Nasal hump treatment with preservation of the dorsum goes back to 1914 when Lothrop[17] reported performing wedge resections on lateral osteotomies alongside transverse osteotomy at the nasion. In 1954 Cottle[3] described a push-down technique with a low septal strip, septal disarticulation from the ethmoid bone, and ethmoid wedge resection. In the 1970s Huizing[4] and Drumheller[5] described let-down techniques which were variations on Cottle's push-down involving wedge resections on lateral osteotomies to better adapt the nasal pyramid. Gola published a high septal strip excision technique in the 1990s,[9] followed by Saban et al[18] in 2006, whose technique involved resecting a strip of septal cartilage and ethmoid bone as close as possible to the dorsum, which allows lowering of the dorsum into the newly created space. Today, there are three main approaches to septal resection: Cottle, with low septal-high ethmoid resection; Saban-Gola, with a high

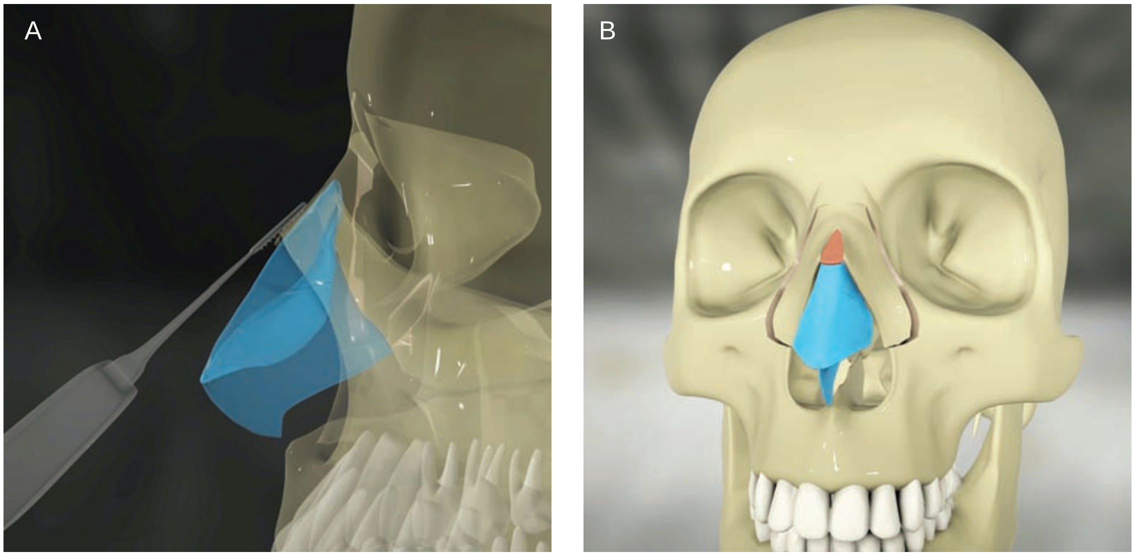


Figure 5. (A) Rasping the nasal bones after lowering the cartilaginous hump with the bony cap. (B) Lateral osteotomies to adjust the nasal bones to the bony cap and stabilize the cartilaginous dorsum.

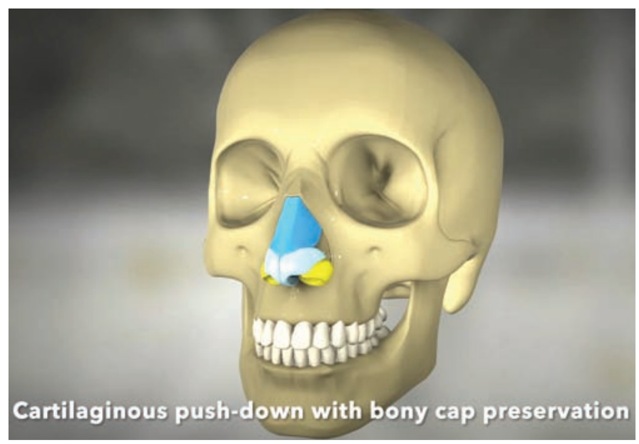
septal-ethmoid strip; and Ishida, with septal strip resection involving only cartilage.[8,18,19]

Although the push-down and let-down techniques preserve the integrity of the nasal dorsum and the keystone area, broad, large, or deviated humps present certain limitations to these "en bloc" treatments, sometimes requiring additional procedures to adequately lower and straighten the nasal hump.[19] Very large bony humps may be difficult to adapt, creating bony gaps, especially on the nasal bridge. Nasal humps with a large angle between the bony and the cartilaginous portions may also require additional procedures for proper lowering.

In contrast, the cartilaginous push-down method described by Ishida et al[6] can treat large, deviated, and/or strongly angled humps. Septal deviation is also corrected as part of the hump treatment. Ferreira et al[20] recently presented a similar approach based on a spare roof technique, involving a cartilaginous push-down with a high cartilaginous septal strip. Both techniques included removal of the bony hump, which creates a rough area despite the preserved cartilage underneath. This area immediately above the keystone may develop irregularities or even a small open roof in the upper third of the nose.

The cartilaginous push-down technique with preservation of the bony cap addresses these problems. By preserving the bony cap, the integrity and smoothness of the keystone area are maintained, along with the broad array of indications for cartilaginous push-down. Finally, the bony cap does not impede lateral and medial osteotomies, allowing the bony pyramid to be narrowed when necessary.

The middle third of the cartilaginous vault plays an important role in nose aesthetics and function. This single cartilaginous structure, formed from the fusion of the ULCs and the septal cartilage, is responsible for the shape and support of the middle third of the nose.[10] By preserving the connection between these cartilaginous processes during



Video 1. Watch now at http://academic.oup.com/asj/article-lookup/doi/10.1093/asj/sjaa061

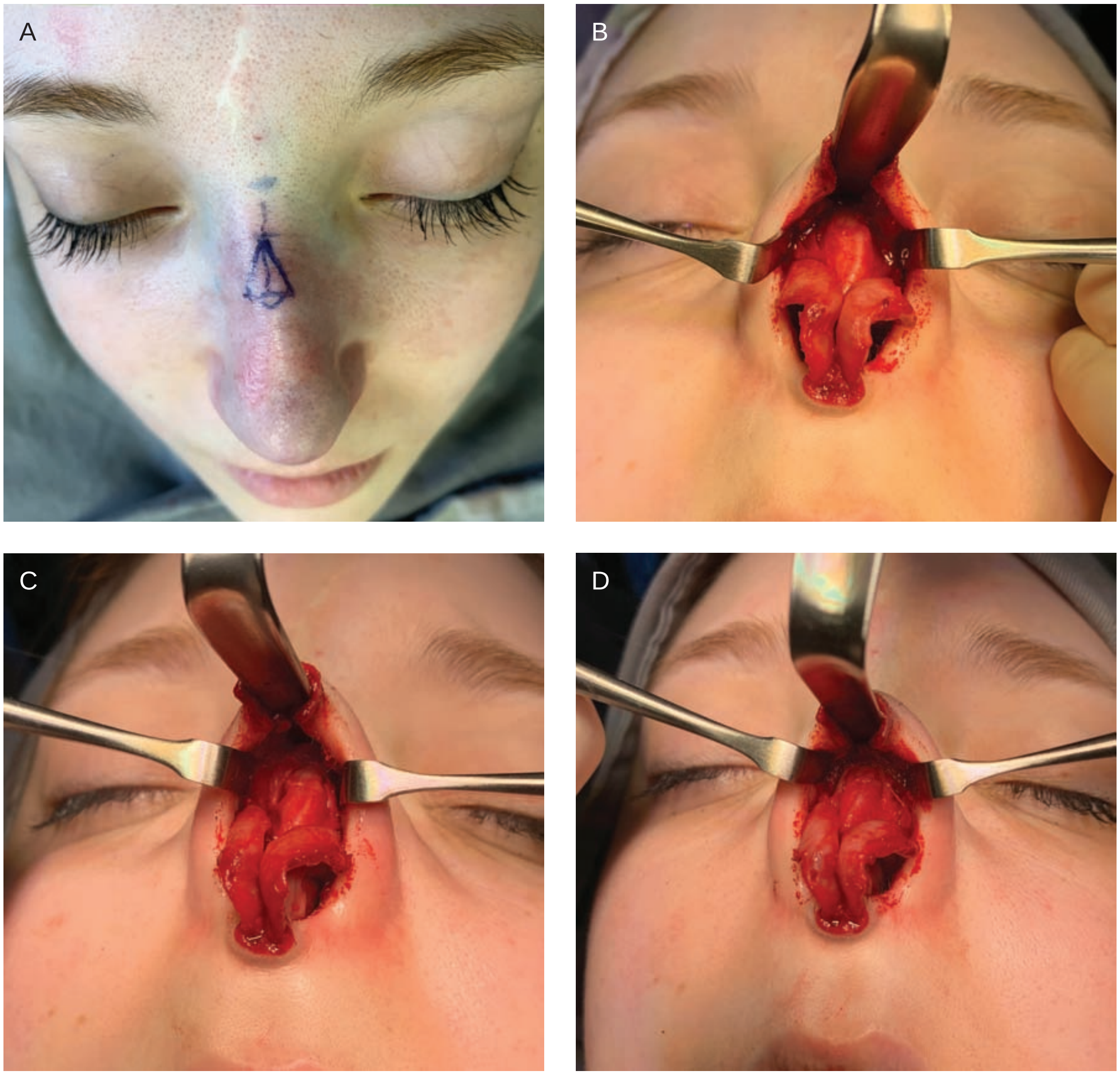


Figure 6. (A) Marking the location of the bony cap on a 26-year-old female patient. (B) Nasal dorsum. (C) Bony cap after isolation from the nasal bones. (D) Perfectly adjusted bony cap after rasping and lateral osteotomies.

hump treatment, the internal nasal valve is maintained, and its function can even be improved if necessary. Release of the keystone region corrects the nasal hump and deviations, and middle third deviation can be fixed without changing hump shape if desired. Treating the cartilaginous portion of the hump isolated from the bony portion permits straightening of the middle third of the nose, whereas deviation of the upper third is treated with regular osteotomies. There is no need to lower the dorsum if this is not desired, which may be especially important in patients who wish to retain the ethnic characteristics of their noses. In these cases, the ULCs should not be released from the nasal bones in order to maintain dorsum height.

One main concern when treating the keystone area is nasal collapse. The integrity of the connection between the ULCs and the septal cartilage stabilizes this structure, and the height of the hump can be controlled by incremental undermining of the ULCs from the nasal bones. As more of the ULCs is detached, the hump is reduced further.

The most common complication observed after cartilaginous push-down is hump recurrence. This most often results from insufficient detachment of the septal cartilage from the

Figure 7. (A, C, E) Preoperative and (B, D, F) 13-month postoperative photographs of a 27-year-old female patient with mild nasal deviation; small hump treated with low septal strip cartilaginous push-down with bony cap.

Figure 8. (A, C, E) Preoperative and (B, D, F) 14-month postoperative photographs of a 25-year-old male patient with medium nasal hump treated with high septal strip cartilaginous push-down with bony cap.

Figure 9. (A, C, E) Preoperative and (B, D, F) 12-month postoperative photographs of a 24-year-old male patient with large hump and mild deviation treated with low septal strip cartilaginous push-down with bony cap.

nasal bones (lateral process) or from the ethmoid plate (posterior process). This is easily corrected by revising and expanding the dissection between the cartilaginous septum and the ethmoid plate and the ULCs from the nasal bones.

Approaches that preserve the anatomy have several advantages over classic hump treatment;[21] internal valve function is preserved, along with the smoothness of the dorsum and its aesthetic lines. The cartilaginous push-down broadens indications for preservation techniques, permitting treatment of larger, deviated, and/or highly angled humps. Adding the bony cap to the cartilaginous push-down preserves the external portion of the keystone area, thus adding a smooth osteocartilaginous transition similar to the push-down and let-down techniques.

In this study, patients with nasal humps were satisfactorily treated with cartilaginous push-down and bony cap preservation, but further studies are needed with larger samples and longer follow-ups to verify efficiency and complications.

CONCLUSIONS

In this study, the nasal hump was adequately corrected in most patients (95.8%). Preserving the bony cap while performing the cartilaginous push-down may prevent complications related to the osseous resection of the keystone area.

The cartilaginous push-down broadens the indications for preservation techniques, treating large, deviated, and/or strongly angled humps and preserving internal valve function. The preservation of the bony cap additionally creates smoothness of the keystone area during nasal hump treatment.

Disclosures

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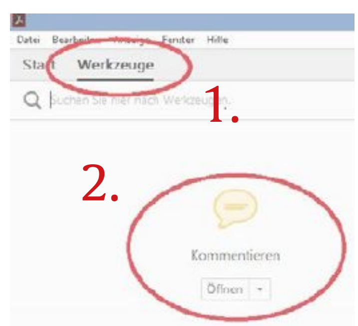

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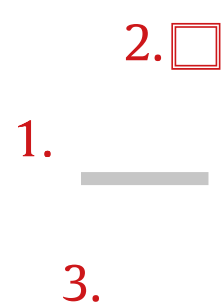

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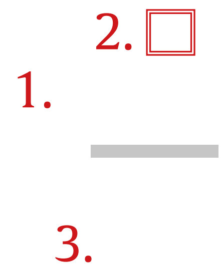

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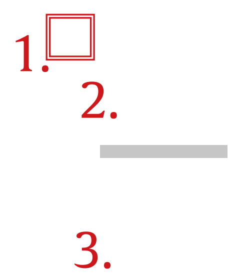

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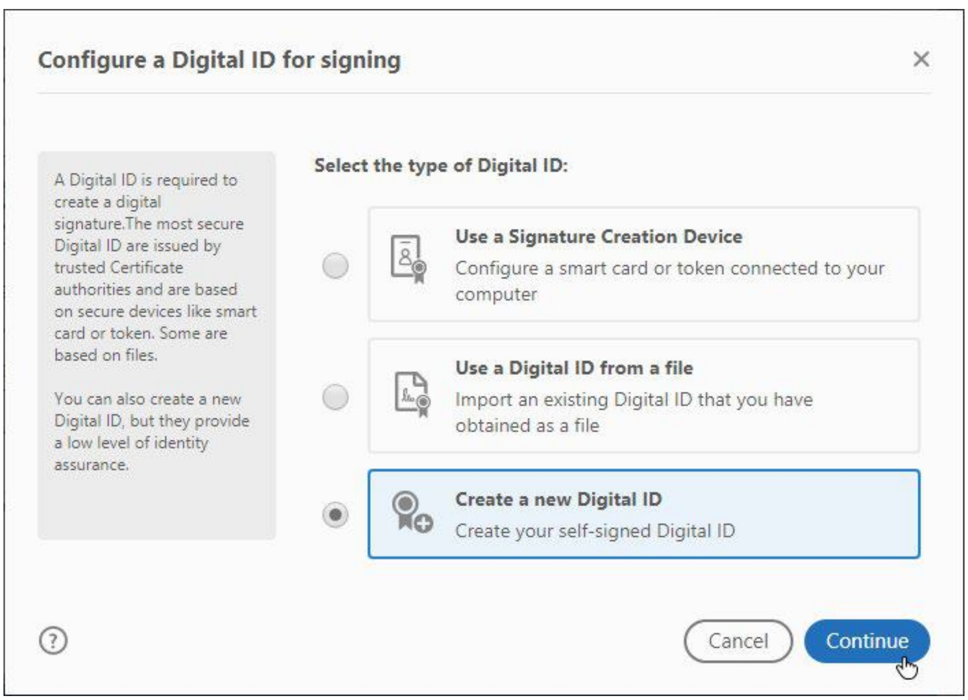

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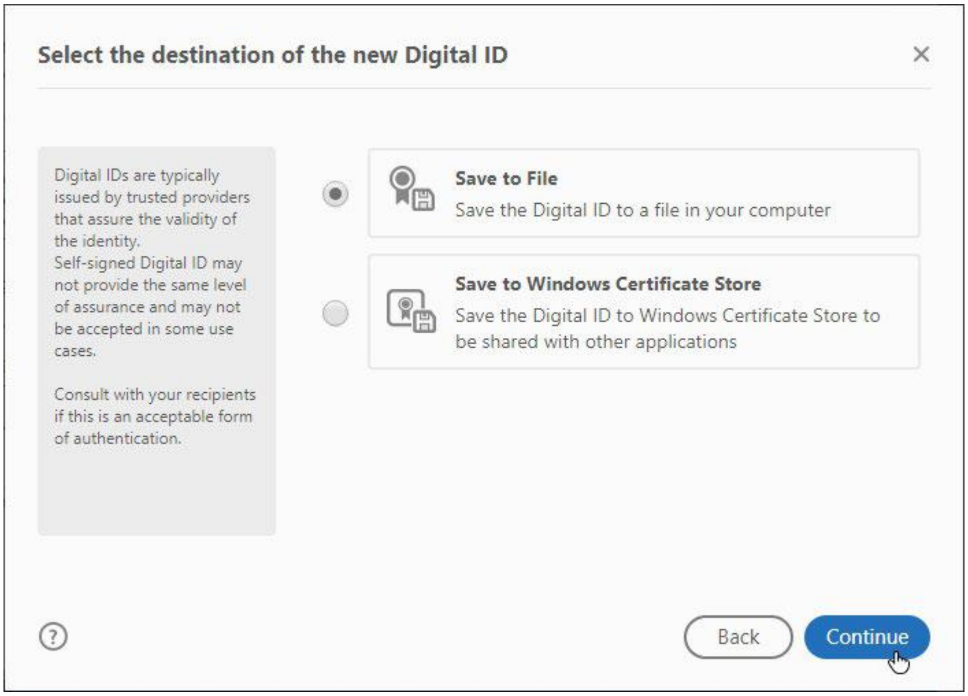

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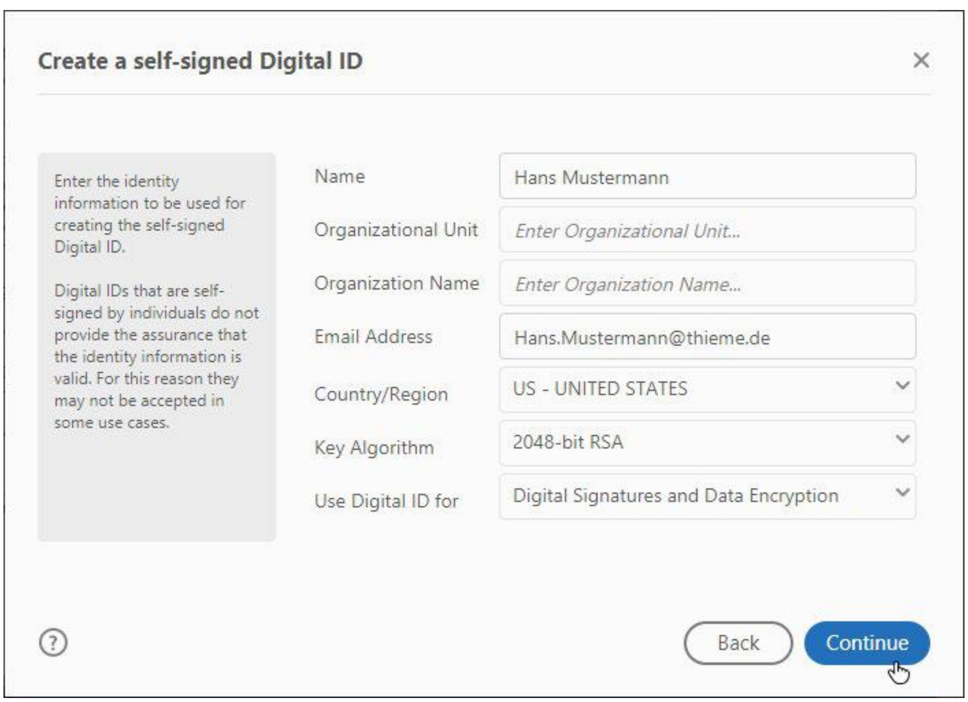

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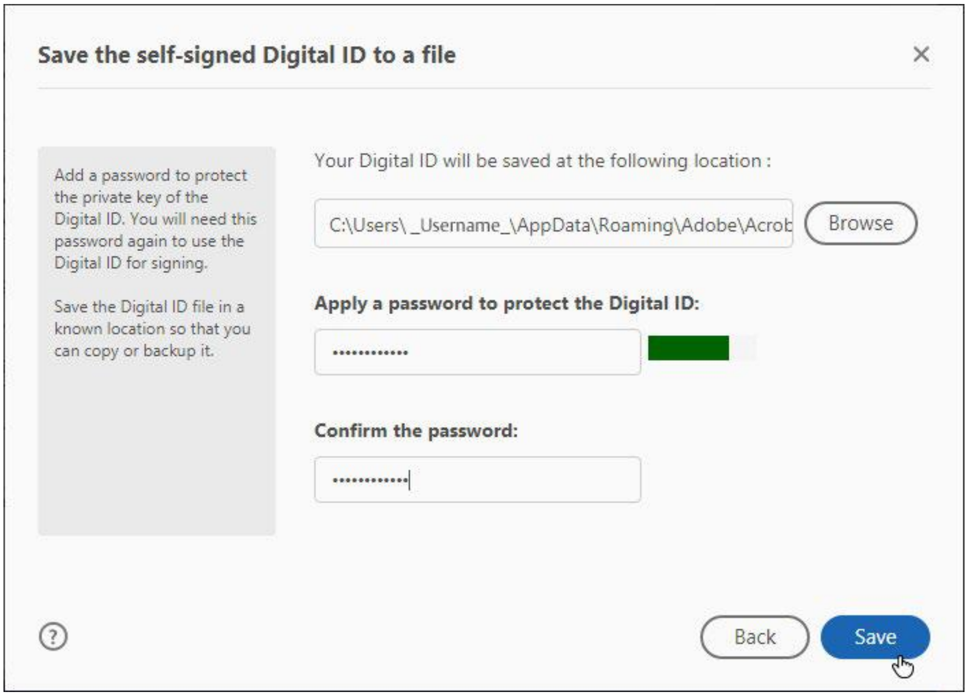

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Optimization of the Soft Tissue Envelope of the Nose in Rhinoplasty Utilizing Fat Transfer Combined with Platelet-Rich Fibrin

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Abstract

A thin or damaged skin soft tissue envelope may cause concerns in primary and secondary rhinoplasty. During postoperative healing, unpredictable scarring and contraction may occur and lead to significant aesthetic and trophic sequelae. Besides a meticulous surgical technique, there are no reliable techniques to prevent long-term skin damage and shrinkage. Fat transfer with addition of platelet-rich fibrin (PRF) harbors the possibility of local soft tissue regeneration and skin rejuvenation through growth factors and mesenchymal stem cells. It may also facilitate the creation of a thin fat layer on the dorsum to prevent shrink-wrap forces and conceal small irregularities. The goal is to provide evidence for the feasibility, durability, and beneficial effect of diced macrofat transfer bonded with PRF on the nasal dorsum. We present the technique of fat transfer conjugated with PRF as a nasal dorsal graft. Clinical endpoints were the prevention of trophic disturbances and atrophy at a 1-year postoperative follow-up. We present the skin mobility test as a clinical indicator of a healthy soft tissue envelope. The presented case series consists of 107 rhinoplasties. Fat was harvested in the umbilical or costal region. PRF was created by centrifugation of autologous whole blood samples. Macrofat was diced, cleaned, and bonded with PRF. The compound transplants were transferred to the nasal dorsum. There were no perioperative complications or wound-healing issues. Mean follow-up was 14 months. Clinical inspection showed good skin quality and no signs of shrinkage, marked scarring, or color changes with positive skin mobility test in all patients. Survival of fat was confirmed by ultrasonography and magnetic resonance imaging. Diced macrofat transfer in conjunction with PRF to the nasal dorsum is a feasible and safe method. A beneficial effect on the soft tissue envelope is demonstrated as well as the prevention of shrink-wrap forces.

Keywords

- platelet-rich fibrin
- PRF
- nasal soft tissue
- rhinoplasty
- fat transfer

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Optimization of the soft tissue envelope in rhinoplasty is gaining more and more attention.[1] A thin soft tissue envelope on the nasal dorsum may cause aesthetic or even functional concerns as pain or paresthesia in the postoperative course for both primary and secondary rhinoplasty cases. During the postoperative healing process, unpredictable scarring and contraction of the soft tissue envelope can occur leading to a plastering down of the soft tissue envelope to the nasal dorsum particularly at the bony cartilaginous junction—the keystone area and in the tip/lower lateral cura area. This may be triggered by iatrogenic trauma to the perichondrium, periosteum, superficial musculoaponeurotic system (SMAS), or adjacent blood vessels and nerves.[2] Eventually, this process can lead to significant aesthetic and trophic sequelae. Scarring and shrinkage of the soft tissue envelope and skin can lead to irregularities or color changes. The development of even painful sensations and paresthesia on the nasal dorsum remains controversial.[3,4] Besides meticulous surgical technique with maximum soft tissue and Q6 blood vessel preservation, few techniques are available to prevent long-term skin damage and shrinkage.[5,6]

Autologous fat grafting of the nose is not a common technique, although there are studies providing evidence for faster postoperative recovery from bruising and swelling.[7,8]

To our knowledge, the long-term effects of fat grafting on nasal skin quality and the long-term survival of free fat transplants in the nose have not been investigated so far.

Fat grafting is a technique first described more than a century ago, but has been widely popularized and technically enhanced by Coleman.[9] Fat grafting for aesthetic and reconstructive cases throughout the body and face has gained popularity. Previous studies have shown that autologous fat grafts from the abdominal wall harbor a significant number of viable adipocytes with stem cell features such as CD34 and therefore harbor the potential of local soft tissue regeneration.[10,11]

The beneficial and rejuvenative effects of adipocyte transfer to local soft tissue has been demonstrated previously, although the optimal method of fat harvesting remains controversial.[12] There is evidence that less traumatic harvesting techniques, such as low pressure suction or direct excision in combination with low speed centrifugation or gravitational sedimentation, are superior for survival of intact transferred adipocytes.[10,13]

In well-vascularized areas with a thicker soft tissue envelope, the survival percentage of transferred fat cells may reach values of up to a maximum of 60%.[14] However, the percentage of adipocyte survival, especially in an area as the nasal dorsum, remains unclear although successful serial microfat injections for correction of irregularities and even volume augmentation in Asian patients have been published in several case series.[15,16]

Platelet-rich fibrin (PRF) is an autologous, highly condensed solution containing thrombocytes, serum, growth factors, serine protease inhibitors, and immunoglobulins. The regenerative effect has been shown previously and is used in reconstructive, aesthetic, and dental medicine.[17,18] Furthermore, PRF has glue-like features and may be used as a autologous serum to bond transplants with sufficient strength to prevent displacement.[19] The authors propose that the addition of PRF to free fat transfer has the possibility to enhance fat graft survival through the addition of growth factors and protease inhibitors that boost local soft tissue regeneration by enhanced adipose-derived stem cell survival.[20] In the nose, it may also facilitate the creation of a thin fat layer to prevent shrink-wrap forces, to conceal small irregularities, and to create a soft tissue glide plane allowing for mobility of the soft tissue envelope.

The novel technique presented has been termed “diced fat,” which is harvested by direct excision with the addition of PRF. The creation of small fat particles with scissors (►**Video 1**) is a less traumatic and damaging treatment—compared with liposuction—trying to minimize the production of cell detritus and subsequent fibrosis. The goal of this methodological case series is to provide evidence for the feasibility, durability, and local beneficial effect of diced fat transfer bonded with PRF to the nasal dorsum.

Video 1

Q6

Patients and Methods

A retrospective chart analysis was performed of 107 consecutive functional and aesthetic rhinoplasty patients between January 2018 and July 2019. One hundred seven patients were included who underwent diced fat with PRF transfer by the authors (M.K. and J.A.V.). A chart analysis of these 107 patients were reviewed and patients were included if they had at least 1 year of follow-up and underwent the composite transfer. All patients received informed consent regarding the investigation; the analysis was performed in accordance with the guidelines of good clinical practice and the Declaration of Helsinki.

Surgical Technique

All patients were operated via open transcolumella approach in general anesthesia with hypotensive blood pressure and a single dose of antibiotic prophylaxis. Soft tissue elevation was done sub-SMAS on the nasal tip, and supraperichondrial and subperiosteal on the dorsum. Operative steps were performed according to individual pathology. Fat transfer was done at the end of operation before closure of skin incisions. To prevent any potential pressure necrosis or other wound-healing issues as well as to increase the viability of fat transplants, the taping and cast on the nasal dorsum was done with low pressure.

Fat Harvesting and Preparation

Autologous fat was harvested from either the inframammary fold (in case of synchronous rib harvesting) or transumbilically. After injection of 10 mL lidocaine 1% with 1:100,000 epinephrine, deep subcutaneous fat was carefully excised using scissors and a fan-like motion to avoid any irregularities (►**Video 1**). Approximately 10 mL of macroscopic fatty tissue was harvested. The macroscopic fat was separated from adjacent connective tissue using 15-blade scalpel or scissors and cut

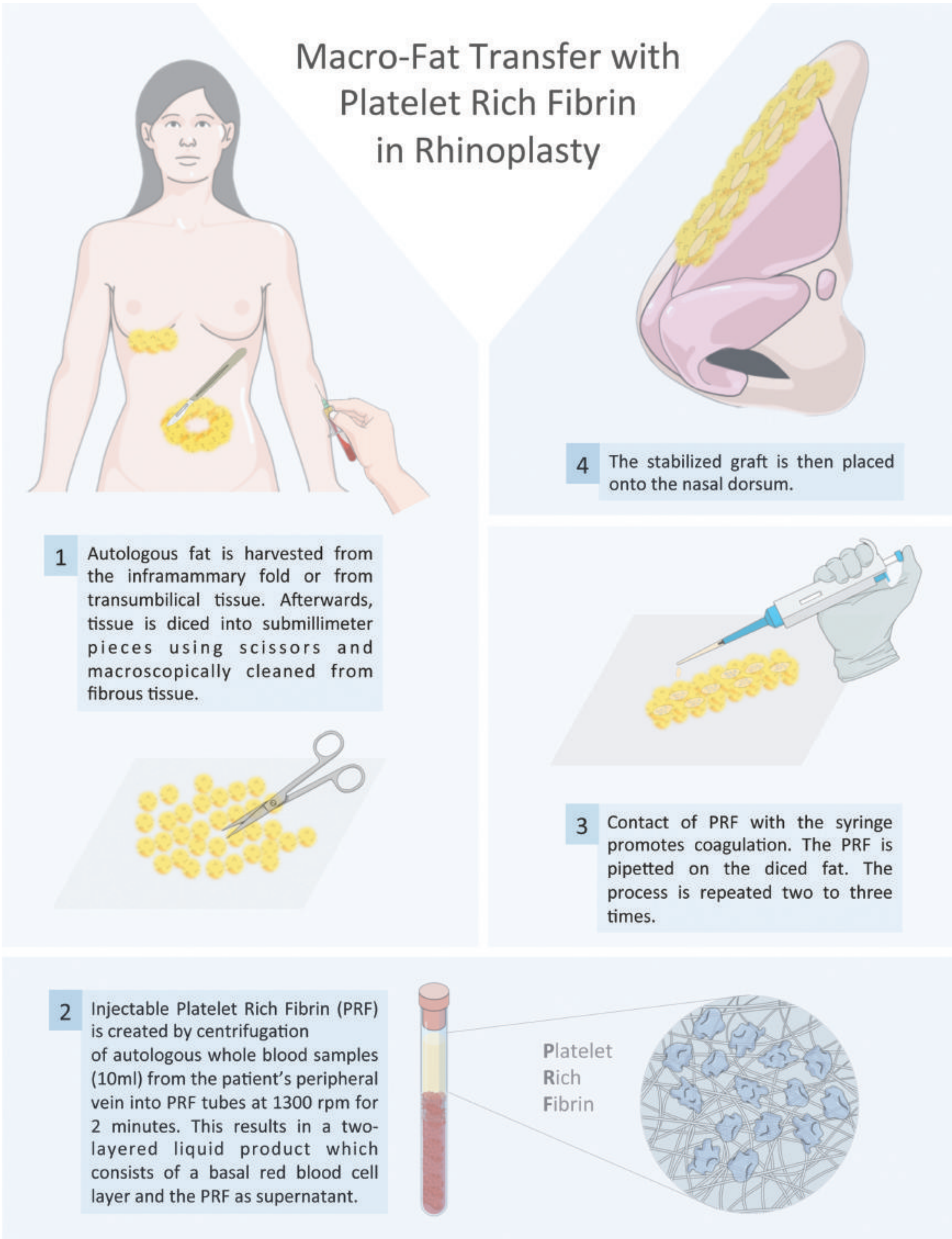

Fig. 1 The surgical steps of fat and blood harvesting (1), preparation of diced macrofat and centrifugation of whole blood to create platelet-rich fibrin (PRF) (2), preparation of diced macrofat/PRF transplant with scissors (3), and placement on nasal dorsum (4) are shown schematically.

into submillimeter pieces. The desired shape for nasal dorsal transplant ($\sim$ 30 mm $\times$ 15 mm $\times$ 1.5–2 mm), was created of loose fatty cells. The transplant was covered with a wet sponge for 2 to 3 minutes and immediately after bonded with the PRF and placed on the nasal dorsum (►**Figs. 1** and **2** and ►**Video 1**).

Preparation PRF

PRF was created by centrifugation of autologous whole blood samples and titration as published previously.[19,21] The protocol for "injectable PFR" (A-PRF, Nice, France) works with centrifuged autologous blood without any addition of

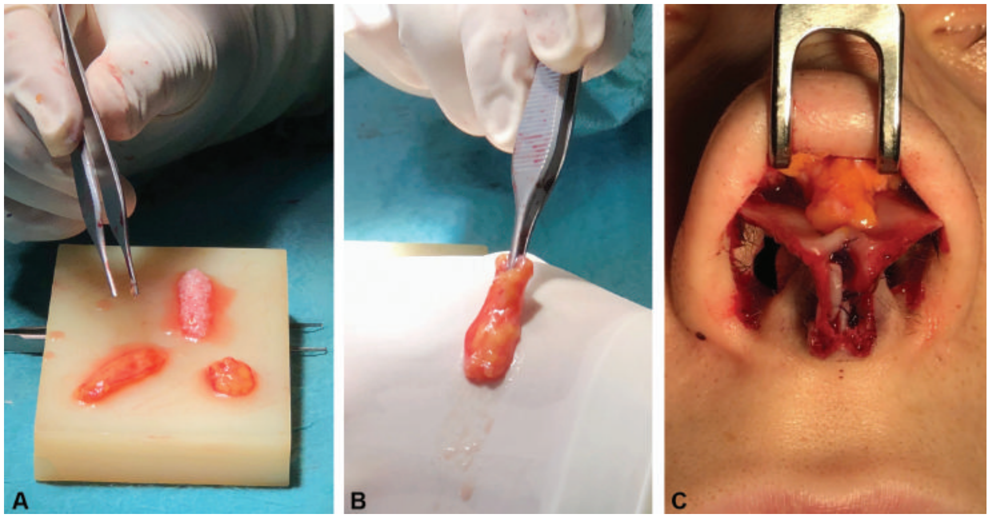

Fig. 2 Diced macrofat transplant bonded with platelet-rich fibrin (PRF) (**A**, **B**) after placement on nasal dorsum (**C**).

anticoagulant and bovine thrombin. For establishment of the liquid PRF we use the following protocol: Approximately 10 mL of whole blood are drawn from the patient's peripheral vein into A-PRF tubes (glass - A-PRF tubes), and centrifuged immediately at 1,300 revolutions per minute (rpm) for 2 minutes and 10 seconds. If the coagulation is faster creating a visible fibrin clot, the process should be repeated with 1,300 rpm for 1 minute and 40 seconds. It is crucial to mention that drawing of the blood must not last more than 10 seconds and be straightforward. If the blood current is slow with possible hemolysis and trauma, problems might occur trying to create a clear separated PRF layer on top. This results in a two-layered liquid product, which consists of a basal red blood cell layer and a yellow supernatant, the PRF. The PRF fraction is pipetted into a glass syringe. Contact of PRF with the glass syringe promotes physiological coagulation. The PRF is immediately sprayed on top of the diced fat compound and coagulation is completed after a few minutes. The stabilized graft with a thickness of 1.5 mm is placed onto the nasal dorsal area (►**Figs. 1** and **2** and ►**Video 1**).

Analysis

Patients were evaluated for soft tissue changes by the surgeon. These variables were assessed visually and by the soft tissue mobility test. Before surgery it is important to assure skin mobility, and in case of scarring and lack of mobility to discuss fat transfer during surgery with the patient. After surgery it is an important sign for prediction of potential shape distortion due to shrink-wrap forces. The skin mobility test is positive if an (ink) dot at the center of the k-area can move/glide with the skin over the bony cartilaginous dorsum for more than 3 mm in a horizontal axis and approximately 2 mm vertically. The test is positive if the soft tissue envelope had normal mobility and pliability at 1 year after surgery (►**Fig. 3**).

Survival of compound transplants was furthermore confirmed by ultrasonography (11 patients) and magnetic resonance imaging (MRI) (4 patients). Ultrasonographic evaluation was performed after 12 months (10 MHz, Phillips) to evaluate survival of the transplant. In 4 patients a postoperative MRI (3 Tesla, Siemens) was performed at 12 months to evaluate survival of the transplant.

Fig. 3 The skin mobility test is positive if an (ink) dot at the center of the k-area can move/glide with the skin over the bony cartilaginous dorsum for more than 3 mm in a horizontal axis (**A**, **B**) and ~2 mm vertically. The test is considered negative if the skin is less mobile and fixed to the bony-cartilaginous framework without gliding plane (**C**, **D**).

Results

Clinical Outcomes

One hundred seven patients were included who underwent diced fat with PRF transfer (80 primary and 27 secondary cases) by the authors (M.K. and J.A.V.). Sixty-seven percent (72/107) of patients were female and the median age was 29 years. Thirty percent (32/107) were smokers. The only other comorbidities were hypertension in two patients. Autologous fat was harvested from either the inframammary fold (in case of synchronous rib harvesting) in 17 cases or transumbilically in 90 cases. On average a fat "blanket" of 15×30 mm with a thickness of 1.5 mm was transplanted on
Q7 the nasal dorsal OCF[Q7] in a sub-SMAS pocket (between radix and supratip) before wound closure. There were no perioperative complications or wound-healing issues including donor site infection or pneumothorax from the fat harvesting. Mean follow-up was 14 months.

Clinical inspection revealed identical or improved skin quality compared with preoperative findings (►**Figs. 4** and **5**). In secondary cases, skin shrinkage and preexisting color changes and dorsal irregularities were improved (►**Fig. 6**). Of the secondary cases, 8/27 had a negative skin mobility test preoperatively. At 1 year, all patients, both primary and secondary had a positive skin mobility test (107/107). No patient complained of scarring or shrinking in the nasal dorsal area. In all patients there was a slightly palpable deep subcutaneous layer, covering potential smaller irregularities and preventing relevant shrinking with possible implications on underlying structures.

Imaging Outcomes

Survival of compound transplants was furthermore confirmed by ultrasonography (11 patients) and MRI (4 patients). Postoperative MRI was done at 12 months and revealed a fatty layer in the deep nasal dorsal soft tissue envelope (►**Fig. 7**). The

Fig. 4 Preoperative views of a female very thin-skinned patient and a deviated hump nose (**A–C**). Twelve-month postoperative views (open piezo-assisted dorsal preservation rhinoplasty with push down, septal extension graft, and dorsal diced fat-grafting with platelet-rich fibrin [PRF]) of the same patient with favorable outcome regarding axis deviation, profile alignment, and prevention of skin shrinkage or discoloration (**D–F**). The skin mobility test was positive.

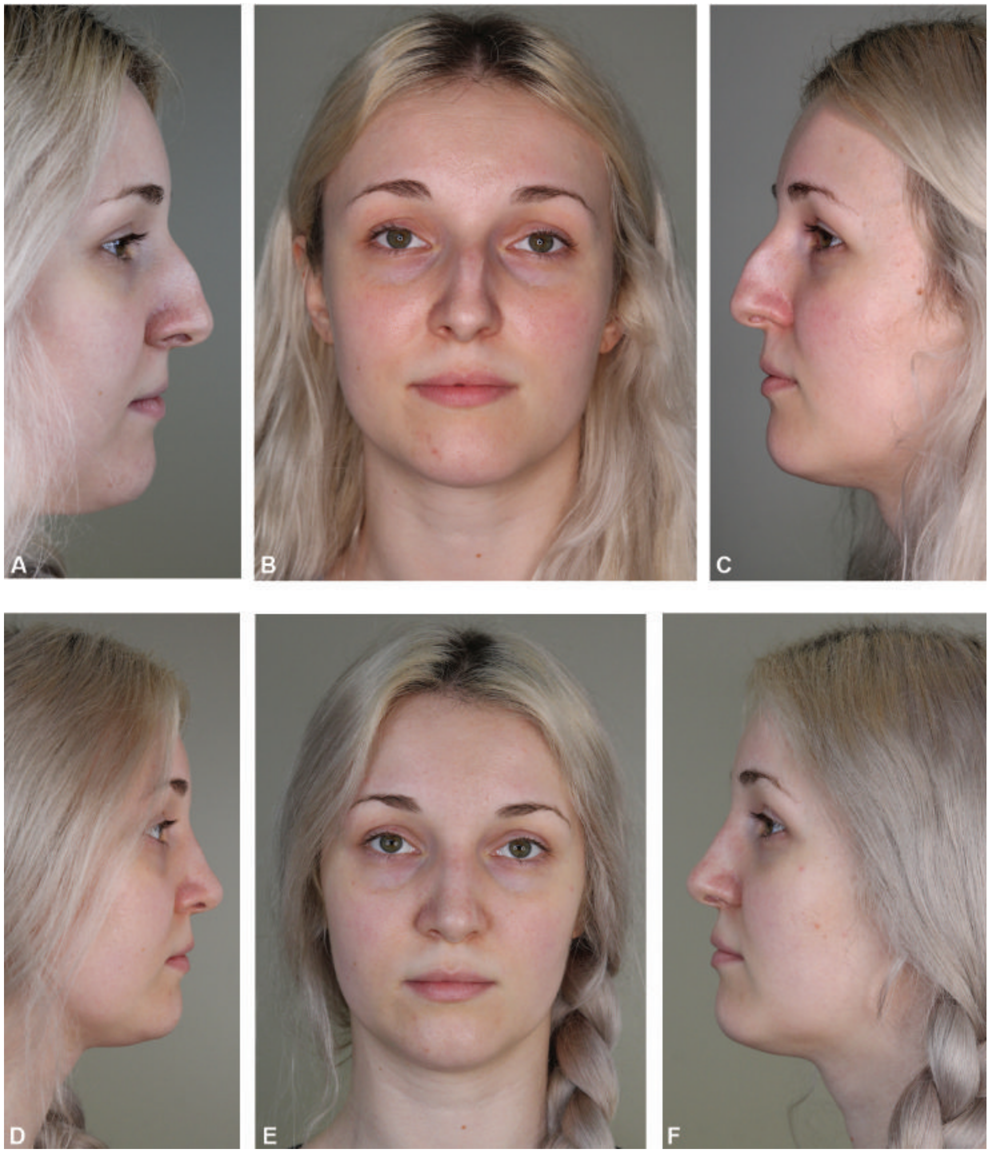

Fig. 5 Preoperative views of a female extremely thin-skinned patient and a deviated hump nose. The hump is creating a whitish discoloration of the skin (**A**–**C**). Twelve-month postoperative views (open piezo-assisted sequential hump removal, spreader grafts, septal extension graft, tip-plasty, and dorsal diced fat-grafting with platelet-rich fibrin [PRF]) of the same patient with favorable outcome regarding axis deviation, profile alignment, and prevention of skin shrinkage or discoloration (**D**–**F**). The skin mobility test was positive.

deep fatty layer was clearly distinguishable from the SMAS and bone layer and showed an estimated fat survival of 55 to 75%.

Ultrasonographic evaluation at 12 months' follow-up (10 MHz, Phillips) revealed a thin (median 0.9 mm [range 0.3–2.2 mm]) extra layer at the nasal dorsum deep to the SMAS layer when compared with preoperative ultrasonography (►**Fig. 8**). This may reflect the additional fatty layer with survival of a relevant portion of transplanted adipocytes.

Complications

In all 107 patients there was a normal clinical course after surgery with transient ecchymosis, periorbital hematoma, and swelling. There were no signs of inflammation, especially in the nasal dorsal area, with all patients following 5-day oral antibiotic regimes. In one patient there was a prolonged bleeding, which led to a subcutaneous nasal hematoma and subsequent fat graft displacement. After resolution of acute swelling a "fat hump" was palpable and visible but was successfully treated with repeated triamcinolone injections (0.1 mL of 10 mg/mL 4 injections in 4 weeks).

Discussion

Management of the soft tissue envelope, especially in thin-skinned patients and secondary cases, is gaining more and more attention in rhinoplasty. Meticulous surgical preparation in supra- or even subperichondreal layers may help to limit soft tissue damage and prevent surgical sequelae as

Fig. 6 Preoperative views of a female presenting after two previous rhinoplasties elsewhere, showing signs of shortened nose, inverted-v-deformity, and skin irregularities (**A–C**). Twelve-month postoperative views (open piezo-assisted revision-rhinoplasty with rib cartilage transplants, extended spreader grafts, septal extension grafts, alar transposition with lateral crural strut grafts, and dorsal diced fat-grafting with platelet-rich fibrin [PRF]) of the same patient with favorable outcome regarding axis deviation, profile alignment, and prevention of skin shrinkage or discoloration (**D–F**). The skin mobility test was positive.

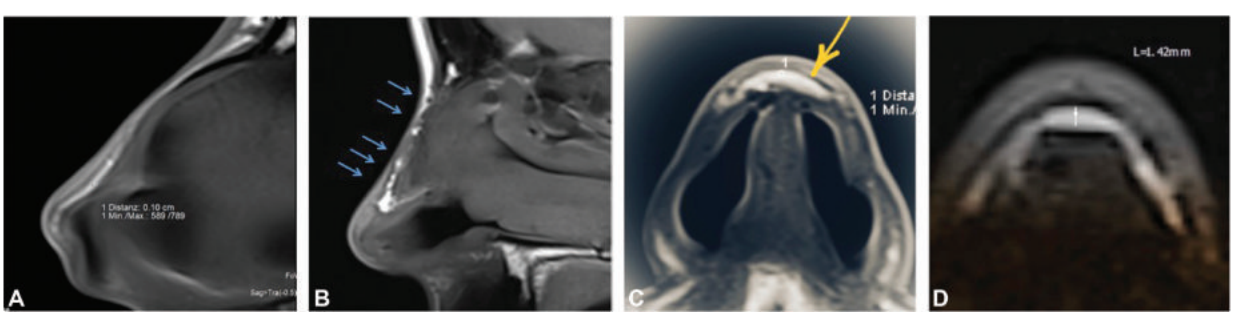

Fig. 7 Sagittal T1-weighed magnetic resonance imaging (MRI) scan of patient without nasal intervention and normal anatomy (**A**). Postoperative, sagittal high-resolution MRI of patient 12 months after rhinoplasty. In T1-weighed imaging fat islands can be identified in the nasal dorsum with a maximum in the supratip and radix area (arrows) (**B**). In axial view the transplanted fat layer can also be distinguished as a max. 1.42 mm fat-isodense area in the deep subcutaneous location above the cartilaginous framework.

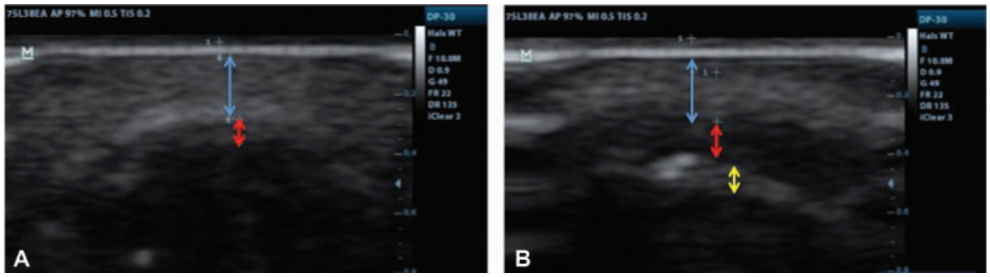

Fig. 8 Preoperative sagittal ultrasonography (10 MHz, Phillips) of patient without nasal intervention and normal anatomy (A). Dermis and subcutaneous tissue (blue arrow) with 2.0 mm in diameter and thin superficial musculoaponeurotic system (SMAS) layer (red arrow) underneath with 0.8 mm. Twelve-month postoperative ultrasonography an additional fat layer (yellow arrow, 0.8 mm) can be distinguished[Q8].

Q8

discolorations, persistent swelling, uncontrolled scar formation, and shrink-wrap forces that may eventually lead to significant esthetic concerns.[2–5] In primary cases with extremely thin dorsal skin or in secondary cases with preexisting soft tissue damage, additional techniques are often necessary to achieve durable results. A negative soft tissue mobility test preoperatively is an absolute indication for diced fat bonded to PRF to restore the glide plane of the soft tissue envelope over the osseocartilaginous vault. Traditionally, autologous or heterologous fascia transplants on the nasal dorsum are used for camouflage and slight dorsal augmentation.[22,23] Although effective, these techniques bear the risk of unpredictable absorption and final thickness, some donor site morbidity, and rare immune reactions in heterologous fascia.

Benefits of Direct Fat Harvesting

Autologous fat transplantation has been described for acceleration of nasal healing or augmentation in Asian patients.[15,24] Positive outcomes have been reported but fundamental questions regarding the optimal harvesting technique and methods to prevent adipocyte lysis remain to be elucidated. For abdominal and peripheral fat harvesting, it is known that trauma to the adipocytes can be limited by usage of optimal blunt cannula and the avoidance of higher negative pressure.[25] With our technique, the direct excision of small quantities limits trauma and required no negative pressure being applied to the adipocytes. Centrifugation is avoided in the described technique by direct downsizing and cleaning with scissors. Naturally, the exact particle size may vary far more in this technique, compared with centrifugation and filtering, but the amount of cell detritus and cytolysis is much more limited. There is evidence that a particle size of around 1 mm cubic is optimal for viability of adipocytes. Smaller particles harbor more cytolysis and larger particles may lead to significant central necrosis of transplants.[15,24,25]

Benefits of PRF for Fat Survival

The most important aspect for survival of fat transplants is the vascularization at the recipient site. Fat transplants should be surrounded by well-perfused soft tissue to allow for vessel ingrowth. The vascularity of nasal soft tissue is abundant in primary cases, but may be limited in secondary cases. There is evidence of the positive effect of PRF onlay alone on the nasal dorsum but no data on the combination of PRF and fat transfer.[26] The addition of PRF to free fat transplants may increase survival of fat cells through the increased density of growth factors such as vascular endothelial growth factor, insulin-like growth factor, and protease inhibitors. There is evidence from animal models that survival of adipocytes can be enhanced significantly by the addition of PRF.[27,28] There is evidence from meta-analysis in animal models, that fat graft survival is enhanced by the addition of PRF compared with control groups.[20] In one animal study an extra PRF injection into the grafting area after 1 week enabled better survival of fat cells. Furthermore, there are publications on the beneficial effect of microfat transfer in the nose.[12,15] Toriumi has recently demonstrated the beneficial effect of nanofat-infused fascia transplants for the damaged skin/soft tissue envelope.[29]

Clinical Implications

Diced fat transfer should be considered in case of

- Primary rhinoplasties with very think skin.
- Primary and secondary rhinoplasties with visible underlying hump or irregularities.
- Primary and secondary rhinoplasties with negative skin mobility test.
- Secondary rhinoplasties with skin irregularities and trophic disturbances.

Limitations of the Study

Our presented case series has limitations due to the retrospective character of the analysis as well as a lack of objective parameters for evaluation of skin quality. Unfortunately, systematic analysis of all patients was not possible due to limited access to MRI. Ultrasonography was only performed in 10% of cases, only 10 MHz ultrasonography was available, which is not optimal for skin examination (better 20 MHz). Nevertheless, prevention of skin shrinkage and amelioration of skin quality were observed in all patients. None of the patients displayed donor site morbidities or prolonged healing episodes or transplant failure or inflammation. One of the true benefits of the applied technique is the true autologous origin of all tissues and a limited technical and time-consuming effort.

Conclusion

In conclusion, free macrofat transfer with PRF was a successful and safe technique in our cases series and helped to prevent dorsal soft tissue damage, skin discolorations, and the development of shrink-wrap forces in primary and secondary rhinoplasty. All patients had a positive skin mobility test postoperatively with an established glide plane over the keystone area and horizontal movement of more than 3 mm. Further studies will be necessary to better understand the long-term effect and durability of this technique.

Conflict of Interest
None declared.

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Rhinoplasty: The Nasal Bones – Anatomy and Analysis

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Abstract

Background: The analysis of nasal anatomy, and especially the nasal bones including the osseocartilaginous vault, is significant for functional and aesthetic reasons.

Objectives: The objective was to understand the anatomy of the nasal bones by establishing new descriptions, terms, and definitions because the existing parameters were insufficient. Adequate terminology was employed to harmonize the anthropometric and clinical measurements.

Methods: A two-part harvest technique consisting of resecting the specimen and then creating a replica of the skull was performed on 44 cadavers to obtain specific measurements.

Results: The nasal bones have an irregular, variable shape, and three distinct angles can be found along the dorsal profile line beginning with the nasion angle (NA), the dorsal profile angulation (DPA) and the kyphion angulation (KA). In 12% of cases, the caudal portion of the nasal bones was straight and without angulation resulting in a "V-shape" configuration. In 88% of cases, the caudal portion of the bone was angulated, which resulted in an "S-shape" nasal bone configuration. The intervening cephalic bone, nasion to sellion (N-S), represents the radix while the caudal bone, sellion to r (S-R), represents the bony dorsum.

Conclusions: By standardizing and measuring existing nasal landmarks and understanding the different anatomic configurations of the nasal bones, rhinoplasty surgeons can better plan their operations within the radix and bony and osseocartilaginous vaults.

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Surgeons are familiar with the clincial nasofrontal and nasofacial angle for surgical planning. However, there is little in-depth analysis available of the actual nasal bone configurations and their relationship to the type of nasal hump which requires removal. The present anatomic study was undertaken to define the angulations intrinsic to the nasal bones and to improve operative planning for rhinoplasty surgery.

Terminology

Nasal terminology is often difficult because differences exist between classic anthropometric bony measurements[1] and clinical soft tissue measurements.[2-4] Because this study was performed on skull samples, classic anthropometric

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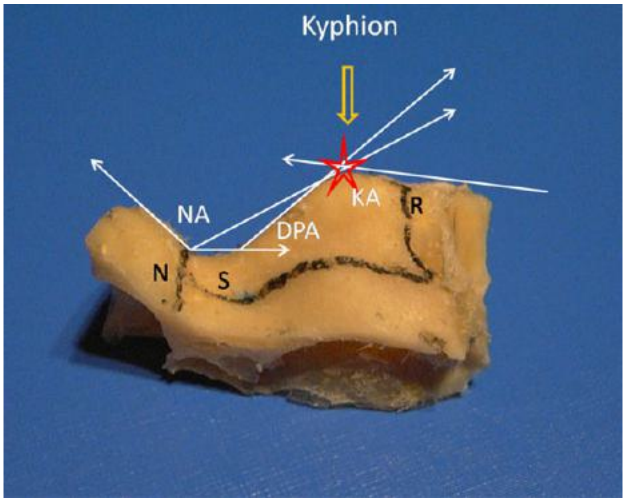

Figure 1. Nasal bone angles and points. The red star is the kyphion, or most prominent portion of the nasal hump. The yellow arrow points to this point.

terminology will be utilized followed by a discussion of possible clinical correlations (see Figure 1).

Points

Nasion (N) is the midpoint of the nasofrontal suture line where the frontal bone and nasal bones join.

Sellion (S) is the deepest depression of the nasal bones and often coincides with soft tissue nasion.

When using pretreatment clinical photographs, clinicians[5] virtually always call the sellion the nasion in their treatment planning.

Kyphion (K) is the most prominent point on the bony nasal dorsum.

Rhinion (R) is the most caudal point of the paired nasal bones and marks the midline junction of the bony and cartilaginous vaults.

Cephalic portion of nasal bones (CeP) is between the Nasion (N) and the Sellion (S).

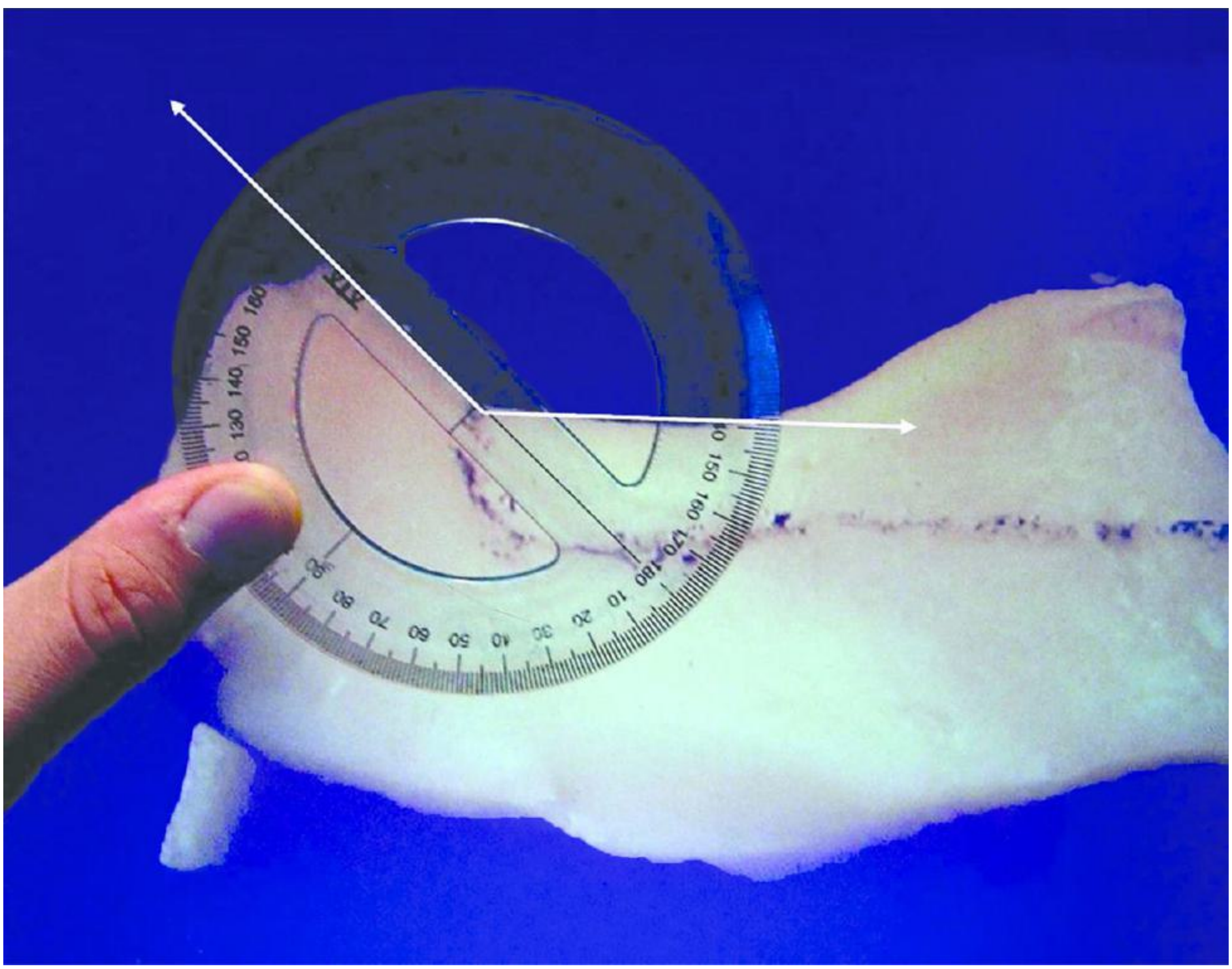

Figure 2. Measurement of the Nasion angle (NA).

Caudal portion of nasal bones (CaP) is between the Sellion (S) and the Rhinion point (R).

Angles

Nasion angle (NA) is the angle measured on the bony surface between the frontal bone and the cephalic portion of the nasal bone[6] (see Figure 2).

Nasofrontal angle (NFA) is defined by the intersection of a line tangent to the glabella and the dorsal line passing from the nasion to tip.[7,8] The clinical NFA is dramatically different from the bony surface NA. During pretreatment planning, surgeons draw the glabella limb as a tangent to the glabellar prominence. Next, the "dorsal line" is drawn from the tip retrograde until it intersects with the glabella tangent line. In contrast the NA is a true bony surface angle between frontal bone and nasal bone. Thus, the NFA is a soft tissue clinical planning tool rather than a true anthropometric measurement (NA).

Dorsal Profile Angle (DPA) is defined by the intersection between a line drawn tangent to the Sellion and a line tangent to the bony hump irrespective of the tip location with the intersection usually occurring at the Sellion point (S) (see Figure 3).

Kyphion Angle (KA) is defined by the intersection of a line drawn tangent to the bony hump and a line drawn tangent to the rhinion with the intersection defined as the Kyphion point (K) (see Figure 4).

These latter two angles represent the first attempt to define the bony hump. These angles and their presence or absence is determined by the configuration of the nasal bones.

Nasal Bone Configurations

The configuration of the nasal bones can be defined and divided based on their intrinsic angulation. Three sequential points are marked: Sellion (S), Kyphion (K), and Rhinion (R).

V-shaped nasal bones have essentially a straight line configuration from S to R and thus one locus of angulation located at the DPA (see Figure 5).

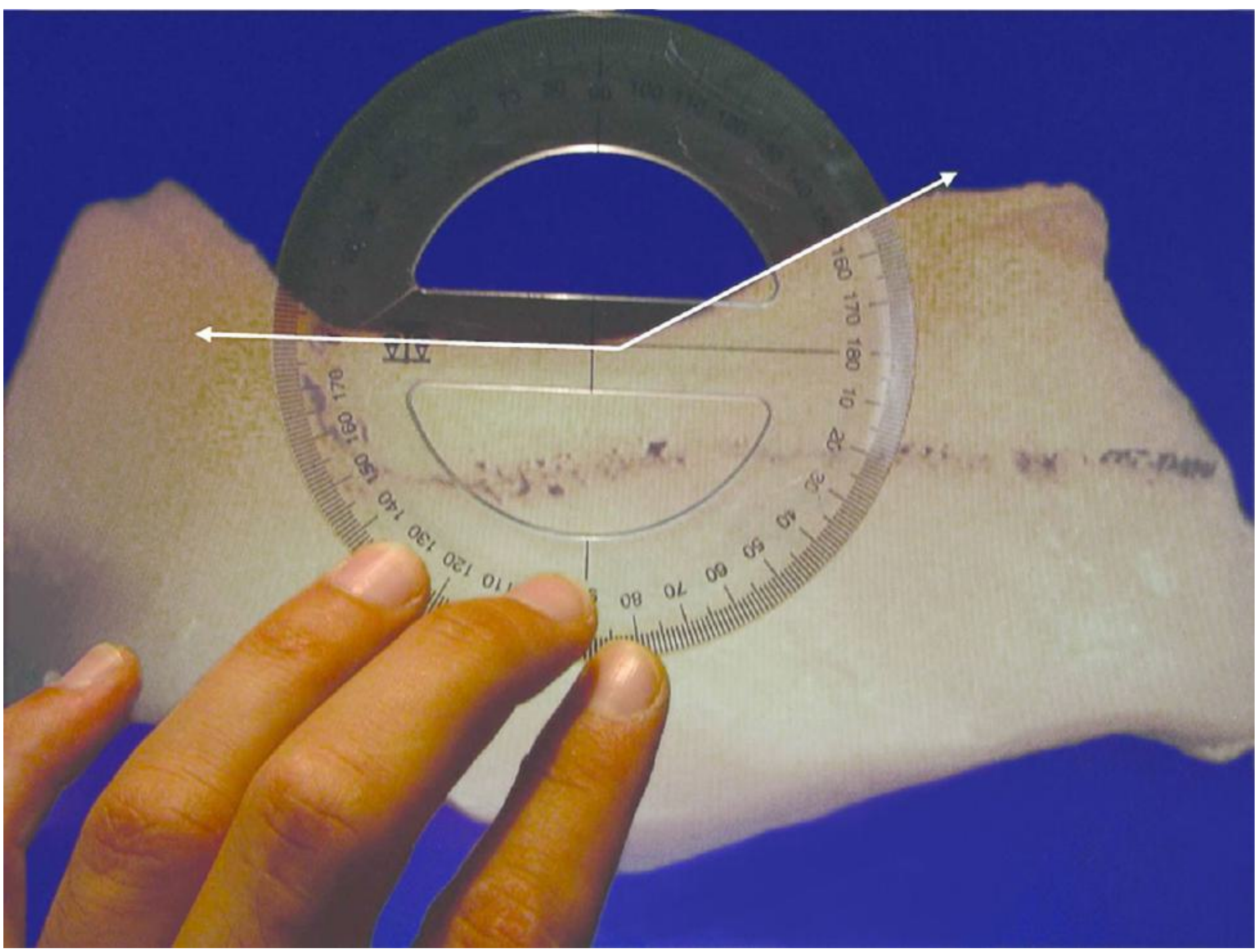

Figure 3. Measurement of the Dorsal Profile Angle (DPA).

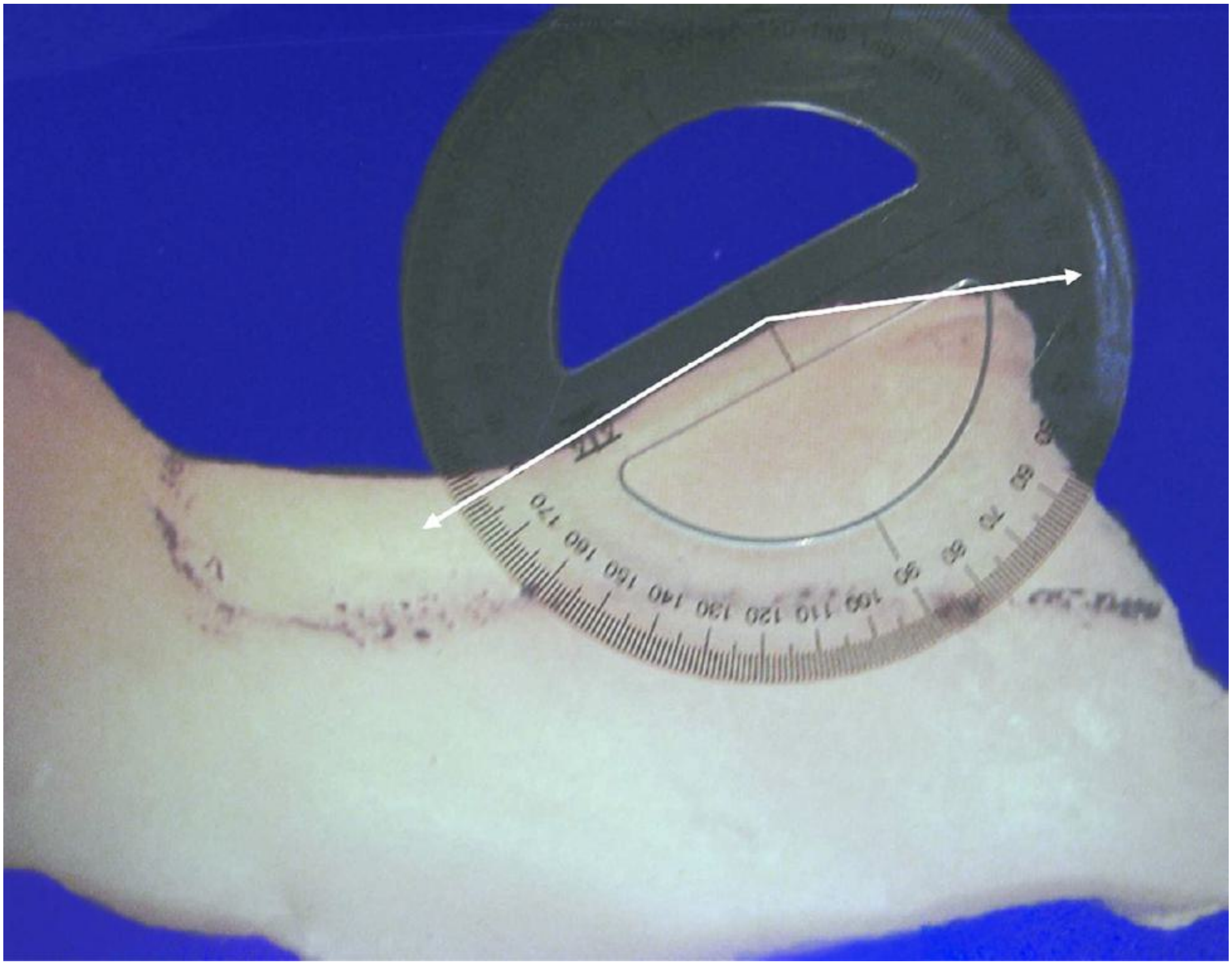

Figure 4. Measurement of the Kyphion Angle (KA).

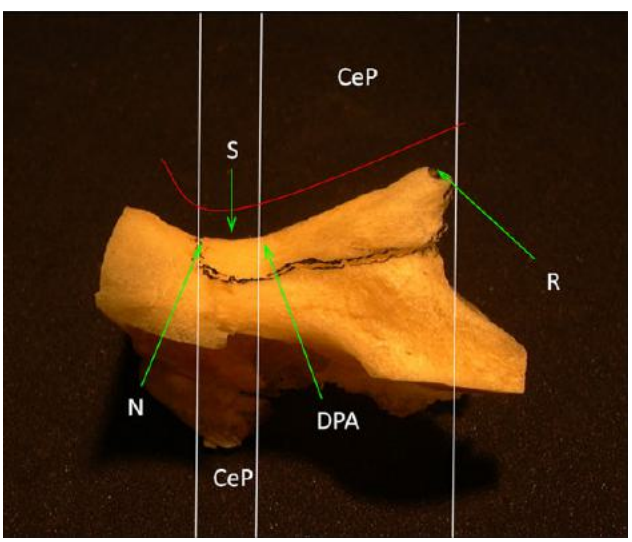

Figure 5. "V-shaped" nasal bones, CeP, Cephalic portion; CaP, Caudal Portion; N, Nasion and S, Sellion; DPA, Dorsal profile angulation.

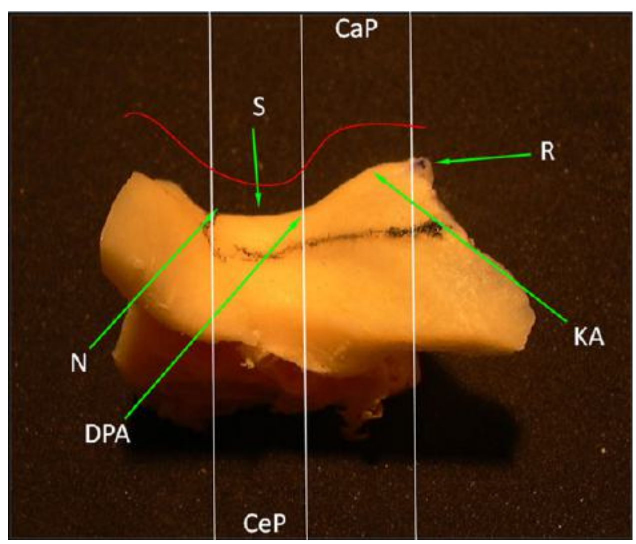

Figure 6. "S-shaped" nasal bones , CeP, cephalic portion; Cap, caudal portion; N, Nasion; S, Sellion; DPA, Dorsal profile angulation; KA, Kyphionic angulation; R, Rhinion.

S-shaped nasal bones have a curved line, which begins at S, passes to a distinct point at K, and plateaus at R. There are two loci of angulation – one located at the DPA and one at the KA (see Figure 6).

METHODS

Forty-four cadavers were obtained from the Institute of Forensic Medicine at the University of Belgrade Medical School during the period 1995 to 2005. Exclusion criteria consisted of any serious injuries of the nose or face. A two-part harvest technique was developed consisting of resecting the specimen and then creating a replica of the skull. The resected en-bloc specimen consisted of the following: nasal plus adjacent portions of frontal bone, frontal processes of the maxillary bone, nasal septum, and upper lateral cartilages. The resection was performed with an electrical craniotome in four lines: 1) the frontal line, parallel to the nasofrontal suture line and down into the ethmoidal cells, 2) the two lateral lines, straight across the frontal process of the maxillary bone 5 mm lateral from the nasaomaxillary junction, and 3) the caudal line, perpendicularly and transversally trough the nasal dorsum 5 mm caudal to the end of the nasal bones. The specimens were detached using a chisel and scissors and stored in 10% formalin solution. Next, a gypsy mass model of the original skull defect was made to allow accurate positioning of the resected specimen. Subsequently, the specimens were decalcified using an equal part solution of 20% sodium citrate and 85% formic acid for 6 weeks. Then, macroscopic examination was performed and measurements of:

(1) Cephalic width of nasal bones
(2) Lateral length of nasal bones
(3) Medial length of nasal bones
(4) Caudal width of nasal bones
(5) Angulation of nasal bones on profile including NA, DPA, and KA
(6) Width of nasal bones at the nasofrontal suture
(7) Width of nasal bones at the DPA
(8) Width of nasal bones at the KA
(9) Distance of DPA from N
(10) Distance of KA from R

To obtain precise measurements of the curved nasal bones, a tin wire, 0.5 mm in diameter, was employed because of its specific flexibility. Measurements were performed using the Vernier scale. Angles were determined using an angle meter on the enlarged photographs of the nasal bone profile.

RESULTS

Cadaver dissections were performed on 22 Caucasian females and 22 Caucasian males, age 18 to 55 years old

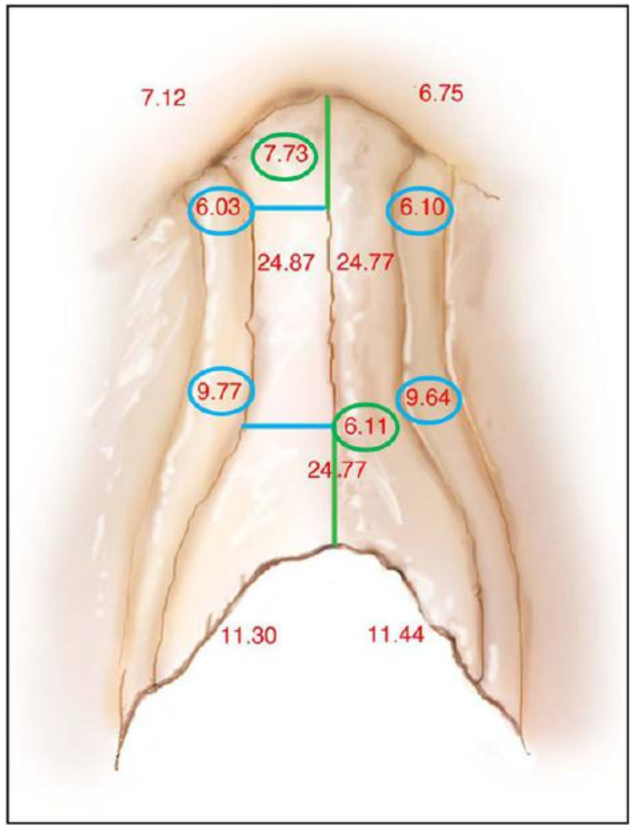

Figure 7. Average distances measured (shown in mm) are illustrated for the nasal bones. The anthropometric N to S as well as K to R are shown with the green lines. The distance S and K to the nasomaxillary junction are shown with blue lines.

Table 1. Measured Values for Nasal Bones Angulations

Specimens	NA°	DPA°	KA°
Male (n = 22)			
Mean	140.41°	155.29°	203.58°
SD	5.73°	3.79°	3.17°
Range	129-143°	145-157°	192-222°
Female (n = 22)			
Mean	142.35°	151.85°	199.95°
SD	4.34°	7.81°	8.51°
Range	124-149°	143-162°	189-207°
Total (n = 44)			
Mean	141.38°	153.57°	201.77°
SD	5.03°	5.81°	5.84°
Range	124-149°	143-162°	189-222°

SD, standard deviation.

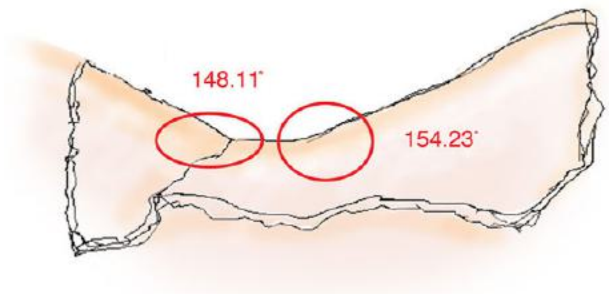

Figure 8. "V - shaped" nasal bones - values of nasion angle and dorsal profile angle in females.

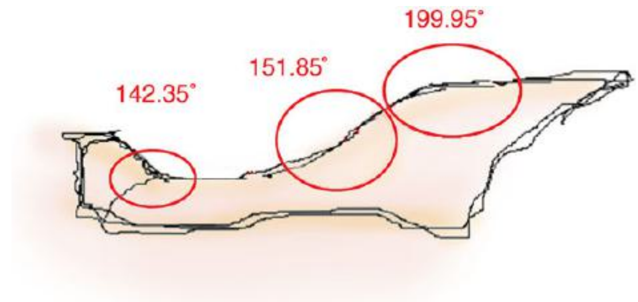

Figure 9. "S – shaped" nasal bones - values of nasion, dorsal profile, and kyphion angles in females.

(average age 59). The average anatomic measurements are illustrated in Figure 7. Although the nasal bones have an irregular variable shape, three distinct angles were found and measured along the dorsal profile line beginning with the nasion angle (NA), the dorsal profile angulation (DPA), and the kyphion angulation (KA) (see Table 1). The NA averaged ♀148.11° and ♂146.22°. The DPA averaged ♀ 154.23° and ♂ 151.78°. In 12% of cases, the caudal portion of the nasal bones was straight and without angulation, which resulted in a V-shape configuration (see Figure 8). In 88% of cases, the caudal portion of the bone was angulated that resulted in an S-shape configuration (see Figure 9). The most prominent convexity within the bony dorsum occurred at K, and KA located on top of the bony dorsum curvature averaged ♀ 199.95° and ♂ 203.58°. The values of NA, DPA, and KA were not significantly different between the sexes (see Figure 10).

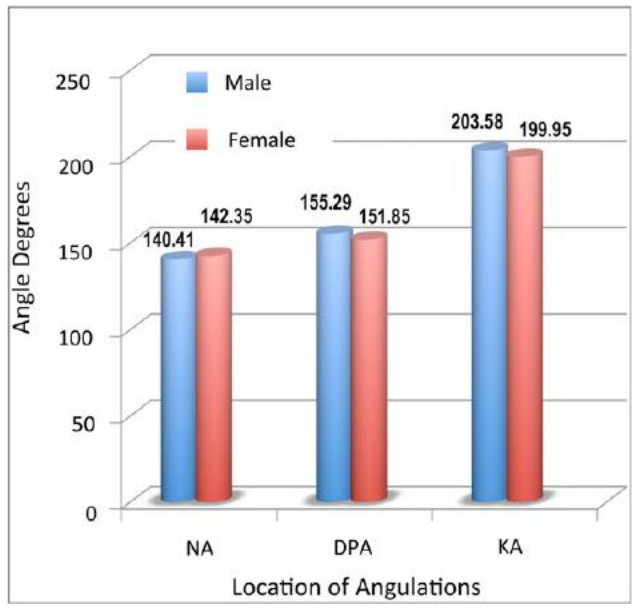

Figure 10. Angulations of nasal bones by gender.

DISCUSSION

Surgery of the nasal bones is crucial to successful rhinoplasty. Eliminating the hump on the profile and creating the cephalic portion of the post-reduction dorsal lines with osteotomies are critical to the post-operative result.[9] It is the morphology of the radix, the bony vault, and the osseocartilaginous vault, with the overlying bony cap, that determines the shape of the pre-reduction nasal dorsum.[3] In the sagittal plane, the nasal bones contain three important anthropometric nasal landmarks: N, S, and R, which in turn determine the nasofacial angle and profile. The importance of our anatomical observations and their potential relevance to rhinoplasty surgery will be discussed.

Anatomical Findings

Prior anatomic studies were limited to recording surface characteristics of the nasal bones. In contrast, the present study emphasizes the profile angulations of the nasal bones from the skull to the caudal portion of the osseocartilaginous vault, which provides a better understanding of the complete nasal profile. The anthropometric N occurs at the midpoint of the nasofrontal suture line and S is the deepest depression of the nasal bones. The intervening cephalic bone, N-S, represents the radix while the caudal bone, S-R, represents the true bony dorsum cephalically and the osseocartilaginous vault caudally. The true bony vault lies cephalad and separate from the osseocartilaginous vault.

The radix was found to be a slightly concave plane, 7.73 mm in length and 6.03 mm above the nasomaxillary junction. With the introduction of DPA and KA, clinicians can further analyze the dorsal hump with greater accuracy as to severity and type. On lateral photographs, the surgeon can mark K at the most prominent point on the bony nasal profile, and R as the most caudal midline point of the nasal bones, which occurs at the osseocartilaginous junction. Then, one can draw the following two angles: the DPA at the sellion and KA at the kyphion. These angles allow one to subdivide the dorsal bony hump into two types:

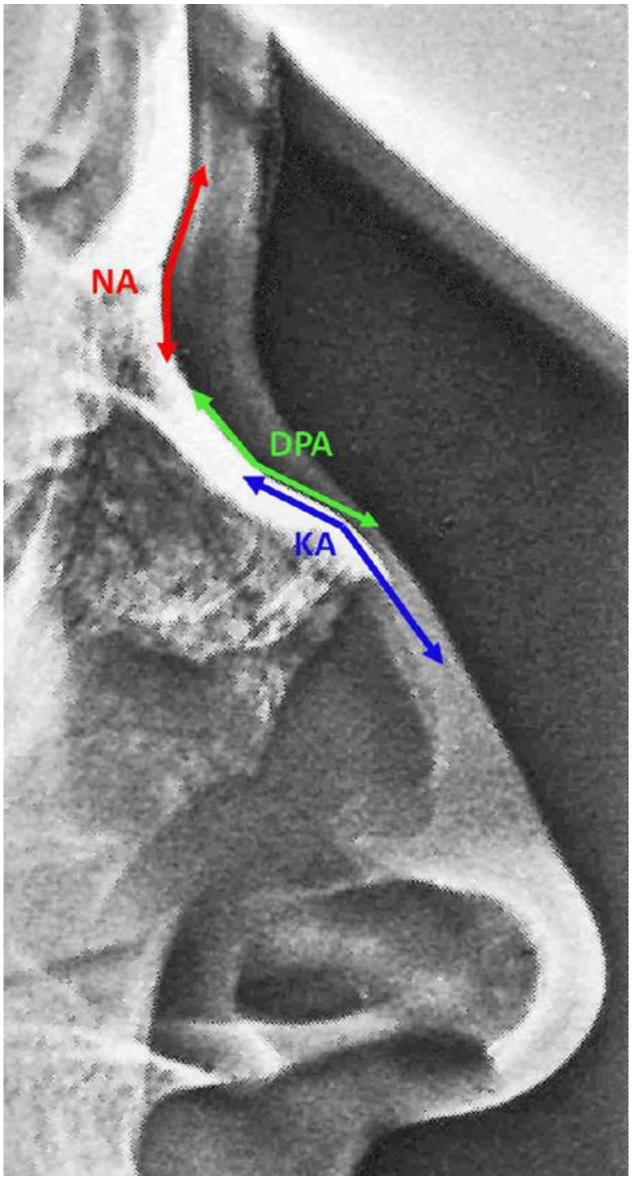

Figure 11. Nasal bones – pretreatment.

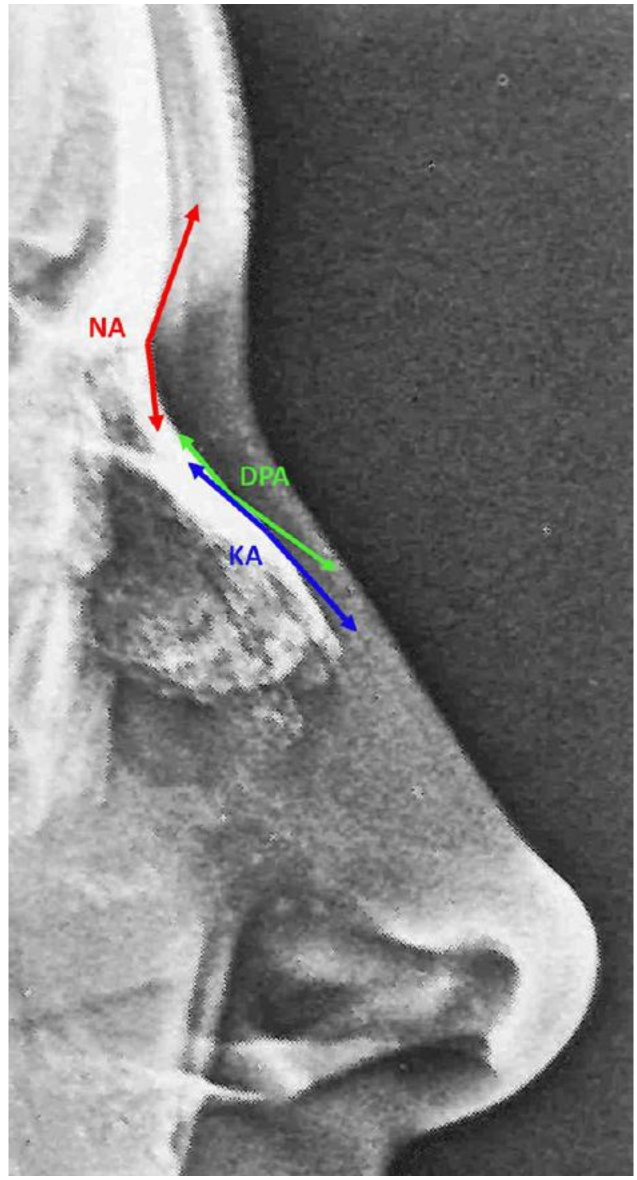

Figure 12. Nasal bones – postoperatively. Conversion of "S-shaped" nasal bones to "V-Shaped."

V-shaped and S-shaped. The V-shaped bones are relatively straight from S to R and do not have a distinct convex K. Despite the absence of a prominent dorsal convexity, a dorsal reduction may be done to reduce the overall size of the nose and to bring the dorsal profile line closer to the face. In contrast, S-shaped nasal bones have a distinct convexity at K, which is often the primary reason that a patient seeks a rhinoplasty.

Clinical Application

Although this is a study focused on the anatomy of the nasal bones, some clinical applications are worth mentioning. As previously mentioned, surgeons tend to transfer anthropometric terms indiscriminately from the bony surface to the skin surface for pretreatment planning. Obviously, this transfer requires certain assumptions that can lead to confusion and inaccuracies. Although purists object to this practice, the authors feel that the application of our anthropometric findings to pretreatment planning in rhinoplasty surgery is far more valuable than any potential conflict. The recognition that the cephalic portion of the nasal dorsum can be separated into radix, bony vault, and osseocartilaginous vault helps with pretreatment planning and analysis. Marking and measuring the different points and angles can help to point out whether the hump pathology lies in the radix, bony vault, or

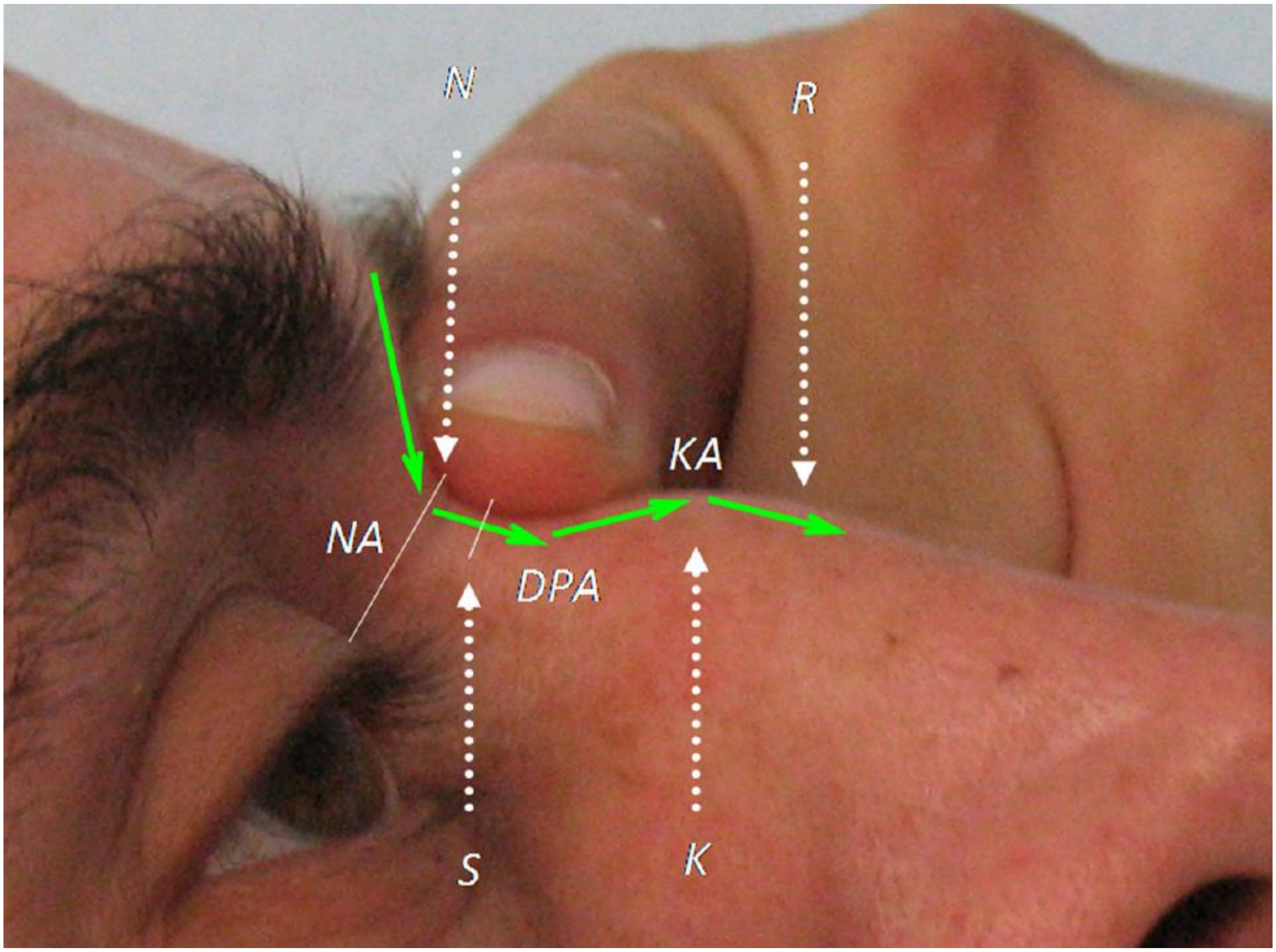

Figure 13. Approximate detection and marking of the nasal bones by palpation on a 47-year-old male subject.

osseocartilaginous vault. For example, for many patients a balanced rhinoplasty may involve osseocartilaginous reduction with radix grafting.[10]

The value of the anthropometric measurements is also demonstrated in analysis of pretreatment and postoperative radiographs. As shown in Figure 11, one can define the critical four points (N,S,K, and R) and then draw the essential three angles (NA, DPA, and KA).The presence of the dorsal convexity confirms that this patient has an S-shape bony configuration. Postoperatively, there is a significant change in the bony angulation following the dorsal reduction (see Figure 12). The soft tissue surface NFA is changed dramatically as the dorsal limb is reduced along with the tip overprojection. In contrast, the anthropometric nasion angle NA is not changed because there was no radix reduction. Both the DPA and the KA are increased significantly following the dorsal reduction. Perhaps more importantly, the K point virtually disappears and to a certain degree the S-shaped nasal bones have been converted to V-shape nasal bones. It should be noted that at times a slight hump (K) might be left to create a straight dorsal profile. This is due to variable thickness in the nasal dorsal skin with thinner skin located in the rhinion.

Study Limitations

This anatomical study identifies anthropometric points, and angles are then measured based on these landmarks. From a surgical planning standpoint, these landmarks can be hard to delineate and localize without using radiography (see Figure 13). Knowing the normal values of these angles of the nasal bones does not in and of itself help a clinician decide whether to remove a hump or how much to remove. In addition, differences in skin thickness and soft tissue may alter the way in which a hump is removed. For example, if radix reduction is necessary, some patients may benefit from reduction with a burr while others may benefit from procerus/soft tissue reduction. However, using the nasal angles does help separate the nasal bones and hump profile into radix, bony hump, and osseocartilaginous vault. By breaking down the hump profile each segment can be analyzed with the requisite reduction or augmentation.

We also must address that the cephalic portion of the nose (radix to osseocartilaginous junction) must be analyzed independently but also in relation to the complete nasal profile. Tip projection must be taken into account to harmonize the nasal tip and nasal dorsum. In fact, some patients may benefit from dorsal augmentation to balance nasal tip projection.[11]

CONCLUSION

This anatomical study identifies and measures three important anthropometric angles of the nasal bones. These angles help surgeons to better understand the pre-reduction nasal profile as well as where the pathology lies when creating the ideal nasal dorsum.

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Dorsal Preservation Rhinoplasty

Jose Carlos Neves, MD[a,b,c,*], Dean M. Toriumi, MD[a,d], Abdülkadir Göksel, MD[a,e]

KEYWORDS

• Dorsal preservation rhinoplasty • Surface dorsal techniques • Preservation impaction techniques • Subdorsal flap techniques • Low strip technique

KEY POINTS

- Preservation rhinoplasty effectiveness can be enhanced with techniques like the Ballerina maneuver and the Dorsal Aesthtetic Lines split maneuver.
- Potential drawbacks like residual humps, radix drop, supra-tip saddling, and post-surgical nasal deviation can be addressed by choosing patients carefully and having a clear knowledge of the nasal and septal anatomy.
- Dorsal preservation techniques preserve the integrity of the middle cartilaginous vault leaving more available septal cartilage for structural grafting in the nasal tip.

PANEL DISCUSSION

In what patients is preservation rhinoplasty indicated, when is it not indicated?
How to decide on the proper technique?
How can I safely introduce dorsal preservation techniques in my surgical armamentarium?
Do I need any special surgical instruments?
How can I prevent complications?
How have your techniques in this area changed over the last 2 years?

QUESTION 1. IN WHAT PATIENTS IS PRESERVATION RHINOPLASTY INDICATED, WHEN IS IT NOT INDICATED?

Neves

At the outset of my career, I was fortunate to receive a fellowship under Wilson Dewes in 2007, who predominantly employed conservative approaches to the dorsum. He meticulously tailored his techniques to maintain the dorsal anatomy across various nasal types, utilizing push/let down concepts for the lateral wall and SPAR A (high strip) and SPAR B (low strip) techniques for the septal wall.[1] This methodology supports the assertion that nearly all patients are candidates for preservation rhinoplasty (PR).

Transitioning back to my own practice, I experienced varying degrees of success with dorsal PR. During certain periods, I predominantly performed PR, while at other times I focused on structural rhinoplasty, influenced by the challenges and limitations encountered in both approaches. As the principles of PR evolved, the introduction of new tools and techniques has facilitated more precise and detailed outcomes. Consequently, some conditions that were once considered absolute contraindications for PR are no longer viewed as such in light of these advancements.

However, there continue to be optimal indications for the preservation of the nasal dorsum, as well as situations that we still consider best avoided in this approach, clearly depending on the strategy and surgical experience with PR.

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1064-7406/24/

For optimal indications, I would say that these include noses with a projected dorsum requiring deprojection but with little curvature, minimal angulation at the rhinion; without a low radix; without a low supratip; with well-defined dorsal aesthetic lines (DAL), ideally of proper width; and tension noses. Noses exhibiting lateralization are considered ideal for this approach since it involves mobilizing the entire structure to center it along the midline. In techniques that disarticulate the cartilaginous septum from the perpendicular ethmoidal plate (such as the Low-Strip approach or Tetris 3), this maneuver is particularly powerful. However, in the initial stages of the learning curve, the greater complexity of this approach may be a reason for hesitancy, as is often expressed by some colleagues. Therefore, a straight nose would be an excellent indication for PR, particularly in the early stages of learning.

Indications that require greater expertise include, beyond greater lateralization of the pyramid, a nose with more than 1 axis of deviation (S shape deviations); a wide nose in which DAL need to be redefined; a nose with a low radix or low supratip; and a nose with a highly angled rhinion.

Today, I categorize as a potential contraindication the presence of a traumatic nose that exhibits numerous surface irregularities or depressions in the bone or cartilage, as well as a septum with multiple fracture lines. In such cases, re-establishing a new central structure over which the lateral nasal wall reconstruction is to be conducted might be considered a preferable option. Certainly, in circumstances where there has been previous surgical intervention, such as septoplasty or rhinoplasty, we often find conditions that contraindicate a preservation approach.

Toriumi

I started using dorsal preservation in June of 2019. In the beginning, I was very selective in the patients that I chose for dorsal preservation.[2] I selected patients with a V-shaped dorsal hump and straight nose. These are ideal patients for starting dorsal preservation. After performing my first 20 dorsal preservation cases, I used the high strip, subdorsal Z-flap, and low strip (Cottle or SPQR). My comfort level increased significantly in the first 20 cases. I eventually incorporated the Tetris as introduced by Jose Carlos Neves and other techniques such as the spare roof type B.[3,4] As I gained more experience, my indications for using dorsal preservation expanded to most all primaries including; crooked noses and patients with S-shaped dorsal humps.

The deviated nose is an ideal indication for dorsal preservation. Preservation techniques are particularly helpful in patients with an axis deviation of their nasal dorsum (**Fig. 1**).

I started using a subdorsal grafting technique to correct the saddle nose deformity and also to augment the low nasal dorsum. Initially, I used

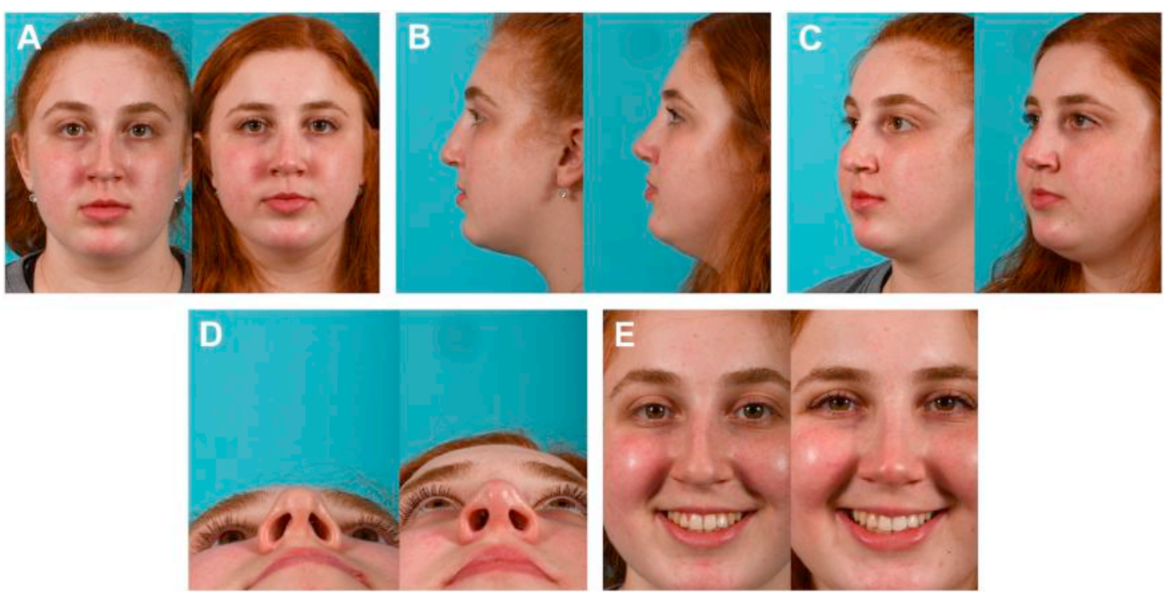

Fig. 1. Patient with an axis deviation and dorsal hump. She is an ideal candidate for dorsal preservation. In this case an overlapping subdorsal Z-flap was used to straighten her nose and reduce her dorsal hump. (*A*) Preoperative frontal view showing deviated nose (*left*). 1 year postoperative frontal view showing straight nose (*right*). (*B*) Preoperative lateral view (*left*). Postoperative lateral view showing straight dorsum (*right*). (*C*) Preoperative oblique view (*left*). Postoperative oblique view (*right*). (*D*) Preoperative base view (*left*). Postoperative base view (*right*). (*E*) Preoperative smiling frontal view (*left*). Postoperative smiling frontal view (*right*).

subdorsal spreader grafts and then progressed to using a subdorsal cantilever graft to augment the dorsum in the ethnic rhinoplasty patient.[5] This expanded the use of dorsal preservationin patients who otherwise would require dorsal grafting.

I also expanded the use of dorsal preservation for revision rhinoplasty patients who had residual dorsal humps. If the patient underwent prior rhinoplasty and had rasping of the dorsum without component hump reduction, a letdown with a subdorsal Z-flap or low strip could be used to straighten the dorsum. In these cases, care must be taken to carefully assess the status of the nasal septum to ensure there is adequate septal cartilage to permit a subdorsal Z-flap, Tetris, or low strip.

At this point, I use dorsal preservation on almost all primary rhinoplasties with a dorsal hump or those needing dorsal augmentation. I also use dorsal preservation in a small number of revision rhinoplasty patients requiring dorsal augmentation. I perform a good number of Asian rhinoplasty surgeries where patients need dorsal augmentation or need their implant removed with immediate dorsal elevation to reestablish proper dorsal height.

I believe dorsal preservation is not indicated in patients who have a complex deformity of their nasal bones or middle vault. In these cases, there is little to preserve, and a structured approach with spreader grafts will be needed to reconstruct the middle nasal vault.

Göksel

The main indications for PR are primary cases in which hump elimination is desired. PR is particularly beneficial for patients who own the following features.

- A primarily cartilaginous, dorsal hump.
- Short V-shaped nasal bones.
- An elevated or normal radix height.
- Straight linear DAL, even if they deviate from the midline axis.
- Narrow tension noses.

The surgeon's expertise is crucial in expanding the indications for PR to include more prominent noses and scoliotic nasal pyramids. This can be achieved by applying techniques such as dorsum-plasty, ostectomies, and asymmetric lateral osteotomies.[6,7]

However, even if the patient falls under the criteria mentioned above, some relative contraindications still exist for PR.

- Septal pathologies such as trauma with multiple fractures, large septal perforations, and severe deviations.
- A partial or complete septum reconstruction is necessary due to a previous aggressive septoplasty.
- Severe S-shaped dorsal axis deviations.
- Revision cases, particularly if open roof deformity is present.
- Less than 150o degrees angle between nasal bones and upper lateral cartilages (ULCs) (the angle between the internasal suture and the midline fusion of the ULC on a sagittal view)

QUESTION 2. HOW TO DECIDE ON THE PROPER TECHNIQUE

Neves

The field of PR has witnessed an explosion of new ideas and concepts, making it challenging to delineate its conceptual boundaries today. In my 17 years of endeavoring to understand the optimal path that aligns with my surgical skills and objectives, I have come to focus on preserving what lies between the 2 DAL, which I refer to as the dorsal platform. This approach aims to maintain continuity between the bone and cartilage in the rhinion region, where the skin is thinnest and surgical vestiges are most readily apparent. Additionally, it helps to preserve the integrity of the nasal septum and ULCs as a unit. Consequently, the entire surgical strategy is centered on the preservation of this platform. Following this line of reasoning sequentially, I explore the following options.

Surface approach

The dorsum is slightly projected (up to 2 mm): In these cases, surface maneuvers such as rhinosculpture are almost always sufficient. I begin with shaving of the nasal dorsum, typically using burrs, although piezo and rasps are also effective. After achieving the desired height of the bony dorsum, I adjust the cartilage projection. Burrs can also be used, but performing a shaving with a cold blade scalpel is another possibility. I have employed electrosculpture (using the cut of the monopolar electrocautery) which provides great precision in cartilaginous sculpting, without completely separating the septum/ULC unit.

Cartilaginous impaction

The bony dorsum is slightly elevated, with a predominantly cartilaginous hump: The dorsum is addressed with rhinosculpture, and the cartilage is deprojected using the Tetris concept. I perform a cartilagineous sub-dorsal flap (Tetris flap) to define the height of the cartilaginous dorsum.

Full pyramid impaction

This is my most frequent approach, which involves impacting the entire nasal pyramid, necessitating work on the nasal septum and the sidewalls. Regarding the septal wall, the position of the ethmoidal plate primarily guides the choice of the impaction technique.

1. If the ethmoidal plate shows no significant deviations, the technique of choice is the Tetris Concept[8] (**Fig. 2**), a sub-dorsal flap that guides and stabilizes the new position of the nasal dorsum. After resecting the excess nasal septum beneath the flap, board-to-board sutures are applied. There is the option of Tetris 1 (the original description, where the flap is defined cephalically at the highest point of the nasal hump and caudally at the caudal border of the ULCs) and Tetris 2 (cephalically the same but caudally the cut is made below the ULCs halfway between the rhinion and W point, thus providing a support point to the caudal cartilaginous vault above the nasal septum).
2. In minor deviations of the nasal pyramid and ethmoidal plate, we use the same concept but consider the possibility of overlapping the flap with the basal septum to compensate for the deviation, it is the lateral Tetris.[8]
3. In cases of marked deviations of the ethmoidal plate, where continuity with the septal cartilage is maintained, both the nasal pyramid and the caudal septum persistently exhibit deviations. In these cases, I always opt for a basal and posterior disarticulation of the septal cartilage. We then have 2 options: the Low Strip approach (popularized by Cottle and later Wilson Dewes, SPAR B) or Tetris 3. This Tetris option is based on a sequence that assesses the need for the extent of disarticulation, whether partial or total. After centering the caudal septum at the anterior nasal spine (ANS) and reducing the projection of the nasal dorsum with the Tetris flap, I assess the degree of deviation of the ethmoidal plate, its location, and its impact on the deviation of the anterior nasal pyramid and septum. Sometimes this ethmoidal plate deviation is more basal, and I disarticulate the septum from the entire pavement and from the basal portion of the plate; I then reevaluate the impact of this maneuver. If it is not sufficient, I perform a complete disarticulation, leaving the septal cartilage detached from the ethmoidal plate, now able to freely perform a swinging door maneuver. It is important to note that this technique completely frees the septal cartilage from its surroundings, thus it is imperative to define a stable sequence. This actually represents a high strip with a subdorsal Tetris flap combined with a Low Strip approach release, thus integrating the advantages of each: better control of the final position of the nasal dorsum and the release of the septal cartilage to correct septal and pyramidal deviations.

Regarding the sidewall, I primarily use the let-down maneuver, not only in the basal portion of the osteotomy but also in the transverse to avoid blocking points. The sidewall is seen more as a facilitator of movement, leaving to the nasal septum the task of defining the position of the nasal profile. An exception to this concept is the “lateral-push”, described by Wilson Dewes, for deviated pyramids. This involves performing a let-down on the longer sidewall and a push-down on the shorter side, to facilitate centering of the nasal pyramid.

Toriumi

Choosing the proper dorsal preservation technique can be somewhat confusing as the indications can

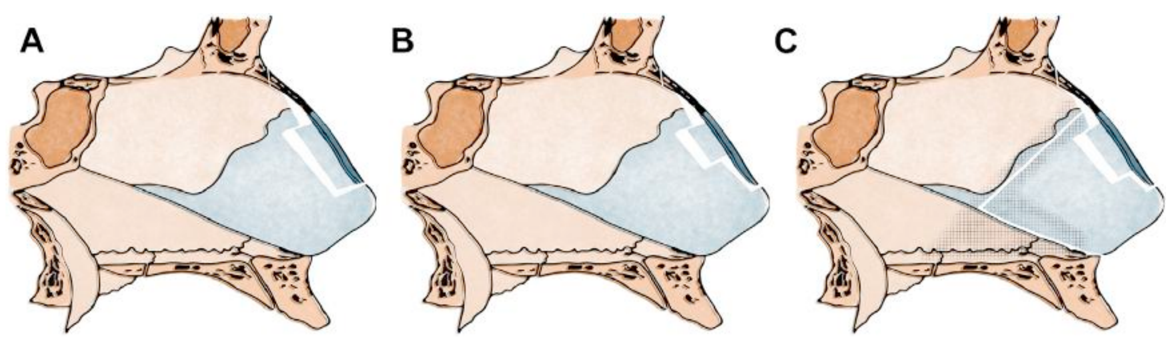

Fig. 2. The Tetris Concept. (*A*) *Tetris 1*: Original description of the subdorsal Tetris flap; the caudal incision is placed at the level of the caudal border of the upper lateral cartilages (ULCs); the cephalic incision at the highest point of the nasal hump; (*B*) *Tetris 2*: The caudal incision was shifted cephalically to preserve some of the quadrangular cartilage below the cartilaginous vault, increasing support to the supratip area; (*C*) *Tetris 3*: After the subdorsal flap is stabilized and the posterior septal angle is fixed in the mid-line, the pyramid is analyzed to detect any residual deviation that may be caused by a deviation of the ethmoidal perpendicular plate. If this is the case, we free the quadrangular cartilage from the ethmoidal plate and perform a swinging door movement. This procedure results in a *Full Release* of the quadrangular cartilage.

vary or overlap. For example, many primaries with a V-shaped dorsal hump can be treated with a high strip, intermediate level strip (subdorsal Z-flap, Tetris, Ishida) or low strip. I chose to use the subdorsal Z-flap, Tetris or low stripin most primaries that have a V-shaped dorsal hump with a normal radix and good supratip position. I will use a Tetris in patients that require more precise control of the supratip position due to a lower or higher supratip position. In the deviated nose, the low strip, subdorsal Z-flap and Tetris work well if there is an axis deviation with a moderately deviated septum with a midline ethmoid bone. If I use an intermediate level technque, I will overlap the subdorsal Z-flap or Tetris to the side opposite the deviation to shift the dorsum to the midline. I also prefer a letdown and in cases with an axis deviation, I will take out a bone strip on the side opposite the deviation and a conventional lateral osteotomy on the side of the deviation.

I prefer to use a low strip in patients with a deviated nose and deviated septum that involves a quadrangular cartilage that is too large for the space it occupies or in the case with a high ethmoid deviation. In these cases, the quadrangular cartilage can be freed from the nasal spine, maxillary crest, vomer, and ethmoid and then resized to fit into the space and resuture the septal flap to the nasal spine. The low strip (Cottle, SPQR) is a very powerful technique and can correct severe septal deformities without performing a subtotal septal reconstruction or extracorporeal septoplasty (**Fig. 3**).[9]

I will use the subdorsal cantilever graft to perform dorsal augmentation in most patients requiring augmentation to avoid using larger dorsal grafts. I do not use diced cartilage and fascia grafts as I believe they are problematic and can leave deformity and can be difficult to revise.

In many situations, the dorsal preservation techniques are interchangeable or can be combined. For example, the subdorsal Z-flap and Tetris are almost interchangeable. In some cases, a Tetris or Z-flap can be combined with a low strip using the low strip to correct the septal deformity and to straighten the nose and the subdorsal Z-flap or Tetris to lower the dorsal hump (Jose Carlos Neves, personal communication, 2022).

Göksel

After a patient's suitability for dorsal preservation is elected, the surgeon must then make critical decisions regarding the surgical approach (open or closed), the conservation of ligaments, the dissection extent of the skin-soft tissue envelope (SSTE), septal management, dorsal work, and the potential need for adjunctive tricks such as the Göksel's Ballerina maneuver or bony cap removal.[6,7]

This preoperative analysis is immensely significant in determining the extent of SSTE dissection in PR because the degree of ligamentous preservation directly influences the redraping of SSTE and the resolution of edema, in my anecdote.[6,7,10]

To ease this process, we recently introduced a classification system for patients, grouping them into 3 classes based on the presence of dorsal deformities. This categorization assesses the suitability of the case for ligamentous conservation, which allows for an individually tailored and practical application of preservation techniques.[6,7]

1. Patients with a straight dorsal aesthetic line necessitating solely reduction of the cartilaginous hump: This group can be managed through limited SSTE dissection along the nasofacial groove, which allows the lateral osteotomies while preserving the SSTE attachment to the dorsum. The dissection should be minimally invasive to achieve the anticipated results (**Fig. 4**A).
2. Patients with straight DAL with a bony hump that requires minor adjustments. Here, a dorsal SSTE elevation and partial ligament dissection are needed. This technique allows access to the central dorsal and symmetric lateral nasal bony compartments. By carefully managing the dorsal skin and selectively dissecting ligaments, surgeons can address the raised bony hump while preserving the overall dorsal aesthetics (**Fig. 4**B).
3. Patients with dorsal irregularities and asymmetries: Those cases may still undergo a PR employing dorsum-plasty and classical preservation techniques. Here a complete dorsal SSTE dissection for restructuring without preserving ligaments. Following the necessary adjustments, the Pitanguy and Scroll ligaments are reattached before the surgery is finished. This allows for the correction of dorsal irregularities and asymmetries (**Fig. 4**C).

The next step is to decide on the best way to manage the septum. If the hump height is less than 4 mm with straight DAL, the high septal strip/subdorsal resection that has been popularized by Saban and colleagues[11] or Mid-Septal Strip/Subdorsal flaps of various configurations that have been described by Most and colleagues,[12] Neves and colleagues,[8] and Kovacevic and colleagues.[13] However, if we deal with a crooked nose with no pathology at the lower septum, the low septal strip (by Cottle.[14] or SPQR by Finocchi and colleagues[15]) works best for me as I need to change direction of the nose, and this is possible only through the separation of the attachment between the quadrangular cartilage and the perpendicular plate, which

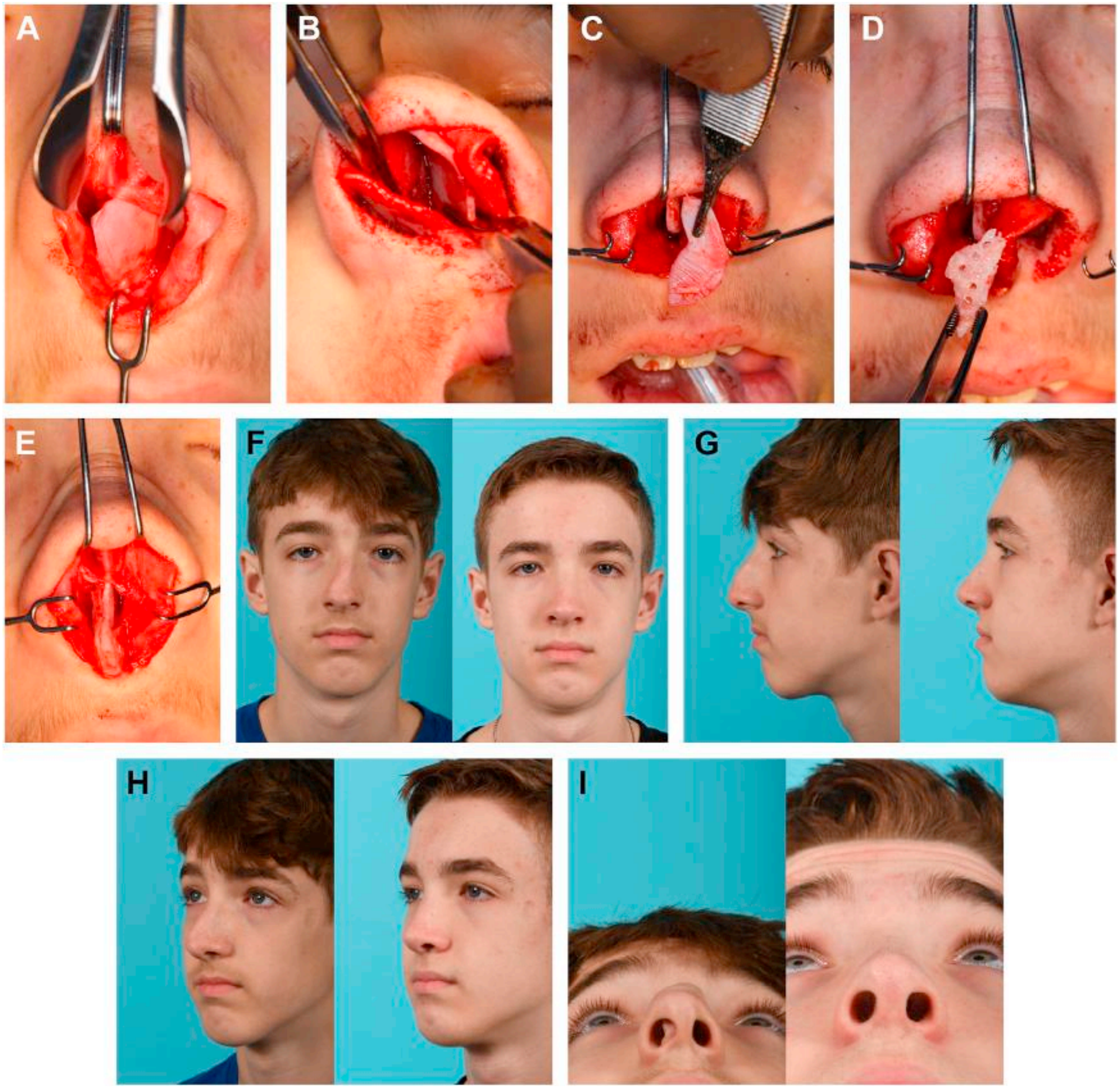

Fig. 3. Patient with a severely deviated nose and deviated caudal septum. (*A*) Severe septal deviation noted. (*B*) After release of the septal flap it was trimmed and rotated caudally. (*C*) Caudal septal extension graft used to reestablish proper length. (*D*) Ethmoid bone used to stabilize the extension graft. (*E*) Septal extension graft in place. (*F*) Preoperative frontal view showing severe deviation (*left*). 3 years postoperative frontal view showing a straight nose (*right*). (*G*) Preoperative lateral view showing dorsal hump (*left*). Postoperative lateral view showing straight dorsum (*right*). (*H*) Preoperative oblique view (*left*). Postoperative oblique view (*right*). (*I*) Preoperative base view showing severe caudal septal deviation (*left*). Postoperative base view showing symmetric nasal base and open airway (*right*).

is hard to achieve in the high-septal strip technique. The specific indications for each PR technique are illustrated in (**Fig. 5**).[6]

QUESTION 3. HOW CAN I SAFELY INTRODUCE DORSAL PRESERVATION TECHNIQUES IN MY SURGICAL ARMAMENTARIUM?

Neves

As previously mentioned, the variety of PR techniques is so vast that it is difficult to outline a single guidance path for beginning this journey. For example, surface techniques, which today are also considered part of PR, have always been in the armamentarium of nose surgeons, regardless of their school of thought, since in various situations it would be necessary to refine the nasal dorsum, using rasps or motorized devices. Today, perhaps we take it a bit further, and thus include it in the PR repertoire.

Regarding impaction techniques, they rely on a 3-dimensional mastery of the entire nasal structure and the ability to predict how movement will occur in each segment, which undoubtedly requires a

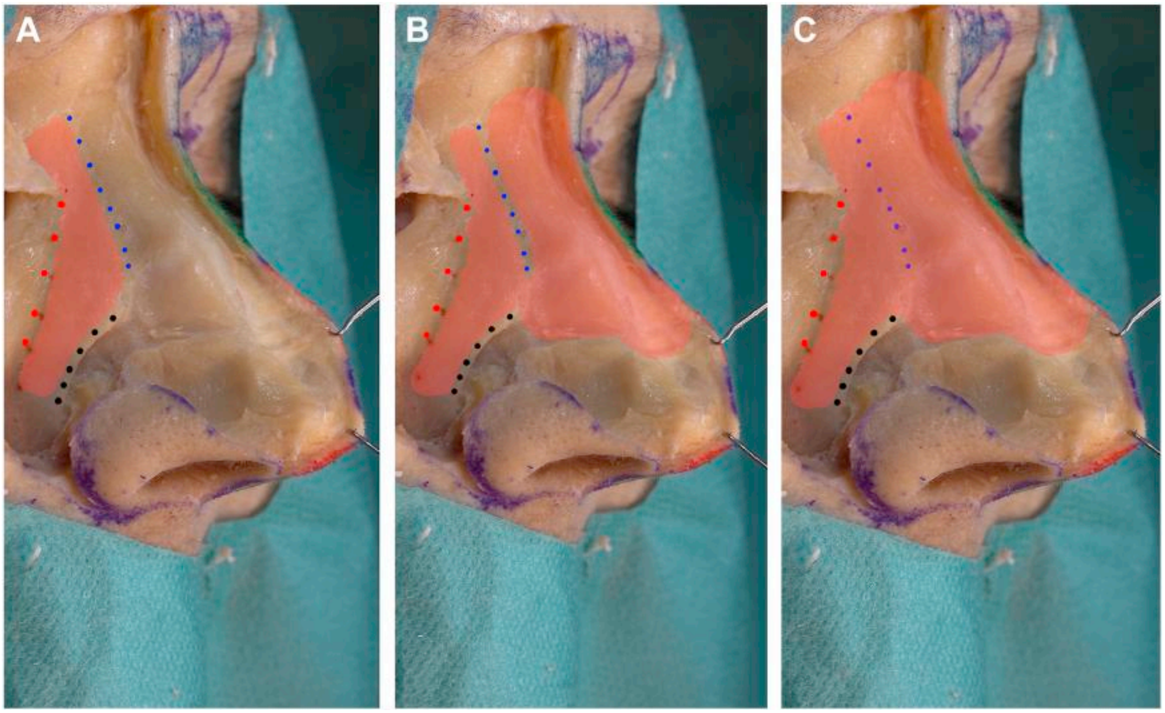

Fig. 4. The red dotted line defines the nasofacial groove, the blue dotted line refers to the site of the nasomaxillary ligament attachment, and the dotted black line delimitates the pyriform aperture. (*A*) Limited dissection with ligament preservation. There is no dissection on the dorsum. (*B*) Limited dissection with ligament preservation; the dorsum is dissected. (*C*) Extended dissection with no preservation of the ligaments.

learning curve and improvement of skills. It is important to note that several surgical actions are performed without observing a change in the pyramid until impaction is executed. This may be the significant difference from structured rhinoplasty, which plans each step sequentially, with each producing a visible modification. Therefore, mastery and control of nasal anatomy are absolutely crucial.

Beyond the obvious anatomy study, I believe it is very important to undertake hands-on cadaver

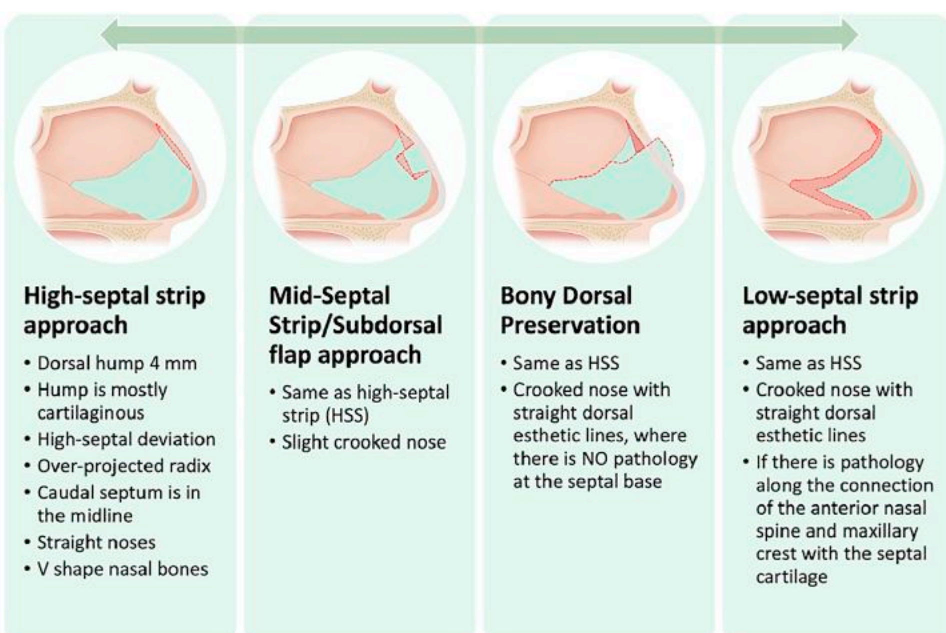

Fig. 5. Septal configurations of preservation techniques.

courses to understand structure and movements. It is also crucial to identify the surgeons whose concepts are most appealing and visit them to see these procedures in real time and clarify any doubts. Then, choose the ideal candidates. As mentioned, today we cannot say there are absolute contraindications in PR, but there are certainly optimal indications. To start, I would recommend a nose with a projected dorsum with a slightly kyphotic hump, without low radix or supratip, without deviations, and with well-defined aesthetic lines. It may also be helpful to include in this initial group of candidates male patients, who, in the event of ending up with a residual hump or a recurrence, generally accept this appearance as a characteristic perceived as masculine, even adding some naturalness.

Although I initially learned the SPAR B[1] (low strip approach) early in my career, this technique is, in my opinion, the most demanding of all and can present significant difficulties in controlling the nasal pyramid and septum. Therefore, in relation to impaction techniques, I would start with those that rely on a stable cartilaginous septum, where there has been no disarticulation with the ethmoidal perpendicular plate, such as the high strip (SPAR A[1], Saban[11]) or techniques similar to high strip with a sub-dorsal flap, also seen as an intermediate strip (Tetris,[8] Most,[12] Z-Flap[13]).

Toriumi

When incorporating dorsal preservation techniques into your practice, it is important to study the publications of different surgeons who have introduced preservation techniques. Going to visit these surgeons can also be very helpful. The most productive means of learning dorsal preservation is to attend a comprehensive fresh cadaver laboratory course. The ideal setting would be to attend a course that offers split time between didactics and cadaver dissections. Additionally, it is ideal to have the opportunity to have multiple fresh heads to practice the high strip, intermediate level strip, and then the low strip. Doing all of these techniques during the course will allow you to personally perform each technique. Such hands-on experiences are key to learning dorsal preservation.

In my case, I did not visit any surgeon or attend a cadaver laboratory. However, I had 30 years of rhinoplasty experience before starting dorsal preservation. Additionally, I watched excellent videos of master surgeons performing the different techniques.

It is also very helpful to have direct contact with experienced surgeons to ask them their opinions on choosing the proper cases. I was able to contact Yves Saban, Milos Kovacevic, Baris Cakir, and Aaron Kosins to ask for their opinion on case selection and the best techniques for each case.

There are many good references to gain information about dorsal preservation including the PR series as well as informative papers on the topic (Jose Carlos Neves, personal communication).[16]

I believe it is very important to learn structure before embarking on dorsal preservation as structure techniques may be needed as a “bailout” if dorsal support is lost.[5,17] Additionally, it is very helpful to be experienced in performing osteotomies as this is needed if performing pushdown or letdown techniques. Because I had over 30 years of experience performing osteotomies, it was an easier transition to performing foundational dorsal preservation techniques. If you have access to a piezotome, bone cuts can be made under direct visualization with great precision. This simplifies the execution of the foundational techniques but does require a wider field of dissection.

There are 2 major types of dorsal preservation methods. These include surface techniques and foundational techniques.[18] In some patients with a V-shaped dorsal hump, the hump can be managed simply by rasping the bony cap. This works with smaller V-shaped humps.

For a safe transition you should start with surface techniques involving modification of the bony cap with or without a Saban style high strip.[16] This approach allows you to convert to a structure approach with spreader grafts if you wish. A natural progression is then to transition to the push down with lateral and transverse bone cuts and radix bone cut. You should start making your radix bone cut from above through a small stab incision in the radix area. Be sure to make an angled radix bone cut to minimize the likelihood of radix drop (**Fig. 6**). Additionally, it is helpful to keep the periosteum and skin attached to the radix area to keep the support of the bone around the radix bone cut.

You should also be careful at the W point to avoid saddle nose deformity. You can vary the degree of septal resection or release of the septal flaps in this area to better control the supratip area.

It is helpful to have access to an endoscope when you are starting so you can clearly see what you are doing subdorsally. Take photos so you can keep a record of what you are doing below the dorsum.

Göksel

Similarly to structural rhinoplasty, preservation techniques have a steep, long learning curve. Consequently, beginners need to observe masters in PR to understand these techniques comprehensively. Moreover, finding an individual mentor with

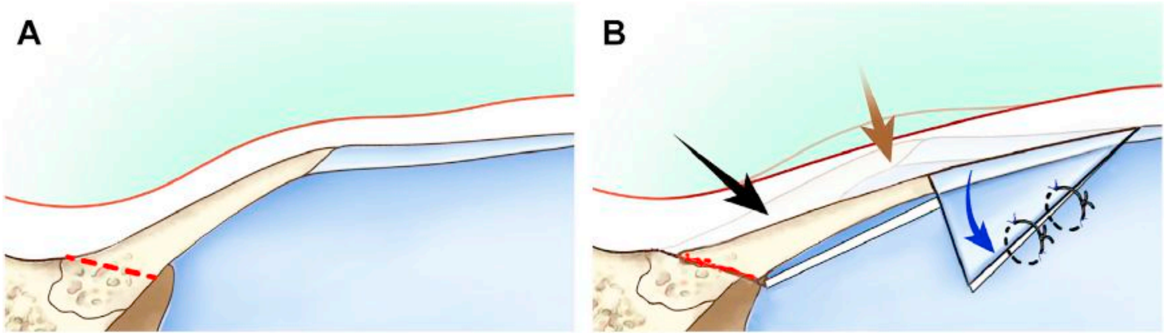

Fig. 6. Angled oblique radix bone cut used to prevent radix drop. (*A*) Note the angle of the radix bone cut. (*B*) The bone slides and does not drop to prevent descent of the radix.

good expertise in PR who can guide the surgeon's learning curve would be very beneficial.

It is also important to understand that PR has limitations and cannot be applied to all cases, so the wise selection of the optimal cases for those techniques is the most crucial safety measure. Here again, mentoring can be of great value in helping to choose the best patients for a PR technique. Furthermore, the supervisor can advise on the best techniques based on his/her mentee's familiarity with PR. For instance, starting with male patients with straight DAL is the best option, to begin with, as the most common complication in PR is a residual hump, which in turn could be desired in men to retain the masculine appearance of the face.

Regarding septal management techniques, starting with the high septal strip technique is advisable, as it allows easier revisions in case of postoperative complications.

QUESTION 4. DO I NEED ANY SPECIAL SURGICAL INSTRUMENTS?

Neves

If the answer were to be strictly a yes/no binary, it would be: No. Indeed, a conventional set of rhinoplasty instruments is sufficient to perform PR. It is noteworthy that this concept has been in existence for over a century. My mentor, Wilson Dewes, used a conventional, non-fancy set that included good quality osteotomes of 2 mm and 4 mm, both straight and curved, and a long scissors designed by him for addressing the nasal septum. In many of my surgeries, I continue to use the same osteotomes and a Heymann scissors for addressing the ethmoidal plate. However, power instruments have expanded our toolkit options.

The piezoelectric tool can enhance precision in performing osteotomies; it can be used in areas where impact might be more traumatic, such as along the DAL; and can be safely used after the mobilization of the pyramid has been achieved. Similarly, burrs create smooth surfaces and are very effective in addressing the lateral wall and naso-facial groove.

In fact, these tools have made a positive addition to rhinoplasty in general, not specifically to PR.

Toriumi

There are a few instruments that can be helpful when performing dorsal preservation. If you can use a piezotome then this device can allow you to perform the bone cuts and also perform rhinosculpture. I have a piezotome but only use it rarely in cases where rhinosculpture is necessary or if I am planning on performing a spare roof type B. I use the piezotome most frequently in secondary rhinoplasty cases where the nasal bones are deformed and require sculpting. I will also use the piezotome in cases where costal cartilage is calcified and requires the piezotome to harvest the rib and sculpt the grafts.

In most primary rhinoplasty cases, I will use osteotomes to perform the bone cuts. If bony cap removal is needed, I will use a narrow rasp (Marina Medical Inc., Davie, Fla.) to take down the bony cap and to sculpt the bones. In most cases, I will use a 2 mm straight osteotome to perform the radix bone cut from below. This is an obliquely oriented radix bone cut to minimize the likelihood of radix drop. I use a 3 mm straight osteotome to perform a high and low bone cut on the ascending process of the maxilla to remove a banana-shaped bone strip. The transverse bone cut is performed through a 3 mm stab incision along the side of the nose near the medial canthus. I first use a Cerkes bone drill (Marina Medical Inc., Davie, Fla.) to make a trough along the path of the transverse bone cut then complete the cut using a 2 mm osteotome. This helps to prevent comminuted bone fractures.

I have recently developed a banana bone strip osteotome/gouge (Marina Medical Inc., Davie, Fla.) that works well removing a 3 mm to 4 mm strip of bone along the ascending process of the maxilla. The osteotome/gouge is curved and has a right and left-sided version to take out the bone strip. The osteotome/gouge is used after a subperiosteal tunnel is created to allow the passage of the instrument.

Another very helpful instrument is the Goksel narrow rongeur and the Cerkes narrow rongeur. The Goksel rongeur is longer and is helpful for taking out bone under the nasal bones. The Cerkes narrow rongeur is useful for taking out the lateral bone strips if you prefer not to use an osteotome making a high and low cut in the bones.

The specific instruments that you will need depend on your level of expertise as some instrumentation requires more skill to use them. This is where a cadaver laboratory will help tremendously so you can feel comfortable using such instrumentation.

Göksel

PR is possible with conventional and power instruments; experienced surgeons could achieve the anticipated results using either. Nonetheless, the Piezotome eases the osteotomy and offers extra safety margins, especially for beginners, as it is more predictable. For example, performing a sagittal orienting lateral osteotomy in a push-down might be challenging using an osteotome that usually follows the weakest point in the bone while it is manageable with the Piezotome. Surgeons should not hesitate to use the Piezotome because of its time-consuming nature.

QUESTION 5. HOW CAN I PREVENT COMPLICATIONS?

Neves

Complications or suboptimal outcomes may be observed from both the profile and frontal views.[19] In the profile view, potential issues include residual hump or recurrence of a hump; loss of control over the radix height; loss of control over the supratip; and loss of control over the entire nasal pyramid, which may result in an infantilized appearance of the nose. From the frontal view, potential complications can include deviation of the nasal axis; widening of the nasal pyramid; and loss of definition of the DAL.

The complication that most concerns surgeons, particularly those considering starting with PR, is the loss of control over the pyramid, especially in the radix region. My main strategies to avoid loss of control of the radix include: not detaching the periosteum in the radix osteotomy area; performing the separation of the septum, both cartilage and ethmoidal plate, from the nasal pyramid tangentially to the inner vault in order to preserve the supporting pillar (therefore, I refrain from using rongeurs); the radix step-up maneuver[19] (which creates a pivot point between the split septal in the rhinion region and the radix osteotomy to create a see-saw movement elevating the radix, which is then adjusted to the desired dorsal height); and oblique radix osteotomy.

The most frequent complication in dorsal preservation (DP), which might rather be seen as a suboptimal outcome, is the persistence of a dorsal hump. This can be due to inadequate control of blocking points and poor execution of maneuvers that flatten the nasal dorsum. These maneuvers aim to allow the central (septal) and lateral walls to spread without resistance, promoting splitting movements.[3] In the nasal septum, at the highest point of the nasal hump, a vertical chondrotomy should be performed to enable forward splitting; on the sidewall, we have 2 options: disarticulation of the lateral K stone area (LKA), popularized by Goksel as the Ballerina maneuver, which promotes lateral splitting or the DAL split maneuver, which allows advancement of the bony sidewall along with the ULC, achieving the same effect of flattening the dorsum.

Distinguishing between a residual hump and the recurrence of a hump is not always straightforward. However, recurrence may be due to inadequate stabilization. Despite controlling all blocking points, the tissues' inherent elasticity can promote the recurrence of the nasal hump. Therefore, robust stabilization is important. The purpose of introducing a sub-dorsal flap (the Tetris flap), as also observed in the work of Most[12] and Kovacevic,[13] is precisely to stabilize the final position of the nasal dorsum more accurately. The traction suture of the flap downward to a stable septum has proven very effective. Similarly, when performing a low strip (SPAR B) or Tetris 3, an oblique suture is executed from the ANS toward the rhinion to stabilize the dorsal position. In these specific cases of Low Strip mobilization, proper stabilization of the posterior border of the nasal septum to the ANS is crucial. Here, I introduce another concept that offers enhanced stability: the sublaminar dissection of the septum[20] (**Fig. 7**). This dissection allows for the preservation of the nasal septum's perichondrium, being performed immediately below the lamina propria, which provides superior resistance to suture passage and avoids the cheese-wire effect, thus safeguarding the position of the quadrangular cartilage and, consequently, the entire nasal structure.

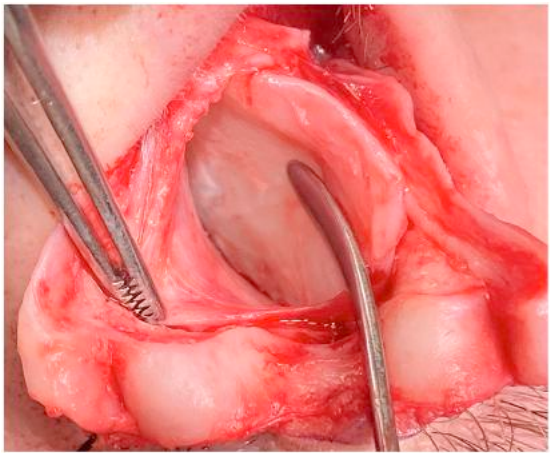

Fig. 7. Sub-laminar septal cartilage dissection allows for observation of the perichondrium overlying the cartilage. Simultaneously, the lamina propria can be observed within the dissected flap.

Another interesting point that should be addressed is the shape of the bony dorsum, which may require surface techniques to flatten the profile. This is especially true for an S-shaped bony dorsum. After achieving the ideal projection of the dorsum, I initiate the second phase of the surgery, which involves refining the profile line. The S-shaped or kyphotic dorsum is addressed using burrs, piezo, or rasps, as previously described in our surface strategies. The same issue can occur with the cartilaginous dorsum which, despite being well-positioned, may present a convexity that needs to be smoothed.

Regarding drawbacks observed from the frontal view, the widening of the nasal dorsum is a common complaint. Even if the width of the impacted nose remains unchanged, the perception that the nose appears wider is common due to the changed relationship between width and projection. However, actual widening of the cartilaginous pyramid can be observed if the cartilaginous blocking points are not controlled. This issue, though seldom discussed, particularly involves the posterior edge of the ULC, which may experience limited movement due to the presence of undissected soft tissues at the base of the sidewalls. For this reason, in most cases, I begin the dissection of the lateral wall at its most basal portion, leaving the dorsal platform undisturbed, which, if necessary, can be elevated later.

To correct a wide nasal dorsum, I follow a sequence of possible strategies. A bone shave can be performed, serving as a surface technique, to narrow the bony wall in cases requiring minor adjustments. If the dorsum is truly wide, I may then opt for DAL osteotomies to redefine the angle of the sidewalls and the width of the dorsal. If I anticipate narrowing the dorsum or defining the DAL, and aim to flatten the nasal dorsum, then I perform the DAL split maneuver.[21] This technique allows to achieve all these objectives with a single maneuver. For an enlarged bony-cartilaginous dorsum, I may consider performing a continuous mattress suture with 5.0 polydioxanone (PDS) at the level of the T plate to control the angle and width of the wall.[22] The use of electrocautery may also be interesting to sculpt the cartilaginous wall.

Toriumi

The primary potential complications when performing dorsal preservation include; radix drop, saddle nose deformity, deviation, comminuted bone deformity, and collapsed nose. A residual dorsal hump or recurrent dorsal hump is not a complication but a suboptimal outcome.

Preventing a residual or recurrent dorsal hump requires proper execution of the technique, proper selection of the technique, and management of the potential blocking points. One of the primary blocking points includes leaving bone and or cartilage under the bony hump. In most instances, 4 mm to 5 mm of bone and or cartilage should be removed below the bony hump to make room for the hump to be reduced (**Fig. 8**). Cartilage can be removed using a 15-blade or rongeur. If there is bone under the dorsum this can be removed with a long narrow rongeur.

When performing the lateral bone cuts or bone strip removal and the transverse bone cuts, if the junction between the 2 is squared off, the corner of the bone can act to block the downward rotation of the dorsal hump. This can be avoided by taking out a banana-shaped bone strip as described by Sabastian Haack. Creating more of

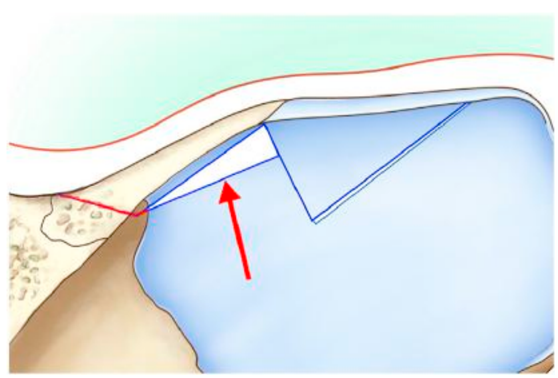

Fig. 8. Note the triangle of bone removed from below the bony hump to allow the hump to descend and not drop excessively. *Red arrow* points to the triangular segment of cartilage removed from under the dorsal hump to prevent blockage of hump reduction.

a continuous curvature from piriform aperture and the radix bone cut will allow a more uniform reduction of the dorsal hump.

The lateral keystone or connection between the caudal nasal bone and the upper lateral cartilage can act as a “tension band” that will prevent complete reduction of the dorsal hump and could result in a popping up of the hump. To prevent this tension effect, a lateral keystone release as described by Goksel will divide the connection and allow more freedom for the 2 zones to separate and allow the hump to “stretch” flat.

Another potential blocking point is Webster’s triangle, where a segment of bone can block the full reduction of the dorsum hump. This blocking point can be removed by taking out a strip of bone along the ascending process of the maxilla. In this area, the periosteum can be elevated to free the bones to release.

When performing a Saban-style high strip, a strip of cartilage and bone is removed under the middle vault and nasal bones. When this strip is removed it is difficult to remove the cartilage flush to the undersurface of the ULCs. In this case, a strip of cartilage is left that runs continuously along the undersurface of the dorsum passing across the rhinion. This strip of cartilage can act as a tension band across the undersurface of the hump. To remove the tension band effect, a couple of vertical incisions can be made across the strip of cartilage to break up the tension band effect and allow the hump to stretch flat. Saban describes this tension band effect as the “clothes hanger effect.”

To avoid complications, there are other maneuvers that can be executed. To avoid radix drop, the radix bone cut can be made in an oblique or beveled orientation. This is accomplished by angling the osteotome at a 30-degree to 40-degree angle off of the horizontal plane. This can be performed either from above or from below. I find it easier to accomplish this by performing the osteotomy from an angled orientation from below. In this case, a comminution of the bone of the radix may be created as opposed to a clean cut that is accomplished using the piezotome or saw. Even greater support of this area can be achieved by leaving the skin and periosteum attached to the bone. In this case, any comminuted bone segments are all left attached to the periosteum and keep the radix intact, not allowing the radix to drop. An additional way to avoid radix drop or the infantile radix, is more bone can be left under the bony hump as this will block the descent of the nasal bones and radix. However, enough bone should be removed to allow the hump to reduce.

Preventing the saddle nose deformity will depend on the specific technique used in the subdorsal septum. For example, if a high strip is used, the strips of cartilage can be removed sequentially to avoid excessive lowering of the supratip. If a subdorsal Z-flap is used, the caudal end of the Z-flap can be preserved leaving a continuity of support from the rhinion to the W-point. If a Tetris is used, the caudal cut of the flap can be adjusted anterior or posterior to set the position of the supratip. If a low strip is used, saddling can occur if too much cartilage is trimmed off of the undersurface of the quadrangular cartilage septal flap (QC flap). Saddling can also occur if the QC flap becomes dislodged from the attachment to the nasal spine. To prevent detachment, the connection should be on no tension and multiple sutures can be used to solidify the connection.

Deviation of the nose can be prevented by choosing the proper technique for the problem. For example, in cases with a severe septal deviation, the low strip is likely the best option for correction. It is important to avoid applying too much tension to the QC flap to prevent deformation of the septum and late deviating of the nose. In most low-strip cases, I will place a very thin plastic stent over the septum to aid in fixation and stabilization. This maneuver can also help prevent disruption of the connection between the spine and the QC flap.

Deviation can result when an intermediate-level septal flap such as the subdorsal Z-flap or Tetris is used to correct a deviated nose that involves more than a pure axis deviation. In these cases, the overlapping of the intermediate-level septal flap can improve the deviation but could shift other parts of the dorsum to create a crooked nose. To prevent this problem, a low strip swinging door maneuver can be performed to straighten the septum. Then a Z-flap or Tetris can be used to reduce the dorsal hump. In these cases, most of the straightening is accomplished by overlapping the septal flap on the side opposite the deviation. Instead of this approach, the low strip swinging maneuvers are used to straighten the deformity, and then the independent Z-flap or Tetris are performed just to reduce the dorsal convexity.

When using osteotomes to make the bone cuts, inevitably some comminution of the bones can occur. If the periosteum is left attached to the bones, the bone fragments will remain in the proper orientation.

Fortunately, nasal collapse is uncommon. In most of these cases, the septum was left distorted, weak, or overly reduced. For example, if too much tension is applied to the septal remnant at the nasal spine, the attachment can be compromised resulting in loss of tip and or supratip support.

Göksel

Complications such as residual hump, radix step, and supra-tip saddling occur in PR. Besides the correct indication for PR, understanding the techniques' biodynamics is the key to avoiding those unpleasant results. Consequently, releasing all the anatomic blocking points described by Göksel and colleagues[23] These points can potentially create intrinsic resistant tensile forces, impeding intraoperative dorsal lowering or allowing the osseocartilaginous framework to revert to its original height.

Moreover, adopting a sequential intraoperative approach would significantly reduce the risk of complications.

QUESTION 6. HOW HAVE YOUR TECHNIQUES IN THIS AREA CHANGED OVER THE LAST 2 YEARS?

Neves

Over the past 2 years, there has been a focus on stabilizing concepts previously developed and acquired, closely observing and reinforcing the best options, and understanding the reasons behind certain drawbacks. However, 2 areas have particularly gained prominence in this period: the implementation of the DAL split maneuver[21] and Tetris 3.

The introduction of DAL osteotomies, refined with burrs or Piezo, has enabled the operation on patients with PR who were previously considered absolute contraindications. Following these osteotomies, a new concept of lateral wall splitting has evolved, which avoids the need for LKA disarticulation (Ballerina maneuver), thereby achieving the same effect of dorsum flattening. The DAL split maneuver (**Fig. 9**) results in a flat dorsum, a narrowed bony dorsum, and enhanced definition of the DAL. Furthermore, an interesting advantage is observed when compared to LKA disarticulation. When impacting the bony wall during LKA disarticulation, it undergoes a posterior (deprojection) and cephalic movement. This cephalic movement creates the most significant blocking point in the bony wall at the region of the transverse osteotomy, necessitating an ostectomy at this level, commonly referred to as a banana ostectomy. By performing the DAL split maneuver, the movement of the sidewall follows the ULC to which it is still attached, resulting in posterior (deprojection) and caudal movements. This caudal movement effectively avoids the blocking points at the level of the transverse osteotomy.

Regarding Tetris 3, it defines itself as the amalgamation of 2 concepts that provide the best of both worlds: the precision of stabilizing the nasal dorsum with a subdorsal flap (Tetris flap) and the ability to correct nasal deviations with a low strip approach (SPAR B). SPAR B is a fantastic technique, with unique capabilities to correct deviations of the nasal pyramid and septum, which was the predominant technique I utilized at the beginning of my journey in PR. However, besides being a less forgiving technique—since loss of control can have more dramatic effects—it lacks precision in defining the new position of the nasal pyramid. Once the entire nasal septum and pyramid are mobilized, defining the new profile position heavily depends on the surgeon's experience, as the reference points are eliminated by this mobilization. Therefore, whenever possible, I prefer to perform the Tetris Concept, which, in contrast, maintains its reference points until the end, allowing me to control the degree of deprojection of the nasal dorsum meticulously. But, when there is a clear deviation of the perpendicular ethmoidal plate without its disarticulation from the nasal septum, I cannot achieve adequate mobilization for effective correction of the nasal pyramid and septum. Thus, Tetris 3 allows for the deprojection and precise aesthetic correction of the nasal dorsum and subsequently mobilizes the quadrangular cartilage freely after

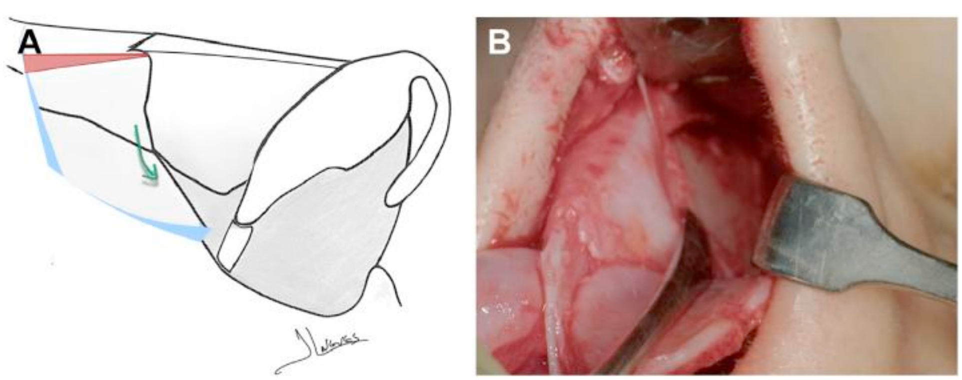

Fig. 9. (*A*) Dorsal Aesthetic Line (DAL) split maneuver. (*B*) A full-thickness DAL osteotomy is performed, enabling the sidewall to advance in conjunction with the ULCs. This maneuver flexes the dorsal profile and controls the width of the bony structure. (Image Courtesy: [*A*] Jose Carlos Neves.)

its disarticulation from the prependicular ethmoidal plate. This results in a *Full Release* of the quadrangular cartilage (see **Fig. 2**B).

A final note regarding my approach to the soft tissues and ligaments of the nose. I always perform a sub-areolar (supra-perichondrial) dissection across the entire extent of the nasal tip cartilages and the middle third of the nose, and a subperiosteal dissection of the upper third.[24] For septal dissection, I perform a sub-laminar (supra-perichondrial) dissection (see **Fig. 7**) on the quadrangular cartilage and a subperiosteal dissection on the bony septum.[20] Maintaining the perichondrium on all cartilages has proven to significantly increase the resistance and stability after suture placement. In the dissection of the midline at the nasal tip, I preserve the Fusion Sling (**Fig. 10**) connected with the cephalic margin of the lower lateral cartilages (LLCs) along their entire length, which will serve as the ultimate anchor for stabilizing the position of the nasal tip. The Fusion Sling, an embryologic structure that connects the cephalic border of the LLCs to their vicinity, consists of perichondrium-like material in the scroll and supra-tip regions and dense connective tissue fibers between the medial crura, intercrural fascia. This structure will be reconstructed in a hook shape over the Anterior Septal Angle, supporting and defining the position of the medial crura and consequently the nasal tip. Over the last 4 years, this has been my workhorse for stabilizing the nasal tip with exceptionally stable results. The vertical ligaments of the supra-tip (Pitanguy) and the scroll are re-sutured for enhanced definition of the supra-tip and supra-alar crease (**Fig. 11**).

Toriumi

Over the past 2 years, I have improved some of the existing techniques with relatively minor adjustments. One of the biggest changes was the change I made in how I performed the lateral bone strip removal. When I started in June of 2019, I began using foundation techniques in the form of a push-down in combination with a push-down with bilateral lateral osteotomies. I then shifted to using a letdown using a 3 mm osteotome to make a high and low bone cut on the ascending process of the maxilla, then removing the banana-shaped bone strip (**Fig. 12**). I then shifted to using a Cerkes narrow rongeur (Marina Medical Inc., Davie, Fla.) to remove the lateral bone strips. Using the narrow rongeur, I tended to leave a narrower gap at the junction between the lateral bone strip and the transverse bone cut. This resulted in a corner at the junction between the 2 bone cuts and left a blocking point at that junction. This resulted in some residual dorsal humps. I then shifted back to using the 3 mm osteotome to make the high and low bone cuts and removing the intervening banana-shaped bone strip that removed the corner between the lateral bone strip removal and the transverse bone cut.

Fig. 10. The Fusion Sling. The sling that connects the cephalic border of the lower lateral cartilages to the adjacent structures. It is formed during the embryologic merging process of the lateral placodes. (Image credits: Kaminskyi team.)

It can be difficult to pass a 3 mm osteotome high and low precisely and then remove the banana-shaped bone strip. This is why I developed the Toriumi banana bone strip osteotome/gouge. Using this right and left-sided instrument, I can easily remove the bone strips along the ascending process of the maxilla.

Another change in the past 3 years is the introduction of the “push-up” for management of the saddle nose deformity and also for dorsal augmentation.[5,17] Working with Milos Kovacevic, we developed a technique that we used to correct the saddle nose deformity by placing a costal cartilage graft under the middle vault after releasing the lateral keystone and piriform ligaments, then pushing up the middle vault to correct the saddle nose deformity. Initially, spreader grafts were used to push up the middle vault.[17] This was accomplished by performing a high strip release of the septum from the ULCs. The spreader grafts were sutured to the septum to push up the middle vault.

Then I further developed the push up concept to incorporate a subdorsal cantilever graft.[5] This costal cartilage graft was modified into the subdorsal cantilever graft type A and the subdorsal cantilever graft type B.[5] The subdorsal cantilever graft type A was used to raise the dorsum with little to no effect on the position of the radix. After completing the high subdorsal incision and extending this to a notch made in the bone under the bony dorsum, this graft is advanced into the notch made under the nasal bones that is then extended caudally to integrate with a caudal septal extension graft. This graft was ideal in patients

Fig. 11. Clinical case: 2.5-year follow-up. (*A–D*) The patient presented with a slight axis deviation, a dorsal hump, and a ptotic tip, making this a suitable case for dorsal preservation rhinoplasty. I performed a septoplasty and a subdorsal Tetris Flap to center the nose and flattened the dorsum; let down with rhinosculpting with cylindrical drill. The tip was stabilized using Fusion Sling fixation and an anterior nasal septal angle (ANSA) Banner.

who need primarily elevation of the middle vault and caudal nasal bones and worked well for the saddle nose deformity and Asian patients who do not desire to have their radix elevated.

The subdorsal cantilever graft type B, is a longer costal cartilage graft that extends through a radix bone cut after the entire bony vault is freed up by performing radix, transverse and lateral osteotomies with a lateral keystone release and division of the piriform ligaments (**Fig. 13**). This graft is more complex and has a tongue of cartilage that extends through the radix osteotomy site and integrates with the caudal septal extension graft below. This graft must be very rigid and preferably partially calcified to hold up the entire dorsum. The graft has a convexity where it sits under the middle vault to adequately push up the ULCs. The graft is fixed to the nasal bones to prevent caudal migration of the graft.

Another change made in the past couple of years is the use of dorsal preservation in the acute nasal trauma patient. In this setting, dorsal preservation techniques such as the low strip, subdorsal Z-flap, or Tetris are used to treat deviations of the septum and nose early after nasal trauma. The advantages of this use of dorsal preservation are that

Fig. 12. Banana shaped bone strip removed from the ascending process of the maxilla to allow the bony hump to reduce.

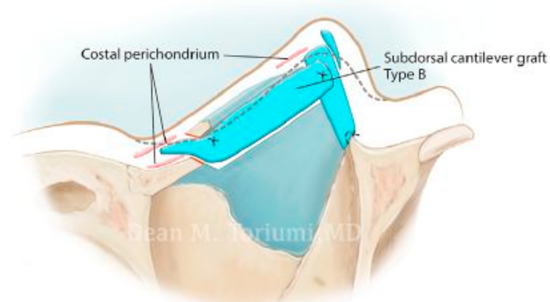

Fig. 13. Subdorsal cantilever graft type B extending through the radix bone cut to sit on the frontal bone and also fixated to the caudal septal extension graft caudally.

it is more effective in correcting the septal deviation and nasal deviation than using an open or closed reduction of the nasal fracture. Care must be taken when using dorsal preservation in the acute nasal fracture as it is possible to lose control of the septal support if a severe septal fracture is present. Therefore, the surgeon must be experienced in using structural techniques such as subtotal septal reconstruction and extracorporeal septoplasty. Additionally, the surgeon should be experienced in using costal cartilage grafting in rhinoplasty.

If the nasal support is lost at any time, a subdorsal cantilever graft can be used to complete the reconstruction and reestablish septal support. If complete nasal septal support is lost, a subdorsal cantilever graft type B can be used to set radix position and support the lower two-thirds of the nose as the L-strut support is reestablished with the subdorsal cantilever graft sitting on the frontal bone and the inferior edge of the graft is integrated with a caudal septal replacement graft that is fixed to the nasal spine.

Jose Carlos Neves has introduced the combination therapy using the low strip in combination with the Tetris to correct a deviated nose with a septal deviation (Jose Carlos Neves, personal communication). In this technique, the low strip swinging door is used to straighten the septum and straighten the nose. Then he used the Tetris to reduce the dorsal hump. The advantage of this approach is that there is no need to perform the overlapping of the Tetris flap as this can create some intrinsic deviations in the nose. As an extension of this Neves concept, I have started using the subdorsal Z-flap in combination with the low strip swinging door for the same reasons.

I have also developed a "reverse" subdorsal Z-flap that is oriented with the vertical limb at the supratip area to reduce prominent supratip convexities.

The incorporation of dorsal preservation into my practice has evolved over the past 5 years and now is used in most of my primary rhinoplasties. The incorporation of dorsal preservation has resulted in shortening of the operation and having more cartilage for structural grafting of the nasal tip.

I have also recently starting performing PR via the endonasal approach. This approach involves using the polygon tip concepts of Baris Cakir with preservation of the Pitanguy ligament and scroll ligaments to better control tip projection and supratip contour.[25,26,27] These changes are dramatic shifts from the purely open structural approach that I have used for over 35 years.

Göksel

Over the past few years, I shifted from an open to a closed approach to PR in most cases. Conservation of the SSTE and its ligamentous attachments to the osseocartilaginous framework has gained paramount importance in my practice. The game changer for me was the Ballerina maneuver that I have previously described, as it solved the dorsal widening and the hump recurrence.

I mainly performed a high-septal strip at the beginning of my PR journey. However, I changed to a low-septal strip for a crooked nose. In this case, the direction of the nose needs to be changed,

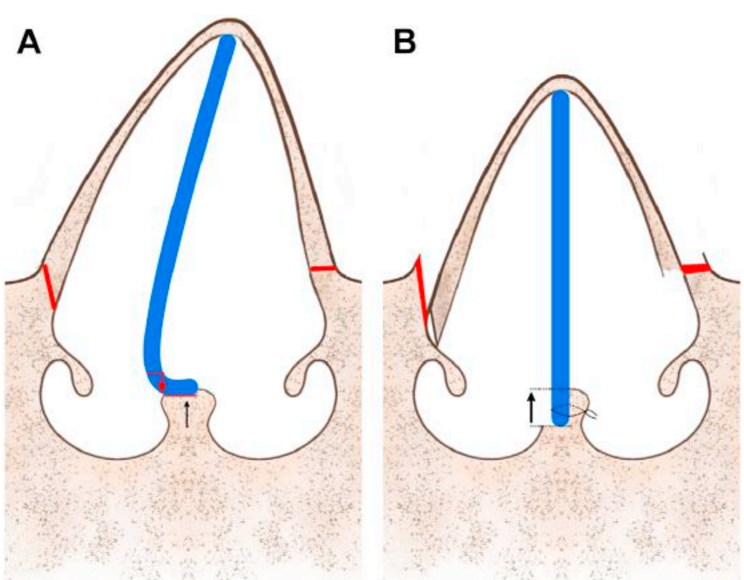

Fig. 14. The red arrow represents the height of the low septal excision, while the black arrow refers to the anterior nasal spine (ANS). The red lines represent the lateral osteotomies in different orientations (sagittal on the right nasal bone and horizontal on the left side) (*A*) It shows a deviated nasal axis with nasal bones of different lengths between the 2 sides besides basal septal pathology. (*B*) Shows how the septum overlaps with the ANS side by side, which is why we should count the height of the ANS in our excision.

and this is possible only through the separation of the attachment between the quadrangular cartilage and the perpendicular plate, which is hard to achieve in the high-septal strip technique.

Regarding the low septal strip excision, my resection measured the exact height I anticipated as a dorsal reduction and was timed just before closing the incision. Meanwhile, I am removing a thinner strip to avoid the supra-tip area depression. Moreover, I am considering the height of the ANS in my calculation of the magnitude of the strip excision as the septum would eventually need to be sited on the side of it in a side-to-side fashion to correct the nose deviation from the midline (**Fig. 14**).

I used the convex nasal bones only to rasp the bone; however, beneath the nasal bone, there is a corresponding upper lateral cartilage shoulder that I started to trim.

CLINICS CARE POINTS

- If an S-shaped dorsal hump is treated, typically the bony cap needs to be altered. Bony cap reduction can be performed using one of many techniques.
- An angled radix osteotomy can help to prevent radix drop and an infantile dorsum.
- Managing blocking points are important to prevent dorsal hump persistence or recurrence.

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Original Article

Avoiding Aesthetic Drawbacks and Stigmata in Dorsal Line Preservation Rhinoplasty

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Abstract

For over a century, discussion on the management of nasal dorsum has been a struggle between the techniques of resection and preservation. This is because, each technique has its advantages and disadvantages, with the Joseph technique dominating over the past 30 years despite its surgical stigmas. The dorsum preservation techniques offers a good option for the treatment of nasal hump but like resective techniques it has its drawbacks. This may be the reason why preservation techniques withered but are now making a resurgence. The aim of this article is to describe how to avoid the aesthetic drawbacks of this technique depending on the selected approach.

Keywords
- rhinoplasty
- preservation
- Tetris concept
- segmental preservation

For many years, a number of surgeons have pursued the goal of modifying the aesthetics of the nose while preserving the dorsal structure of the nasal pyramid. Starting with Goodale[1] in the 19th century, the sum of new ideas during the next century was insufficient to revolutionize the mainstream world of rhinoplasty. Lothrop,[2] Cottle,[3,4] Huizing,[5] and Gola[6–8] are all examples of those who contributed tremendously to the development of the concept.

Traditionally associated with closed approach rhinoplasty, the new era of the open approach and the excitement it provoked around the world was an obstacle, while in most cases and for many years conservative maneuvers provoked little interest due to being visually unexciting. Knights like Wilson Dewes, Fausto López-Infante, and Yves Saban kept the philosophy alive and inspired many surgeons to start a new chapter.

Like any other surgical technique, dorsal conservative rhinoplasty has its indications and limitations. In this article, we focus on our personal strategies to avoid some of the drawbacks and *stigmata* of the dorsal line preservation rhinoplasty.

Common Drawbacks in Dorsal Line Preservation Rhinoplasty

Even though for some surgeons deprojectioning the nasal profile without touching the dorsal line structure was a conceptual revolution, for others, living in their natural habitat of preservation, the challenge was achieving better results in a predictable and consistent way.[8–20]

At the start, the excitement of performing the *push-down maneuver* (the deprojection maneuver) revealed some fragilities of the technique when not appropriately executed, resulting in very low radix or entire nasal dorsum, with residual dorsal hump or supratip saddling. It is essential to understand the mechanical process of the technique in a tridimensional fashion and choose the right patient to achieve the best result.

Aesthetic drawbacks and *stigmata* seen in dorsal line preservation rhinoplasty, both in profile and frontal views, as well as functional issues are listed below and discussed (►**Table 1**).

Profile Drawbacks

Residual Hump or Hump Recurrence

The ideal scenario for a pyramid *push-down/let-down maneuver* is a high flat tension nose. When we face a convex dorsal profile that needs to be flattened, several considerations need to be taken into account to avoid a residual hump or other *stigmata* postoperatively.

To some extent the definition of residual hump depends on the eye of the beholder. Sometimes results are shown and

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Table 1 Drawbacks and stigmata

Profile view drawbacks and stigmata
Hump recurrence
Radix step
Low nasal radix and dorsum
Supratip saddling
Frontal view drawbacks
Pyramid lateralization
Pyramid broadening
Functional impairment
Blockage associated with push-down (bone impaction)
Blockage associated with LKA disarticulation

Abbreviation: LKA, lateral Keystone area.

described as having no hump where it is possible to see a residual convexity and based on that some surgeons admit to <5% of residual hump while others 15%.[21–23] Though one may regard a small hump as natural, it is important to achieve a result planned at preoperative consultation, flat or slightly convex.

In smaller convexities, pushing the pyramid down and hiding a possible radix step below the thick-soft tissues may be a good strategy for producing a flattened profile. We prefer to avoid radix steps, except when the radix is high and bringing it down is part of the surgical strategy. So, routinely we employ additional maneuvers that philosophically question whether we are actually performing real preservation surgery, once we disrupt structures in the foundation of the nasal pyramid.

We consider three aspects to obtain an ideal profile: (1) accurate and predictable deprojection; (2) dorsal line flattening movement; (3) stability of the final position avoiding relapses (►**Fig. 1**).

Let-Down Technique

While the lateral wall can be approached using the push-down technique (PDO) or the let-down technique (LDO)[24,25] (►**Fig. 2A, B**), we prefer the LDO since it allows a good pyramid mobilization avoiding bone impaction into the nasal cavity and consequently the benefits of not impinging on nasal airway.

The precision of the wedge resection in LDO has no impact on pyramid stabilization or the final profile position, as the septal wall is the guiding structure dictating the final result. Even if we excise a wedge of bone matching the exact amount of dorsal height deprojection, the two borders of bone are not in contact as the remaining bony pyramid is narrower than the basal bony structure, with the possible contact happening exclusively in the cephalic end. Any gap in the bony continuity left after the pyramid is adjusted to the new position will be filled by neo-osteogenesis, because of the periosteal preservation (►**Fig. 3**).

Splitting the Three Walls

In low and intermediate strip approaches, the septal wall ideally must be split at the level of the most prominent point of the hump, generally caudal to the rhinion (almost always is septal cartilage that we have to resect), in order to create the necessary movement to correct the convex profile. To be effective when stretching the dorsal convexity, the mid wall should have two pillars (at caudal and a cephalic end of the

Fig. 1 (**A, B**) A low strip push-down approach was performed. A residual hump and a minor supratip saddling.

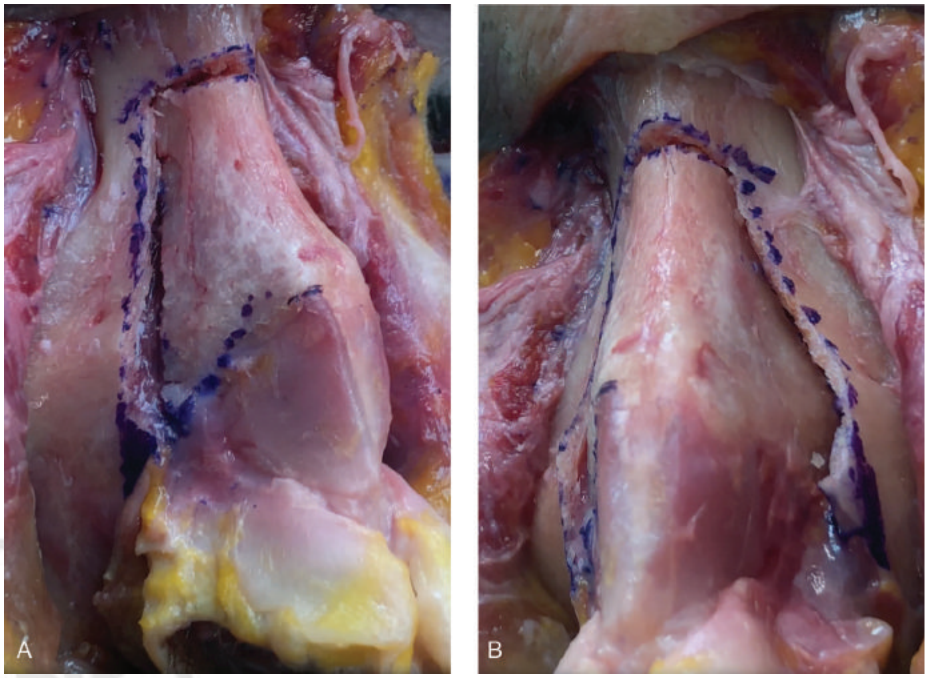

Fig. 2 Cadaveric study showing a let-down technique (**A**) at the right side (with no bone impaction into the nasal cavity) and a push-down technique (**B**) at the right side (where the impaction is visible).

curve) supporting the forces imposed in between them, over the splitting point. It works like the splits (►**Fig. 4**).

The lateral wall should follow the same concept. In most of our cases we perform the lateral K stone area (LKA) disarticulation (►**Figs. 3** and **5**), which creates a lateral split and allows for a sliding movement of the cartilaginous structure in an anterior and caudal vector.[26–28] The more the distance from the dorsal line the more the limitation in the movements that the pyriform ligament and upper lateral cartilage (ULC) lateral bony wall cause. The lateral wall will work as a

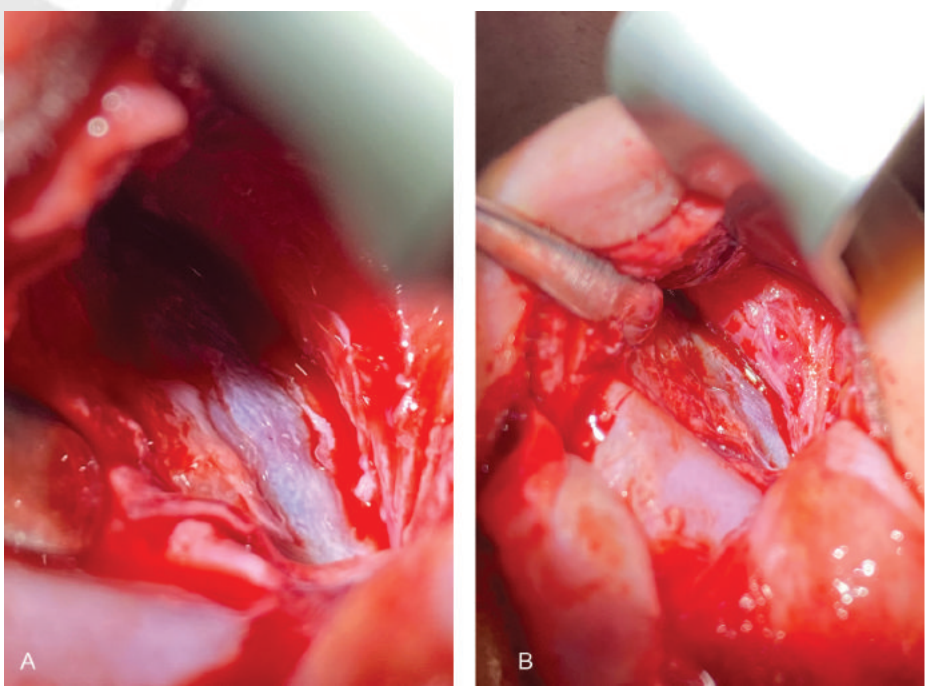

Fig. 3 One-year postoperative revision case; a let down technique was performed. (**A**) New bone in the gap created is seen, thinner and whiter. (**B**) An LKA disarticulation was performed in the previous surgery. Note the normal continuity and stability in between the UL and the bony wall. LKA, lateral Keystone area.

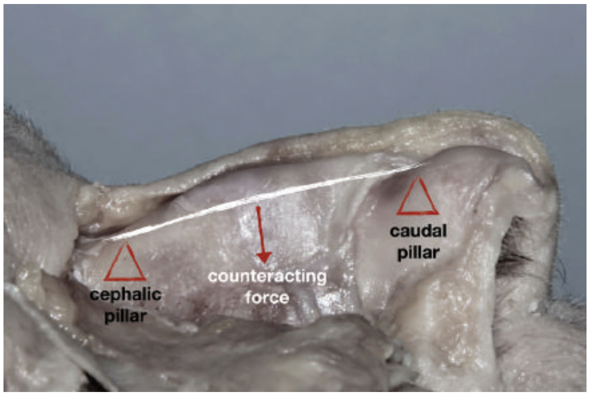

Fig. 4 Two stable pillars must be preserved, one cephalic at the radix area, another one caudal at the supratip region. A force that counteracts the spring effect responsible for hump recurrency is paramount to predict accuracy and stability.

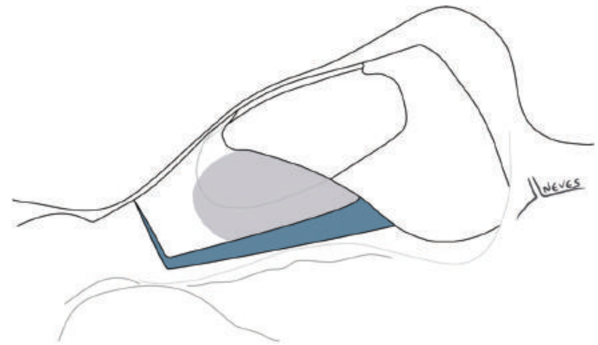

Fig. 5 Let-down technique (blue). The gray shadow represents the periosteal elevation area after releasing the pyriform ligament from the pyriform aperture.

facilitator for defining the final dorsal profile that follows the septal work.

Subrhinion Stabilization

The spring effect has its maximum force vector at the highest point of the hump. To counter this phenomenon, we preserve a piece of cartilage attached to the pyramid below the most prominent point of the hump that will be anchored with PDS sutures to a stable basal segment of the septum. That means we are performing an intermediate approach or eventually a partial intermediate approach, as in the Tetris concept[29,30] (►**Fig. 6**).

In the low approach the probability of relapsing and having a residual hump is greater. All the mobile pyramid is stabilized to the anterior nasal spine region. A stretching effect of the hump is produced by the caudal and anterior rotational movement that flattens the hump. However, the spring effect is not directly counterbalanced. Even if it is not possible to be as effective as the parallel opposite sutures previously described, we use two or three oblique sutures to the spring effect vector to achieve stabilization of the cartilaginous vault (►**Fig. 7**).

In the high approach a transdorsal suture can be placed, passing over the cartilaginous pyramid and stabilizing it to the basal septum.

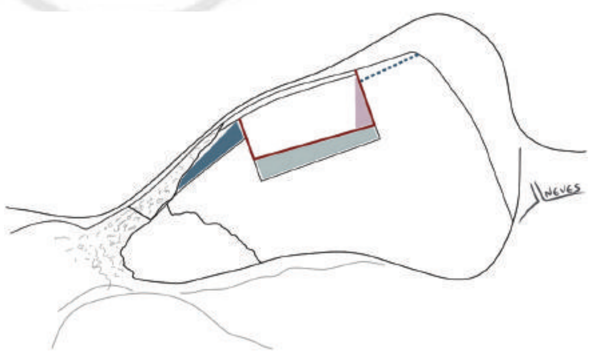

Fig. 6 The Tetris Concept. A 5 to 8 mm height block is designed in between the WASA and the dorsal hump most prominent point (red line); a trapezoid figure is drawn below the block, it represents the amount of hump to be reduced (gray trapezoid); a triangular figure is drawn below the bone pyramid, from the block till the lateral wall transverse osteotomy level to facilitate the push-down movement (blue triangle); to avoid overlapping the caudal aspect of the Tetris block with the natural caudal septal strut we trim a triangular portion of the block cartilage (purple triangle); to adjust the new dorsal profile level a trimming of the anterior border of the caudal septal strut must be performed (blue dots). WASA, area between the cuadal portion of the upper lateral cartilage and the anterior septal angle.

Reshaping the Residual Bony Hump

In dorsal preservation rhinoplasty the analysis of the osseous upper third is paramount. The concept of *S*-shaped and *V*-shaped nasal bones introduced by Lazovic et al[30] is being discussed as a guide for the best indications for full dorsal preservation techniques, with the *V* shape being the best scenario since it will produce a smooth transition to the dorsal cartilaginous surface.

The *S*-shaped nasal bones can promote the appearance of an osseous residual hump that represents a potential *stigma* of the dorsal conservative procedures. After the deprojection maneuver is performed the appearance of this residual hump may be unnoticed during surgery, therefore refinement maneuvers may have to be considered.

Depending on the approach rasps, burs or piezotome may be used. We prefer cylindric burrs to create smooth surfaces and transitions (►**Fig. 8**). The bony cap will be reshaped to the desired level obtaining the ideal profile line, as well as the lateral walls and the nasofacial groove.

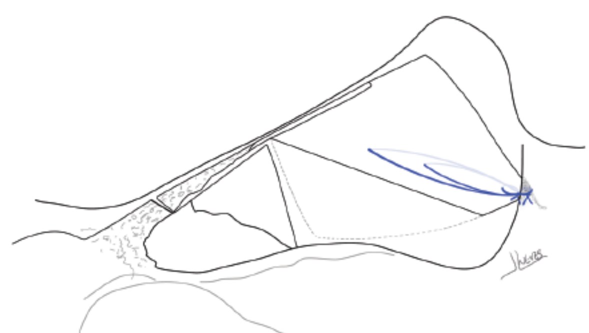

Fig. 7 In a low approach two or three oblique sutures to the spring effect vector are placed to achieve stabilization of the final profile line avoiding recurrences of the hump.

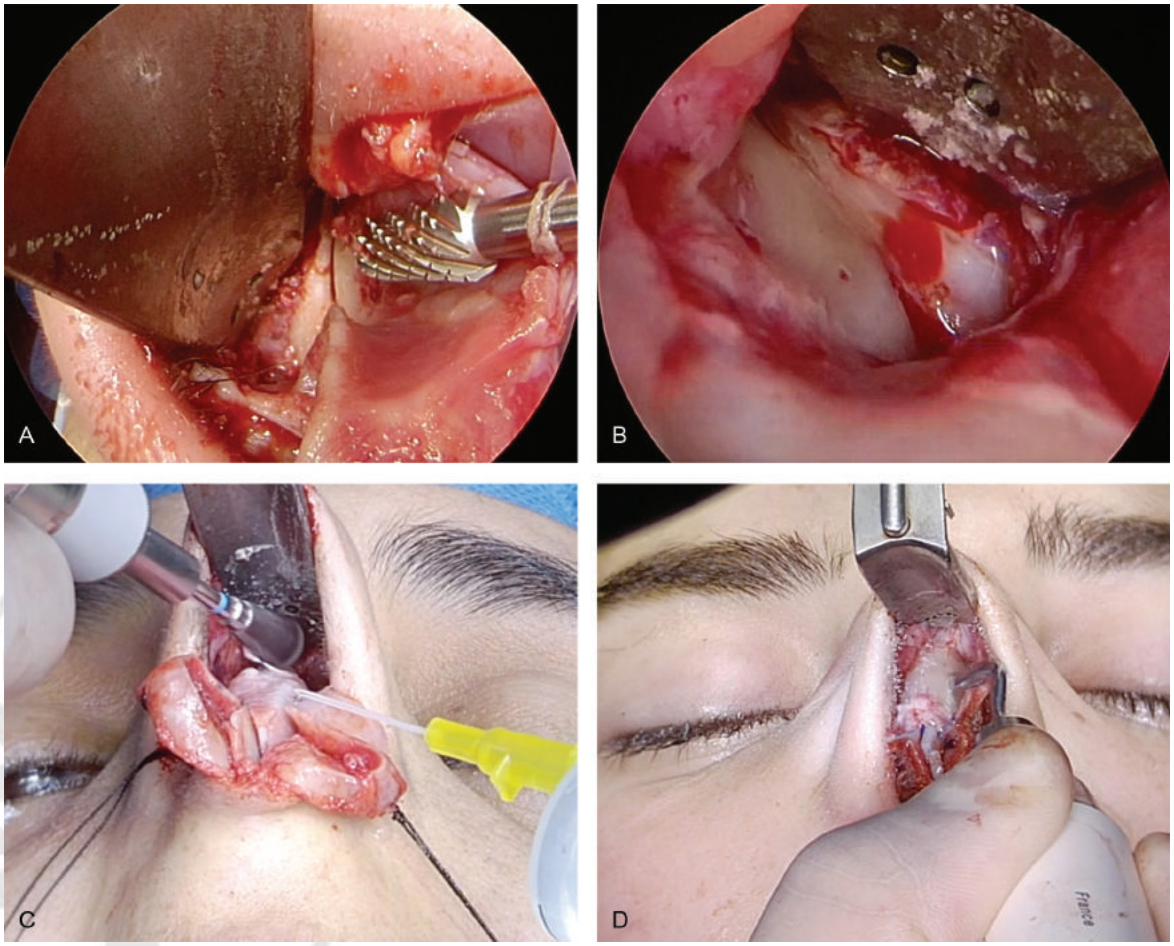

Fig. 8 Refinements in dorsal preservation rhinoplasty. (**A**) A step at the right nasofacial groove can be seen; a cylindrical burr will be used; (**B**) Smooth transition at the left nasofacial groove after it has been corrected; (**C**) Sculpting S-shaped nasal bones; (**D**) Paramedian osteotomies with an ultrasound device to narrow the bony vault.

Reshaping the Residual Cartilaginous Hump

The cartilaginous hump can show an intrinsic convexity exhibiting: (1) a residual localized cartilaginous hump (caudal hump greater than the original) and (2) depression at the caudal end of the cartilaginous profile (►**Fig. 9**).

Controlling the convex arch of the cartilaginous line follows the same principles as used on the septum to control the nasal hump. The cartilaginous septum is split midway of the arch to achieve flatness. This can be done by splitting the quadrangular cartilage into a strategic line. The segmental preservation concept considers the possibility of splitting the *Tetris* block (►**Fig. 10**) and so designing a flattened or eventual concave curve. Moreover, by preserving a natural caudal septal strut (in between the anterior nasal septal angle and W point) it allows us to precisely design the supratip area and avoid eventual saddling.

Radix Position Control

Periosteum Dissection

Subperiosteal dissection is the best way to address the upper third of the nose. However, in dorsal preservation rhinoplasty the soft tissues over the radix may be left untouched, completely or partially thus acting as a tent to support an eventual descent of the pyramid at the level of the transverse osteotomies.

Transverse Osteotomies

Location of transverse osteotomies is crucial. From the level of the medial canthal tendon a line is marked that goes superiorly in an oblique fashion reaching the radix in a more cephalic position, where the radix is deepest from skin surface. This serves to camouflage step deformity should it occur (►**Fig. 11**).

Routinely, two lateral percutaneous osteotomies follow the drawn line and leave a fragment of bone in the midpoint to facilitate the greenstick fracture and spare a periosteal stripe. If a midline osteotomy is needed (best avoided in most cases), the osteotome must be placed obliquely to obtain two oblique line fractures that support the free pyramid and protect it from collapse.

Septal Wall Work

With the pyramid free, the support for the bony pyramid entirely comes from the septum. The lateral wall in LDO acts as a facilitator. At this point, the convex pyramidal arch is

Fig. 9 (A, B) A residual cartilaginous convexity can be seen postoperatively. A full intermediate approach was used with subrhinion stabilization. A cartilaginous split would have helped flattening the cartilaginous profile.

supported by at least two stable pillars, one at the radix, caudal to the transverse osteotomies (cephalic pillar), the other at septal angle (►**Fig. 4**).

Depending on how the septal segment below the bony vault is addressed the radix keeps its original position, goes up or down. It has both cartilaginous element (the quadrangular cartilage) and osseous one (the perpendicular ethmoidal plate). In most cases, the cartilaginous component is predominant.

Preserving a piece of perpendicular plate below the bony dorsum (extending caudal to the transverse osteotomies) gives the necessary nasal pyramid support and avoids collapse and radix step.

In most cases, cartilaginous septum is trimmed precisely with sharp, slightly curved scissors, to avoid cartilage shearing. Large instruments like rongeurs are best avoided. Technically, the scissors are inserted convex side up, tangentially to the inner surface of the nasal vault from the splitting point to the transverse osteotomy point. This will free the nasal pyramid from the septum. Then, small triangles are excised using the scissors with concavity looking up and adjusting the ideal profile. At this point, different options include:

1. *Keeping the radix at the same level*: The exact amount of septal excess is resected and the pyramid rests completely on the septum or only a cephalic stable portion of PEP is

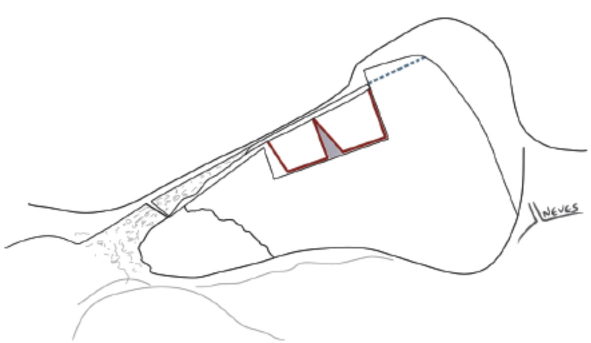

Fig. 10 The split Tetris concept. Splitting the Tetris block (red lines) allows the cartilaginous segment to flatten or eventually to become concave. The wider the gray triangle the more concave this segment will be.

Fig. 11 Anterior and cephalic line to perform a transcutaneous transverse osteotomy.

Fig. 12 Let down technique with perpendicular ethomoidal plate control bringing the radix down to a pleasant level.

preserved working as a true pillar for the pyramid stability, allowing extensive septoplasty.

2. *Creating a step-down*: As already mentioned, the transverse osteotomies can be performed strategically where an eventual step-down is camouflaged by the overlying thick-soft tissues, promoting a bony step-down not visible in profile. When the radix is high and the nose appears to start at eyebrow level, it is possible to create a lower starting point by bringing the radix area down. The septal supportive point of the pyramid is resected incrementally until the profile reaches the desired level (►**Fig. 12**). This is a delicate maneuver that requires an accurate cut of the septum, especially at perpendicular ethmoidal plate. If resected excessively free pyramid can collapse with disastrous results that must be compensated with grafts (►**Fig. 13**).
3. *Creating a step-up*: Preservation technique is not suited for low radix patients. However, when radix position is controlled as already explained, one can achieve to lift the radix using step-up technique: when approaching the septum, we define a pivotal point where the pyramid remains at the same position. Caudal to it the pyramid is

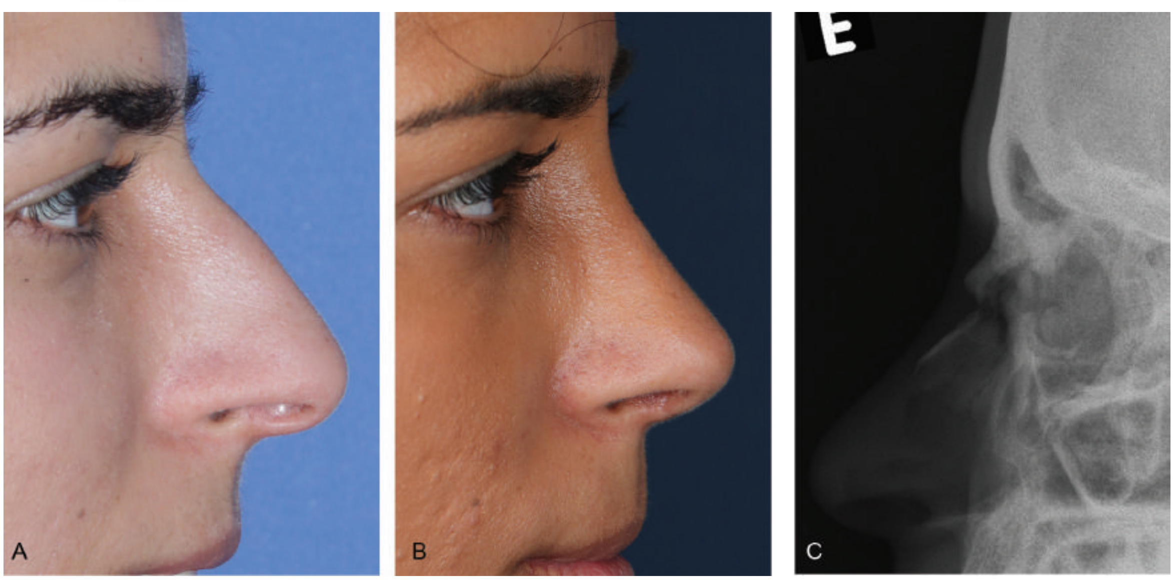

Fig. 13 (**A, B**) Let down technique with loss of perpendicular ethomoidal plate control creating a low radix of the nose, that were partially compensated with grafts. (**C**) The Rx image shows the loss of control of the patient's pyramid.

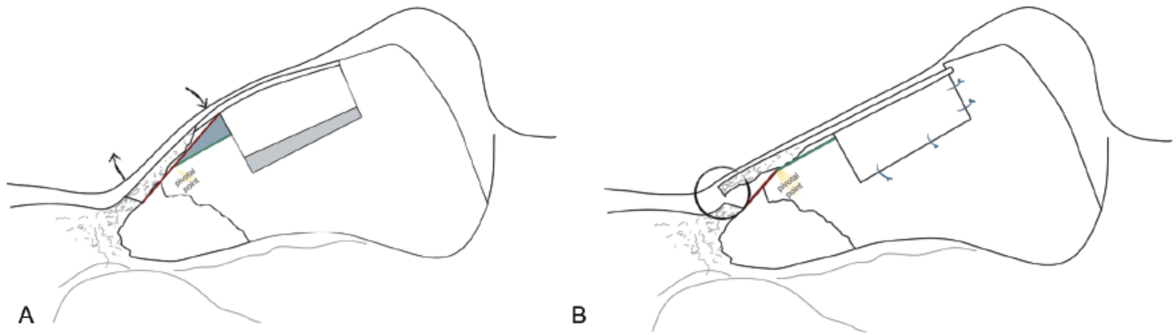

Fig. 14 (**A**) A pivotal point where the pyramid remains at the same position is designed. (**B**) Caudal to the pivotal point the pyramid is pushed down; cephalic to it the pyramid goes up, creating the desired radix step-up.

pushed down and cephalic to it the pyramid goes up, creating the desired radix step-up. After defining the pivotal point, a predefined triangular piece of septum is trimmed caudal to the pivot. This triangular space allows for the deprojection maneuver, and the free pyramid cephalic to the pivot goes up (►**Figs. 14** and **15**).

Supratip Position Control

The supratip saddling is a common drawback and *stigma* especially in low approach preservation rhinoplasty. The main reasons for this are: (1) inability to correct the dorsal convexity, leading to a profile that curves to a low supratip area, (2) poor control of the septal height when resecting septal cartilage excess, (3) poor fixation of the new position of the septum to the anterior nasal spine. Based on the above factors, supratip position should be defined carefully.

Supratip over resection is avoided in the high strip[21] and the partial intermediate approach by sparing a natural caudal strut that can be trimmed as desired. This also aids in designing precise profile of this segment.

In the low approach, an excess of septal resection at the supratip line must be avoided to prevent saddling. Height measurements are taken with septal rotational movement and sutured securely. If anchorage of the septum to the anterior nasal spine is deficient, some posterior and cephalic movement may lead to a supratip depression and hump recurrence. In Septum Pyramidal Adjustment and Repositioning (SPAR) concept and when possible, Dewes developed a strategy to retain a stripe of basal septum, especially at the anterior nasal spine, to stabilize more easily and effectively.[32,33]

Pyramid Lateralization

Apart from hump recurrence, pyramid lateralization is probably the most common reason for revision. With good septal stabilization, in deviated noses, the longer wall is approached by LDO and the shorter with PDO. Alternative is LDO

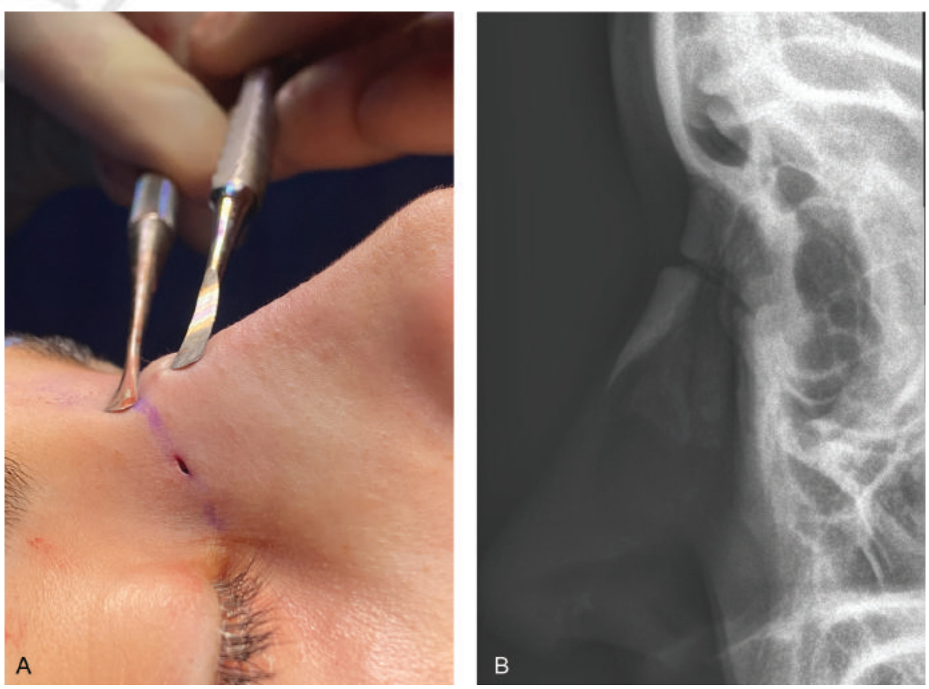

Fig. 15 (**A**) The bony elevation created by the step-up technique. (**B**) Postoperative X-ray showing the step-up.

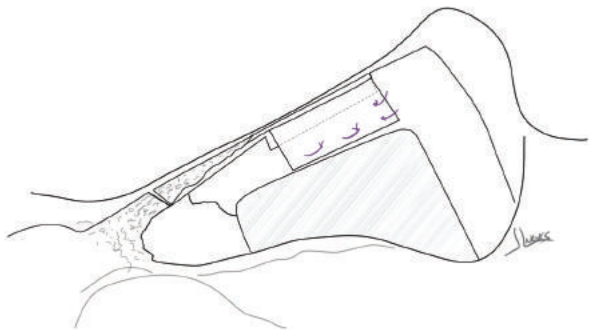

Fig. 16 The lateral Tetris concept in deviated pyramids. When performing the procedure in deviated pyramids it is indicated that there would be no slot creation below the Tetris block (red line) and consequently no trapezoid resection as seen in previous demonstrations; the block will suture to the stable septum in the opposite site of the deviation for compensation. The grey grid represents the septal harvesting leaving a stable *L*-shaped septum after suturing the Tetris block.

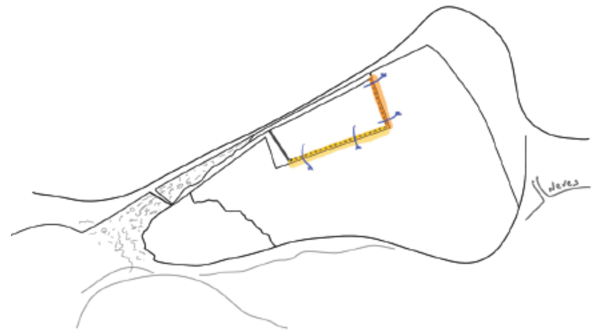

Fig. 17 Two axis stabilization. The posterior border of the block (yellow) avoids oblique axial-coronal tilting (mainly axial). The caudal border of the block (orange) avoids oblique coronal-axial tilting (mainly coronal).

technique allowing pyramid movement on both sides facilitating repositioning.

The low approach techniques (Cottle or SPAR) are the best indications for the treatment of deviated noses that need a complete septoplasty and a septal repositioning. The "lateral Tetris,"[29,30] which is a partial intermediate approach, overlaps the free septal cartilage at the opposite side of the deviation and compensates for smaller pyramid lateralization (►**Fig. 16**).

The worst scenario is converting a straight nose to a deviated pyramid. To avoid this, lateral wall should be free to move but the septum should be fixed firmly. Even in a straight structure conflict at the inner concavity of the vault can be seen at the septal wall. When the triangular piece of the septal wall is removed below the bony vault, it is common to see a residual septum coming from the concave roof, which is sometimes difficult to remove completely, and especially at the perpendicular ethmoidal plate. During the deprojection maneuver, this residual septum may assume a side-to-side position with the basal septum and deviates the nasal axis, especially at the radix level. For this reason, accurate reduction and fixation is important. A definite advantage of designing the Tetris block is the two-axis stabilization in straight septum, by blocking cephalic-caudal and anterior–posterior vector movements (►**Fig. 17**).

Broad Pyramids and Mid Third Broadening

Broad nasal pyramids and irregular dorsum surfaces are generally contraindications for dorsal preservation rhinoplasty. Broad cartilaginous vault particularly at its cephalic portion is a prime example.

Bony Pyramid

Having the pyramid set in its new intended position, refinements such as sculpting and thinning the pyramidal bone are done. A partial paramedian osteotomy (using an ultrasonic device) may be placed at the dorsal aesthetic lines to reduce the width (►**Fig. 8**).

Cartilaginous Pyramid

During the deprojection maneuver, the cartilaginous mid third tends to widen. This can be advantageous as it opens the internal valve but has aesthetic drawback. It can be avoided dissecting the LKA and liberating the lateral wall for a free anterior to posterior movement of the ULC. Care must be taken to avoid central key stone area disarticulation.

Discussion

We analyzed 100 consecutive cases operated with dorsal preservation rhinoplasty following the surgical concepts previously described to evaluate eventual drawbacks. The following were inclusion criteria: primary rhinoplasty, full dorsal preservation concepts, no grafts over the dorsum, and minimum 3 months follow-up. Postoperative analyses were restricted to nasal dorsum only. Tip issues and revisions were excluded.

Three different approaches were used in the patients: (1) Tetris concept—in straight tension and kyphotic noses (51 patients), (2) Lateral Tetris, in minor pyramid lateralization with convex profile (30 patients), (3) modified SPAR B (low strip approach), for severe lateralization and more extensive septoplasties (19 patients). The results are tabulated below (►**Table 2**)

When assessing drawbacks on profile and frontal views, strict criteria were followed to avoid bias (such as a mild hump). In the profile view, any deviation from the ideal straight profile line was considered a drawback (even with minimal or no impact on aesthetic outcome) and in the frontal view minimal pyramidal deviation was considered a drawback.

Residual humps and hump recurrences were seen in seven patients (36.9%) in the Modified SPAR B, 3 with a minimal convexity of the profile, three with acceptable smooth convexity and only one patient (5.2%) with indication for revision. In the Tetris approach no residual global convexity was identified but four patients (4.9%) showed a residual bony hump, due to the stability of the cartilaginous vault based on the subrhinion suture but can show a kyphotic bone that was not ideally reshaped.

Radix steps were not relevant in the Tetris concept (one case, 1.2%) but were palpable and slightly visible in 15.7%

Table 2 Dorsal preservation rhinoplasty approaches and eventual drawbacks

	Tetris concept		Lateral Tetris concept		Modified SPAR B		Total	
Number of surgeries	**51**		**30**		**19**		**100**	
Residual hump	**5**	9.8%	**1**	3.3%	**4**	21.0%	**10**	10.0%
Rhinion	**0**	0	**0**	0	**3**	15.7%	**3**	3.0%
Bony hump	**3**	5.8%	**1**	3.3%	**1**	5.2%	**5**	5.0%
Cartilaginous hump	**2**	3.9%	**0**	0	**0**	0	**2**	2.0%
Hump recurrence	**1**	1.9%	**0**	0	**3**	15.7%	**4**	4.0%
Rhinion depression	**3**	5.8%	**1**	3.3%	**0**	0	**4**	4.0%
Radix step	**0**	0	**1**	3.3%	**3**	15.7%	**4**	4.0%
Nasal infantilization	**0**	0	**0**	0	**1**	5.2%	**1**	1.0%
Supratip saddling	**0**	0	**0**	0	**0**	0	**0**	0
Pyramid lateralization	**1**	1.9%	**2**	6.7%	**5**	26.3%	**8**	8.0%
Pyramid broadening	**0**	0	**2**	6.7%	**1**	5.2%	**3**	3.0%
Upper third	**0**	0	**2**	6.7%	**1**	5.2%	**3**	3.0%
Mid third	**0**	0	**0**	0	**0**	0	**0**	0
Patients with any kind of remark	**7**	13.7%	**4**	13.3%	**9**	47.3%	**20**	20.0%
Patients for revision	**2**	3.9%	**1**	3.3%	**1**	5.2%	**4**	4.0%

Abbreviation: SPAR, Septum Pyramidal Adjustment and Repositioning.

(three patients) in the Modified SPAR. When performing an extensive septoplasty, the perpendicular ethmoidal plate can lose stability leading to the lack of support of radix pillar, thought of promoting the radix step.

The same occurs when analyzing pyramid lateralization. The "lateral Tetris" was indicated in tilted noses, while the SPAR B was indicated in more complex cases with deviation. Five patients, (26.3%) showed some degree of deviation from the central axis, even if all of them showed a great improvement of the initial condition. Four of these patients were very satisfied with the minimal lateralization; one patient was indicated for surgery. The same patient also had hump recurrency, being part of the seven previously discussed patients with hump recurrence. One case of the Tetris concept performed in a straight nose developed a full pyramid deviation. New osteotomies and repositioning were performed in a very conservative fashion.

Nasal mid third broadening was never an issue, justified by the constant realization of an LKA disarticulation.

Summing up, we identified 20% of the patients with some kind of remarks which, although apparently high due to our rigid criteria, are subjective. Nevertheless, only four (4%) needed revision: one (1%) for reshaping a residual bony hump after Tetris concept, two (2%) to correct pyramid lateralization after Tetris and lateral Tetris concept, and another (1%) to correct a pyramid lateralization with a hump recurrence after performing a modified SPAR B.

Conclusion

In appropriate patients dorsal preservation rhinoplasty is a safe and a natural operation to deproject the nasal pyramid. Correct patient selection remains the first step to avoid drawbacks and complications. Even with this approach, several *stigmat*a and drawbacks may be seen. It therefore follows that, each must be anticipated, analyzed, and controlled. The best way to approach the nasal pyramid is by segments, interpreting their characteristics and solutions, to achieve a predictable, accurate, and aesthetically pleasing result.

Conflict of Interest
None declared.

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Original Research

Osteotomy Techniques in Preservation Rhinoplasty with an Analysis of a Radix–Skull Base Computed Tomography Series

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Abstract

This study aims to explain our experience with dorsal preservation osteotomies, focusing on transverse, lateral, and dorsal aesthetic lines (DAL) osteotomies. We describe the utilization of a variety of surgical instruments, including osteotomes, saws, burrs, and piezo. This paper describes our concept of transcutaneous ultrasonic osteotomy, microedged-specific osteotomy, applying drills for lateral wall reshaping, and integrating piezo technology to establish new DAL. Furthermore, we present a radix–skull base computed tomography series analysis to evaluate the safety of transverse and radix osteotomies.

Keywords
- DAL osteotomies
- radix osteotomy
- TUO
- MESO
- skull base trauma

Nasal osteotomy plays a crucial role in rhinoplasty procedures, addressing various aspects of nasal aesthetics and function. It can be employed to close an open roof, narrow the nasal pyramid, correct deviations and asymmetries in the nasal bones, or a combination of these. The challenging aspects are achieving long-term stability of fracture lines and attaining natural and aesthetically pleasing dorsal lines while preserving nasal function. Over the years, osteotomy techniques have evolved. The earliest documented rhinoplasty osteotomy dates back to 1892 when Robert Weir introduced a method to address lateral nasal wall issues. He used nasal forceps with internal and external blades to fracture the lateral nasal wall.[1] Although his approach effectively achieved a narrower nose, it unfortunately compromised nasal airflow.[2] Cottle introduced a unique pushdown (PD) technique aimed at preserving nasal airflow. He combined septum reduction, lateral osteotomies, and repositioning of the nasal dorsum to reduce the nasal hump. For significant hump reduction, he utilized bilateral intermediate osteotomies to remove the lateral nasal wall.[3] The configuration of lateral osteotomies has since evolved to prioritize the preservation of Webster's triangle and the nasal airway. The starting point for these osteotomies has been adjusted to a higher position on the nasal sidewall relative to the face of the maxilla, creating a high-low lateral osteotomy.[4] Building upon these refinements, Farrior further amended the technique by recommending a high–low–high curved lateral osteotomy. This modification aimed to maintain the lateral suspensory ligament at the level of the piriform opening, thus minimizing the risk of iatrogenic nasal obstruction.[5] Over the last two decades, there has been a noticeable shift from standardized osteotomies toward personalized approaches tailored to each patient's unique anatomical features.[6] Osteotomy instruments can

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be broadly categorized as nonpowered or powered. Nonpowered osteotomies typically involve using instruments like chisels and hammers, saws, or baby rongeurs, whereas powered osteotomies can be performed with electrical saws or piezo.[7–9] The powered tools offer several advantages, including enhanced precision, reduced unpredictability in fracture lines, and the ability to achieve smoother bone contours. Furthermore, they contribute to decreased soft tissue trauma, resulting in less postoperative edema and ecchymosis.[10,11] The ideal method of lateral nasal osteotomy in rhinoplasty remains debatable. The nasal pyramid may be approached through the transcutaneous or endonasal technique. The transcutaneous technique is direct, and the literature suggests that it preserves periosteal support and thus limits lateral nasal wall collapse, minimizing hemorrhage, ecchymosis, and edema postoperatively, offering consistent results.[6,12–14] On the other hand, the endonasal approach can effectively increase the mobility of the bony vault and narrow the nose but may compromise periosteal support. Additionally, it can constrict the piriform aperture sufficiently to compromise the airway, create significant soft tissue displacement, and increase hemorrhage, edema, and ecchymosis.[12–14] Recently, dorsal preservation (DP) techniques have gained popularity. The foundation techniques aim to preserve the keystone area and the entire osseocartilaginous vault continuity at the dorsal platform.[15–17] Classically, they are indicated in the following noses: (1) the straight nose with or without a kyphotic hump; (2) the straight tilted nose; (3) the cartilaginous nose with small nasal bones and weak cartilages; and (4) the tension nose with elongated vertical nostrils and narrow collapsing internal nasal valves.[18,19] With the above background, the following section reviews our experience in performing osteotomies in DP rhinoplasty.

Osteotomies Sequence Strategies

The approach to the nasal pyramid takes on various sequences. One commonly practiced sequence involves releasing the nasal septum from the pyramid and then proceeding with lateral wall osteotomies. However, we prefer to start with the sidewall first by strategically designing the transverse and lateral osteotomies. Ideally, the two transverse osteotomies should not be in contact, leaving a bridge of bone in the midline to help in stabilization. The location of transverse osteotomies is crucial. We mark a line starting slightly caudal to the medial canthal tendon, extending obliquely upward, reaching the radix in a more cephalic position—where the radix lies deepest beneath the skin surface. This positioning serves to conceal any step deformity that might arise. In straight pyramids or minor deviations, our preference is the Tetris concept.[20,21] For cases with severely crooked noses (pyramid and/or septum), the low strip approach is a powerful technique if a DP is considered. However, it is worth noting that this technique is more demanding and challenging than the subdorsal flap technique. When it comes to performing lateral wall osteotomies without releasing the pyramid from the septum, two golden rules must be strictly followed: (1) the osteotomy impact vector on the sidewall, especially the transverse one close to the midline, must be lateral-to-medial and (2) no impaction forces should be applied at this point, although some gentle lateralization movements of the pyramid may be permitted, to avoid any trauma to the perpendicular ethmoidal plate. This precautionary measure will prevent damage and loss of the radix supporting pillar and eventual transmission of energy to the skull base, which theoretically could result in an injury and cerebrospinal fluid leak (refer to the "Radix-Skull Base Computed Tomography Scan Analysis" section). Many surgeons suggest starting by releasing the septum from the roof of the nasal vault to the level of the radix osteotomy, creating a gap between the roof and the septum, which avoids direct transmission of osteotomy force. ►**Table 1** provides a detailed description of the three possible routes that can be utilized.

Radix–Skull Base Computed Tomography Scan Analysis

A random analysis of 100 paranasal sinus computed tomography (CT) scans was conducted with an age range of 15 to 82 years (►**Fig. 1**). The primary focus of our investigation was to ascertain the distance between the radix and the cribriform plate. Examinations were performed using a GE Revolution CT Scanner with 64 slices with a slice thickness of 0.6 mm, and multiplanar reconstructions were generated. In coronal and axial views, we established a reference line situated laterally to the midline, specifically at the most anterior point of the cribriform plate where the skull base is most vulnerable. In the sagittal view, measurements were taken along the marked line, specifically at two key points: the radix (*) and the anterior aspect of the cribriform plate (**), as seen in ►**Fig. 2**. It is essential to note that the anatomical position of the radix is variable, serving as the transition point between the nasal bone and the nasal dorsum. Findings revealed a notable range of measurements from 13 to 26 mm with an average distance of 20.01 mm. Additionally, the median distance was 20 mm. Furthermore, our study included a gender-specific analysis to investigate potential variations in the distance from the radix to the cribriform plate. In males, the average distance was 20.92 mm, and the median distance was 21 mm. Meanwhile, in females, the average distance was 19.34 mm, and the median distance was 18 mm.

Osteotomy Devices

Osteotomes

Osteotomes are still the most used tool to perform osteotomies. They may be used endonasally or transcutaneously, under direct vision, or by palpation. Because we do a wide exposure of the lateral wall, we do most osteotomies under direct vision using 2- and 3-mm osteotomes without a guard. One of the main discussions on osteotomies is whether that piezo can be superior in making precise and straight cuts preserving the periosteum compared with a simple osteotome. We describe a technique, microedged-specific osteotomy (MESO), where a fracture line is produced without damaging the periosteum and blood vessels.

Table 1 Describes the three osteotomy sequences utilized by the author

Sequence 1	Sequence 2	Sequence 3
Straight septum/mild deviation	**Mild/moderate pyramid and septal deviation**	**Severe pyramid and septal deviation**
Lateral wall • **Transverse osteotomies, preserving the radix** • **Letdown or push/letdown osteotomies** • **Lateral keystone areas (LKA) disarticulation**	Lateral wall • Transverse osteotomies, preserving the radix • Asymmetric Letdown or push/letdown osteotomies • LKA disarticulation • Release the pyramid with a radix greenstick fracture or with a radix oblique osteotomy	Mid-wall • Designing the septal flap (high, intermediate, or low strip) • Separate the septum from the bony vault roof
Mid-wall • **Designing the septal flap (high, intermediate, or low strip)** • **Separate the septum from the bony vault roof**	Mid-wall • Designing the septal flap (high, intermediate, or low strip) • Separate the septum from the bony vault roof	Lateral wall • Transverse osteotomies, preserving the radix • Letdown or push/letdown osteotomies • LKA disarticulation • Release the pyramid with a radix greenstick fracture or with a radix oblique osteotomy
Lateral wall • **Release the pyramid with a radix greenstick fracture or with a radix oblique osteotomy**	–	–
Mid-wall • **Create the space below the bony vault, considering the step-up maneuver** • **Work on the cartilage to achieve the desired pyramid position** • **Suturing the quadrangular flap to stabilize the structure**	Mid-wall • Create the space below the bony vault, considering the step-up maneuver • Work on the cartilage to achieve the desired pyramid position • Suturing the quadrangular flap to stabilize the structure	Mid-wall • Create the space below the bony vault, considering the step-up maneuver • Work on the cartilage to achieve the desired pyramid position • Suturing the quadrangular flap to stabilize the structure

It uses the edge of a nonguarded 2- or 3-mm osteotome to etch a precise superficial line to guide the osteotomy (►**Fig. 3A**). One or more subsequent passages will complete the fracture line with no periosteal injury, as in piezo osteotomy (►**Fig. 3B**). It is an effective technique in letdown [LD] maneuver, as illustrated in ►**Fig. 3C** and **D**, ►**Supplementary Video 1** (available in online version only). To use the same concept in the transverse osteotomies, a 2-mm osteotome is introduced transcutaneously, the edge of the osteotome etches the osteotomy line, and the MESO process is performed. This concept is not exclusive to preservation rhinoplasty.

Supplementary Video 1

MESO (microedged-specific osteotomy). Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2285-6278.

Saws

The use of saws has been described in the literature over the years, but they have recently gained popularity. The perpendicular convex saw is an accurate tool for drawing the transverse osteotomy line in DP. It enables surgeons to create thin and precise cuts without significant soft tissue elevation in both open and closed approaches (►**Fig. 4**). Furthermore, the straight saw is another tool that can be utilized to perform basal osteotomies, obviating the need for extensive dissection. However, it is important to note that employing this tool may impose physical strain on the hand and arm during maneuvering, which can be inconvenient.

Rongeurs

Rongeurs can be used to remove the bone for wedge resection in LD technique or Webster triangle resection in PD technique. However, we do not recommend their use for ethmoidal perpendicular plate osteotomy to avoid creating an uncontrolled fracture resulting in a step.

Piezo

The ultrasound device (piezo) is a refined tool. It typically requires extensive degloving to approach the sidewall osteotomies when used. However, our approach takes a different path by offering a wide exposure of the lateral wall through a marginal incision. This approach allows us to reach the lateral crura while preserving the dorsal platform, thereby safeguarding the radix periosteum and preventing the

RADIX – SKULL BASE CT SCAN DATABASE

n	sex	age	value (mm)
1	F	51	17
2	F	63	17
3	M	49	23
4	F	62	21
5	F	63	18
6	M	15	18
7	M	50	19
8	F	67	17
9	F	52	21
10	F	48	25
11	M	52	18
12	F	46	15
13	M	41	23
14	M	58	22
15	F	58	17
16	F	16	20
17	F	63	17
18	M	42	20
19	F	55	14
20	F	19	23
21	F	19	21
22	M	31	21
23	F	43	23
24	F	82	17
25	F	37	17
26	M	41	22
27	M	15	22
28	F	73	18
29	M	48	23
30	F	44	20
31	F	45	23
32	F	57	16
33	F	81	18
34	M	59	21
35	M	53	23
36	M	17	18
37	F	69	22
38	F	50	21
39	F	16	21
40	F	44	20
41	F	40	17
42	M	63	20
43	F	20	19
44	F	44	22
45	M	59	23
46	F	33	22
47	M	65	19
48	F	20	22
49	M	64	23
50	F	44	22

N	sex	age	value (mm)
51	M	45	20
52	M	31	21
53	F	20	22
54	F	42	19
55	F	64	21
56	F	20	16
57	F	68	24
58	F	63	18
59	M	65	23
60	F	49	18
61	M	16	23
62	F	63	16
63	M	69	20
64	F	36	19
65	M	63	26
66	F	60	13
67	M	41	18
68	F	62	23
69	M	54	16
70	F	45	21
71	M	43	19
72	M	66	19
73	F	44	21
74	M	71	21
75	M	75	23
76	M	25	22
77	F	61	16
78	F	47	18
79	F	52	17
80	F	60	20
81	M	72	22
82	M	51	22
83	F	53	15
84	M	34	23
85	F	38	23
86	M	43	22
87	M	33	23
88	M	23	20
89	F	56	21
90	M	42	18
91	F	16	20
92	F	49	17
93	M	19	22
94	F	60	22
95	M	33	18
96	F	25	21
97	M	63	19
98	F	72	17
99	F	49	21
100	M	52	21

TOTAL	n=100
AGE	yo
Maximum	82
Minimun	15
Average	47,49
DISTANCE	mm
Maximun	26
Minimum	13
Average	20,01
Median	20

FEMALE	n=58
Average age	48,24
DISTANCE	mm
Maximun	25
Minimum	13
Average	19,34
Median	18

MALE	n=42
Average age	46,45
DISTANCE	mm
Maximun	26
Minimum	16
Average	20,92
Median	21

Fig. 1 Represents a random study of 100 computed tomography scans to determine the distance between the radix and the anterior aspect of the cribriform plate.

occurrence of a step deformity. While piezo excels at achieving precise cuts in the bony vault, it is worth noting that these cuts can occasionally be slightly wider compared with cuts made using osteotomes and saws (►**Fig. 5**). Moreover, when utilizing piezo, the lateral wall can be accessed endonasal or transcutaneously, whether employing an open or closed approach (►**Fig. 6**). In endonasal approach, an angulated piezo's saw can be used in an adequately exposed nasal pyramid. To reach the anterior and upper end of the oblique osteotomy line, a wide periosteal elevation must be performed at the radix area, which we prefer to avoid. In transverse osteotomies, we use the piezo through a 2-mm incision in the skin of the lateral wall—transcutaneous ultrasonic osteotomy (TUO). A stab incision is performed using the 2-mm osteotome, where the straight piezo insert fits properly (we use Comeg piezotome straight saws) and cuts the bone precisely in a subperiosteal tunnel created following the line drawn preoperatively (►**Fig. 7**). This transcutaneous use of piezo can also be adopted in other osteotomies, like low-to-low osteotomies, avoiding a complete open approach. Robiony et el[23] demonstrated the use of ultrasonic osteotomy through a 2-mm incision without creating any subperiosteal tunnel. They reported a reduction of bleeding during surgery, minor edema, ecchymosis, and no visible scar postoperatively. In our experience, refraining from creating a tunnel can lead to some degree of damage or burning of the deep soft tissue. To prevent any potential damage to bone and soft tissues from heat, we adhere to three essential rules (►**Supplementary Video 2**, available in online version only):

- The piezo tip must be inserted deeply into the lateral dissected tunnel, assuring that the tip of the watering port of the piezo insert irrigates the tunnel and cools the bone and

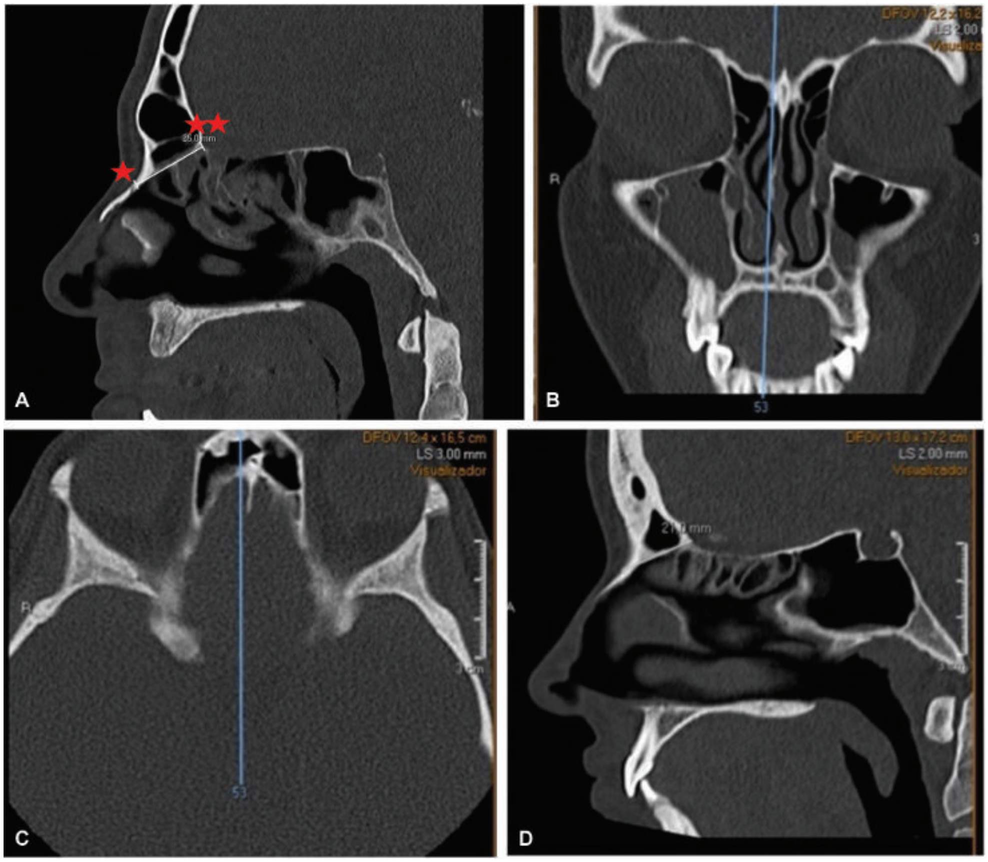

Fig. 2 (**A**) The distance between the radix * and cribriform plate** is 25 mm; (**B**, **C**, and **D**) placing the lines in the coronal and axial planes to guide the measurements in the sagittal view, in this case 21 mm.

subcutaneous tissue. To ensure that, we deeply introduce the insert by elevating the skin proximal to it with a dissector.

- While performing the osteotomy, the skin must be generously irrigated with cold water to avoid heat-induced soft tissue damage.
- The two-second rule is very effective; we cut for 2 seconds and stop for another two, ensuring that the heat does not rise to high temperatures and provoke burning injury. During the 2-second pause, irrigating with cold water allows the temperature to drop fast; this process is repeated till the osteotomy is complete.

Supplementary Video 2

Transcutaneous ultrasonic osteotomies (TUO) designing the transverse osteotomy. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2285-6278.

Drills

Drills (burrs) are powered surgical instruments that have gained increasing prominence in rhinoplasty. While their primary use is often associated with refining and sculpting the surface of the nasal pyramid, they can also be strategically employed to create fracture zones by selectively thinning the lateral wall of the nose. In wide pyramids, where the definition of new dorsal aesthetic lines (DALs) is necessary (►**Supplementary Video 3**, available in online version only), our approach begins with reducing the thickness of the lateral wall until we reach the inner cortical bone, characterized by its gray granite-like appearance. After determining the desired width for the bony dorsum, we can precisely delineate the two DALs, and subsequently, the lateral wall must be repositioned medially. In certain scenarios, simply sculpting and thinning the sidewall may not suffice to achieve the desired reduction of the nasal pyramid. In such cases, it becomes imperative to perform DAL osteotomies, shifting the lateral wall inward, as illustrated in ►**Fig. 8**. This fracture can be executed as a greenstick fracture after the drill has weakened the bone.

Supplementary Video 3

Designing the new DALs using the drill and piezo. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2285-6278.

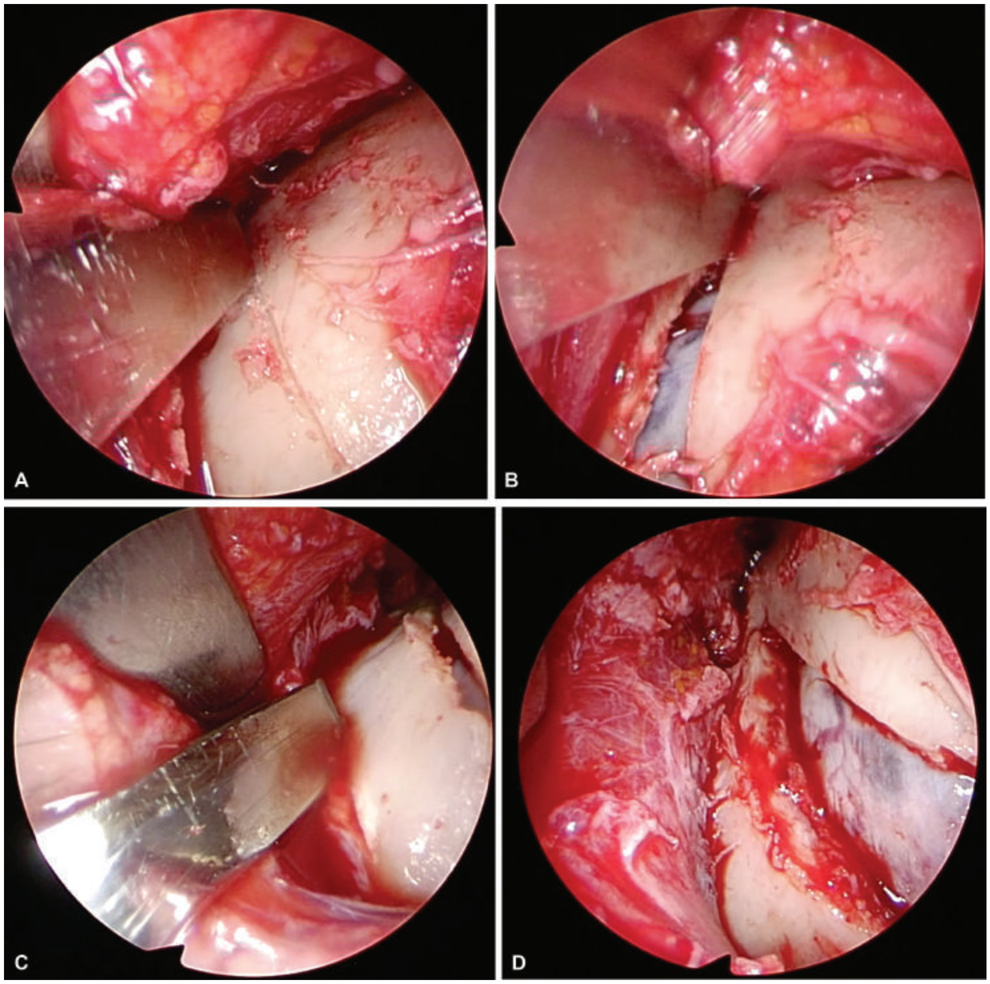

Fig. 3 MESO (microedged-specific osteotomy) in letdown technique. (**A**) The edge of a nonguarded 2- or 3-mm osteotome is used to etch a precise superficial line to guide the osteotomy. (**B**) One or more subsequent passages will complete the fracture line with no periosteal injury. (**C**) When performing let down technique a second fracture at the base of the pyramid is produced creating a triangular bony wedge. (**D**) Periosteum and vessels can be seen preserved.

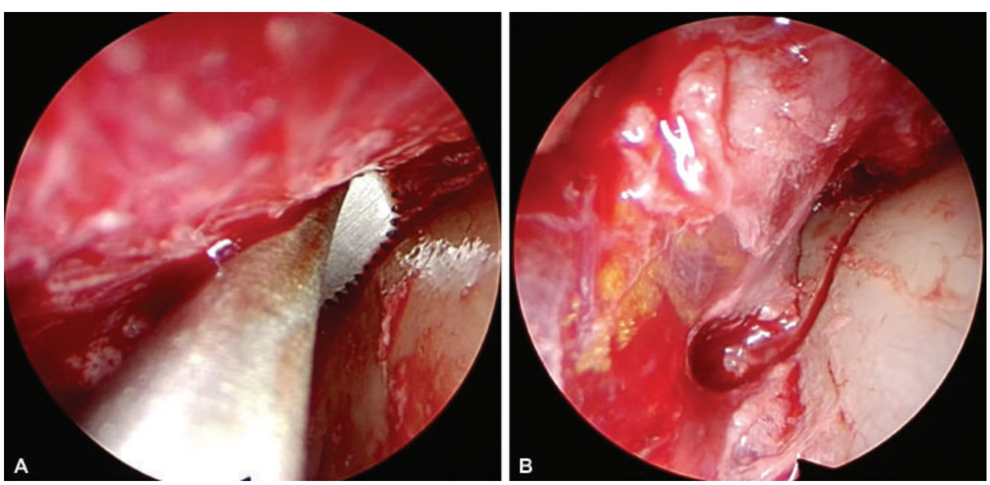

Fig. 4 The use of saws for transverse osteotomies.

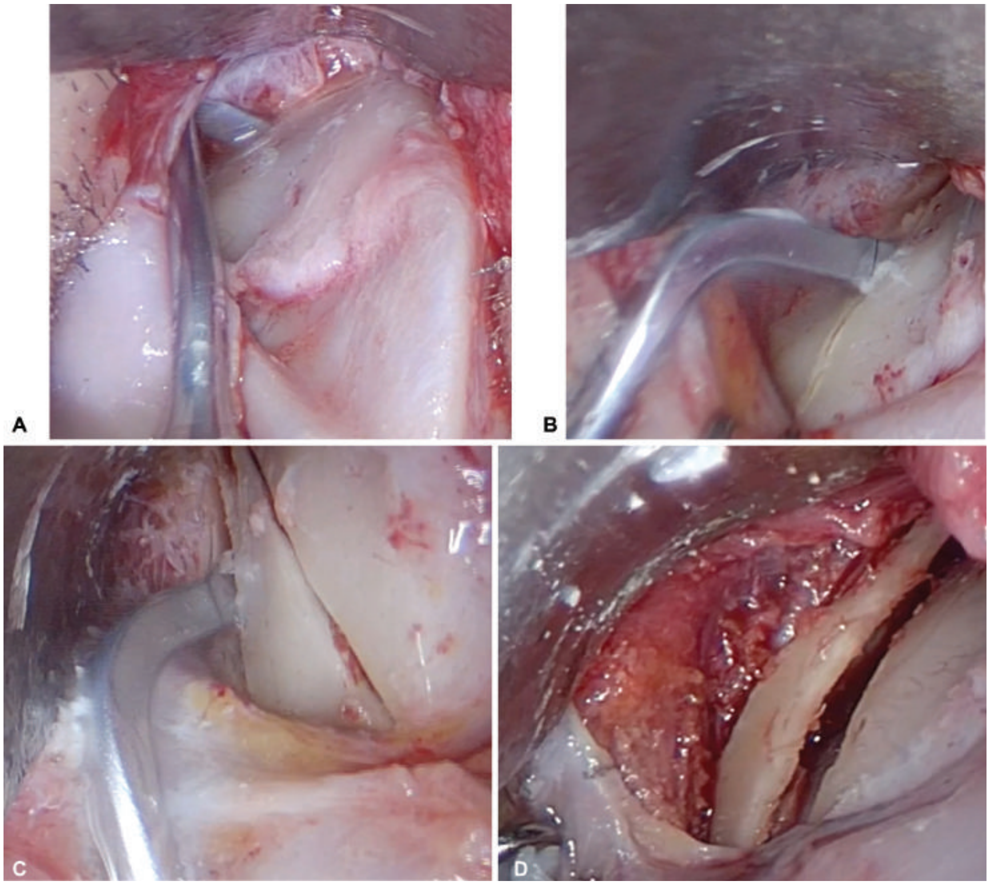

Fig. 5 The use of endonasal piezo for the wedge resection in the letdown technique. (**A**) Transverse osteotomy. (**B,C**) Lateral osteotomies in Letdown technique creating a bony wedge. (**D**) The triangular bony wedge detached from the pyramid.

Transverse Osteotomies

Transverse transcutaneous osteotomies using osteotomes can be performed through a 2-mm transcutaneous incision halfway between the inner canthus and the radix, leaving an imperceptible scar (►**Fig. 9**). The lateral approach allows us to control the orientation of the fracture line. As an additional safety maneuver, we prefer to design the fracture line in an oblique, anterior, and cephalic orientation to prevent a radix step.[24] The edge of the osteotome may be used to create this line, gradually deepening it and creating a controlled fracture (transcutaneous MESO at the lateral wall). Alternatively, an incision at the inner end of both brows to introduce the osteotome can be used to hide the incision, as shown by Dewes et al.[25] Another option is through a single central incision at the radix, allowing

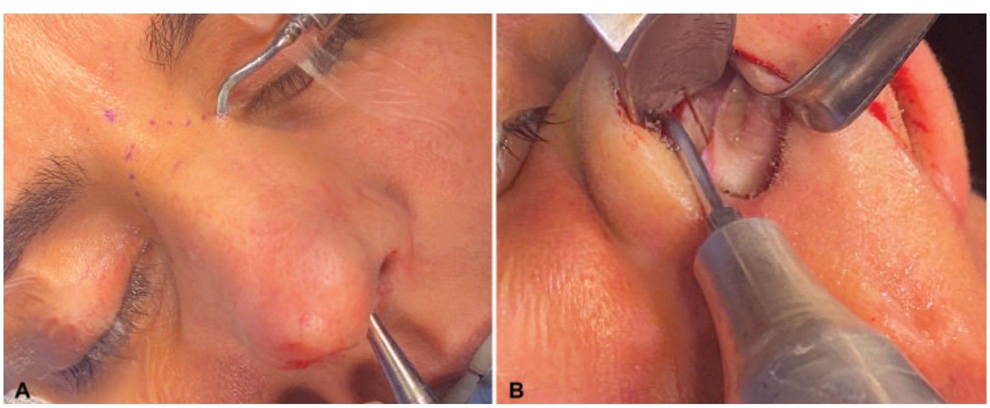

Fig. 6 Using piezo in a closed approach. (**A**) Transverse osteotomies using TUO technique and (**B**) endonasally lateral osteotomies. TUO, transcutaneous ultrasonic osteotomies.

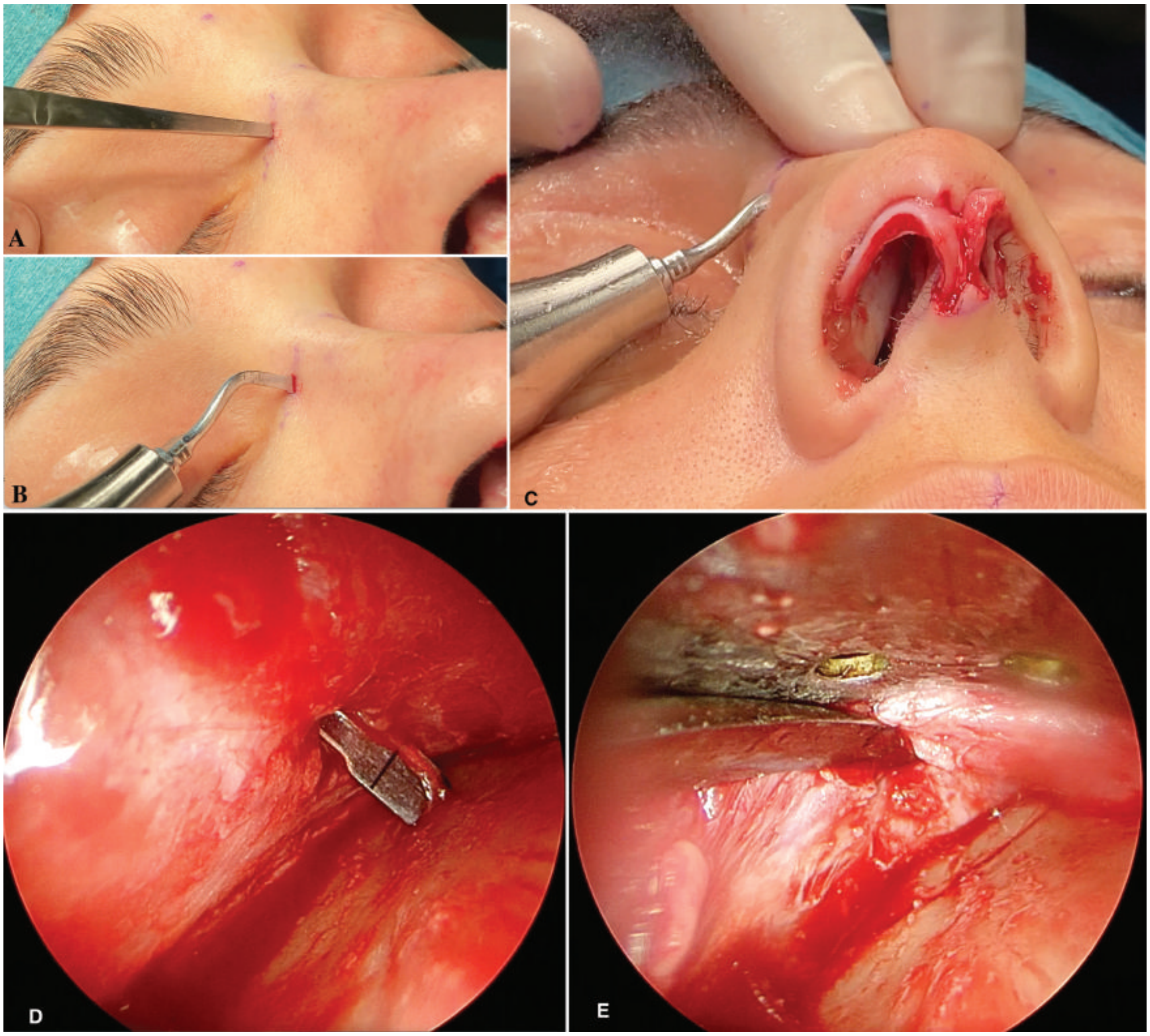

Fig. 7 Transcutaneous ultrasonic osteotomies (TUO) designing the transverse osteotomy. (**A** and **B**) a stab incision is performed using the 2 mm osteotome where the piezo straight insert fits properly; (**C**, **D**, and **E**) performing the transverse osteotomy.

lateral osteotomies on both sides by cutting the bone obliquely with angulation to prevent loss of radix control and skull base trauma. This is only performed after separating the perpendicular ethmoidal plate from the bony vault (►**Table 1**). The piezo is an excellent option for transverse osteotomies. Although the angulated piezo's saw can draw the oblique osteotomy line, it is worth noting that a wide periosteal elevation must be performed at the radix to reach its anterior and upper end. Our preference, however, is to leave this area undisturbed. Based on that, we prefer the TUO approach when utilizing piezo. An alternative option is using a saw like a "Tastan-Çakir's saw" (►**Fig. 4**) to create a precise thin line. However, it is worth noting that creating the described oblique line with this saw can be challenging and physically demanding on the surgeon's wrist and arm due to its inclined design.

Sidewall Osteotomies

In DP rhinoplasty, the performance of lateral osteotomies involves the elevation of an outer periosteum flap with or without inner periosteum flap elevation. In the LD technique, a V-shaped section of bone is excised, while in the PD technique, the bone remains intact, yet both the outer and inner bony surfaces are freed to enable the smooth sliding movement of the nasal pyramid.[26,27] In the PD technique, the basal osteotomy can be executed using either a guarded or nonguarded osteotome. Conversely, in the LD technique, a higher osteotomy is strategically placed at the desired level, considering the specific bony wedge that needs to be removed before the basal osteotomy can be performed. We use the MESO concept to design a fracture line that preserves the periosteum and its vessels without an inner

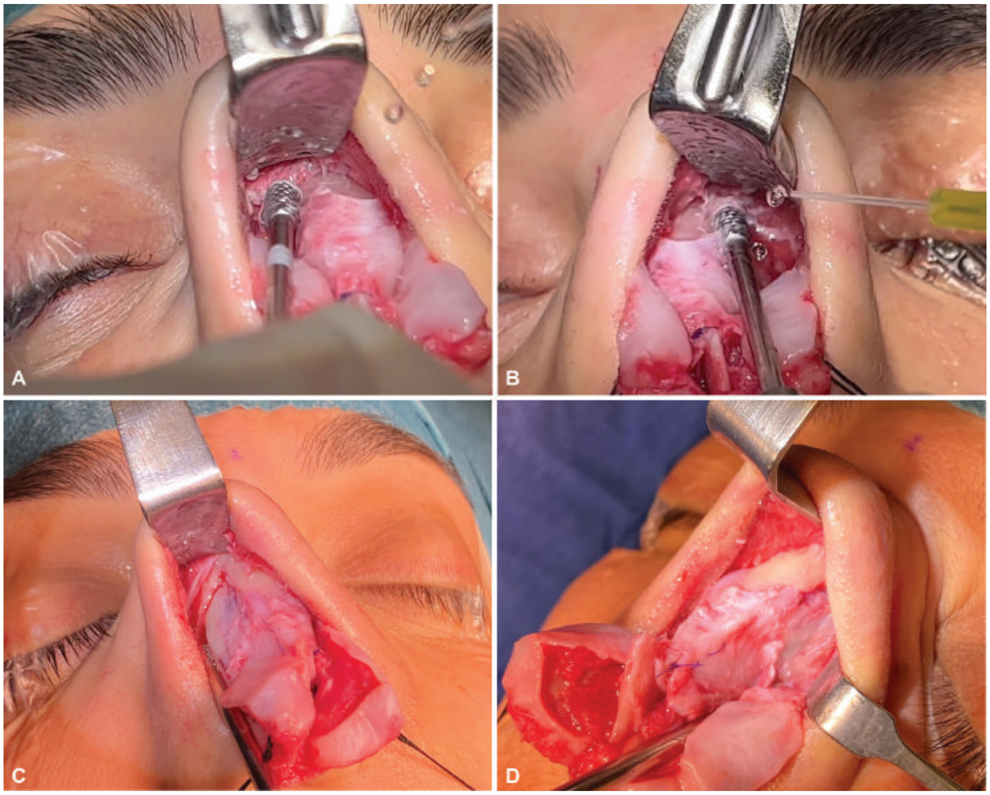

Fig. 8 Designing the lateral wall after the letdown impaction. The cylindrical drill was used to thin both lateral walls (**A** and **B**); a push in maneuver fractured the wall at the level of the DALs (**C** and **D**), and the lateral bony wall at the DALs was reduced to paper-thin (see the thickness of the medial cortical bone).

periosteal flap elevation (►**Fig. 3** and ►**Supplementary Video 1**, available in online version only). Transcutaneous osteotomies could be an excellent solution to correct a lateral step if the basal osteotomy was produced at a higher level than the nasofacial groove. The lateral osteotomy is a perfect indication for using piezo. Angulated or straight (our preference) insert produces a controlled, precise fracture line without soft tissue damage (►**Fig. 5**). The TUO concept can be used as previously described, as well as the classic subperiosteal tunnel osteotomy in an open or closed approach (►**Fig. 6** and ►**Supplementary Video 2**, available in online version only). As previously mentioned, saws can be

Fig. 9 (**A** and **C**) before Transverse transcutaneous osteotomies, (**B**) Immediately after a TUO approach and (**D**) 1-year postop. No scar is visible.

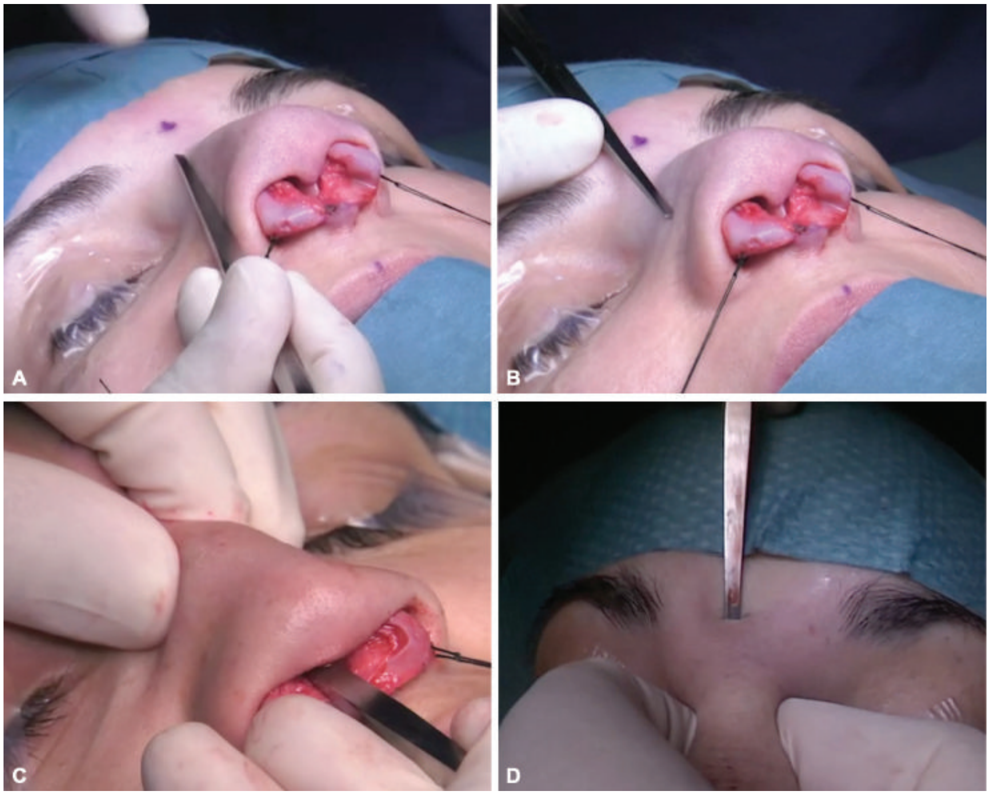

Fig. 10 Oblique osteotomy: (**A**) endonasally; (**B**) transcutaneously; (**C**) performing endonasal radix osteotomy; (**D**) performing transcutaneous radix osteotomy.

Fig. 11 (**A**, **B**) original DALs; (**C**) defining new DALs in a wide dorsum using piezo; (**D**) the narrowed DALs; the cartilaginous vault was also addressed.

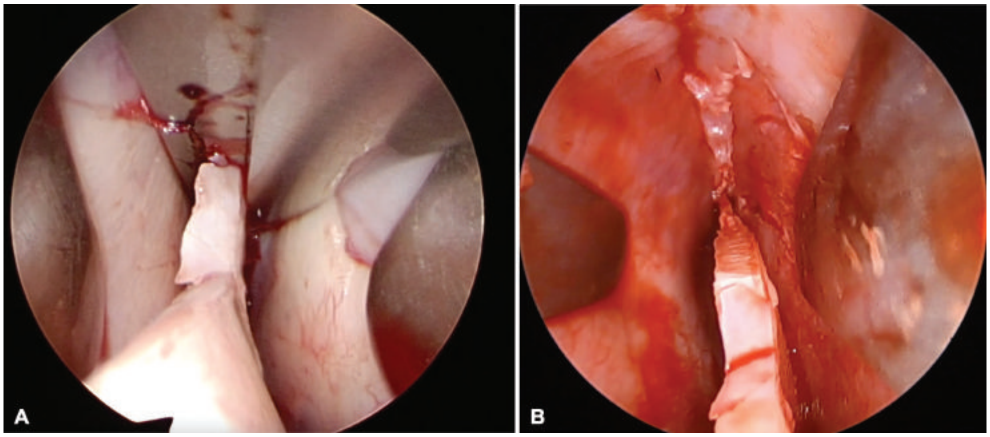

Fig. 12 Approaching the subdorsal septum at the bony level. (**A**) The scissors blades can be seen cutting the septum (initially cartilage and after bone); (**B**) the triangular space created. Note the ethmoidal plate precise cut.

very effective. A straight Tastan-Çakir saw can be used to perform the lateral osteotomies (►**Fig. 4**). From our perspective, rongeurs should be used exclusively to remove a sleeve of bone as required for LD or to remove the Webster triangle in PD technique. It can be used in open or closed approaches or eventually through a prepyriform aperture approach.

Radix Oblique Osteotomy

Radix osteotomy is a specific maneuver in DP, allowing the nasal pyramid to be released when needed. Ideally, this fracture should be performed obliquely to allow the two surfaces of the fracture to overlap so that there is no slippage, preventing a step (►**Fig. 10** and ►**Supplementary Video 4**, available in online version only). It can be performed transcutaneously or endonasally with an osteotome or piezo following the release of the septum from the pyramid.

Supplementary Video 4

The radix support of the oblique osteotomy. The radix pillar (the ethmoidal plate below) was removed entirely to show how the two surfaces of the oblique osteotomy contact and avoid step deformity. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/a-2285-6278.

Dorsal Aesthetic Lines Osteotomies

Defining the DAL or redefining new ones is very powerful in DP rhinoplasty. In our PD concept, our main objective is to preserve the continuity of the dorsal platform by transferring the trauma to the lateral wall of the pyramid, where problems are much less likely to be encountered. This means that we will work between the two DAL, which can be the original ones or the ones we designed. When the bony dorsum is wide, two strategies may be considered. One is based on sculpting the sidewall, which we prefer to perform with cylindrical drills[28] (►**Fig. 8** and ►**Supplementary Video 3**, available in online version only), but it can also be done with piezo (►**Fig. 11** and ►**Supplementary Video 3**, available in online version only). This reduces the convexity of the sidewalls, creating a more defined and medialized bony dorsum. The other option is the creation of two DAL osteotomies to define the new width of the dorsum and, therefore, the new DALs.[28]

Subdorsal Septum Osteotomy

When addressing the septum, bilateral mucoperichondrial/periosteal or eventually supraperichondral/subperiosteal flap should be elevated as needed. The first step should be separating the septal wall from the vault. Most septal walls will have caudal cartilaginous and cephalic bony segments. We advise using curved scissors to separate the septum from the inner vault till the transverse osteotomy level (►**Fig. 12**). The incision must be as tangential to the inner vault as possible to preserve the cephalic pillar. New, longer piezo inserts are available and are excellent for performing this cut. Next, we define how much septum needs to be removed to achieve the ideal dorsal profile. Our preferred instrument to perform this step is Caplan septum scissors or, as an alternative, Heymann nasal scissors. Using precise instruments can make it possible to design the step-up maneuver that works as a preventive measure to avoid losing control of the radix and as a strategy to elevate it. Occasionally, the pyramid cannot be mobilized after the septum is released, because the transverse osteotomies left a continuity at the radix midline. One option to overcome this is to create a greenstick fracture through a midline oblique radix osteotomy to control the radix position, which can be performed transcutaneously or endonasally. Other options include redoing the transverse osteotomies until reaching the desired level.

Discussion

The above sections discuss the benefits and drawbacks of various osteotomy techniques. The way conservative approaches evolved during the past 20 years has transformed the concept and the results. Osteotomies play a fundamental role in rhinoplasty, particularly in DP. The type of instruments used and the planned osteotomies strategy represent the success achieved. Understanding the benefits and harms of each cut is fundamental. The risk of osteotomies at nasal radix and the perpendicular ethmoidal plate manipulation have been discussed.

The CT scan analysis presented in this paper demonstrates results supporting osteotomy safety in DP rhinoplasty. The first author has been performing dorsal conservative approaches since 2008, using mainly sequences 1 and 2 (►**Table 1**), without ever experiencing any skull base problem. We performed the radix osteotomy in three possible ways: connecting the lateral transverse osteotomies, oblique transcutaneous osteotomy, and oblique endonasal subdorsal osteotomy. In all three strategies, the orientation of osteotomy avoids spreading the impact to the skull base. Another strategy to avoid damage to the ethmoidal plate is to perform the oblique osteotomy first to separate it from the roof of the bony pyramid, as seen in the sequences we described. In our perspective, working on the perpendicular ethmoidal plate is where the bigger risk to the skull base may occur, specifically during high septoplasty and eventually during the pyramid–plate separation, when the vectors of energy may spread to the skull base. Using instruments or strategies that can create torsion of the plate should be avoided. We use precise cuts with scissors or piezo, avoiding ethmoidal manipulation with rongeurs. To our knowledge, MESO has not been described in the literature. We recommend adopting this technique because it produces precise bone cuts while effectively preventing damage to the periosteum and vessels. It can be performed endonasally or under direct vision in a wide-open approach, and finally, it is not heat-generating and is more cost-effective compared with piezo while giving the same accurate results.

Conclusion

Precise osteotomies are challenging and paramount in rhinoplasty. In DP rhinoplasty, the mobilization of the nasal pyramid depends on how the osteotomies are performed. Controlling the osteotomies under direct vision showed great value in precision without any drawbacks. Although various methods have advantages, we presented our preferred sequences and how we mix several available instruments for osteotomies.

Conflict of Interest
None declared.

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The Nasal Ligaments and Tip Support in Rhinoplasty: An Anatomical Study

Rollin K. Daniel, MD; and Peter Palhazi, MD

Abstract

Background: In 1971, Janeke and Wright[1] published a now classic study on the support of the nasal tip in which they found four areas of anatomic support. These findings led to the "tripod concept" of tip support. Recently, surgeons have begun repairing and/or preserving the nasal ligaments as a method to control tip projection and rotation. Therefore, a reassessment of the nasal ligaments and tip support is warranted.

Objectives: The present study was done to investigate the ligamentous and structural support of the nasal tip. Clinically, surgeons are aware of the role of the nasal ligaments and are beginning to utilize tip suture techniques to achieve greater tip refinement and long-term support.

Methods: Anatomic studies were conducted on 24 fresh cadavers at the time of autopsy. The two groups consisted of the following: (1) group 1 included dissection of 10 cadavers concentrated on the various ligaments of the nose; and (2) group 2 involved dissections of 14 cadavers analyzing the relationship between the alar domes and the anterior septal angle (ASA).

Results: Regarding the ligaments of the nose, we were able to consistently identify the following ligaments: (1) interdomal; (2) intercrural; (3) Pitanguy's midline; (4) pyriform; and (5) a scroll ligament complex consisting of the longitudinal and vertical scroll ligaments. We did not find two commonly accepted ligaments: (1) a "footplate ligament" from the footplate of the medial crus to the caudal septum; and (2) a "sesamoid ligament" attachment from the accessory cartilage to the pyriform aperture. Dissections done to study the relationship between the domes and ASA revealed that the domes projected an average of 5.7 mm (range, 2.2-9.6 mm) above the ASA and were longitudinally 5.5 mm (range, 2.9-9.5 mm) caudal to the ASA. Thus, there was no direct support from the ASA to the domes.

Conclusions: It is our recommendation that surgeons should consider preservation of the nasal ligaments whenever possible and utilize them to manipulate tip projection, position, and rotation. Awareness of the relationship between the dome and the caudal septum will hopefully minimize problems with the tongue-in-groove operation.

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In 1971, Janeke and Wright[1] published a now classic study on the support of the nasal tip in which they found the following four areas of anatomic support: (1) the scroll junction between upper lateral cartilages (ULCs) and lower lateral cartilages (LLCs); (2) the lateral sesamoid cartilage complex; (3) the junction between medial crura and caudal septum; and (4) the interdomal sling. Subsequently, Tardy et al[2] divided tip support into major and minor with the three major structures including the following: (1) the intrinsic integrity of the alar cartilages; (2) the medial crural footplates to the caudal septum; and (3) the scroll junction between the upper lateral and lower alar cartilages. Thus, the interdomal sling and sesamoid attachment to the pyriform were given minor status. During the past few decades, there has been additional anatomic studies[3,4] and a greater clinical emphasis on ligamentous suture techniques.[5] Therefore, an in-depth anatomic investigation is warranted to provide an anatomic basis for further clinical advances.

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E-mail: rkdanielmd2@gmail.com

METHODS

This study was conducted in accordance with the Declaration of Helsinki. Anatomic dissections were done in 24 fresh cadavers at the time of autopsy. These were fresh Caucasian cadavers, without freezing or any storage distortions. The cadavers had a mean age of 65.8 years (range, 47-89 years) with a sex distribution of 14 females and 10 males. The dissections can be dividied into two broad groups: group 1 consisted of 10 cadavers, with an emphasis on dissecting the various ligaments of the nose; and group 2 consisted of 14 cadavers, with an emphasis on the relationship between the alar domes and the anterior septal angle (ASA) as well as the contour of the caudal septum. The dissections were done between May 2015 and August 2016. Because the mean age of the cadavers was 65.8 years, the fact that the ligaments were present in the elderly discounts the idea that they might be difficult to identify in older individuals. It should be noted that the two groups of dissections were done sequentially and thus the assignment of cadavers to the two groups was not an issue.

In group 1, the skin envelope and then the subcutaneous fatty tissue was meticulously removed. Care was taken not to disturb the superficial muscular aponeurotic system (SMAS) layer of the nose, especially the transversalis muscle and its ligamentous connections to the scroll area, tip, and columella. Simultaneously, the connections between the paired domes were preserved. Then the intercartilaginous and osseocartilaginous connections were studied between the pyriform aperture and the cartilagionus components of the nose, the caudal border of the ULCs, and the cephalic border of the lateral crus, as well as the paired alar cartilages and septum. Photographs were taken to document the individual ligaments of the nose.

In group 2, the entire right side of the nose was removed, exposing the septum. The mucoperichondrial coverage of the septum was removed to reveal precisely the caudal border of the septum. Then the dome on the opposite side was identified and dissected without disturbing its position in the soft tissue nor changing its relationship to the ASA. Standardized photographs (true lateral views) were taken, including placement of a ruler in the the field of interest. Measurement were done to document the dome and ASA locations as well as the contour of the caudal septum.

RESULTS

Group 1

As will be discussed in depth, we were able to identify concistently the following ligaments: (1) interdomal ligament; (2) intercrural ligament; (3) Pitanguy's midline ligament; (4) a transverse footplate ligament; (5) the pyfriform ligament; (6) a longitudinal scroll ligament; (7) a veritcal scroll ligament; and (8) a vertical pyriform aperture ligament. There was no ligament from the medial crural footplate to the caudal septum nor was there a sesamoid fibrous attachment to the pyriform aperture.

Group 2

Dissections were done in 15 fresh cadavers to study the relationship between the domes and the ASA. The domes projected an average of 5.7 mm (range, 2.2-9.6 mm) above the ASA and were longitudinally 5.5 mm (range, 2.9-9.5 mm) caudal to the ASA. There was no direct support from the ASA to the domes. The convexity of the caudal septum is marked by the presence of a caudal point (CP) above the posterior septal angle (PSA). The CP can be defined as the most CP of the septum and is readily apparent. We utilized two methods for evaluating the contour and inclination of the caudal septum. For evaluating the contour of the caudal septum, a line was drawn between the PSA and the ASA. For assessing the inclination of the caudal septum, a line was drawn between the CP and the ASA, which averaged 133.6 degrees (range, 119-146 degrees). In addition, we measured the distance from the caudal septum to the middle crus (ie, the largest width of the membranous septum). The width of the membranous septum averaged 4.7 mm (range, 2.0-7.1 mm). We also measured the distance between the caudal septum and the midportion of the middle crus, which indicates the distance one would shorten the nose in a tongue-in-groove (TIG) procedure. This distance was nearly averaged 4.7 mm (range, 2.1-7.7 mm), thus it was nearly identical to the average width of the membranous septum.

DISCUSSION

The anatomic term "ligament" is defined in Terminologia Antomica[6] as "a band or sheet of fibrous tissue connecting two or more bones, cartilages or other structures." Therefore, this broad definition can lead to the identification of a large number of ligaments. We will review the most commonly accepted ligaments and discuss their surgical relevance.

Ligaments

Interdomal Ligament

The interdomal ligament connects the two middle crura at the cephalic junction of the infralobular segment (Figure 1). Technically, the ligament does not run between the domes, but rather between the middle crura in a more posterior and cephalic location. It is easily found in all

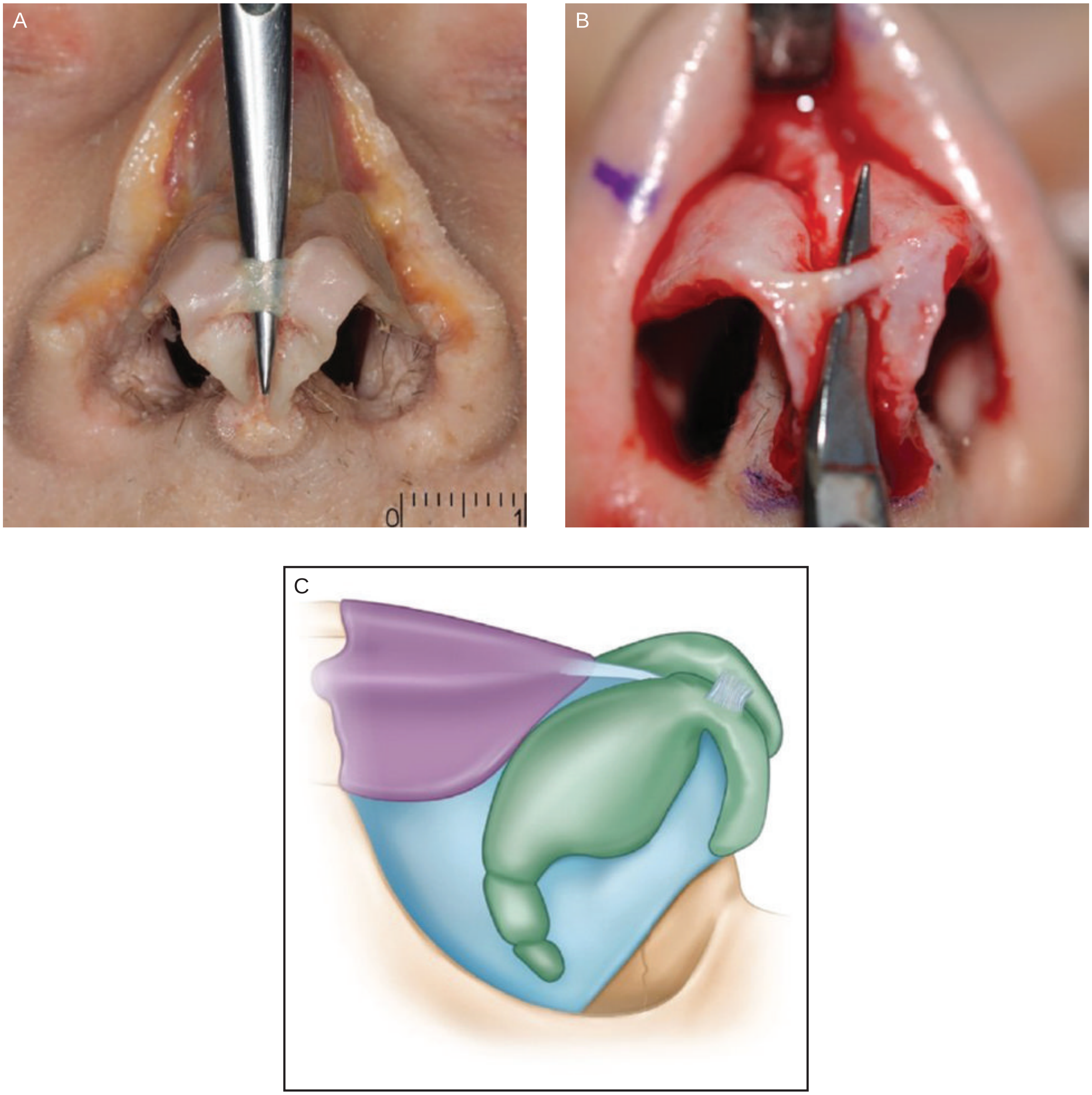


Figure 1. The interdomal ligament runs between the cephalic border of the lobular segment of the middle crus as seen in (A) a cadaver, (B) clinically, and (C) schematically.

noses and is often quite rigid. Although many surgeons cut it during the insertion of a columellar strut, the interdomal ligament can be easily preserved due to its cephalic postion away from the caudal border of the middle crura. Obviously, this preservaton is not possible if a tip split procedure is performed.[7] Rohrich[8] routinely inserts an interdomal suture to narrow the interdomal distance, which in reality merely represents reestablishment of the previously cut interdomal ligament.

Intercrural Ligament

The intercrural ligament connects the cephalic border of the entire alar cartilages including the lateral, middle, and medial crura (Figure 2). It passes just above the mucosa and holds the alar cartilages together. In its cephalic portion along the lateral crus, it acts as the suspensory ligament of Converse[9] passing just above the ASA. In its midportion, it is posterior to both the interdomal ligament and the deep portion of Pitanguy's midline ligament.[10] Its

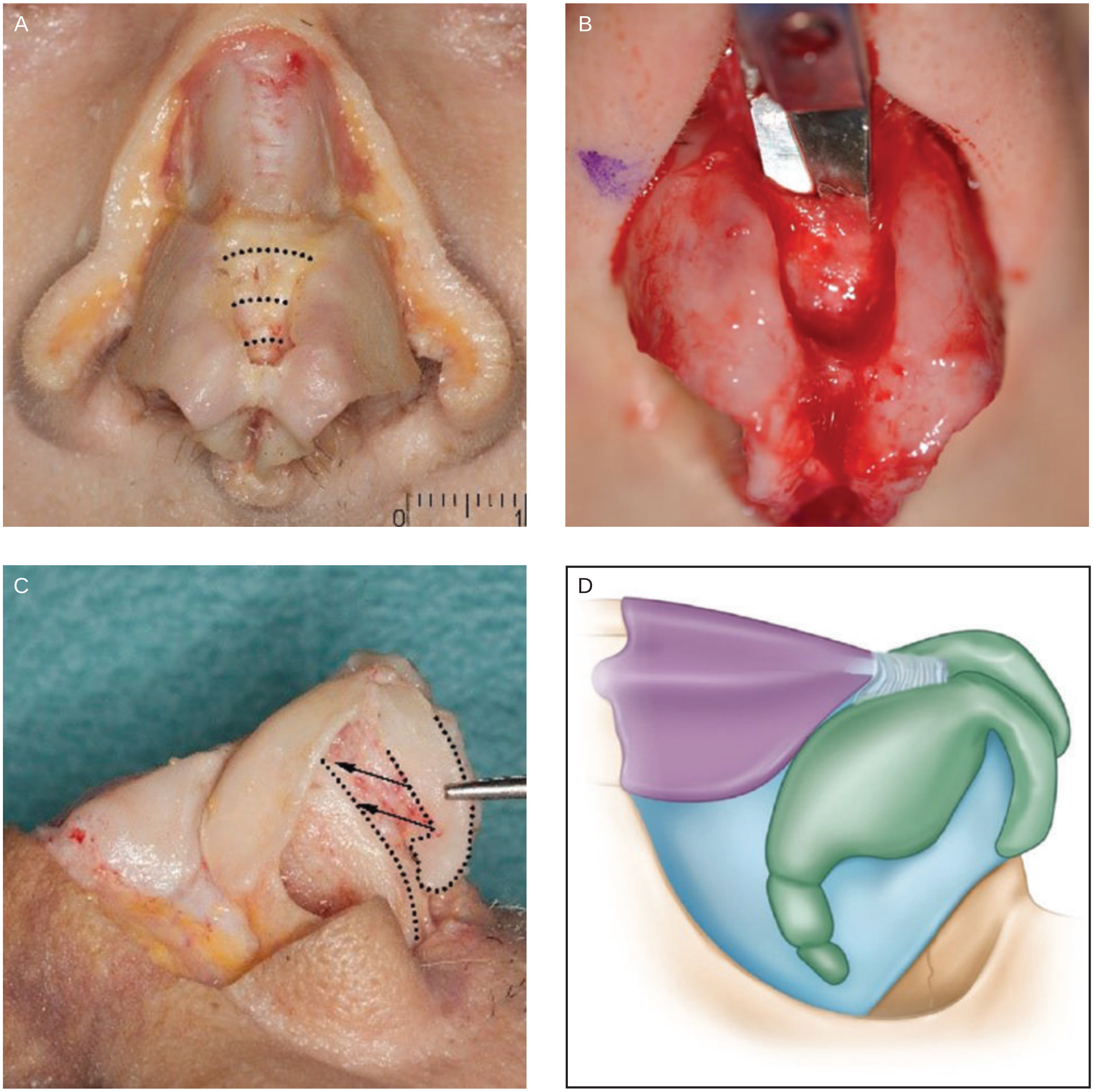


Figure 2. Intercrural ligament. (A) Cadaver dissection showing transverse connections between alar cartilages. (B) Clinical case with intercrural ligament above scissors. (C) Traction on the medial crus reveals the connection throughout the alar cartilages. (D) Schematic drawing of the dorsal portion of the intercrural ligament.

caudal component effectively restrains the medial crus and footplate, pulling them toward the caudal septum. The intercrural ligament unifies the two alar cartilages and acts as a suspensory sling over the anterior septum. During rhinoplasty surgery, this ligament can either be preserved or disrupted. In an open approach, a "tip split" procedure will divide the ligament and require the surgeon to restore support, usually with a columellar strut. However, downward traction on the alar cartilage followed by a "dorsal split" allows one to maintain the intercrural ligament. A bilateral transfixion incision through the membranous septum will disrupt the intercrural ligament support between the footplates. Alternatively, one can perform a high septal transfixion incision utilizing the technique of Cakir,[5] which is a modification of the original technique by Parkes and Brennan.[11] Essentially, one makes the transfixion incision through the caudal septum approximately 2 to 3 mm back from the caudal border, thereby ensuring total preservation of the intercrural ligament.

Footplate Ligament

In their classic study of nasal tip support, Janeke and Wright[1] listed the junction of the medial crura and caudal septum as one of the four pillars of nasal tip support. Tardy et al[2] considered it one of the three major tip support mechanisms. Subsequently, Gunter[12] diagrammed these as a distinct fibrous attachment between the footplates and the caudal septum. Based on numerous dissections, *a distinct footplate ligament between the footplate of the medial crus and the caudal septum does not exist*. Clinically, one only has to pull on his or her own columellar to note its mobility and the absence of a restraining ligament. Our conclusion is that there are three components to the relationship between the medial crus and the caudal septum. First, the intercrural ligament acts as a suspensory ligament uniting the entire alar cartilage complex without direct fixation to the dorsum and caudal septum. Second, there is a transverse ligamentous attachment in between the lobular segments of the medial crura, but not to the caudal septum. Third, the footplates wrap around the caudal septum in a caudal to cephalic direction, but they rest upon the soft tissue in the columellar base.[13] There is a distinct anatomic variation between the length of the footplates and the height of the columellar. The longer the footplates, the shorter the columellar base.[14]

Sesamoid Ligament

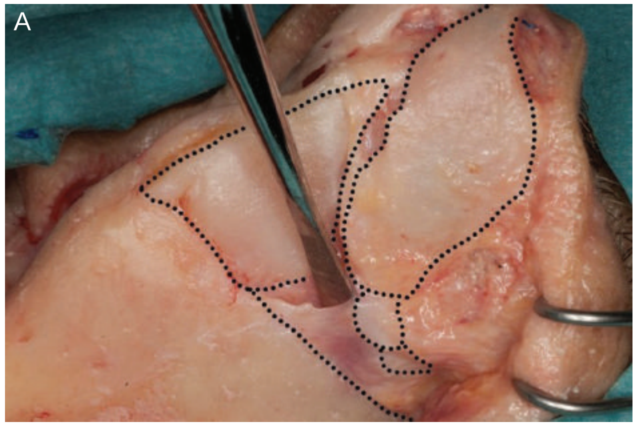
Numerous surgeons described a narrow circular fibrous attachment beginning at the latera crus, incorporating sesamoid cartilages, and then attaching to the pyriform aperture.[15,16] This observation is incorrect for two reasons. First, these attachments are not inconsistent small fragmented sesamoid cartilages, but rather distinct consistent accessory cartilages. In many anatomic texts, these accessory cartilages are named "the lesser alar cartilages."[17] Second, they are attached to the mucosa and are part of an alar ring without a direct attachment to the pyriform aperture.[18] The accessory cartilage chain is part of the *ala ring,* which begins at the footplate of the medial crus, passes along the entire length of the alar cartilage, and continues in the accessory cartilage chain toward the anterior nasal spine. Functionally, this flexible alar ring undergoes dilation or compression depending upon the nasal musculature. Thus, there is little evidence of a significant supporting ligamentous structure between the accessory cartilages and the pyriform aperture. Despite the beliefs of the advocates of the tripod concept, these structures do not provide major direct structural support to the tip.

Pyriform Ligament

Rohrich et al[19] has identified a broad ligament between the bones of the pyriform aperture and the adjacent cartilages. Although the purpose of their study was to describe the static ligamentous connections of the alar base, it was obvious that the pyriform ligament runs in too deep a plane to have any direct connection to the alar base. The pyriform ligament is probably a vestigial ligamentous sheet left over from absorption of the cartilaginous capsule between the periosteum of the bony pyriform aperture and the perichondrium of the adjacent cartilage (Figure 3). However, it does reinforce the mucosal space, which is a dynamic structure that functions as the bellows of the nose and is associated with lateral wall insufficiency.[20] Because surgeons have sought total exposure of the bony vault for piezoelectric surgery, it has become necessary to cut a portion this ligament.[21]

Scroll Ligament Complex

A longitudinal fibrous attachment has long been recognized in the scroll area between the cephalic border of the LLCs and the caudal border of the ULCs. Recently, Saban and Polselli[22] identified a distinct fibrous attachment from the undersurface of the transversalis muscles to the scroll junction. Thus, we now have a "longitudinal and a vertical scroll ligament" that can be collectively referred to as the "scroll ligament complex." The longitudinal scroll ligament occurs at the junction between the LLC and ULC and often has interspersed sesamoid cartilages within the fibrous tissue (Figure 4). Drumheller[23] found three distinct variations between the cartilages including appositional, alar overlap, and alar underlap. Preservation of this ligament can be achieved by maintaining the cephalic lateral crus. Alternatively, one can do a "cephalic preservation" procedure as recommended by Ozmen et al.[24] When the longitudinal scroll ligament is divided through an intercartilaginous incision, it can theoretically be repaired with two interrupted sutures. Saban and Polselli[22] introduced the concept of a "vertical scroll ligament" that emerges from the undersurface of the deep SMAS layer and inserts into the internal nasal valve area (Figure 5). Saban and Polselli[22] also noted distinct superior and inferior lateral nasal ligaments along the pyriform aperture, which they designated "ligamentum laterale superius and inferius nasi." We have found these ligaments to be inconsistent as distinct entities, but we have found a consistent vertical attachment between the entire pyriform aperture and the overlying soft tissue envelope, which we have designated as the "pyriform aperture ligament" (Figure 5). It is particularly dense at the keystone area and on occasion along the lateral border. Release of this pyriform aperture ligament has become important in the total dorsal exposure associated with complete lateral osteotomies done with a piezoelectric saw.[21]



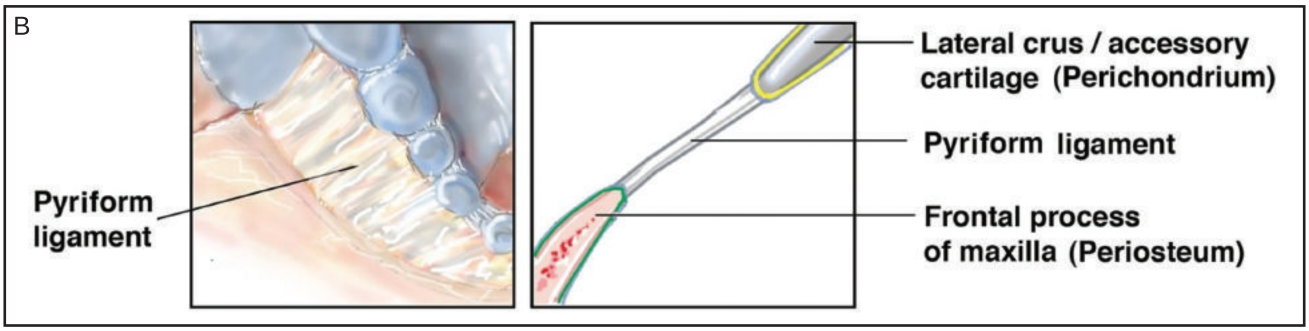


Figure 3. Pyriform ligament. (A) Pyriform ligament extends between the pyriform aperture and the accessory cartilage chain. (B) Schematically, the pyriform ligament represents the perichondrium of the cartilaginous capsule.

Pitanguy's Midline Ligament

Pitanguy[25,26] described a ligament originating on the undersurface of the dermis and running tangentially down to and in between the alar cartilages. He reported a connection between this ligament and the depressor septi nasi (DSN), which was later confirmed by de Souza Pinto.[27] Recently, Saban et al[10] demonstrated that the medial SMAS at the level of the internal nasal valve divides into a superficial layer and a deep layer. The superficial medial layer runs caudally below the interdomal fat pad, but *above* the interdomal ligament into the columella. The deep medial layer of the SMAS runs *beneath* the interdomal ligament, but above the ASA into the membranous septum and then downward toward the anterior nasal spine. Saban et al[10] concluded that the deep medial SMAS could correspond to Pitanguy's ligament.

Based on the accepted five-layer laminate concept of the nasal soft tissue envelope, Pitanguy's ligament cannot be a true dermocartilaginous ligament, because it would have to run tangentially from the dermis across and through the SMAS to reach the cartilaginous structures in the tip. We have modified the original terminology and advocate the use of the term "Pitanguy's midline ligament," which reflects its origin as part of the midline SMAS layer. Our dissections confirm previous observation.[14] We would emphasize that Pitanguy's midline ligament divides into a "superficial portion," which passes above the interdomal ligament and becomes continuous with the superficial orbicularis oris nasalis (SOON) muscle, and a "deep portion," which passes below the interdomal ligament and becomes continuous with the DSN muscle (Figure 6).

Surgically, division and repair of Pitanguy's midline ligament has become an important method of supporting the nasal tip. However, it must be emphasized that it is the deep branch that is repaired, whereas the superficial branch is usually irreparably disrupted during exposure. Utilizing a closed approach, Cakir[5] identifies, marks, divides, and then repairs Pitanguy's midline ligament. He feels that this method allows him to ensure long-term tip support. In our thick-skin patients, we often excise the SMAS tissue in the supratip region to reduce the bulk of the soft tissue envelope. Once the tip suturing is completed, we often utilize a tip position suture to rotate and support the tip. The suture passes from the distal deep SMAS of Pitanguy's midline ligament to the dorsal septum near the ASA. One is utilizing the ligament as a tether to control tip position.

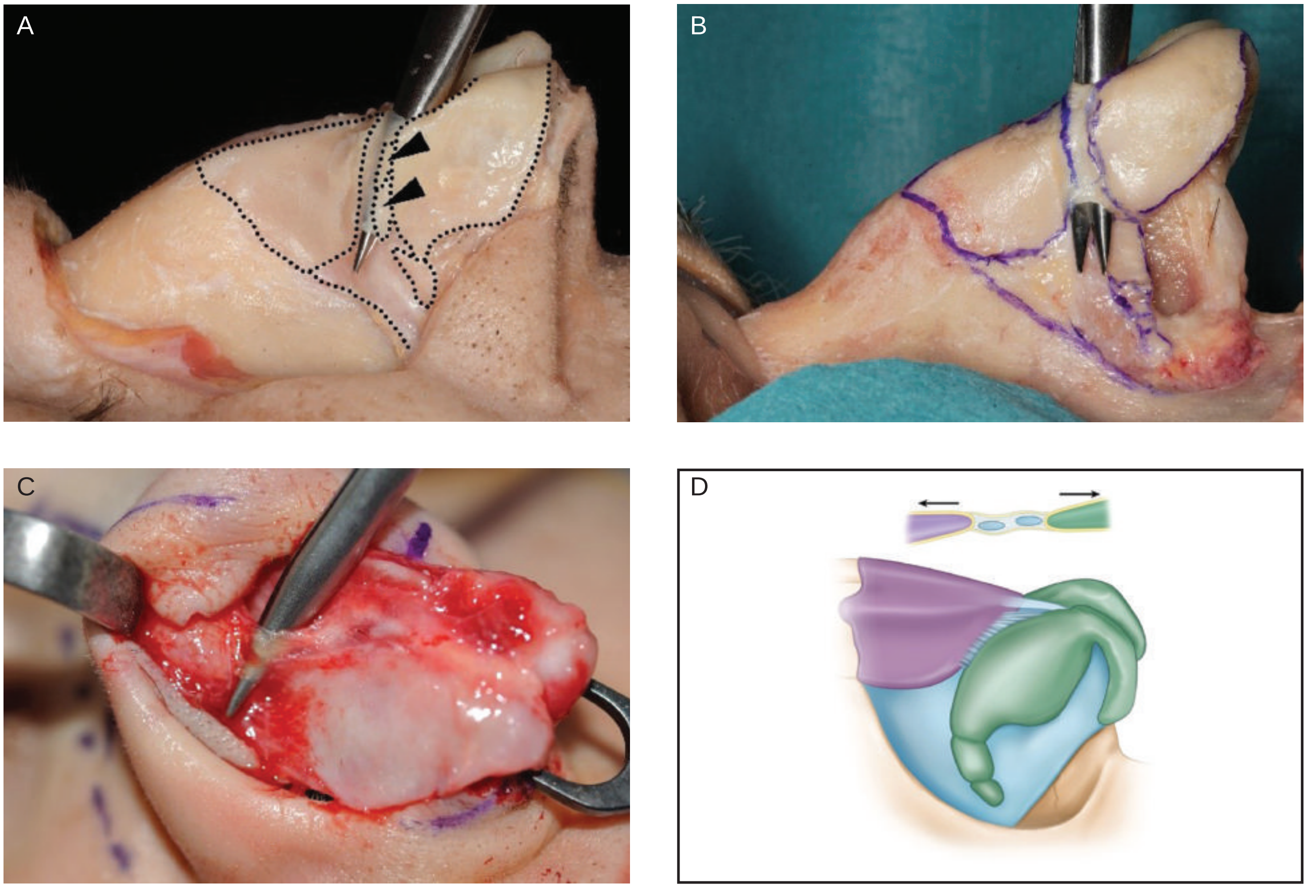


Figure 4. Longitudinal scroll ligament. (A, B) Cadaver dissection showing longitudinal scroll ligament running transversely between the lower lateral cartilage (LLC) and the upper lateral cartilage (ULC). (C) Clinical exposure showing the longitudinal scroll ligament. (D) Schematic drawing emphasizing the presence of sesamoid cartilages in between the cartilage junction.

Structural Tip Support

In addition to nasal ligaments, another source of tip support has been postulated to be the relationship between the anterior nasal septum and the alar domes. Bitik et al[28] stated that in the normal nasal anatomy, "an anterior septal angle of sufficient height keeps the feet of the medial crura off the anterior nasal spine; the medial crura do not bear a significant load." Constantian[29] considers the ASA-to-tip relationship to be the cardinal point in planning and performing tip surgery. However, what is the actual anatomic relationship between the ASA of the dorsal septum and the alar cartilage? Our studies indicate that four landmark points must be defined (Figure 7). The anterior septal prominence (ASP) is the most projecting point on the dorsal septum. It may range from the ASA to the keystone area depending on the patient's dorsal hump. The anterior septal angle is a commonly used term, but rarely defined. The consensus is that the ASA represents the junction between the dorsal and caudal septa. The posterior septal angle (PSA) is the junction between the caudal septal cartilage and the anterior nasal spine, which is easily defined. Based on our dissections, we have identified a new landmark—the caudal point (CP)—which is the most caudal portion of the caudal septum.

From our dissections, it is obvious that the domes are caudal to the ASA (average, 5.7 mm; range, 2.2-9.6 mm) while projecting above the ASA (average, 5.5 mm; range, 2.9-9.5 mm). This anatomic finding confirms the observation in 1985 by Lessard and Daniel,[30] who stated that "in more than 80% of dissections, the alar domes projected far above the septal angle (8.0 mm), thus discounting the concept of the septum providing direst support to the nasal tip." Interestingly, Byrd et al[31] recommended that the tip projection above the septum should be 6 mm in thin-skin patients and 10 mm in thick-skin patients, for an average of 8 mm. Thus, anatomically and surgically, the domes should project above the ASA.

Surgical Implications

Preservation vs Transection

With a clear understanding of the nasal ligaments, surgeons must decide whether to preserve, transect, or repair

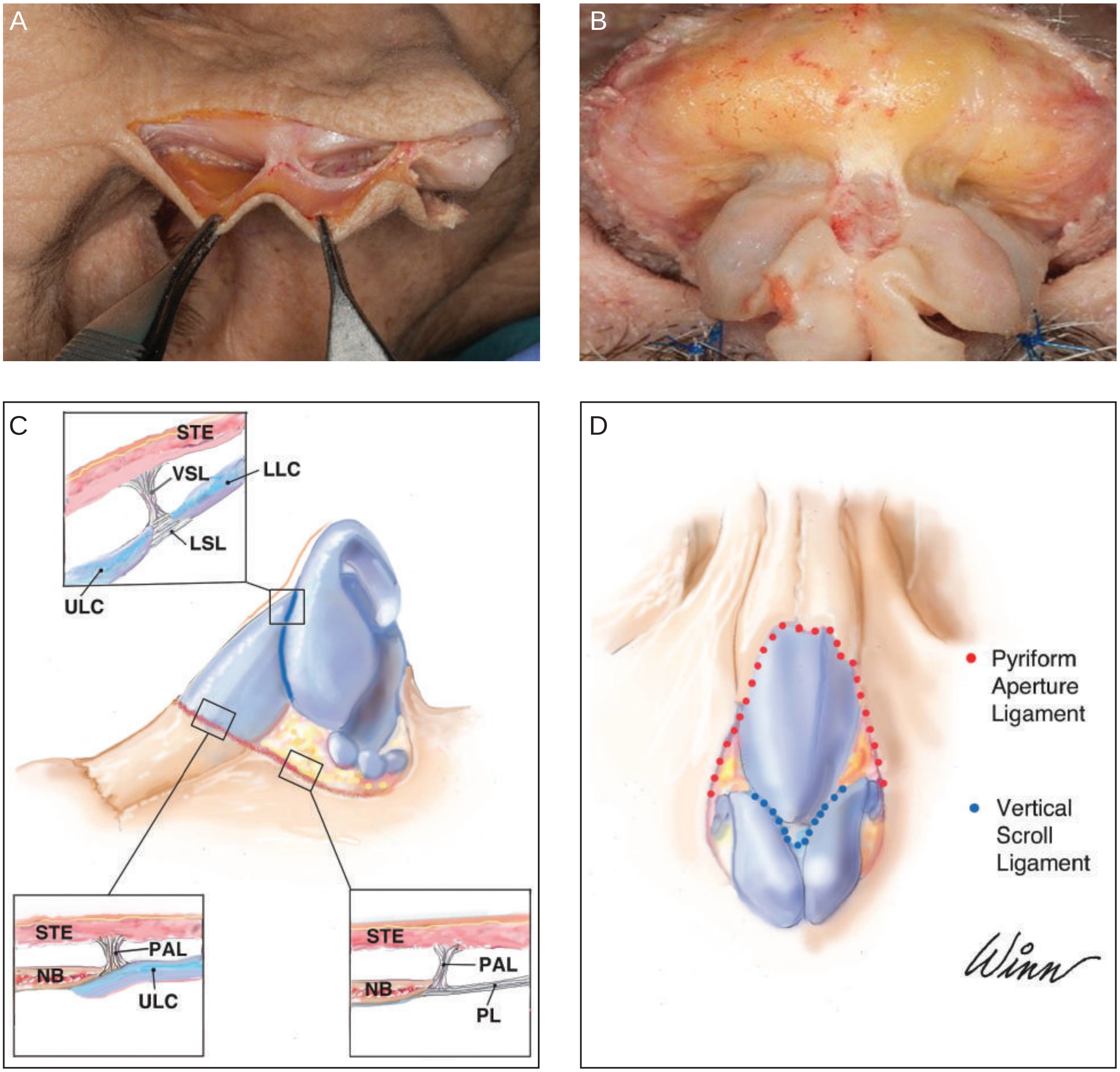


Figure 5. Vertical scroll ligament (VSL) and pyriform aperture ligament (PAL). (A) Cadaver dissection showing the vertical scroll ligament (VSL) at the junction between LLC and ULC and the vertical pyriform ligament (VPL) between the ULC and the NB. (B) Origins of VSL and VPL. (C, D) Schematic representation of the vertical scroll ligament and pyriform aperture ligament. LLC, lower lateral cartilage; LSL, longitudinal scroll ligament; NB, nasal bone; PAL, pyriform aperture ligament; PL, pyriform ligament; STE, soft tissue envelope; ULC, upper lateral cartilage; VPA, vertical pyriform attachment (VPA); VSL, vertical scroll ligament.

the ligaments they encounter during rhinoplasty surgery. One only has to watch intraoperative videos of surgeons performing an open "tip split" procedure to see the division of the interdomal and intercrural ligaments. In primary rhinoplasty cases, one can achieve adequate exposure of the dorsum and septum with simple downward retraction of the alars, followed by a distal dorsal split in the area of the ASA. Rather than a transfixion through the membranous septum that disrupts the intercrural ligaments, one can do either a unilateral or a complete septal transfixion incision, which preserves the entire ligamentous membranous septum. Preservation of the cephalic portion of the lateral crus with its associated ligamentous scroll attachment is possible in many cases. Automatic resection of the cephalic

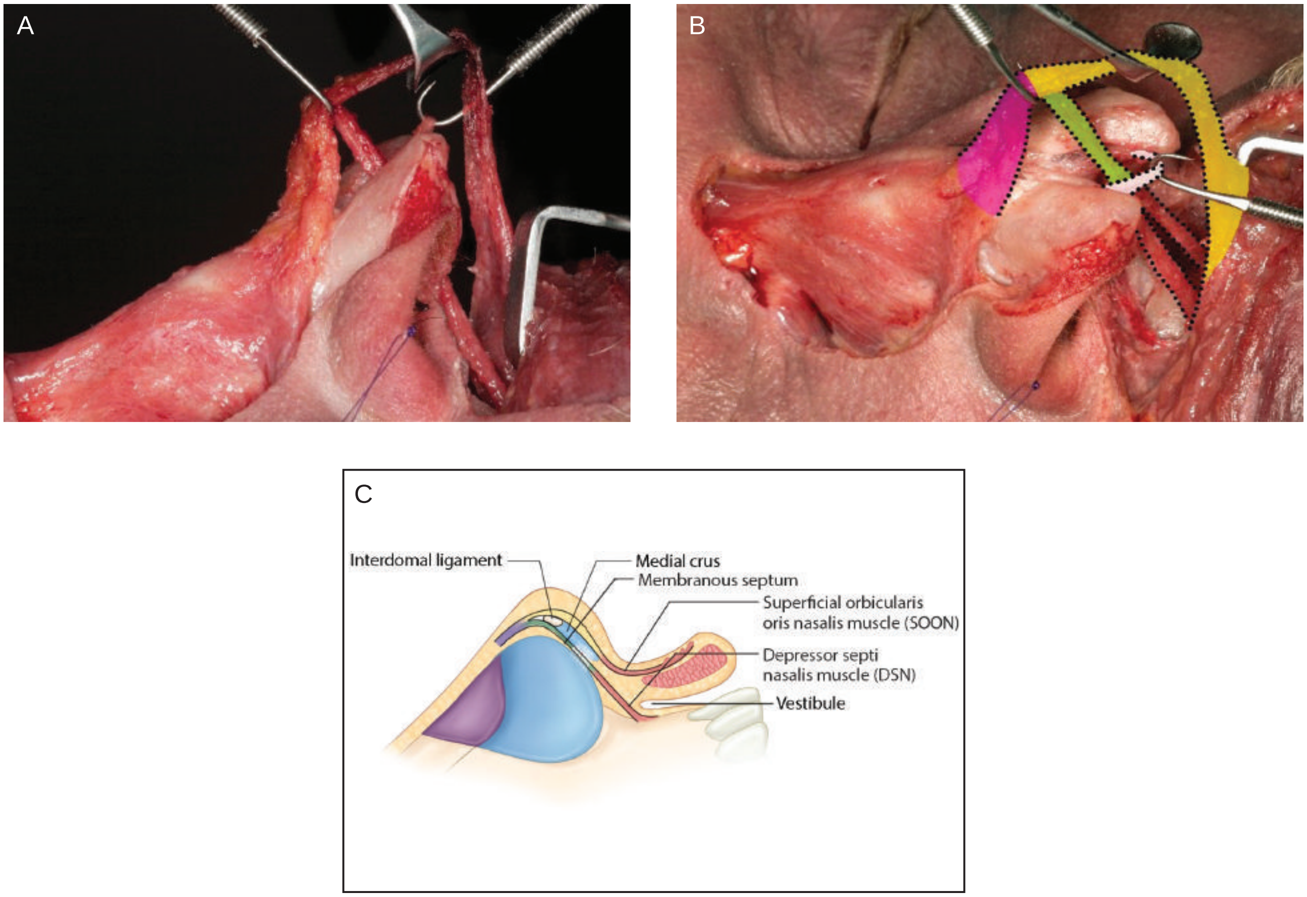


Figure 6. Pitanguy's midline ligament. (A, B) Cadaver dissection showing a split of the midline superficial muscular aponeurotic system (SMAS) (pink) into its superficial (yellow) branch, which continues to the superficial orbicularis oris nasalis (SOON) muscle and its deep branch (green), which continues to the depressor septi nasi (DSN) muscle. (C) Schematic representation of Pitanguy's midline ligament and its muscle junction.

lateral crus should be avoided, as well as the creation of a standard 6 mm rim strip. An individualized approach should be taken, beginning with the question "Can the entire lateral crus be preserved?"

For almost a century, surgeons have tried to achieve a desired tip shape by incision and excision of portions of the alar cartilages. However, the almost routine excision of the cephalic lateral crus can be associated with tip deformities, alar rim retraction, and external valve collapse. In 2010, Gruber et al[32] popularized the concept of preserving an "island" of the cephalic lateral crus to prevent alar rim retraction. His technique consisted of the following steps: (1) an open approach; (2) an intercartilaginous incision; (3) a transcartilaginous incision through the lateral crus 6 mm back from the caudal border; (4) correction of any bulbosity with a lateral crura convexity suture; (5) sliding the *island* of cephalic lateral crus *under* the rim strip; (6) trimming of any distorting irregularities at the cephalic border; and (7) fixation of the two segments with two sutures of 5-0 PDS. Ozmen et al[24] had described a similar technique of simply *sliding* the intact cephalic portion of the lateral crus under *without* the intercartilaginous incision and the creation of an island. The method of Ozmen et al ensures preservation of the longitudinal scroll ligament between the ULCs and LLCs.

Ligamentous Tip Suturing

Obviously, preservation of the nasal ligaments during exposure is highly recommended. If transected, the ligamentous structures can be repaired as part of the tip suturing process. The most obvious example is the repair of Pitanguy's midline ligament. During exposure, the ligament can be isolated and then divided between two 6-0 marking sutures. At the end of the case, the ligament is repaired, which pulls the soft tissue envelope downward, thus reducing the supratip dead space and potentially stabilizing the tip. In thick-skin noses, one often resects the SMAS layer in the supratip region to debulk the area, which includes the proximal portion of Pitanguy's midline ligament. However, its distal portion is not resected, and a

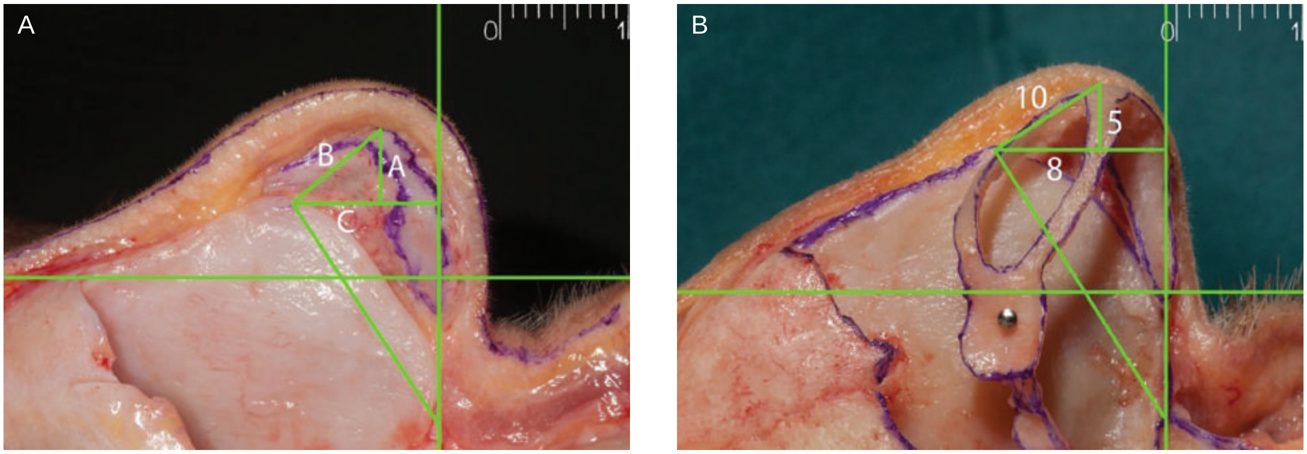


Figure 7. Tip support. (A, B) Measuring the distance from the anterior septal angle (ASA) to the alar dome tangentially (b) as well as longitudinally (c) and vertically (a). The alar dome is caudal and above the ASA with no direct structural support.

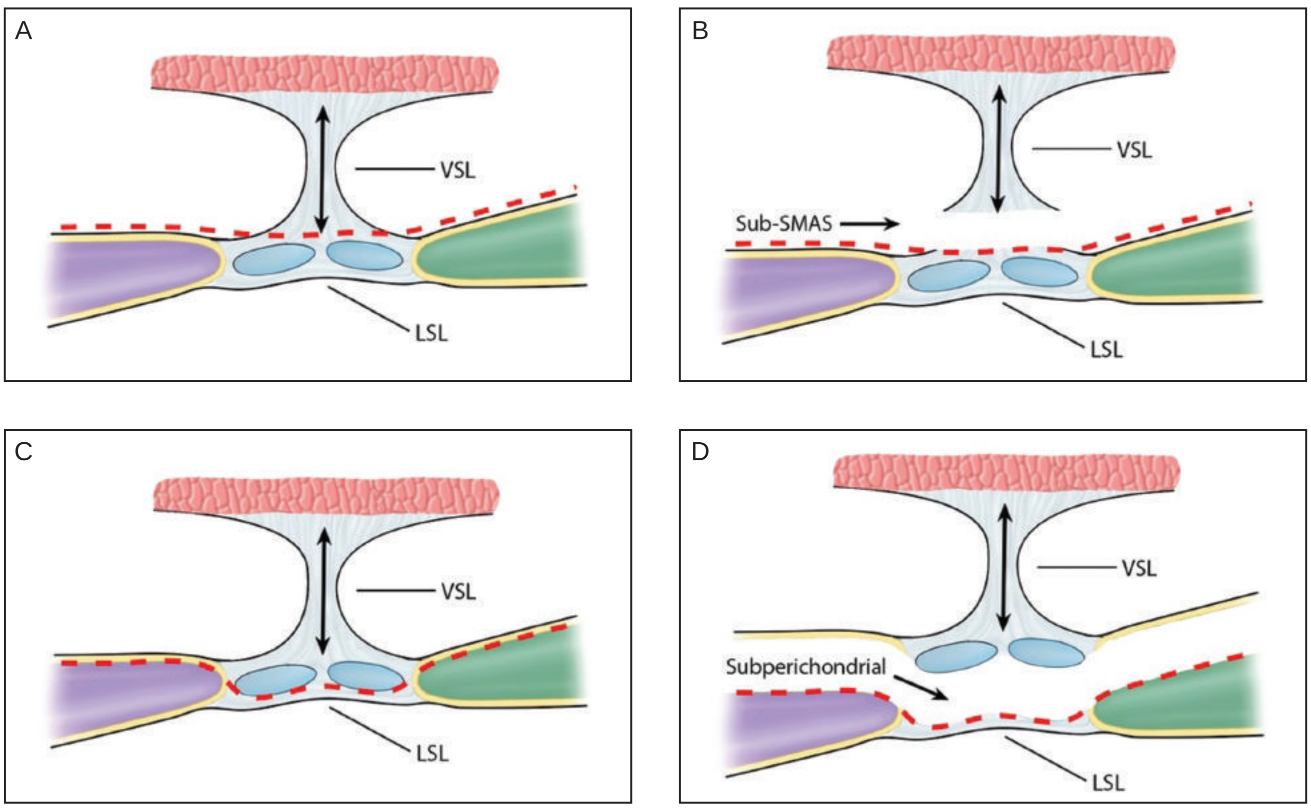


Figure 8. Scroll ligament complex. (A) The junction between the vertical (VSL) and longitudinal (LSL) scroll ligament, which form the scroll ligament complex. (B) The sub-SMAS dissection plane detaches the VSL from the LSL (C, D) The subperichondrial dissection splits the LSL, allowing elevation beneath the sesamoid cartilages and preservation of the integrity of the scroll ligament complex. LSL, longitudinal scroll ligament; SMAS, superficial muscular aponeurotic system; VSL, vertical scroll ligament.

tip-position suture can be inserted for rotating the tip. Its effectiveness is indicated by the greatest risk being over-rotation of the tip. The concept of a "scroll ligament complex" has important surgical and functional implications (Figure 8). In the standard sub-SMAS dissection, one cuts through the fusion of the vertical and longitudinal scroll ligaments at the insertion of the vertical scroll ligament into the longitudinal scroll ligament. At the time of closure,

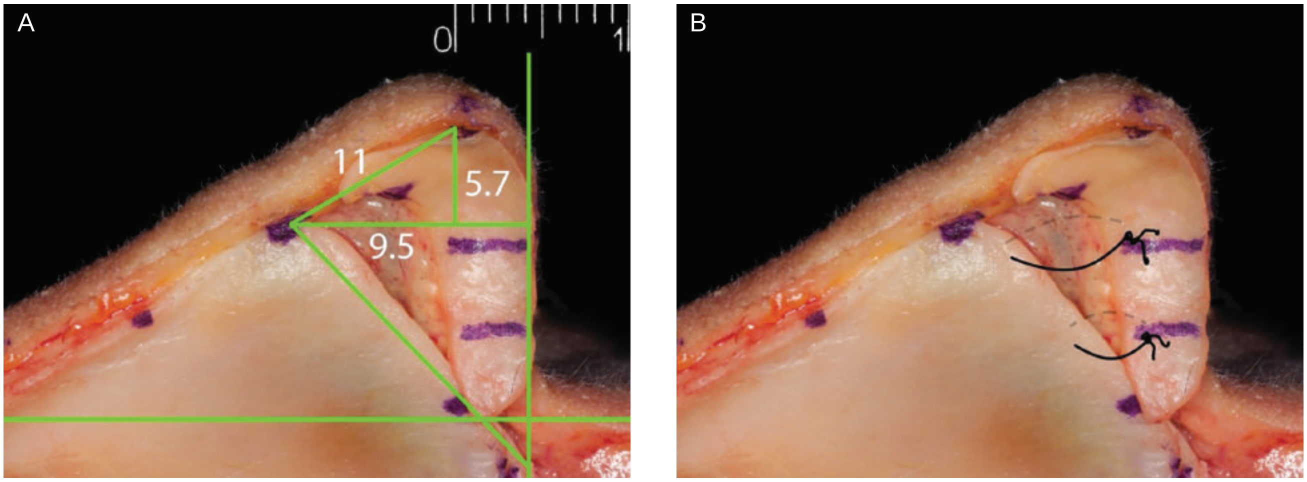


Figure 9. Tongue-in-groove (TIG) operation. (A) Relationship of the medial and middle crus to the caudal septum. Note: the membranous septum is 9.5 mm wide, and the caudal septal inclination is 145 degrees. (B) A TIG procedure would result in excessive tip rotation.

the vertical scroll ligament can be sutured to the underlying structures to both accentuate the alar groove and to close lateral dead space. Alternatively, if one performs a meticulous subperichondrial dissection over both the ULC and the LLC, one can split the longitudinal scroll ligament below the sesamoid cartilages and raise the scroll ligament complex intact. Reattachment to the underlying structures not only accentuates the alar groove and closes lateral dead space, but also potentially minimizes functional disruption. Surgeons are now emphasizing preservation or repair of the nasal ligaments as a means of achieving tip projection and rotation without the use of classic columellar and septal extension grafts.[5,28] Also, it is logical to assume that if the scroll ligaments are not disrupted during exposure, that nasal function will be maintained with minimal risk of scar contracture.

Tongue-in-Groove Procedure

One of the most valuable findings from our structural study was the observation of the relationship between the alar cartilages and the inclination of the caudal septum, which explains many of the problems that occur with the TIG operation. Kridel et al[33] popularized the TIG operation for treating the hanging columellar. The specific steps are as follows: (1) correction of any caudal septal deviation through bilateral full-transfixion incisions; (2) retrograde dissection between medial crura with optional soft tissue excision; (3) telescoping of the columellar on to the caudal septum; (4) fixation with 4-0 chromic sutures; and (5) bilateral membranous septum excision. Based on our experience with secondary rhinoplasty patients having had a previous TIG procedure, the most common errors include the following: (1) underresection of the anterior nasal spine; (2) persistent deviation of the caudal septum; and (3) excessive upward tip rotation. Excessive upward columellar/tip rotation is a devastating deformity for the patient to accept and for a subsequent surgeon to fix. Why does it occur? As seen in Figure 9, the inherent inclination of the caudal septum is 145 degrees, and any suture fixation of the middle crus to the caudal septum will result in too much upward rotation, Therefore, we advocate a modified TIG in which only the medial crus is sutured to the caudal septum, thereby setting columellar inclination. The middle crus is sutured to a shortened free-floating columellar strut, thus allowing the direct control of tip rotation and projection independent of the caudal septum.

CONCLUSION

Based on our studies, two of the four ligamentous structures identified by Janeke and Wright[1] are inaccurate. There is no distinct fibrous attachment between the medial crural footplates and the caudal septum, nor is there a distinct ligamentous attachment between the accessory cartilages and the pyriform aperture. However, the alar cartilages are joined together by the interdomal and intercrural ligaments. Rather than utilizing the fixed structural "tripod concept" of the alar cartilages, we propose a more dynamic concept of the tip. It begins with the intrinsic integrity of the alar cartilages, which are held together by ligaments. These cartilages are then encased in the nasal SMAS, which attaches through insertions and even muscle origins (anterior dilator, compressors). Thus, the alar cartilages are controlled by the SMAS and act as a dynamic structure that abuts the cartilaginous framework. Our second group of dissections indicate that there is no direct fixation or support between the domes and the ASA. Thus, the alar cartilages are dynamically mobile and can be surgically manipulated. It is our recommendation that surgeons should consider preservation of the nasal ligaments whenever possible and utilize them to control tip projection, position, and rotation. Awareness of the relationship of the dome and caudal septum will hopefully minimize problems with the TIG operation.

Disclosures

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The Role of Piezoelectric Instrumentation in Rhinoplasty Surgery

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Abstract

Background: In rhinoplasty surgery, management of the bony vault and lateral walls is most often performed with mechanical instruments: saws, chisels, osteotomes, and rasps. Over the years, these instruments have been refined to minimize damage to the surrounding soft tissues and to maximize precision.

Objectives: This article will present the evolution of the authors' current operative technique based on 185 clinical cases performed over an 19-month period using piezoelectric instrumentation (PEI).

Methods: A two-part study of cadaver dissections and clinical cases was performed using PEI. Evolution of the authors' clinical technique and the operative sequence were recorded.

Results: Thirty cadaver dissections and 185 clinical cases were performed using PEI, including 82 primary and 103 secondary cases. An extended subperiosteal dissection was developed to visualize all aspects of the open rhinoplasty including the osteotomies. Ultrasonic rhinosculpture (URS) was utilized in 95 patients to shape the bony vault without osteotomies. To date, 11 revisions (6%) have been performed. There were no cases of bone asymmetry, irregularity, or excessive narrowing requiring a revision.

Conclusions: Based on the authors' experience, adoption of PEI is justified and offers more precise analysis and surgical execution with superior results in altering the osseocartilaginous vault. With extensive exposure, surgeons can make an accurate diagnosis of bony deformity and safely contour the bones to achieve narrowing and symmetry of the bony dorsum. Stable osteotomies can be performed under direct vision with precise mobilization and control. As a result of PEI, the upper third of the rhinoplasty operation is no longer shrouded in mystery.

Level of Evidence: 4

4
Therapeutic

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In rhinoplasty surgery, management of the bony vault and lateral walls is most often performed with mechanical instruments: saws, chisels, osteotomes, and rasps.[1,2] Over the years, these instruments have been refined to minimize damage to the surrounding soft tissues and to maximize precision. However, the continued lack of precision and the associated uncontrollable fracture lines prompted a search for more precise surgical tools. Subsequently, electric instruments with reciprocating heads were developed to overcome the limitations of manual instruments.[3,4] Power-assisted rasps, burrs, and saws were designed specifically for use in rhinoplasty surgery with good results. However, limitations exist such as the expense, increased operative time, risk of soft tissue injury, more extensive exposure, and difficulty performing lateral osteotomies. Recently, surgeons have begun using piezoelectric-powered ultrasonic instruments for the management of the bony vault and lateral osteotomies.[5,6] These devices minimize soft tissue injury, because a frequency of 25 to 29 kHz is utilized to cut bone, although a frequency

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greater than 50 kHz is necessary to cut neurovascular structures. Piezoelectric inserts have the ability to selectively act on bones and/or hard cartilage, without injuring soft tissues: skin, mucosa, and flimsy cartilages such as the upper lateral cartilages (ULCs) and lower lateral cartilages. Importantly, the fracture lines created by PEIs are very accurate and eliminate the risk of radiating fracture lines encountered with traditional instrumentation.This paper will present the evolution of our current operative technique based on 185 clinical cases performed over an 19-month period from June 2013 to December 2014.

Piezoelectric surgery is based on piezoelectric vibrations generated by an electrically supplied piezoceramic transducer, which can then be utilized to cut bone through various tips (herein after referred to as *inserts*) (see http://sites.synthes.com/na/piezoelectric/Overview/Pages/Piezoelectric-System.aspx for a review of the inserts and the operating components). Essentially, an electric current passes across the ceramic, resulting in an oscillation of ultrasonic frequency that is then amplified and transferred to a vibrating insert.[7,8] Bony tissue is emulsified and removed by suction irrigation without thermal or mechanical injury to the surrounding tissue. The ultrasonic frequency is set at a low level, which causes the metallic insert to oscillate for cutting hard tissues (bones, stiff cartilages), while leaving soft tissues (vessels, nerves, mucous membranes) untouched. The insert's tip vibrates within a range of 60 to 200 µm, allowing a very precise bone incision. Water irrigation is provided through a distal port of the working tip through a hydraulic circuit inside the handpiece. A peristaltic pump enables differential water flows. A foot pedal allows the surgeon to control all the parameters (power, mode, and irrigation). For simplification of the text, we will refer to piezoelectric surgery as PE and the various piezoelectric instruments as PEIs, which will include the numerous inserts: saws, rasps, burrs, and scalpels.

PE is suitable for all bony surgery, but it is particularly valuable when access is restricted and/or the bones are near delicate soft tissues (vessels, nerves, skin, mucosa, dura, and pleura). It allows the surgeon to perform osteotomy, ostectomy, and osteoplasty. PE is well established clinically, with review articles detailing its evolution over the past 20 years.[9] Initially, PE was utilized in dental and oral surgical procedures such as excision of cysts, third molar extraction, preparation of implant sites, creation of an opening into the maxillary sinus, and elevation of endosteum. Subsequently, PE was utilized in maxillofacial surgery with extension to maxillary LeFort I osteotomies, mandibular sagittal split osteotomies, and cranial bone harvesting.[10] PE is particularly useful in craniofacial surgery, because it allows extensive osteotomies without injury to the underlying dura and adjacent neurovascular structures.[11] Concurrently, applications have been found for the use of PE in otological surgery (stapedectomy and chain replacement as well as facial nerve decompression) and hand surgery (osteotomy and hardware removal).[12,13] Histologic examination of bony cut surfaces shows that coagulative necrosis does not occur.[14]

The first application of PEI in rhinoplasty surgery was reported by Robiony[5] in 2004 and published in 2007. The initial publication reported on the use of a piezo scalpel for performing lateral osteotomies through a percutaneous approach. The vibrating scalpel was passed continuously along the ideal osteotomy line, resulting in a continuous osteotomy as opposed to a perforating osteotomy. A greenstick transverse fracture was then performed to achieve the desired movement. Several months later, Robiony[15] published a preliminary report on additional applications in rhinoplasty surgery including management of the bony vault as well as medial and lateral osteotomies. Hump removal was performed en-bloc, with an incision of the cartilaginous hump being made along the proposed profile line using a scalpel followed by a piezoelectric saw to remove everything cephalic to the keystone junction. Medial osteotomies were performed as vertical cuts at the junction between the septum and the nasal bone, and lateral osteotomies performed through the aforementioned percutaneous technique. In 2013 Cochran and Roostaeian[6] reported five cases of lateral, continuous low to low osteotomies using a PE aspirator through an intranasal lateral approach.

In 2010, Pribitkin et al[16] reported on their experience using PEI for dorsal hump removal in 60 patients. In addition to management of the bony vault, deepening of the radix/glabellar area was performed as indicated. Importantly, they were able to smooth the mobilized nasal bones following osteotomies without the risk of disrupting critical soft tissue attachments. They also reported the use of PEI for septoplasty, turbinectomy, and anterior nasal spine resection. In 2011, Greywoode and Pribitkin[17] expanded their retrospective clinical study to dorsal reduction in 103 patients with additional emphasis on anterior nasal spine resection (10 patients) and glabellar deepening (3 patients), plus routine use in smoothing mobilized nasal bones and sculpting convexities of the nasal bones. Then in 2013 these same authors updated their series to 150 patients and provided a detailed description of the use of PE for septoplasty and inferior turbinoplasty.[18] They stated that over 100 turbinectomies had been performed without any significant bleeding, synechiae, or bone necrosis.

METHODS

Initial Experience

The lead author (O.G.) began using PEI for rhinoplasty surgery in February 2013. At first, a VarioSurg machine (Nakanishi, Inc., Tochigi, Japan) was utilized with standard available inserts that had been designed primarily for dental and maxillofacial surgery. Later, a Piezotome M+

duo (Acteon Group, Mérignac, France) and a piezoelectric system (Synthes International, West Chester, Pennsylvania, USA) were utilized. Initially, surgery of the bony vault was performed using the standard soft tissue elevation techniques over the central part of the nose. Bony cap removal was achieved through sonic fragmentation of the bony cap above the cartilaginous vault using a rasp for small humps, thin bones, or in cases of thin skin. A blade or scraper was utilized for larger humps. Medial oblique osteotomies were easily performed using a saw. In all cases, smoothing the bones after hump removal or osteotomies was performed with the diamond rasp. Attempts to perform a lateral osteotomy through the usual lateral subperiosteal tunnel were unsatisfactory, because the existing saws were too short and their shape too cumbersome. Thus, lateral and transverse osteotomies continued to be performed with standard osteotomes. Next, we attempted to do external percutaneous osteotomies using PE instruments with small angulated saws for both lateral and transverse osteotomies. Although the technique did work, the PE instruments were considered less than ideal because: 1) the inserts were less adaptable than a 2 or 3 mm osteotome, 2) the skin opening was larger than a simple stab incision using a percutaneous 2 mm osteotome, 3) the skin had to be protected to avoid burn injury caused by friction, and 4) they had a greater time requirement. Therefore, a new set of inserts were developed specifically for rhinoplasty surgery. It consisted of longer instruments, which allowed lateral osteotomies and transverse osteotomies to be performed after having dissected a lateral subperiosteal tunnel. Those instruments were also designed to perform septal surgery.

Cadaver Studies

While these clinical cases were being conducted, the lead author (O.G.) began an ongoing study in cadavers to assess the effectiveness of PEI for rhinoplasty surgery between July 2013 and February 2014. All cadavers were acquired through affiliations with the Medico Legal Institute in Hamburg, Germany and the Semmelweis University in Budapest, Hungary. Cadaver dissections were not performed on patients with previous nasal surgery. During the cadaver dissections, the technique was either to remove the nasal skin completely or to perform a complete subperiosteal exposure of the bony vault from maxilla to maxilla. Visual assessment of the bones was completed, noting the asymmetries and heights of the bones. The bony cap was then removed using PEI. The amount of time it took to expose the underlying cartilaginous vault was recorded, and the overlap of the osseocartilaginous vault measured (Figure 1). Bony cap removal continued on the lateral sidewall, where the removal depended on the shape of the hump; the wider the hump, the more lateral the extent of bone removal. After exposure and bony cap removal, it was noted that a large amount of cartilage was preserved. Spreader flaps were performed noting whether or not the ULCs needed to be dislocated from the overlying nasal bones. Complete osteotomies (lateral-transverse-medial oblique) were performed, and the stability of the nasal wall (whether or not there was collapse into the nasal cavity) was recorded. The amount of medial movement was observed as well as the ability to independently and concurrently rotate the nasal sidewall. Finally, sculpting of the bony sidewalls was performed even on mobilized bones.

Clinical Technique

From June 2013 to December 2014, all patients presenting for rhinoplasty were included in the current study. Informed consent was given by all patients, although IRB approval was not obtained, because the study was performed in the authors' private practice. The current clinical technique and the methods detailed below have evolved over the past 18 months.

Extensive Exposure

Based on our cadaver dissections, we began to extend exposure of the bony vault in our clinical cases. A full subperiosteal dissection of the bony vault was performed longitudinally from the keystone junction up to the cephalic part of the radix and transversely from one ascending frontal process of the maxilla to the other side. Usually, the lateral pyriform aperture ligaments (from the lateral part of the ULC to the pyriform aperture) are elongated or trimmed, depending on their strength, to allow complete access to the nasal bony wall along the pyriform aperture. This extended dissection permitted the use of short angulated saws to achieve a continuous complete osteotomy under direct vision, which resulted in complete mobilization of the lateral bony wall. In June 2013 we performed our first open rhinoplasty with extended soft tissue elevation, allowing a complete visual assessment of the entire osseocartilaginous vault. It should be noted that no dissection of the lining was performed under the bones, which keeps the posterior support intact.

Hump Removal

After exposure, hump removal is the first part of every reduction rhinoplasty. The bony cap was removed to lower the dorsal profile line, to narrow the lateral keystone area (especially when osteotomies were not performed), and to remove any bone that would prevent a harmonious reshaping of the ULC when using spreader flaps. Bone removal was performed with a diamond burr if the hump was small or if the skin was thin, and it was performed with a scraper or blade if the hump was larger or if the skin was thick. Whichever instruments we utilized, an open roof never occurred, because the underlying cartilages and mucosa were unharmed through PEI. The bone work was performed first to set the width and shape of the bony segment of the nose

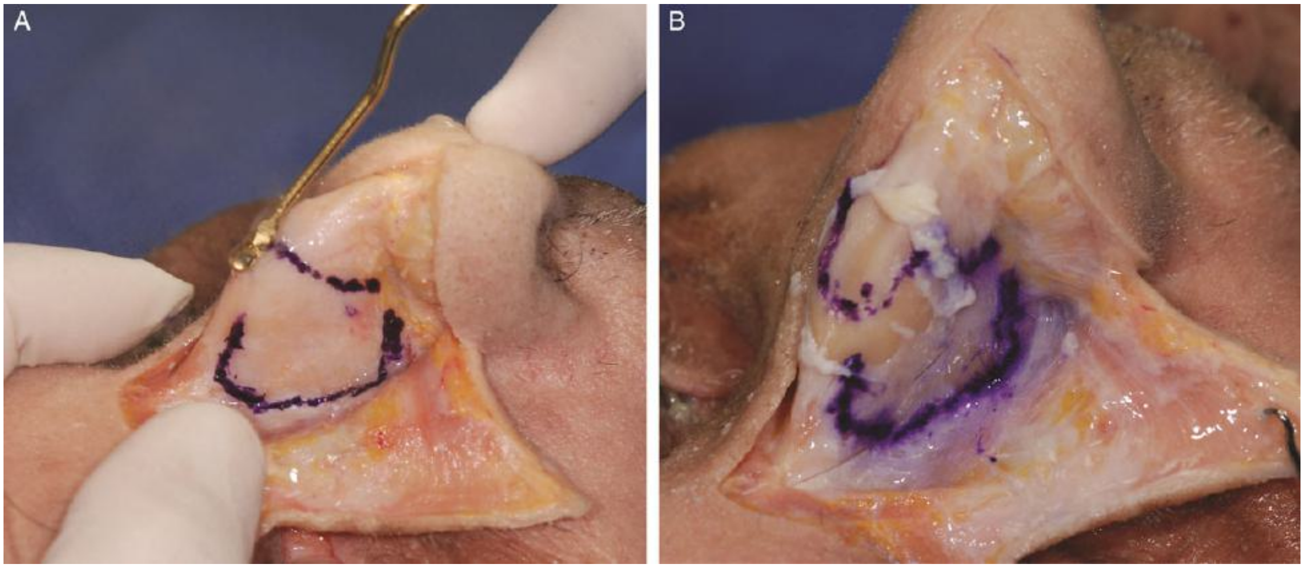

Figure 1. The clinical sequence of this 68-year-old male cadaver began with bony cap removal. (A) The cadaver after removal of the skin, and (B) after bony cap removal with the Piezo.

before opening the middle third. Submucosal dissection of the bones was *not* performed, because the mucosa would act as an internal splint for the mobilized bones. By using this sequence, the cartilage vault was managed independently from the bony pyramid *after* the bone was corrected.

Osteotomies

Osteotomies were indicated only if the bones were too wide either laterally or dorsally on preoperative assessment or dorsally after hump removal. In most cases, we prefer the following sequence. First, a low to low *lateral osteotomy* was performed as low as possible. The fracture line was initiated from the pyriform aperture just above the insertion of the inferior turbinate and continued along the nasofacial angle with an angulated saw. Then, a *transverse osteotomy* was performed. The length and shape of the transverse cut depended on the cephalic orientation of the lateral osteotomy, and also on the intended motion on the nasal bone. Finally, a *medial oblique osteotomy* was performed from the cephalic extent of the hump removal in an oblique direction beginning at the desired dorsal aesthetic line and connecting to the transverse osteotomy. This osteotomy wasn't usually performed when the radix was narrow; rather, in this case, medializing the bone with a blunt periosteal elevator introduced in the lateral osteotomy was enough to narrow the bony pyramid. Next, the completeness of the osteotomy was confirmed using a blunt periosteal elevator, and the bone flap was mobilized medially. The bone flap can be moved more caudally or more cephalically, depending on the pattern of the bony pyramid.

From our initial experience, it became clear that bone mobilization is composed of two vectors: a horizontal vector and a rotational vector. When the combination was a low to low lateral osteotomy plus a longer transverse osteotomy and a medial oblique osteotomy, then the movement was predominantly a horizontal movement of the lateral wall. In case of a more "triangular pattern" osteotomy composed of a low to high lateral osteotomy, followed by a very short transverse osteotomy and a medial oblique osteotomy, then the main movement was rotation of the mobilized bone. Both motions could be combined. A rotation was desired when the lateral wall is flat and needs to be verticalized. Otherwise, a horizontal translation of the bone was utilized to narrow the bony pyramid. No overlapping of the bones occurred medially, because the bones meet end to end and were very stable. Once the osteotomies were completed, the bony edges could be smoothed with a diamond burr. Visually one could evaluate the bones and then assess them digitally through the skin. Usually a burr was utilized to smooth the dorsal edge of the medial oblique osteotomy. Finally, additional smoothing with a burr or a rasp could be performed at the end of the surgery, even when the skin has been sutured in the case of open approach, to reduce any irregularity palpated during the final checking.

Ultrasonic Rhinosculpture

Bone reshaping procedures with associated narrowing and remodeling are designated as *ultrasonic rhinosculpture* (*URS*). In cases in which the bony vault required only a slight reduction (1-3 mm), a true osteoplasty of the bony pyramid was possible by shaping the different parts of the nasal bones and osteotomies were not required. The bony cap was removed, followed by a superficial ostectomy performed with the more convex side burred down more than the opposite side. In very asymmetric cases, the bony cap was removed first from the medial and lateral keystone area. If the convexity was more lateral where the bones were thick, then ostectomy with saws or burrs was favored. If the convexity was more medial where the bones were thin, vertical and horizontal cuts were performed in a criss-cross pattern to straighten the convexity without removing a significant amount of bone.

Middle Third Reconstruction

Reconstruction of the middle third was directly related to the amount of dorsal reduction. If the profile line was good after treatment of the bony pyramid, then we did nothing to the middle third. Slight narrowing could be achieved using a 4, 0 mattress suture placed at the cephalic end of the ULC. If this suture increased the height of the arch slightly, then the ULC could be partially released from its junction with the bones. If the profile line needed to be lowered less than 1 mm, and/or if the dorsum was too broad, then the cartilaginous hump could be tangentially shaved to lower it or to reshape it. In all other cases of middle third lowering, a split incision was made vertically on both sides of the septum, separating the septum from the ULC. All the septal work was then performed and the dorsal height lowered. After removal of the bony cap both in the central and lateral keystone areas, it became possible to fully mobilize the ULC inwards without having to dislocating it from the bone. Also, it was possible to place more sutures in the cephalic end of the ULC. Spreader flaps were created by folding the ULC over and suturing them with 4-0 sutures. If the ULC were too flimsy or too stiff, spreader grafts could be utilized. When spreader grafts were performed, they were overlaid with bent ULC to achieve a curved shape for the reconstructed dorsum.

Septoplasty

Long saws were developed to allow very precise cuts on the exposed septum. Spurs were easily corrected by tangential trimming in a sagittal direction. A big advantage of piezo-assisted septoplasty was safe treatment of *high* septal deviations. A small strip of perpendicular plate was removed safely, without using the twisting motion of the septum. Also, there was much less risk of a radiated fracture to the skull base. Once the bony excess of the septum was removed, the remaining part could be medialized.

Perioperative Care

All patients were given a preoperative antibiotic dose of a first-generation cephalosporin as well as a 5-day oral course of antibiotics postoperatively. A standard splint was applied at the end of the operation for 5 to 7 days, and taping was done every night for 3 weeks.

RESULTS

Cadaver Results

The following important findings from the cadaver studies are illustrated in Supplementary Video 1, which can be viewed at www.aestheticsurgeryjournal.com. Thirty cadaver dissections were performed (18 male, 12 female), with an average age of 68 years in the cadavers (range, 21-87 years).

(1) Direct visual assessment of the bones showed that in nearly all cases (n = 28, 93%), the lateral nasal bony walls were asymmetric with a more convex side and a more concave side. Measurements of lateral nasal bone length were available in the rhinoplasty literature.[19] The average time for wide exposure took an extra 4 minutes on average, compared with a standard rhinoplasty approach.

(2) During hump removal, it was easy to remove only the bony cap without injuring the underlying cartilaginous vault and/ or the mucosa more cephalically. Thus, a true open roof never occurred with the use of PEI. Injury to the cartilaginous tissues was virtually impossible with PEI. The overlapping of the bone over the ULC ranged from 6 to 20 mm in longitudinal length with an average of 12 mm. The time required to remove all the bone over the cartilaginous hump ranged from 2 to 5 minutes, with an average of 3.2 minutes depending on the height of the hump and its cephalic extent.

(3) Bony cap removal continued on the lateral sidewall depending upon the shape of the hump; the wider the hump, the more lateral the extent of bone removal.

(4) Because bone removal was easy and accurate over the medial and lateral keystone areas, the result was more extensive exposure of the underlying cartilaginous vault than is common with the use of either osteotomes or rasps. Because the ULCs were more visible, it was easier to shape them and they allowed shaping with greater precision. This extensive exposure of the cartilaginous vault allowed easier creation of spreader flaps without the need to dislocate the ULC from its bony attachment. Also, mattress sutures could be placed much more cephalically, because the bone had been removed from the lateral sidewalls. Spreader flaps were more stable, because more cephalic sutures could be added compared with traditional techniques.

(5) The stability between the ULC and the bone was intact even after extended bony hump removal. Preservation of fixation occurred, because all the connections between the posterior periosteum of the bone and the anterior perichondrium of the ULC were not damaged. Even when pushing as hard as possible on the ULC with a forceps, no gap between the ULC and the bones was observed.

(6) When a complete osteotomy (lateral-transverse-medial oblique) was performed, the bony wall remained extremely stable without collapse into the nasal cavity in all cadavers (Figure 2). This essential finding led us to begin performing an extended subperiosteal dissection of the bony pyramid in clinical cases. The first purpose of this extended dissection from one ascending branch of the maxilla to the other was to assess the whole length of the fracture line, and to be sure that a complete osteotomy was performed when indicated. Very quickly, this extended dissection became part of the routine dissection, allowing a very accurate assessment of the asymmetry, shape, and tailored treatment of the bones.
(7) The underlying periosteum and mucosa were never injured in any cadavers after we performed osteotomies using an ultrasonic saw.
(8) Controlled medial movement (transversed inwards) and rotation of the lateral wall was possible (Figure 3). These two movements could be performed independently or more frequently combined. This combination of bone movements was nearly impossible to assess and to control when osteotomies were executed without direct visualization. When performing lateral osteotomies, the inclination of the saw had an impact on the bone mobilization. The more angled the saw blade, the easier it was to move the bone inward. In contrast, a very horizontal cut increased the stability of the bones and made it more difficult to move the bones inward.
(9) Sculpting of the lateral bony wall was possible, either before the osteotomies or even on mobilized bones. This sculpting was performed with a burr or saw by removing a slice of bone where it was the most convex. In thin bones, the convexity could be treated with crisscross cuts to eliminate the convexity.

Clinical Results

From June 2013 to December 2014, the senior author (O.G.) performed PEI in 185 patients including 82 primary rhinoplasty cases and 103 secondary rhinoplasty cases. These patients ranged in age from 17 to 60 years (average, 27 years), with 105 females and 80 males. Average follow-up was 13 months, with 128 patients having 12 months of follow-up or more (range, 3 weeks to 20 months). The current techniques are demonstrated in Supplementary Video 2, which can be viewed at www.aestheticsurgeryjournal.com.

URS is defined as shaping of the bony vault with incremental ostectomies performed by scraping, rasping, or burring. URS was performed in 96 patients. Modification of the bony vault was achieved without any osteotomies. Indications for URS included patients with a normal bony width at the base plus a mild-to-moderate width of the bony vault, a mild-to-moderate osseocartilaginous hump (1-3 mm), or a localized convexity (asymmetries and irregularities). In 24 cases, rasping of the remaining bony excess was performed through a closed approach. In 17 of these cases, the patients were undergoing primary rhinoplasty through an open approach and the excess was noted after closure of the transcolumellar incision. It is easy to place a piezo rasp through the infracartilaginous incision and under the skin sleeve to perform fine-tuning at the end of the procedure. This group also included seven secondary patients who had traditional osteotomies by another surgeon, but had remaining localized bone excess and/or convexity. In these patients, a small tunnel was made using an endonasal, intercartilaginous approach to treat the bone excess.

In 89 cases, an osteotomy was performed on at least one side when the bony base width was judged to be too wide from the lateral to the medial canthus. A partial osteotomy consisting of a low to low osteotomy following the nasofacial groove, and a transverse osteotomy (without medial oblique osteotomy), was performed when the bones were too wide, but with a narrower upper bony pyramid, ie, narrow radix. Bony mobility was assessed with a blunt periosteal elevator, and when the inward displacement of the bone was judged sufficient, the medial part of the transverse osteotomy and the medial oblique osteotomy were postponed until after any septal work was completed. Depending on the opening of the cartilaginous vault and its management, the spring effect of the upper part of the ULC on the bones was reassessed, especially at their cephalic part. The medial portion of the transverse osteotomy and the medial osteotomy were completed if the bony vault was still too wide.

In 105 patients, the bony part of the septoplasty was completed using PE saws. In particular, it was utilized in patients with high septal deviation of the perpendicular plate of the ethmoid bone. Most frequently, a strip of bony and cartilaginous septum was removed at the turning point of the deviation, and the rest of the septum was then moved medially. When there was severe deviation of the bony septum, a larger piece of ethmoid and/or vomer was trimmed. In cases of a bony septal spur, the spur was trimmed tangentially with a piezo saw, keeping the lower part of the vomer in place if it was in the midline.

For 59 patients, a drill hole was made in the anterior nasal spine using a PE drill to facilitate relocation or stabilization of the caudal septum. In 14 patients, the premaxilla was reshaped by doing ostectomy or rasping on the pyriform aperture. An anterior nasal spine reduction was performed in 8 patients.

To date, there have been 11 revisions (6%) with 2 (1%) requiring additional radix reduction, 4 (2%) for middle vault asymmetry, and 5 for tip and alar rim asymmetries (2.5%). There were no cases of bone asymmetry, bone irregularity, or excessive narrowing requiring a revision. There were also no cases of soft tissue damage from PEI, nor did any patients have abnormal swelling from the

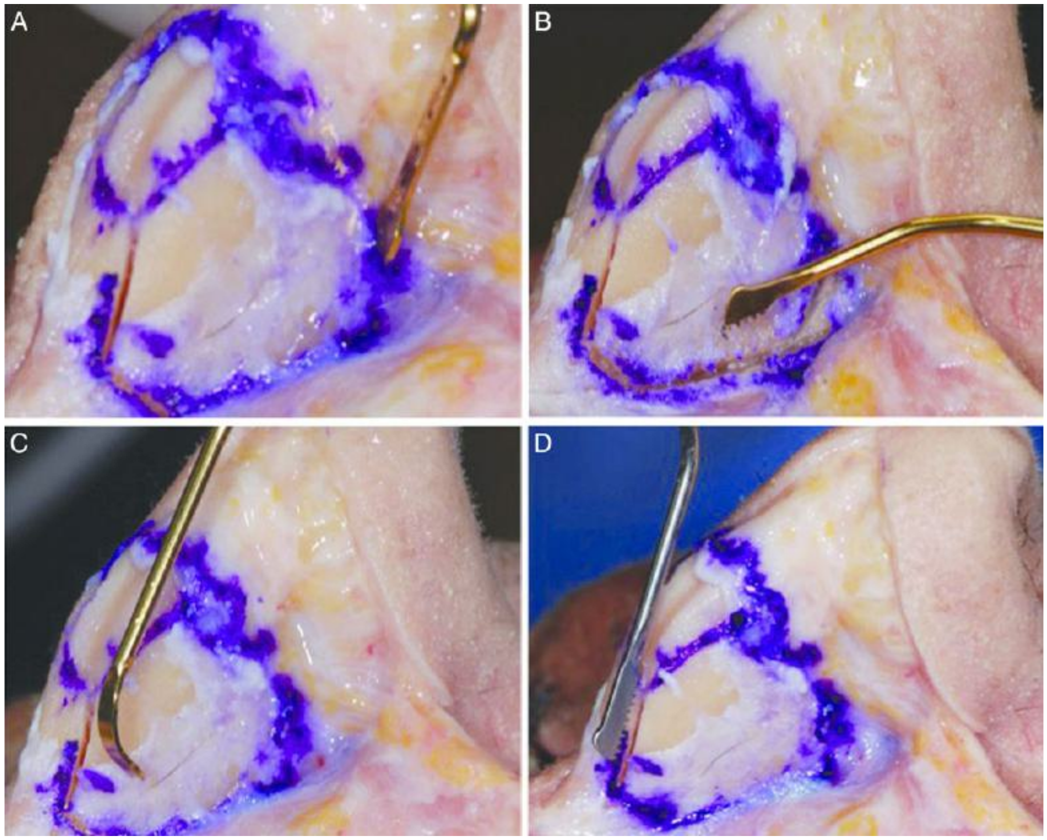

Figure 2. The osteotomy sequence in this 52-year-old male cadaver. (A) The osteotomy begins at the pyriform aperture, (B) followed by the low osteotomy, (C) then the transverse osteotomy, and (D) finally the optional medial oblique.

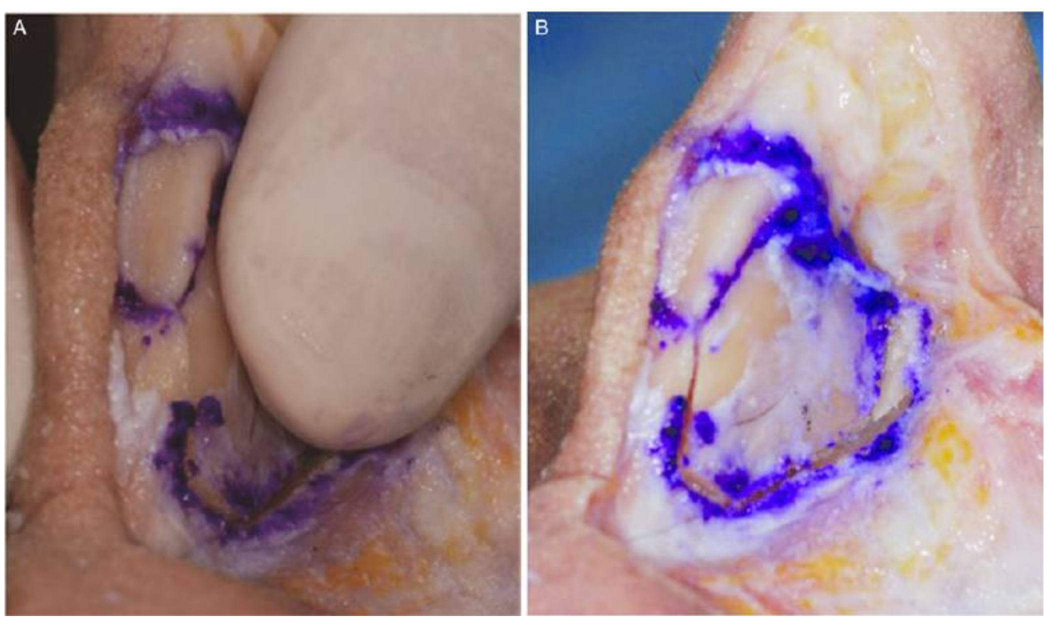

Figure 3. After the osteotomy sequence of the same 52-year-old male cadaver shown in Figure 2, manual pressure with palpation or a periosteal elevator is utilized to assess mobility and to create movement. (A) Manual pressure and (B) medial movement of the nasal bone without collapse into the nasal vault.

extended exposure. In four patients (2%), one of the bones was considered to be not stable enough after performing osteotomies. This meant that even if it was not collapsing in the airway, the fragment was felt to be unstable. In those cases, drill holes were made so that the bony fragment could be secured to the stable central segment. This was not considered to be a result of PEI; rather, wide exposure may have contributed to the "instability" of this segment. The time spent performing osteotomies and ostectomies has varied. However, we have become more efficient, because we have a better understanding of the instruments and adoption of inserts designed specifically for rhinoplasty surgery. URS with hump removal and ostectomies now takes approximately 10 minutes on average. The complete sequence of hump removal plus bilateral osteotomies and final touch-ups with ostectomies and bone polishing, takes approximately 20 minutes on average. Representative clinical examples from our study are shown in Figure 4-6, and Supplementary Video 3, the latter of which can be viewed at www.aestheticsurgeryjournal.com.

DISCUSSION

The adoption of new techniques in rhinoplasty surgery can be simple or complex. For example, switching from closed to percutaneous osteotomies is essentially a change in instrumentation and approach rather than principles.[20] The current clinical report is more complex and even disruptive of many rhinoplasty principles. For example, a new component is extensive elevation of the skin envelope combined with complete osteotomies. Traditionally, a complete osteotomy resulted in transection of the underlying periosteum and mucosa, thereby increasing the risk of the nasal bones falling into the pyriform aperture. As a result, limited skin elevation and greenstick fractures were recommended (Sheen, a rhinoplasty surgeon). In contrast, complete osteotomies performed with PEI preserve the underlying periosteum and mucosa, resulting in greater stability and optional methods of mobilization. This discussion will focus on the major changes in our rhinoplasty operation after we started using piezoelectric instruments.

Preoperative Analysis and Operative Planning

Bony vault preoperative analysis has become of paramount importance in planning the rhinoplasty, because more options are available. We have found semibasal and helicopter views more important for bony analysis than the frontal view. Because bone shape and asymmetry can be difficult to assess on frontal views, analysis and planning based on frontal views can be misleading. Palpation is also of paramount importance in planning the surgery: bone size (length, width), shape (concave, straight, concave) and asymmetries are easily assessed by palpation and can confirm visual assessment. We do this by having the patient lay on the examination table so that we can palpate the nasal bones between our thumb and index finger.

At least four changes in operative technique and sequence are readily apparent. First, extensive elevation of the soft tissue envelope permits greater visibility and assessment of the bony vault before and after surgical modification. Second, one can utilize the concept of URS to correct asymmetries of the bony vault directly by changing the thickness of the nasal bones both dorsally and laterally as well as their intrinsic convexity. The operating surgeon is no longer limited to varying the level, angulation, or number of osteotomies to achieve symmetry. Third, removal of the dorsal hump is staged with removal of the bony cap first without altering the underlying cartilaginous vault. The delay in modifying the cartilage vault until after the osteotomies allows maximum preservation of the cartilage. Fourth, complete osteotomies with intact underlying periosteum/mucosa permit more precise mobilization and stabilization than previously possible. It is only after the lateral bony wall has been mobilized that the cartilaginous vault is altered. Thus, one sees a dramatic change in operative planning and sequence compared with current methodology.

Extensive Exposure

To utilize the short PEI for the lateral osteotomies, the surgeon must elevate the skin envelope subperiosteally from one frontal process of the maxilla across the nasal bridge to the opposite side. Dissecting far laterally and cephalically as well as releasing the pyriform aperture ligaments are the two keys for optimal bone treatment with PEI. One of the principal advantages of this extensive exposure is the ability to visually assess the bony vault before and after osteotomies, with the latter performed under direct visualization. Previously, the bony vault was shrouded in mystery because of limited exposure. Traditionally, narrowing the bony vault was often accomplished using a low-to-high lateral osteotomy followed by a manual transverse fracture into the open roof. The surgeon simply assumed that the osteotomies and the fracture lines were symmetrical. However, no attempt was made to see the fracture lines or even the bony dorsum. The result of uncontrolled osteotomies is shockingly asymmetric, because the two fracture lines have different angulations and are located at different points. In our cadaver studies, fracture lines occurred at the intrinsic weak point of the lateral walls and took the path of least resistance into the open roof, which may or may not coincide with the aesthetic goal. Once observed, a controlled, medial oblique osteotomy placed at the desired point and angulated to account for the intrinsic asymmetry of the two bony lateral walls undoubtedly offers greater control and aesthetic correction of asymmetry. Once the nasal bones are directly visualized with complete exposure, the surgeon can no longer ignore the preexisting deformity, nor accept the limited improvement.

Figure 4. This 32-year-old woman underwent ultrasonic rhinosculpture (URS). This patient complained of a broad nose and undefined tip. Following complete exposure of the osseocartilaginous vault, an open URS was performed. First, approximately 1 mm of the bony cap was removed, and the upper lateral nasal walls contoured. Next, the lateral nasal walls were sculpted to narrow the width and to reduce convexity, all without osteotomy. A component cartilaginous hump reduction was performed with removal of 2 mm of dorsal height. Next, dorsal reconstruction was achieved using spreader grafts. The upper lateral cartilages (ULCs) were folded over and fixed with 4-0 polydioxanone (PDS) sutures. A 1 mm caudal septal trim was also performed. The tip deformity was treated by cephalic trim, a columellar strut, and tip sutures. The results are shown preoperatively (A, D, G), 6 days postoperatively (B, E, H), and 1 year postoperatively (C, F, I) after URS without osteotomies. Note the lack of bruising and swelling at 6 days even with the extensive exposure from maxilla to maxilla.

Figure 5. This 35-year-old woman underwent osteotomies with piezoelectric instrumentation (PEI). This patient complained of a hump and a nose that appeared masculine. She had a high, C-shaped septal vertical deviation towards the left. Structural open rhinoplasty was performed with septoplasty and repositioning of the remaining bony septum. Bilateral complete osteotomies (medial oblique, transverse and low to low) were performed after bony cap removal and a component 3 mm cartilaginous hump reduction was performed with dorsal reconstruction through spreader flaps. Cephalic trim, a columellar strut and tip sutures were utilized to treat the tip. The results are shown preoperatively (A, D, G), 6 days postoperatively (B, E, H), and 1 year postoperatively (C, F, I) after PEI with osteotomies. Note the lack of bruising and swelling even with the extensive exposure from maxilla to maxilla as well as osteotomies at 6 days.

Figure 6. This 42-year-old man with an asymmetric developmentally deviated nose (ADDN) who underwent PEI. This patient with severe facial asymmetry complained of a twisted nose that was slightly too long. He had no history of nasal trauma or surgery. Speculum examination revealed a significant S-shaped septal deviation with a cephalic convexity towards the right and a caudal convexity toward the left. First, the bony cap was removed utilizing the open approach. Complete osteotomy on the right vault was performed as well as sculpting of the sidewall. The middle vault was reconstructed with spreader grafts and the caudal septum was trimmed 2 mm and relocated to the midline. Cephalic trim, a columellar strut, and tip sutures were utilized to treat the tip. The results are shown preoperatively (A, C, E) and 1 year postoperatively (B, D, F) after PEI with osteotomies.

An extensive subperiosteal undermining can also be performed through a closed approach, and long instruments have been developed for such a purpose and to perform septal work. The technical difficulty with long instruments is to maintain efficiency; long instruments work well on thin bones, such as the vomer and the ethmoid, but they are time consuming for osteotomies and importantly, the bones cannot not visualized.

Ultrasonic Rhinosculpture

Ultrasonic rhinosculpture (URS) is an important new surgical approach, with dramatic application in both primary and secondary rhinoplasty. URS was employed in the majority of our cases (52%, 96/185). URS involves direct shaping of the bony vault to achieve the desired aesthetic goal without osteotomies. In primary rhinoplasty, the bony pyramid may be slightly wide or asymmetric. Using conventional techniques, the former would require medial oblique osteotomies and the latter asymmetric lateral osteotomies. Alternatively, URS permits removal and thinning of the nasal bones along the dorsum, thus narrowing the dorsal width. In asymmetric cases, the convex lateral bony wall can be directly thinned until the asymmetry is minimized. Focal bony convexities are easily removed. Compared with conventional techniques, URS proved extremely valuable in secondary cases with residual bony asymmetry, insufficient narrowing of the bony pyramid, or remaining convexity (localized bone excess). A significant number of secondary patients complain of a wide bony dorsum due to previous verticalization of the lateral bony walls after aggressive lateral osteotomies. One is able to directly contour the upper bony walls and achieve significant narrowing of the cephalic dorsal lines.

Bony Hump Reduction

Anatomically, the dorsal hump comprises a bony cap covering the cartilaginous vault.[21] With the recent introduction of spreader flaps, preservation of the underlying ULCs has become paramount.[22] Removal of the bony hump with an osteotome often leads to damage of the underlying cartilaginous vault or creation of an "open roof" extending 6 to 10 mm cephalic to the keystone junction. In contrast, PEI permits graded removal of the bony cap without creating an open roof or damaging the underlying cartilage. The result is the ability to extend spreader flaps cephalically in the bony vault, resulting in a more natural dorsal reconstruction. In addition, incremental controlled ostectomies can be performed laterally onto the nasal bones to narrow the dorsal width. Equally, any sharp edges or spicules after osteotomies can be easily eliminated using PEI even on mobilized bones. As noted by Gruber,[23] removal of the bony cap with maximum preservation of the cartilage is a critical first step in creating spreader flaps. In cadaver dissections the cephalic extension of the cartilaginous hump beyond the keystone junction averaged 8.9 mm (range, 4-14 mm).[20] In our combined clinical experience, we have seen only one case in which the cephalic end of the cartilaginous hump was identified and mucosa seen extending cephalically within the open roof after bony cap removal. Admittedly, this was an extreme case with a very large dorsal reduction (11 mm). Our explanation of the difference between anatomical and clinical findings is "patient selection," ie, all clinical patients having a reduction rhinoplasty have a "hump," which implies a significant cartilaginous vault component. An additional explanation may be the ossification of cartilages with aging, which means that there is a shorter length of the cartilaginous vault during cadaver dissection on older cases.

Another significant advantage of removing the bony cap with PEI is that the fibrous junction between the ULC anterior perichondrium and the bone's posterior periosteum is kept intact. Thus there is no gap between the bones and the ULC when spreader flaps are performed, and consequently no step off in the keystone area after having reconstructed the dorsum with spreader flaps. Traditionally, dislocating the cephalic part of the ULC from the bones in the central area of the dorsum was a source of instability and frequently a bony-cartilaginous gap, especially when the ULCs are dissected in a subperichondrial plane. The spreader flaps can now extend the full length of the open roof and not stop at the keystone junction. Rather than fixing just the middle third of the dorsum, one can now do a full-length reconstruction of the dorsum.

Osteotomies

The role of osteotomies in rhinoplasty surgery, both their objectives and types, has been recently reviewed.[24] Currently, the most popular technique would appear to be a medial oblique osteotomy, then a lateral osteotomy, then a transverse greenstick fracture. In contrast, our sequence would be a lateral osteotomy, then a transverse osteotomy, and finally an optional medial oblique osteotomy.

A very low lateral osteotomy can be performed under direct vision at the nasofacial groove with the angulated saw. The saw can be oriented to affect the amount of mobilization. The transverse osteotomy begins at the cephalic end of the lateral osteotomy and extends toward the dorsum, with the orientation depending on the degree of bony movement desired. Finally, the medial oblique osteotomy is performed from the cephalic extent of the bony hump removal in an oblique direction at the desired dorsal aesthetic line to the anterior termination of the transverse osteotomy. Previously, our indication for the medial oblique osteotomy was to control the dorsal line, and it was performed before the lateral osteotomy. Now it is performed to narrow the upper part of the bony vault, and the bony dorsal aesthetic lines are further modified by sculpting the bones. These movements are much more precise and performed with visual inspection to assure that the bone moves in a specific direction to a specific extent. Even crisscross osteotomies can be performed to treat a significant bony convexity when the bones are thin. This osteotomy allows control of the bone curvature in a horizontal and vertical axis, contrary to the double-level osteotomy, which treats only the vertical convexity. Overall, the surgeon has much more control over the bony vault.

Summary of Advantages and Disadvantages

As currently employed in rhinoplasty surgery, PEI has distinct advantages and disadvantages compared with handheld and power-assisted instruments. PEI has 12 distinct advantages. First, there is minimal if any damage to the surrounding soft tissues and no significant risk of osseonecrosis compared with power-assisted instruments.[14] Second, extensive exposure allows the surgeon to more accurately analyze and surgically correct deformities of the osseocartilaginous vault. Indication, execution, and evaluation of osteotomies are no longer performed blindly, which allows far greater precision. Third, bony cap removal can be performed atraumatically, which minimizes damage to the underlying cartilaginous vault and maximizes its use as spreader flaps for reconstruction of the dorsum high into the bony vault. Fourth, PEI is utilized to remove the lateral edges of the bony vault with optional extension onto the lateral side wall. This extension has two powerful effects: 1) it allows the cephalic dorsal lines after hump reduction to be determined by cartilage rather than by the bony lateral wall; and 2) it allows shaping of the cephalic cartilaginous vault with sutures, thereby reducing the need for medial oblique osteotomies to modify and narrow the dorsal bony vault. Fifth, lateral bony wall asymmetry can be directly addressed by URS rather than merely by breaking the bone. Sixth, all types of osteotomies can be performed more precisely without risk of radiating fracture lines, which occurs with osteotomes and chisels. Seventh, osteotomies and rasping can be performed on brittle or thin bones as well as on mobilized lateral bony walls without the risk of disruption. Eight, complete osteotomies can be performed with stability, because the underlying periosteum and mucosa are not damaged, and avoiding this damage is very difficult with conventional techniques. Ninth, there is no assistant required to assist the surgeon in executing osteotomies, thus eliminating both force and assistant variations from mallet strikes. Tenth, PEI can be utilized on the septum to reduce bony spurs and deviations, thus preserving more of the bony septum. Eleventh, PEI can be utilized safely on the turbinates, pyriform aperture, anterior nasal spine, and premaxilla. Finally, the extended dissection allows the surgeon to easily stabilize unstable bones by drilling holes in the bones and suturing them to the central dorsum.

The disadvantages of PEI include the cost, increased operating time, and a learning curve. In contrast to power-assisted instruments that are routinely available in most surgical centers, PEI has to be purchased. The initial cost of the system is approximately $10,000 and the inserts are $100 each, although reuse up to 10 times is possible. Initially, the increase in operating time is probably 30 minutes because of the need for elevating the soft tissue envelope and having controlled visualization of the osteotomies. With experience, the surgeon can execute these steps quicker, and the precision of the surgical steps performed with the PEI leads to fewer adjustments later in the operative sequence. As with the adoption of any new technique, there are modifications in the operative technique and a learning curve for the instrumentation. Fortunately, the inserts are similar to standard power-assisted instruments with rasps, burrs, and saw blades. Rather than using reciprocating heads, the inserts are pressed against the bone, leading to vaporization and then aspiration of the bone. Surprisingly, tactile feedback is similar to that of conventional instruments. One example is the harvesting of rib grafts, in which the surgeon can feel a distinct difference in resistance between the central rib and the thicker outer rib surface. As with the introduction of the endoforehead technique, the surgeon has the option of converting to more familiar conventional instruments during the procedure without compromising the final result.

Potential limitations of this paper include the limited follow-up, because only 128 out of 185 patients had more than 12 months of follow-up. Also, the technique evolved over time and therefore was not completely consistent. Finally, the instrumentation also changed and evolved over time.

CONCLUSIONS

Based on our experience, the adoption of PEI is easily justified, because it offers more precise analysis and surgical execution with superior results in altering the osseocartilaginous vault. With extensive exposure, one can make an accurate diagnosis of bony deformity and safely contour the nasal bones to achieve narrowing and symmetry of the bony dorsum. Stable osteotomies can be performed under direct vision with precise mobilization and control. Therefore, the upper third of the rhinoplasty operation is no longer shrouded in mystery.

Supplementary Material

This article contains supplementary material located online at www.aestheticsurgeryjournal.com.

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Preservation Rhinoplasty and the Crooked Nose

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KEYWORDS

• Rhinoplasty • Preservation rhinoplasty • Crooked nose • Septoplasty

KEY POINTS

- Crooked noses are among the most difficult cases in rhinoplasty.
- A partially structural approach may be required while adhering to preservation techniques.
- Careful examination of facial bony asymmetry is paramount.

INTRODUCTION

The principles of preservation rhinoplasty are to respect conserve or restore the soft tissue envelope ligaments, minimize the resection of cartilage through reorientation and to keep the dorsal continuity of the patient's own bridge. The origins of the operation date back to the beginning of the 20th century.[1] Although initially described as an endonasal procedure, preservation rhinoplasty can be performed via open or closed approaches.

Crooked or deviated noses pose a specific challenge, as many of the elements in a deviated nose are not symmetric and therefore not ideal for preservation techniques.[2–4] Indeed, deviated noses are often where there is a hybridization between preservation and structural rhinoplasty.

The first question to ask is whether the deviation is part of a facial asymmetry—that is, the underlying foundation of the nose (maxilla) is different between left and right sides either in left to right vertical height or anterior posterior discrepancy. This is usually obvious by looking at the orbit or brow position, the insertion of the alar base of the cheek, the cant of the smile, and the dentition if the patient has not undergone orthodontic treatment. It is easy to assess bony asymmetries by using a head down frontal photograph or by walking round behind the patient to examine the nose from above. This ascertains whether the deviation involves predominantly the bony pyramid, the cartilaginous part of the nose, or the whole nasal structure. It also permits assessment of asymmetries in the nasal sidewalls and the tip. The axis of a nose can be straight but sidewall asymmetry can create the appearance of deviation.[4,5]

Trauma in childhood often results in a similar growth-related disorder to the developmentally deviated nose without a history of injury, except here there will be evidence of the previous injury with angulations in the cartilaginous and bony dorsum. The septum has a major role to play in deviated or crooked noses particularly as it may contribute to a dysfunctional airway due to compromise of the nasal valve—anywhere from the front of the nostril to behind the head of the inferior turbinate. The secondary changes in the turbinate size or shape usually demand that lateral nasal wall surgery will be combined with rhinoplasty or endoscopic sinus surgery.

This makes an external and internal and functional assessment so important in deciding the appropriate procedure. Careful palpation of the nasal pyramid and CT scanning is highly recommended in evaluating the underlying architecture nose and septum plus examination of the nose by endoscopy (**Fig. 1**).

CROOKED OR DEVIATED NOSES

The working definition for deviation can be any deviation of the nasal form from a vertical line dropped from the midpoint of the intercanthal distance.[2] This of course is an approximation as in facial asymmetry the midline between the

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Fig. 1. Axial CT of nasal pyramid with deviation, different bone thickness, septal deviation, and pneumatized expansion of the left middle turbinate.

eyes, the philtrum the dental midlines and the chin point may not lie on the same vertical axis. However, we assume that the nose is the central feature about which we evaluate the whole face; however, this seems to vary between Western and Asian cultures. For facial learning and recognition, westerners focus more on the eyes and mouth in a triangular pattern, whereas Eastern Asians rely more on the central face, mainly the nose. So the perception of facial deformity and tolerance of deformity particularly with respect to the nose may differ between different cultures.[6]

In Western noses which in general are slimmer with a higher dorsum and have more projection, deviation of the nose creates very different profiles particularly in the three-quarter view often leading to the adoption of 'head tilt'—an adaptive mechanism whereby an individual often subconsciously presents the perceived least deformed side in pictures or face-to-face meetings.

These variations in perception may need to be accounted for in a patient's acceptance of improvement over perfection—something that is very difficult to achieve in deviated noses, that is, an improvement is possible, symmetry is not, especially from all the different angles. A straighter nose is possible on an asymmetric face.

In the history of preservation rhinoplasty, one of the reasons dorsal preservation may not have been adopted for deviated or crooked noses was the inability to correct a deformed or twisted bridge and for the need to correct a complex septal deformity. There may be several reasons why preservation techniques are now being reapplied to deviated noses. The first is the ability to accurately image by CT or cone-beam CT, the second is the ability to reshape and move nasal bones using the piezoelectric technology, and the third is a reappraisal of the management of the nasal septum in deviated noses, moving away finally from the 'L strut'. Fundamentally therefore, the ability to change the foundation of the nose (maxilla) or the roof (dorsal profile) safely and predictably means the preservation techniques can be applied to noses other than those that have existing pleasing dorsal aesthetic lines.

The basis of a straight nose is to have a central septum fixed to a midline nasal spine and equal sidewall slopes in terms of angulation, if not length. Creating more symmetric dorsal aesthetic lines but perhaps not symmetric lateral aesthetic lines is probably a realistic goal in correcting nasal deviations by preservation. Additional augmentation of one side of the maxilla is possible with diced cartilage or fat transfer.

THE SKIN ENVELOPE

Developmentally deviated noses invariably have differences in the size of the soft tissue envelope—not only skin but also the muscles and ligaments. The soft tissue envelope has an ability to adapt or contract there is often considerable difference in the healing response from a deception in the subperichondrial/periosteal plane compared with the sub-SMAS. Although it may be possible to preserve many of the ligaments in deviated noses, some may have to be modified. In particular, the position of insertion of the vertical scroll ligament on the short side of the deviated nose will be different with the repositioned nasal pyramid. Release of certain ligaments, for example, the pyriform ligament and adjacent upper lateral/nasal junction may be necessary to create length on the short side of the nose. When an overprojected deviated nose is reduced, however, there will be a relative excess of the envelope. If there is little need to adjust the profile, a straight nose that has axis deviation to one side may not need a soft tissue dissection over the upper laterals or nasal bones and shifting the pyramid to one side can readily correct minor axis deviations (**Fig. 2**).

In general, it is the author's preference to undertake a subperichondrial/periosteal dissection especially in the middle and upper third of the nose. Wide dissection down to the face of the maxilla is required for piezo sculpting. A limited dissection or sometimes no soft tissue elevation is required for simple rotation of the pyramid through a closed approach.

The Dorsum: Bony Pyramid/Bone Cap Cartilage Complex

CT scanning can be very helpful in determining, first, the slope angle of each nasal sidewall and second, the shape of the sidewall being straight convex or concave.

Straight bones that lean to one side lend themselves ideally to a preservation technique,

Fig. 2. Straightening an axis deviation without dorsal soft tissue elevation.

whereby the osteotomy on the more oblique bone is combined with an ostectomy in the nasomaxillary groove (**Fig. 3**A). A sagittal lateral osteotomy having removed Webster's triangle with elevation of the internal periosteum will create the space allowing the bony sidewall to slide down on the inner aspect of the piriform aperture. On the opposite more vertical nasal bone, a transverse cut is made without internal mucoperichondrial elevation allowing this side to be a hinge, as the oblique side impacts downward on the inner aspect of the piriform aperture. The transverse osteotomy between the lateral and the radix cuts may be performed percutaneously with a 2-mm chisel, with a powered instrument or hand saw. The radix cut is usually perpendicular to the nasal bone connecting the transverse cuts (**Fig. 3**B, C). An oblique radix cut may be used to create a rotational hinge of the dorsum, therefore preventing posteriorly displacement of the radix point.

If the dorsal aesthetic lines are already slim, this is a very effective way of treating a nasal dorsum that has purely axis deviation, combined with a reposition of the nasal septum to the midline affixing it to the spine with a secure suture through a drill hole (**Figs. 4 and 5**).

With increasing degrees of axis displacement, not only is there a discrepancy in the anterior/posteriorly length of the nasal bones but also in the length vertically of each nasal sidewall.

Without compensating for this, there is a limit to how far the whole dorsal unit can just be aligned by osteotomies. More severe asymmetries occurring in the middle third cartilaginous portion additional maneuvers may be necessary to lengthen one side compared with the other.

Partial release of the upper lateral/bony junction known as the lateral K area can gain the required length to achieve symmetry. The pyriform ligament is sectioned and released across the mucosal space of the nose. Sharp dissection of the upper lateral, nasal bone overlap parallel to the upper lateral cartilage and extending up to within 5 mm of the dorsum will allow the vertically short side to elongate minimizing the risk of redeviation. This will almost always be necessary in concert with repositioning of the quadrangular cartilage of the septum (**Fig. 6** A,B).

RHINOSCULPTING

Modifying the shape of asymmetric nasal bones has a limited value in achieving a straighter looking nose and depends on the thickness and shape of the bone. CT scanning is an important investigation in ascertaining the limits of rhinosculpting. Thicker convex bones can be thinned but not to

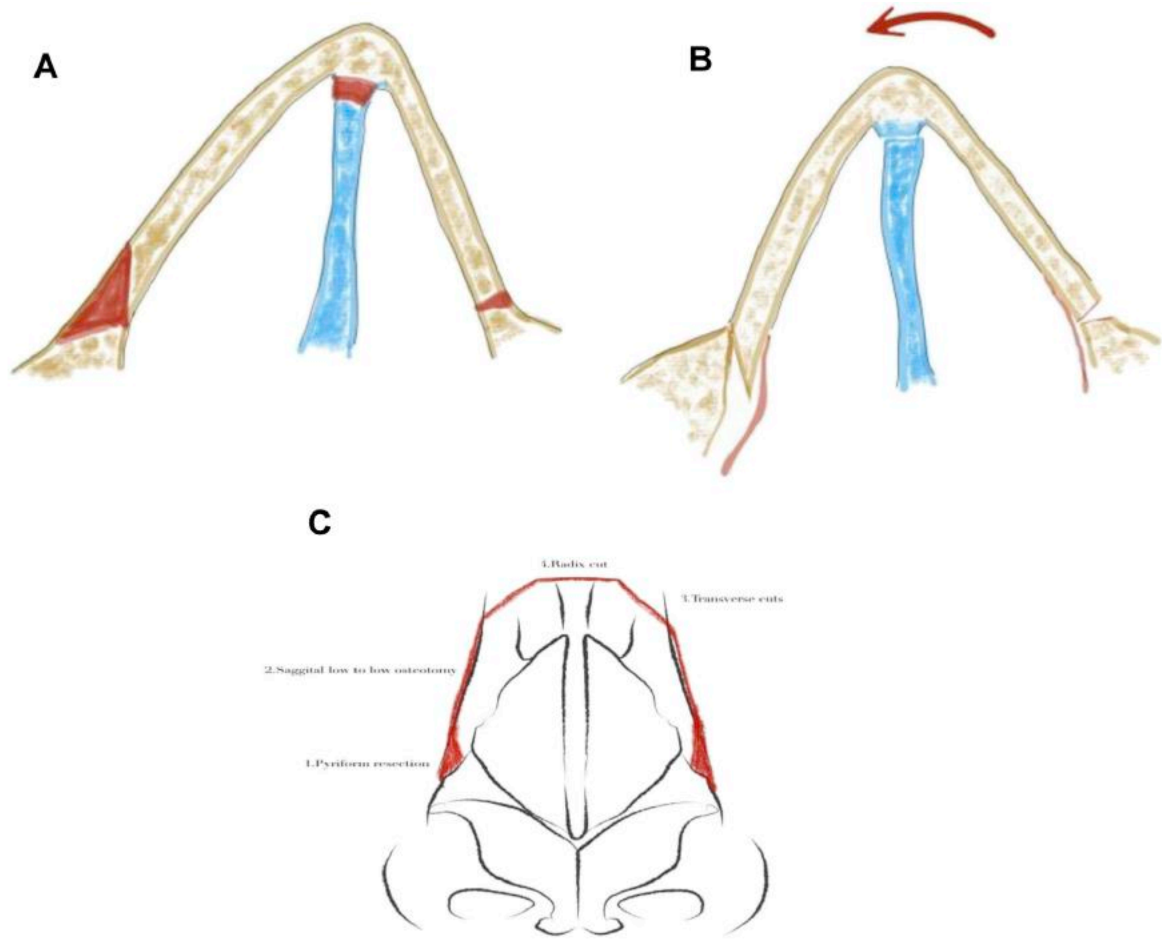

Fig. 3. Schematic for preservation osteotomies in a deviated nose.

the point where there is a risk of fracture. An alternative way to change the convexity of a nasal bony sidewall is to perform a series of criss-cross cuts using the fine piezo saw but not damaging the deep mucoperiosteum. This is analogous to a series of tiles on a flexible backing and will allow subtle convexity is to be flattened without performing longitudinal or transverse osteotomies using osteotomes. In the same degree, modification of the bony nasal can be performed by local rasping or contouring with powered instruments and this may be all that is necessary in a post-traumatic nose correction that involves the rhinion.

THE CARTILAGINOUS VAULT

Distortions in the cartilaginous vault are difficult to correct in dorsal preservation—marked twists in this area invariably need release of the upper laterals from the septum possibly with spreader graft or flap reconstruction.

Where the upper laterals are of a similar length but displaced along with the dorsal more caudal septum, the middle third of the nose can be controlled by a complete release of the septum via a low strip section from the vomer and release from the perpendicular plate of the ethmoid together with if necessary resection of a triangular piece of perpendicular plate under the nasal bones. This allows the septum and the cartilaginous vault as one unit to be rotated back to the midline. This may also be facilitated by removal of the bony cap, still preserving the whole cartilaginous dorsum intact (see **Fig. 5**).

A variation of preservation rhinoplasty called ‘spare roof technique’ allows the dorsal cartilage vault separation from the septum after removal of the bone cap.[7] By releasing the cartilaginous vault completely including a lateral K area dissection, the bony sidewalls can be treated by paramedian and lateral osteotomies to narrow the bony base. The cartilage roof is either pushed down or centralized and then reattached to an

Fig. 4. (*A, B*) Low strip, dorsal preservation septorhinoplasty.

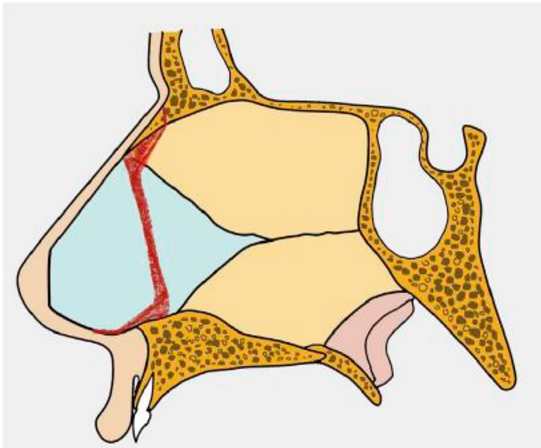

Fig. 5. The septal cuts for a low strip preservation rhinoplasty with deviation. The vertical cut is made at the maximum convexity of the rhinion and the caudal septum advanced and sutured to the spine moving the whole axis to the midline.

independently repaired septum by suturing. This almost certainly requires an open approach, as there is frequently a widening effect in the middle third which will need suture control ideally with a criss-cross technique to achieve the correct contour. It must be inserted behind the W point to avoid valvular narrowing (**Fig. 7**). This has an advantage insomuch as it will minimize the risk of further axis displacement by overriding segments of the neodorsum on an underlying unfavorable high septal deformity and overcomes the limitations of high strip excision in preservation rhinoplasty where extensive septal surgery is required—an extracorporeal septal reconstruction is possible before replanting and fixation at the nasal spine and to the upper lateral 'roof' (**Fig. 8** reproduced by permission M GF).

SOFT TISSUE LIGAMENT REPAIR

The reliance on the support of the soft tissue ligaments, for example, scroll ligament the deep and superficial medial SMAS after rhinoplasty for a deviated nose is still unclear.[8] It is the authors' experience that in correcting some deviated noses, it has been preferable to excise the sesamoid cartilages in the scroll and not reattach the ligament particularly on the shorter side. First, the discrepancy in the skin envelope may recreate a deformity and second, the scroll cartilages may displace cranially producing an unfavorable supratip bulge which can need to be excised endonasally in a minor revision procedure. Where a caudal septal reconstruction with an extension graft or strut is used to support the nasal tip, there is little point in re-establishing the deep medial SMAS. However, refixation of the dorsal perichondrium/periosteal flap by fixation to the anterior septal angle and repair of the superficial medial SMAS to help suspend the upper lip in an open approach are advocated. **Fig. 9**. The periosteal/perichondrial flap tensioning is analogous to plicating or tightening the SMAS in a facelift and has a considerable effect in helping the soft tissue envelope redrape as well as closing dead spaces.

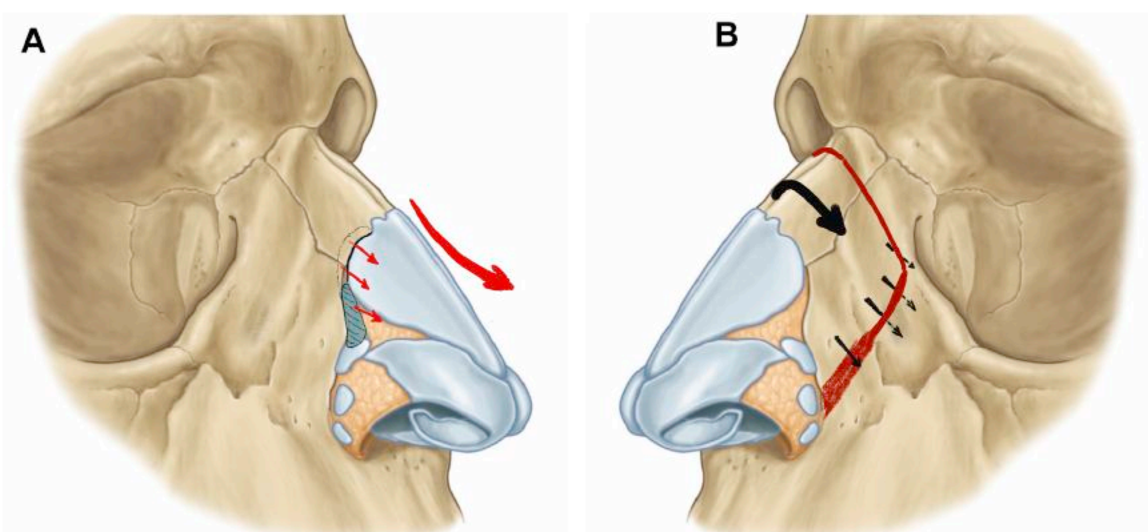

Fig. 6. (*A*) Section of the pyriform ligament (cross hatched) and separation of the lateral keystone will allow a rotational lengthening of a short middle third. (*B*) Rotation of the whole dorsum impacting the longer wall inside the pyriform aperture.

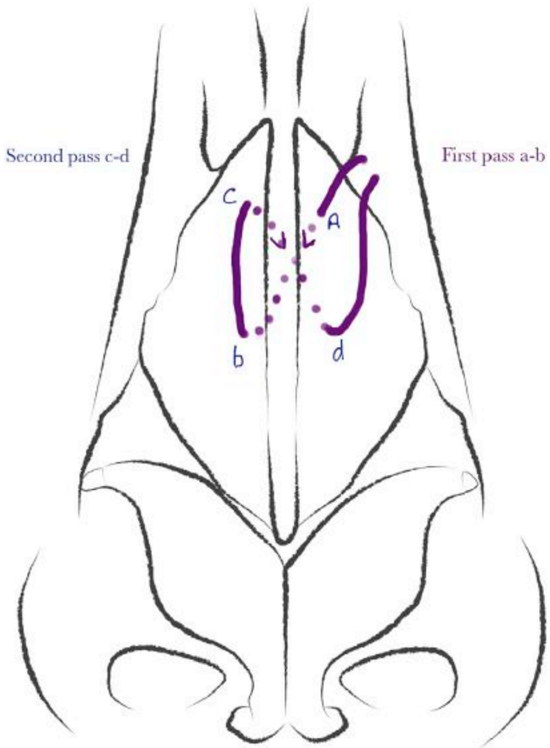

Fig. 7. Criss-cross suture fixation.

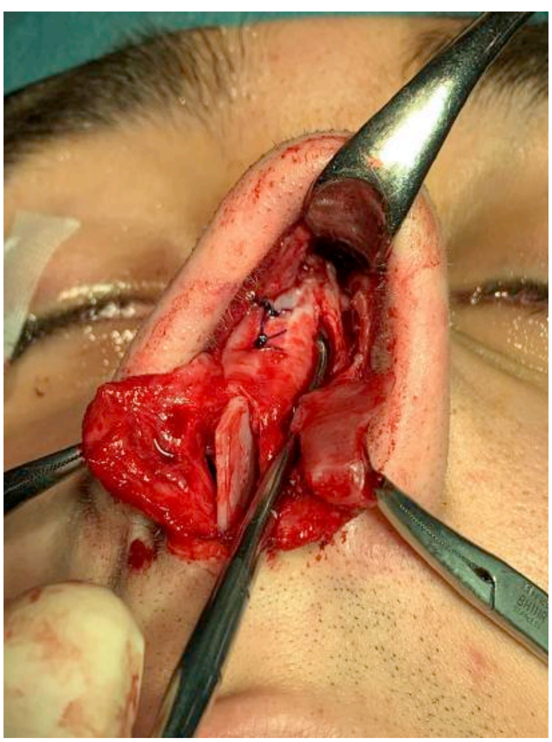

Fig. 8. Fixation of the cartilage vault to the lowered septum. Note the lateral K release to allow flattening of the rhinion. The bone cap has been removed creating a near complete cartilaginous dorsum.

THE NASAL TIP

Developmentally deviated noses will invariably have a degree of asymmetry in the nasal base in a vertical or an anteroposterior plane. There may be pre-existing nostril asymmetry and a need for differential alar base reduction. In principle, the more vertical side of the nasal tip will need to be lengthened to allow the dome to be approximated in the midline with its opposite number. A form of lateral crural steal on one side or release at the junction of the A—A1 cartilage supported with a lateral crural strut graft or rim graft may be required. The use of a lateral crural strut together with sectioning of the levator labii alaeque nasi muscle can lower high insertion of the alar on to the cheek skin. In all these instances, there is a departure from pure preservation rhinoplasty and in general a form of hybrid operation is invariably performed but with the principles of suturing and reorientation with minimum cartilage resection.

The use of a septal extension graft attached to the midline septum is an excellent anchor point for creating tip symmetry, and although there is a tendency to stiffness in the nasal tip, this is preferable to recurrence of deviation. Release of the nasal tip from the muscles around the piriform aperture may be required together with augmentation of the premaxilla under the alar using free segments of cartilage or diced cartilage injected via an incision in the floor of the nasal vestibule in a similar fashion to augmenting a depressed alar sidewall in a cleft nose.

Otherwise the principles of preservation by minimum cephalic resection, lateral crural underlay techniques, dome suturing and lateral crural flare sutures are used to build a symmetric tip on a stable midline medial crural column.

Fig. 9. Retensioning the deep soft tissues to close a dead space.

SUMMARY

Although it is clear that the most deviated or twisted noses will require a reconstructive approach to septorhinoplasty, the principle of deep dissection in a subperichondrial periosteal plane in the upper two-thirds and the realigning of a mild axis deviated nose via transverse lateral and radix osteotomies are all achievable goals following the goals in preservation techniques.[9] Therefore, apart from simple axis deviation of the nose with good aesthetic lines, corrections of deviated noses tend to need a hybrid approach often with minor grafting.

CLINIC CARE POINTS

- Ostectomy and saggital osteotomies allow impaction techniques in preservation rhinoplasty.
- Lateral K release permits lengthening of a short midvault and permits flexion of the central K area.
- Fixation of the quadrangular cartilage on the centralised nasal spine is key to stability.

DISCLOSURES

None.

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Preservation Rhinoplasty: Open or Closed?

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Abstract

Background: Preservation rhinoplasty (PR) is an evolving philosophy.

Objectives: The open approach was initially utilized, but the author felt a closed approach might be of benefit in certain patients.

Methods: A total 162 primary rhinoplasty cases were studied retrospectively between May and November 2020. One hundred cases had at least 1 year of follow-up. Patients had follow-up at 1 week, 1 month, 3 months, and 1 year after surgery. Technical details were recorded, including dissection planes, preservation of the dorsum (DP) vs component reductions, surface vs foundational DP techniques, and open vs closed approach.

Results: One hundred patients had at least 1 year of follow-up. Fifty-six patients underwent an open approach and 44 a closed approach. Eighty-three patients had preservation of the dorsal soft tissue envelope. All patients who underwent a closed approach had preservation of the dorsal soft tissue envelope. Sixty-seven patients underwent DP, with 38 receiving surface techniques and 29 undergoing impaction techniques. Thirty-three patients underwent structural rhinoplasty with piezoelectric osteotomies and mid-vault reconstruction. All structural cases were performed employing an open approach. Four revision surgeries were necessary.

Conclusions: Open and closed approaches have indications depending on the tip and dorsal deformities. A closed PR is favored with thin skin, minimal dorsal modification, osseocartilaginous preservation (foundation techniques), less complex tip deformities, and overprojected noses. An open PR is favored for extensive dorsal modification, S-shaped nasal bones, complex tip deformities, and tip augmentation. Structural dorsal rhinoplasty is always conducted open and preferred for complex dorsal deformities and severe septal deviations.

Level of Evidence: 4

4
Therapeutic

Editorial Decision date: February 7, 2022; online publish-ahead-of-print April 20, 2022.

Preservation rhinoplasty (PR) is an evolving philosophy in rhinoplasty surgery that has gained the interest of surgeons around the globe. The concepts and techniques that have been developed make intuitive sense to most surgeons, and as each individual becomes more comfortable with the procedures, they look for unique ways to apply PR to their primary rhinoplasty patient population. The open approach was initially utilized by the author because it allowed more accurate assessment, execution, and learning of dorsal preservation (DP) as well as the utilization of piezoelectric instrumentation (PEI). With experience and the continued evolution of DP surgery, the author felt that a closed approach might be of benefit in certain patients, especially those with thin skin, V-shaped humps, and less difficult tip deformities. The initial closed approach experience was favorable and led to a gradual increase in the

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percentage of cases conducted with a closed approach. Ultimately, the challenge became patient selection and how to adapt various DP and PEI techniques employing a closed approach. This article presents a series of 100 primary rhinoplasty patients who underwent rhinoplasty surgery with an emphasis on the indications, different types of DP, and whether the surgery was conducted employing an open or closed approach. Although closed DP rhinoplasty, and closed rhinoplasty in general, can be more challenging technically, the primary author believes that many surgeons performing primary rhinoplasty can achieve a better result with a closed approach.

For review, PR is composed of 3 distinct parts.[1] This includes preservation of the soft tissue envelope by dissecting in a subperichondrial-subperiosteal plane as well as the preservation (closed approach) or reattachment (open approach) of the nasal ligaments. This concept can be taken to the next level utilizing limited dissection techniques of the dorsum as advocated by Goksel, or no dorsal skin dissection techniques as advocated by Gola et al.[2-4] The second component of PR includes preservation of the entire osseocartilaginous dorsum or the cartilaginous dorsum by maintaining the integrity of the middle third, as advocated by Ishida, Ferreira, and Kosins.[5-7] The last component of PR includes preservation of the alar cartilages with tensioning, suture techniques, and Pitanguy ligament preservation as opposed to excisional techniques. DP (number 2) is 1 component of PR that avoids the detachment of the upper lateral cartilages from the septum, thereby avoiding the "open roof" that requires reconstruction. In DP surgery, the osseocartilaginous structures are maintained or modified while lowering the profile by employing septal resections.

Although many variations exist, most surgeons perform the septal resection either high underneath the osseocartilaginous vault or low along the nasal floor. In addition, surgeons either mobilize the entire osseocartilaginous dorsum via osteotomies with a pushdown or letdown procedure or mobilize the cartilaginous vault (with or without the bony cap) and treat the bones separately. These techniques were recently reviewed.[7] This article will review a series of 100 rhinoplasties and includes the adaptation of PEI to closed dorsal PR to bypass the shortcoming of osteotomes—namely lack of precision, uncontrolled fracture lines, and incomplete release of the bony vault. The primary author has utilized piezoelectric inserts since 2013 and can selectively act on bony structures without injuring soft tissues.[8] This paper will present the evolution of the current technique, allowing the operative surgeon to selectively perform osteotomy, ostectomy, and osteoplasty in a closed approach. It will also detail determinants of patient selection and an algorithm for open vs closed rhinoplasty.

METHODS

A total 162 primary rhinoplasty cases were studied retrospectively between May 2020 and November 2020. One hundred cases had at least 1 year of follow-up and were therefore included in the study. No secondary rhinoplasty or secondary septoplasty cases were included. Asian patients were excluded because their dorsums are rarely reduced and are thus not candidates for DP. Any patient not having at least 1 year of follow-up was also excluded. All patients included had no previous nasal surgery whatsoever. Data were collected in all cases regarding age, gender, ethnicity, and technical details of the operation. Patients were seen for follow-up at 1 week, 1 month, 3 months, and 1 year after surgery. Written consent was obtained from all patients who agreed to analysis and utilization of their data. Technical details were recorded including dissection planes, preservation of the dorsum vs traditional reduction and mid-vault reconstruction, the utilization of surface vs foundational DP techniques, and the utilization of an open vs closed approach. The guiding principles of the Declaration of Helsinki were utilized in the design of the study.

Surgical Techniques

Rhinoplasty surgery is highly varied, with virtually unlimited techniques that are selected based on analysis and aesthetic objectives. The following description reflects the author's current techniques.

Elevation of the Soft Tissue Envelope: Closed Approach

When performing a closed approach, a full subperichondrial-subperiosteal elevation of the Soft Tissue Envelope (STE) is performed in a 3-step sequence as advocated by Cakir: (1) a continuous subperichondrial-subperiosteal dissection (SSD) over the dorsum, (2) subperiochondrial dissection of the tip, and (3) connecting the 2 pockets at the scroll ligament complex when necessary.[9]

The dorsal dissection is conducted first through a unilateral transfixion incision whereby a subperichondrial plane is entered at the anterior septal angle (ASA) and dissected laterally to the pyriform ligament, cranially to the caudal portion of the nasal bones, and caudally to the vertical scroll ligament. After exposure, the cartilaginous dorsal dissection is completed and bilateral infracartilaginous incisions are made. The subperichondrial tip dissection begins at the turning point of the lateral crus and continues medially over the domes and down to the columellar footplates. Entrance into a subperichondrial plane over the alar cartilages is tedious and requires sharp dissection and small elevators to access the correct plane. Once entered, the perichondrium lifts easily as a sheet, and an elevator is employed to sweep the perichondrium upwards. No bleeding or visible Superficial Musculo-Apaneurotic System (SMAS) tissue should be seen. Finally, if necessary, the vertical scroll ligaments are released with upward sweeping motions, and the dorsal and tip dissections are connected at the scroll ligament complex. Finally, a subperiosteal dissection of the bony pyramid is performed.

A percentage of patients require no dissection of the dorsal soft-tissue envelope, and all dorsal surgery is conducted via endonasal incisions as well as stab incisions on the bridge of the nose. An even fewer percentage of patients require no dissection of the dorsal soft-tissue envelope as well as the tip complex, and all surgery is similarly performed via endonasal incisions as well as stab incisions on the bridge of the nose, as advocated by Finocchi.[4]

Elevation of the STE: Open Approach

When performing an open approach, 3 possible dissection planes are utilized for the tip—subdermal, sub-SMAS, and subperichondrial—and 2 possible planes are utilized for the dorsum—sub-SMAS and superichondrial. For the purposes of this article, I will focus on the technique of subperichondrial dorsal dissection in an open approach.

Regardless of the dissection plane of the nasal tip, once the soft-tissue envelope has been lifted off the tip complex, Pitanguy's ligament is encountered as well as the ligament's lateral extensions—the scroll ligament complex made up of the vertical and longitudinal scroll ligaments. Pitanguy's ligament is marked with 2 sutures and divided. At this point, sharp scissors are utilized to develop a subperichondrial plane at the ASA. Once entered, an elevator is employed to sweep laterally and caudally to the vertical scroll ligaments, which are released with scissors. Finally, a subperiosteal dissection of the bony pyramid is conducted up to the nasal radix and down to the maxilla in preparation for piezoelectric surgery (extended open approach).[10]

Preservation of the Dorsum: Closed Approach

After elevating the STE, a wide submucosal dissection of the subdorsal septum is performed as well as dissecting for at least 2 to 3 mm under the upper lateral cartilages. Two anatomical points must clearly be delineated: the ASA and the W-point. The W-point may be defined as the point of the separation of the upper lateral cartilages from the dorsal septum. The intervening area between the ASA and W-point is called the W-ASA segment. DP consists of 2 parts: septal strip resection to flatten the dorsal hump and osteotomies to lower either the entire osseocartilaginous vault (impaction technique) or the cartilaginous vault with or without the bony cap (surface technique).

Septal Strip Removal

Septal strip removal is completed utilizing either a high septal strip or low septal strip technique performed through a unilateral transfixion incision. Preoperatively, the position of the ideal dorsum is marked on the patient's profile. This allows visualization of the size and shape of the strip(s) that will be removed. It should be noted that in DP surgery, the amount of septum removed is slightly greater than the intended reduction because the dorsum is lowering and flattening. In the high septal strip technique, the initial strip resection starts approximately 10 mm cephalic to the ASA at the W-point. The W-ASA segment will be modified at the time of tip surgery.[11] Initially, 2 to 3 mm of septum is resected directly under the dorsum. This is conducted to test how the dorsum will move. Curved scissors are employed for the anterior cut to stay immediately under the dorsum and straight scissors for the posterior cut to ensure a straight cut. Once the cartilage strip is removed, a tapered triangular portion of the perpendicular plate of ethmoid is incrementally resected (if necessary and an impaction technique is chosen) utilizing PEI and/or a narrow, long rongeur. Any remaining septum on the undersurface of the osseocartilaginous vault is scored with scissors to help break the tension of the chondro-osseous joint.[12]

In the low septal strip technique, the quadrangular cartilage is completely released from the anterior nasal spine, vomer, and perpendicular plate of ethmoid—a true swinging door septoplasty. A back cut is made caudally to the highest point of the nasal hump. This releases the quadrangular cartilage flap with its pivot point at the apex of the osseocartilaginous hump. Initially, 2 to 3 mm of septum is resected at the posterior edge of the quadrangular cartilage flap. This is conducted to test how the dorsum will move as the quadrangular cartilage flap rotates and advances caudally. Once the cartilage strip is removed, a tapered triangular portion of the perpendicular plate of ethmoid is incrementally resected (if necessary and an impaction technique is chosen) utilizing PEI and/or a narrow, long rongeur.

Osteotomies

After the initial 2- to 3-mm strip of septum is removed, osteotomies are performed depending on whether an impaction or a surface technique is chosen.

Impaction technique (lowering the entire osseocartilaginous vault): If an impaction technique is chosen, 4 incisions are made: 2 endonasal incisions and a 2.5-mm incision on each side of the nasal bridge at the level of the medial canthus. Based on experience, the author performs a 2-step procedure: first, scoring the bones with a 2-mm osteotome and then a definitive cut with a piezoelectric saw. A 2-mm osteotome is first placed through the bridge incisions, and the periosteum is scored along the transverse and radix osteotomy lines. The smallest, straight piezoelectric saw is then introduced through the bridge incisions, and the transverse and radix osteotomies are performed utilizing ice-cold water than has been cooled in an ice bath for at least 30 minutes. It is very important that the surgeon's assistant drips ice cold water onto the incision to avoid any skin damage or hyperpigmentation. After these ostetomies have been completed, low to low osteotomies are performed with a long, straight piezoelectric saw through the endonasal incisions. First, subperiosteal tunnels are created on the lateral and medial sides of the nasal bone, and a narrow and aggressive rasp is utilized to score the low-to-low osteotomy line and to perform an ostectomy (thinning) of the lateral nasal bone. Then the piezoelectric saw is employed to complete the cut for a pushdown or a rongeur is utilized to remove lateral nasal bone with a rongeur. Again, it is important that the assistant drips water on the area and that a wet sponge is placed between the skin and against the piezoelectric saw handle. I prefer piezo technology because the cuts are precise and can be made at any angle I choose, with minimal radiating fractures and bleeding.[8] In addition, the blocking points are fully released. Once the nasal bony pyramid is released, the nose can be mobilized with side-to-side movement to push down into the pyriform aperture. Once the bony pyramid is released, the surgeon checks the movement of the dorsum to determine if further septal resections are necessary. Any additional septal resections are conducted in 1- to 2-mm increments while watching the movement of the dorsum. Only after lowering is septal work conducted to harvest cartilage or to reset the caudal septum.

It should be noted that even in a closed approach, modification of the bony cap and treatment of small asymmetries are possible with the piezoelectric rasps, especially at the lateral keystone area. If the skin envelope is tight, a right intercartilaginous incision is added to the transfixion incision for better exposure.

Surface technique (lowering the cartilaginous vault with or without the bony cap): If a surface technique is chosen, all piezoelectric rhinosculpture, bony cap modification, and medial osteotomies are conducted via the infracartilaginous incisions. Rarely (<10%), a patient will have an acute hump or a tight soft-tissue envelope requiring a unilateral intercartilaginous incision for added exposure.

The bony work is conducted medially first and laterally second. If the bony cap must be modified or removed, it is performed with a piezoelectric scraper. If the bony cap is to be released and included with lowering of the cartilaginous vault, a straight piezoelectric saw is employed to perform 2 paramedian osteotomies with slight angulation medially to release a triangle of bone, as described by Ishida.[5] At no time should a rasp be introduced because it will dislodge the bony cap. Once the bone is removed, modified, or preserved, a lateral keystone release is performed to separate the cartilage vault from the bony vault, allowing descent of the hump. Finally, any protruding edges of bone medially are smoothed with a piezoelectric rasp.

After the hump has been lowered and flattened, traditional osteotomies are conducted with the piezoelectric saws. Medial oblique osteotomies are performed first with a small, straight piezoelectric saw. Second, endonasal incisions are made and lateral osteotomies are performed with a long, straight piezoelectric saw. Complete fractures are preferred for maximal narrowing. It should be noted that because the middle vault has not been opened, complete osteotomies are much more stable.

Fixation

Fixation is an important step to postoperatively prevent a residual hump that would lead to revision surgery. Utilizing a low strip technique, fixation is conducted at the anterior nasal spine once the quadrangular cartilage flap has rotated and advanced into its new position. All tension must be taken off the flap so it does not retract cephalically with depression of the supratip region. If a high strip technique is employed, an extramucosal stitch of 4-0 PDS on a straight needle is utilized to lock down the dorsum at the highest point of the initial hump as described by Teoman Dogan ("teo-stitch").[1,2]

Preservation of the Dorsum: Open Approach

After elevating the STE, a wide submucosal dissection of the subdorsal septum is performed as well as dissecting for at least 2 to 3 mm under the upper lateral cartilages. Two anatomical points must be clearly delineated: the ASA and the W-point. The W-point may be defined as the point of the separation of the upper lateral cartilages from the dorsal septum. The intervening area between the ASA and W-point is called the W-ASA segment. DP consists of 2 parts: septal strip resection to flatten the dorsal hump and osteotomies to lower either the entire osseocartilaginous vault (impaction technique) or the cartilaginous vault with or without the bony cap (surface technique).

Septal Strip Removal

Septal strip removal is conducted exactly the same as in the closed approach. If a septal extension graft is employed to support the tip, then a tip split approach is utilized. When beginning DP, a tip split and open approach is recommended for maximal visualization.

Osteotomies

After the initial 2- to 3-mm strip of septum is removed, osteotomies are performed depending on whether an impaction or a surface technique is chosen.

Impaction technique (lowering the entire osseocartilaginous vault): After the initial 2- to 3-mm strip of septum is removed, Webster's triangle is removed bilaterally in all impaction procedures because this is a major blocking point and can also restrict airflow if it is impacted onto the inferior turbinate. A caudally based triangular portion of the front process of maxilla is removed, often measuring 6 to 8 mm at its base and 8 to 10 mm in length. Once this has been completed, a low-to-low osteotomy is started on the patient's left nasal bone with a curved saw from the edge of the pyriform aperture along the base of the nose. I prefer piezotechnology because (1) exposure is maximum with the extended open approach, and (2) the cuts are precise and can be made at various angles to the face of the maxilla.[8] Sagittal angulation allows lowering of the bony vault into the pyriform aperture because cuts parallel to the maxilla make medial movement more difficult. Once the low to low is made, the saw is curved to begin the transverse osteotomy to the midline. This is repeated on the right nasal bone, meeting in the transverse midline at the "radix osteotomy." If a hinge of the dorsum is desired, the dominant thumb is utilized to create a greenstick fracture at the radix. If radix reduction is desired, the radix ostetomy is completed and connected down to the perpendicular plate resection. The nasal bony pyramid is released, and the nose can be mobilized with side-to-side movement to push down into the pyriform. At times, there are areas of bony contact that need to be released further, and they can be checked employing the full-open approach. Once the bony pyramid is released, the surgeon checks the movement of the dorsum to determine if further septal resections are necessary. Further resections are performed in 1- to 2-mm increments while watching the movement of the dorsum. Final touches on the dorsum are conducted caudally near the ASA where the septum proper is removed. Only after lowering is septal work conducted to harvest cartilage or to reset the caudal septum.

Surface technique (lowering the cartilaginous vault with or without the bony cap): If a surface technique is chosen, all piezoelectric rhinosculpture, bony cap modification, and medial osteotomies are conducted first with ease because of the extended open approach. Just as with traditional structural rhinoplasty, the bony work is conducted medially first and laterally second. If the bony cap must be modified or removed, it is performed with a piezoelectric scraper. If the bony cap is to be released and included with lowering of the cartilaginous vault, a straight piezoelectric saw is utilized to perform 2 paramedian osteotomies with slight angulation medially to release a triangle of bone. At no time should a rasp be introduced because it will dislodge the bony cap. Once the bone is removed, modified, or preserved, a lateral keystone release is performed to separate the cartilage vault from the bony vault, and this allows descent of the hump. Finally, any protruding edges of bone medially are smoothed with piezoelectric rasps.

After the hump has been lowered and flattened, traditional osteotomies are executed with the piezoelectric saws. Medial oblique osteotomies are conducted first with a small, straight piezoelectric saw. Second, lateral osteotomies are performed with curved saws. Complete fractures are preferred for maximal narrowing, and drill holes are easily placed in each nasal bone if they require suturing.

Fixation

Fixation is an important step to postoperatively prevent a residual hump that would lead to revision surgery. Employing a low strip technique, fixation occurs at the anterior nasal spine once the quadrangular cartilage flap has rotated and advanced into its new position. All tension must be taken off the flap so it does not retract cephalically with depression of the supratip region. With a high strip technique, suture fixation of the dorsum can be conducted at 3 points, as previously described.[13] After the nose is opened, drill holes are placed in the nasal bones laterally at the point of maximum projection of the hump (K-point). Once the dorsum is lowered to the appropriate height, a 4-0 PDS needle is passed from the left drill hole down to the remaining septum approximately 7 to 8 mm posterior to the leading anterior edge of the dorsal septum and back up through the right drill hole. The position of the dorsum is checked and the suture tied, locking the most projecting part of the dorsum down to the remaining septum. A second suture is performed at the most caudal aspect of the dorsum, attaching the distal upper lateral cartilages to the remaining septum at the W-point. This suture is very useful because the dorsum can be sutured to one side or the other if the cartilaginous dorsum is deviated. Also, the upper lateral cartilages can be attached above the dorsum to gain 1 to 2 mm of projection if needed. The last suture is placed in between the first 2 sutures, making sure to lock down the whole dorsum as needed. This suture can be employed to widen, narrow, or correct minor asymmetries on the dorsum depending on how it is placed. For example, a suture placed in the groove of the cartilaginous vault (midline) will cause the middle vault to widen. Alternatively, a suture can be placed as a horizonal mattress to narrow the dorsum. Multiple sutures can be employed as needed. Alternatively, or in addition, the Teo-stitch can be utilized once the incisions have been closed.

RESULTS

One hundred patients from the study period had at least 1 year of follow-up (Figure 1). Eighty-four patients were female and 16 were male. The average age was 28 years (range, 15-57). All patients underwent a primary rhinoplasty.

Case Studies

Case Study 1: Closed Approach, Impaction Technique Without Skin Dissection

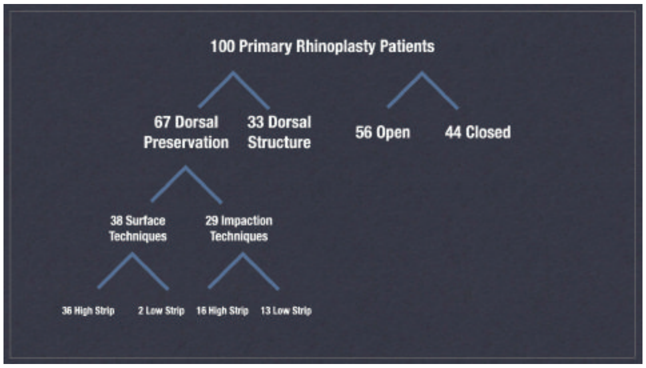


Figure 1. Breakdown of results: open vs closed approach, dorsal preservation vs structural reconstruction of the dorsum, surface vs impaction dorsal preservation techniques, and high vs low septal strip dorsal preservation techniques.

A 19-year-old female of Middle Eastern background complained of a dorsal hump, bulbous tip, and plunging tip on smiling. Shown are her preoperative (A-F) and 1-year postoperative (G-L) views (Figure 2). On analysis, the patient had ideal dorsal aesthetic lines, and no bony modification was necessary. The Obagi skin pinch revealed normal thickness skin, and she had fairly strong alar cartilages that measured 9 mm wide intraoperatively. No skin dissection of the dorsum was performed, and an SSD of the tip was selected with preservation of all ligaments and alar cartilage. Tip suturing was performed with cephalic dome sutures and a 4-mm lateral steal procedure, and a columellar strut was utilized for central support. Sliding alar cartilage flaps were performed, maintaining 7-mm symmetric rim strips. The patient had a normally projected nasal tip, and therefore a columellar strut was chosen. Her dorsum was found to be ideal on anterior view with V-shaped nasal bones, and a high strip DP (letdown) of 5.5 mm was performed. Postoperatively, the nasal hump was eliminated, the dorsal aesthetic lines were narrow and symmetric, and the nasal tip had much better definition.

Figure 2. Case Study 1: closed approach, impaction technique without skin dissection. This 19-year-old female of Middle Eastern background complained of a dorsal hump, bulbous tip, and plunging tip on smiling. Shown are her preoperative (A, C, E, G, I, K) and 1-year postoperative (B, D, F, H, J, L) views. On analysis, the patient had ideal dorsal aesthetic lines, and no bony modification was necessary. The Obagi skin pinch revealed normal thickness skin, and she had fairly strong alar cartilages that measured 9 mm wide intraoperatively. No skin dissection of the dorsum was performed, and a subperichondrial-subperiosteal dissection of the tip was selected with preservation of all ligaments and alar cartilage. Tip suturing was performed with cephalic dome sutures and a 4-mm lateral steal procedure, and a columellar strut was employed for central support. Sliding alar cartilage flaps were performed maintaining 7-mm symmetric rim strips. The patient had a normally projected nasal tip and therefore a septal extension graft was chosen. Her dorsum was found to be ideal on anterior view with V-shaped nasal bones, and a high strip dorsal preservation (letdown) of 5.5 mm was performed. Postoperatively, the nasal hump was eliminated, the dorsal aesthetic lines were narrow and symmetric, and the nasal tip had much better definition.

Figure 3. Case Study 2: closed approach, impaction technique without skin dissection of tip or dorsum. This 26-year-old female of European background presented with a dorsal hump, an overprojected nose, and a dorsal hump. Shown is her preoperative (A, C, E, G, I, K) and 12-month postoperative (B, D, F, H, J, L) views. The Obagi Skin pinch revealed thin skin. The patient's dorsum was found to be ideal, with axis deviation and V-shaped nasal bones. The tip was found to be ideal but simply overprojected with alar base asymmetry due to the septal deviation. A low septal strip procedure was selected without dissection of the dorsum or tip. Via a hemi-transfixion incision, a swinging door septoplasty was performed to straighten the cartilaginous vault and an asymmetric letdown procedure was conducted with removal of 4 mm of bone on right left side via endonasal and transcutaneous incisions. Postoperatively, the nasal hump was eliminated, the dorsal aesthetic lines were narrow and symmetric, and the nasal tip and dorsum were lowered with correction of the alar base asymmetries.

Case Study 2: Closed Approach, Impaction Technique Without Skin Dissection of Tip or Dorsum

A 26-year-old female of European background presented with a dorsal hump, an overprojected nose, and a dorsal hump. Shown are her preoperative (A-F) and 12-month postoperative (G-L) views (Figure 3). The Obagi Skin pinch revealed thin skin. The patient's dorsum was found to be ideal with axis deviation and V-shaped nasal bones. The tip was found to be ideal but simply overprojected with alar base asymmetry due to the septal deviation. A low septal strip procedure was selected without dissection of the dorsum or tip. Via a hemi-transfixion incision, a swinging door septoplasty was performed to straighten the cartilaginous vault, and an asymmetric letdown procedure was conducted with removal of 4 mm of bone on the left side via endonasal and transcutaneous incisions. Postoperatively, the nasal hump was eliminated, the dorsal aesthetic lines were narrow and symmetric, and the nasal tip and dorsum were lowered with correction of the alar base asymmetries.

Case Study 3: Closed Approach, Surface Technique

A 25-year-old female of Hispanic background presented with a small dorsal hump, a normal to low radix, and a plunging tip on smiling. Shown are her preoperative (A-F) and 1-year postoperative (G-L) views (Figure 4). The Obagi Skin pinch revealed normal thickness skin but relatively strong alar cartilage. A subperichondrial dissection was done of her tip and a SSD of her nasal dorsum. Her cartilaginous dorsum was found to be ideal on anterior view with V-shaped nasal bones. A high strip DP of the cartilaginous vault of 3 mm was performed after release of the bony cap and lateral keystone release. Closed medial oblique and low-to-low piezoelectric osteotomies were performed. A columellar strut was employed for tip support, and tip suturing was performed with cranial tip sutures and a lateral steal procedure of 4 mm. Postoperatively, the nasal profile was straight with good tip projection and definition. The plunging tip illusion was eliminated and the radix height maintained.

Case Study 4: Open Approach, Impaction Technique

A 28-year-old female of European background presented with a large and cephalic dorsal hump, a high radix, and a plunging tip on smiling. Shown are her preoperative (A-F) and 1-year postoperative (G-L) views (Figure 5). The Obagi Skin pinch revealed normal thickness skin, but she was felt to have weak alar cartilage. A large amount of bony

Figure 4. Case Study 3: closed approach, surface technique. This 25-year-old female of Hispanic background presented with a small dorsal hump, a normal to low radix, and a plunging tip on smiling. Shown are her preoperative (A, C, E, G, I, K) and 1-year postoperative (B, D, F, H, J, L) views. The Obagi Skin pinch revealed normal thickness skin but relatively strong alar cartilage. A subperichondrial dissection was conducted of her tip and a subperichondrial-subperiosteal dissection of her nasal dorsum. Her cartilaginous dorsum was found to be ideal on anterior view with V-shaped nasal bones. A high strip dorsal preservation of the cartilaginous vault of 3 mm was performed after release of the bony cap and lateral keystone release. Closed medial oblique and low-to-low piezoelectric osteotomies were performed. A columellar strut was utilized for tip support, and tip suturing was performed with cranial tip sutures and a lateral steal procedure of 4 mm. Postoperatively, the nasal profile was straight with good tip projection and definition. The plunging tip illusion was eliminated and the radix height maintained.

modification would be needed specifically of the radix and lateral bony walls. A sub-SMAS dissection was conducted of her tip and a SSD of her nasal dorsum. Her cartilaginous dorsum was found to be ideal on anterior view, with V-shaped nasal bones and a high radix. A DP (letdown) of 10 mm was performed after modification of the bony cap and lateral bony walls. A large radix drop was performed with contouring of the cephalic frontal bone. A taco graft was employed for tip support, and tip suturing was performed with cranial tip sutures and a lateral steal procedure of 3.5 mm. Postoperatively, the nasal profile was straight with good tip projection and definition. The plunging tip illusion was eliminated and the radix lowered.

Case Study 5: Open Approach, Impaction Technique

A 29-year-old female of Hispanic background presented with axis deviation, a small dorsal hump, a bulbous tip, and wide alar base. Shown are her preoperative (A-F) and 1-year postoperative (G-L) views (Figure 6). The Obagi Skin pinch revealed thick skin, and she had weak alar cartilages. A subdermal dissection of her nasal tip was conducted with SMAS debulking and an SSD of her dorsum. The dorsal aesthetic lines were ideal, and the dorsum required minimal dorsal modification. An asymmetric letdown procedure utilizing a low septal strip was performed, removing 5 mm of bone from the face of the left maxilla. Tip suturing was performed with cephalic dome sutures with a 2-mm lateral steal. The patient was felt to have inadequate projection, so a septal extension graft was chosen. Alar-based reduction was also performed. Postoperatively, the nasal profile was much straighter with narrow and symmetric dorsal aesthetic lines. The tip contour was improved. Weir excisions were also performed.

Case Study 6: Open Approach, Impaction Technique

A 26-year-old female of European background presented with an asymmetry of the nose, a small dorsal hump, a bulbous tip, and a plunging tip on smiling. Shown are her preoperative (A-F) and 1-year postoperative (G-L) views (Figure 7). The Obagi Skin pinch revealed medium thickness skin. A sub-SMAS dissection of her nasal tip was done and an SSD of her dorsum. A low strip DP was performed after rasping of the bony cap and lateral keystone release (5 mm of cartilage was removed at the base of the septum). The dorsal aesthetic lines were ideal, and an asymmetric letdown procedure utilizing a low septal strip was performed to remove 3 mm of bone from the face of the left maxilla. Tip suturing was performed with cephalic

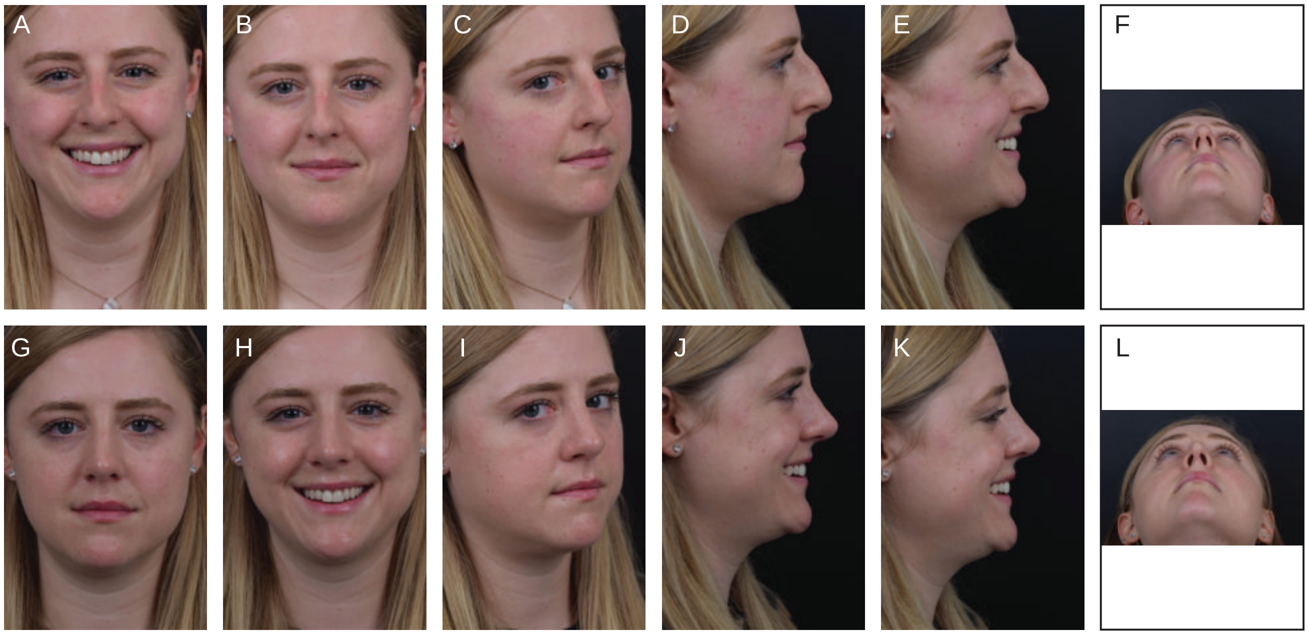


Figure 5. Case Study 4: open approach, impaction technique. This 28-year-old female of European background presented with a large and cephalic dorsal hump, a high radix, and a plunging tip on smiling. Shown are her preoperative (A, C, E, G, I, K) and 1-year postoperative (B, D, F, H, J, L) views. The Obagi Skin pinch revealed normal thickness skin, but she was felt to have weak alar cartilage. A large amount of bony modification would be needed specifically of the radix and lateral bony walls. A sub-SMAS dissection was done of her tip and a subperichondrial-subperiosteal dissection of her nasal dorsum. Her cartilaginous dorsum was found to be ideal on anterior view with V-shaped nasal bones and a high radix. A dorsal preservation (letdown) of 10 mm was performed after modification of the bony cap and lateral bony walls. A large radix drop was performed with contouring of the cephalic frontal bone. A taco graft was employed for tip support, and tip suturing was performed with cranial tip sutures and a lateral steal procedure of 3.5 mm. Postoperatively, the nasal profile was straight with good tip projection and definition. The plunging tip illusion was eliminated and the radix lowered.

dome sutures with a 3.5-mm lateral steal. The patient had an open rhinoplasty, so a septal extension graft (taco graft) was chosen. Finally, release of the left levator labii superioris aqueli nasi was performed with 0.2 cc of diced cartilage placed in the left peri-pyriform region to drop the left alar base. Postoperatively, the nasal profile was much straighter with narrow and symmetric dorsal aesthetic lines. The tip contour was improved.

Case Study 7: Open Approach, Surface Technique

A 21-year-old female of Middle Eastern background presented with wide nasal bones, a small dorsal hump, a low radix, a bulbous tip, and a plunging tip on smiling. Shown are her preoperative (A-F) and 1-year postoperative (G-L) views (Figure 8). The Obagi Skin pinch revealed very thick skin, and she had weak alar cartilages. A subdermal dissection of her nasal tip was conducted with SMAS debulking and an SSD of her dorsum. The dorsal aesthetic lines were wide, and the dorsum required extensive osteotomies. A high strip DP of the cartilaginous vault of 2.5 mm was performed after release of the bony cap and lateral keystone release. Piezoelectric medial oblique and low-to-high osteotomies were performed after removal of 2-mm bony wedges medial to each medial oblique osteotomy. Tip suturing was performed with cephalic dome sutures with a 2.5-mm lateral steal. The patient was felt to have inadequate projection, so a septal extension graft (taco graft) was chosen. Finally, a radix graft of diced cartilage in fascia was placed. Postoperatively, the nasal profile was much straighter with narrower and symmetric dorsal aesthetic lines. The tip contour was improved.

Approach

Fifty-six patients underwent an open approach and 44 underwent a closed approach.

STE Preservation

Eighty-three patients had preservation of the dorsal soft-tissue envelope employing a full SSD. Four patients had a sub-SMAS dissection of the dorsum, 2 patients had a sub-SMAS dissection of the dorsum because of difficulty entering this soft-tissue plane, and 2 patients had a sub-SMAS dissection of the dorsum because of very flimsy cartilage on visual inspection/palpation. Finally, 13 patients had no dissection of the dorsal soft-tissue envelope. All patients who underwent a closed approach had preservation of the dorsal soft tissue envelope.

Figure 6. Case Study 5: open approach, impaction technique. This 29-year-old female of Hispanic background presented with axis deviation, a small dorsal hump, a bulbous tip, and wide alar base. Shown are her preoperative (A, C, E, G, I, K) and 1-year postoperative (B, D, F, H, J, L) views. The Obagi Skin pinch revealed thick skin, and she had weak alar cartilages. A subdermal dissection of her nasal tip was conducted with SMAS debulking and a subperichondrial-subperiosteal dissection of her dorsum. The dorsal aesthetic lines were ideal, and the dorsum required minimal dorsal modification. An asymmetric letdown procedure utilizing a low septal strip was performed, removing 5 mm of bone from the face of the left maxilla. Tip suturing was performed with cephalic dome sutures with a 2-mm lateral steal. The patient was felt to have inadequate projection, so a septal extension graft was chosen. Alar-based reduction was also performed. Postoperatively, the nasal profile was much straighter with narrow and symmetric dorsal aesthetic lines. The tip contour was improved. Weir excisions were also performed.

Dorsal Preservation

Sixty-seven patients out of 100 studied underwent DP, with 38 (57%) receiving surface DP techniques and 29 (43%) receiving impaction DP techniques. Thirty-three patients underwent structural rhinoplasty with traditional piezoelectric osteotomies and mid-vault reconstruction with spreader grafts and/or flaps. No augmentation rhinoplasties were included in the studied group.

In 36/38 patients who underwent a surface technique, a high strip method was employed. The average resection of septum measured 2.5 mm (range, 1.5-4 mm). The bony cap was partially removed in 6/38 patients to transform the dorsum into a more cartilaginous vault if the hump appeared to be kyphotic or if longer nasal bones were present. The bony cap was preserved in 32/38 patients. Of the DP patients who underwent surface techniques, 14/38 patients had a radix graft of fascia or diced cartilage in fascia to augment the radix. A camouflage graft of cartilage paste was utilized in 4/38 patients, and all had removal of the bony cap.

In 16/29 patients who underwent an impaction technique, a high strip method was employed. The average resection of septum measured 4.5 mm (range, 2.5-11 mm). In 13/29 patients, a low septal strip was removed for impaction, with an average resection of 6 mm (range, 2-9 mm).

Open or Closed Approach

All structural rhinoplasty cases were performed employing an open approach. Of the 67 patients who underwent DP, 44 received closed rhinoplasty and 23 had open rhinoplasty. Of the 13 patients who had no dissection of the dorsal soft-tissue envelope, 5 of the procedures were conducted employing a closed tip approach, 6 were performed open, and 2 had no dissection of the tip skin.

Revisions

Three revision surgeries were necessary. The first patient had a residual hump that became apparent after 3 months and requested more tip rotation. The patient originally underwent a cartilage vault DP utilizing an open approach. At 1 year, the nose was reopened. The cartilage vault was shaved with a 15-blade to remove the convexity, and a 3-mm lateral steal was performed bilaterally to increase tip rotation.

The second patient had a residual hump and requested more tip definition. The patient originally underwent a low septal strip osseocartilaginous preservation employing a closed approach. At 1 year, a revision surgery was performed with an open approach. The bony cap was removed with a piezoelectric scraper, and the height of the

Figure 7. Case Study 6: open approach, impaction technique. This 26-year-old female of European background presented with a asymmetry of the nose, a small dorsal hump, a bulbous tip, and a plunging tip on smiling. Shown are her preoperative (A, C, E, G, I, K) and 1-year postoperative (B, D, F, H, J, L) views. The Obagi Skin pinch revealed medium thickness skin. A sub-SMAS dissection of her nasal tip was done and a subperichondrial-subperiosteal dissection of her dorsum. A low strip dorsal preservation was performed after rasping of the bony cap and lateral keystone release (5 mm of cartilage was removed at the base of the septum). The dorsal aesthetic lines were ideal, and an asymmetric letdown procedure utilizing a low septal strip was performed, removing 3 mm of bone from the face of the left maxilla. Tip suturing was performed with cephalic dome sutures with a 3.5-mm lateral steal. The patient had an open rhinoplasty, so a septal extension graft (taco graft) was chosen. Finally, release of the left levator labii superioris aqueli nasi was performed with 0.2 cc of diced cartilage placed in the left peri-pyriform region to drop the left alar base. Postoperatively, the nasal profile was much straighter with narrow and symmetric dorsal aesthetic lines. The tip contour was improved.

upper lateral cartilages was shaved with a 15-blade. The columellar strut was removed and septal harvest was performed through a tip split. A septal extension graft was placed and the tip projected, resulting in better definition.

The third patient underwent a closed surgery and developed bowing of the left medial crura secondary to malposition of the columellar strut. The columellar strut was removed and reinserted at 1 year employing a closed approach.

Morbidity

There was no incidence of surgical bleeding requiring operative intervention. Early in the series, 2 patients had hyperpigmentation of the transverse incisions where a piezoelectric saw was inserted employing a closed approach. This influenced the author to score the periosteum with a 2-mm osteotome and to utilize ice-cold water during the osteotomies as described above. No incisional issues have been encountered since these maneuvers were added to the osteotomy sequence. In addition, this transcutaneous approach is not favored in patients with complex skin types (eg, Indian patients). No septal perforations were found on postoperative speculum examination.

DISCUSSION

Traditionally, many surgeons were taught a closed approach and transitioned to the open approach for better visualization, teaching, and execution of complex maneuvers. Some surgeons still favor a closed approach for rhinoplasty surgery and have integrated DP principles into that operation. Saban reviewed almost 30 years of closed DP with a relatively low complication rate.[14] Other surgeons such as Cakir and Finocchi initially learned the techniques of rhinoplasty utilizing an open approach but currently favor a closed approach with preservation of the Pitanguy and scroll ligament complex system in polygon tip surgery.[15] Finocchi elegantly described a progressive approach for transitioning from an open to a closed approach.[16] DP was incorporated into this closed approach later. The present author's experience is quite different. The open approach was employed initially because it allowed more accurate assessment, execution, and learning of DP as well as utilization of PEI. With experience and the continued evolution of DP surgery, the author felt that a closed approach might be of benefit in certain patients,

Figure 8. Case Study 7: open approach, surface technique. This 21-year-old female of Middle Eastern background presented with wide nasal bones, a small dorsal hump, a low radix, a bulbous tip and a plunging tip on smiling. Shown are her preoperative (A, C, E, G, I, K) and 1-year postoperative (B, D, F, H, J, L) views. The Obagi Skin pinch revealed very thick skin, and she had weak alar cartilages. A subdermal dissection of her nasal tip was conducted with SMAS debulking and a subperichondrial-subperiosteal dissection of her dorsum. The dorsal aesthetic lines were wide, and the dorsum required extensive osteotomies. A high strip dorsal preservation of the cartilaginous vault of 2.5 mm was performed after release of the bony cap and lateral keystone release. Piezoelectric medial oblique and low-to-high osteotomies were performed after removal of 2-mm bony wedges medial to each medial oblique osteotomy. Tip suturing was performed with cephalic dome sutures with a 2.5-mm lateral steal. The patient was felt to have inadequate projection, so a septal extension graft (taco graft) was chosen. Finally, a radix graft of diced cartilage in fascia was placed. Postoperatively, the nasal profile was much straighter with narrower and symmetric dorsal aesthetic lines. The tip contour was improved.

especially those with thin skin, minimal humps, minimal tip deformities, and relatively simple septal surgery, and patients who required deprojection of the nasal tip. The initial closed approach experience was favorable and led to a gradual increase in the percentage of cases conducted with a closed approach. Ultimately, the challenge became how to adapt various DP techniques and PEI techniques for a closed approach as well as patient selection.

The ideal rhinoplasty operation would have the following characteristics:

- No transcolumellar scar
- Optimal control of the bony pyramid
- Minimal to no manipulation to the surface of the osseocartilaginous skeleton
- Minimal to no manipulation of the soft tissue envelope
- A stable, natural, and attractive postoperative result that ages naturally with time

The initial rhinoplasty operation employed by the author involved an open approach, sub-SMAS dissection of the soft-tissue envelope, component reduction of the dorsum, conventional osteotomies with osteotomes, middle vault reconstruction with a combination of spreader grafts and flaps, a columellar strut for tip support, and a combination of suture and grafts at the native domes for tip aesthetics. Although the results were favorable, several issues became clear within 5 years of practice. An open approach was good for learning, but the soft-tissue envelope did not always conform to the underlying structure. A sub-SMAS dissection did cause soft-tissue thinning in some patients, and the swelling curve was difficult to understand. Component reduction was a reliable way to remove a dorsal hump. Conventional osteotomies were difficult to control, and the learning curve was steep. Middle vault reconstruction was the most difficult aspect of rhinoplasty to predict and was the leading cause of long-term failures. A columellar strut was not enough support in many patients and led to a loss of definition and projection because 1 floating graft was not enough to replace all the internal nasal support that was taken apart (leading cause of short-term failures). Finally, traditional tip suturing and grafts at existing domes required the utilization of many, many grafts. For a young surgeon, the questions became:

- How to avoid complications?

- How to avoid scar contracture?
- Does a surgeon need to perform thousands of these operations to get better?
- Does a surgeon need to be technically better than everyone else to yield superior results?
- Can there be another way?

In 2013-2014, the primary author and Rollin Daniel began working with Olivier Gerbault on the topic of piezosurgery in rhinoplasty. At that point, it became apparent that a different philosophy and technique could be utilized to shorten the learning curve of the rhinoplasty operation and to provide excellent results. In his book *Structure Rhinoplasty: Lessons Learned in 30 Years*, Toriumi states that “managing the bony vault is the least precise part of the rhinoplasty operation,” and that “the surgeon must take maximal care to execute the cuts in the bone with precision.”[17] However, the utilization of PEI allowed the primary author to become facile with osteotomies very quickly and with a high amount of accuracy. Over time and after becoming adept at most surgical maneuvers, it became clear that the most difficult part of the rhinoplasty operation to predict long term was (1) control of soft-tissue envelope redrape, and (2) long-term predictability of dorsal reconstruction.

Three distinct areas will be discussed: (1) utilization of PEI, (2) open vs closed approach, advantages and disadvantages, and (3) patient selection and DP. One important point that must be stressed is that each surgeon’s experience and patient population are different and will require appropriate adaptation from these recommendations.

Utilization of PEI

The utilization of piezosurgery in surgery and rhinoplasty is not a new idea but was introduced in 2015 as a substitute for conventional osteotomes. Initially, the idea was met with scrutiny secondary to the wide exposure needed, expense, fear of burning the bone, fear of burning the skin, fear of bone instability, and others. Over time, the accuracy and reproducibility of the osteotomy techniques allowed PEI to help revolutionize bony surgery of the nose. Many expert surgeons still employ osteotomes, but also many surgeons worldwide were able to shorten their learning curve of bony surgery by adding PEI to their surgical armamentarium. Since 2014, the primary author has employed PEI in more than 99% of his cases where bony surgery was necessary. The combination of accuracy, visualization, reproducibility, and stability are just a few reasons why osteotomes were in large part abandoned.

During the initial learning curve of DP, the author utilized PEI to perform all osteotomies. While many surgeons (eg, East, Kovacevic, Gerbault, and Palhazi) were utilizing PEI during the learning curve in their DP patients, Goksel and Saban elegantly published and described the osteotomy sequences and provided results.[18] In the initial conversion to a closed approach, the author employed rasps and osteotomes to perform the bony work. The resurgence of bony irregularities, unwanted fracture patterns, and limited visualization was frustrating. After a dozen cases utilizing the closed approach, multiple adaptations were made to facilitate the utilization of PEI.

Many surgeons may not have access to the piezotome. PEI makes DP surgery much easier because the cuts are precise and atraumatic. Good results can also be achieved with osteotomes; however, the skill level of the operating surgeon becomes a greater factor. In general, the surgeries are easier to learn with an open approach. If a surgeon does not have access to a piezotome, an open approach is favored during the initial learning curve.

Piezosurgery of the Keystone Area and Lateral Bony Walls in Closed Approach

The initial area treated utilizing PEI in a closed approach was the bony cap and lateral bony walls. Three adaptations were utilized for access and avoidance of complications. First, the saline employed for the piezoelectric system is cooled in an ice bath for 30 minutes before utilization. In addition, the water flow was increased by 50% (water flow of 70 on the Acteon piezoelectric system) to assure cooling of the handpiece and inserts to avoid burning the skin or bone. Second, exposure via the infracartilaginous incision was increased by completing dissecting the bony periosteum as well as the lateral pyriform attachments as is done in the open approach. Essentially, the extended open approach can be employed via closed incisions. In addition, the subperichondrial dissection of the lateral crura extends very far laterally to allow for more exposure. Third, in the case of a tight skin envelope or acute humps, an intercartilaginous incision can be connected to the hemitransfixion incision for more exposure.

Piezosurgery for Lateral Osteotomies in a Closed Approach

The second portion of the operation adapted for utilization of PEI in a closed approach was the lateral osteotomy. Four adaptations were made to facilitate the utilization of PEI for the lateral osteotomies. First, the endonasal incision above the inferior turbinate was made slightly larger for visualization of the piezoelectric saw. Second, dissection of the medial AND lateral periosteum off the nasal bone allows for precise cuts without tearing of the internal periosteum or bone heating. Third, in addition to the ice bath running through the piezoelectric tubing, an ice-cold sponge is placed underneath the saw insert on the cheek and nostril to avoid burning the skin. Fourth, a small but aggressive microrasp is employed to conduct a lateral ostectomy of the proposed osteotomy line before the actual saw is utilized. This thins the bone and allows for an accurate osteotomy line.

Piezosurgery for the Transverse and Radix Osteotomies With Dorsal Preservation in a Closed Approach

The last portion of the operation adapted for the utilization of PEI in a closed approach was the transverse and radix osteotomies performed in DP. Initially, a 2-mm osteotome was utilized, but this proved difficult to perform; it was, frankly, a somewhat violent maneuver and left many irregular edges to the bone. Next, the Cakir-Tastan hand saw was attempted. This too was tiring to perform and required wide exposure. The goal was to find an alternative that was accurate, easy to perform, fast, left less irregularity on the bone, and, importantly, could be employed without skin dissection.

Three adaptations were made to facilitate the utilization of PEI for the transverse and radix ostetomies. First, 2 small stab incisions (2.5 mm long) are made with a 15 blade with the skin on tension. Second, the corner of a 2-mm sharpened osteotome is employed to create a groove in the periosteum from medial canthus to medial canthus. This acts as a guide for the piezoelectric insert, creates space under the skin so the bone and skin can be cooled, and thins the bone. Third, ice-cold water is decanted into a basin and dripped on the piezoelectric insert and skin throughout the osteotomy to continuously cool the skin. This combination of maneuvers allows for excellent skin healing, no burning of the underlying bone, and accurate osteotomies with smooth edges. The saw can also be angled to avoid or to promote lowering of the radix. It should be noted that this technique is avoided in patients with complex skin types (eg, Fitzpatrick 5-6 skin types).

Open vs Closed Approach

The author's early experience in tip surgery was frustrating. In some patients, the skin could be released, the skeleton modified and supported with a columellar strut, and the skin would redrape well, revealing a new tip shape with better definition. However, in many patients, projection was lost or soft-tissue envelope redrape was poor, leading to a loss of definition. The nasal tip is enclosed by skin, mucosa, and the scroll ligament complex (including Pitanguy's ligament). During an open rhinoplasty, the skin and ligament complex is released and the tip reshaped. In some sequences, the mucosa can be released as well as some of the central supporting ligaments (middle crural ligaments, etc). Once all of this is released, how can it be put back together to maintain support and to control soft-tissue redrape so that tip definition can be achieved? A beautiful tip shape is achieved when a specific shape of alar cartilage projects with enough force against the soft-tissue envelope to create defined aesthetic polygons. As the surgeon, we must control not only the alar cartilage shape but also projection and the redrape of the soft tissues (Figure 9).

The Open Approach

In an open approach, the projection of the alar cartilage can be maintained with a septal extension graft, and the ligament complex can be employed to close the dead space and control soft-tissue redrape (Figure 10). Septal extension grafts have been shown by numerous authors to be superior in maintaining tip projection and is therefore preferred in an open approach.[19,20] The author's preference is to employ a wraparound septal extension graft (ie, "taco graft") to support the nasal tip in an open approach.

The ideal septal extension graft would (1) be strong and less prone to loss of projection without the use of rib cartilage, which is a downside of an end to end septal extension graft; (2) not require a strong caudal septum, which is a downside to an end-to-end septal extension graft and a side-to-side septal extension graft; (3) not be flexible because that can result in a loss of projection; (4) be easy and quick to place; (5) have a low tendency for deviation, which is a downside for a side-to-side septal extension graft; (6) have a low tendency for alar base/footplate asymmetries, which is a downside for a side-to-side septal extension graft; and (7) allow for the surgeon to control the medial and middle crura separately. To place a taco graft, a portion of the septal body is harvested, usually 12 × 15 mm. The septal cartilage is scored in the midline, wrapped around the caudal septum, and fixed with two 25-gauge needles. A running, locking suture is performed caudally and cephalically, incorporating different parts of the caudal septum. The entire graft usually requires <5 minutes to fashion and place (Figure 11; Video, available online at www.aestheticsurgeryjournal.com). This graft (1) is strong and less prone to loss of projection, (2) strengthens the caudal septum, (3) is not flexible, (4) is easy and quick to place, (5) has a low tendency for deviation, (6) has a low tendency for alar base and footplate asymmetries because it is a symmetric graft, and (7) allows for control of the medial and middle crura separately. There is a very important technical pearl for utilization of this graft. The graft is employed as a rigid, internal support to the tip, and only the columellar segment of the middle crura is actually attached to the graft. This means that the domes (domal segment of the middle crura) sit anterior and cephalic to the graft while the medial crura are controlled separately with a small cartilage strut. The tip contours are separate from the graft,

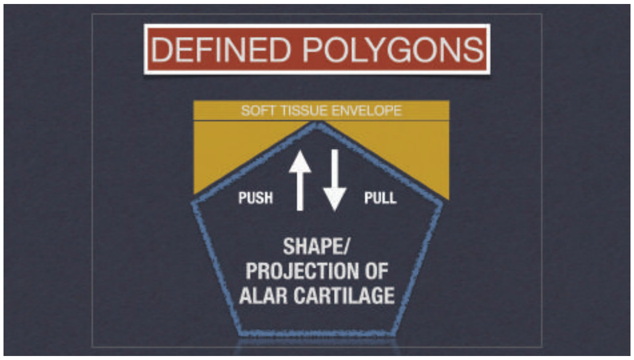


Figure 9. Mechanics of surface aesthetics. Surface aesthetics are demonstrated when the alar cartilages are forced against the soft tissue envelope to create definition. In an open approach, the alar cartilages are pushed up against the soft tissue envelope. In a closed approach, the soft tissue envelope is pulled down against the alar cartilages.

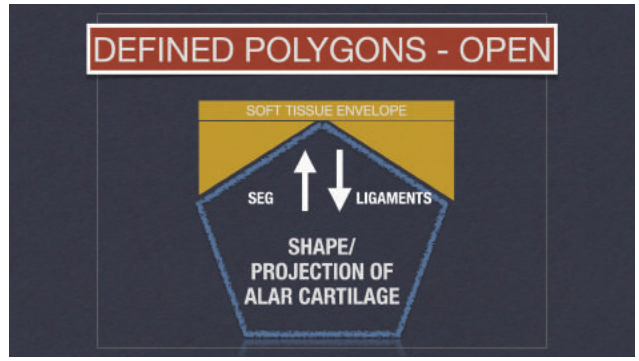
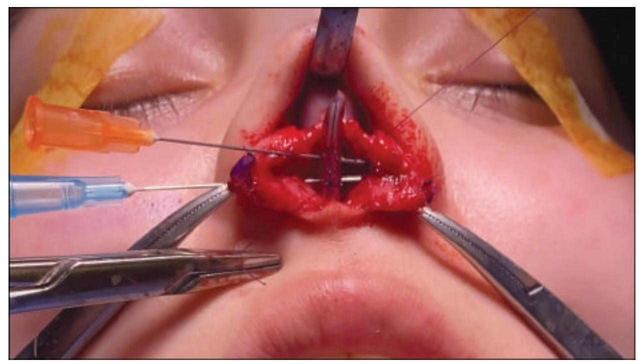


Figure 10. Mechanics of an open approach. Projection is maintained/gained with the utilization of a septal extension graft ("taco graft"). Redraping and closure of dead space are enhanced with the reconstruction of the Pitanguy and scroll ligament complex.

Figure 11. A wrap-around septal extension graft ("taco graft") placed in an open approach via a tip split approach to the septum.



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allowing it to be soft. Also, if the graft deviates, it is much less obvious because the tip itself is attached to the graft at only 1 site.

This type of tip support is essential when dealing with the difficult tip, the flimsy tip, and the underprojected tip, and when lateral crural repositioning must be performed. Some common pitfalls can be hyperprojection as well as the fact that this tip will be stiffer. If the nose is opened for any reason, the taco graft is employed to maintain tip support. Once this is conducted, the soft-tissue envelope redrape must be addressed. This is performed in 3 phases. First, the perichondrium that was lifted with the skin envelope off the middle vault is reattached on the caudal dorsum, which re-tensions the dorsal soft-tissue envelope. Second, the scroll ligament complex is repaired bilaterally by reattaching the vertical scroll ligament on the skin sleeve to the longitudinal scroll ligament with 2 sutures. Lastly, Pitanguys' ligament is reattached. It should be noted that if any rotation is performed of the nasal tip or a significant change in tip projection occurs, the ligament reattachment will create an irregular bulge. This is because the ligament is a specific length and becomes too short with significant rotation/projection. The ligament is grasped with forceps and dissected free of the dorsal soft-tissue envelope, thereby lengthening the ligament. It is then reattached to the previously cut portion or to the appropriate area on the caudal dorsum. The ligament reconstruction does not maintain the tip position. The purpose of the reconstruction is to close the dead space on the dorsum and in the supratip area and to help with soft-tissue redrape.

The main advantage of the open approach (with a septal extension graft and ligament reconstruction) is the wide exposure and the precise ability to control tip position and tip asymmetries. The main disadvantage is that although soft tissue redrape is improved, it is not as precise as the closed approach, as detailed in the next section. Also, more cartilage is needed, which could theoretically create the need for additional donor sites in secondary or revision surgeries.

The Closed Approach

The mechanics and dynamics of closed, subperichondrial polygon tip surgery as advocated by Cakir are very different and should not be confused with open tip surgery. Unlike the open approach, where the soft-tissue envelope is released from the skeletal framework, in a closed approach the scroll ligament complex including Pitanguy's ligament is kept intact and is utilized to not only control projection but also to control soft-tissue redrape. The combination of a strong columellar strut, lateral crural steal, and the ligament system allow one to simultaneously control tip position while also precisely controlling soft-tissue redrape (Figure 12). Essentially, the ligaments and a lateral crural steal procedure change the shape of the alar cartilage and force the skeleton against the soft-tissue envelope, while preservation of ligaments also pulls the soft-tissue envelope back down to the skeleton.

The major advantage of this surgery is a smaller and, if needed, deprojected nasal tip with excellent soft-tissue redrape and no transcolumellar scar. The main disadvantage is that projection cannot be easily increased, lateral crural repositioning is very difficult, gross asymmetries are difficult to correct, and a subperichondrial dissection does weaken the alar cartilages. In addition, exact tip position is harder to predict and requires experience because the surgeon relies on a flexible ligament system and a floating columellar strut.

Patient Selection and Dorsal Preservation

In addition to soft-tissue redrape, long-term middle vault deterioration remains a huge challenge in rhinoplasty. Theoretically, DP has many advantages, including a natural dorsum with predictable healing, no need for midvault reconstruction, fewer grafts required, easier revisions, long-term stability and narrowness, and more cartilage available for tip surgery, to name a few. When approaching each individual patient, the question remains: What is the easiest and safest way to treat the dorsum that will remain attractive and predictable in the medium and long-term time periods? There are 4 possibilities: open structure, closed structure, open preservation, and closed preservation. Open structure, open preservation, and closed preservation have indications in the author's practice.

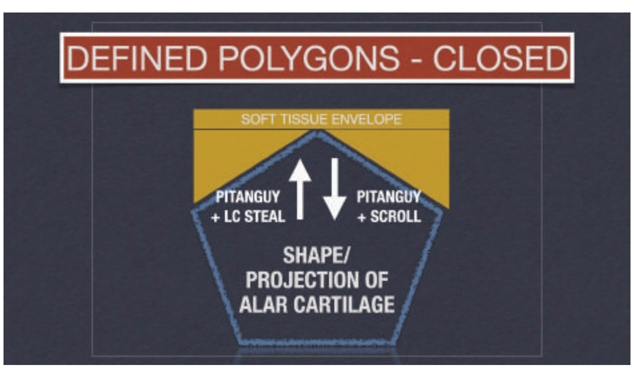

Figure 12. Mechanics of a closed approach utilizing the Pitanguy ligament system. Projection is maintained with the utilization of a columellar strut and a lateral crural steal procedure. Redraping is enhanced with the Pitanguy and scroll ligament complex.

Dorsal Structural Rhinoplasty

Dorsal structural rhinoplasty was performed in exactly one-third of patients, and all these patients had an open approach. In evaluating these 33 patients, the indications for structural rhinoplasty include dorsal aesthetic lines that were too narrow or too wide, grossly asymmetric dorsal aesthetic lines, poor candidates for DP with moderate to severe S-shaped nasal bones, major septal issues, and prior trauma. These patients are treated with conventional component reduction, piezoelectric bony surgery, and combination spreader flap/graft mid-vault reconstruction. The author does not perform closed structural rhinoplasty. Dorsums that require structure tend to be more difficult, and closed dorsal reconstruction is more difficult because of limited visualization, less accurate reconstruction, and greater technical difficulty working on the cephalic part of the nose. If the dorsum must be structured, the noses are more difficult, and an open approach is favored. In addition, if the nose is opened, a septal extension graft is employed to structure the tip.

Dorsal Preservation Rhinoplasty

DP was utilized in two-thirds (67%) of patients, which is an increase from the author's original paper on PR that reviewed cases performed in the first half of 2017.[1] What has changed? Two trends are responsible for this change. The first is the natural increase in comfort and execution of dorsal impaction of the osseocartilaginous vault. The second is the increased utilization of surface DP techniques, which greatly increases the surgeon's ability to employ DP.[7] In fact, of the DP procedures performed, 57% were performed with cartilaginous, surface techniques. These techniques are technically easier to perform and broaden the applicability of DP in specific patients and have previously been reviewed. Surface techniques allow patients with easier dorsal issues including smaller humps, mild to moderate S-shaped nasal bones, broad nasal bones, low radixes, and others to become good candidates for DP. DP is preferred when patients have ideal or close to ideal dorsal aesthetic lines. In general, easier noses, patients with thin skin, and minimal septal issues are also good candidates. These indications mirror those described by Saban, who has provided the most comprehensive long-term follow-up and evaluation of results.[21]

Three points deserve discussion. The first is that Yves Saban has taught the rhinoplasty world a great deal about DP, and our learning curve has been made easier building on his more than 30 years of experience and teaching. The second point is that Saban utilizes DP in a greater percentage of patients than the author. This is likely due to his greater surgical experience that allows him to push the limits of DP with good success. The third point is that Saban employs almost exclusively a closed approach in primary rhinoplasty. This again is likely due to his longer surgical experience as well as the fact that he is operating on a more homogenous European population. In the author's surgical practice, only 20% to 25% of patients are of European background, with a large number of patients being Latin, Middle Eastern, Asian, Indian, etc. These patients tend to have attributes that make achieving excellent results in a closed approach more difficult—namely, thicker skin, weaker crural cartilage, S-shaped nasal bones, and low ASAs, to name a few.

Open Dorsal Preservation

Of the patients who had DP, 23 (34%) received an open approach. If a patient is found to be a good candidate for DP, 2 decisions influence selection of an open or closed approach. If a patient is a good candidate for DP but will need open tip surgery, then the surgery is conducted open. However, it should be noted that 6 of the 23 patients who had an open approach for the tip had DP without dorsal skin dissection performed. Second, open DP is preferred when major dorsal modification of the bony cap or complex osteotomies are required. Essentially, the more complex bony work required, the greater the indication for an open approach.

Closed Dorsal Preservation

Of the patients who had DP, 44 (66%) received a closed approach. If a patient is a good candidate for DP and closed tip surgery can be employed, then a closed approach is preferred. If minimal bony modification is needed, closed DP is also utilized. As in the open approach, 5 patients had closed surgery of the tip but DP without skin dissection.

Putting It All Together

In approaching each patient, a stepwise analysis is conducted to determine the least invasive operation to achieve the desired result. Emphasis is placed on the least amount of disruption to the native anatomy, the least amount of dissection possible, and the minimization of uncontrolled healing forces. Analysis begins with the dorsum and ends with the tip.

Patient analysis starts with analysis of the dorsum. If structural rhinoplasty is necessary, then an open approach is chosen. A component reduction is performed followed by piezoelectric osteotomies, mid-vault reconstruction, and a septal extension graft to support the tip. Tensioning and reshaping of the alar cartilage is conducted, and the dead space is closed with reconstruction of the perichondrium and the tip ligament system. If it is determined that dorsal PR can be performed, a surface or impaction technique is then chosen. If major bony modification must be performed, or the mid-vault may need additional grafting, an open approach is employed. Consequently, after the open DP is performed, a septal extension graft is placed, alar cartilage tensioning and reshaping is conducted, and reconstruction of the ligament system concludes the surgery. If minimal bony modification can be performed, then a closed approach is considered. Attention is then turned to the tip. If the tip can be done employing a closed approach, then a closed approach is chosen. If no dorsal modification is needed and an impaction technique is chosen, then DP is conducted without skin dissection and tip surgery is analyzed separately. If the tip requires open surgery, the tip is opened. If the tip requires closed tip surgery, a closed approach is chosen. If no tip surgery is needed, then no dissection of the dorsum or tip is performed, and the dorsum is lowered via the hemi-tranfixion and endonasal incisions. Interestingly, 11% of patients had no dissection of the nasal dorsum and 2% of patients had no dissection of the nasal dorsum or tip.

Limitations

The limitation of this study is that it analyzes the results of a single surgeon still on the learning curve of PR. A patient-reported outcome measure (PROM) was not utilized to evaluate the results, and an algorithm is presented to help aid the decision of how to utilize preservation principles in clinical practice. Follow-up is only 1 year, and analysis of results over decades is necessary to evaluate the clinical importance of these maneuvers. In addition, an intermediate strip technique was not evaluated in this series. Two patients had an intermediate strip (subdorsal Z flap) during the study period, but follow-up was inadequate for evaluation.[22] Although this technique as well as others are promising and have their own indications and advantages, they were not evaluated in this series.[23]

CONCLUSIONS

Both the open and closed approaches have different indications depending on the tip and dorsal deformities. A closed PR is favored with thin skin, minimal

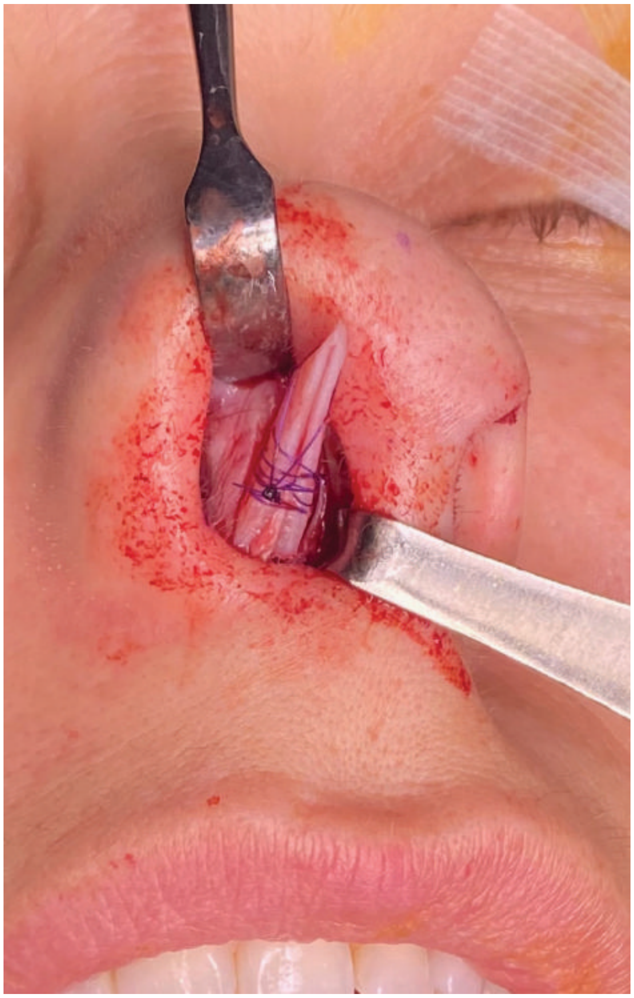

Figure 13. A wrap-around septal extension graft ("taco graft") placed in a closed approach via a unilateral hemi-transfixion incision.

dorsal modification, osseocartilaginous preservation (foundation techniques), less complex tip deformities, and overprojected noses. An open PR is favored when more dorsal modification is needed to accomplish DP, S-shaped nasal bones, more complex tip deformities, and tip augmentation. Structural dorsal rhinoplasty is always performed open and is preferred for more complex dorsal deformities, severe septal deviations, and middle vault asymmetries. The principles and techniques of PR will continually evolve, and new operations are being developed to increase the adaptation of PEI (new inserts) and the closed approach (closed taco graft) (Figure 13). The adoption of PEI occurred because the results were outstanding and the downsides minimal. Over the next decade, PR too will reveal its advantages and disadvantages as more data are collected and the results are analyzed over time.

Supplemental Material

This article contains supplemental material located online at www.aestheticsurgeryjournal.com.

Disclosures

Dr Kosins has designed a preservation rhinoplasty set for Micrins Instruments (Lake Forest, IL) and is a shareholder/consultant/medical advisor to ZO Skin Health Inc. (Irvine, CA). Dr Kosins is a Rhinoplasty section co-editor for *Aesthetic Surgery Journal*.

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Decision Making in Preservation Rhinoplasty: A 100 Case Series With One-Year Follow-Up

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Decision Making in Preservation Rhinoplasty: A 100 Case Series With One-Year Follow-Up

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Abstract

Background: Preservation rhinoplasty (PR) is a new chapter in rhinoplasty history. The term was coined by Daniel in 2018 and represents a fundamental change in philosophy.

Objectives: The aim of this study is to discuss a single-surgeon case series utilizing PR techniques.

Methods: One hundred fifty-three primary rhinoplasty cases were studied retrospectively between December 2016 and August 2017. One hundred cases had at least 1 year of follow-up. Technical details were recorded, including dissection plane, ligament preservation, tip support, lateral crural maneuvers, alar contour grafts, and preservation of the dorsum vs traditional reduction. These 100 cases can be categorized as either complete preservation rhinoplasty (PR-C) or partial preservation rhinoplasty (PR-P).

Results: All patients had open rhinoplasty and the average follow-up time was 13 months. All patients had preservation of the dorsal soft tissue envelope, and in 36 the entire soft tissue envelope and ligaments were preserved. Fifty-four had preservation of the alar cartilages. Thirty-one had dorsal preservation. The combinations include: PR-C (skin, dorsum, and alars): 24; PR-P (skin and dorsum): 2; PR-P (alars and dorsum): 2; and PR-P (skin and alars): 7.

Conclusions: In most patients, the dorsal soft tissue envelope and nasal ligaments can be preserved. When possible, the lateral crura should be preserved and tensioning chosen over excision. Dorsal preservation is a versatile technique when proper patient selection is undertaken, and long-term issues with the middle vault and keystone area can be avoided. Some patients will benefit from total preservation where nothing is removed/disrupted and underlying structures are reshaped.

Level of Evidence: 4

4
Therapeutic

Editorial Decision date: March 15, 2019; online publish-ahead-of-print April 8, 2019.

Preservation rhinoplasty (PR) is a new chapter in rhinoplasty history. The term was first coined by Daniel[1] in 2018 and represents a fundamental change in philosophy. Just as the open approach transformed rhinoplasty surgery, PR is similarly transformative, leading surgeons to rethink traditional dogma. In certain cases, the standard teaching of reduce and rebuild can be replaced with preserve and reshape. Structural rhinoplasty evolved as surgeons realized that when nasal anatomy is taken apart and/or made smaller, structures must be rebuilt and strengthened to resist the forces of scar contracture. However, if anatomy is preserved, less structural rebuilding is necessary. This paper presents a series of 100 consecutive primary rhinoplasties with a review of preservation techniques and applicability. It will also address how to incorporate these techniques into your rhinoplasty practice.

Dr Kosins is a Clinical Assistant Professor and Dr Daniel is a Clinical Professor, Department of Plastic Surgery, University of California, Irvine School of Medicine, Irvine, CA. Drs Kosins and Daniel are Rhinoplasty Section Co-editors for *Aesthetic Surgery Journal*.

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What Is Preservation Rhinoplasty?

PR comprises the following 3 elements: (1) elevating the skin sleeve in the subperichondrial-subperiosteal plane; (2) preserving the osseocartilaginous dorsum; and (3) maintaining the alar cartilages with minimal excision while achieving the desired shape using sutures. Note: PR refers to 3 components, 1 of which is dorsal preservation—the 2 terms should not be used interchangeably.

Skin Sleeve

For decades, surgeons have preferred the sub-superficial musculoaponeurotic system (SMAS) plane when elevating the skin sleeve as this plane is relatively avascular and less disruptive than the previously utilized subcutaneous plane. However, sub-SMAS dissection is still associated with significant posttreatment swelling, numbness, prolonged scar remodeling, and induration. Long-term thinning of the soft tissue envelope (STE) is a major concern as noted by Tardy and recently demonstrated by Toriumi.[2,3] In contrast, elevating the STE in a continuous subperiochondrial-subperiosteal dissection (SSD) results in minimal swelling, near-normal sensation, minimal scar remodeling, and avoidance of long-term thinning of the STE.[4] Elevation of the STE as a single sheet is critical to minimizing both short- and long-term problems.

Dorsum

In the majority of rhinoplasties performed today, the dorsal hump is resected, leading to the creation of an "open roof" that requires osteotomies and midvault reconstruction with upper lateral cartilage tensioning sutures, spreader grafts, or spreader flaps. In contrast, dorsal preservation maintains the dorsal structures while eliminating the dorsal hump through the use of septal resection followed by osteotomies to reduce the height of the dorsal line. Thus, one is able to modify the dorsum without destroying its normal anatomy. As a result, no midvault reconstruction is necessary and the dorsal aesthetic lines are maintained. Saban et al[5,6] have recently simplified Cottle's original push-down procedure by resecting a high subdorsal septal strip, which allows the dorsal convexity to flatten. Mobilization and lowering of the bony nasal pyramid is achieved with either a push-down or let-down procedure. A push-down procedure lowers the bony pyramid into the pyriform aperture. A let-down procedure also lowers the bony pyramid; however, bone is also removed laterally at the junction of the nose with the maxilla. In a let-down, the bony pyramid can sit on the ascending process of the maxilla or descend into the pyriform aperture.

Alar Cartilages

Traditionally, surgeons achieved the desired tip shape through the use of a combination of excision, incision, sutures, and grafts. Although the results were good initially, a significant percentage of these cases degraded over time. However, the adoption of tip suturing, and structural support with various columellar struts, septal extension grafts, and tongue-in-groove procedures have dramatically improved intermediate results with maintenance of projection and fewer tip deformities. PR advances tip surgery even further by preserving virtually the entire alar cartilage, which enhances function and reduces potential problems. In addition, revisions are much simpler. The combination of a subperichondrial exposure and maintenance of a completely intact alar cartilage represents a dramatic new advance in tip preservation surgery.

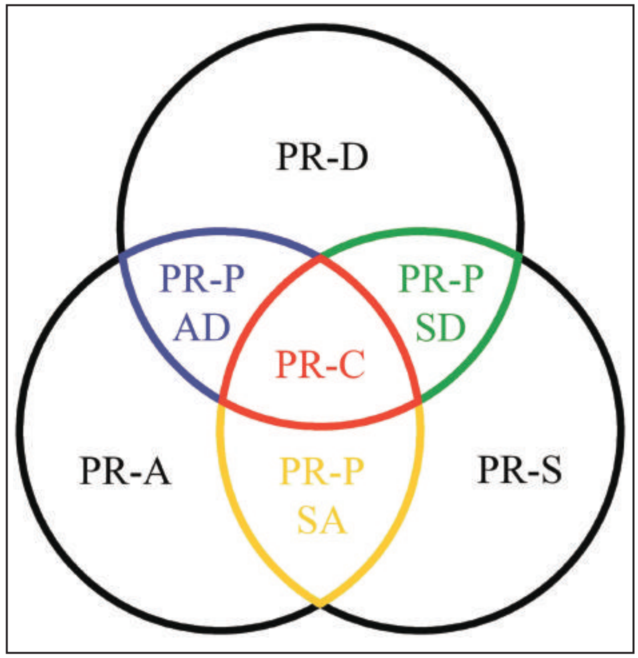

Figure 1. The chart illustrates how preservation rhinoplasty (PR) is composed of the following 3 parts: (1) elevating the skin sleeve in the subperichondrial-subperiosteal plane; (2) preserving the osseocartilaginous dorsum; and (3) maintaining the alar cartilages with minimal excision while achieving the desired shape using sutures. If all 3 techniques are done, we consider this to be total preservation, or PR-C (complete). However, the reality is that certain patients will not require all 3 preservation modalities, resulting in a partial preservation rhinoplasty (PR-P). PR-P(S) refers to preservation of the soft tissue envelope, PR-P(D) refers to preservation of the dorsum, and PR-P(A) refers to preservation of the alar cartilages. Different combinations are possible depending on the patients.

Classification

Due to the wide variety of anatomy and aesthetic goals, surgeons employ a large number of preservation surgical techniques (Figure 1).[7] Ideally, a complete preservation rhinoplasty

(PR-C) would be done, consisting of elevating the STE as a single subperichondrial-subperiosteal sheet, preserving the dorsum, and retaining all of the alar cartilages and ligaments. However, the reality is that certain patients will not require all 3 preservation modalities, resulting in a partial preservation rhinoplasty (PR-P). For example, many Latin patients have thick skin and an underprojected tip. The tip may require extensive debulking. On the other hand, the dorsum is preserved and lowered, while the alar cartilages are preserved and supported on a septal extension graft. Thus, the procedure can be classified as a type of partial preservation rhinoplasty, termed PR-P(DA), where D and A refer to dorsum and alars. This indicates that the dorsum and alars were preserved but the STE was not. Similar modifications will lead to different combinations of preservation as ultimately PR is both a set of principles for all aspects of rhinoplasty surgery as well as specific surgical techniques.

METHODS

One hundred fifty-three primary rhinoplasty cases were studied retrospectively between December 2016 and August 2017. The study was conducted in accordance with the principles set forth in the Declaration of Helsinki. One hundred cases had at least 1 year of follow-up and were therefore included in the study. No secondary rhinoplasty or secondary septoplasty cases were included. Asian patients were excluded as their dorsa are rarely reduced and thus they are not candidates for a PR-C. Any patient not having at least 1 year of follow-up was also excluded. All patients included had not undergone any previous nasal surgery whatsoever. Data were collected in all cases regarding age, gender, ethnicity, and technical details of the operation (dissection plane of tip, dissection plane of dorsum, preservation of ligaments, columellar strut vs septal extension graft, lateral crural maneuvers, use of alar contour grafts, and preservation of the dorsum vs traditional reduction and midvault reconstruction). Patients were seen for follow-up at 1 week, 1 month, 3 months, 6 months, and 1 year after surgery. These 100 cases can be categorized as either PR-C or PR-P.

Surgical Techniques

Rhinoplasty surgery is highly varied with virtually unlimited techniques selected based on analysis and aesthetic objectives. The following description reflects the senior author's (A.M.K.) current techniques.

Elevation of the STE

Elevation of the STE in the subperiochondrial-subperiosteal plane is a 3-step sequence: (1) a continuous SSD over the dorsum; (2) subperiochondrial dissection of the tip; and (3) connecting the 2 pockets at the scroll ligament complex. It should be noted that an open approach is utilized in 98% of patients and exposure is done in the following manner.

Dorsal dissection is performed first through a unilateral hemitransfixion incision whereby a subperichondrial plane is entered at the anterior septal angle and dissected laterally to the pyriform ligament, cranially to the caudal portion of the nasal bones, and caudally to the vertical scroll ligament. After the cartilaginous dorsal dissection is finished, bilateral infracartilaginous incisions are made. The subperichondrial tip dissection begins at the turning point of the lateral crus and continues medially over the domes. Entrance into a subperichondrial plane over the alar cartilages is tedious and requires sharp dissection and small elevators to access the correct plane. Once entered, the perichondrium lifts easily as a sheet and an elevator is used to sweep the perichondrium upwards. No bleeding or visible SMAS tissue should be seen. Once the perichondrium has been lifted off of the domes, a transcolumellar incision is made and the lateral and central pockets are connected. This releases the tip complex from the STE and Pitanguy's ligament is encountered as well as the ligament's lateral extensions—the vertical scroll ligaments. Pitanguy's ligament in marked and divided with 2 sutures. At this point, the vertical scroll ligaments are released with upward sweeping motions and the dorsal and tip dissections are connected at the scroll ligament complex. Finally, a subperiosteal dissection of the bony pyramid is done up to the nasal radix and down to the maxilla in preparation for piezoelectric surgery (extended open approach).[8]

Preservation of the Dorsum

After elevating the STE, a wide submucosal dissection of the subdorsal septum is performed as well as dissecting for at least 5 mm under the upper lateral cartilages. Two anatomic points must clearly be delineated: the anterior septal angle (ASA) and the W-point. The W-point is defined as the point of the separation of the upper lateral cartilages from the dorsal septum. The intervening area between the ASA and W-point is called the W-ASA segment. Dorsal preservation consists of 2 parts: septal strip resection to flatten the dorsal hump, and osteotomies to mobilize the bony pyramid and to lower the dorsal bridge.

Septal Strip Removal

Pretreatment, the position of the ideal dorsum is marked on the patient's profile. This allows visualization of the shape of the strip(s) that will be removed. It should be noted that in dorsal preservation surgery, the amount of subdorsal septum removed is slightly greater than the intended reduction because the dorsum is lowering *and* flattening. The initial strip resection starts approximately 10 mm cephalic to the ASA at the W-point. The W-ASA segment will be modified at the time of tip surgery.[9] Initially 2 to 3 mm of septum is resected directly under the dorsum. This is done to test how the dorsum will move. Curved scissors are used for the anterior cut in order to stay immediately under the dorsum, and straight scissors for the posterior cut to ensure a straight cut. Once the cartilage strip is removed, a tapered triangular portion of the perpendicular plate of ethmoid is resected incrementally with the use of piezoelectric instrumentation and/or a narrow, long rongeur. Any remaining septum on the undersurface of the osseocartilaginous vault is scored with scissors to help break the tension of the chondro-osseous joint.[10]

Osteotomies to Release the Bony Pyramid

After the initial 2- to 3-mm strip of septum is removed, a low to low osteotomy is started on the patient's left nasal bone with a curved saw from the edge of the pyriform aperture along the base of the nose. I prefer piezotechnology because: (1) exposure is maximum with the extended open approach; and (2) the cuts are precise and can be made at an angle that is 30° to 45° to the face of the maxilla.[11] This angulation allows lowering of the bony vault into the pyriform aperture because cuts parallel to the maxilla make medial movement more difficult. Once the low to low osteotomy is made, the saw is curved to begin the transverse osteotomy to the midline. This is repeated on the right nasal bone, meeting in the transverse midline where the "radix osteotomy" is completed, and connected down to the perpendicular plate resection. The nasal bony pyramid is released and the nose can be mobilized with side-to-side movement to push down into the pyriform. At times there are areas of bony contact that need to be released further and these can be checked using the full open approach. In addition, a piezoelectric rasp can be used at the lateral osteotomy sites (especially cephalically) to create a gap that allows more free movement of the bony pyramid down into the pyriform aperture. With this technique, lateral strips of bone do not need to be removed even with 7 to 8 mm of lowering. Once the bony pyramid is released, the surgeon checks the movement of the dorsum to see if further septal resections are necessary. Further resections are done in 1- to 2-mm increments while watching the movement of the dorsum. Final touches on the dorsum are done caudally near the ASA where septum proper is removed. Only after lowering is septal work done to harvest cartilage or to reset the caudal septum.

Fixation

Fixation is an important step to prevent the dorsum from "popping up" posttreatment, which would require revision surgery. Suture fixation of the dorsum is done at 3 points as previously described.[12] After the nose is opened, drill holes are placed in the nasal bones laterally at the point of maximum projection of the hump (K-point). Once the dorsum is lowered to the appropriate height, a 4-0 PDS needle is passed from the left drill hole down to the remaining septum, and back up through the right drill hole. The position of the dorsum is checked and the suture tied, locking the most projecting part of the dorsum down to the remaining septum. A second suture is done at the most caudal aspect of the dorsum attaching the distal upper lateral cartilages (ULCs) to the remaining septum at the W-point. This suture is very useful as the dorsum can be sutured to one side or the other if the cartilaginous dorsum is deviated. In addition, the ULCs can be attached above the dorsum to gain 1 to 2 mm of projection if needed. The last suture is placed in between the first 2 sutures, making sure to lock down the whole dorsum. With this 3-suture fixation technique, there have been no dislocated dorsa and no recurrent hump deformities.

Preservation of Alar Cartilages

Preserving the alar cartilages, and in particular the lateral crus, is a relatively recent development. The critical steps are to achieve tip support with struts, to shape the domal cartilage with sutures, and to control the lateral crus with tensioning techniques.

Columellar Strut vs Septal Extension Graft

In all cases, either a columellar strut or septal extension graft is used. Pretreatment imaging and simulation of the posttreatment result guides the decision. A septal extension graft is used for the following clinical cases: (1) an underprojected tip; (2) a normally projected tip encased in a thick, soft tissue envelope; (3) a normally projected tip, but the patient requests maximum tip definition; and (4) a tip with major crural asymmetry. A columellar strut is preferred in the following cases: (1) normal projection; (2) overprojection; and (3) the desire for an elastic, mobile tip (the patient rejects the notion of a stiffer tip posttreatment). If a columellar strut is chosen, preservation of ligaments is crucial to maintain tip support.[13] In cases with a columellar strut, the septum is exposed through a right, unilateral transfixion incision. This incision is actually a transseptal incision as it leaves 1 to 2 mm of caudal septum attached to the membranous septum. This approach preserves Pitanguy's ligament intact, and this "posterior strut" can be used to control tip projection and supratip contour.[14] After the dorsal work has been completed, the nasal ligaments (Pitanguy's and bilateral scroll ligaments) are reattached and tip suturing is performed. The columellar strut is then inserted and attached to the tip complex in a floating fashion. The strut does not increase projection. It only helps to maintain tip support. Finally, the posterior strut is reattached to the caudal septum. The sutured Pitanguy's

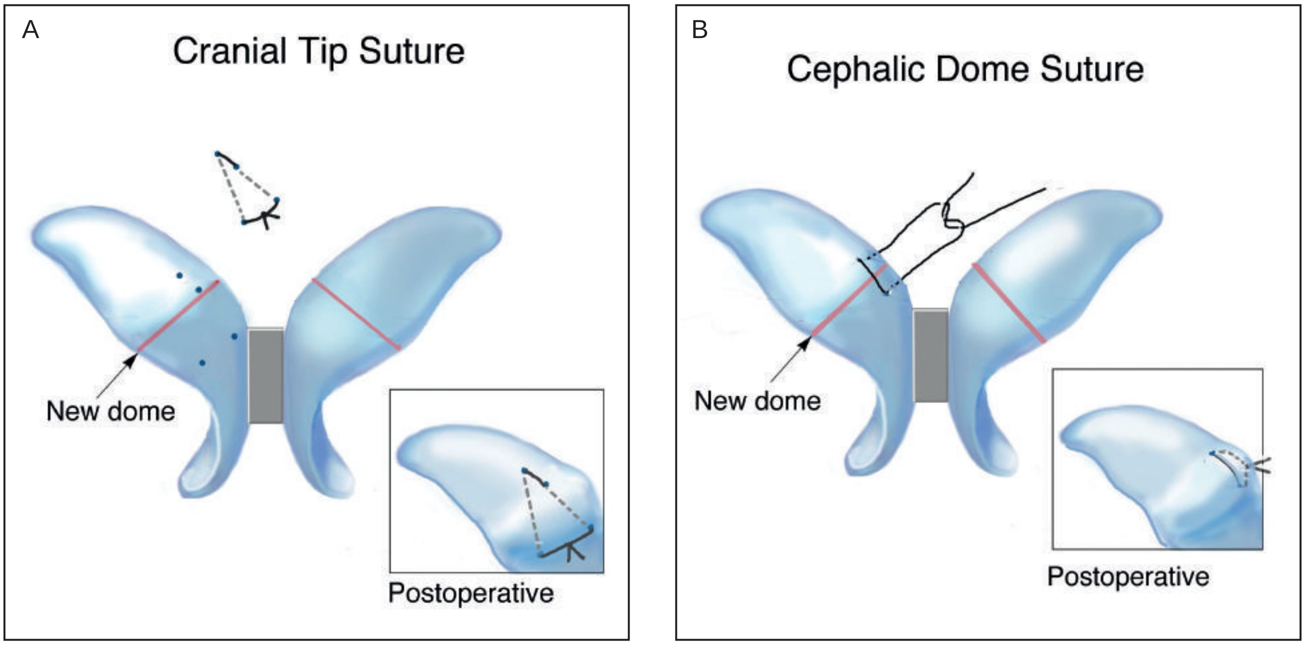

Figure 2. Domal definition is achieved through the use of domal creation sutures with lateral placement. (A) The cranial tip suture was developed by Kovacevich and involves a triangular suture sutured across the new dome. (B) The cephalic dome suture was developed by Cakir and involves a simple suture tied cephalic to the new dome. Both sutures create domal definition, stiffen and tension the lateral crura, and evert the caudal border of the lateral crura.

ligament provides additional tip support and compresses the infralobule.

If a septal extension graft is chosen, preservation of ligaments is crucial to close dead space in the supratip and scroll regions and to control the soft tissue envelope. The septum is exposed through a tip-splitting incision as the soft tissue is divided from the domes down to the footplate segment of the medial crura. This soft tissue is not repaired as support will come from the septal extension graft itself. When using a septal extension graft, it is paramount to make certain the graft is in the midline. An overlapping method with a contralateral spreader graft to brace the graft is preferred. Care is also taken to make sure the posterior portion of the graft does not "bulge" into the nasal airway or cause footplate distortion. The caudal end of the graft can be tailored to create an aesthetic curve of the infralobule. This will help prevent the need for contour grafts. After the dorsal work has been completed, the septal extension graft is secured and then tip suturing is performed as well as attachment of the tip complex to the graft. Once the tip is finished, the nasal ligaments are reattached.

Domal Definition

Accentuation of domal definition is achieved with sutures. With a subperichondrial dissection, the alar cartilages are significantly more malleable and easier to shape with sutures. One of 2 sutures is used for domal creation with lateral placement (depending on the amount of the lateral crural steal).[15] A cranial tip suture, as described by Kovacevich,[16] is a triangular stitch across the neo-dome. This stitch gives definition to the dome, while also straightening and strengthening the lateral crura. A cephalic dome suture, as described by Cakir, is a more aggressive suture.[14] It is used as a simple suture tied on the cranial edge of the neo-dome. Intrinsically, the cephalic dome suture does the same thing as a cranial tip suture; however, it gives a sharper dome, more concavity to the lateral crura, and major eversion of the caudal border of the lateral crura. This suture is used in patients with thick skin, strong cartilage, and/or patients who request maximum tip definition. More than 1 suture can be used on each dome and/or both sutures can be used depending on the shape of the cartilage (Figure 2).

Lateral Crural Tensioning

After the nose is opened, the nasal tip is assessed. With rare exception, every attempt is made to keep the entire lateral crura, and not to violate the longitudinal scroll ligament. When necessary, a lateral crural steal is planned to create the optimal dome point, to optimize projection/rotation, and to stiffen and straighten the lateral crura while everting the caudal border. This procedure is extremely valuable in wide tips with minimal definition and underprojection as it provides projection, rotation, and lengthening of the infratip lobule (intrinsic tip). In addition, a lateral crural steal helps to tension the lateral crura and the tip complex, giving it strength and rigidity.

The neo-dome is marked bilaterally and checked to make sure that the new lateral crural lengths from neo-dome to the lateral crural turning points are equal. After domal creation, the domes are again checked to make sure that the dome to turning point distances are equal on the right and left side with equal tensioning. A domal equalization suture as described by Daniel is placed to create tip symmetry.[10] After suturing, the cephalic edges of the neo-domes should just touch, creating the nasal tip polygons. The last step is to attach the lobular segment of the middle crura to the columellar strut or septal extension graft. These sutures help to define the shape of the infralobule and the columellar breakpoint. Intradomal sutures and sutures to close the infralobular polygon are avoided. Transections of lateral crura are never done unless a lateral crural strut graft is to be placed. Ultimately, lateral crural tensioning occurs due to 3 factors. First, the domal creation sutures create tension by forming a flatter and stronger lateral crus with the caudal border higher than the cephalic border. Second, the lateral crural steal creates tension by shortening and straightening the lateral crus. Third, attachment to a strut and especially a septal extension graft tensions the tip medially. The combination of the 3 creates a rigid tip complex tensioned at all 3 legs of the tripod.

RESULTS

Eighty-six patients were female and 14 were male. The average age was 27 years with a range from 16 to 59 years. All patients had open rhinoplasty and the average follow-up time was 13 months. The average operative time was 154 minutes. Thirty-six patients were of Latin descent (inclusive of Central and South America) with 27 being of Mexican descent (3 were half-Mexican and half-European), 4 Brazilian, 2 El Salvadoran, 1 Guatemalan, 1 Colombian, and 1 Peruvian. Twenty-eight patients were of Middle Eastern descent (20 Iranian, 3 Iraqi, 2 Syrian, 1 Lebanese, and 1 from Yemen). Thirty were of European descent. Two patients were of Indian descent. One patient was of Pakistani descent. Three patients did not know their ethnic heritage. All patients had preservation of the dorsal soft tissue envelope, and 36 patients had preservation of the of the soft tissue envelope (dorsum and tip) and ligaments. Fifty-four patients had preservation of the alar cartilages. Thirty-one patients had dorsal preservation. The combinations include:

- PR-C (skin, dorsum and alars): 24 patients
- PR-P (skin and dorsum): 2 patients
- PR-P (alars and dorsum): 2 patients
- PR-P (skin and alars): 7 patients

STE Preservation

Using the Obagi skin pinch test, and sometimes ultrasound, 22 patients were found to have thick skin, 60 were found to have normal skin, and 18 were found to have thin skin. Tip dissection plane was recorded in all patients. Thirty-six patients underwent subperichondrial dissection to preserve maximum soft tissue coverage in 19 thin-skinned patients, to weaken the lateral crura in 9 patients, and to achieve both in 8 patients. The remaining patients underwent sub-SMAS or subdermal dissections. The SSD plane was utilized for the dorsum in all patients.

Tip Support and Alar Preservation

A columellar strut was used in 29 patients and a septal extension graft (SEG) in 71 patients. During photographic analysis, 29 patients were deemed to have either adequate projection or overprojection and/or strong lateral crura. A columellar strut was used in these patients. The remaining patients were underprojected or had adequate projection with weak cartilaginous support. An SEG was used in these patients. Of note, 76 patients were found to have a plunging tip on smiling and were treated with either a columellar strut (18 patients) or an SEG (58 patients). These tip support grafts were used to fix the tip position to correct the plunging tip illusion.[17] Nasal muscles, including the depressor septi nasi, were not removed in any patient. All 76 patients had relief of the plunging tip illusion posttreatment.

Fifty-four patients had total preservation of the lateral crura without cephalic or caudal trim. Of the remaining 46 patients, 35 had a “slide under” procedure with preservation of the longitudinal scroll ligament, 7 had a formal cephalic trim procedure because of the extreme strength of the lateral crura, and 3 had lateral crural strut grafts because of severe alar malposition and length in 2 cases and reshaping in 1 case secondary to weak and deformed lateral crura. One patient of 46 had a cephalic turnover to treat concave lateral crura. Sutures were used to achieve domal definition in all patients. Cranial tip sutures were used in 68 patients and cephalic dome sutures in 28 patients. The remaining 4 patients received a combination of sutures. A lateral steal procedure was performed in 88 patients with an average steal of 2.5 mm (range, 1-6 mm). A domal equalization suture was used in all patients. No intradomal sutures were used. Four tip position sutures were used to gain projection and rotation. Alar contour grafts were used in only 16 patients to fix asymmetries, as opposed to over 80% of patients in the past.[18] Lateral crural tensioning has decreased the use of alar contour grafts.

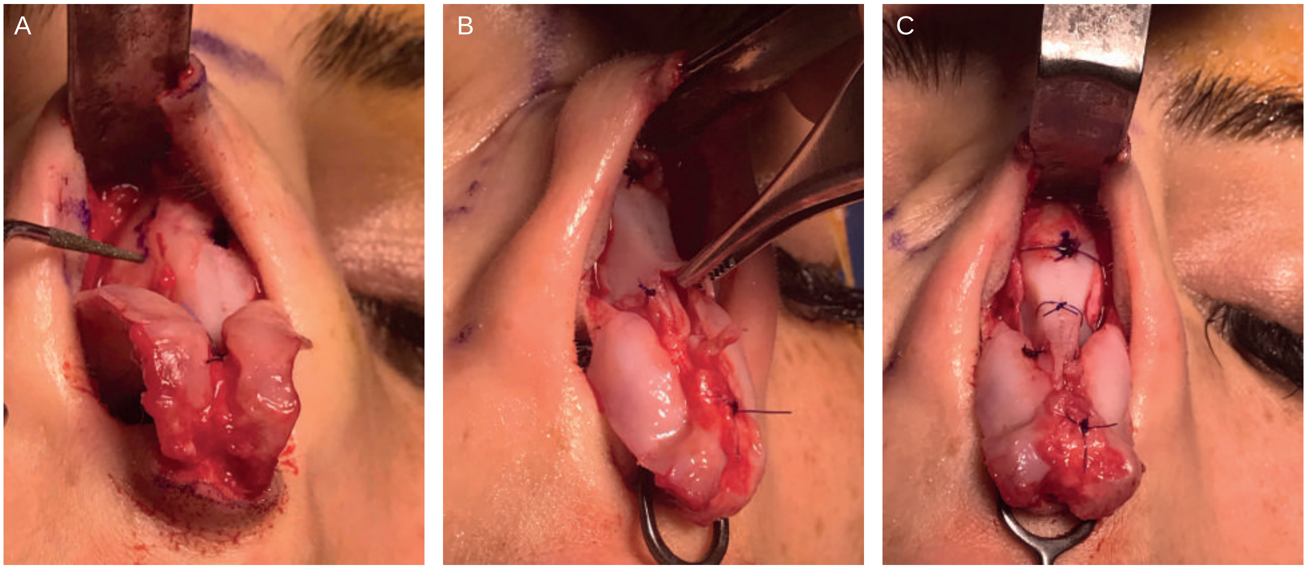

Figure 3. In patients with a small dorsal hump and ideal dorsal aesthetic lines, a cartilaginous dorsal preservation can be performed. The patient in this example is a 28-year-old female. (A) First, the bony cap is removed with the use of piezoelectric instrumentation. The purple dot marks the original position of the keystone junction. Eight millimeters of dorsal bone have been removed as well as the lateral keystone area. (B) Second, the septal strip is removed and the cartilaginous dorsum is released laterally from the bony pyramid attachments (perichondroperiosteal attachments). (C) Finally, the cartilaginous dorsum is sewed down to the underlying subdorsal septum and the lateral bone edges are removed. In this way, the cartilaginous dorsum is preserved and the middle vault is never opened.

Dorsal Preservation

Thirty-one patients underwent dorsal preservation. In 2 of 31 patients, a cartilage-only preservation was done by removing the bony cap, removing a subdorsal strip, releasing the cartilaginous dorsum from the nasal bones laterally, and suturing the cartilaginous dorsum down to the underlying septum (Figure 3). Release of the bony pyramid and osteotomies were not necessary. The average resection of septum measured 4 mm (range, 2.5-8.5 mm). Only one patient was male. The bony cap was partially removed in 7 of 31 patients to transform the dorsum into a more cartilaginous vault if the hump appeared to be kyphotic or longer nasal bones were present. The undersurface of the dorsum was scored in 29 of 31 patients; in the 2 patients where it was not, the dorsum was straight and simply overprojected. Of the dorsal preservation patients, 6 of 31 patients had a radix graft of fascia or diced cartilage in fascia to maintain an ideal radix position. Camouflage grafts were not necessary along the transverse osteotomy line although removal of a palpable step was done in 2 of 31 patients with a 3-mm osteotome.

All 31 patients underwent 3-point fixation. Two patients also had cartilage wedges placed in the lateral osteotomy sites bilaterally to hold the bony pyramid in place. No patients required revision surgery and no patients had the dorsum dislocate anteriorly after surgery. Three patients still appeared to have a slight hump posttreatment but did not request revision. Two of these patients had kyphotic humps and 1 had long nasal bones and the bony cap had not been removed. One patient had a slightly underprojected tip secondary to an error in judgment in that the patient needed an SEG. Ten consecutive patients underwent ultrasound of the dorsum to demonstrate to them the changes made during surgery. In all 10 patients the dorsum flattened and the radix and ASA points were lowered. Eight patients were determined to have a straight dorsum from primarily osseocartilaginous joint flexion. The remaining 2 patients had incomplete flexion; however, the hump also disappeared secondary to lowering of the radix and ASA points (Figure 4).

Revisions

Three revision surgeries were necessary. One patient originally underwent ultrasonic rhinosculpture and remained with a wide dorsum requiring formal piezoelectric osteotomies. One patient had middle vault asymmetry and required a spreader graft on 1 side. Previously only spreader flaps had been used. The last patient requested less tip definition/projection and her septal extension graft was lowered. No revisions were necessary for the dorsal preservation cohort and no patients had revision surgery for nasal airway obstruction.

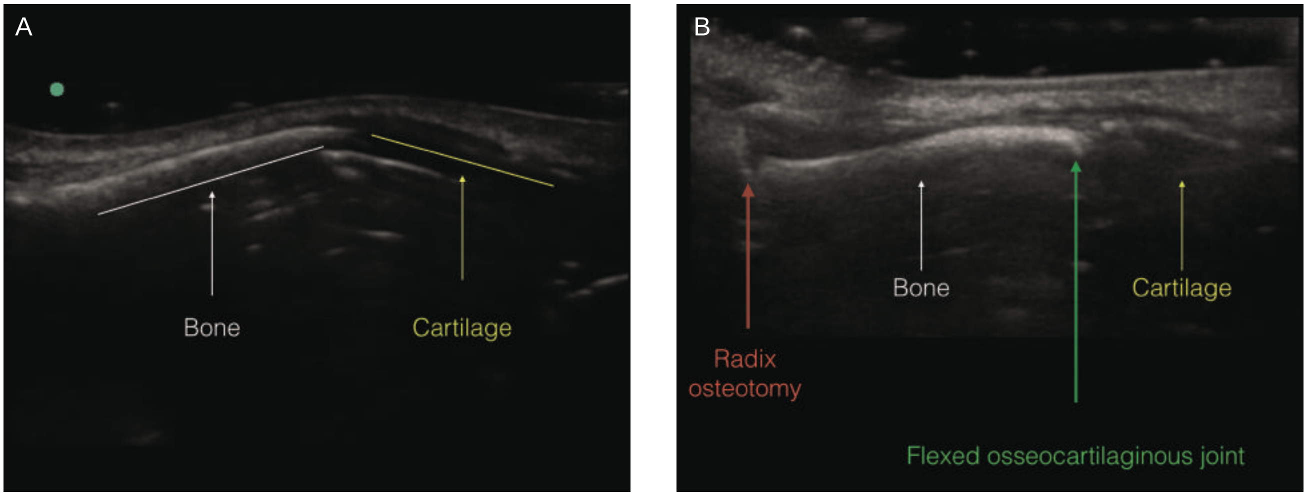

Figure 4. (A) Ultrasound view of a 26-year-old female patient with V-shaped nasal bones before a dorsal preservation procedure. The bone and cartilage are labeled, and the dorsal hump is clearly seen. (B) Three-month posttreatment view demonstrating a straight dorsum. Note that the osseocartilaginous vault has flexed and descended posteriorly. The bone and cartilage are marked as well as the radix osteotomy site. The vault has flexed and descended posteriorly.

In general, the most common revision a surgeon will encounter is a residual hump/convexity if the bridge was not lowered enough. This is fixed by removing an additional septal strip followed by release of the bony pyramid. Dislocation of the osseocartilaginous vault is also theoretically possible, but is prevented with suture fixation as described above. In the closed approach, this is more difficult to perform.

Morbidity

There was no incidence of surgical bleeding requiring operative intervention. One patient had a submucosal septal infection requiring drainage and antibiotics. Her culture was positive for *Pseudomonas*. No septal perforations were found on posttreatment speculum examination.

Case Studies

Four representative case studies are presented as Figures 5 to 8; these demonstrate PR-C (Figure 5), and various combinations of PR-P, namely, PR-P(SD) (Figure 6), PR-P(AD) (Figure 7), and PR-P(SA) (Figure 8), where S, D, and A indicate skin, dorsum, and alars, respectively.

DISCUSSION

Each of the 3 critical components of PR can be discussed in terms of their actual execution as well as how they fit within the spectrum of rhinoplasty techniques.

Preservation of the STE

The standard dissection plane in rhinoplasty for the tip and dorsum has been the sub-SMAS plane. This is a distinct plane directly above the perichondrium. Surgeons who perform rhinoplasty, and specifically secondary rhinoplasty, are cognizant that dissection through the SMAS layer (instead of below the layer) causes more tissue injury, bleeding, and a longer recovery process. In fact, possibly the most difficult aspect of secondary rhinoplasty is dealing with a difficult soft tissue envelope. Fascia grafts, dermal grafts, fat grafting, and, most recently, microfat-infused soft tissue augmentation have been used to rehabilitate the soft tissue envelope.[2] Preservation of the soft tissue envelope and nasal ligaments is paramount to avoiding long-term deformities. Cerkes[19] described a subperichondrial dissection of the nasal dorsum for the purpose of camouflage and dorsal reconstruction. However, the skin was first lifted in a sub-SMAS plane and then the perichondrium separately dissected from the upper lateral cartilages. Although the perichondrium is specifically preserved, the tissue layers between the perichondrium and SMAS are not. Cakir[4] proposed a full SSD of the nasal tip and dorsum with preservation of ligaments. Although this is technically challenging, bleeding is almost entirely absent from the operative field. If done correctly, a perichondrial-periosteal sheet is lifted off the osseocartilaginous nose. The subperiochondrial-subperiosteal plane is utilized in the dorsum in all cases and includes the tip in the following cases: (1) thin STE; (2) normal thickness STE and normal cartilages; and (3) normal STE but cartilages are excessively strong and/or convex. SSD weakens the lower lateral cartilages and allows them to be much more malleable. This is the preferred plane because the soft tissues, vessels, nerves, and lymphatics of the STE remain undisturbed. This preservation of soft tissues results in faster healing time with less swelling and induration as demonstrated previously on ultrasound examination.[20] A SSD is always done over

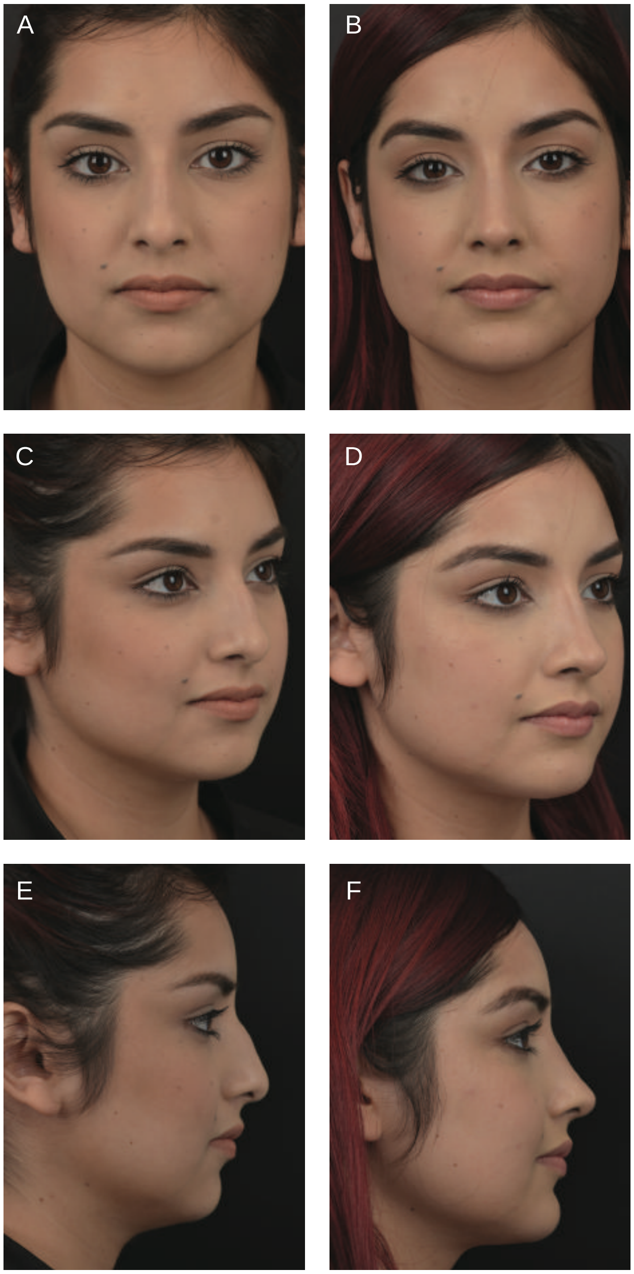

Figure 5. Complete preservation rhinoplasty (PR-C) case example. A 24-year-old female of Hispanic background complained of a dorsal hump, bulbous tip, and plunging tip on smiling. Pretreatment (A, C, E, G, I) and 1-year posttreatment (B, D, F, H, J) views are shown. The Obagi skin pinch revealed normal thickness skin and she had fairly strong alar cartilages that measured 7.5 mm in width intraoperatively. A subperiochondrial-subperiosteal dissection of the tip and dorsum was selected with preservation of all ligaments and alar cartilage. Tip suturing was performed with cephalic dome sutures and a 2.5-mm lateral steal procedure. The patient had an underprojected nasal tip and therefore a septal extension graft was chosen. Her dorsum was found to be ideal on anterior view, with V-shaped nasal bones, and a dorsal preservation (push-down) of 4 mm was performed. Posttreatment the nasal hump has been eliminated, the dorsal aesthetic lines are narrow and symmetric, and the nasal tip has much better definition. Chin augmentation and suction-assisted lipectomy of the neck were also done for facial balance.

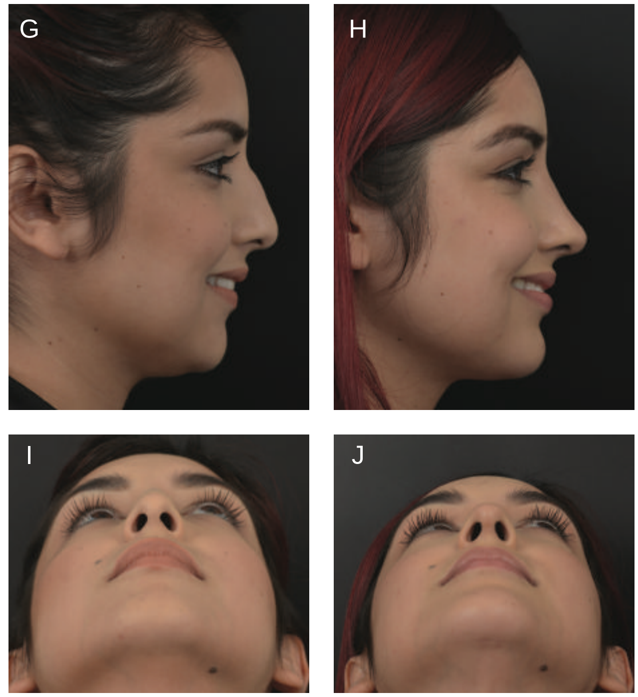

Figure 5. Continued

the dorsum for 2 reasons. First, it weakens the cartilaginous vault, making it more pliable. Second, it facilitates dissection across the perichondrial-periosteal junction at the keystone area, which is a key maneuver to allow the osseocartilaginous joint to flex. The SSD was used in 100 patients over the dorsum and a full SSD over the dorsum and tip in 36 patients.

Preservation of Pitanguy's ligament and the vertical scroll ligaments (which connect the longitudinal scroll ligament to the SMAS) is preferred in all cases unless a subdermal dissection of the nasal tip is used to excise the ligaments for maximum tissue debulking. These ligaments are marked and divided when opening the nose and reattached during closure. This accomplishes 3 goals. First, it preserves the normal anatomy of nose and prevents supratip or transversalis bulging posttreatment. Second, the ligaments form the supratip break and scroll facets that are critical to closing dead space and creating tip definition. Third, Pitanguy's ligament in particular is critical to long-term tip support. Dividing Pitanguy's ligament causes the tip-defining points to drop 4 mm posteriorly and 3 mm caudally on average when opening the nose.[21]

Figure 6. Partial preservation rhinoplasty involving skin and dorsum [PR-P(SD)] case example. A 32-year-old female of European background presented with a dorsal hump and plunging tip on smiling. Pretreatment (A, C, E, G, I) and 13-month posttreatment (B, D, F, H, J) views are shown. The Obagi skin pinch revealed thin skin and she had cephalic and caudal excess of her lower lateral cartilages (12 mm in width). A subperiochondrial-subperiosteal dissection of the tip and dorsum was selected. A 1.5 mm autorim flap was performed bilaterally to treat caudal excess as well as a slide-under flap of excess cephalic alar cartilage measuring 2.5 mm. Tip suturing was performed with cephalic dome sutures and a 2-mm lateral steal procedure. The patient had adequate projection and a columellar strut was chosen. Her dorsum was found to be ideal on anterior view with V-shaped nasal bones, and a dorsal preservation (push-down) of 3.5 was performed. Posttreatment, the nasal hump has been eliminated, the dorsal aesthetic lines are narrow and symmetric, and the nasal tip has better definition with a more ideal facet polygon. Chin augmentation and suction-assisted lipectomy of the neck were also done for facial balance.

Figure 6. Continued

Reattachment gives the nasal tip projection and rotation, as well as a "rubber band" effect between the SMAS that travels through the supratip region and posterior to the medial crura. When this rubber band is released, projection is lost and the infralobule bulges caudally. It should be noted that when a septal extension graft is used, reattachment of Pitanguy's ligament sometimes creates an unnatural fullness in the supratip area. If this occurs, a supratip stitch is used, as described by Guyuron et al,[22] to close the dead space.

Preservation of the Dorsum

The concept of dorsal preservation is simple—preserve the dorsum by lowering the osseocartilaginous vault with subdorsal resection instead of traditional dorsal reduction. The keystone is kept intact and the middle vault is not opened; therefore irregularities, asymmetries, and long-term distortion are avoided. Technically, a few points should be emphasized. The open approach with a tip split

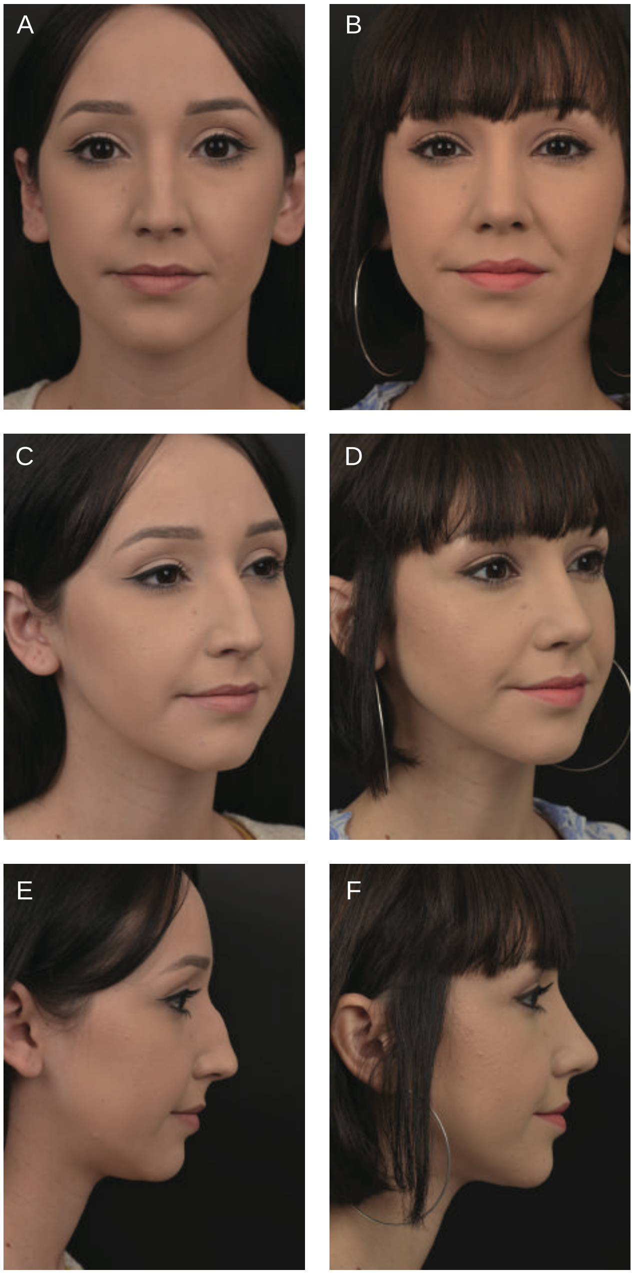

Figure 7. Partial preservation rhinoplasty involving alars and dorsum [PR-P(AD)] case example. A 26-year-old female of Hispanic background presented with a dorsal hump, plunging tip on smiling and low radix. Pretreatment (A, C, E, G, I) and 1-year posttreatment (B, D, F, H, J) views are shown. The Obagi skin pinch revealed normal thickness skin, but she was felt to have weak alar cartilage. A sub-superficial musculoaponeurotic system dissection was done of her tip and a subperiochondrial-subperiosteal dissection of her nasal dorsum. Tip suturing was performed with cranial tip sutures and a lateral steal procedure of 1 mm. The patient had inadequate projection and weak cartilage, so a septal extension graft was chosen. Her dorsum was found to be ideal on anterior view with S-shaped nasal bones and a low radix. A dorsal preservation (push-down) of 4.5 mm was performed after removal of the bony cap. The bony cap was removed to transform the dorsum into a more flexible framework. A radix graft was added for balance. Posttreatment, the nasal profile is straight with good tip projection and definition. The plunging tip illusion has been eliminated.

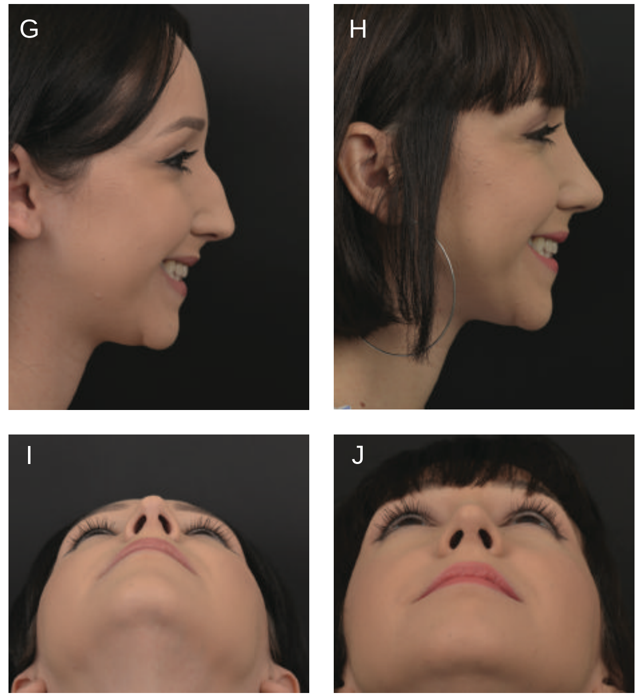

Figure 7. Continued

is technically easier than a closed approach. Beginning the septal strip removal at the W-point is conservative and allows for ASA lowering separately. This sequential excision avoids a visual saddle deformity with too much lowering of the dorsum caudally. The septal strip is always done before osteotomies as it allows for a "bail-out" to the traditional reduction method. Dorsal preservation can make a much smaller nose than traditional reduction methods, especially cephalically where the bony pyramid is lowered. Patient selection is the key to success. Dorsal preservation plays almost no role in secondary rhinoplasty unless the dorsum has had no surgical manipulation and the septum is intact, which is rare.

Patient Selection

When selecting patients, the initial decision is made by inspecting the natural dorsum in terms of the width and shape of the dorsal aesthetic lines on frontal view. Selection will be different for each surgeon depending on his/her tolerance for asymmetries, deviation, and width. If

Figure 8. Partial preservation rhinoplasty involving skin and alars [PR-P(SA)] case example. A 22-year-old female of European background presented with a wide dorsum, bulbous tip, and dorsal hump. Pretreatment (A, C, E, G, I) and 1-year posttreatment (B, D, F, H, J) views are shown. The Obagi skin pinch revealed normal thickness skin and normal alar cartilages. A subperiochondrial-subperiosteal dissection of her nasal tip and dorsum was done. Tip suturing was performed with cephalic dome sutures at the native domes. The patient was felt to have inadequate projection, so a septal extension graft was chosen. Her dorsum was found to be wide throughout, and therefore a 3 mm dorsal reduction was done. Bilateral medial oblique and low to high osteotomies were performed with piezoelectric saws to narrow the bony dorsum. Middle vault reconstruction was completed with spreader flaps. Posttreatment, the nasal profile is straight with narrow and symmetric dorsal aesthetic lines. The tip contour is improved. Basal view asymmetry was introduced because a side to side septal extension graft was used on the left side of the caudal septum. Care must be taken to make sure it does not bulge into the airway.

Figure 8. Continued

the dorsum is not totally ideal in terms of width and the shape of dorsal aesthetic lines, the senior author (AMK) chooses a traditional reduction method. Once a surgeon has decided that the dorsum is ideal on anterior view, the next step is to examine the profile. The following should be assessed.

Position of Radix

With dorsal preservation, the radix lengthens in the vertical plane and the starting point of the nose (nasion or radix point) moves caudally. Ideal patients have a normally positioned or slightly high radix. Patients with a low radix, strong glabella, and/or a prominent premaxilla must be approached more carefully and a radix graft considered. Dorsal preservation in these patients may result in a short nose.

Type of Hump

Ideal patients for dorsal preservation have a straight, overprojected dorsum. In these cases one can lower the whole dorsum without removing any hump. However, most patients have a hump and understanding the difference between a V- and an S-shaped humps is critical to the initial selection of patients for dorsal preservation.[23] It is technically easier to "flatten" the osseocartilaginous vault in patients with a V-shaped hump as they have only 1 locus of angulation. S-shaped humps are more difficult as they tend to have an acute takeoff of the hump from the sellion, resulting in a high kyphion point and a second locus of angulation. It has been my experience that these noses are very difficult to flatten even with more advanced technical maneuvers. In these cases, large amounts of septum and perpendicular plate of ethmoid are resected, allowing the dorsum to push down further cephalically, and essentially the thick radix soft tissue envelope camouflages the hump. Patients tell the surgeon that their nose looks straight but they can still "feel" the hump. This is true because the hump has not been flattened; the surgeon has taken advantage of the thick radix soft tissue envelope that is often 4 times thicker than the keystone soft tissue envelope. In summary, dorsal preservation patients should be chosen who have an overprojected and straight dorsum, small humps, and V-shaped nasal bones (humps).

Length of Bony Vault

Longer bony vaults (nasal bones) are more difficult to flatten because cartilage is easier to flex than bone. Dorsal preservation patients who have primarily cartilaginous noses should be chosen. Alternatively, the bony cap can be removed, which transforms the dorsum into one that is more cartilaginous.

Position of ASA

The position of the ASA must be inspected carefully before treatment is started. A surgeon may take out a strip of septum only to find that they have caused what appears to be a saddle deformity. Visualization of a straight nose via sonogram demonstrates that the keystone area projects much more than the sellion or ASA. It is the soft tissue envelope thickness that makes the nose look straight. Avoiding this problem will be discussed below.

Position of Radix Relative to Premaxilla

Aesthetically, radix position relative to the subnasale is inspected, and in most patients the radix and subnasale lie in approximately the same vertical facial plane. Patients with a prominent maxilla and/or subnasale often complain of tip overprojection. The prominent premaxilla gives the visual appearance of overprojection because the nose is sitting on a platform that is overprojected. Dorsal preservation in these patients can create an overprojected nose that sticks out like Pinnochio. The appearance occurs because the radix lengthens and moves caudally, giving an even bigger discrepancy between the radix and tip-defining points. These patients often do better with radix grafting and/or reducing the dorsum more caudally than cephalically.

Using this type of analysis, the dorsum was preserved in 31% of patients who the senior author (A.M.K.) felt had an ideal dorsum and characteristics for a push-down procedure.

Preservation of Alar Cartilages

Preservation of the alar cartilages, and in particular the lateral crura, has been evolving over the past decade. In 2009, Ozmen et al[24] described a technique of incising the cephalic lateral crura longitudinally and then sliding the intact cephalic portion of the lateral crus underneath the remaining strip. This method ensures preservation of the scroll ligament complex and its attachments between the upper and lower lateral cartilages. Gruber et al[25] further popularized the concept of preserving the cartilage by creating an "island" of cephalic lateral crus to prevent alar retraction. The disadvantage of this technique was that it achieved mobility of the cephalic island segment with an intercartilaginous incision, thus compromising the scroll ligament. The next major advance was the concept of sidewall tensioning advanced by Davis.[26] He stated that the combination of lateral crural steal and a septal extension graft had the following 3 benefits: (1) preservation of the structural support of the lateral crura and accessory cartilages; (2) maintenance of nasal valve function without disrupting the scroll area; and (3) shortening of excess lateral crural length. However, small excisions were removed immediately lateral to the domes and occasionally segmental excisions at the domes in large and/or asymmetric tips. In short, Davis feels that tensioning is superior to transection and transposition. To circumvent segmental excisions at the dome when doing a lateral crural steal, Cakir et al[14] excised segments at the junction of middle and medial crura. Theoretically, this is preferential as this segment does not provide support when a columellar strut or septal extension graft is used. Gerbault[27] has recently reported tensioning the lateral crus to the pyriform ligament, which is lateral tensioning of the lateral crus. Essentially, the lateral crus can be tensioned with sutures medially (domal creation with lateral crural steal), with sutures laterally to the pyriform ligament, and with a septal extension graft.

Ultimately, the goal is to reposition and rearrange the alar cartilage to achieve the desired goal without excising any cartilage. As noted in the Results section, 54 patients had total preservation of the lateral crura and an additional 35 had a slide-under procedure as advocated by Ozmen. In these 89 patients, the scroll-ligament complex was kept completely intact. When possible, preserving alar cartilage and the scroll-ligament complex is important to maintaining long-term tip shape and stability. Tensioning is always done with domal sutures with or without a lateral steal procedure. A septal extension graft is often preferred as a third method of tensioning as the domes can be "pulled" onto the graft. With a columellar strut, transections of the medial crura are more common as the lateral steal produces increased rotation and projection, and because the columellar strut is floating, it cannot tension the tip complex.

Study Limitations

The limitations of this study include its retrospective nature. Furthermore, dorsal preservation surgeries were only being perfomed by the author for a few months before the start of the inclusion period. The learning curve is ongoing. In addition, the boundaries of dorsal preservation were initially pushed to understand which patients benefited most. In current practice, only 35% to 40% of patients undergo dorsal preservation. One-year follow-up is adequate for an article but inadequate in terms of long-term longevity of dorsal preservation in particular. The reader interested in larger studies with long-term follow-up is referred to articles by Saban et al.[5,6] Finally, no formal airway obstruction measurement tool was used although no dorsal preservation patients subjectively complained of airway obstruction. When septal strips larger than 6 mm are removed, the surgeon must inspect the airway carefully to make sure the pyriform has not been narrowed too much.

CONCLUSIONS

PR represents a paradigm shift in rhinoplasty. In the majority of patients, the dorsal soft tissue envelope can be preserved as well as the nasal ligaments. When possible, the lateral crura should be preserved and tensioning techniques should be chosen over excision. Dorsal preservation is an excellent technique if patients are chosen properly. No dorsum looks as good as a natural dorsum, and long-term issues with the middle vault and keystone area can be avoided. Some patients will benefit from total preservation where nothing is removed/disrupted and the underlying structures are simply reshaped.

Disclosures

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“The Resting Angle Suture”

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Summary

The goal of every rhinoplasty surgeon is the creation of both a functionally and aesthetically pleasing nose. The lateral crura resting angle is a key concept that has recently emerged, we believe that it should always be taken into consideration to achieve a satisfactory result.

In this paper, we describe a novel technique: the resting angle suture, the idea for this suture comes from the inversion suture used to correct ectropion deformity in lower eyelid surgery.

The Resting Angle Suture

Nasal tip plasty is perhaps the most complex and controversial area of aesthetic septorhinoplasty. The aim of the surgeon is to ensure good appearance and function, to achieve this demanding goal, a myriad of techniques and rules to apply and follow are available.

In recent years a key concept has emerged: the lateral crura resting angle.

The aim of this paper is to describe the lateral crura resting angle (LCRA) suture.

The LCRA is the angle of incidence between the upper lateral cartilage (ULC) and the lateral crura (LLC). As Çakir showed in his book[1] this angle should ideally be 100°. If the LCRA gets over 100° the result will be unnatural/unpleasant and nasal breathing is easily jeopardized.

Many classical suture techniques do not take into account the LCRA and thus lead to an unfavorable result.

A deep understanding of lateral crura 3D anatomy and of the scroll ligament complex is of paramount importance to understand the functional and aesthetical implications of the LCRA.

On an anatomic aspect in this area we found the scroll ligament complex, it consists of a longitudinal scroll ligament, extending from the cephalic edge of the lateral crus and the upper lateral cartilage and containing multiple sesamoid cartilages and a vertical scroll ligament connecting the undersurface of the transverse nasalis muscle to the scroll junction[2].

Regarding the surface anatomy, this area is identified in the supraalar groove or scroll line and represent the transition between the upper lateral polygon and the lateral crus polygon[3].

From a functional point of view this region represents the intermediate nasal valve, the volar face of the lateral crus area coincides with the middle section between external nasal valve and the internal nasal valve.

In a patient with an improper resting angle, the LLCs can collapse during forced inhalation due to the negative pressure caused by the airflow. When we correct the resting angle, we act on the intermediate section and on the external nasal valve obtaining greater structural resistance and improving support to the alar rim. A clear functional improvement in this area can be verified with the vertical compression test described by Cakir[1]: The tip of the nose is compressed between three fingers (thumb on columella and second and third fingers on the sides of the tip) this maneuver manually changes space 3d orientation of LLCs to a proper resting angle.

Toriumi was the first who pointed out the concept of LCRA. In his article[4] he affirmed that the caudal margin of the lateral crura should be oriented more anterior than the cephalic margin, he also described an obliquely oriented dome suture[5] designed to bend the lateral crura so that the caudal margin is positioned anterior to the cephalic margin, in the same article he described several benefits of this procedure.

In 2014 Kovacevic and Wurm described the cranial tip suture[6], it runs through the medial edge of the intermediate crus to the cephalic margin of the lateral crus, the second bite of the suture is placed parallel to the cephalic margin of the lateral crus to rotate the lateral crura into a more favorable orientation.

Also Neves et al.[7] described the utility of the cephalic oblique dome suture in everting the caudal margin of the lateral crura and its significance for a good final result.

Cakir described the cephalic emi-dome suture or “lateral crus-angling suture”[3] designed to correct the lateral crus spatial position and to obtain the desired resting angle.

All these techniques, sometimes might not be sufficient in obtaining a good resting angle or in some cases a slight asymmetry may remain between the alar cartilages.

This is especially true in the case of secondary rhinoplasty, in fact previous scarring tissue or the presence of deformed and remodeled cartilages can make it difficult to reach a proper resting angle.
In these cases, we have developed the use of a mucosal plication suture of the scroll junction.
The idea for this suture comes from the eversion and inversion sutures used in oculoplastic surgery to correct lower eyelid malposition. Figure n.1
Using a 4-0 PDS suture, the sutures are placed in the space between the upper lateral cartilage ULC and lower lateral cartilage LLC; the suture engages the mucous vault of the intercartilagineous space just caudally to the ULC caudal margin directed to an exit point located near the cephalic margin of the LLC. The return bite of the suture is placed just above the cephalic margin of the lower lateral cartilage and passes back through the mucosa running in an “oblique fashion” to exit adjacent to the entry site.

The suture has the effect of shortening the tissue between the cephalic edge of the LLC and the caudal edge of the ULC, thus obtaining an inward rotation of the LLC cephalic border which immediately improves the resting angle.

The suture aim is a mucosal plication and the cartilage component of ULC and LLC is not involved.

If possible the previous dissection of the scroll area is achieved connecting the subperichondrial plane over the LLC and ULC, in this manner scroll cartilages and the scroll ligaments are elevated. This will help scroll area final reconstruction before skin closure.

Once the suture has been completed and a satisfactory angulation reached, the scroll area is repaired; it is usually done with 2\3 internal stitches (4\0 PDS) between the longitudinal component of the scroll ligament and the mucous space between ULC and lateral crus. In a nutshell, they are like Baroudi stitches that are used in abdominoplasty to close dead space[8].

The ligaments repositioning gives a sort of "internal taping" effect which has several advantages[9]: reinforces the position of the LCRA, closes the dead spaces and thus the chance of post scarring supratip deformity[10], reducing the chance of post-operatory scar contraction also minimize the risk of vertical LLC cephalic malposition that can also lead to alar retraction, it restores the function of transversalis muscle which help the opening of the valve area[2] and finally helps skin redraping improving lateral tip definition.

In conclusion, we believe that this is a simple but effective technique, which can be added to our surgical quiver helping us in achieving a satisfactory aesthetic and functional result.

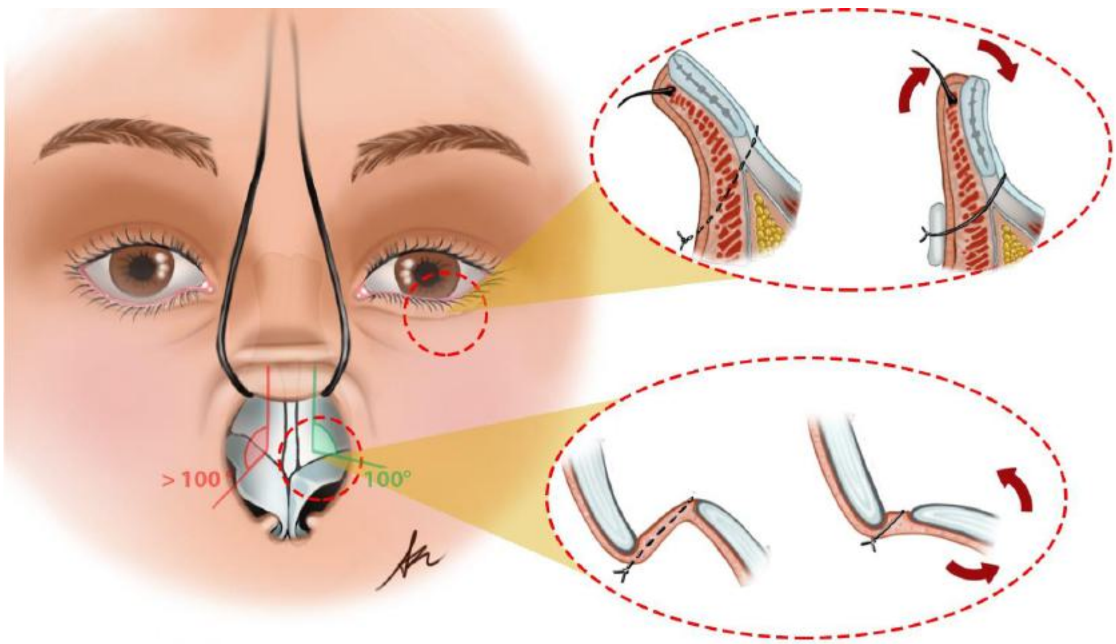

Figure n.1

The image shows the lateral crura resting angle suture and the inversion suture used to correct the malposition of the lower eyelid, from which the idea was born.

The right side of the patient is pre-correction, the left side is corrected.

The ideal degree of the lateral crura resting angle is also indicated.

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Special Topic

Dorsal Preservation: The Push Down Technique Reassessed

Yves Saban, MD; Rollin K. Daniel, MD; Roberto Polselli, MD; Maria Trapasso, MD; and Peter Palhazi, MD

Abstract

Management of the nasal dorsum remains a challenge in rhinoplasty surgery. Currently, the majority of reduction rhinoplasties results in destruction of the keystone area (K-area), which requires reconstruction with either spreader grafts or spreader flaps, both for aesthetic and functional reasons. This article will present the senior author's current operative technique for dorsal preservation in reduction rhinoplasty based on 320 clinical cases performed over a 5-year period. The author's operative technique is as follows: (1) endonasal approach; (2) removal of a septal strip in the subdorsal area whose shape and height were determined preoperatively; (3) complete lateral, transverse, and radix osteotomies; and (4) dorsal reduction utilizing either a push down operation (PDO) or a let down operation (LDO). The PDO consists of downward impaction of the fully mobilized nasal pyramid and is utilized in patients with smaller humps (<4 mm). The LDO consists of a maxillary wedge resection and is performed in patients who need more than 4 mm of lowering. A total of 320 patients had a dorsal preservation operation (DPO). Postoperatively, there were no dorsal irregularities nor inverted-V deformities. Among our 44 personal revision cases, 27 patients (8.74%) had had a previous DPO, 16 of whom required tip revisions with no further dorsal surgery. Of the remaining 11 patients, the main problems were either hump recurrence and/or lateral deviation of the dorsum or widening of the middle third, which required simple surgical revision. Based on the authors' experience, adoption of a PDO/LDO is justified in selected primary patients. The key question before any primary rhinoplasty procedure should be "Can I keep the nasal dorsum intact?" Precise analysis and surgical execution are required to preserve the dorsal osseocartilaginous vault and K-area. Dorsal preservation results in more natural postoperative dorsum lines and a "not operated" aspect without the need for midvault reconstruction. Moreover, this technique is quick and easy to perform by any rhinoplasty surgeon. Rhinoplasty surgeons should consider incorporating dorsal preservation techniques in their surgical armamentarium rather than relying solely on the Joseph reduction method or an open structure rhinoplasty.

Level of Evidence: 4

4
Therapeutic

Editorial Decision date: July 5, 2017.

In most white noses, dorsal hump reduction is an essential step consisting of resecting portions of both the bony and cartilaginous dorsum. After dorsal height reduction, the keystone junction area is destroyed and must be reconstructed for both aesthetic and functional reasons. Thus, it is our opinion that if the preexisting nasal dorsum can be kept intact, then it is possible to preserve the natural aesthetic dorsum as well as nasal function. In addition, one can avoid many of the secondary deformities that lead to revisional surgery.

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The obvious question is: how can the surgeon reduce the dorsal profile line without resecting the dorsum? The answer is by utilizing the "push down technique" popularized by Cottle[1,2] as an alternative to the dorsal resection technique championed by Joseph.[3,4] Based on our experience utilizing dorsal preservation techniques in 320 primary rhinoplasties over a 5-year period, we have been able to achieve the following goals: (1) to simplify the technique, making it easier and quicker for all surgeons including those with less experience; (2) to keep the nasal dorsum intact while reducing the dorsal hump from 2 mm to 8 mm in height; and (3) to obtain excellent aesthetic and functional results.

OVERVIEW OF DORSAL PRESERVATION TECHNIQUES

Many younger rhinoplasty surgeons are not familiar with the push down operation (hereinafter PDO) and its major differences from the Joseph resection rhinoplasty. Thus, a brief review of the PDO is essential before delving into its technical nuances. The fundament goal of the PDO is to preserve both the keystone area (K-area) and the continuity of the cartilaginous vault. This conservative approach avoids nasal valve collapse, with its adverse effects on respiration and the dorsal aesthetic lines. In addition, lowering the intact cartilaginous vault during the PDO produces a vertical vector downwards on the scroll area junction between the upper lateral cartilages (ULCs) and lower lateral cartilages (LLCs), which in turn causes a cephalic rotation of the LLCs.[5] The concept of dorsal preservation in nasal surgery was first introduced by Lothrop in 1914.[6] He demonstrated a good aesthetic and functional result in one case of tension nose. His technique consisted of "nasal impaction" utilizing the following 3 basic steps: (1) resection of a high strip of septal cartilage and perpendicular plate of ethmoid, (2) triangular bony resections of the frontal processes of the maxilla, and (3) direct percutaneous osteotomy of the radix. His pioneering work was followed by Sebileau and Dufourmentel in France in 1926.[7] They proposed a resection of the 3 nasal pillars done in the posterior portion of the nose, thereby leaving the nasal dorsum intact. Subsequently, in 1940, Maurel[8] reported his experience with the Lothrop technique of high septal resection followed by lateral bony resection of the frontal processes of the maxilla.

In 1946, Cottle et al[1,2] described the *push down technique* (PDO), in which the nasal dorsum continuity was preserved by impaction of the bony and cartilaginous hump around the keystone point. This maneuver prevented collapse of the ULCs and closure of the valve area. In addition, the rotation of the quadrangular septal cartilage was an essential but difficult surgical step. Cottle's PDO technique became popular in the 1960s. In 1989, Gola[9] refined the concept of lowering the bony cartilaginous dorsum simply by removing a strip of nasal septum below the nasal dorsum. Central to the procedure is the location of the septal excision, which can be subdivided into the classic low location of Cottle[1,2] with its associated anterotation vs the high subdorsal resection championed by Saban,[10,11] which permits a direct lowering. The reader should review Figure 1 to understand the differences in the location of the septal resection.

Drumheller,[12] in his review of Cottle's technique, and Huizing[13] reassessed the basic PDO technique by adding osseous wedge resections from the frontal ascending processes of maxillary bones, thus allowing the nasal pyramid to descend freely. This modification became known as the "let down" operation (LDO). Thus, the 2 approaches for managing the lateral bony wall are the following: (1) osteotomy only with push down into the nasal fossa (PDO)) or (2) lateral bony wedge resection with lowering of the bony pyramid onto the frontal process of the maxilla (LDO).

Although the results of dorsal preservation techniques were generally good to excellent, the techniques were gradually abandoned for 3 reasons. First, the classic Cottle PDO[1,2] involved complex and challenging septal surgery, especially in the preendoscope era.[14,15] Second, the techniques were not versatile enough to be utilized in a wide range of rhinoplasties, ie, the preoperative dorsum must be relatively natural rather than distorted. Third, the open approach offered greater visibility, more accurate control of structures, and facilitated teaching.[16] What has changed that justifies a reassessment of dorsal preservation techniques? Currently, rhinoplasty surgeons have begun to realize the aesthetic and functional consequences of destroying the K-area. Why should we reconstruct something if we can preserve it? To simplify the text of this article, we will primarily utilize 3 terms: dorsal preservation operation (DPO), push down operation (PDO), and let down operation (LDO).

SURGICAL ANATOMY

Anatomic dynamics of the K-area are essential to understand before performing any primary reduction rhinoplasty. Two main anatomic structures comprise the osseocartilaginous K-area: the overlap of the bony cap and the cartilaginous vault underneath. Contrary to popular belief, these 2 structures are not rigidly fused, but rather joined together as a *chondro-osseous joint*.[16,17]

The periosteum on the deep surface of the bony cap[18] fuses with the perichondrium on the superficial aspect of the cartilaginous vault (Figure 2A, B). *The result is a flexible dorsum that allows the convexity of the dorsum to be eliminated by reducing the underlying cartilaginous septal support.* Thus, the vault can be modified from convex

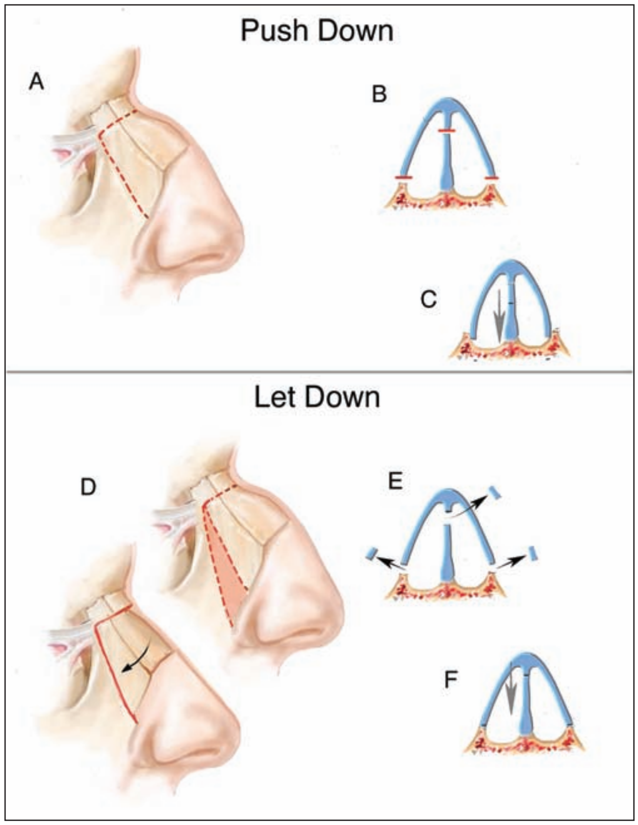


Figure 1. Two methods of dorsal preservation. (A, B, C) Push down operation (PDO) with a high septal resection followed by lateral and transverse osteotomies. Subsequent impaction of the bony vault downward into the pyriform aperture. (D, E, F) Let let down operation (LDO) with a high septal resection followed by resection of a portion of the ascending frontal process of the maxilla. Subsequent downward positioning of the bony vault onto the frontal process of the maxilla.

to concave without losing its continuity. The subdorsal K-segment of the cartilaginous septum is a critical area.[19] The upper part of the quadrangular septal cartilage is crucial in maintaining the height and stability of the dorsal vault. Anatomically, there is a subdorsal portion of the cartilaginous septum that extends very high cephalically toward the radix. Thus, there is almost no bony septum under the bony cap (Figure 2C, D). The starting point of the upper *bony septum* occurs at the anterior angle of the perpendicular plate of the ethmoid, below the nasal spine of the frontal bone. Moreover, the younger the patient, the greater the cephalic extent of the subdorsal septal cartilage.[18,19]

The upper septum must be divided or removed to allow the elimination of the dorsal hump. In Cottle's technique,[2,12] a *complete vertical splitting disarticulation* between the perpendicular plate of the ethmoid and the quadrangular cartilage is mandatory to allow further anterotation of the septum/cartilaginous vault. In Gola's[20-22] and Saban's[11,23,24] techniques, a *strip excision of subdorsal septal cartilage* as close as possible to the dorsal beam is done just below the bony cap, which allows lowering of the dorsum into the newly created space. The height of the cartilaginous strip excision correlates with the desired dorsal reduction. The more convex the dorsal vault, the greater the septal resection.

In the conventional hump reduction, this M-shaped arch is removed and the ULCs become semimobile "flying wings" that no longer articulate with the septum. Thus, the ULCs can collapse toward the septum, resulting in functional and aesthetic problems. For this reason, spreader grafts and spreader flaps are utilized to reconstruct this anatomic unit.[25-30] However, it is our opinion that preservation is far superior to any reconstruction.

PREOPERATIVE ASSESSMENT

Pertinent to dorsal preservation cases, preoperative evaluation of the nasal dorsum should include external examination of the size, shape, and orientation of the dorsum, as well as palpation of the cartilaginous and bony components of the nasal pyramid. The rhinoplasty surgeon must answer the critical question, *Can I keep the dorsum intact?* Many times, the answer is that the dorsum appears natural and can be preserved. Also, the more cartilaginous the dorsum,

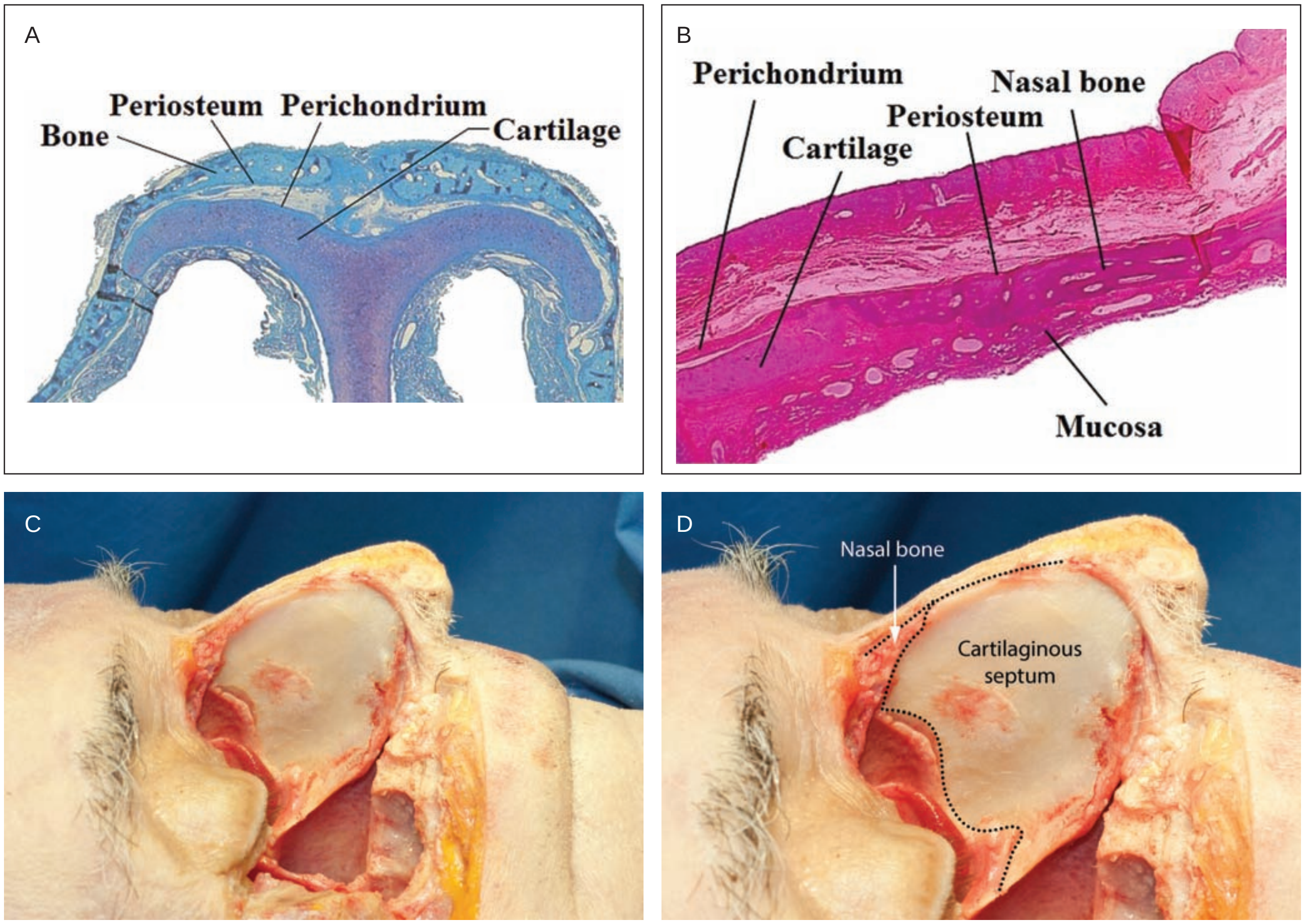


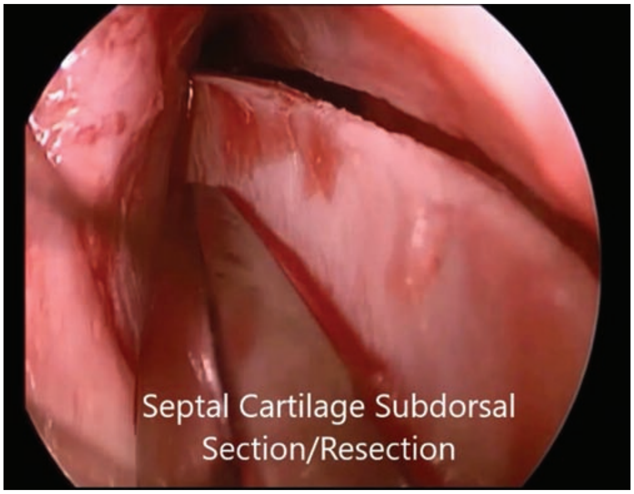
Figure 2. Critical anatomy of the osseocartilaginous junction at the K-area demonstrated on a 75-year-old male cadaver. (A, B) Histological sections demonstrating the chondro-osseous junction between the bony and cartilaginous vault with fused layers of perichondrium and periosteum. (C, D) Cephalic continuation of the quadrangular cartilage from the osseocartilaginous junction upward toward the nasion.

the greater the indication for a preservation technique. Preoperative diagnosis of deviations and asymmetries are of great importance in selecting the method of septoplasty and osteotomies. A careful analysis of the nostrils is done regarding their size, orientation, and aesthetic landmarks. In tension noses, the nostrils are narrow and present an excess of height whereas the nasal lobule appears shorter. After dorsal lowering is performed utilizing impaction techniques, the nostrils will flare and the internal nasal valve will open. Sometimes, this sequelae are an expected and desirable result, but if it is excessive, an alar base reduction must be performed at the end of the procedure.

Additionally, a careful clinical and endoscopic examination of the septum and nasal cavity is completed by utilizing a flexible endoscope to assess septal deviation or deflection, especially when it is high in its upper portion. These septal deformities can lead to postoperative dorsal distortion, asymmetry, and deviation. Moreover, turbinate abnormalities and concha bullosa should be diagnosed before surgery, because they will be corrected as the first steps in the septorhinoplasty procedure.

Standard photographs and computer simulations are done in collaboration with all patients. The amount of dorsal resection is planned on the computer simulation by comparing the present patient profile with the simulated one. The shape of the planned septal resection will follow the shape of the dorsum so that: (1) the higher line will correspond to the preoperative dorsal shape; (2) the lower line can be straight or concave depending on the desired dorsal shape simulation; and (3) the intervening area becomes the planned septal strip resection.

In most cases, a cone-beam CT scan is done to assess bony septal abnormalities, turbinate pathology, and sinus disease. Correction of bony septal deviation is a critical component of septoplasty. When necessary, a swinging door technique is utilized to preserve as much septal cartilage support as possible after unilateral mucoperichondrial undermining. The resection or the sagittal repositioning of



Video 1. Watch now at https://academic.oup.com/asj/article-lookup/doi/10.1093/asj/sjx180

the bony septal abnormalities include vomerine spur, deviation of the ethmoid lamina perpendicularis, or maxillary crest deviation according to the preoperative assessment. The full analysis is made together with the patient, and the findings from the cone-beam examination are explained.[24]

SURGICAL TECHNIQUES

Ninety percent (90%) of our patients are operated on in an outpatient surgery center. General anesthesia with endotracheal intubation or a laryngeal mask is utilized. Total intravenous anesthesia (TIVA) propofol (10 mg/mL) and midazolam (5 mg/mL) are given. In addition, a local regional anesthetic block is injected 10 minutes before the incision utilizing ropivacaine (2 mg/mL) and adrenaline 0.005 mg/mL in a 5 mL syringe with a 31-gauge needle. The operative steps pertinent to dorsal preservation will be discussed in depth (Video 1, available online as Supplementary Material at www.aestheticsurgeryjournal.com). Because the concepts of dorsal preservation and hump reduction seem contradictory and virtually impossible, one should observe the changes that occur clinically (Figure 3).

Exposure

An endonasal approach is done in all primary rhinoplasties. An open approach can be added, but only in cases with difficult tips or when it is the surgeon's preference. A unilateral interseptal-columellar incision is performed on the right side at the caudal border of the quadrangular cartilage utilizing a #15 blade. After exposure of the caudal septum, a unilateral submucoperichondrial undermining is done on the right side utilizing the tip of Converse scissors or Cakir's subperichondrial elevator. Next, a superior tunnel is made on the contralateral left side. Exposure of the septum is continued until the keystone junction area is reached. Then a partial elevation of the perichondrium-periosteum from the deep aspect of the dorsum is performed. Essentially, one is creating a major extramucosal tunnel as advocated by Robin.[31] The dissection is generally performed utilizing an endonasal endoscope with video monitoring, and by feeling the contact of the smooth cartilage and then the rough bone with the tip of the elevator.

Next, the soft tissue covering of the dorsum is undermined starting at the anterior septal angle and continuing upward up to the glabella and laterally to the maxilla. Dissection can be done either in the subsuperficial muscular aponeurotic system (sub-SMAS) plane or the subperichondrial/subperiosteal plane. Thus, a degloving of the nasal pyramid is done, but with attachment being maintained at the scroll area through the vertical scroll ligament.[32] At this point, the nasal skeleton is under complete vision and the Y-shaped septum/ULCs junction has been freed in 3 areas: superficial soft tissue above as well as right and left submucoperichondrial below. This exposure permits visual assessment of the septal anatomy and precise surgical control.

Septal Cartilage Resection

The amount and shape of the subdorsal septal resection is critical, because it determines how much septum remains, which in turn correlates directly will the height and shape of the desired nasal dorsum (Figure 4). Under direct or endoscopic visualization, the cartilaginous resection starts just below the level of the ULCs/septal junction near the anterior septal angle. Utilizing a V-tip sharp scissors, the incision proceeds from the anterior septal angle directly under the dorsal vault until there is bony contact at the perpendicular plate of the ethmoid beneath the bony cap. At this point, a saddle deformity of the middle third, which has to be evaluated to avoid excess cartilaginous septal resection, already appears. Then, a second incision is made below the first at a lower level. The amount and shape of the intervening septum to be excised depends on the preoperative planning that was done. In general, the upper cut is truly subdorsal and therefore reflects the contour/convexity of the dorsal deformity. The lower cut is relatively straight and its location determined by the planned amount of hump reduction. This incision continues cephalically until it makes contact with the ethmoid perpendicular plate. Then, utilizing the tip of a Joseph elevator, a disarticulation between the cartilage and the bone is performed and the cartilaginous strip is removed. Next, a Blakesley straight endonasal forceps 4 mm in width, is introduced into the freed septal space just below the dorsal vault, and a portion of the ethmoid bone is removed. This resection can be done safely as this site, because it is

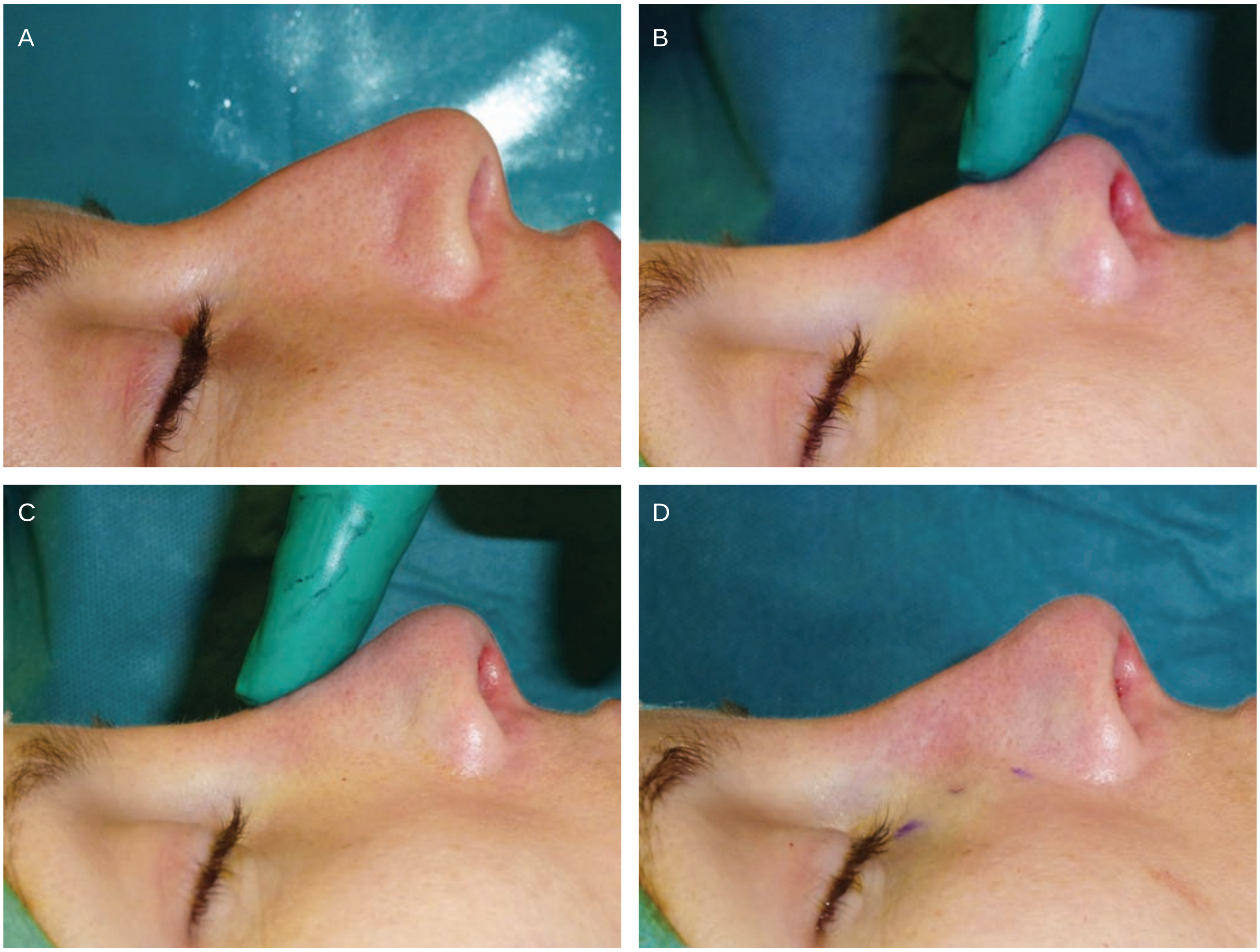


Figure 3. Intraoperative sequence of a 6 mm push down procedure. (A) Preoperative markings. (B) Creation of a controlled saddling following the septal resection. (C) Compression and impaction of the bony vault into the maxilla. (D) Significant change in the dorsal profile without any dorsal resection.

far from the *lamina cribriformis* and the skull base. Gola et al[20-22] reported a 2 to 4 mm cartilaginous excision in patients with major kyphotic hump deformities. In our experience, we have resected cartilaginous strips greater than 8 mm in some patients with a very high dorsum. This cartilage resection allows one to obtain a very large hump reduction while preserving the dorsum.

Bony Pyramid Mobilization

One can arbitrarily divide the bony mobilization into complete osteotomies with push down for small humps and complete osteotomies with lateral wedge resection for larger humps. In all cases, *the entire bony vault is mobilized "en bloc" with separation of the nasal bony pyramid from the frontal processes of the maxillary bones and the nasal spine of the frontal bone*. This maneuver requires complete lateral and transverse osteotomies[20] (Figure 5). At this point, a clear understanding of the difference between a PDO and a LDO is essential and is shown in both Figures 1 and 6.

In case of small humps and/or minimal reduction, we prefer complete lateral osteotomies performed percutaneously. For the lateral osteotomy, the tip of the osteotome must be perpendicular to the lateral bony wall. A true horizontal cut is important, because it allows a better sliding of the bony surfaces and facilitates the push down maneuver while reducing the risk of excessive narrowing of the base. Next, a percutaneous perpendicular transection of the nasal spine of the frontal bone is done according to Gola's technique.[20-22] A 2 mm osteotome is pushed through the skin at the nasion and a transverse root osteotomy of the nose is completed. Additional transverse cuts can be made from the cephalic termination of the lateral osteotomy upward toward the nasion. The result

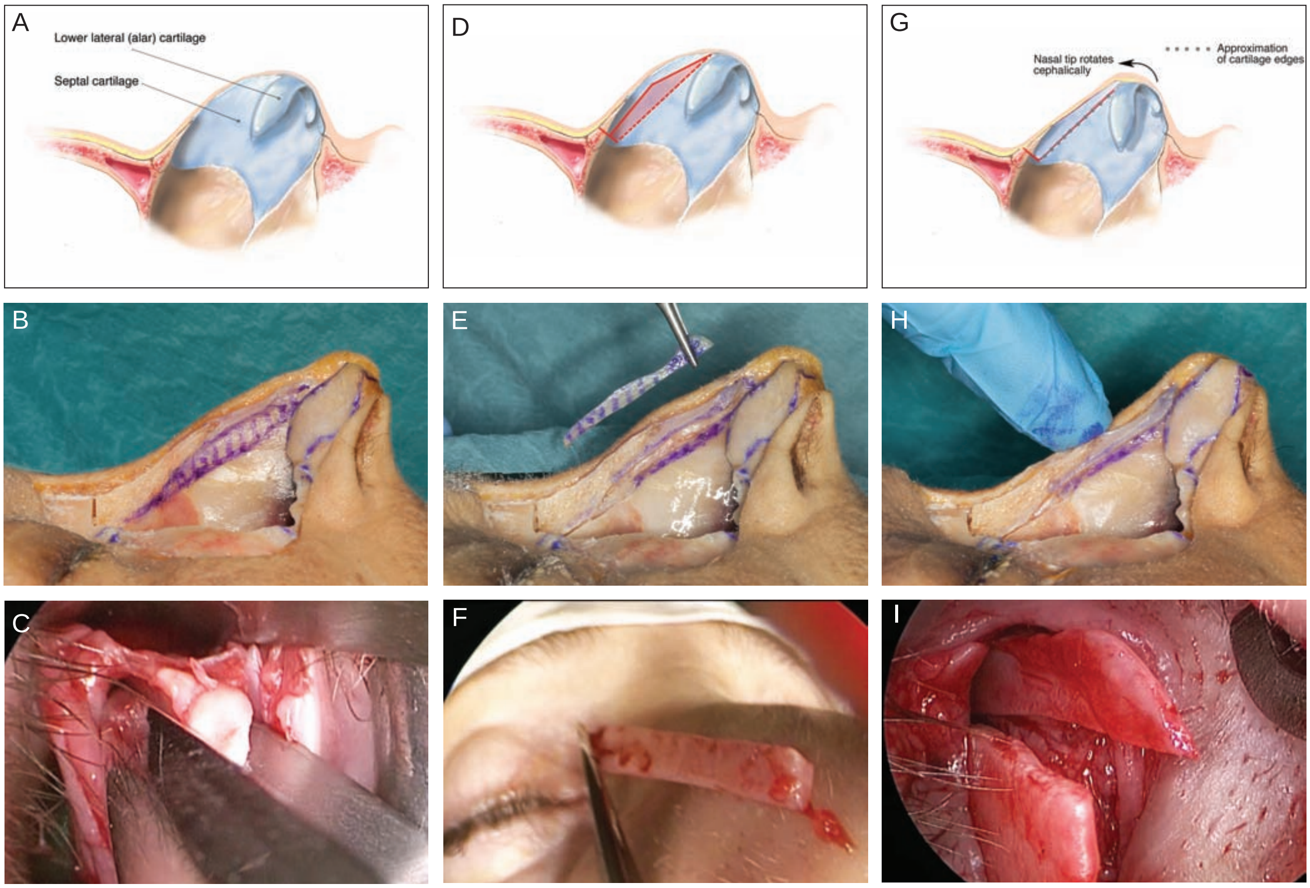


Figure 4. Septal strip resection demonstrated on a 75-year-old male cadaver. (A-C) Location of septal strip excision just below the keystone junction. (D-F) The amount of septal excison correlates directly with the amount of desired dorsal lowering. (G-I) Impaction of the dorsum downward eliminates the convexity.

must be a totally mobilized nasal pyramid allowing for transverse movement.

If a more extensive lowering of the nasal pyramid (more than 4 mm) is required, the a *let down technique* (LDO) is usually preferred by performing a triangular bony wedge resection of the frontal processes of the maxilla (Figure 6D-F).[12,33-35] This excision must be done very low laterally, in the nasofacial groove to avoid any palpable or visible step. An endonasal approach is utilized. The site of the intranasal incision is at the transition from nasal vestibular skin to mucosa just superior to the attachment of the head of the inferior turbinate. A small artery lies within the soft tissues at this point between the skin of the face and the nose. To avoid any bleeding, it is best to make the incision utilizing a bipolar cautery or a Colorado needle.[33]

The incision is made perpendicularly to the skin/mucosa junction until bony contact is made. Then, utilizing the tip of Converse scissors, the anterior crest of the pyriform aperture is exposed on both the internal and external sides. This space must be wide enough to allow passage of the instruments and facilitate a precise bony resection. A subperiosteal undermining is performed on both the internal and external surfaces of the frontal processes of the maxillary bone. The undermining proceeds first onto the deep aspect of the maxillary process. On the endonasal surface, the exposure continues upward to the lachrymal bossa and the head of the middle turbinate. The external subperiosteal undermining is done until the anterior insertion of the medial canthal tendon, which can be lifted with the elevator, is reached. Then, *bony wedges of the frontal processes of the maxilla* are resected on both the left and right sides at the level of the facial plane. This lateral basal resection can be done either through precise osteotomies under direct vision or by utilizing bone rongeur forceps, or even piezoelectric instruments. Once the bony wedges are resected, then the bony pyramid can descend freely until it rests on the maxillary bone.

Lowering the Dorsum

At this point in the operation, the septum has been divided from the nasal dorsum and its height has been reduced

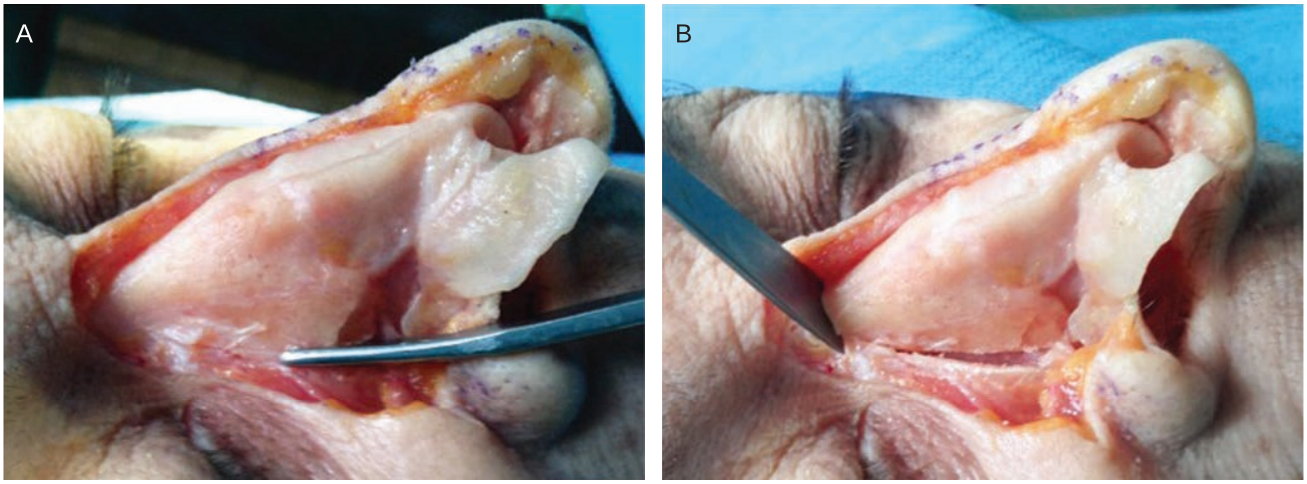


Figure 5. Bony vault osteotomies demonstrated on a 75-year-old male cadaver. (A) A low to low osteotomy is done in the nasofacial groove. (B) A transverse radix osteotomy at the nasion. The bony vault is totally mobile and can be move transversely from side to side.

according to the preoperative planning. In addition, the lateral bony walls of the nose have been divided and the entire nasal pyramid is completely mobile. The bony-cartilaginous dorsum can be lowered or impacted in between the facial bones utilizing the following 3 steps: (1) transversal mobilization of the whole nose separated from the face; (2) pinching the bony sides of the nasal vault symmetrically; and (3) performing a downward movement of the nasal bony pyramid into the nasal fossa (Video 2, available online as Supplementary Material at www.aestheticsurgeryjournal.com). With this push down process (PDO), the lateral nasal walls slide inside the frontal processes of the maxilla. In the meantime, the bony-cartilaginous vault goes down onto the remaining septum (Figure 6A-C). When performing an LDO, the nasal pyramid comes to rest on the midline septal central pillar, while laterally the bony lateral walls simply come down and rest on the frontal process of the maxilla (Figure 6D-F).

Thus, the new height of the nose is determined by the level of the septum, which acts as the central pillar of the nasal framework. If further lowering is required, another strip of cartilaginous septum can be incrementally resected until the desired result is achieved. If a straight nasal dorsal contour is desired, then the lower cut of the septal strip is cut straight. A more concave dorsal contour can be achieved by making the lower cut of the septal cut concave. At this point, it is important to check the upper septum just below the K-area to avoid a rocker effect. Essentially, one palpates the dorsum by gently pushing downward on the dorsum, making sure that the dorsum is in contact with the septum and that it does not rock downward, ie, no teeter-totter, see-saw movement. If such a movement occurs, then additional septal resection is done until the desired final shape of the dorsum is achieved. We prefer a

Video 2. Watch now at https://academic.oup.com/asj/article-lookup/doi/10.1093/asj/sjx180

slight overcorrection near the K-area, but we always avoid an excess of cartilage resection in the supratip area, which can lead to a saddle deformity. The resected cartilaginous strips can be reserved as a graft for subsequent use, often as a columellar strut or alar rim grafts.

To fixate the dorsum, one or two Vicryl 4/0 sutures on a round needle are placed between the dorsum and the underlying septum near the anterior septal angle. If necessary, a percutaneous nylon suture can be placed through the ULCs and the septum, maintaining the desired position, and stitched externally on a "bourdonnet" dressing. Alternatively, a small hole can be drilled through the nasal bones on both sides and a transosseous suture can be inserted. The treatment of the tip is done later, according

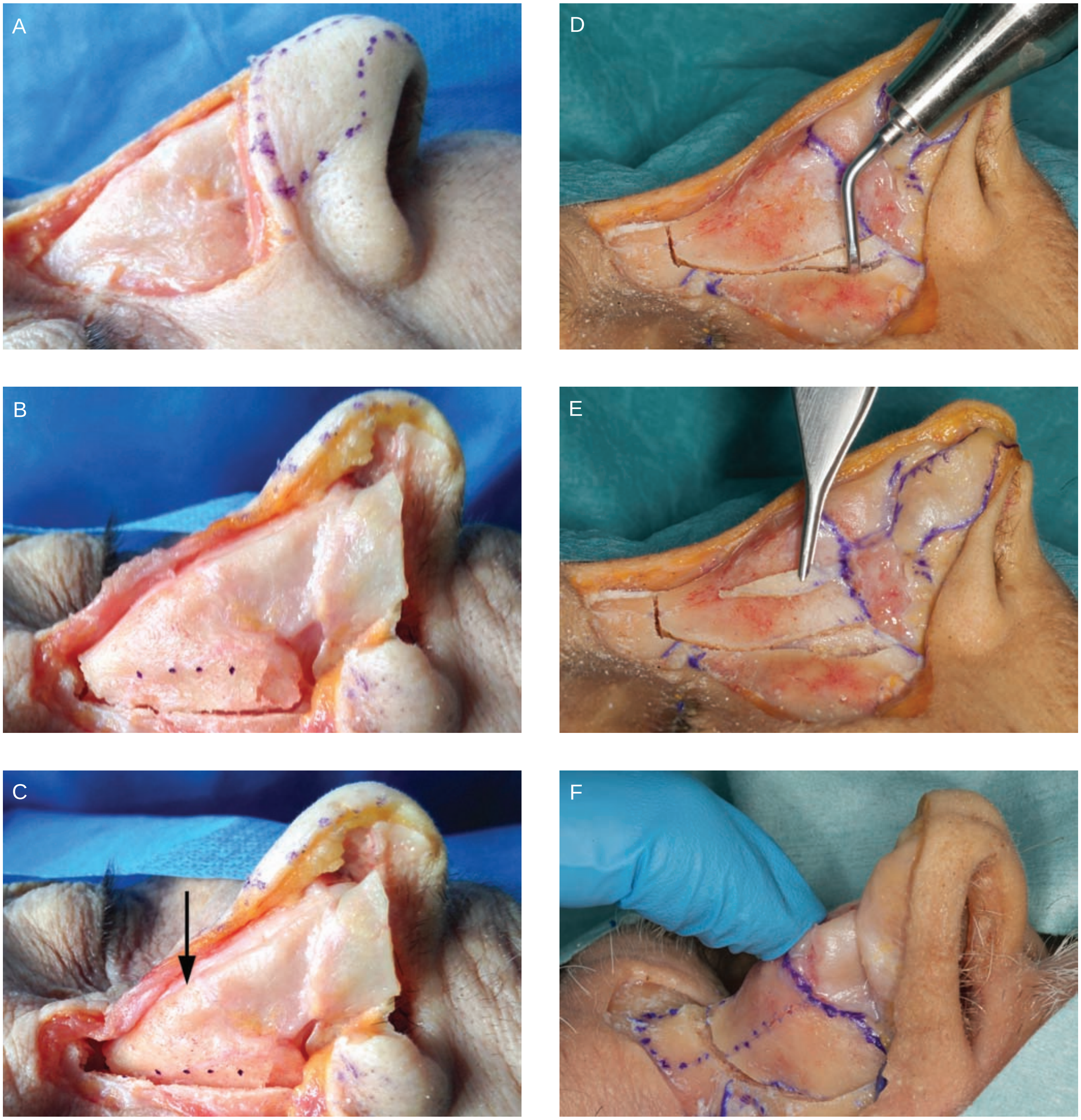


Figure 6. Push down operation vs let down operation. (A, B, C) Following complete osteotomies laterally and transversely, the dorsal vault is **pushed down** into the nasal vault. (D, E, F) Following excision of a bony strip of the frontal process of the maxilla, the bony vault is **let down** to rest on the frontal process of the maxilla.

to necessity. Because impaction of the dorsum will change tip position and rotation, it is always better to start the rhinoplasty with modification of the bony vault. In patients with a high convex dorsum, the lowering of the vault will open the K-area, leading to a longer dorsum following simple mathematic rules. In these cases, it is mandatory to excise part of the new anterior septal angle to allow for rotation of the tip.

After checking the position, shape, and symmetry of the dorsum, endonasal sutures are performed utilizing a Vicryl rapid 5/0 suture, and the dressing is performed in the standard manner with support on the glabella to avoid any movement of the bony pyramid. We usually leave the inner dressing in place for 4 days with Doyle silicone splints on both sides of the septum in the nasal fossae. The cast is removed after 8 days.

CLINICAL SERIES

We reviewed 740 septorhinoplasties and nasal valve surgeries performed by the senior author (Y.S) between January 2011 and June 2016. The study was conducted in accordance with the Declaration of Helsinki. A total of 156 (21.1%) cases were secondary septorhinoplasties performed on patients operated elsewhere. Among the 584 personal cases, 540 (92.5%) were primary septorhinoplasties and 44 (7.5%) were personal revision cases. A total of 320 (54.8%) patients had a DPO. The age range of the patients who had these primary rhinoplasties was from 13 years old (deviated nose with nasal obstruction) to 71 years old (nasal valve surgery) with a mean age of 29. The mean follow-up time was 2 years and 5 months (range, 6 months to 5.5 years). The sex ratio was 9:1 with females predominating (286 females, 34 males). In these 320 primary DPO rhinoplasties, various techniques were utilized according to their pathology and preoperative assessment. In 57.2% of all primary rhinoplasties, a push down technique (PDO) or let down technique (LDO) was performed. Selection of which technique to utilize was determined by the size of the planned dorsal reduction: a push down procedure (PDO) was preferred when the dorsal reduction planned was less than 4 mm, whereas a lateral wedge resection (LDO) was done when a reduction of more than 4 mm was planned. Essentially, there was a virtually even distribution between the 2 techniques in our clinical series.

Our complications from this series consisted of 44 revision cases with tip revisions performed in 16 patients. Of the remaining 11 revision cases, the main problems were either hump recurrence, lateral deviation of the dorsum, or widening of the middle third. Thus, the revision rate for our dorsal preservation procedure was 3.4% (11/320). It should be noted that none of the following complications occurred in our series: saddle deformity, cerebrospinal fluid (CSF) leak, anosmia, or nasal obstruction. With hump recurrence (2 cases), a closed roof rhinoplasty was performed utilizing simple rasping. In 9 cases, the patients underwent a complete revision of the rhinoplasty utilizing a closed approach: the septoplasty was redone and an additional strip of septal cartilage was removed. At the same time, mobilization of the bony pyramid was performed without the need for redoing the osteotomies, because the bones were stable but mobilized, similar to a pseudarthrosis. The mobilization associated with the revisional septoplasty allowed correction of the lateral deviation. When widening of the middle third was the indication for revision, an incomplete division of the ULCs from the septum was performed from the caudal junction, with resection of a small triangular amount of ULCs as advocated by Kern.[36] At the same time, this is also an excellent way to reduce the nasal length, preserving the valve function by rebuilding the anatomy. In 6 patients (0.02%), a classic Cottle technique[1,2] or a disarticulation technique[37,38] with bony cap resection and K-area preservation was done because of difficult posttraumatic septal deformities, which involved septal cartilaginous resections and loss of septal support, making the dorsal strip resection impossible. A true Cottle procedure is always time consuming and it is a bit difficult to position the new dorsum.

CASE STUDIES

Case Study #1: Tension Nose, Let Down Procedure

A 29-year-old woman complained of having a high dorsum, a high frontonasal angle, and a closed nasolabial angle (Figure 7). Because the dorsum had good aesthetic lines, the procedure performed consisted of an endonasal approach utilizing an interseptal columellar incision, undermining of the dorsal soft tissues, creating superior bilateral septal tunnels, subdorsal incremental 8 mm septal strip resection, subperiosteal lateral bony wall undermining on the internal and external sides, and bony wedge resection utilizing a 4 mm wide bone rongeur. This was completed through endonasal low to low osteotomies and radix percutaneous osteotomies, followed by a let down maneuver. The tip rotation was achieved through a 3 mm caudal septal angle triangular trim. Utilizing a marginal approach, tip refinement was done, after lateral cranial crus reduction, through cranial tip and interdomal sutures as proposed by Kovacevic[39] and fixed with a 4-0 Vicryl round needle suture. Alar base reduction was performed to reduce alar flare. The results are shown preoperatively, 8 days postoperatively, and 1 year postoperatively. Note the lack of bruising and swelling at 8 days even with the extensive exposure from maxilla to maxilla and after bony resection and complete osteotomies.

Case Study #2: Deviated Nose, Asymmetric Push Down Technique

A 35-year-old woman complained of a deviated nose and nasal obstruction (Figure 8). The patient had no history of nasal trauma or surgery. She presented with a thin-skin, deviated bony-cartilaginous dorsum and septum, and she did not want to change her profile lines or nasal tip. Speculum examination and cone-beam CT scan revealed a significant S-shaped septal deviation with a

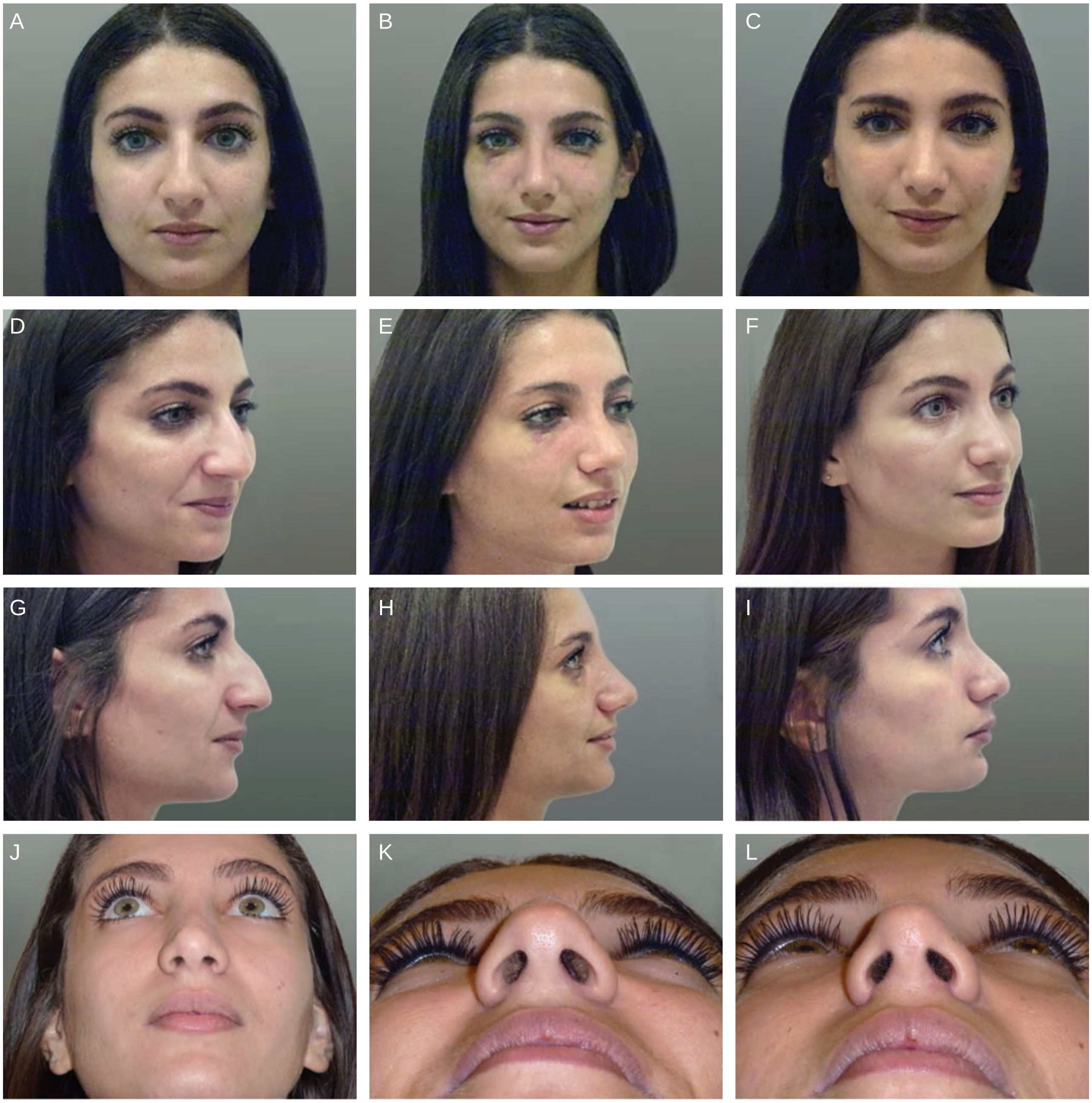


Figure 7. Case Study #1. A 29-year-old woman complained of a high dorsum, a high frontonasal angle, and a closed nasolabial angle. The operation consisted of a subdorsal endonasal approach with an incremental 8 mm septal strip resection, a bony wedge resection utilizing a bone rongeur 4 mm wide forceps, completed by an endonasal low to low osteotomies and radix percutaneous osteotomies, and then the let down technique. The patient is shown preoperatively (A, D, G), 8 days postoperatively (B, E, H), 1 year postoperatively (C, F, I), and 1 year postoperatively (J, K, L).

cephalic convexity toward the right and a caudal convexity toward the left. An endonasal approach was utilized beginning with an interseptalcolumellar incision. Then a wide undermining of the soft tissue envelope was done. The septal surgery consisted of the following: (1) superior bilateral septal tunnels and unilateral septal complete undermining on the right side; (2) a swinging door endoscopically video-assisted technique with resection of the deviated bony components: vomer, maxillary crest, and part of the ethmoidal perpendicular plate; and (3) repositioning of the quadrangular cartilage on the midline without septal cartilage resection. Asymmetric osteotomies

Figure 8. Case Study #2. A 35-year-old woman complained of a deviated nose. She had no previous nasal trauma or surgery. A cone-beam CT scan revealed a significant S-shaped septal deviation with a cephalic convexity toward the right and a caudal convexity toward the left. After extensive discussion, the patient did not want any significant changes in her profile or tip. She only wanted a straighter nose and improved respiration. An endonasal approach was done, followed by an extensive septoplasty. Asymmetric osteotomies were done with a low to low osteotomy on the left side (long side) and complete percutaneous osteotomies on the right side. Finally, an asymmetric push down technique was done by rotating the nasal pyramid en bloc onto the left side. The patient is shown preoperatively (A, D, G), 8 days postoperatively (B, E), and 1 year postoperatively (C, F, H).

were done with a low to low osteotomy on the left side (long side) and complete percutaneous osteotomies on the right (short side). Finally, an asymmetric push down technique was done by rotating the nasal pyramid en bloc onto the left side. The results are shown preoperatively, 8 days postoperatively, and 1 year postoperatively. Note the symmetry of the dorsal lines. At the patient's request, there were no changes in the profile or the tip.

DISCUSSION

In rhinoplasty, there is no universal technique to utilize, because there are different noses, different patients, and different clinical histories. The goal of a dorsal preservation technique is to keep intact the K-area and the entire osseo-cartilaginous vault. The dorsal hump should be eliminated, and no irregularities or discontinuity should be found either by the patient or the surgeon. Functionally, the competence of the internal valve should be preserved and all valves should be opened through the enlargement of the nasal base and its reorientation following the rotation processes. Transversally, the ULCs act like springs and open the internal valve angle (Figure 9). Longitudinally, the lowering of the ULCs modify the scroll area, which is untouched during the procedure.[9,11,22,33] A definite improvement in nasal respiration was reported by the 309 patients who underwent a dorsal preservation rhinoplasty. Within this

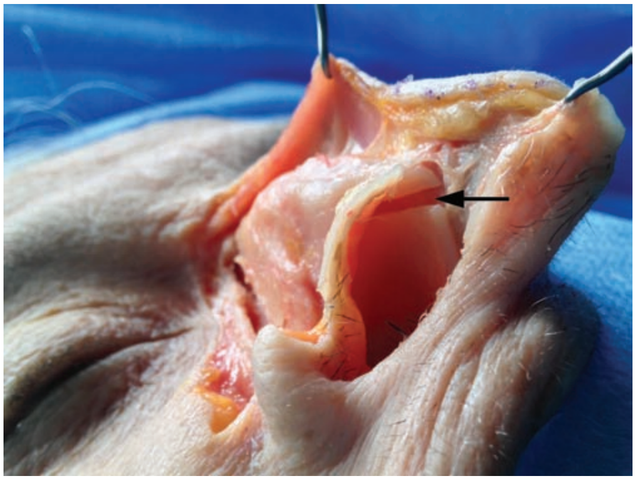


Figure 9. The effect of the push down operation on opening the internal valve.

series of patients, a subset of 30 patients was given a NOSE questionnaire for assessing nasal respiration preoperatively and postoperatively. There was a definite improvement in 90% (27/30) of patients, with the remaining 3 patients stating that they had no change and no worsening. As with all nasal surgeries, appropriate functional procedures are incorporated on an as-needed basis, including laser-assisted partial turbinectomy and septoplasty. This persistence of improved respiration is in direct contrast to resection rhinoplasty, in which the quality of respiration tends to deteriorate with time because of age-related thinning and retraction of the surgically altered musculocutaneous layer overlying the modified cartilaginous dorsum.[40,41]

Technical Challenges

Problems that can occur utilizing the dorsal preservation technique are represented by hump recurrence and possible lateralization of the nasal pyramid. To avoid these complications, we believe that it is mandatory to fixate and to better stabilize the dorsum in the new position. Any residual hump can be corrected easily under local anesthesia, with a simple rasping through a closed approach. Ishida et al[38] reported a partial hump recurrence of 15% in 120 patients who underwent a conservative rhinoplasty, caused by the difficulty to know and to quantify the size of the septal strip that should be resected and the consequence of the memory of the soft tissues. A minor revision was needed in these cases, resulting in a satisfactory final aesthetic result. Reviewing Ishida's technique,[38] the septal resection is done at a lower midlevel than our preferred subdorsal septal location. Thus, precise evaluation of dorsal lowering is more difficult and recurrence is more common.

Obviously, certain technical questions arise as to how to adapt standard reduction techniques within the context of dorsal reservation. As with all rhinoplasty surgery, appropriate septal surgery is required. Bony septal deviation and vomerine spurs are rested as necessary to improve respiration. Caudal septal deviations are mobilized, relocated, and fixed to the anterior nasal spine. Once the septal trip resection has been completed, then additional cartilage can be harvested from the cartilaginous body provided that a 10 mm L-shape septal strut remains. In many cases, the excised septal strip will be sufficient for a columellar strut or alar rim grafts. One of the inherent advantages of dorsal preservation techniques is that there is no need for spreader grafts. In cases of a wide dorsum, one can control width to a limited degree by pushing down the bony vault, which leads to narrowing of the bony vault width. When a truly wide or very asymmetric cartilaginous dorsum is present, other procedures should be considered. One advantage of DPO procedures is the necessity for a complete transverse osteotomy, which allows for radix reduction in particularly reducing the distance from the nasion to the corneal plane. Because complete mobilization occurs in the radix area, pushing downward on this point will reduce the radix.

In our series, we did not have that many recurrent humps, which we attribute to the following: (1) the resection is done high, just beneath the vault; and (2) fixation of the ULCs/ septum junction is done routinely. It is critical that the septal resection be done flush with the dorsum. Any small residual amount of subdorsal septum will prevent changing the shape of the dorsum from convex to concave. Moreover, the preoperative measurement of the planned dorsal reduction can be directly transposed to the intraoperative septal height resection. Thus, it is possible to immediately evaluate the lowering of the dorsum by measuring the height of the septal strips that have been removed, and if necessary, any additional correction can be done just by resecting another strip of septal cartilage. Compared to Cottle's classical push down technique,[1,2] our technique does not require any deep or extensive septal surgery and thus has a shorter operative time and quicker recovery with safer postoperative outcomes.

In contrast to Gola,[20-22] it is our opinion that undermining the dorsal skin envelope is an essential step in the procedure. We begin with an interseptocolumellar approach, done on the caudal border of the septum posterior to the membranous septum, thus avoiding any injury to the nasal ligaments and nasal SMAS extensions.[32] Once the caudal septum is exposed, undermining of the dorsum in the subperichondrial and subperiosteal plane is easily completed. Gola's rationale for not elevating the dorsal soft tissues is that there is no damage to the skin envelope and a shorter operative time. However, we think that elevation of the dorsal soft tissue is necessary, especially in the deviated noses, because the skin participates directly in maintaining the shape of the deformity. Moreover, in unilateral let down, the excess of skin needs to redrape to avoid the risk of incarceration in the freed space. If undermined in the proper plane, the skin will redrape freely after the procedure and without damage to the SMAS and neurovascular structures.

Indications/Contraindications

Dorsal preservation is limited to primary reduction rhinoplasties. As previously stated, patient selection is a critical part of rhinoplasty planning and dorsal preservation is not a universal operation. In evaluating patients, the main question to answer is: *can we keep the nasal dorsum?* For example, a "cartilaginous" nose is an excellent indication for dorsal preservation of the K-area, because it avoids any collapse of the ULC after dorsal resection. In contrast, the very kyphotic bony hump with a deep nasofrontal angle or an irregular bony pyramid is not a good indication for dorsal preservation. A conventional Joseph rhinoplasty was required for 41% of our patients. The initial shape of the dorsum and its susceptibility to be changed was the primary limiting factor. When the K-area is not anatomically correct because of asymmetry, depression, or scars, preservation of the dorsal shape is impossible. A wide dorsum is not a contraindication, because multiple lateral and intermediate osteotomies can narrow the nose. As previously stated, 156 (21.1%) cases were secondary septorhinoplasties previously operated elsewhere and thus were not candidates for a dorsal preservation technique, because the dorsum had been destroyed previously. An algorithm based on the patient's presenting deformity is offered to guide in the selection of the appropriate technique (Figure 10).

One point that must be stressed is that modifications of the dorsum must be the first step before any nasal tip surgery is done, because dorsal lowering can dramatically alter many of the extrinsic tip characteristics. In tension noses, it is quite common to see the overprojected, downwardly rotated tip achieve attractive characteristics once the dorsum has been corrected. Dorsal preservation techniques are especially indicated in the following noses: (1) the straight nose with or without a moderate kyphotic hump; (2) the straight deviated nose; (3) the cartilaginous nose with small nasal bones and weak cartilages; and (4) the tension nose that often has elongated vertical nostrils (external nasal valve) and narrow internal nasal valves that tend to collapse.[20,22]

CONCLUSIONS

Dorsum preservation techniques should become a part of every rhinoplasty surgeon's repertoire. Whenever possible, dorsal preservation is preferred to resection and destruction with its obligate reconstruction. Obviously, the question is, "can we keep the nasal dorsum?" This must be answered through precise preoperative assessment. As described by Lothrop[6] a century ago, the concept is to reduce the height of the nose by removing or cutting the 3 pillars of the nasal pyramid. A septoplasty is the essential first step. A strip of septal cartilage, whose height corresponds to the desired and planned preoperative measurements, is removed just below the nasal bony-cartilaginous vault. Depending on the height and shape of the septal resection, the dorsum is converted from convex to a straight or concave shape. The lateral basal bony resections or osteotomies are extended by a transverse osteotomy across the radix, thus separating the nasal pyramid from the face. With this total mobilization, the nose is impacted, or descends into the facial plane, in between the maxillary processes, followed by fixation in its correct position.

Because this procedure is generally quick, it saves time for difficult tips. Because it is simple and does not lead to tissue injuries, difficult revisions are avoided. The nose often appears untouched postoperatively, with no impingement on the nasal valves and no disruption of the aesthetic dorsal lines, so there is no need for midvault reconstruction. Although conventional reduction techniques must also be mastered, surgeons should consider learning dorsal preservation techniques with their functional and aesthetic benefits.

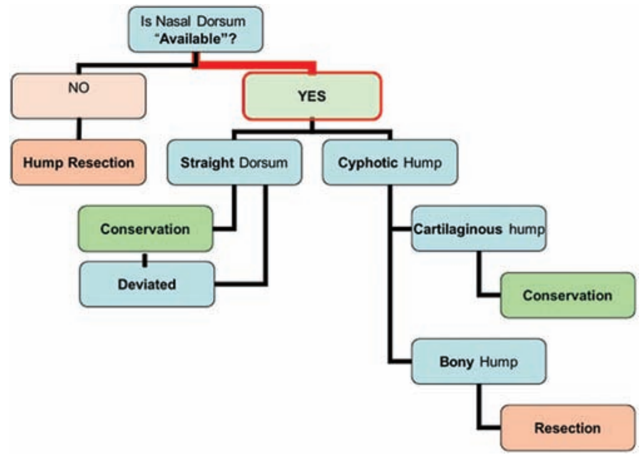


Figure 10. A decision tree for selecting resection or preservation of the dorsum.

Supplementary Material

This article contains supplementary material located online at www.aestheticsurgeryjournal.com.

Disclosures

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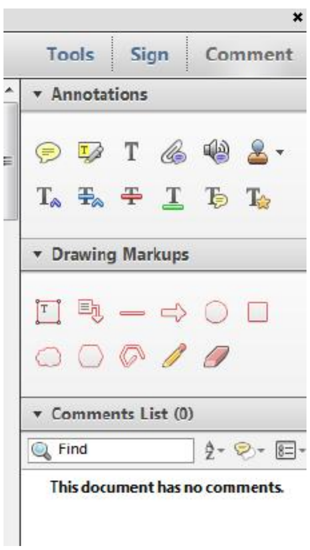

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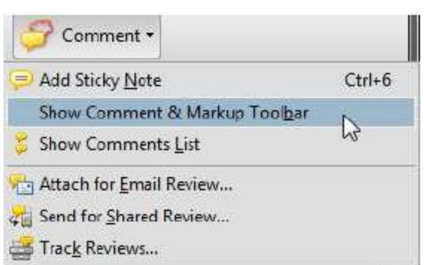

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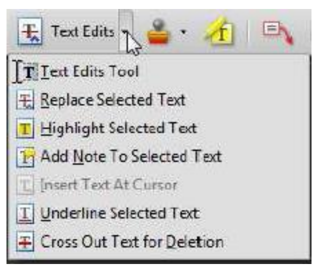

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A 3-Level Impaction Technique for Dorsal Reshaping and Reduction Without Dorsal Soft Tissue Envelope Dissection

Valerio Finocchi, MD; Valentino Vellone, MD, PhD; Mattioli Rubens Giorgio, MD; and Rollin K. Daniel, MD

Abstract

Background: Preservation rhinoplasty (PR) techniques are continuously evolving and many variations of established techniques have been proposed since Daniel coined this term in 2018.

Objectives: The aim of this study was to describe indications for a new "3-level impaction" technique, allowing, in selected cases, a complete profile correction and dorsal reduction without dissection of the dorsal soft tissue envelope (STE).

Methods: Three hundred and fifty primary closed rhinoplasty cases were retrospectively studied from January 2018 and October 2019. Age, sex, race, technical details, surgical time, and complications were registered. Ninety-five dorsa were reduced and shaped without dissecting the dorsal STE by combining: (1) a swinging-door septoplasty with low septal strip resection, (2) endonasal bony cap mosaic osteotomies, and (3) let-down or push-down operation.

Results: All patients showed a dramatic change in profile height and shape without either dorsal STE dissection or bony cartilage dorsal tissue resection. Mosaic osteotomies converted the dorsal keystone area from S- to V-shaped dorsum, let-down-operation and low septal strip resection enabled impaction, and profile setting was achieved by quadrangular cartilage flap rotation. The average follow-up time was 14 months (range, 12-16 months).

Conclusions: In selected patients, dorsum can be preserved without STE dissection. By combining multiple endonasal maneuvers it is possible to obtain a dramatic change without dissecting the STE, while simultaneously avoiding any dorsal tissue resection. This method offers a versatile technique in selected patients, which leads to fast recovery and natural results.

Level of Evidence: 4

4
Therapeutic

Editorial Decision date: June 11, 2021; online publish-ahead-of-print June 27, 2021.

The philosophy of preservation rhinoplasty (PR) has had a profound impact on rhinoplasty surgery, and the surgical technique of PR continues to evolve.[1] The lead author (V.F.) has extensive experience with both high-strip and low-strip dorsal preservation (DP) techniques.[2,3] One persistent challenge has been the treatment of patients with S-shaped humps due to the intrinsic curvature of the bony cap which is often refractory to indirect flattening maneuvers.

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Traditional DP techniques are limited in any attempt to flatten the kyphion, resulting in an excessive removal of bone tissue with consequent opening of the roof. To solve this problem, the technique of endonasal mosaic micro-osteotomies of the bony cap was incorporated into our standard DP operations. This approach allows direct modification of the intrinsic curvature of the bony cap with the added benefit of not requiring any dorsal skin dissection.

This article will concentrate on a series of 95 primary rhinoplasties performed by a 3-level impaction technique with the bony cap being modified by mosaic micro-osteotomies. The anatomic basis of the technique and its application within the spectrum of DP procedures will be discussed.

Relevant Surgical Anatomy

The shape and size of the nasal dorsum remains the primary reason why Caucasian patients seek aesthetic nasal surgery. An in-depth evaluation of 3 relevant anatomic areas—the keystone area, the subdorsal septum, and the nasal walls—allows one to understand dorsal hump configurations and to select appropriate surgical techniques.

The Keystone Area

Palhazi et al introduced the concept of the cartilaginous vault being composed of a dorsal keystone area (DKA), which consists of the T-shaped dorsal septum, and a lateral keystone area (LKA), which reflects the cephalic portions of the upper lateral cartilages.[4] The anatomy of the osseocartilaginous junction, and in particular its area of overlap (8-9 mm on average)[4] at the keystone area (KA), is a direct reflection of its embryologic development. As shown histologically,[5] there is a juxtaposed layer of periosteum and perichondrium wherever there is osseocartilaginous overlap. Another important feature of the keystone is the pyriform aperture ligament which consists of perichondrial/periosteal fibers joining the upper lateral cartilage and nasal bone.[6-9] This ligament can be as thick as 1 mm and attaches directly to the bone at its distal edge, confirming its anchor role. On the dorsal keystone area, the ligament is very thick (>1 mm) and comprises multiple layers of fibrous periosteum and perichondrium running in different directions.[6] As emphasized by Saban et al, the KA is not a rigid fixed structure, but rather a flexible chondro-osseous joint, thus allowing change of the dorsal shape.[10] Histologic studies of the KA indicate that the periosteum on the deep surface of the bony cap fuses with the perichondrium on the superficial aspect of the cartilaginous vault. The result is a flexible dorsum which allows the convexity of the dorsum to be modified by reducing the underlying cartilaginous septal support. Thus, the vault can be changed from convex to concave without losing its continuity.

The Subdorsal Septum

The subdorsal segment of the cartilaginous septum is a critical area, both in longitudinal and vertical directions. Longitudinally, the subdorsal junction of the cartilaginous and bony septum is highly variable, often extending quite cephalically towards the radix.[11]

In an in-depth study of cone beam computed tomography (CBCT) scans, East et al found that the mean distance from the transverse radix osteotomy plane to the junction between the perpendicular plate of the ethmoid (PPE) and the quadrangular cartilage (QC) (which they termed the E point) is –7.25 mm (range, –19.2 to 5.22 mm).[5] A negative value denotes that the subdorsal septal junction E point is located posterior to the transverse radix osteotomy plane, meaning that the cartilaginous septum underlies the KA in the majority of cases. Thus, the direct septal support of nasal humps is usually cartilaginous rather than bony. With experience, release of the subdorsal cartilaginous septum from the E point to the rhinion pivot point (R point) can be achieved with careful dissection.

Lateral Bony Nasal Walls

The lateral bony walls are formed by the nasal bone and the ascending process of the maxillary bones which represent the lateral dorsal pillars. In cross section, the maxillary ascending branch is thicker than the nasal bones. In contrast to hump modification, which is directly influenced by resection of the subdorsal septum, reduction of dorsal height is achieved by osteotomies at the base of the lateral wall, thus allowing preservation of the dorsum. The head of the inferior turbinates is often in close contact with the caudal portion of the lateral walls in the area of Webster's triangle. Because medial movement of the bone could impinge on this portion of the nasal valve area, a triangular portion of bone at Webster's triangle is excised, especially with reductions greater than 4 mm.

Hump Analysis/Classification

To date, there have been relatively few articles detailing analysis and classification of both the dorsal hump and the dorsal profile. Subsequent to Topinard's 5 basic profiles, attempts were made to measure profile angles and components of the nose. At the present time, 2 articles are of particular relevance. Recently, Saban et al presented the concept of a combined reduction—hump reduction and dorsal height reduction—which is a particularly valuable concept for DP procedures (Figure 1A-C).[12] In the traditional Joseph resection rhinoplasty, both goals were achieved in a single major reduction. In DP procedures where the hump is not resected, it is eliminated by reducing direct support to the hump (septal strip excision) and allowing flexion at the chondro-osseous joint. Dorsal height reduction is then achieved with either a cartilage vault or bony vault impaction maneuver. These DP methods work well

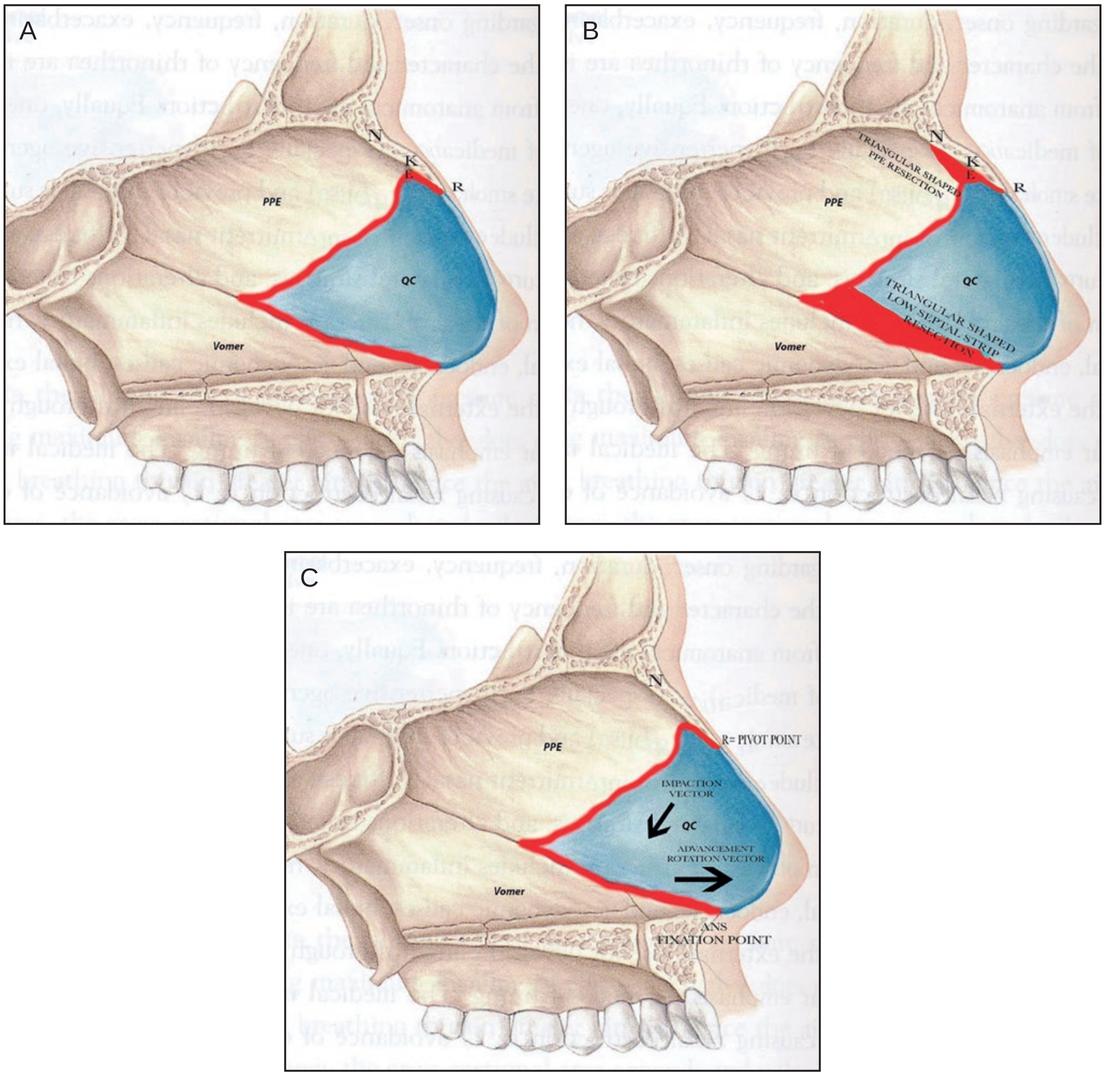


Figure 1. Two-part dorsal reduction consisting of hump reduction (A, B) and dorsal height reduction (C). ANS, anterior nasal spine; K, kyphion; N, nasion; PPE, perpendicular plate of the ethmoid; QC, quadrangular cartilage; R, rhinion.

on cartilaginous structures, but not on intrinsic bony vault contour deformities. Thus, the surgeon needs to analyze the shape and composition of the nasal hump as well as select an operative technique for the desired aesthetic profile change. The second critical paper is by Lazovic et al, who classified the dorsal profile as V-shaped or S-shaped based on profile analysis of bony hump anatomy (Figure 2A,B).[2] The V-shaped dorsum has a flat bony cap starting at the level of the nasion (N) and finishing at the level of the rhinion (R). The nasion is defined as the deepest point in the radix area of the bony vault on profile view. The rhinion is defined as the most caudal point of the paired nasal bones and marks the midline junction of the bony and cartilaginous vaults. The S-shaped dorsum has a curved bony cap. The line starts at the level of the nasion, passes to a distinct point called the kyphion (K, the most prominent point of the nasal bone) before continuing to the rhinion. The S-shaped dorsum has a distinct angulation from nasion to kyphion and then a plateau from kyphion to rhinion. The bones have a sharp takeoff of the hump from the nasion resulting in a high kyphion point and a second locus of angulation.

Therefore, the intersection of the 2 lines N-K and K-R creates the kyphion angle. Extrapolation of the studies by Lazovic et al and Palhazi et al on cadavers to patients seeking rhinoplasty can be challenging.[2,4] With the increasing use of preoperative CBCT scans for analysis, it has become clear that the soft tissue envelope (STE) can obscure clinical presentation of the bony vault anatomy (Figure 3A,B,E,F). For this reason, one can often have a hidden S-shaped dorsum in which the bony vault has an intrinsic kyphion angle, but a V-shaped clinical dorsal profile

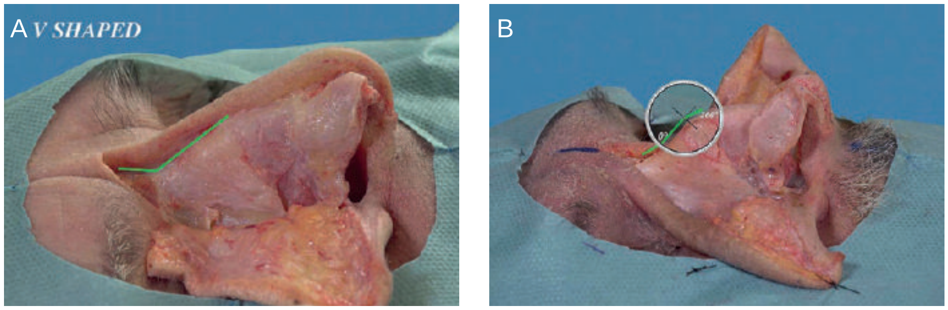


Figure 2. Cadaver dissections. (A) A V-shaped bony dorsum with a straight line from nasion to rhinion with absence of the kyphion point and thus no kyphion angle. (B) An S-shaped bony dorsum with a distinct kyphion point and therefore a kyphion angle.

(Figure 3C,D). The diagnosis can be made on palpation as a distinct kyphion point can be felt cephalic to the rhinion junction within the bony cap. Although not essential, the diagnosis can be confirmed by CBCT. It is these types of hidden S-shaped dorsa that are ideal for the 3-level impaction technique. Ultimately, the surgeon must subdivide dorsal surgery into planned hump reduction and dorsal profile reduction/modification by analyzing their composition to determine the optimal operative plan.

METHODS

A retrospective and observational study was conducted on 350 primary rhinoplasty cases from the same surgeon (V.F.), operated between January 2018 and October 2019. Written informed consent was obtained from all patients, and the study was conducted in accordance with the tenets of the Declaration of Helsinki as revised in 1989. Inclusion criteria were patients who had a primary rhinoplasty with a 3-level impaction technique and minimum 1-year follow-up. All of the included patients had not had any previous nasal surgery and therefore no secondary cases were included. Patients with structural primary rhinoplasty were excluded because in our clinical practice they represent less than 5%.

Age, gender, ethnicity, and anatomy as well as operative technical details were recorded (V- or S-shaped dorsum, bony cap treatment, septal operation, type of impaction). Patients had a follow-up at 1 week, 1 month, 6 months, and 1 year after surgery. Ninety-five cases cases were corrected with a "3-level impaction" technique and are the focus of this report. All of these patients had a mild or hidden S-shaped dorsum.

Surgical Technique: 3-Level Impaction

The "3-level impaction" method is a DP technique in which the shape and size of the dorsum is changed without the need for dissecting the dorsal STE. In most DP procedures, impaction is achieved in 2 steps: septal strip resection to reduce the dorsal hump, and osteotomies to mobilize the bony pyramid thus allowing dorsal height reduction. These integrated maneuvers allow one to minimize the hump and lower the nasal profile while preserving the anatomic integrity of the dorsum. The 3-level impaction technique incorporates a series of multiple micro-osteotomies of the bony cap resulting in a mosaic fragmented configuration which eliminates the intrinsic curve of the bony cap and flattens it. Because the micro-osteotomies are performed by an endonasal approach there is no need for dorsal skin dissection. The operative sequence is as follows.

Level 1: Septoplasty and Septal Strip Removal

A swinging-door septoplasty is performed via bilateral mucoperichondral flap exposure followed by release of the QC—from the anterior nasal spine (ANS), premaxilla, vomer, and the PPE (Figure 4A,B).[3] Next, the subdorsal segment of the cartilaginous septum is released and the dorsal pivot point is selected which usually corresponds to the rhinion (Figure 4A). Any posterior septoplasty is completed as indicated at this time. In order to create space for future impaction, 2 septal strips are removed: (1) a subdorsal strip cephalic to the pivot point, and (2) a triangular septal strip at the base of the QC (Figure 4B). The shape of the subdrosal strip resection can be either triangular or rectangular and is achieved with a rongeur. A triangular strip resection allows a hinge movement on dorsal impaction which avoids radix descent. In contrast, a rectangular strip resection is chosen for high radix patients where a radix drop is desired. Next, a limited low septal strip resection is performed to allow mobilization. An additional definitive resection of the inferior septum will be done after the circumferential osteotomies. The QC remains attached to the cartilaginous vault, but is freed from the influence of the bony septum and can be moved in 3 dimensions. The planes of movement include the following: (1) side to side in the frontocoronal plane, (2) caudal to cephalic in the sagittal plane, and (3) anterior to posterior in the sagittal plane.

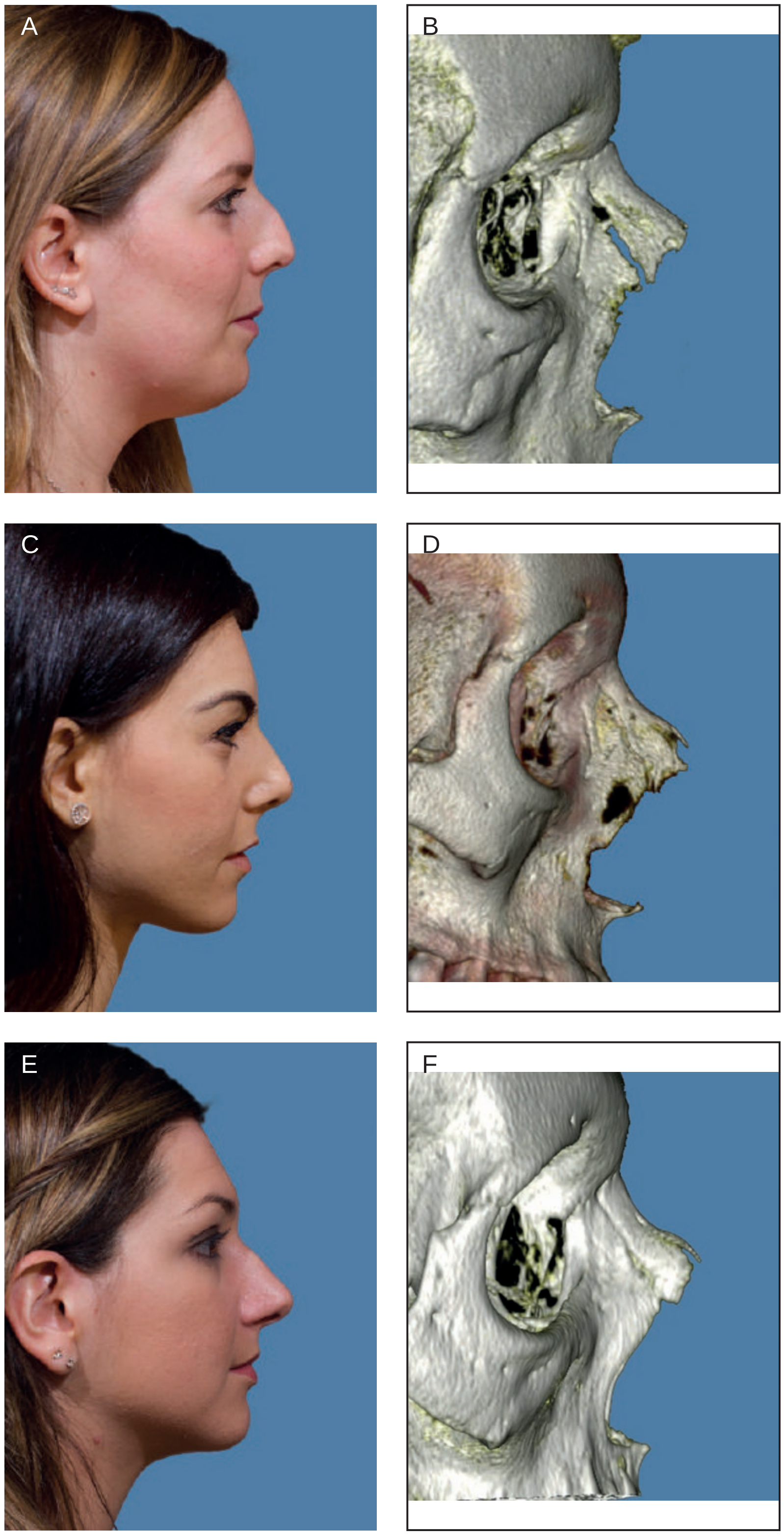


Figure 3. Range of dorsal deformities. (A) A 26-year-old female patient with a V-shaped dorsum. The bony vault is flat and therefore there is no need for bony vault shaping (B). (C) A 28-year-old female patient with a hidden S-shaped dorsum. There is a mild S-shaped dorsum on palpation that is confirmed by computed tomography scan (D), but the external profile is more of a V-shaped dorsum. The palpable bony cap curvature indicates the need for bony cap reshaping. (E) A 28-year-old female patient with severe S-shaped dorsum (F). This case requires extensive bony vault reshaping for which the authors' preferred method is an Ishida technique.

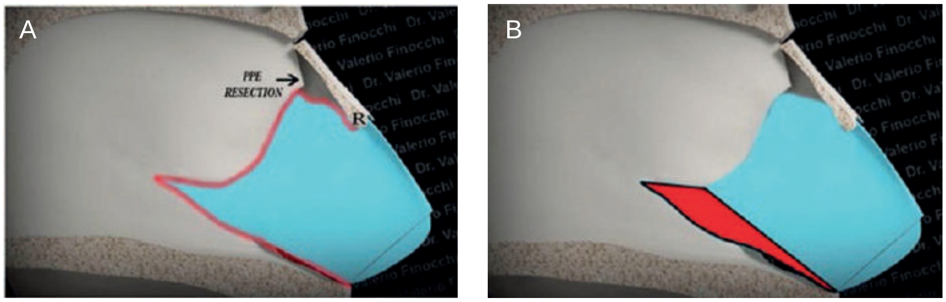


Figure 4. Swinging-door septoplasty with bipartite septal resection. (A) A “swinging-door” septoplasty is achieved by total mobilization of the quadrangular cartilage from its bony attachments. The subdorsal dissection releases the junction of the quadrangular cartilage with the perpendicular plate of the ethmoid and then turns caudally towards the rhinion. (B) The excisional cuts for removal of the inferior strip should be done in a triangular fashion, less anteriorly and more posteriorly.

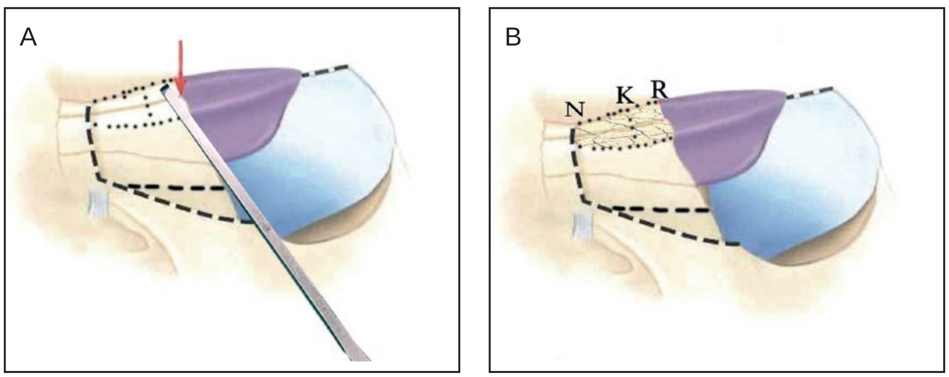
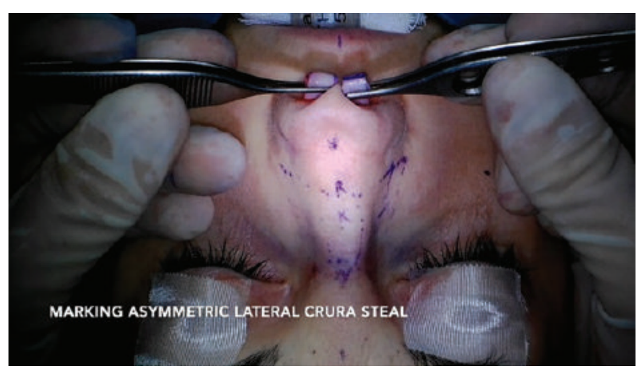


Figure 5. Mosaic micro-osteotomies of the bony cap. (A) Markings for bony cap osteotomies indicated by small dots. It is H-shaped with the bilateral longitudinal bony cap osteotomies passing along the dorsal keystone area from the rhinion up towards the nasion. Transverse osteotomies interrupt the kyphion to break its angle. Accessory transverse osteotomies can be added to achieve a more concave profile line. Circumferential osteotomies for complete mobilization are indicated by heavy dashed lines. In such cases, transverse, radix, and let-down osteotomies are performed. (B) A 2-mm osteotome is used to perform osteotomies. The osteotome is inserted between mucoperichondral flaps and is inclined in an oblique fashion to realize small fractures along the lateral border of the bony cap. K, kyphion; N, nasion; R, rhinion.

Level 2: Mosaic Micro-osteotomies of the Bony Cap

Micro-osteotomies of the bony cap in a mosaic configuration allow flattening of a curved bony cap without the need for dorsal skin dissection (Figure 5A). The osteotomies are performed endonasally with a 2-mm osteotome inserted between the mucoperichondral flaps in an oblique direction. Multiple fractures are created in the bony cap and at the level of the kyphion angle to break the intrinsic curvature of the bony cap (Figure 5B). This portion of the bony vault is usually very thin and easy to break, with the resulting fragments creating a type of mosaic. The fragments are not displaced because the periosteum keeps them in position (Video, available online at www.aestheticsurgeryjournal.com). It should be noted that a range of bony cap deformities are encountered in 3 dimensions: vertical bone thickness, transverse width, and longitudinal angulation. Therefore, the micro-osteotomies most frequently have a longitudinal H-shape with the parallel lines along the desired dorsal aesthetic lines (DALs) and the transverse bar at the level of the kyphion (K point), thus breaking the bony kyphion angle.



Video. Watch now at http://academic.oup.com/asj/article-lookup/doi/10.1093/asj/sjab261

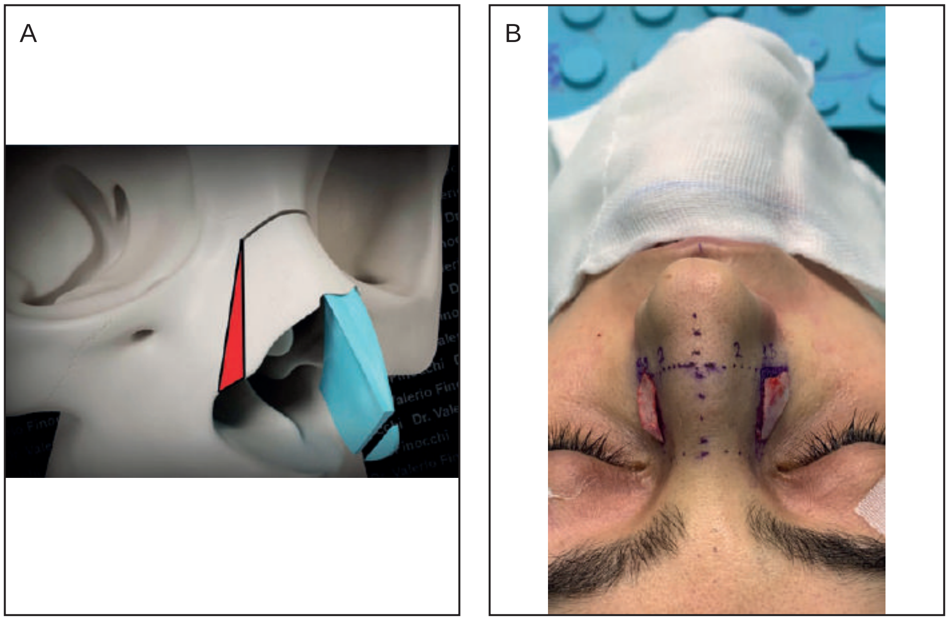


Figure 6. (A) Let-down operation: a 3-dimensional model showing the shape and position of the bony wedge to resect by the let-down technique. (B) A 29-year-old female complained about a crooked nose; an asymmetric let-down operation was performed. Bony wedge resection can be performed with a 4-mm osteotome, the inferior is always performed after the superior, or with the help of a rongeur, taking care to avoid any twisting motion during resection of small bony fragments. This makes it possible to avoid any unwanted fracture lines.

When the bony cap is thicker or wider, multiple osteotomies are required, resulting in a true mosaic configuration throughout the bony cap. The postoperative dressing is very important. After tape application, a pad is positioned over the dorsum to provide additional pressure to minimize any potential displacement. A thermoplastic cast is then applied to ensure even more stability for the mosaic micro-osteotomies.

Level 3: Push-Down Operation or Let-Down Operation

The choice between a push-down operation (PDO) and a let-down operation (LDO) depends on the size of the desired dorsal reduction. A PDO is performed if the reduction is less than 5 mm, whereas a LDO is preferred for reductions greater than 5 mm. In both procedures, percutaneous transverse and radix osteotomies are performed first with a 2-mm osteotome. The radix osteotomy direction can change according to the case—oblique for a hinge motion or vertical for radix reduction. In the PDO procedure, the lateral low-to-low osteotomy is done with a 3-mm guarded osteotome. It is placed endonasally and continues from the piriform aperture up to the level of the transverse osteotomy. Special attention must be paid to the blocking points that can prevent impaction. The blocking points are often created by the internal periosteum and the medial canthal tendon, both of which should be released to prevent a “spring effect” after impaction.[11]

If a major reduction (>5 mm) is required, then a LDO procedure is performed. Following the transverse and radix osteotomies, an inferior wedge of bone is resected from the piriform aperture up to the transverse osteotomy (Figure 6A). The resection can be done by employing a guarded osteotome or a small rongeur (Figure 6B). When osteotomes are used, the superior osteotomy is performed first to ensure stability and resistance. The LDO procedure is the most common procedure performed and has (in the authors’ opinion) multiple advantages including the following: (1) it minimizes narrowing at the level of internal nasal valve area, (2) it precludes narrowing at the level of the piriform aperture, and (3) it facilitates release of the piriform ligament with improved osseocartilaginous joint flexion.

The mosaic osteotomies join those circumferential at the level of the radix. This approach nevertheless offers great stability and control because there is no STE dissection and therefore the osteotomies are protected from unwanted collapse. This detail turns into an advantage because the periosteum acts as a bridge between the bone stumps and the bony cap fragments.

Final Fixation

After the 3 impaction maneuvers are performed, the septoplasty is completed by advancing and rotating the QC flap to obtain final flattening of the dorsal profile. The

QC flap should reach the ANS without tension. Special attention should be given to the final trimming of the QC base to ensure solid contact of the septum along the premaxilla and the ANS. If pushing downward on the dorsum results in a curve in the QC flap, then the QC size is excessive and additional 1-mm inferior strips are resected until the cartilage becomes straight. Once all these key points are addressed, the QC flap is fixed to the ANS periosteum with a 4/0 PDS figure-of-eight suture.

To assess the QC, one can perform a simple "pressure test" by applying pressure with a finger to the dorsal septum at the anterior septal angle and evaluating the following: (1) the contact of the inferior border of the QC along the premaxilla and ANS and (2) any bowing of the septum indicating excess QC in the vertical plane, If the QC is excessive, additional 1-mm inferior strips are resected until the caudal septum becomes straight and stays on the midline without any tension.

RESULTS

The gender distribution of the 95 cases was 77 females and 18 males. The average age was 25 years (range, 16-50 years). All patients were Caucasian and had closed rhinoplasty with an average follow-up time of 14 months (range, 12-16 months). The average operative time was 100 minutes. The osseocartilaginous dorsum was preserved, and mosaic osteotomies were done at the level of the bony cap. There was no elevation of the dorsal STE, thus ensuring anatomic continuity over the entire dorsum. In 45 patients, the scroll area was dissected for tip modification and reconstructed at the end of surgery prior to closure. The average resection of the low septal strip measured 4 mm (range, 2-8 mm).

LDO was performed in 85 patients (90%), whereas PDO was done in 10%. None of the 95 patients had revision surgery with "3-level impaction" technique up to now. Only 2 patients presented a minimal dorsal irregularity, but it did not bother the patients. No septal perforations were found on posttreatment speculum examination.

Case Studies

Three representative case studies are presented as Figures 7 and 8 and Supplemental Figure 1. The 3-level impaction technique was performed in the case studies.

DISCUSSION

This 3-level impaction technique can be discussed in terms of actual execution as well as how it fits within the spectrum of rhinoplasty techniques, specifically other DP procedures.

Current DP Techniques

Within the framework of DP procedures, 2 broad approaches can be described: (1) the classical complete osseocartilaginous vault lowering, and (2) dorsal modification followed by cartilage vault lowering.[13,14] The classic DP operation with its septal strip excision followed by PDO or LDO produces excellent results in the majority of cases.[15] As broader application by a greater number of surgeons developed over the past 4 years, however, 2 challenges appeared at either end of the nasal deformity spectrum. First, the significantly S-shaped nose proved challenging. The more severe the S-shaped kyphotic dorsum, the more difficult it is to flatten with DP procedures. In many cases, the entire bony vault was disarticulated with a major drop-off at the radix and the osseocartilaginous vault pushed down into the pyriform aperture. Clinically, the profile would be straight, but the patient could still palpate a hump. The preserved dorsum with its curved bony cap was visible on CT scan. The more severe the S-shaped deformity, the higher the revision rate.[16,17] Second, disarticulation of the bony vault by circumferential osteotomies did not appear warranted or necessary for many smaller humps (<4 mm). The concept of intact cartilage vault lowering was first demonstrated by Ishida et al in 1999.[18] The procedure involved resection of a septal strip, excision of a cephalic bony hump, followed by cartilage vault push down to achieve the desired profile line. Subsequently, Ferreira et al proposed the "spare roof technique," which preserves the cartilaginous vault with resection of a portion of the caudal bony cap.[19] A crushed cartilage graft is inserted before closure to ensure a smooth contour. As noted by Kosins, the bony cap can be shaped by piezo or rasp, reducing or minimizing any dorsal deformity.[13] Ishida et al recently modified the cartilage vault push down to reduce any dorsal irregularites following resection of the bony vault.[20,21] The operation consists of the following steps: (1) septal strip excision, (2) release of the cartilaginous vault, (3) preservation of a bony cap segment, (4) adjustments of the bony dorsum, and (5) appropriate osteotomies. The critical difference is retention of a segment of the bony cap beginning at the rhinion, incorporating the kyphion point, and continuing cephalically towards the nasion for a variable distance. These osteotomies achieve the following 3 things: (1) an intact segment of the bony cap in continuity with the cartilage vault is created; (2) the intrinsic S-shape in the bony dorsum, especially the kyphion angle, is virtually eliminated; and (3) the remainder of the bony dorsum can be shaped with rasps or osteotomes. The advantage of the modified Ishida procedure is that it minimizes any dorsal irregularities associated with dorsal modification procedures and eliminates the need for crushed cartilage concealment grafts.

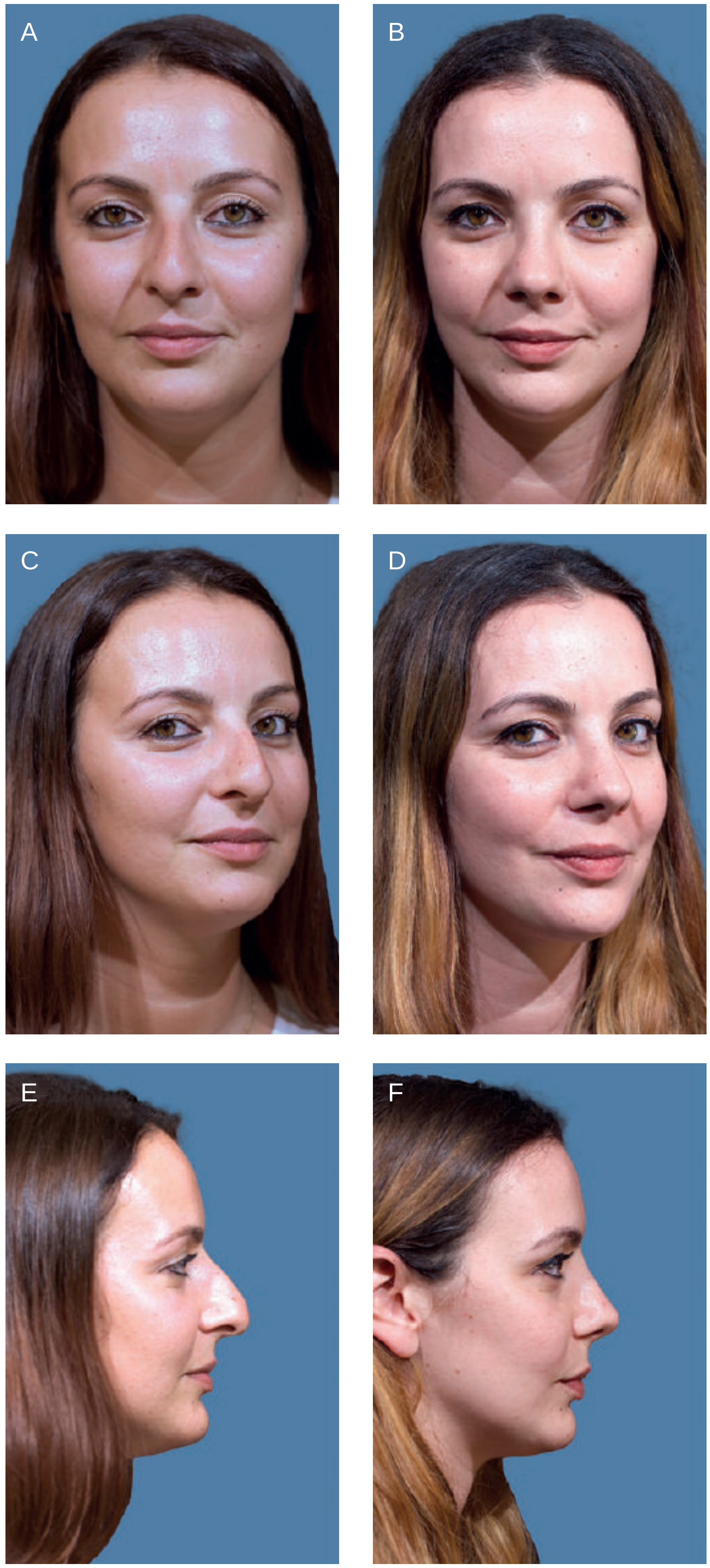


Figure 7. Three-level impaction technique case example. A 30-year-old female complained of a slight dorsal hump with bulbous, droopy, and plunging tip on smiling. Pretreatment (A, C, E, G, I) and 1-year posttreatment (B, D, F, H, J) views are shown. A subperiochondrial-subperiosteal dissection of the tip and septum was selected with preservation of all ligaments. Tip

Figure 7. Continued.

Further research is needed to compare this technique with other approaches for treating patients with "mild" or hidden S-shaped dorsal deformities.

Mosaic Micro-osteotomies

As previously emphasized, the challenge with the S-shaped dorsum is the rigid kyphion angle intrinsic to the bony vault which cannot be flattened irrespective of septal strip excision. Previous surgical options have been to ignore it, resect it, or create a bony flap in continuity with the cartilage vault. A new option is mosaic micro-osteotomies done endonasally which minimizes the S-shape intrinsic to the bony cap in selected cases. The technique is as follows: (1) a 2-mm osteotome is passed between the mucoperichondral flaps; (2) the initial osteotomies are beneath the bony cap, passing along the desired DAL on either side up to the level of the transverse/radix osteotomies; and (3) a transverse

suturing was performed with cephalic dome sutures, and a 2.5-mm lateral steal procedure with the association of a columellar strut for tip stabilization. Her dorsum was found to be ideal on anterior view but on profile it was a tension nose with an overprojected dorsum. Clinically it presented a V-shape but radiology and palpation showed a hidden S-shaped bony dorsum. A 3-level impaction was performed by avoiding soft tissue envelope dissection, associating mosaic osteotomies for bony cap fragmentation, let-down operation (6-mm-wide bony wedge resection), and 8-mm low septal strip resection for whole dorsal impaction. Right profile curvature was achieved by quadrangular cartilage flap rotation and fixation to the anterior nasal spine. A 4-mm caudal septal resection was performed for columellar show correction. Postoperatively the nasal hump has been eliminated, the dorsal aesthetic lines are symmetric, and the nasal tip is well projected with good definition.

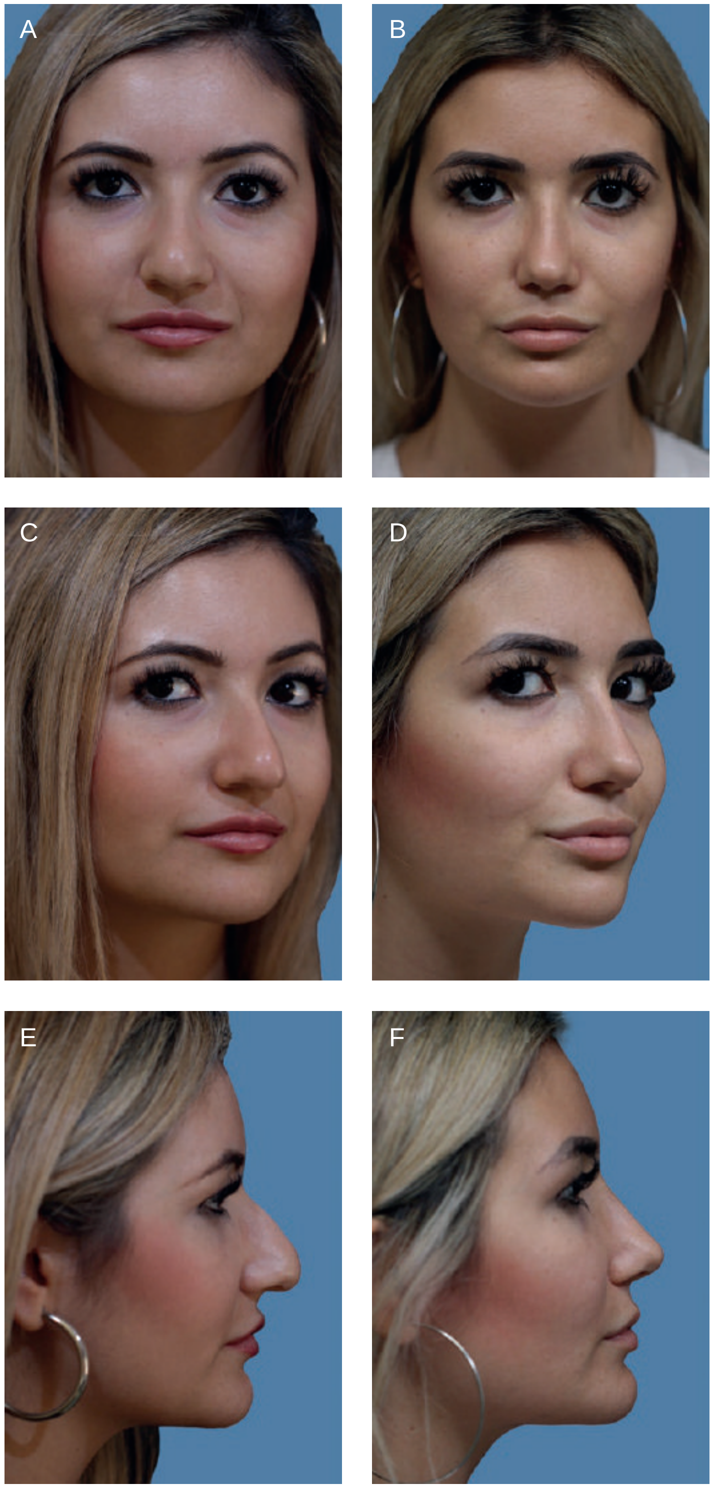


Figure 8. Three-level impaction technique case example. A 25-year-old female presented with a dorsal hump and plunging tip on smiling. Pretreatment (A, C, E, G, I) and 1-year posttreatment (B, D, F, H, J) views are shown. A subperiochondrial-subperiosteal dissection of the tip and septum was selected. Tip suturing was performed with cephalic dome sutures and a 4-mm lateral steal procedure. Columellar strut was inserted for tip stabilization. Dorsal aesthetic lines were found to be ideal on anterior view but on profile were slightly overprotected with a V-shaped bony dorsum. A 3-level impaction was performed by avoiding soft tissue envelope dissection, associating mosaic osteotomies for bony cap fragmentation, let-down operation

Figure 8. Continued.

micrososteotomy is performed at the level of the kyphion. The result is that the multiple fracture lines throughout the bony cap and at the level of the kyphion angle thereby effectively break the intrinsic curvature of the bony cap. In most cases, the bony cap is very thin and easily broken, thus resulting in a mosaic set of fragments which do not move as the periosteum keeps them in position. The bony cap is therefore segmented, but each piece is vascularized through its periosteal attachment. Approximation of the bony fragments is maintained with a dressing that consists of an external pad, taping, and acrylic cast that is left on for 7 to 10 days. Because there is no STE dissection over the dorsum, the fibroblast and osteoblast activity will be more limited, resulting in a faster postoperative recovery.

Micro-osteotomies in nasal surgery were described in 1970s and by Mattioli in 1996 for standard osteotomies.[22] The current paper describes the use of micro-osteotomies to eliminate the intrinsic curvature of the bony cap. This type of procedure is termed "osteoclasis," and is performed without releasing the periosteal connections. Osteoclastic techniques are often used in orthopedic surgery to treat bone deformities (ie, osteogenesis imperfecta), especially in children where bone devascularization must be avoided during growth.[23,24] As shown in Figure 9, the CT scan demonstrates a flat bony cap postoperatively following an extensive modification of a wide and rigid bony cap. The mosaic method allows the surgeon to address one of the primary causes

(4-mm-wide bony wedge resection), and 6-mm low septal strip resection for whole dorsal impaction. Right profile curvature was achieved by quadrangular cartilage flap rotation and fixation to the anterior nasal spine. Caudal septum was not resected to maximize tip stability and improve columellar show. Postoperatively the nasal hump has been eliminated, the dorsal aesthetic lines are symmetric, and the nasal tip is well projected with good definition.

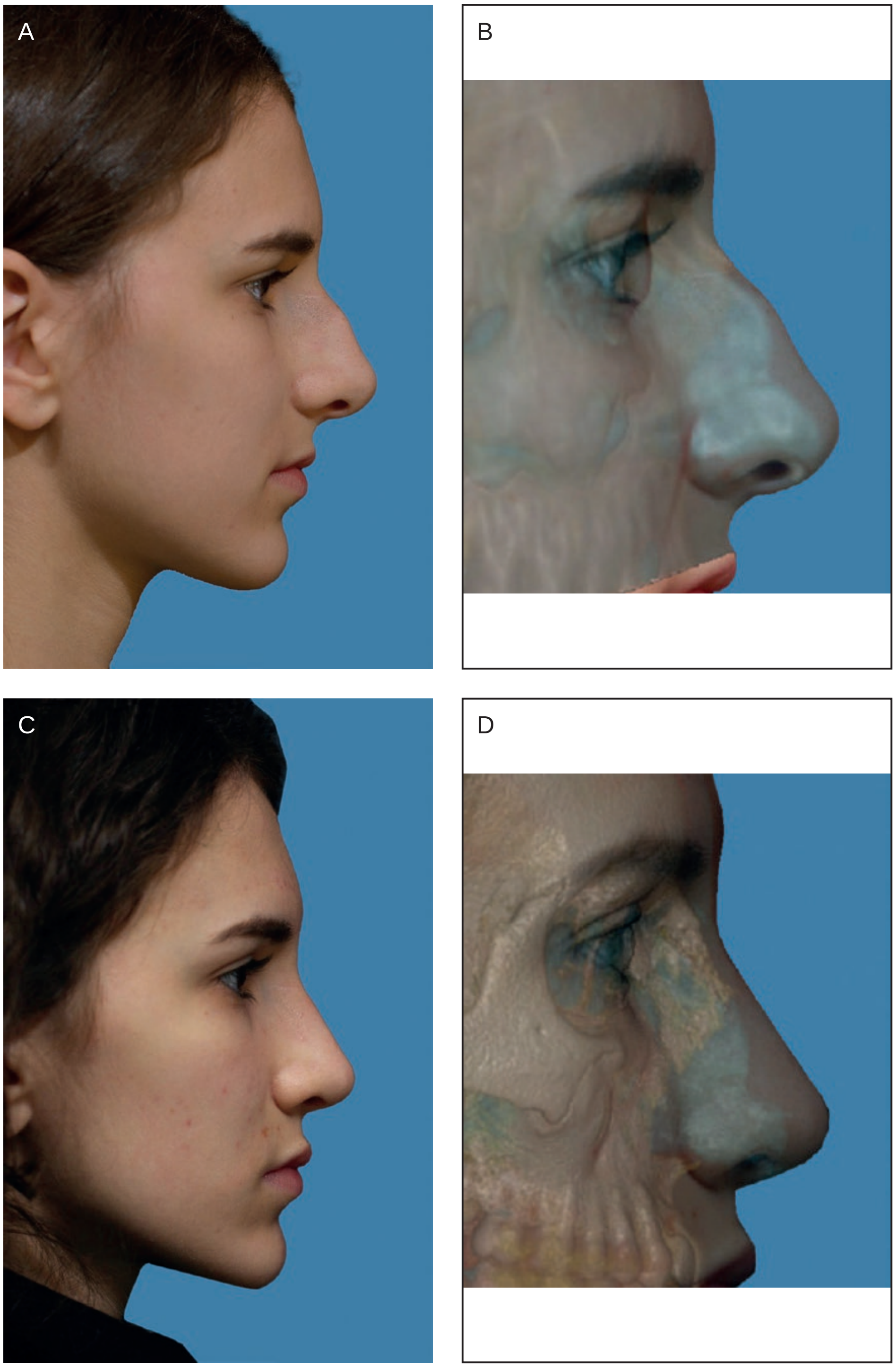


Figure 9. A 22-year-old female. Photographs of nasal bones pretreatment (A) and 1 year posttreatment (C) and 3-dimensional CT lateral views pretreatment (B) and 1 year posttreatment (D). CT scan demonstrates a flat bony cap postoperatively following an extensive modification of a wide and rigid bony cap. The mosaic method allows the surgeon to address one of the primary causes of recurrent hump deformities following dorsal preservation procedures—persistent curvature of the bony cap. CT, computed tomography.

of recurrent hump deformities following DP procedures—persistent curvature of the bony cap.

Three-Level Impaction Technique

Although mosaic micro-osteotomies can be used for very minor bony hump deformities as an isolated technique, the senior author (V.F.) has found it most valuable as part of the 3-level impaction operation. The first step is a swinging-door septoplasty followed by a bipartite septal strip resection. The first septal strip excision is below the bony vault and usually starts at the level of the rhinion before continuing to the level of the nasion. The resected tissue from the subdorsal area can vary in composition: cartilaginous septum, bony perpendicular plate of ethmoid, or a combination. The second septal strip is at the inferior level of the QC which allows the cartilaginous vault to impact downward. It is important to remove this tissue in order to create room to allow for flattening of the dorsal hump and for the multifractured bony cap.

Next, mosaic micro-osteotomies of the bony cap are performed to flatten its intrinsic curvature and minimize any recurrent hump. Essentially, one is achieving the desired bony dorsal configuration similar to a cartilage conversion technique but with 3 major differences. First, there is no dorsal skin dissection which is a major advantage because avoiding this dissection lessens postoperative inflammation and is especially valuable in thin-skinned patients with a high risk of postoperative visible irregularities. Second, it maintains the entire bony cap without the need of resecting 4 to 8 mm of caudal bony cap and avoids the intrinsic risks involved in reshaping the remaining bony vault with power tools. Third, there is no need for concealer grafts of cartilage dust or other materials because there is no skin dissection. Essentially, one can eliminate the kyphion angle intrinsic to the bony cap, thereby converting the dorsal profile from angulated to straight.

LDO can achieve more impaction than PDO. The latter is achieved by sliding the nasal bones inside the piriform aperture with a narrowing effect of the nasal base, but this sliding must be limited to avoid internal nasal valve obstruction, whereas the LDO involves a wedge bony resection at the level of the ascending branch of the maxilla. Thus the bone stumps come into contact and it is possible to control the impaction without any base narrowing. LDO and double septal strip resection allows the surgeon to avoid LKA dissection. As the LDO procedure releases part of piriform ligament, an LKA dissection is not necessary to achieve a straight dorsum profile.

Avoiding Dorsal Skin Dissection

One of the most severe sequelae of resection rhinoplasty is thinning and scarring of the STE, especially over the dorsum. To avoid damage of the STE, surgeons have progressively deepened the plane of dissection from subcutaneous to sub–superficial muscular aponeurotic system to subperichondrial/subperisoteal. Ideally, avoiding dissection of the STE would have 5 major benefits. First, direct damage to the neurovascular and superficial muscular aponeurotic system structures of the nasal STE would be eliminated. Second, one could avoid initiation of a major inflammatory cascade over the dorsum which can result in postoperative edema and fibrosis. Third, one prevents any dead space formation which would be filled with new connective tissue and scar tissue during the healing process. Fourth, there is no permanent disruption of the nasal ligaments in the internal valve area because there is no dissection above that required for tip surgery. Fifth, the incidence of early postoperative morbidity (bruising, swelling), intermediate-term patient disappointment (lack of definition, supratip-dorsal swelling), and late-term sequelae (skin thinning, visible irregularities) would be either minimized or eliminated. Essentially, a technique that avoids dorsal skin dissection is a major benefit.

Dorsal preservation without STE dissection was first described by Gola et al.[25] The procedure they favored consisted of a high subdorsal septal transection or strip excision followed by a push-down of the nasal vault without any dorsal skin dissection. Gola's experience with over a thousand cases is summarized in his textbook,[26] where he states that the primary complication he encountered was a residual hump. Saban, who was a surgical fellow with Gola, adopted many of his principles, but favored dorsal skin undermining.[10] Saban felt that elevation of the skin was especially required in deviated noses as the skin would maintain the deformity unless released. His preference for skin undermining probably reflects the wide range of asymmetric cases where unilateral let-down and bony vault rotation without skin restriction were essential.[15] As validated by this study, it is possible to avoid dorsal skin dissection in the majority of primary rhinoplasties depending on the surgeon's preference of surgical techniques and the patient population.

Learning Curve

The limits of mosaic osteotomies were initially pushed to understand which patients benefited most and to understand the relative indications for both the 3-level impaction with mosaic osteotomies and the modified Ishida technique. A 2-mm osteotome is the right compromise because it easily breaks the bones but at the same time offers the surgeon good control to avoid excessive pressure with possible skin perforation. It is important to angle the tip of the instrument in an oblique fashion so that just 1 corner of the cutting edge is in contact with the bone. This method allows the surgeon to minimize the required force of the hammer during the osteotomy, thus reducing the risk of periosteum disruption and skin perforation. In this way the force of the hammer is transferred to a smaller surface and the pressure, according to the equation pressure = force/area, is increased.[27] Before beginning the operation, it is important to mark on the skin the bony cap limits and its anthropometric points (nasion, kyphion, and rhinion). These markings are important to define the fragmentation area. After the osteotome is inserted between the mucoperichondral flaps, the first target is the kyphion in order to break the intrinsic bony curvature. The nurse taps the osteotome with the hammer with soft, but frequent, strokes. Proceeding in this way, the surgeon can feel the progression of the osteotome tip through the bone. The micro-osteotomies are continued caudocranially in the center of the marked area until the nasion is reached. The feeling under the fingers should be a net softening of the tissue in the center and 2 bony osteotomy clefts at its sides which reflect the cephalic bony portion of the DAL. The size of the bony cap and its curvature are the main features that affect the entity of the fragmentation and therefore the osteotomy quantity (ie, short bones are the easiest to correct because of the low number of mosaic fragments, whereas long and curved bones need more fragmentation). After the central area has been fragmented, the surgeon should decide the height of the new DALs by breaking the bony clefts at the desired height, proceeding in the same caudocranial direction by angling the osteotome in an oblique medial to lateral direction.

Patient Selection

The shape of the nasal dorsum is determined by the cephalic bony vault, the osseocartilaginous nasal hump, and the cartilaginous dorsum. If we look at all the DP procedures in our series of 350 cases, there were 170 cases that met the selection criteria including documented follow-up. These 170 patients can be broken down into the following 3 groups based on clinical classification of their dorsal hump and the surgical technique selected to correct their deformity: (1) hidden S-shape (95 cases, 55%), (2) V-shape (45 cases, 26%), and (3) severe S-shape (30 cases, 19%). A progressive surgical approach was used as determined by the type/severity of the dorsal hump and not by the total amount of dorsal reduction.

V-Shape

The V-shaped dorsum can be corrected with a standard DP technique because there is no need for bony vault reshaping. A straight or slightly concave profile can be achieved by septal strip excision and flexion of the chondro-osseous joint. The choice between PDO or LDO depends on the total amount of reduction to be done. Because there is no need to correct an intrinsic deformity of the nasal bones/bony cap, a double-level impaction technique is sufficient: a septal strip excision (low or high), followed by PDO or LDO. For those cases, it is possible to apply a technique that does not involve dorsal STE dissection such as simplified preservation quick rhinoplasty (SPQR) V2/V3[3] (the SPQR procedure can be divided into 3 groups based on the extent of STE dissection: [1] SPQR with wide nasal STE dissection (V1); [2] SPQR without any dorsal dissection—only tip exposure is done to perform tip plasty (V2); and [3] SPQR without any STE dissection (V3), when there is no tip deformity) for low septal strip resection, or the variation described by Gola et al for high septal strip resection.[25] Of 45 V-shaped cases, in 35 cases we performed SPQR, in 3 cases a Gola procedure, and in 7 cases an Ishida procedure because of a wide dorsum.

Significant (Severe) S-Shape

In the S-shaped dorsum, there are various degrees of curvature at the level of the bony cap which are measured by the kyphion angle. The kyphion angle varies on average between 203° in the male to 200° in the female. Our decision is made more on "surgical judgment" rather than on an anthropometric radiologic measurement. The choice of surgical technique is based on multiple factors. A combination of radiologic, photographic, and palpatory investigations allows the surgeon to understand the 3-dimensional bony cap configuration (thickness, width, length, and coronal and sagittal curvature) and its intrinsic features (resistance). The transition between no STE dissection/mosaic osteotomies and STE dissection/Ishida lies in the 3-dimensional bony cap configuration and its intrinsic features. A thin bony cap, short nasal bones, and an elastic joint is the best indication for mosaic osteotomies. If the bony cap curvature is excessive with an important kyphion and strong bony component, our favorite technique is DKA manipulation or resection with complete cartilaginous vault preservation. It is the opinion of the lead author (V.F.) that the modified Ishida technique is the preferred method for dealing with significant S-shaped deformities with a straight R-ASA. AQ5

Following septal strip excision and cartilage vault release, a continuous osseocartilaginous segment is preserved. The dorsal component of the underlying bony vault can be lowered and reshaped to achieve the desired profile line followed by vault impaction to achieve the desired height reduction.

Hidden (Moderate) S-Shape

These cases look like a V-shaped dorsum on profile, but on careful examination and palpation, a bony curvature with a distinct kyphion point is present. The thick, soft tissues in the radix area reduce the expression of the bony curvature, thus creating the illusion of a straight bony profile. It should be noted that the majority (95/170, 55%) of our DP cases had this deformity. Bony cap manipulation is necessary to achieve the final result; otherwise, patients will complain of a persistent hump on palpation or a visible deformity on oblique view. Mosaic micro-osteotomies resulting in osteoclasis modify the intrinsic bony cap deformity, thereby eliminating the kyphion point and angle. Essentially, one converts the preoperative S-shaped bony cap to a V-shape as the bony fragments heal in their new position. The 3-level impaction technique is effective in dealing with the mild S-shaped dorsum, but only if the DALs are ideal. Patients with straight, wide DALs are considered a contraindication for mosaic osteotomies because the width remains unaltered and therefore unacceptable. Another relative contraindication occurs when the bony component of the hump is very dominant and thick because numerous osteotomies would be required to fragment the bony cap, with possible postoperative irregularities.

Because the micro-osteotomies are performed by an endonasal approach (inside-out direction), there is no need to elevate the dorsal STE. The avoidance of damaging the dorsal skin envelope is a major advance. As reviewed by Kovacevic et al, a damaged STE is a major concern following primary rhinoplasty and a major challenge in secondary cases.[28] Unpredictable scarring and contraction occur and can lead to significant aesthetic and trophic sequelae. Potential damage of the dorsal STE is a real risk in the area overlying the bony cap which is the thinnest portion of the dorsal skin and thus predisposed to damage. Mosaic osteotomies allow the surgeon to expand the indications for a "no dorsal skin dissection" approach to a greater number of cases and to reduce the risk of postoperative morbidity.

Study Limitations

The limitations of this study include its retrospective nature. Furthermore, this technique was performed by the first 2 authors for a few months before the start of the inclusion period. The learning curve is ongoing.

Many studies on classical DP procedures with long-term follow-up have been published by Saban et al, but often the S-shaped nose was an exclusion criteria for this technique.[15,29,30] Finally, no formal airway obstruction measurement tool or validated patient-reported outcome questionnaire were used, although none of the patients in this series subjectively complained about the aesthetic result or reported airway obstruction and no anatomic nasal obstruction was noted on postoperative examination. One should consider this to be a description of in-depth experience with the described surgical procedure rather than a detailed outcome study.

CONCLUSIONS

Given proper patient selection, the 3-level impaction technique described here offers distinct advantages compared to standard DP techniques. Because no skin dissection is involved, recovery time is reduced and progressive skin thinning, which usually occurs in the years following surgery, is avoided. No tissue resection is performed, reducing the risk of depressions at the level of the bony vault. The aim of this technique is to preserve as much tissue as possible, thereby improving recovery time and reducing postoperative complications. AQ6

Supplemental Material

This article contains supplemental material located online at www.aestheticsurgeryjournal.com.

AQ7

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ORIGINAL INVESTIGATION Rhinoplasty

Functional and Aesthetic Outcomes of Let Down Dorsal Preservation Rhinoplasty

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Abstract

Background: Preservation rhinoplasty is a re-emerging technique that lacks data on functional and aesthetic outcomes.

Objective: To measure the change in patient-reported nasal aesthetic perception, nasal breathing, and sleep and compare outcomes between two different septal cartilage manipulation techniques among patients undergoing preservation rhinoplasty.

Methods: Functional and aesthetic outcomes of a let down dorsal preservation rhinoplasty using either the modified subdorsal strip method (MSSM) or subdorsal Z-flap are assessed pre- and postoperatively using the validated assessment tools Nose Obstruction Symptom Evaluation (NOSE), Sinonasal Outcome Test (SNOT-22), Standardized Cosmesis and Health Nasal Outcomes Survey (SCHNOS), and Epworth Sleepiness Scale (ESS).

Results: Fifty-two patients, 40 women and 12 men ages 15–69 years, underwent dorsal preservation rhinoplasty and the majority reported at 1, 3, 6, and 12 months postoperatively significant improvement based on a paired *t*-test in NOSE, SNOT-22, SCHNOS, and ESS scores except for ESS scores at 6 and 12 months. No significant difference based on a two-sample *t*-test was observed between the MSSM and Z-flap techniques implemented.

Conclusion: Let down dorsal preservation rhinoplasty with either the MSSM or Z-flap cartilage manipulation technique can achieve significant improvement in nasal aesthetics, nasal breathing, and sleep according to patient responses on validated assessment tools.

Background

The concept of preservation rhinoplasty was pioneered by the otolaryngologist Goodale in 1899.[1] He addressed a dorsal hump by excising subdorsal cartilage and performing lateral osteotomies with disarticulation of the nasal-frontal junction, allowing descent of the dorsum and hump elimination. In 1914, Lothrop highlighted resecting a high strip of septum including cartilage and bone, removing triangular pieces of maxillary bone, and performing a percutaneous osteotomy at the radix.[2] The technique was modified and called the push down method by Cottle in 1946, becoming popular in the 1960s.[3,4]

Cottle's technique involved impaction of the bony and cartilaginous hump at the keystone and rotation of the septal cartilage, which was challenging to implement. Subsequently, modifications for septal cartilage manipulation ensued with Saban championing the high subdorsal resection.[5] Cottle's technique was further modified by

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KEY POINTS

Question: Does the preservation rhinoplasty technique deliver patient desired cosmetic results and improve patient perceived nasal breathing and sleep?

Findings: Patients who underwent preservation rhinoplasty reported on questionnaires improvement in appearance of the nose, nasal breathing, and sleep.

Meaning: Patients who underwent preservation rhinoplasty were happy with the cosmetic result and had improved nasal breathing and sleep.

Drumheller and Huizing in the 1970s to include osseous wedge resections from the maxilla.[6,7] This method became known as the let down preservation rhinoplasty.

Historically, aesthetic and functional results of the aforementioned preservation techniques were favorable.[8] However, these techniques were abandoned because of perceived low versatility and need for complex septal manipulations. Preservation rhinoplasty techniques have re-emerged with new modifications for septal excision. Neves published on the tetris concept where the dorsal septum is lowered as a flexing block.[9,10] Ishida described a mid-septum strip excision extending to the anterior septal angle without bony septum excision.[11]

Similar to Neves, Most published on an intermediate excision between the Saban subdorsal and Ishida midseptal resection techniques known as the modified subdorsal strip method (MSSM).[12] This method allows for preservation of a caudal strut and a small dorsal strut as well as the option to remove inferior septal cartilage and ethmoid bone for grafting.[12] Kovacevic established yet another modification for septal manipulation involving a subdorsal Z-flap with incisions in the cartilaginous and bony septum.[13,14] Prior publications on preservation rhinoplasty have primarily focused on technique variations. Functional nasal breathing and quantifiable aesthetic outcomes have not been thoroughly studied.

Methods

A dorsal preservation rhinoplasty technique using the piezoelectric system to complete osteotomies was performed in a private practice setting. Patients included men and women ages 15–69 years presenting for cosmetic rhinoplasty with some patients admitting to secondary concerns of nasal obstruction and sleepiness. One patient was a revision rhinoplasty. Outcome measures assessed included Nose Obstruction Symptom Evaluation (NOSE), Sinonasal Outcome Test (SNOT-22), Standardized Cosmesis and Health Nasal Outcomes Survey (SCHNOS), Epworth Sleepiness Scale (ESS), and standardized before and after photographs.[15–18]

NOSE and SNOT-22 primarily assess functional nasal breathing, SCHNOS focuses on patient perceived aesthetics, and ESS evaluates subjective situation-based sleep parameters. These assessment tools were administered pre- and postoperatively at 1, 3, 6, and 12 months. All dorsal preservation rhinoplasties were performed by the same surgeon. Advarra IRB approval was obtained to collect data on cosmetic surgery patients operated on at Texas Center for Facial Plastic and Laser Surgery.

Surgical Technique

An open approach let down dorsal preservation rhinoplasty technique was performed in all patients. Periosteum is elevated off both the external and internal aspect of the maxilla through an incision at the head of each inferior turbinate. The piezoelectric saw is used to make low-low-high lateral osteotomies on each side. A small wedge of maxillary bone that includes Webster's triangle—triangular area of the caudal aspect of the maxillary frontal process—is removed bilaterally. If the dorsum is crooked, a larger wedge of bone is removed on the side opposite to the side of deviation. A transverse osteotomy at the nasion that connects with the lateral osteotomies is made using the piezoelectric scalpel flat by Synthes attachment while protecting the undersurface of the soft tissue envelope with an Aufricht retractor.

Dorsal septal cartilage is manipulated in one of two ways. Either a modified subdorsal strip method (MSSM) (Figs. 1 and 3) or a subdorsal Z-flap (Figs. 2 and 4) is performed. The former technique is a modification of the Saban method popularized by Most.[12] A horizontal strip of septal cartilage ~5–10 mm inferior to the dorsum edge is excised, leaving a 1.5 cm caudal strut intact to maintain tip support. The width of the excised cartilage depends on the amount of hump let down desired.

A vertical releasing incision through the dorsal septum is made inferior to the point of maximum dorsal convexity. This incision extends to but not through the junction between the upper lateral cartilage and septum. This creates a flexion point for dorsum let down. The let down

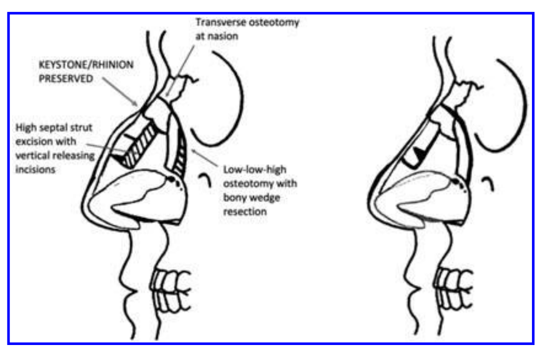

Fig. 1. Osteotomies and septal incisions shown for the MSSM technique with resultant let down dorsal hump. MSSM, modified subdorsal strip method.

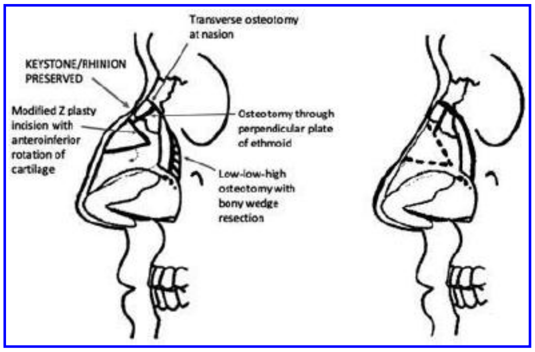

Fig. 2. Osteotomies and septal incisions shown for the subdorsal Z-flap technique with resultant let down dorsal hump.

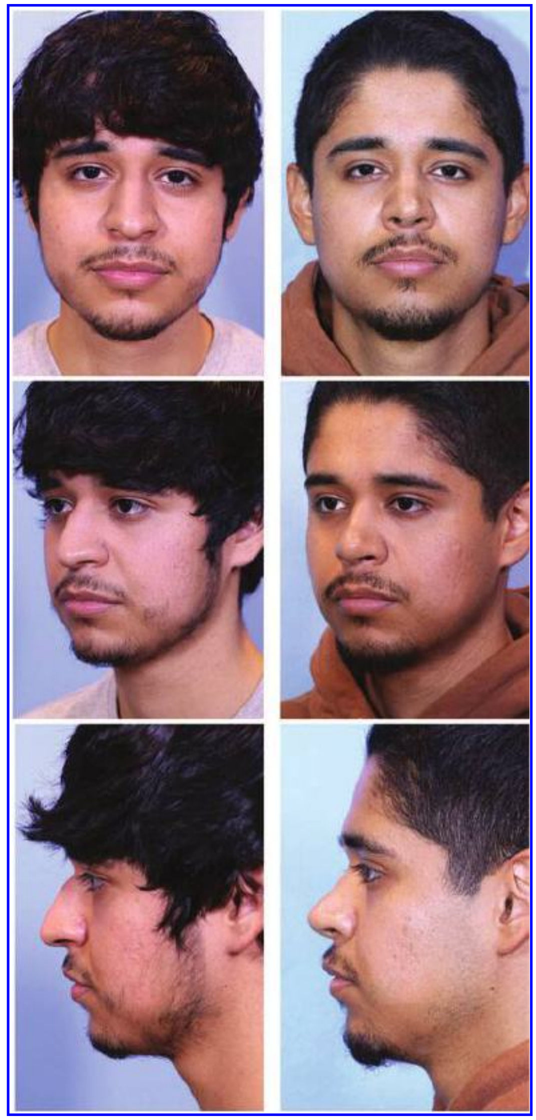

Fig. 3. Before and 1 year after photos of patient who underwent dorsal preservation rhinoplasty with the MSSM technique.

dorsal hump is secured with suture that passes through the upper lateral cartilages over the dorsum. A wedge of septal cartilage or complete transection through the dorsum (tetris modification) at the W-point may need to be performed to alleviate buckling.[10] A narrated video of this technique can be accessed through a previous publication.[19]

The latter technique is a modification of the Cottle method popularized by Kovacevic.[13,14] Incisions are made through the cartilaginous dorsum in a triangular shape with the point oriented inferiorly. The triangle is formed by a vertical releasing incision inferior to the point of maximum dorsal convexity and an oblique incision extending to the W-point. This triangular flap of cartilage is connected to an angled osteotomy made through the perpendicular plate of ethmoid bone and extending to the previously performed transverse osteotomy to achieve a subdorsal Z-flap. The triangle of cartilage is mobilized anteroinferiorly to let down the dorsal hump and is overlapped on one side of the native septum to correct any baseline asymmetry and secured.

In both septal cartilage manipulation techniques, the keystone area remains intact. Once the let down dorsal hump is secured, the dorsum is evaluated to confirm the desired contour is achieved. Inferior septal cartilage is harvested for needed grafts, leaving a one centimeter T strut of septal cartilage caudally and centrally intact for support. Tip work is subsequently performed employing traditional practices. In this study, the authors began with the MSSM and then transitioned to the subdorsal Z-flap technique to allow for greater versatility in addressing large humps and middle vault asymmetries without the need for additional spreader grafts.

Results

Fifty-two patients were included. All patients except one underwent primary rhinoplasty. Data for 41 patients were obtainable postoperatively at 1 month, 33 patients at 3 months, 29 patients at 6 months, and 16 patients at 12 months (Table 1). Statistical significance at each time interval postoperatively was calculated using a paired t-test. A two-sample t-test was used to assess significance between the two surgical techniques.

The majority of patients at all time intervals reported significant improvement in NOSE, SNOT-22, SCHNOS, and ESS scores with the only exception being lack of significant change in ESS scores at 6 and 12 months. Patients with a score of 0 preoperatively that remained unchanged postoperatively were also reported. No significant difference was observed in patient-reported scores between the MSSM and Z-flap techniques utilized. To fully evaluate aesthetic outcomes, the aesthetic components of the SCHNOS score were isolated and analyzed.

Fig. 4. Before and 1 year after photos of patient who underwent dorsal preservation rhinoplasty with the subdorsal Z-flap technique.

The majority of patients at all time intervals reported significant improvement (Table 2).

Discussion

The majority of patients at all time intervals reported improvement on standardized outcome assessments of nasal breathing, nasal aesthetics, and sleepiness with no statistical difference observed between the two surgical techniques employed. Maintenance or improvement of the nasal airway as well as achievement of a favorable aesthetic outcome using the dorsal preservation rhinoplasty technique were validated in this study in line with previous publications. Most and colleagues showed no significant increase in NOSE or SCHNOS scores after cosmetic rhinoplasty using preservation techniques.[20] Other studies have compared different cartilage manipulation techniques but focused on nuances of a specific technique rather than quantitative data on outcomes.[12–14] This study showed no significant difference in functional and aesthetic outcomes between the MSSM and subdorsal Z-flap cartilage manipulation techniques.

The let down dorsal preservation rhinoplasty technique was intentionally utilized instead of the push down technique. Impacting nasal bones into the pyriform aperture as in the push down approach potentiates nasal airway narrowing and the possibly of increased airway obstruction as demonstrated previously by Most in cadaveric studies.[21] However, radiographic studies have shown that both a let down and push down preservation rhinoplasty increase internal nasal valve dimensions, although the let down technique resulted in a greater change.[22,23]

The let down approach removes a wedge of maxillary bone, essentially Webster's triangle, negating the need for impaction and potential airway obstruction. Removing this wedge of bone also prevents medialization of the inferior bony segment that could narrow the airway. Another type of preservation rhinoplasty not included in this study is a resurfacing technique. For patients with smaller dorsal humps and under-rotated tips, only small dorsal changes are needed to achieve the desired aesthetic profile once the tip is elevated. A diamond file attachment on the piezoelectric can be used to reduce the bony cap without violating the keystone.[24,25]

The main appeal of dorsal preservation rhinoplasty compared with traditional structural rhinoplasty is that the keystone area remains intact. This mitigates potential for irregularities at the rhinion and produces a more natural aesthetic result. Traditional component reduction rhinoplasty resects the keystone with removal of the bony cap and dorsal septal cartilage after releasing the upper lateral cartilages from the septum. A significant amount of native tissue is excised and numerous attachment points are violated, necessitating extensive reconstruction and subsequent scarring. Outcomes for a dorsal preservation rhinoplasty are reproducible and more predictable as the scarring process is less of a factor since most structures and attachments are preserved. In addition, no extensive reconstruction of the midvault is required, limiting the need for additional cartilage grafting, typically spreader grafts or dorsal onlay grafts, and suturing.

Dorsal humps and midvault deviations were able to be addressed with a dorsal preservation rhinoplasty. In the senior author's hands, the subdorsal Z-flap technique proved to be more versatile and required less use of additional cartilage grafting compared with the MSSM. The former technique allows for a greater arc of septum movement and ability to achieve a more sloped profile, regardless of the initial dorsal hump magnitude.

Table 1. Study population characteristics and reported percent improvement or maintenance of NOSE, SNOT-22, SCHNOS, and ESS scores with comparison between the modified subdorsal strip method and the subdorsal Z-flap method

Patient characteristics

	All cases	*MSSM*	*Z-flap*
Patients	52	33 (63%)	19 (37%)
Gender			
Male	12 (23%)	5 (15%)	7 (37%)
Female	40 (77%)	28 (85%)	12 (63%)
Age (years)			
Mean	29	28	31
Range	15–69	15–52	17–69
Median	27	27	28

Assessment tool	*% improved + % unchanged*		*Average score* $\Delta \pm SD$	*p**
1 month post-op ($n=41$, MSSM: 29, Z-flap: 12)				
NOSE	61% +5%		-3.2 ± 4.1	0.008
	MSSM: 66% +2%	Z-flap: 50% +0%		0.479
SNOT-22	68% +1%		-8.8 ± 11.3	0.002
	MSSM: 69% +1%	Z-flap: 67% +0%		0.080
SCHNOS	84% +1%		-15.1 ± 8	<0.005
	MSSM: 88% +1%	Z-flap: 75% +2%		0.390
ESS	58% +7%		-1.8 ± 3.2	0.002
	MSSM: 57% +7%	Z-flap: 58% +11%		0.371
3 months post-op ($n=33$, MSSM: 24, Z-flap: 9)				
NOSE	79% +12%		-6.0 ± 2.7	<0.005
	MSSM: 79% +2%	Z-flap: 78% +4%		0.299
SNOT-22	76% +2%		-15.0 ± 9.9	<0.005
	MSSM: 75% +3%	Z-flap: 78% +0%		0.227
SCHNOS	97% +0%		-19.8 ± 4.9	<0.005
	MSSM: 100% +0%	Z-flap: 89% +0%		0.600
ESS	61% +7%		-1.6 ± 3.6	0.012
	MSSM: 54% +8%	Z-flap: 78% +4%		0.181
6 months post-op ($n=29$, MSSM: 20, Z-flap: 9)				
NOSE	69% +10%		-5.7 ± 3.4	<0.005
	MSSM: 70% +1%	Z-flap: 67% +6%		0.767
SNOT-22	76% +1%		-16.4 ± 8.9	<0.005
	MSSM: 75% +1%	Z-flap: 78% +2%		0.609
SCHNOS	96% +0%		-20.9 ± 7.7	<0.005
	MSSM: 100% +0%	Z-flap: 89% +0%		0.900
ESS	72% +4%		-1.6 ± 4.3	0.082
	MSSM: 70% +5%	Z-flap: 78% +0%		0.025
12 months post-op ($n=16$, MSSM: 14, Z-flap: 2)				
NOSE	63% +12%		-4.4 ± 3.2	0.017
	MSSM: 64% +4%	Z-flap: 50% +17%		
SNOT-22	75% +0%		-16.1 ± 9.2	<0.005
	MSSM: 71% +0%	Z-flap: 100% +0%		
SCHNOS	93% +0%		-22.7 ± 9.2	<0.005
	MSSM: 92% +0%	Z-flap: 100% +0%		
ESS	63% +2%		-1.0 ± 4.3	0.245
	MSSM: 71% +2%	Z-flap: 0% +0%		

**p*-Values were calculated using a paired *t*-test and two-sample *t*-test, respectively.

ESS, Epworth Sleepiness Scale; MSSM, modified subdorsal strip method; NOSE, Nose Obstruction Symptom Evaluation; SCHNOS, Standardized Cosmesis and Health Nasal Outcomes Survey; SD, standard deviation; SNOT-22, Sinonasal Outcome Test.

Table 2. Breakdown of SCHNOS functional (Func) and cosmetic (cos) components with reported percent improvement or maintenance of scores

Functional and cosmetic SCHNOS score components

Time post-op		*% improved + % unchanged*	*Average score* $\Delta \pm SD$	*p**
1 month	Func	54% + 7%	-1.8 ± 5.4	0.005
	Cos	87% + 1%	-13.4 ± 4.6	<0.005
3 months	Func	71% + 4%	-5.0 ± 2.5	<0.005
	Cos	94% + 0%	-14.8 ± 3.6	<0.005
6 months	Func	70% + 5%	-5.2 ± 3.5	<0.005
	Cos	96% + 0%	-15.6 ± 4.6	<0.005
12 months	Func	60% + 5%	-5.1 ± 3.4	<0.005
	Cos	93% + 0%	-17.2 ± 6.5	0.005

**p*-Values were calculated using a paired *t*-test.

In addition, midvault deviations are corrected by overlapping the Z-flap triangular cartilage segment onto the remaining native septum on the side opposite of the deviation; no additional grafts are needed. The Z-flap triangular cartilage segment essentially acts as a spreader graft. Conversely, the MSSM has limitations on the dorsal profile that can be achieved. This technique generally produces a straight profile although large dorsal humps can still be corrected using this method. To correct a midvault deviation, the septal strut that is excised to bring down the dorsal hump can be used as a spreader graft. For these reasons, the authors prefer the subdorsal Z-flap technique over the MSSM to manipulate the septum in a preservation rhinoplasty.

Confounding factors that were not controlled for in the analysis include history of seasonal allergies and use of nasal steroid sprays. A confounding factor that was assessed was bilateral inferior turbinate reduction and outfracture. Only 10 patients underwent this additional procedure and all but one endorsed NOSE and SNOT-22 score improvement at all time intervals. No patients reported a diagnosis of obstructive sleep apnea.

Less data are available at each time interval postoperatively due to missed follow-up appointments. Despite the attrition, the functional and aesthetic results are unlikely to change given the significance of current patient-reported improvement across all scales. Although the number of patients is limited, outcomes at 12 months postoperatively were able to be assessed, demonstrating reported improvements are maintained long term as healing continues to progress.

Conclusion

Let down dorsal preservation rhinoplasty with either the MSSM or subdorsal Z-flap cartilage manipulation technique can achieve significant improvement in nasal aesthetics, nasal breathing, and sleep according to patient responses on validated assessment tools recorded up to 1 year postoperatively. The subdorsal Z-flap technique was more versatile and required less use of additional cartilage grafting compared with the MSSM with no significant outcome difference between techniques. Patients undergoing a preservation rhinoplasty should continue to be followed and assessed with questionnaires to evaluate long-term outcomes.

Authors' Contributions

J.E.B. was the primary surgeon for all rhinoplasties. J.M.G. collected data. J.S.L. collected and analyzed the data, drew Figures 1 and 2, and wrote all material in this submission. All authors have reviewed and approved the final submission content.

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Structural Preservation Rhinoplasty: A Hybrid Approach

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Summary: Structural preservation rhinoplasty merges two popular philosophies of rhinoplasty—structure rhinoplasty and preservation rhinoplasty—in an effort to maximize patient outcomes, aesthetics, and function. This allows the surgeon to both preserve the favorable attributes of the nose, and also to structure the nasal tip and dorsum with grafts to maximize contour and support. The concept of dorsal preservation is to preserve favorable dorsal aesthetic lines without the creation of an "open roof." However, the addition of some structure concepts can expand the utility of dorsal preservation in primary rhinoplasty patients. The authors discuss these structure concepts and their applicability to dorsal preservation. (*Plast. Reconstr. Surg.* 149: 1105, 2022.)

Structural preservation rhinoplasty is a combination of two philosophies: (1) dorsal preservation techniques in combination with structural grafting to optimize patient outcomes for the nasal dorsum, and (2) structural grafting techniques to manage the lower third of the nose. Both philosophies have similar underlying principles that center around "optimizing nasal structure" to maximize long-term aesthetic and functional outcomes. These two philosophies initially appeared to be conflicting in nature; however, efforts made by a small group of committed surgeon educators brought the two schools together in 2018.[1] Surgical indications were stressed as technical details improved, and it became clear that certain patients benefit from preservation, certain patients benefit from structure, and certain patients benefit from a hybrid approach. This is true not just for dorsal preservation, but also for the other two components of preservation rhinoplasty: soft-tissue envelope and alar cartilage preservation. A tailored approach seemed more appropriate for each individual patient.

Structure rhinoplasty was first introduced in 1989 by Johnson and Toriumi when *Open Structure Rhinoplasty* was published, describing the use of structural grafting to support the nasal structures by means of the open rhinoplasty approach.[2] This technique initially involved the use of columellar struts and shield tip grafts to shape the nasal tip.[2] A traditional Joseph dorsal resection approach was used to remove the dorsal hump, using spreader grafts to reconstruct the middle nasal vault.[2,3] Structure rhinoplasty evolved over the years with the incorporation of the caudal septal extension graft to support the nasal base, replacing the columellar strut.[4] Shield tip grafting was used less frequently and was replaced with dome suturing with alar rim grafts or lateral crural strut grafting with or without repositioning.[5–10] Nasal tip contouring focused less on narrowing and more on moving shadows into more favorable positions using suture and grafting maneuvers.[7]

The term "preservation rhinoplasty" was coined by Rollin K. Daniel and the philosophy focused on "preservation" of as much of the native nasal structure as possible.[11] The early innovators of the dorsal preservation techniques were Goodale in 1898 and Lothrop in 1914.[12,13] Many would agree that Yves Saban is the primary person responsible for the resurgence of dorsal preservation in this era.[14] Baris Cakir, Aaron Kosins, and Rollin K. Daniel have championed all components of preservation rhinoplasty that include (1) elevation in a subperichondrial/subperiosteal plane with preservation of supporting ligaments,

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(2) preservation of the nasal dorsum to avoid the "open roof"(dorsal preservation), and (3) preservation of the alar cartilages with minimal excision and shaping using sutures.[11,15,16]

In structural preservation rhinoplasty, dorsal preservation techniques are used to manage the upper two-thirds of the nose in appropriate primary rhinoplasty cases, whereas structural cartilage grafting techniques are used to optimize dorsal aesthetic lines (in combination with dorsal preservation) and to structure the nasal tip. Dorsal preservation techniques have the strongest indications for primary rhinoplasty cases with certain anatomical criteria such as a V-shaped dorsal hump, normal radix height, and uncomplicated deviations involving axis deviation.[16] Surface modifications (bony cap removal, trimming upper lateral cartilages, and radix grafting) are well known and can be used to convert primary cases to allow effective execution of dorsal preservation techniques.[17] However, structure techniques such as spreader grafting can be used in some cases that would otherwise not be good candidates for dorsal preservation to expand the indications. Subdorsal septal work can also take on a "structural" concept as directional forces are used to control dorsal contour while treating septal deformities. The following article will discuss patient selection and structural techniques that can be combined with dorsal preservation to expand indications for dorsal preservation. In addition, structural grafting of the nasal tip will be discussed in the context of our dorsal preservation procedure.

PATIENT SELECTION

Traditional dorsal preservation involves (1) removal of a septal strip to release the dorsum from the septum, (2) osteotomies to release the dorsum from the face (foundation methods), and (3) a push-down or let-down of the dorsum to lower the nasal profile and to flatten a dorsal hump. Although this was shown to work well in a subset of patients, certain dorsa can be converted to optimize dorsal aesthetics. The shape of the dorsal convexity is important in selecting good candidates for dorsal preservation techniques. V-shaped dorsal humps have a straight-line configuration from nasion to rhinion, whereas an S-shaped dorsal hump has a distinct angulation from nasion to kyphion (most prominent point of the dorsum) and minimal curvature from kyphion to rhinion[17,18] (Fig. 1). The V-shaped humps are ideal for dorsal preservation, whereas the S-shaped humps may require surface modification to allow adequate flattening, such as reduction of the bony cap, placement of a radix graft, and maximal stretching of the dorsal hump.[16] Cartilage vault modifications, piezoelectric rhinosculpture, and cartilage vault preservation techniques were developed to deal with these issues that mostly occurred in the native nasal bony anatomy such as S-shaped nasal bones, wide nasal bones, nasal bone asymmetries, and a low radix. These techniques largely separated the cartilaginous vault from the nose, with or without the bony cap, and lowered it separately from the nasal bones. The nasal bones were then treated with traditional osteotomies. However, certain issues have still persisted even with these techniques that principally affect the cartilaginous vault of the nose. These include cartilage vault widening and asymmetries, cartilage vault concavities, and caudal septal deformities. Surgical techniques are discussed for the treatment of the above-mentioned surgical problems.

SURGICAL TECHNIQUES

Dorsum

Plane of Dissection

Two planes of dissection have been traditionally used for dissection of the nasal

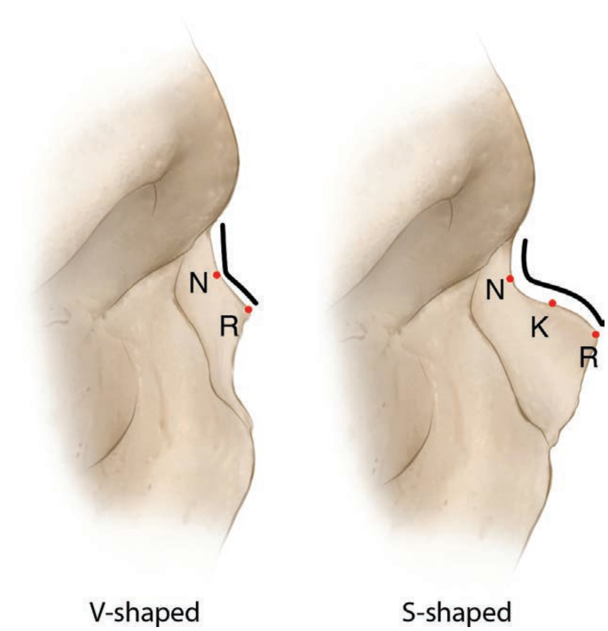

Fig. 1. (*Left*) V-shaped dorsal hump with a straight line from nasion to rhinion. (*Right*) S-shaped hump with curvature from nasion to kyphion. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

dorsum—subperichondrial/subperiosteal and sub–superficial musculoaponeurotic system. Surgeons have the option to dissect in the subperichondrial and subperiosteal tissue planes and to preserve the supporting ligaments (Pitanguy ligament, scroll ligament, and nasomaxillary suture line ligament).[16] Cakir developed this dissection plane using an open approach and converted to a closed approach.[15] The benefits are a thicker and preserved soft-tissue envelope and theoretically less swelling and soft-tissue damage. The authors prefer the subperichondrial/subperiosteal plane even in an open approach. The full open approach can be used if piezosurgery is being used, or a limited dorsal dissection over the nasal dorsum can be used performing the bony work through small stab incisions externally or subdorsally with subperiosteal tunnels laterally.

Septum-Subdorsal Z-Flap Technique for Reducing Dorsal Humps

One of the most important concepts in dorsal preservation is the lowering and flattening of the dorsal hump using caudal/posterior forces at a pivot point on the undersurface of the dorsal convexity. With the high septal strip technique as advocated by Saban, the hump is lowered and flattened as the osseocartilaginous vault relaxes in a posterior direction. With the low septal strip techniques, a septal rotation-advancement flap is "pulled" posteriorly and caudally to flatten the hump. The use of this particular maneuver is most helpful in cases with larger or S-shaped dorsal humps where maximal flattening is needed. Dorsal preservation techniques that have powerful stretching capability include the Cottle technique, Finocchi's simplified preservation quick rhinoplasty, Neves' segmental preservation rhinoplasty technique (Tetris concept), and others.[16,19–21] What these techniques have in common is the firm, "structural" connection of subdorsal septal cartilage to the undersurface of the dorsal hump to allow the hump to be pulled posterior and caudally to stretch it flat. These are "structural" forces that are acting on the undersurface of the dorsal prominence to flatten the dorsal hump.

The "subdorsal Z-flap" technique was introduced by Milos Kovacevic to stretch and flatten the dorsal hump. This dorsal preservation technique incorporates a subdorsal triangle-shaped attachment to the undersurface of the dorsal hump to allow for posterior and caudal traction on the middle vault[22] (Fig. 2). [**See Video 1 (online)**, which demonstrates the subdorsal Z-flap.] This is a simplified form of the classic Cottle technique, which incorporates the entire cartilaginous septum as a reverse Z-flap (as opposed to a simplified subdorsal Z-flap). After exposure is complete, a needle is placed exactly on the top of the keystone area, and the subdorsal cuts are made. The first cut goes from the keystone area approximately 7 to 10 mm posteriorly into the septum, and the second cut moves caudally, creating a triangle toward the supratip. Whether or not the caudal extension reaches the W-point depends on whether the supratip needs to be lowered. Now that the subdorsal triangle can be moved out of the way, a third cut is made under the cranial dorsum underneath the nasal bones up to the area of the proposed radix osteotomy. We leave a 2- to 3-mm strip of cartilage below the cartilaginous midvault to prevent deformation of the middle vault. One should avoid leaving cartilage and/or bone below the bony pyramid, as this can frequently act as a blocking point that can result in a recurrent hump. This cartilage and/or bone can be removed with a Takahashi or Blakesley forceps or with the Piezotome (Acteon, Mount Laurel, N.J.) if available.

Once the osteotomies are completed (as detailed below), a strip of cartilage is removed from below the triangle to allow posterior and caudal movement. Depending on the shape and extent cranially of the hump, a strip of cartilage and possibly some bone are then removed from below the upper dorsum extending to the radix osteotomy. The benefit of the subdorsal Z-flap lies in the ability to stretch flat the dorsal hump and allow for significant cartilage harvest below the triangle still leaving a 1-cm strut of dorsal support (Fig. 3). In addition, the triangular shape helps to prevent drop of the dorsum in the supratip area.

It is important to note that Goksel advocates the lateral keystone release (ballerina maneuver) to allow proper stretching and flattening of the dorsal hump. This maneuver can be performed sharply with a no. 15 blade or sharp scissors, allowing release of the bony attachment to the upper lateral cartilages[16] (Fig. 4). We believe this is particularly important in patients with larger dorsal humps and deviated noses. Once the hump is allowed to lower and flatten, incremental strips of cartilage can be removed from below the triangle to further lower the dorsum.

Osteotomies

The osteotomies are performed only after the initial septal cuts to release the septum from the osseocartilaginous vault are executed. This is necessary to avoid excessive forces applied

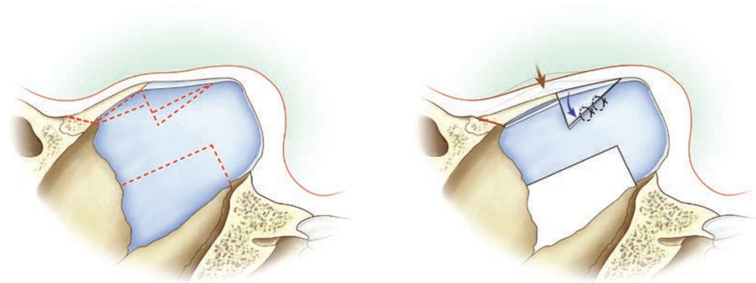

Fig. 2. Subdorsal Z-flap technique in the straight nose. (*Left*) Subdorsal Z-flap is indicated by the *dotted red line*. Also noted is the extension of the subdorsal cut to meet the oblique radix osteotomy. A segment of cartilage is removed from below the subdorsal Z-flap. (*Right*) The Z-flap is pulled inferior and caudally and fixated with two 4-0 polydioxanone sutures. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

to the ethmoid bone at the skull base. For the bony work, our preference is the let-down over the push-down to remove any potential blocking points such as Webster's triangle. A strip of bone is removed at the site of the lateral osteotomies, and bilateral transverse osteotomies are finally connected to an obliquely oriented radix osteotomy (Fig. 5). [**See Video 2 (online)**, which demonstrates bone cuts for let-down.] Once the osseocartilaginous vault has been released from the face, the pyramid can be lifted with a long speculum and any excess cranial part of the remaining strip is removed under direct vision. This maneuver allows for incremental reduction of the cephalic part of the hump and also prevents axis shift postoperatively, which can occur if the subdorsal remnant shifts off midline. Using these techniques, Kovacevic observed no hump recurrences in 57 consecutive cases over a 6-month period.

As stated above, a full open approach is used over the osseocartilaginous vault or a limited dorsal dissection combined with a lateral dissection along the ascending process of the maxilla to provide exposure. With the full open approach, the Piezotome is used to remove bone strips bilaterally to perform a let-down maneuver. When a limited lateral dissection is used, a bone rongeur is introduced through lateral endonasal incisions. Transverse osteotomies can be performed with a 2-mm osteotome or Piezotome or through small percutaneous stab incisions. Likewise, the radix osteotomy can be performed with a 2-mm osteotome through a small stab incision from above or from below the bony vault, or with the Piezotome. The bone cuts are created to allow full release of the bony vault and allow a let-down maneuver to reduce the bony hump. If the bony vault has an axis deviation, a bone strip is removed on the side opposite the deviation of the bone and a conventional osteotomy is executed on the side of the deviation (Fig. 6). This will allow the bony vault to tilt back to the midline.

Fixation

Once the dorsum has been released from the face with osteotomies and is allowed to descend, a forceps is used to stretch and flatten the hump longitudinally. Incremental strips of cartilage are removed from underneath the triangle caudally and underneath the bone cephalically to further lower the dorsum. The dorsal keystone is in essence a "joint" that can be flexed by pulling down posteriorly and caudally on the undersurface of the hump. With the firm grip provided by the subdorsal Z-flap in combination with the let-down bone cuts and lateral keystone area release, maximal stretching and flattening of the dorsal hump is possible. Finally, fixation is performed with one or two sutures of 4-0 polydioxanone attaching the triangle down to the remaining septal strut.

If there is an axis deviation of the nasal dorsum, the subdorsal triangle can be overlapped to the contralateral side of the underlying septal strut to allow straightening of the dorsum. Instead of excising the cartilage, the triangle is overlapped and sutured, giving maximal strength to the repair (Fig. 7). This overlapped fixation provides maximal "structural" support to prevent hump recurrence in addition to straightening the nose (Fig. 8).

Fig. 3. Patient with V-shaped dorsal hump and deviation to the right treated using overlapping subdorsal Z-flap. Lateral crural strut grafts with dome sutures (no repositioning) were placed to flatten the lateral crura. (*Left*) Preoperative frontal, lateral, and base views. (*Right*) One-year postoperative frontal, lateral, and base views.

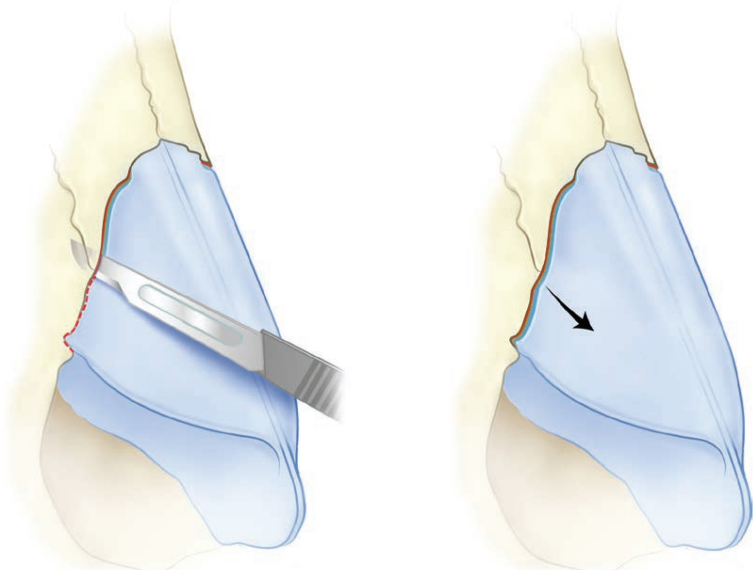

Fig. 4. Lateral keystone release. (*Left*) A knife or sharp scissors are used to release the upper lateral cartilage from nasal bone laterally. (*Right*) This allows the upper lateral cartilage to release caudally and stretch the hump flat. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

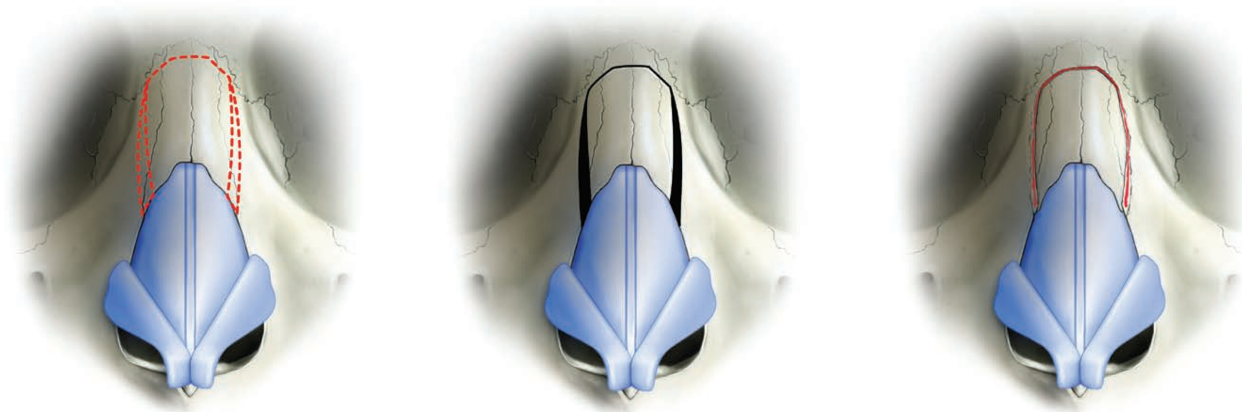

Fig. 5. Osteotomy and bone cuts for let-down. (*Left*) *Red lines* indicate path of bilateral bone strip excision, transverse osteotomies, and radix osteotomies. (*Center*) Osteotomies completed. (*Right*) Gaps closed and hump reduced. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

EXPANDING DORSAL PRESERVATION TECHNIQUES WITH STRUCTURAL MODIFICATIONS

One of the key aspects of this article is to provide the reader with "structural" surgical techniques to expand the indications of dorsal preservation to cases that otherwise would be poor candidates.

Segmental Spreader Flaps

One major limitation of dorsal preservation is a wide cartilaginous vault or prominent upper lateral cartilage "horns," particularly when a subperichondrial dissection is used and/or with removal of the bony cap. Often, the bony cap is convex, and this will not flatten by simply removing a subdorsal strip of septal cartilage and lowering the osseocartilaginous vault. The bony convexity can be rasped or reduced using the Piezotome to decrease some of the curved component of the convexity. These are "surface" techniques of dorsal preservation as described by Ferreira et al., Gerbault et al., Zholtikov et al., and others.[23–26] It

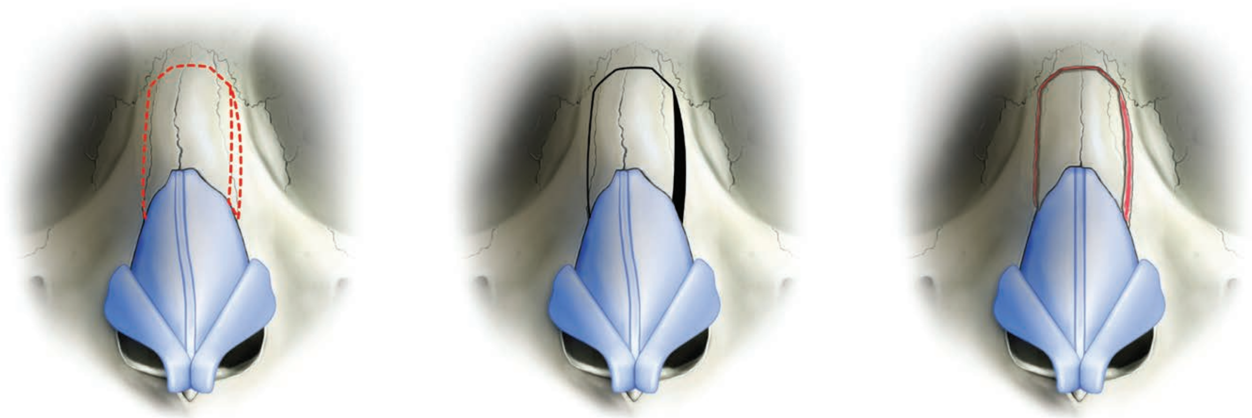

Fig. 6. Osteotomy bone cuts for deviated nasal dorsum. (*Left*) Deviated nasal dorsum requiring bone strip on side opposite the deviation and lateral osteotomy on side of deviation. (*Center*) Bone cuts completed. (*Right*) bony vault tilts back to midline. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Vide*os. St. Louis: Quality Medical Publishing; 2021.)

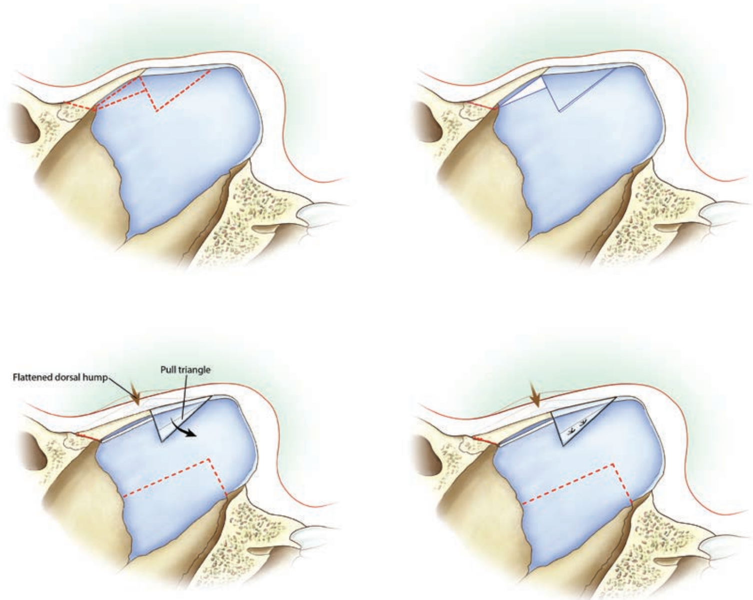

Fig. 7. Subdorsal Z-flap for deviated nose. (*Above*, *left*) Proposed septal cuts. (*Above*, *right*) Z-flap incised with vertical limb at rhinion. (*Below*, *left*) Subdorsal triangle pulled inferior and caudal to stretch hump flat. (*Below*, *right*) Subdorsal triangle overlapped on side opposite deviation and sutured into place. (Reprinted with permission from Toriumi DM, Davis RE. Marina *Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

is preferable to avoid removing the entire bony layer of the hump; otherwise, Y-shaped rhinion horns may protrude up, recreating the hump or causing dorsal irregularity in thin-skinned patients.[16,17] The rhinion horns can be trimmed without opening the mucosa in thicker skinned patients. In patients with thin skin or a wide nose, one can perform "segmental spreader flaps" to turn in the prominent area of the upper lateral cartilages to reduce the rhinion horns and/or to narrow a wide middle vault.[27] The upper lateral cartilages at the site of the rhinion horns or wide middle vault are divided from the dorsal septum, rolled in, and sutured to the dorsal septum

Fig. 8. Patient with deviated nose to the left and S-shaped dorsal hump. The patient was treated with removal of bone strip on left and conventional lateral osteotomy on the right to tilt the bony vault to the midline. Subdorsal Z-flap overlapped on the left as well. Lateral crural strut grafts and dome sutures for her tip (no repositioning). (*Left*) Preoperative frontal, lateral, and base views. (*Right*) One-year postoperative frontal, lateral, and base views.

to flatten the prominence (Fig. 9). [**See Video 3 (online)**, which demonstrates segmental spreader flaps.] A perichondrial flap can be sutured over the top of the spreader flaps to secure the width and positioning of the segmental spreader flaps.

Submucosal Spreader Grafts

In many primary rhinoplasties, there are some anatomical features that do not lend themselves to dorsal preservation techniques. Kosins and Daniel popularized cartilage vault modification techniques that can be used to transform many suboptimal primary cases into appropriate candidates for dorsal preservation.[28] These maneuvers include bony cap resection, trimming the upper lateral cartilage shoulders without opening the mucosa, radix grafting, and placing spreader grafts concurrent with dorsal preservation.[16,17] Our preference for placing spreader grafts when performing dorsal preservation techniques is to place "submucosal spreader grafts," that are positioned under the mucosal layer of the upper lateral cartilage, or in a tunnel along the superior aspect of the septum where an area of mucosa is left intact/attached to the septum.[10]

Treating Concavity

Submucosal spreader grafts can be placed at sites of asymmetries of the upper lateral cartilages to correct unilateral concavities and allow execution of dorsal preservation techniques in primary patients who would otherwise be poor candidates. In patients where there is a unilateral concavity of the middle vault with one upper lateral cartilage positioned inferomedially, 5 to 8 mm of mucosa is left attached high on the septum during the septal dissection. A narrow subperichondrial tunnel is created separately from the septal dissection using a narrow Cottle elevator (Fig. 10). [**See Video 4 (online)**, which demonstrates submucosal spreader grafts.] A key point is that the tunnel for the spreader graft is positioned at the junction between the upper lateral cartilage and dorsal septum, and not solely against the septum. As the Cottle elevator is advanced into the

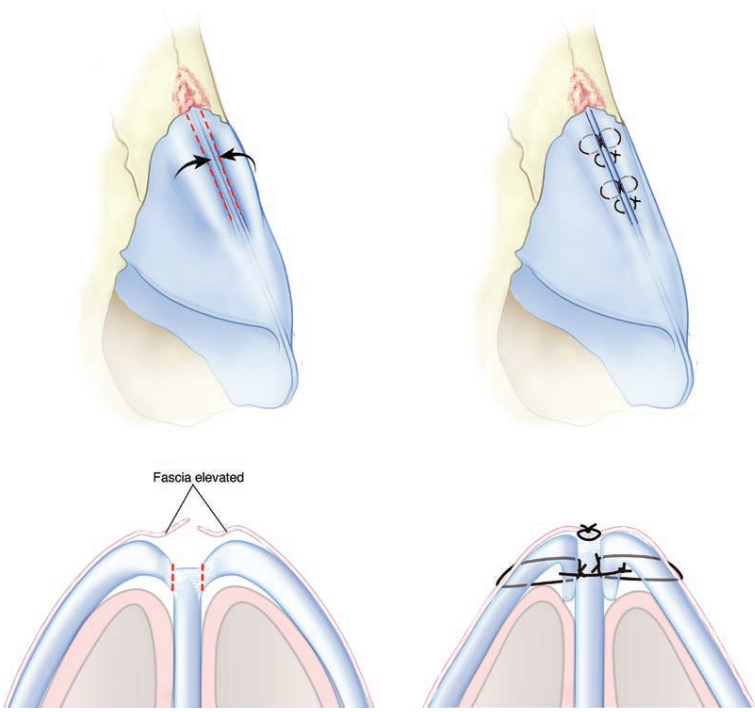

Fig. 9. Segmental spreader flaps. (*Above*, *left*) Wide middle nasal vault. *Dotted lines* indicate planned incisions. (*Below*, *left*) Perichondrial flap elevated off of the middle vault. (*Above*, *right*) Spreader flaps turned in and sutured with 5-0 polydioxanone sutures. (*Below*, *right*) Spreader flaps sutured to dorsal septum narrowing middle vault. Perichondrium sutured over the top of the middle vault. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing, 2021.)

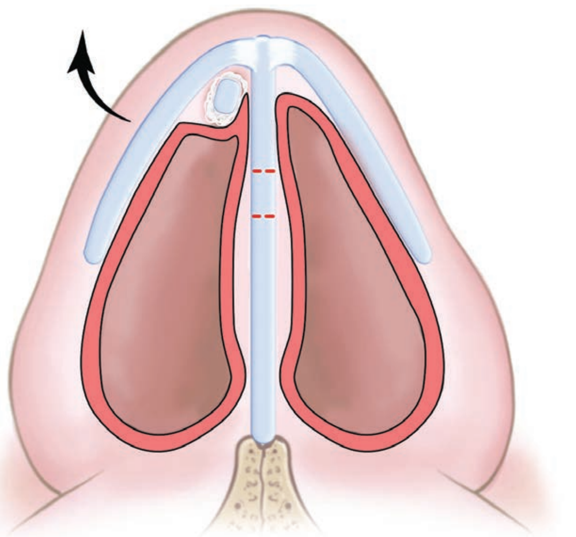

Fig. 10. Submucosal spreader graft placed unilaterally to correct concavity. Note the mucoperichondrium left attached around the spreader graft. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

subperichondrial tunnel, it must be gently rotated to allow the instrument to slide over the cartilage and not cut through the cartilage. The end of the spreader graft should be beveled to allow easy passage into the tunnel. Most spreader grafts are 2 to 3 mm in thickness and should span the area of concavity. As the spreader graft passes into the tunnel, one will note the lateralization of the upper lateral cartilages. A 6-0 Monocryl (Ethicon, Inc., Somerville, N.J.) suture can be placed caudally to fix the graft into position. One advantage of the Z-flap over a high septal strip procedure is the ability to place these grafts without having to release the upper lateral cartilages. The graft can span the entire length of the Z-flap (Fig. 11). It should be noted that with larger humps, asymmetries of the dorsum can occur if a unilateral spreader graft is placed and the hump is flattened. For this reason, unilateral spreader grafts should only be placed when smaller humps are reduced to avoid deformity (Fig. 12).

Treating a Narrow Cartilaginous Vault

Bilateral spreader grafts can be placed to widen an overly narrow middle vault by making bilateral submucosal tunnels under the medial margin of the upper lateral cartilages as they meet the dorsal septum. In this case, bilateral mucoperichondrial flaps are elevated off of the septum, leaving mucosa attached to the upper 5 mm of the dorsal septum as it meets the upper lateral cartilages. If this method is used to place bilateral spreader grafts, a subdorsal Z-flap, modified Ishida intermediate strip, and other dorsal preservation techniques can be used to flatten the hump (Fig. 13).[29] Patel et al. describe a similar lower strip excision that allows for placement of spreader grafts bilaterally as well.[30]

Extended Spreader Grafts

Submucosal spreader grafts can be left longer to extend beyond the anterior septal angle to stabilize an end-to-end septal extension graft. The extended spreader grafts can also straighten slight deviations or deformities of the caudal septum.

Extension Grafted Cottle Rotation-Advancement Flap

The extension grafted Cottle rotation-advancement flap is a dorsal preservation technique that incorporates a caudal septal reconstruction into the Cottle rotation flap for the treatment of patients with severe caudal fractures of the septum. In 1994, Toriumi published the subtotal septal reconstruction technique, where segments of the septum are excised, and the L-shaped septal strut is reconstructed.[31] In this operation, a dorsal remnant is left attached to the ethmoid bone and the remainder of the cartilaginous septum is removed, followed by reconstructing the L-strut. The extension grafted Cottle rotation flap allows for caudal septal reconstruction in patients with a fractured or severely deviated caudal septum, while also performing dorsal preservation.[22]

Unlike our traditional Z-flap, this technique must be combined with a full release of the quadrangular cartilage, not just a triangle. Initially, a complete reverse Z is cut in the septum (Cottle procedure) releasing it from the ethmoid bone, vomer, and maxillary crest, including the nasal spine. Some septal cartilage is left on the vomer, ethmoid, and posterior maxillary crest to allow harvesting septal cartilage for a septal extension graft. The cartilaginous flap is left attached to the undersurface of the middle vault cartilages and the flap is rotated caudally and posteriorly to stretch and flatten the dorsal hump. The fractured or deviated segment of the caudal septum is excised, shortening the cephalocaudal septal length. Then, the posterocaudal corner of the septal flap is fixed into a notch made in the nasal spine with two 4-0 polydioxanone sutures. In addition, a notch can be made along the inferior margin of the septal flap to allow the septum to sit firmly in the spine and not shift cranially (Fig. 14). To maximize caudal support and open the nasolabial

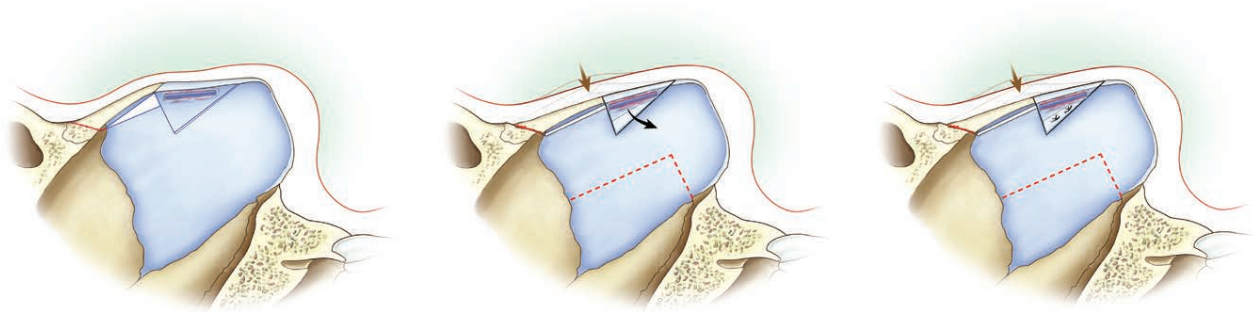

Fig. 11. Submucosal spreader grafts are placed along the base of the subdorsal Z-flap. (*Left*) Note positioning of spreader grafts at junction between upper lateral cartilage and dorsal septum. (*Center*) After Z-flap rotated with graft in place. (*Right*) Z-flap sutured into position overlapping on the right side of the septum. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

angle, the notch can be placed in front of the nasal spine to prevent cranial displacement. If the nasal spine is off midline, it can be fractured back to the midline with a 5-mm straight osteotome.[10] The fixation to the nasal spine is critical and must be stable to avoid loss of dorsal septal support.

To reconstitute appropriate septal length, a caudal septal extension graft is sutured end-to-end and fixed with slivers of cartilage or vomer bone to stabilize the reconstruction and to extend the caudal dimension of the septal flap. The size and shape of the extension graft is based on the need for projection, rotation, and/or nasal length. The septal cartilage for the extension graft is either the repurposed segment that was removed caudally or a segment that can be harvested from the posterior inferior septum. Using this technique, a dorsal hump can be corrected in addition to reconstructing a severely deviated caudal septum (Fig. 15). [**See Video 5 (online)**, which demonstrates an extension grafted Cottle rotation-advancement flap. This is a video of the patient in Fig. 15.]

Key points with this technique are to initially assess the amount of harvestable septal cartilage that is available. If only small amounts of harvestable septal cartilage are available, one may need to harvest costal or auricular cartilage to complete the reconstruction. One can estimate the size of the extension graft needed based on the fractured segment. It should be noted that some vomerine bone can be harvested and thinned out to use in the reconstruction. This bone can be used to help fixate the caudal septal extension graft to the caudal end of the septal flap. There should be minimal tension on the septal flap when transposed to minimize any bending or deformity. The medial crura are then sutured to the caudal septal extension graft in a "tongue-in-groove" fashion to set nasal tip position. Care must be taken to ensure adequate nasal length and to avoid overrotation of the nasal tip. A medial crural footplate suture should be placed to maximize stability of the base of the nose.[10]

One of advantages of this technique is that the nose can be straightened without performing a subtotal septal reconstruction. In the past, we would have removed the caudal septum and reconstructed with extended spreader grafts and a caudal septal replacement graft. This would likely have required going to the ear or rib to have adequate cartilage to complete the reconstruction. The advantage of the Cottle technique is that by releasing the septum from the nasal spine, maxillary crest, vomer, and ethmoid, the forces on the septum are allowed to relax and straighten. By leaving the middle vault intact, the need for spreader grafts is eliminated, allowing this operation to be performed using the patient's existing septal cartilage. The authors believe this to be a significant advantage of this technique.

SURGICAL TECHNIQUES: TIP

Plane of Dissection

As originally championed by Cakir in a closed approach, and later Kosins in a full open approach, surgeons have the option to dissect in the subperichondrial and subperiosteal tissue planes and to preserve the supporting ligaments (Pitanguy ligament, scroll ligament, and nasomaxillary suture line ligament).[16] By using a subperichondrial dissection over the lateral crura, surgeons should be aware that surface tension, especially of thin cartilage, can be altered. As a consequence, the lower lateral cartilage may lose its elasticity and can fracture or deform when tip sutures are used. This can leave visible bossae in patients with thin skin.

Fig. 12. Patient with a deviated nose and concave right upper lateral cartilage. She underwent placement of a unilateral submucosal spreader graft to correct the concavity. (*Left*) Preoperative frontal, lateral, and base views. (*Right*) One-year postoperative frontal, lateral, and base views showing improved dorsal aesthetic lines.

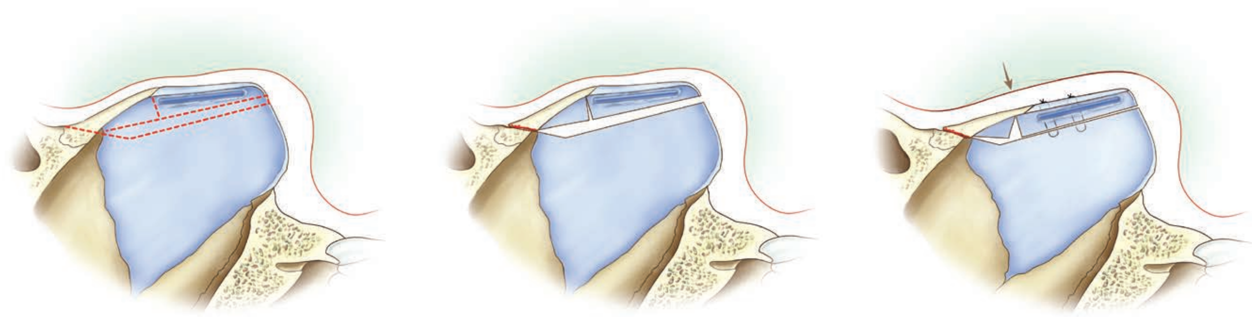

Fig. 13. Submucosal spreader grafts placed high on the septum in the submucoperichondrial tunnel above intermediate level Ishida type septal strip. (*Left*) Note the position of spreader graft above the septal cut. (*Center*) Note vertical releasing incision to allow stretching. (*Right*) Hump reduced, stretched flat, and sutured into position. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

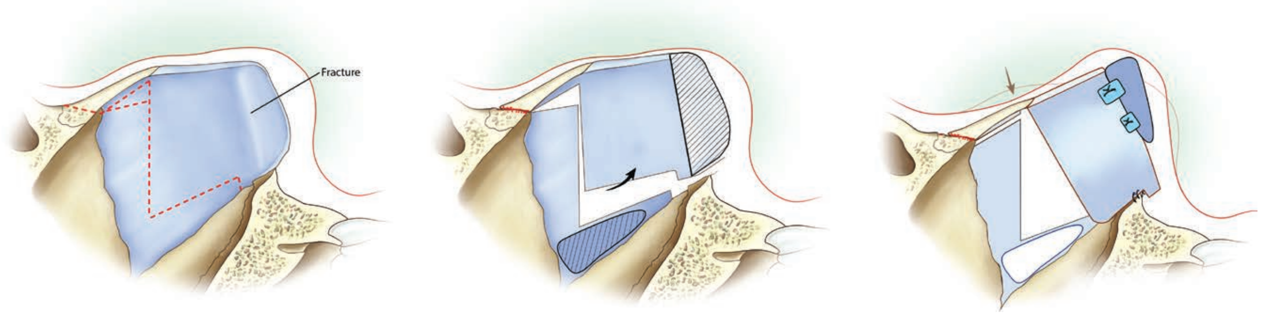

Fig. 14. Extension grafted Cottle rotation-advancement flap. (*Left*) Reverse Z-shaped septal flap with planned septal incisions. (*Center*) Septal cuts made and rotation of septal flap with resection of the deviated/fractured caudal septal segment. (*Right*) The caudal septal extension graft is used to extend the length of the septum after deformed caudal septum has been excised. Note the notched base of the septal flap caudal to the nasal spine to prevent cranial displacement of the fixation point. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

In the case where the surgeon may dissect the vestibular skin off of the undersurface of the lateral crura (e.g., when performing lateral crural strut grafts), we recommend dissecting over the lateral crura in a supraperichondrial plane to keep perichondrium on one surface of the lateral crura. Perichondrium should be left on at least one surface to ensure adequate support and vasculature to the cartilage. We will frequently dissect supraperichondrially over the tip and then in a subperichondrial and subperiosteal plane for the nasal dorsum. The ultimate choice for plane of dissection of the nasal tip depends on the strength of the cartilage and the need for vestibular mucosal dissection.

Structure Tip Techniques

With structural preservation rhinoplasty, structural grafting techniques are used to treat the lower third of the nose. We have already discussed how structural grafting maneuvers can be used to enhance dorsal preservation techniques (extension grafted Cottle rotation-advancement flap and submucosal spreader grafts). The most important structural graft used in the lower third of the nose is the caudal septal extension graft.[4,7,10] The caudal septal extension graft provides maximal tip support to aid in setting tip position and preventing postoperative loss of tip projection. In most cases, we prefer an end-to-end placement of the caudal septal extension graft stabilized with extended submucosal spreader grafts, slivers of cartilage, or ethmoid bone. When performing dorsal preservation techniques, torque can be placed on the caudal septum, resulting in deviation or curvature of the caudal septum. In these cases, an overlapping caudal septal extension graft can be used to straighten, support, and set midline tip position.

Our preference for managing the tip cartilages is a progressive approach starting with obliquely

Fig. 15. Patient with severely deviated nose with large dorsal hump and severe caudal septal deviation. Treated with extension grafted Cottle rotation-advancement flap. (*Left*) Preoperative frontal, lateral, and base views. (*Right*) One-year postoperative frontal, lateral, and base views.

oriented domes sutures or cranial tip sutures.[7,10,32] Alar rim grafts with or without articulation can support the junction between tip lobule and alar lobule and promote favorable tip shadowing.[6,7,10,33] With cephalically oriented lateral crura, and asymmetric and/or overprojected tip cartilages, we will frequently use lateral crural release, placement of lateral crural strut grafts, and repositioning.[7,10,34,35] Shield tip grafts have particular utility in patients with an underprojected tip with thicker skin.[7,10,34]

At the end of the procedure, one may wish to reattach the Pitanguy ligament to the anterior septal angle to reset the position of the supratip skin.[18,27] Proper realignment of the Pitanguy ligament may not be possible if the nasal tip is lengthened, shortened, rotated, or counterrotated.[22] It is also possible to reattach the scroll ligaments.[27,36] The significance of this maneuver is not clear; however, it is likely beneficial to decrease dead space, to preserve the vestibular valve, and to decrease the chance of cephalic displacement of the lateral crura during the healing process.

CONCLUSIONS

With the incorporation of dorsal preservation techniques into our practices, the need for middle vault reconstruction and dorsal camouflage has decreased dramatically in primary rhinoplasties. This provides more cartilage for other grafts such as the caudal septal extension graft, alar rim grafts, and/or lateral crural strut grafts. Use of submucosal spreader grafts in select situations has expanded the indications for dorsal preservation techniques in primary rhinoplasty. This shift to dorsal preservation has almost completely eliminated the need to harvest ear or rib cartilage or fascia in primary rhinoplasty patients. We believe the advantages of dorsal preservation over the Joseph method include the following: (1) preserving the favorable attributes of the nose on frontal view; (2) decreased need for spreader grafts and spreader flaps (no need for middle vault reconstruction); (3) decreased number of cartilage grafts used; and (4) more rapid healing of the upper two-thirds of the nose. From an aesthetic point of view, we believe there is less likelihood of creating excessive width or collapse of the middle vault and nasal bone deformities.

Structural preservation rhinoplasty is a hybrid approach to the primary rhinoplasty patient. Dorsal preservation allows maintenance of the favorable features of the nasal dorsum with the potential for surface modifications if needed. Structure rhinoplasty techniques can be used in the lower third of the nose for both stability and long-term lateral wall support to maximize nasal function.[10,34,35] Eliminating the resection of the roof of the bony dorsum and cartilaginous midvault removes the potential for long-term issues with dorsal irregularity or progressive narrowing (inverted-V deformity) over time. In addition, the possibility of creating excessive width with spreader grafts is no longer an issue. Structural preservation rhinoplasty will likely continue to evolve as more surgeons embrace this hybrid approach to primary rhinoplasty.

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PATIENT CONSENT

Patients provided written informed consent for the use of their images.

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The Blocking Points: The Keys to Consistent Success in Preservation Rhinoplasty

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PATIENT SAFETY

Summary: Preservation rhinoplasty is a growing area of interest among rhinoplasty surgeons. Dorsal preservation—a tenet of preservation rhinoplasty—is predicated on maintaining the integrity of the nasal midvault and effecting aesthetic change through alterations to the bony nasal pyramid and underlying septum. A challenge that is unique to dorsal preservation is the phenomenon of hump recurrence, because of the existence of anatomical blocking points. Blocking points are resistant tensile forces that either impede dorsal lowering intraoperatively or push the dorsum back to its native convexity over time. Five anatomical blocking points have previously been described, which the authors expand on and include an additional two. The seven anatomical blocking points are as follows: the cartilaginous septum, the perpendicular plate of the ethmoid, the lateral osteotomy site, the Webster triangle, the internal mucoperiosteum of the maxillary bone, the medial canthal ligament, and the lateral keystone area. It is critical that the surgeon be aware of the particular blocking points relevant to his or her chosen technique, and to appropriately and methodically address them to ensure consistent long-term results. *(Plast. Reconstr. Surg.* 153: 922e, 2024.)

Preservation rhinoplasty is an evolving topic that is gaining increasing momentum among surgeons around the world. The term preservation rhinoplasty encompasses three general principles that can be performed in varying degrees: preservation of the soft-tissue envelope and nasal ligamentous-like structures, using tip-shaping techniques that preserve the native alar cartilages, and reshaping the dorsum without necessarily disarticulating the cartilaginous midvault—thus avoiding the creation of an open roof deformity and subsequent need for middle vault reconstruction.[1] This third tenet, more specifically termed dorsal preservation, has been a fervent area of attention in the preservation rhinoplasty community.

Dorsal preservation rhinoplasty (DPR) hinges on the concept that the keystone area (K-area) is not a rigid structure, but instead functions as an osseocartilaginous joint.[2] By mobilizing and extending this joint, dorsal convexities can be reduced without having to disarticulate the cartilaginous midvault. For this to be accomplished, the underlying septum and the proximal nasal pyramid must be modified to permit lowering of the dorsum into its ideal position. Options for modification of the septum are numerous, and include simple strip excisions such as the high septal strip popularized by Gola et al. and Saban et al., to more complex derivations that use geometric resections or elements of advancement and rotation, such as the mid septal strip/subdorsal flap techniques described by Neves et al. (the tetris concept), Kovacevik et al. (subdorsal Z-flap), and Most, and the low septal strip techniques first described by Cottle and Loring and later modified by Finocchi et al.[2–9] Recently, the first author introduced the concept of bony dorsal preservation, whereby the entire osseocartilaginous vault is lowered independent of the

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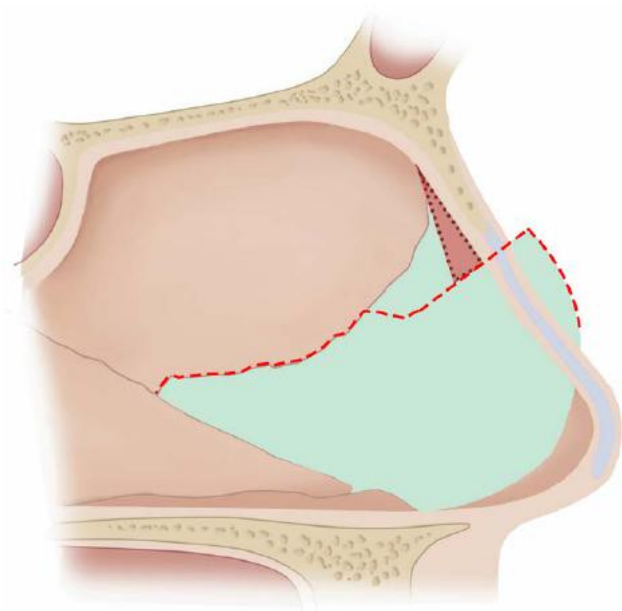

Fig. 1. Goksel bony dorsal preservation. The osseocartilaginous vault has been detached from the underlying septum and lowered independently.

Table 1. Preservation Rhinoplasty Indications According to Septal Technique

Septal Technique	Indications
High septal strip approach	• Dorsal hump ≤4 mm • Hump is mostly cartilaginous • High radix • V-shaped nasal bones • High septal deviation • Midline caudal septum • Straight noses • Tension noses
Mid septal strip/ subdorsal flap approach	• Same as HSS • Slightly deviated nose with straight dorsal aesthetic lines
Low septal strip approach	• Same as HSS • Deviated nose with straight dorsal aesthetic lines • Cases of disease along the connection of the anterior nasal spine and maxillary crest with the septal cartilage
Bony dorsal preservation	• Same as HSS • Deviated nose with straight dorsal aesthetic lines, where there is no disease at the septal base

HSS, high septal strip.

septum, which has been temporarily detached from the upper lateral cartilages (ULCs) but remains firmly anchored to the septal base (Fig. 1).[10] Patients best suited for DPR are those with tension-type or crooked noses with parallel dorsal aesthetic lines. Indications for the various preservation septal approaches are summarized in Table 1.

Techniques for dealing with the nasal pyramid entail complete mobilization, with combined lateral, transverse, and radix osteotomies—termed "impaction" techniques—or techniques that convert the bony hump into a cartilaginous one by means of ostectomy of the cap, described by Ferreira et al. as the spare roof technique.[11] The two primary impaction techniques are the push-down, whereby the nasal pyramid is depressed into the pyriform aperture, and the let-down, which involves ostectomies at the ascending process of the maxilla (Fig. 2).

Regardless of technique, a challenge that is unique to DPR is the phenomenon of hump recurrence, because of the "spring effect," whereby persistent tensile forces push the dorsum back to its native convexity over time.[12] Contrary to structural rhinoplasty, in DPR the hump is not being directly excised, but instead flattened through mobilization, expansion, and reshaping. Maintenance of the new dorsal profile is reliant on overcoming resistance forces, such as tissue memory and overlapped or impacted bone fragments. These resistance forces, or anatomical blocking points, can sabotage outcomes and lead to hump recurrence.[13] Five anatomical blocking points were initially described,[13,14] which have now been expanded to include an additional two, and are expounded on further in this article. These have been derived from the senior author's (A.G.) extensive experience performing DPR and conducting anatomical studies over his career, and the corroborating reports of other international experts in this field.[6,9,13,15,16] The seven anatomical blocking points in DPR and their respective solutions are summarized in Table 2. Long-term maintenance of the dorsum in its new position is predicated on the release of these relevant blocking points and the secure fixation of the dorsum in its new position. Although residual or recurrent humps do not affect the majority of cases, they are the most common complication associated with DPR. The authors' goal is to arm the surgeon with a thorough knowledge of the key potential blocking points and offer practical solutions to enable a more stable, lasting surgical outcome.

ANATOMICAL BLOCKING POINTS

Cartilaginous Septum

Regardless of which technique the surgeon chooses, lowering of the cartilaginous dorsum is dependent on the sufficient reduction and release

Fig. 2. Bony vault mobilization techniques. Push-down technique (*left*). Low-to-low piezo-osteotomy placed on the nasofacial groove in preparation for a push down of the nasal pyramid into the pyriform aperture. Let-down technique (*right*). Ostectomy of a strip of bone along the nasofacial groove to allow for descent of the nasal pyramid.

Table 2. Anatomical Blocking Points and Their Solutions

Blocking Point	Solution
Remnant subdorsal cartilage at the K-area (in high septal strip technique)	Make vertical cuts in the remnant subdorsal cartilage
PPE and bony spicules	Address the PPE where appropriate and remove all bony spicules
Thick overlapped lateral osteotomy edges in push-down method	Osteotomies in the sagittal plane
Webster triangle	Excise the Webster triangle or use let-down method
Mucoperiosteal resistance with push-down method	Elevate mucoperiosteum of the inner surface of the maxilla
Medial canthal ligament	Release attachment to nasal bone (only if wish to lower height of radix)
Lateral keystone	Lateral keystone release (ballerina maneuver)

PPE, perpendicular plate of ethmoid.

of the underlying septum. Thus, it is crucial that the septal cuts are clean and precise, taking care to remove any septal remnants within the planned resection area that could block reduction by causing premature contact of the new septal edges. When using techniques that can potentially leave an intact strut of cartilage beneath the dorsum, the inherent tension within that remnant subdorsal cartilage must be released to enable the necessary dorsal mobility. For example, in the high septal strip technique, despite the surgeon's best attempt to place the septal cut flush with the ULC and nasal bones, there is frequently a remnant of intact subdorsal cartilage immediately beneath the dorsal hump at the K-area. This blocking point

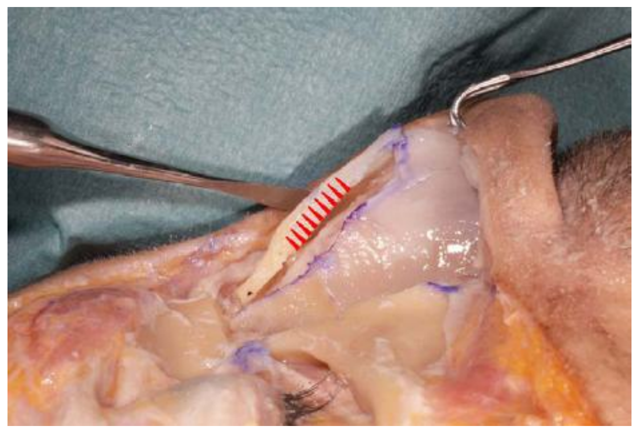

Fig. 3. Vertical cuts to the remnant septal cartilage under the hump in the high septal strip technique to release the tension obstructing dorsal flattening.

can hinder the necessary movement required for flattening of the dorsal convexity.[13] To address this, vertical cuts can be made in the remnant subdorsal cartilage to release the tension and allow for expansion of the remnant as the dorsal hump is flattened (Fig. 3).[14] The midseptal strip similarly leaves an intact strut of subdorsal cartilage, and requires a vertical chondrotomy at the K-area, as described by Patel et al. (Fig. 4).[17]

Perpendicular Plate of the Ethmoid

Full mobility of the nasal pyramid is a prerequisite when using an impaction technique, and can only be achieved when the subdorsal septal resection extends to the level of the radix osteotomy (Fig. 5).[13] This is relevant to high, mid, and low septal strip techniques. The amount of

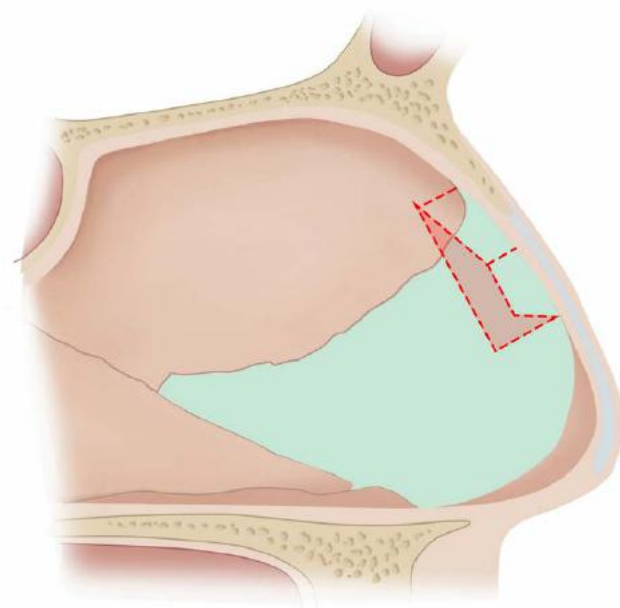

Fig. 4. Most modified midseptal strip, demonstrating the inclusion of a vertical chondrotomy of the subdorsal strut beneath the hump to allow for flattening.

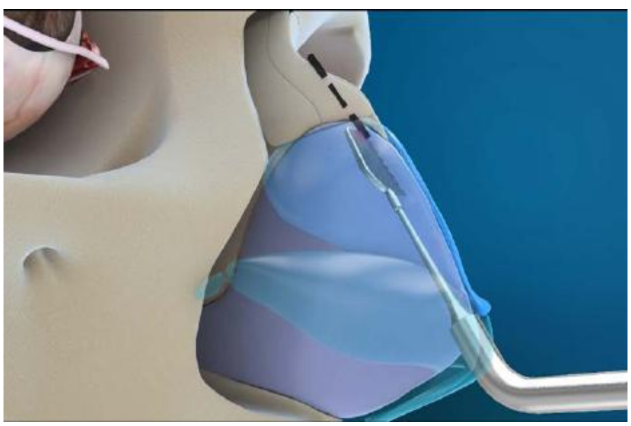

Fig. 5. High septal strip excision with demonstration of the presence of the PPE beneath the hump. Septal cuts must extend proximally through this bony septum to the level of the radix osteotomy to allow for sufficient dorsal mobility.

bony septum, or perpendicular plate of the ethmoid (PPE), that is included in the subdorsal resection varies depending on the location of the dorsal hump in relation to the E-point—the point beneath the nasal pyramid where the cartilaginous septum meets the PPE.[18] Ferreira et al. demonstrated in a radiographic study that 97% of patients had an E-point proximal to the dorsal hump.[19] Similarly, Sadri et al. used computed tomography to show the E-point to be located an average of 7.25 mm proximal to the level of

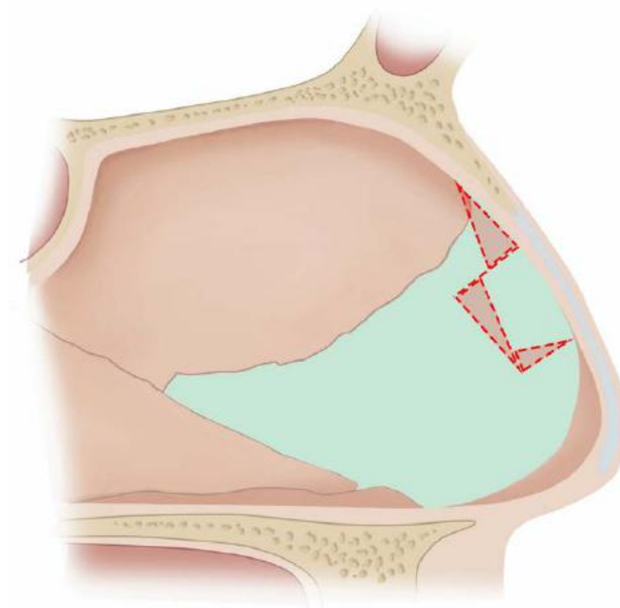

Fig. 6. Tetris concept described by Neves et al., demonstrating the importance of clean septal cartilaginous and ethmoid bony cuts and the removal of any bony spicules under the dorsum, which could prevent reduction of the dorsal convexity.

anticipated radix osteotomy, with only 5.6% of patients having an E-point distal to this site.[20] Thus, the subdorsal resection will often consist of cartilaginous septum rather than bone. However, it is important to understand that this may not always be the case, and failure to recognize a more distally located E-point could lead to insufficient mobility of the dorsum. In instances where the PPE needs to be addressed, it is critical that any ensuing bony spicules immediately under the hump be thoroughly cleared, as residual bony fragments could potentially block the downward movement of the dorsum (Fig. 6).

Lateral Osteotomy

When using the push-down technique, the thick bones of the frontal process of the maxilla can present another blocking point. For the push-down technique to be successful, the nasal pyramid must medially traverse and descend within the confines of the pyriform aperture. Although pinching the nasal bones together can allow for enough of a discrepancy in diameter to accomplish this, osteotomies that are made horizontally along the surface of the maxilla can create an unfavorable leading edge that impedes descent of the nasal pyramid base, particularly at the level of the medial canthal ligament, which corresponds to the thickest part of the maxillary bone in the low-to-low osteotomy

Fig. 7. The medial canthal ligament area corresponds to the thickest part of the low-to-low osteotomy line which could block the push-down of the nasal bones into the pyriform aperture.

line (Fig. 7).[2,21] This resistance at the lateral osteotomy site during a push-down osteotomy can be minimized by changing the direction of the bony cuts from a horizontal to a sagittal plane.[13,21] When the osteotomized edges of the maxilla and nasal pyramid are both parallel to the sagittal plane, there is less bony resistance to posterior displacement of the dorsum during push-down. With this modification in mind, two options for the lateral osteotomies are available to the surgeon, depending on whether or not the bony vault is deviated.[21] If the bony vault is straight and simply requires lowering, bilateral low-to-low sagittal osteotomies are performed (Fig. 8). However, if there is bony vault deviation, the surgeon can use asymmetric osteotomies: horizontal-oblique on the short side of the nasal bone to minimize posterior displacement, and sagittal on the longer side to allow for posterior displacement and pyramidal tilting to bring the bony vault to midline (Fig. 9).

Webster Triangle

In their original description of this anatomical region, Webster et al. advocated performing osteotomies in a manner that preserved a small triangle of maxilla at the inferior portion of the lateral osteotomy because of its proximity to the head of the inferior turbinate.[22] However,

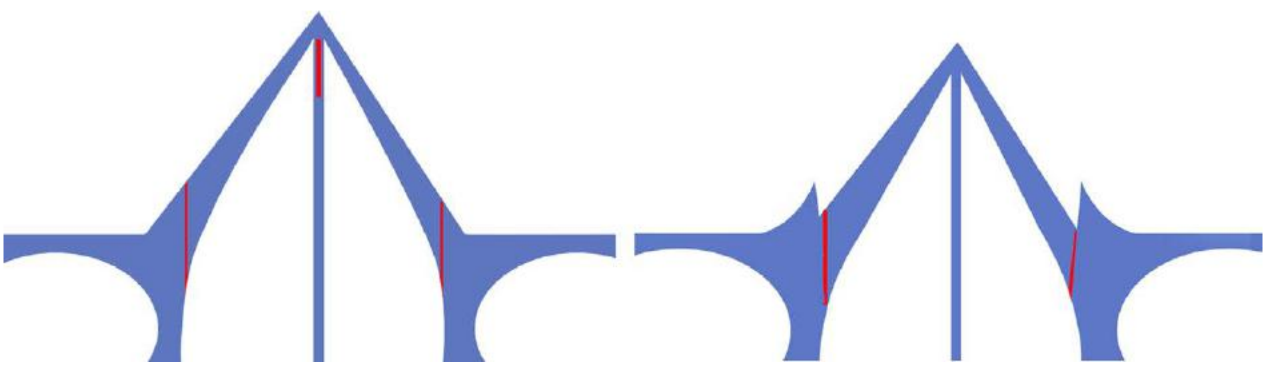

Fig. 8. Bilateral sagittal lateral osteotomies (*left)* allow for bony pyramid downward sliding with subsequent push-down (*right*).

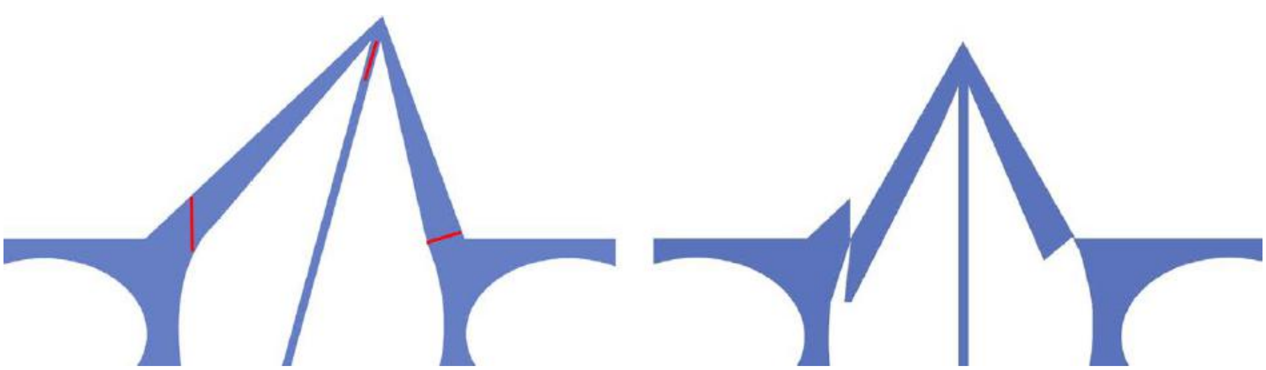

Fig. 9. Asymmetric osteotomies for the deviated bony vault. Sagittal and horizontal osteotomies before (*left*) and after (*right*) crooked nose correction. The osteotomy on the short side of the pyramid is horizontal, to minimize posterior displacement. On the long side, a sagittal cut is used to allow posterior displacement and correction of the pyramid.

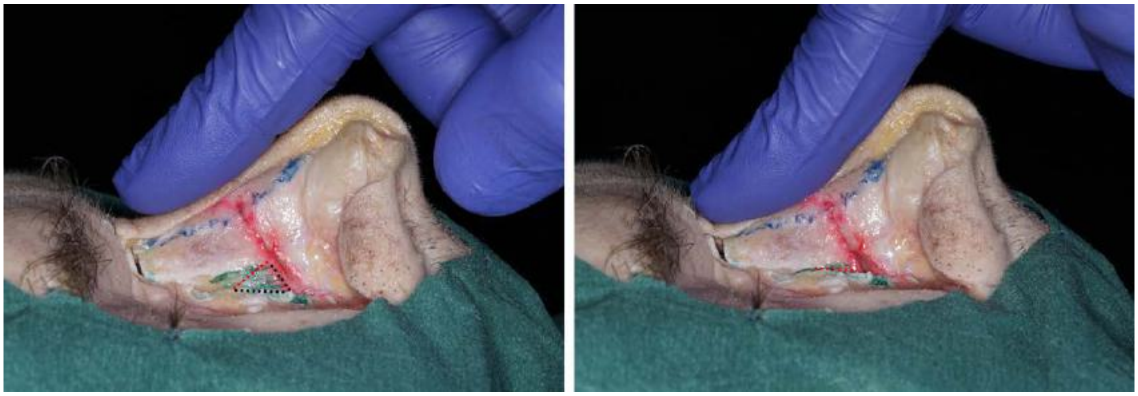

Fig. 10. Resection of the Webster triangle (*dotted triangle*) (*left*) allowing bony vault descent without impacting with the head of the inferior turbinate in the hybrid push-down/let-down method of dorsal preservation rhinoplasty (*right*).

subsequent studies have shown no difference in airway dynamics whether this triangle is preserved or removed.[23] The authors recommend removal of the Webster triangle when performing a push-down by performing a triangular ostectomy at the caudal portion of the nasal pyramid at the pyriform aperture (Fig. 10). In addition to being a major blocking point preventing descent of the nasal pyramid, the proximity of the bony attachment of the head of the inferior turbinate can risk impingement by the overlapping lateral bony pyramid—especially in long, narrow noses—and can adversely affect nasal airflow (Fig. 11).[13,24] This has led some surgeons to favor the let-down procedure to avoid having to deal with this blocking point separately, as the Webster triangle is effectively removed in the ostectomy.[18]

Internal Mucoperiosteum of the Maxillary Bone

Another potential blocking point that is present at the lateral osteotomy site is the resistance presented by the mucoperiosteal lining of the inner surface of the maxilla. After the osteotomies are performed, and before the push-down, the mucoperiosteum of the internal surface of the maxilla along the lateral osteotomy line should be elevated beginning at the pyriform and continuing cephalically (Fig. 12). This maneuver can prevent periosteal tissue resistance to dorsal lowering by creating added space to accommodate descent of the bony vault into the pyriform aperture during push-down.[14,21] Furthermore, the inner mucoperiosteum can be elevated bilaterally for the straight nose and

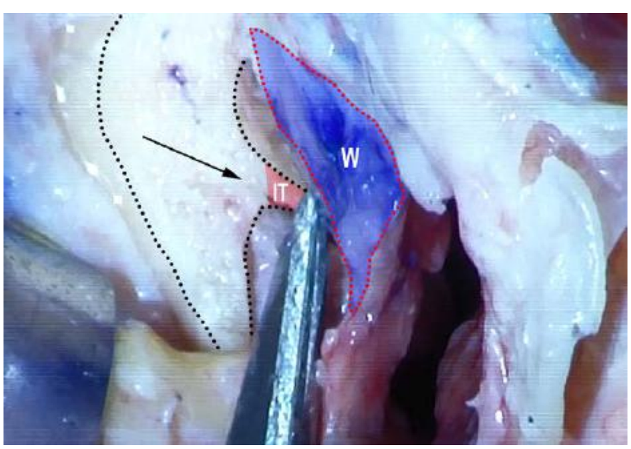

Fig. 11. Webster triangle (*W*) (*red dotted line*) and inferior turbinate (*IT*). The inferior turbinate's conchal bone insertion on the inner wall of the frontal process of the maxilla corresponds to the location of the Webster triangle.

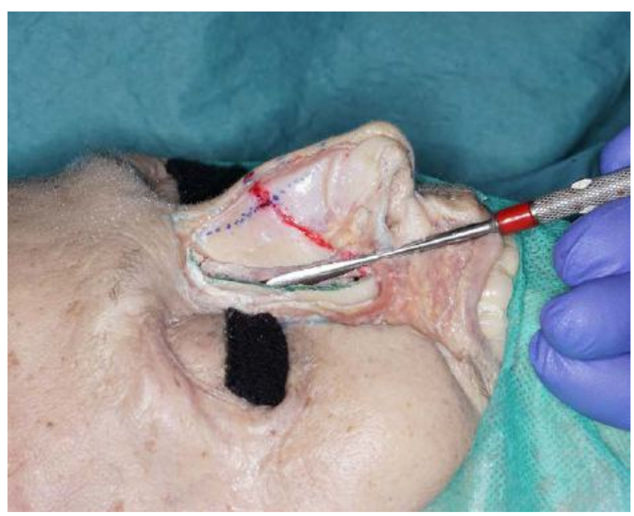

Fig. 12. Mucoperiosteal elevation of the inner surface of maxillary bone can be performed through the lateral osteotomy fracture line to create space for bony pyramid descent in push-down.

Fig. 13. Medial canthal ligament (outlined in *red*) and its attachment to the nasal bone.

Fig. 14. Ballerina maneuver; blunt disarticulation between the upper lateral cartilage and nasal bone at the lateral K-area. *LLC*, lower lateral cartilage; *HPL*, horizontal pyriform ligament; *LKA*, lateral keystone area.

only on the side with the longer nasal bone in crooked bony vault cases.

Medial Canthal Ligament

The medial canthal ligament is a structure that attaches to the periosteum, not to the bone, and can act as a blocking point that the surgeon should consider undermining if they wish to drop the radix height (Fig. 13).[19] This is achieved by performing subperiosteal tunnels up to the level of this ligament, before making osteotomies. Conversely, if there is no intention to change the radix height following radix osteotomy, it would be advantageous to deliberately preserve the medial canthal ligament attachment, as it will help prevent a half-step irregularity on the radix. In practice, this translates to not performing subperiosteal tunnels and instead proceeding directly to low-to-low osteotomies.

Lateral K-Area

Modification of the lateral K-area is frequently required to facilitate mobility of the dorsum. It is important to understand the intimate relationship between the nasal bony cap and the cephalic ULCs of the K-area, which is not a simple end-to-end attachment but instead an overlapping interface of dense attachments because of the fusion of the ULC perichondrium to the periosteum of the nasal bones.[25] Remembering that the K-area is a three-dimensional structure, this fusion is present laterally and dorsally. These dense sidewall connections can restrict the "hinge" mobility of the dorsal keystone, analogous to tight collateral ligaments preventing extension of a joint. If kept intact, lateral keystone attachments can prevent adequate flattening of the dorsum, particularly in cases of the convex or kyphotic bony hump. To circumvent this, a separation technique known as the "ballerina maneuver" can be used, whereby the lateral K-area is mobilized with blunt dissection between the ULCs and nasal bones while keeping the dorsal keystone intact (Fig. 14).[13,14] Freeing these dense sidewall connections allows the surgeon to perform what is essentially a stretching maneuver that changes the shape of the dorsum from convex to straight.

RELEVANCE OF THE BLOCKING POINTS: HUMP RECURRENCE

Dorsal preservation allows for significant aesthetic changes of the dorsum while avoiding the obvious disadvantages incurred by disarticulating the ULCs from the septum as in structural rhinoplasty. Hump recurrence is a potential sequela, however, and is unique to DPR, as structural rhinoplasty affords direct excision of dorsal convexities. A distinction should be made between the presence of a residual hump versus hump recurrence. Tuncel et al. describes a residual hump as being noticed 1 to 3 months postoperatively—after surgical swelling has subsided—and being the result of inadequate treatment of the dorsal hump with insufficient septal resection at the index operation. Recurrent humps, in contrast, typically occur later in the postoperative course and are the result of persistent forces that push the dorsum toward its native position over time.[26] Generally speaking, this is the result of the inadequate treatment of the blocking points and/or inadequate fixation of the dorsum in its new location.

Blocking points prevent the dorsum from taking new shape, whether intraoperatively by preventing adequate hump reduction, or postoperatively by manifesting as a hump recurrence because of the continued occult tensile forces incurred by these points. The authors have expanded on the previously described five blocking points and included an additional two: the PPE and the medial canthal ligament.[13] It is important to recognize that these blocking points are not relevant to every preservation technique. Nevertheless, it is critical for the surgeon to be aware of the particular blocking points that are applicable to his or her chosen technique.

The blocking points of the lateral osteotomy sites, periosteum of the inner maxillary surface, and the Webster triangle occur with the push-down technique. Techniques that create space or bypass the need to completely mobilize the nasal pyramid are not restricted by these blocking points. The let-down is an example of a technique that creates space by removing a strip of bone at the junction of the maxilla and nasal bones along the facial groove, allowing the bony pyramid to descend and rest on the ascending process of the maxilla.[27] Cartilage conversion and the "spare roof" technique avoid mobilization of the bony pyramid entirely, obviating the need for osteotomies.[11] Instead, by performing an ostectomy of the bony cap, the underlying cephalic ULCs under the keystone are exposed, effectively converting the dorsum into a cartilage-only hump. Cartilage conversion is particularly relevant in cases of the kyphotic bony hump. The shape of the nasal bones, although itself not a blocking point, is nonetheless an important aspect of dorsal anatomy that must be taken into consideration.[28] If the nasal bone has an S-shape, as opposed to a V-shape, it means the bone is kyphotic, and it is necessary to rasp and change the bony pyramid by removing the bony cap; otherwise, it will not be possible to completely flatten the hump.

All DPR techniques, however, have the potential to be affected by septal blocking points if insufficient septum is resected at the index operation causing premature contact of the septal edges. This would be evidenced by a residual hump discovered in the early postoperative period that is revealed after swelling has subsided. Prevention of hump recurrence, in contrast, is reliant on the ability of the underlying septum to change shape to match that of the desired dorsal contour. Regardless of the level or configuration of the septal modification, the rigid septum directly beneath the hump requires alteration to allow for flattening of the overlying dorsum. The subdorsal Z-flap described by Kovacevik, Neves's tetris concept, Most's modified midseptal resection, Cottle's low septal resection, and the simple preservation quick rhinoplasty modification by Finocchi all intrinsically incorporate a vertical chondrotomy beneath the dorsal hump in their designs, creating an axis for expansion or rotation at the most projecting point of the hump.[5–9] The high septal strip, predicated on making a subdorsal cut that follows the contour of the convexity, should be treated no differently. Attention should be paid to the presence of any remnant subdorsal cartilage directly beneath the hump and, if removal proves difficult, it should be scored or a vertical chondrotomy made to facilitate expansion.[13]

The medial canthal ligament attachment to the nasal bone is an often overlooked but nonetheless important blocking point, particularly as it pertains to the position of the radix. Its detachment or preservation can be used to the surgeon's advantage, depending on their intention to either lower or preserve the radix height. It is important to note that the radix osteotomy, although itself not a blocking point, is nonetheless important for also protecting the radix height and preventing a step irregularity. The authors recommend that the radix osteotomy be performed in an oblique manner using a 2-mm osteotome percutaneously, with an entry point just above the radix that is angled caudally to create a hinge effect.[13]

The final blocking point is the resistance generated by the lateral K-area. Dense attachments at this interface formed by the pyriform ligaments and fused periosteum of the nasal bones and perichondrium of the ULCs can prevent the anterior and caudal expansion required at the lateral K-area to facilitate flattening of the dorsal convexity.[18,25] Each DPR technique is reliant on stable extension of the osseocartilaginous K-area. Lateral release can disrupt the tissue memory at the K-area and thus avoid the "spring effect" of the dorsum reverting to its native convexity over time.[13,15] Performing this release only laterally allows for the necessary dorsal mobility without functional impairment. As the integrity of both the dorsal keystone and underlying ULC-septal complex are preserved, dorsal stability is maintained and deformities such as the inverted-V are avoided.

Once the relevant blocking points are addressed, stable fixation of the dorsum in its new position is a requirement. Midseptal strip and subdorsal flap techniques, such as the subdorsal Z-flap and tetris concept, afford the ability to use septal sutures for fixation.[5,6] Low septal strip techniques, such as that described by Cottle in addition to Finocchi's simple preservation quick rhinoplasty, rely on a single point of fixation of the freed caudal septum to the anterior nasal spine. High septal strip techniques require the septum to be secured directly to the dorsum, most commonly by affixing the ULCs to the dorsal septum in a cerclage fashion or by using the criss-cross suture method to secure the osseocartilaginous dorsum to the underlying septum.[14] The key with high septal strip fixation sutures is to avoid tying them too tightly to prevent inadvertent middle vault distortion. Bony dorsal preservation, which can be considered a hybrid of preservation and structural techniques, ends with suture reattachment of the ULCs to the trimmed dorsal septum.

Although the method of fixation varies according to the septal modification technique used, secure fixation is a key step to counteract ongoing tensile forces that occur during the postoperative healing process. In 1999, Ishida et al. reported a hump recurrence rate of 15% in their series of 120 patients undergoing a midseptal strip.[29] In their technical description they deemed suture fixation "not completely necessary"; however, it is unclear what proportion of these patients ended up receiving some form of fixation.

The rate of hump recurrence has improved in recent years, which could plausibly be attributed in some part to better awareness of the blocking points, and an emphasis on both their release and the necessity of fixation. Saban et al. reported a 3.4% hump recurrence rate in their series of 320 patients, and stressed the importance of complete removal of the subdorsal septum and the securement of the dorsum to the underlying septum at the anterior septal angle.[2] Kosins and Daniel recently published their experience of 31 dorsal preservation patients and reported no recurrences.[30] Scoring of the subdorsal cartilage and release of the lateral keystone attachments were emphasized, and all patients underwent three-point suture fixation: one placed between the septum and nasal bones, a second between the dorsum and septum at the W-point, and a third in between these. Perhaps most notably, Tuncel et al. were able to decrease their recurrent hump rate from 12.1% to 5.3% by implementing judicious resection of the subdorsal cartilaginous and bony septum, lateral keystone dissection, vertical chondrotomies of the subdorsal septum, and two-point suture fixation.[16,31] Each of these studies reports low hump recurrence rates and acknowledges release of relevant blocking points combined with fixation of the dorsum. Although their independent role in minimizing hump recurrence is difficult to quantify given significant variability in techniques and stringency of indications to perform DPR, it is our opinion that education and proper management of blocking points can yield consistent results and minimize hump recurrence.

CONCLUSIONS

Preservation rhinoplasty represents a growing shift in rhinoplasty philosophy toward preserving structurally sound anatomy and using manipulation techniques to reshape existing nasal structures into aesthetic and functional ideals. The challenge that is unique to DPR is the phenomena of the residual hump and hump recurrence, because of the existence of various anatomical blocking points—resistant tensile forces that either impede dorsal lowering intraoperatively or push the dorsum back to its native convexity over time. It is critical that the surgeon be aware of the particular blocking points relevant to his or her chosen technique, and to appropriately and methodically address them to ensure consistent long-term results.

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DISCLOSURE

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SPECIAL COMMUNICATION | Rhinoplasty

Subdorsal Cantilever Graft for Elevating the Dorsum in Ethnic Rhinoplasty

Dean M. Toriumi, MD*

Abstract
Augmentation of the nasal dorsum is frequently required in the ethnic rhinoplasty patient to create a narrowing effect and to balance the upper two thirds of the nose with the desired increase in tip projection. The subdorsal cantilever graft (SDCG) provides a method to elevate the nasal dorsum to complement the increase in nasal tip projection. SDCG type A is situated below the bony dorsum and acts to raise the dorsum with limited elevation of the radix. The SDCG type B extends through a radix osteotomy site and raises the radix down to the supratip after complete release of the bony dorsum and middle nasal vault. Placement of the SDCG below the dorsum has many advantages, including preserving the features of the natural dorsum (dorsal aesthetic lines), controlled narrowing, and camouflage of the subdorsal graft. This is a complex procedure that requires a good understanding of dorsal preservation techniques. Use of the SDCG to raise the nasal dorsum in ethnic patients combines structure rhinoplasty with the principles of dorsal preservation for augmentation of the profile in patients with a low dorsum.

Introduction

Augmentation of the nasal dorsum in the ethnic patient is typically performed to correct the low dorsum with poorly defined dorsal aesthetic lines. There are many methods of augmenting the dorsum, including placing a single solid dorsal graft,[1,2] diced cartilage and fascia (DCF),[3,4] or other methods.[5] All of these methods have drawbacks that can contribute to an unnatural appearing nasal dorsum.[6] These problems include the following: graft visibility, shifting or deformity of the grafts, graft resorption, poorly defined dorsal aesthetic lines, and so on.

Dorsal preservation has made a resurgence, in part, due to the ability to preserve many of the natural features of the nasal dorsum by lowering the dorsum from below the leading edge.[7,8] The author presents a technique of dorsal augmentation that elevates the nasal dorsum and middle vault to preserve the natural contours of the bony and cartilaginous vaults. The primary concept is to raise the radix, nasal dorsum, and middle vault to complement the tip projection and provide the desired dorsal height to a level that eliminates the need for larger dorsal grafts. When using the subdorsal cantilever graft (SDCG), it may be necessary to place smaller soft tissue (fascia, scar, etc.) or thin soft crushed cartilage grafts for camouflage or fine-tuning of the dorsal profile. The key is to eliminate the need for larger grafts that can become visible, shift, or deform over time.

The concept of the ''push up'' has been published in the past.[9,10] Dewes was the first to discuss the ''push up'' initially described in 2013 as the SPAR type C.[9] In most instances, these techniques have not been widely adopted, in part, due to the recurring forces acting upon the underlying modified structures (Wilson Dewes, pers. comm.).

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The author describes the use of an SDCG in ethnic patients with a low, wide nasal dorsum that would otherwise need to be augmented. The unique features of this novel technique are the ''cantilever'' feature of the graft positioned at or below the radix and the robust nature of the costal cartilage subdorsal graft, hence the name SDCG. In addition, the wide release of the lateral keystone, piriform ligament, and scroll ligament maximizes elevation of the middle nasal vault and minimizes the antagonist forces.

Patient Selection

Candidates for this procedure are those who are requesting elevation and narrowing of their nasal dorsum. The Asian patient with the low dorsum is an ideal candidate as they typically do not desire a large amount of radix augmentation. Patients who are deviated are good candidates as well, as the nose can be straightened using an offset SDCG that can shift the dorsum to the midline. Black patients with a low dorsum are also excellent candidates for the SDCG. The primary difference will be the aesthetic differences between the two ethnicities. Most Asian patients desire a lower nasal starting point that starts at the level of the midpupil with less radix augmentation, whereas many black patients may benefit from a slightly higher nasal starting point at the level of the supratarsal crease and greater radix augmentation.[2]

The projection of the forehead is important as well. If the forehead is flat and the glabella is poorly defined, elevation of the radix is a relative contraindication. If radix elevation is desired, glabellar augmentation may be necessary to balance elevation of the radix. This will be necessary to prevent a continuity of the dorsum into the forehead on lateral view. Asian patients frequently will have a poorly projecting glabella and could benefit from glabellar augmentation using costal cartilage grafts wrapped in soft tissue such as perichondrium infused with microfat.[2]

Preoperative computer imaging is very important in these patients to come to agreement on the degree of radix elevation, the amount to tip projection, positioning of the middle vault, contour of the supratip break and width of the dorsum. The amount of nasal tip projection will dictate the overall projection of the upper two thirds of the nose. Chin projection will also dictate the amount of tip projection that can be tolerated. If necessary, chin augmentation can be performed to enhance profile alignment. All of these parameters can be controlled using the custom-contoured SDCG with fine-tuning soft tissue or soft cartilage grafting.

Nonethnic patients with a low dorsum who are requesting augmentation are candidates as well. If the patient has a small convexity and the plan is to raise the dorsum, small grafts may need to be placed above or below the dorsal convexity or a small bony cap may need to be reduced to create a proper dorsal contour. The patient with a saddle nose deformity can be treated with a similar subdorsal graft.[11] The saddle nose patient typically has a properly projected bony dorsum with a saddled (underprojected) middle vault requiring elevation of the middle vault and not the bony vault and radix.

Relative contraindications to using this technique include the following: prior surgery on the nasal dorsum, severely contracted mucosal lining, unrealistic expectations, and soft rib cartilage.

Technique

The technique requires harvesting a 6–7 cm segment of costal cartilage. The preference is a denser, more calcified costal cartilage. If the patient's cartilage is soft, then a bone segment can be harvested as a costochondral rib segment. The seventh rib is preferred because of its straighter shape, but the sixth rib is also acceptable. The rib segment should be relatively straight and can have a bony component. It is preferable to leave the native perichondrium/periosteum attached to one side of the harvested rib segment to act as an ossifying interface that will fix the SDCG to the undersurface of the bone.

It is important for the rib cartilage to be rigid and firm to support the nasal dorsum. Soft rib cartilage will not support the dorsum and will likely fail. The rigidity and degree of calcification of the rib can be assessed by pricking the rib with a 1.5-inch 22-gauge needle. The needle can be used to palpate the rib and one will be able to assess if the rib cartilage is soft. This is one instance where a partially calcified rib is ideal for the SDCG. The piezotome is very helpful when harvesting a costochondral graft and also allows precise sculpting of the bone portion of the graft. Only an autologous rib should be used to ensure stable fixation of the nasal dorsum. There is the potential that a second rib may need to be harvested to provide adequate cartilage for other structural grafting.

The rib should be carved in an anteroposterior orientation to maximize the strength of the SDCG and minimize warping in the lateral plane (Fig. 1). This will allow the graft to be placed vertically under the bony vault and middle vault and provide maximal support to the repair. This orientation maximizes strength and allows a narrower graft.

Typically, an open rhinoplasty approach should be used to maximize exposure, but the technique can be performed via an endonasal approach. When performing the external rhinoplasty approach, dissection should be extended to the supratip and then a narrow subperiosteal tunnel along the midline of the dorsum. Then, the medial crura are dissected apart and bilateral mucoperichondrial flaps are elevated to expose the septum.

Fig. 1. Initial sectioning of the harvested costal cartilage leaving a very strong segment that can be used for the SDCG (yellow arrow). The rib is sectioned in an anteroposterior orientation to leave very low risk for warping in the lateral plane. Figure is copyrighted by the author, Dean M. Toriumi ©. SDCG, subdorsal cantilever graft.

Elevation of the Dorsum with Minimal Radix Augmentation

Once the septum is exposed, a high subdorsal septal cut similar to a Saban style subdorsal strip just under the upper lateral cartilages is performed to release the middle vault and nasal bones from the septum. If the nasal bones are not to be elevated (pushed up), then the subdorsal cut extends to the area immediately below the radix. A strip of bone is removed to make room for the SDCG. The space does not extend above the radix to avoid weakening the ethmoid at the base of the skull. If only minimal radix elevation is needed, then a radix osteotomy may not be necessary. In patients with long nasal bones, lateral, transverse, and a green-stick radix osteotomy may be necessary to allow elevation of the caudal portion of the bony vault.

The SDCG type A is designed to fit into the notch below the bony vault and middle vault and is fixated to the caudal septal extension graft (Fig. 2). In this case, elevation is primarily in the middle vault to balance increases in tip projection. A lateral keystone release and division of the piriform ligament may be necessary to allow tension-free elevation of the middle vault.

A small radix graft can be placed in a narrow pocket to slightly (<2 mm) elevate the radix. In this case, the SDCG is used primarily to elevate the middle vault, caudal nasal bones, and supratip to complement the increase in nasal tip projection (Case #1 and Case #2). Most Asian patients desire a small amount of radix elevation and are ideal candidates for the SDCG type A with less aggressive release of the bony vault.

Radix Elevation with Entire Dorsum

If the radix requires elevation, then the subdorsal cut is extended to the radix where a complete radix osteotomy is performed with a 2 mm straight osteotome and connected to transverse and lateral osteotomies. The radix osteotomy can be performed subdorsally or through a small dorsal stab incision. In most ethnic patients, it is preferable to avoid external incisions in the radix area as this can leave a hyperpigmented scar. Bilateral low to low lateral osteotomies are performed via lateral subperiosteal tunnels. A wide subperiosteal dissection is performed around the lateral osteotomy site and extends over the maxilla by about 1.5 cm. Then bilateral transverse bone cuts are made from below or from small stab incisions along the sidewall, connecting the radix bone cuts to the lateral bone cuts (Fig. 3). The bone cuts can also be made using the piezotome via a wide subperiosteal dissection over the nasal dorsum.

A lateral keystone release (Ballerina maneuver) with extended release of the piriform aperture and piriform ligament should also be performed to maximize the movement of the dorsum and middle vault (Fig. 4). In

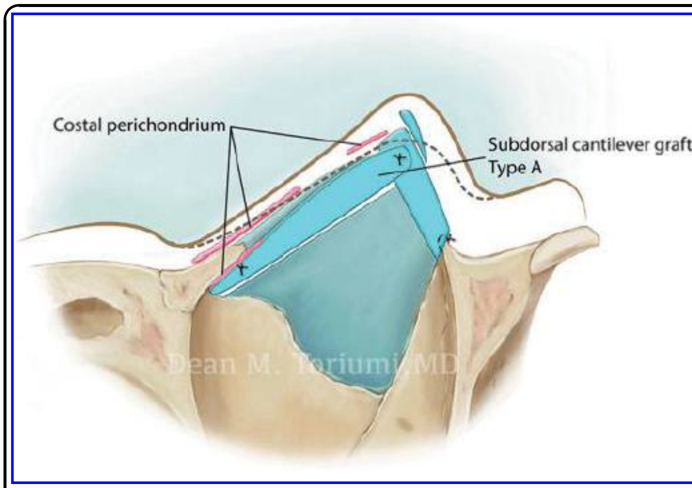

Fig. 2. SDCG type A extending to a subdorsal groove under the nasal bones, but not extending through the radix osteotomy site to raise the radix. The graft is placed under the nasal bones into a space created above the ethmoid bone. Note the convex contour of the segment of the graft that lies below the middle vault to promote proper elevation of the supratip. (Used from the library of Dean M. Toriumi, MD, with permission.) Figure is copyrighted by the author, Dean M. Toriumi ©.

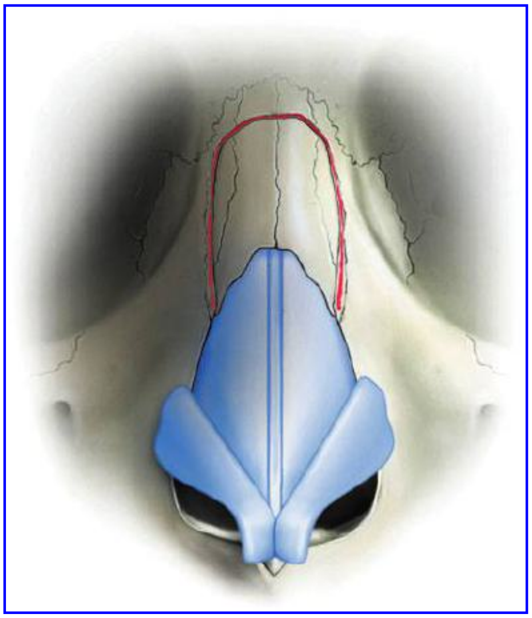

Fig. 3. Bone cuts needed (lateral, transverse, and radix) to release the bony vault and allow anterior projection. Once the dorsum is elevated, a gap will be created that will ossify if the periosteum is left between the bone segments. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

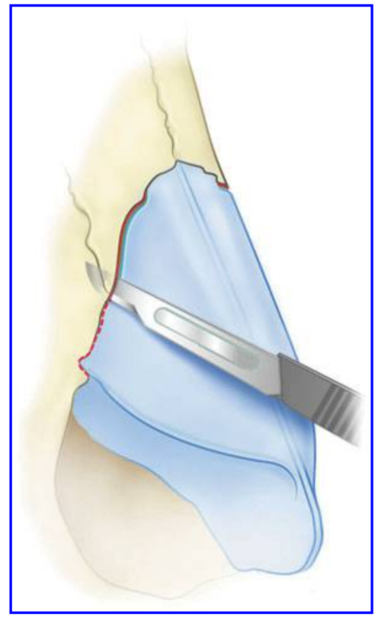

Fig. 4. Lateral keystone release (LKA release or Ballerina maneuver) along the lateral nasal bone not extending to the keystone in the midline. The release is extended laterally to the piriform ligament and dissection can be performed along the maxilla as well. (Reprinted with permission from Toriumi DM, Davis RE. *Marina Medical Rhinoplasty Cadaver Dissection Course Videos*. St. Louis: Quality Medical Publishing; 2021.)

some patients, a release of the scroll ligament may be needed as well. At this point, the entire bony vault should be free to move. A 2 mm osteotome can be inserted into the radix osteotomy site and the entire bony and cartilaginous vault can be lifted anteriorly (Supplementary Video S1).

A caudal septal extension graft is shaped and is fixed to the caudal septum or nasal spine. A notch can be made in the nasal spine and the septal extension graft can be placed into the notch and sutured in place with two 4-0 polydioxanone sutures.[2] Then the caudal septum can be trimmed to allow it to integrate with the caudal septal extension graft. In most ethnic patients, the septum is fairly weak and will ultimately provide little support to the final structure but can be preserved to help stabilize the new structure. In most cases, the existing septum will need to be trimmed to accommodate the new cartilage architecture.

Once the septum is trimmed back dorsally and caudally, there is no option to abort the augmentation. In most cases, the septal extension graft should be at least 3 cm in length and 10 mm in width and 1.5–2 mm in thickness. The length of the extension graft will be determined by the amount of tip projection that is desired.

Placing the SDCG

At this point, the SDCG can be custom carved. The native perichondrium can be left on at least one surface of the SDCG to aid in ossification of the graft to the undersurface of the bony vault.

The SDCG type A typically measures less than 4 cm and extends into the groove created under the nasal bones and integrates with the septal extension graft. A trough can be carved in the middle of the graft to accept the remnant septal stump if present under the dorsum (Fig. 5). For maximal narrowing, the subdorsal septal stump should be trimmed with a number 11 blade.

If radix elevation is desired, the cephalic end of the SDCG type B is uniquely carved with a superior extension extending ''through'' the radix bone cut and sits on top of the frontal bone (Fig. 6). This segment of the graft must be rigid and preferably partially calcified. If the costal cartilage is soft, then the superior end should be primarily bone (costochondral graft). The piezotome or bone drill can be used to shape the cranial end of the graft that extends onto the frontal bone. The amount of radix elevation is determined by the contour and depth of the portion of the graft that extends through the radix bone cut.

Fig. 5. SDCG type A with a channel along the superior margin to accommodate the septal stump under the middle vault. This graft will be integrated with the caudal septal extension graft. Note the edge of the graft that lies under the dorsum is relatively narrow to avoid widening the dorsum. Native perichondrium is left on the graft to enhance fixation under the dorsum. Figure is copyrighted by the author, Dean M. Toriumi ©.

It is frequently beneficial to design the graft with a higher projecting section under the middle vault to aid in providing adequate supratip augmentation. The segment of graft that sits on top of the frontal bone can be palpable and must be camouflaged with a strip of costal perichondrium and/or crushed cartilage. The perichondrium is ideal as it will ossify and create a naturally feeling radix. If there is an edge of bone that is palpable, it can be refined using the piezotome. The middle portion of the graft will sit directly under the bony and cartilaginous dorsum and will need to be carved to allow proper positioning of the middle vault.

The SDCG should be vertically oriented with a carved out cranial end (green arrow) that extends through the radix osteotomy to allow proper positioning of the nasal bones (Fig. 7). The anterior surface may also need to be carved out to prevent excessive projection of the nasal bones or a prominent step off.

The existing septum will be in the way of the vertically oriented SDCG and may require trimming to accommodate the graft. In most instances, the SDCG will measure 6 mm to 8 mm in width but will vary depending on the amount of narrowing desired. The SDCG should be beveled along the superior edge to enhance narrowing. The anterior edge of the SDCG should be relatively narrow to set proper width to the bones and middle vault. If the graft is not adequately beveled under the bones and middle vault, then the dorsum may be too wide.

For the deviated nose, the SDCG can be shaped to straighten the nose. If there is a C-shaped deformity, the SDCG can be slightly curved opposite the deviation to counterbalance the deviation and therefore straighten the nose. In addition, the subdorsal stump can be lodged on the side opposite the deviation to straighten the nose.

It may be necessary in some cases to perform rhinosculpture with a piezotome to narrow the lateral projections of the nasal bones. In most cases, the nasal bones will narrow adequately by pinching the lateral nasal bones to the proper width after the lateral bone cuts are completed. When periosteal healing occurs, the nasal bones will ossify into the new narrower contour and no bone grafts are required laterally.

At this point, the SDCG type B can be lifted caudally and anteriorly, while the cranial end is cantilevered over the frontal bone carrying the entire bony and cartilaginous vaults. To allow full release of both vaults, a complete lateral keystone release (Ballerina maneuver) must be executed as well as dividing the piriform ligament.[8] In addition, the periosteum can be dissected along the inner and outer surfaces of the piriform aperture to allow the tissues to lift. The amount of release will be determined by the amount of desired dorsal elevation. The key is to minimize lateral tension that could result in relapse of the lower dorsal projection.

The caudal end of the SDCG will integrate with the caudal septal extension graft. This connection can be executed in a couple of different ways. The preference is to make the caudal margin of the SDCG slightly wider to allow making a notch in the caudal end that can be integrated with the caudal septal extension graft. A shelf can be made on the cranial end of the septal extension graft to allow the SDCG to set on. This connection should be covered with a layer of costal perichondrium that will act as cement to rigidly fix the superior edge of the SDCG with the caudal septal extension graft.

The position of the integration of the two grafts will set the supratip break and height of the middle vault. Ideally, there should be 6–10 mm differential between the two grafts to allow the supratip to be in the proper position. It is preferable to set a good supratip break and then fill with a smaller supratip graft at the end, once the final tip projection is set. Frequently, a supratip suture may be needed to ensure that the thicker supratip skin is positioned properly.[12] Special attention will need to be taken managing the supratip to ensure proper contouring and to prevent postoperative pollybeak deformity.

Fixation of the SDCG is necessary to avoid caudal displacement. This is accomplished by drilling a

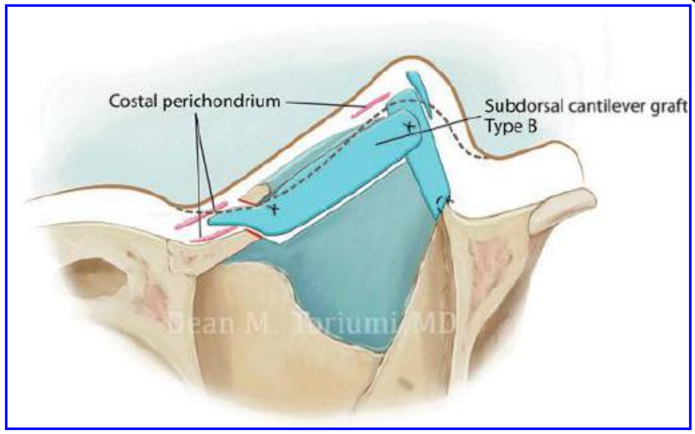

Fig. 6. SDCG type B extending through the radix osteotomy site to raise the entire bony vault after performing bilateral lateral, transverse and a radix osteotomy. The radix extension sits on top of the frontal bone and supports the new position of the bony dorsum. This graft is also integrated with the caudal septal extension graft. Note the concave contour of the graft that sits under the nasal bones and the convex contour that lies under the middle vault. This is important to promote proper dorsal contour. (Used from the library of Dean M. Toriumi, MD, with permission.) Figure is copyrighted by the author, Dean M. Toriumi ©.

transosseous hole across the dorsum using multiple 16-gauge needles or a sheath-protected drill attachment. Then a 4-0 PDS suture is passed through the holes and also engages the SDCG and passes over the bony dorsum to fix it firmly into position[2] (Supplementary Video S2). Other methods of fixation can be used if desired.

At this point, the bony and cartilaginous vaults should be elevated and in good position. Depending on the design of the SDCG, there may be some slight depressions along the dorsum. If these are noted, then the costal perichondrium or soft cartilage can be placed along the midline to fill the concavity. One must be sure the radix end of the SDCG is adequately camouflaged to avoid visibility or palpability.

The remainder of the tip work can be completed by setting the medial crura on the caudal septal extension graft. It is preferable to elevate the medial crura on the septal extension graft to create a favorable columella upper lip junction, shorten the upper lip, and allow tension-free closure of the columellar incision.[2] In most of these patients, a shield tip graft and lateral crural grafts are placed on top of the existing soft tip cartilages to set proper tip projection.[2] The stability of the base is critical to success, and postoperative loss of tip projection can create a convex dorsum. The shield tip graft can be camouflaged with some soft tissue and articulated alar rim grafts.[2]

Stiff septal splints are placed high on the septum and sutured with 3-0 nylon sutures to ensure that the graft remains in the midline. The splints should be left in place for at least 2 weeks. If there is blockage of the airway, it may be due to the septum being pushed over by the SDCG. At this point, the cartilaginous septum is not providing structural support and can be trimmed or removed. An endoscope should be used to view the upper dorsum and nasal valve to ensure that there is no deviation or blockage. This can be corrected by

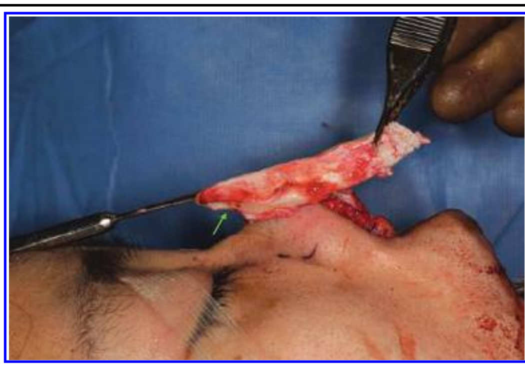

Fig. 7. This SDCG has a more concave contour for the area under the middle vault to promote a lower supratip to accommodate thick supratip skin. Note the extension that extends through the radix osteotomy is shaped to sit on the frontal bone. The green arrow is pointing to the carved out segment of the graft that sits on top of the frontal bone. Figure is copyrighted by the author, Dean M. Toriumi ©.

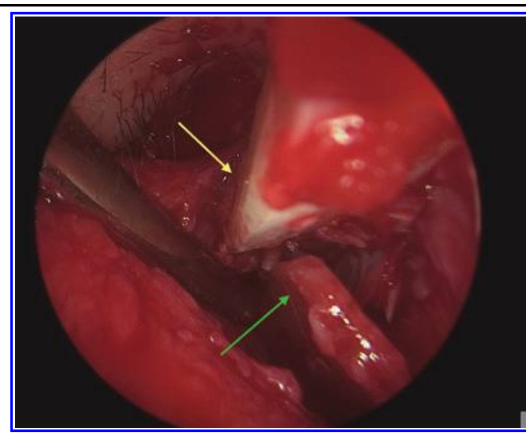

Fig. 8. Endoscopic view of the SDCG (yellow arrow) with remnant septum (green arrow) positioned below the graft. There is a couple of millimeter gap between the graft and the septum.
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Fig. 9. (Continued).

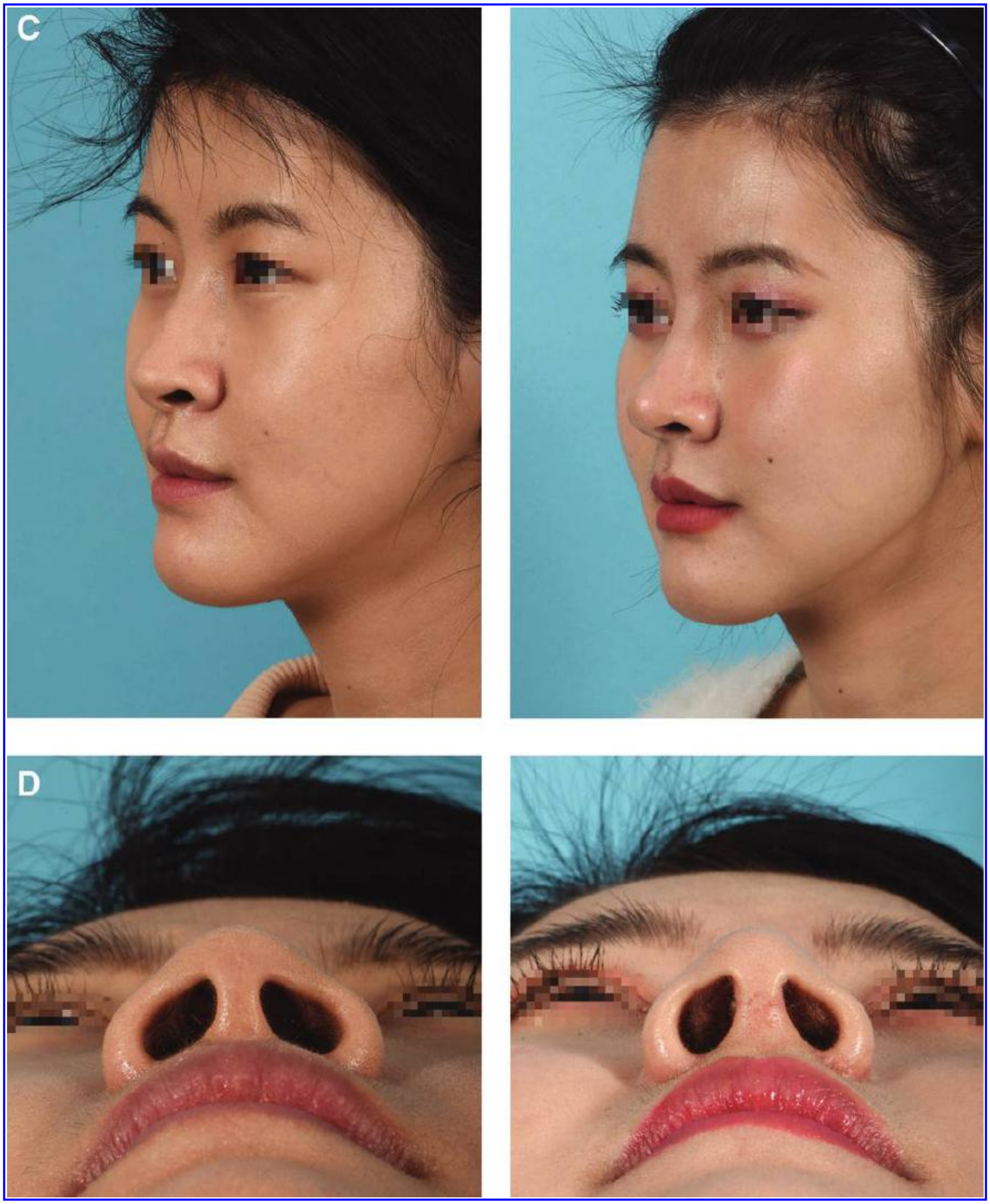

Fig. 9. Asian patient who underwent dorsal elevation using an SDCG type A, with no radix extension and soft tissue augmentation to raise the radix. The middle vault and lower bony vault were elevated using the SDCG attached to the caudal septal extension graft. The patient also underwent glabellar and forehead augmentation. **(A)** Preoperative frontal view (left). Eight-month postoperative frontal view (right). **(B)** Preoperative lateral view (left). Postoperative lateral view (right). **(C)** Preoperative oblique view (left). Postoperative oblique view (right). **(D)** Preoperative base view (left). Postoperative base view (right). Figure is copyrighted by the author, Dean M. Toriumi ©.

Fig. 10. (Continued).

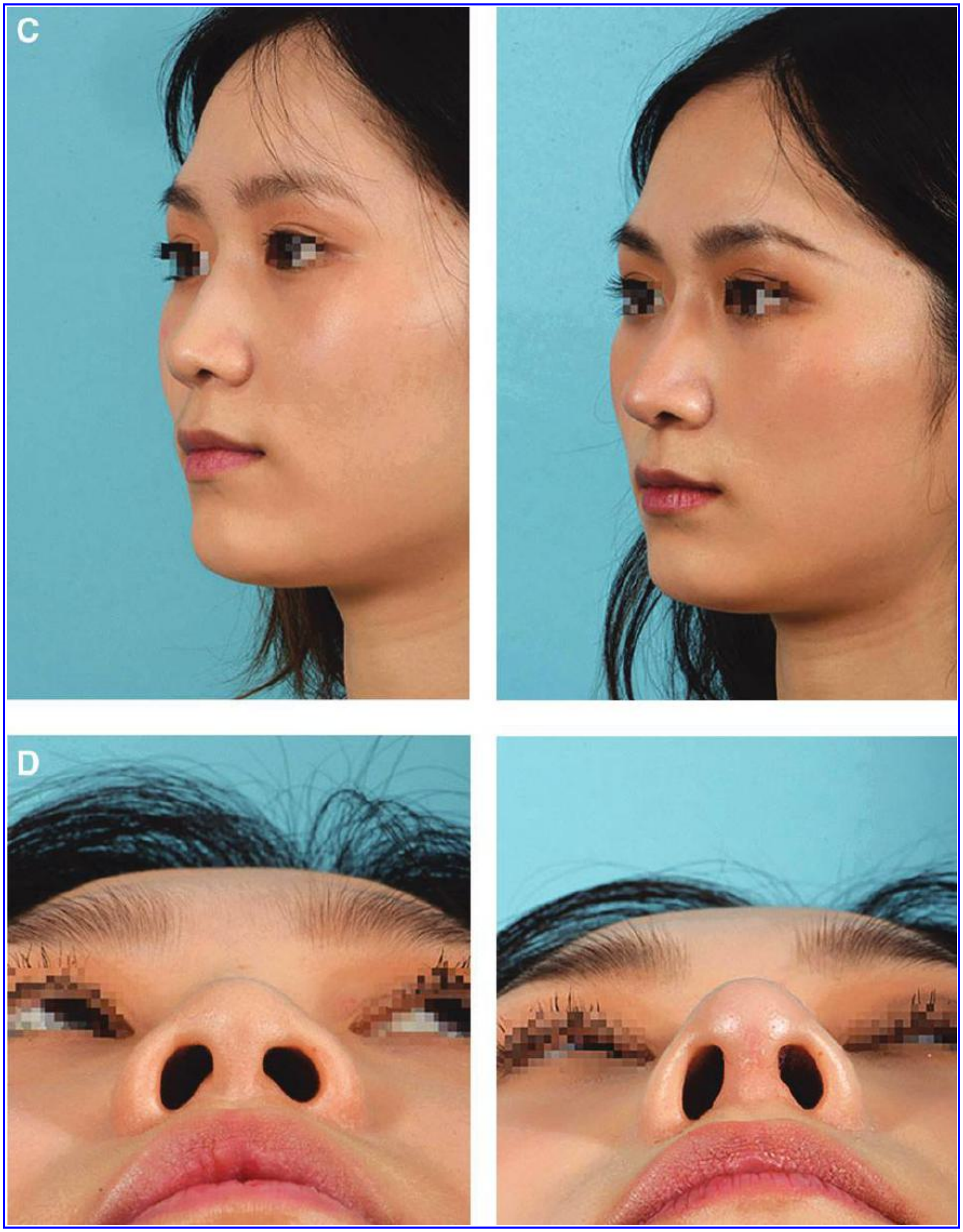

Fig. 10. Asian patient who underwent dorsal augmentation using SDCG type A with some soft tissue augmentation (perichondrium) for the radix. The tip was projected with a septal extension graft and tip graft with lateral crural grafts. **(A)** Preoperative frontal view (left). Ten-month postoperative frontal view (right). **(B)** Preoperative lateral view (left). Postoperative lateral view (right). **(C)** Preoperative oblique view (left). Postoperative oblique view (right). **(D)** Preoperative base view (left). Postoperative base view (right). Figure is copyrighted by the author, Dean M. Toriumi ©.

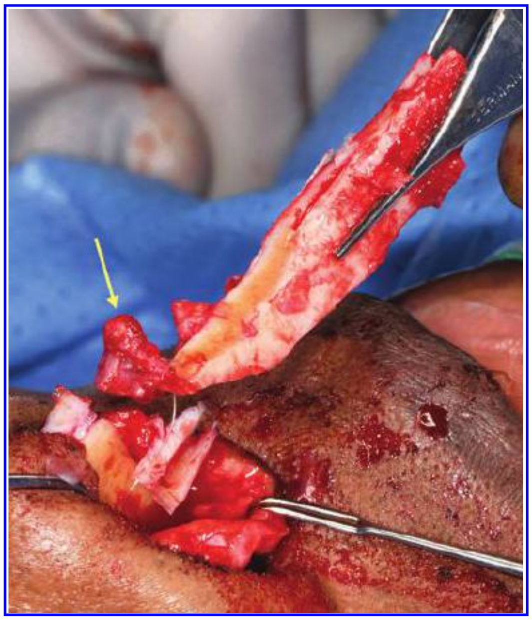

Fig. 11. SDCG type B used in the patient Case #3. This graft extended through the radix osteotomy to raise the radix and elevate the nasal dorsum. Note the graft is carved out cranially and convex under the middle vault. Also note the costal perichondrium sutured to the cranial end of the graft to help camouflage the graft so there is no palpable edge under the skin of the radix (yellow arrow). Figure is copyrighted by the author, Dean M. Toriumi ©.

trimming the septum so that it can fit under the SDCG (Fig. 8) and then splinted. In some cases, the lower margin of the SDCG may need to be trimmed to avoid airway blockage.

Case Examples

Case #1

This patient is a 25-year-old Asian patient with a low wide dorsum, small dorsal convexity, an underprojected tip, and a flat forehead with poorly defined glabella. She underwent placement of an SDCG type A that extended into a subdorsal groove under the nasal bones (Supplementary Video S3). Her nasal base was stabilized with a caudal septal extension graft. She also had a shield tip graft with lateral crural grafts. She did well with a significant increase in tip projection and narrowed nasal dorsum. Her dorsum, middle vault, and supratip were elevated to accommodate the increase in tip projection (Fig. 9). Slight radix elevation was achieved as well. Her glabella was augmented using a piece of costal cartilage covered with costal perichondrium that was infused with microfat.

The microfat and soft tissue are important to camouflage the graft and to avoid visibility over time. Her forehead was augmented with microfat as well. This was important to balance her increased radix height with the forehead and glabella.

Case #2

This patient is a 26-year-old Asian patient with a low wide dorsum and an underprojected nasal tip. She underwent placement of an SDCG type A and caudal septal extension graft. Her SDCG extended into a subdorsal groove under the nasal bones to raise the middle vault and elevate the gap between the nasal bones and tip. She also underwent placement of a shield tip graft with lateral crural grafts. This is similar to the technique used to correct a saddle nose deformity as her supratip needed to be elevated to align with the increase in tip projection. Slight radix elevation was achieved as well. She did well with a moderate dorsal elevation with perichondrium for fine-tuning the dorsal line (Fig. 10). The increased projection of her tip created a desirable narrowing of her nasal base as well.

Case #3

This patient is a 40-year-old black female patient with a low dorsum, low radix, wide base, and a poorly defined nose on frontal view. She was treated with an SDCG type B extending through her radix osteotomy site, raising her radix and dorsum by several millimeters (Fig. 11) (Supplementary Video S4). The SDCG was integrated with the caudal septal extension graft caudally. A tip graft with lateral crural grafts was used to set the tip position. She did well with a relatively large elevation of her dorsum with radix elevation as well (Fig. 12). She also had excellent narrowing of her dorsum improving her frontal view.

Case #4

This patient is a 32-year-old Asian patient with a low dorsum and low radix and an underprojected tip. Her nose was very wide as well. She underwent placement of an SDCG type B and caudal septal extension graft. Her SDCG extended through her radix osteotomy site, raising her radix and dorsum by several millimeters (Fig. 13). The SDCG was integrated with the caudal septal extension graft. A shield tip graft with lateral crural grafts was used to increase tip projection. She did well with excellent narrowing of her nose and elevation of her dorsum.

Discussion

Augmentation of the nasal dorsum in the ethnic patient is frequently required to enhance the frontal view appearance of the platyrrhine nose. Many Asian and black patients have a low wide dorsum that demonstrates poor lateral wall shadowing and hence has poorly defined dorsal aesthetic lines. In an effort to improve the definition of the nasal dorsum, surgeons will perform osteotomies to narrow the dorsum or augment the dorsum to increase

Fig. 12. (Continued).

Fig. 12. Black patient undergoing dorsal/radix elevation using an SDCG integrated through the radix osteotomy site (SDCG type B) with full bone cuts to release and raise the bony vault. Note the elevation of the radix and narrowing of the nose. **(A)** Preoperative frontal view (left). Ten-month postoperative frontal view (right). **(B)** Preoperative lateral view (left). Postoperative lateral view (right). **(C)** Preoperative oblique view (left). Postoperative oblique view (right). **(D)** Preoperative base view (left). Postoperative base view (right). Figure is copyrighted by the author, Dean M. Toriumi ©.

Fig. 13. (Continued).

Fig. 13. Asian patient who underwent dorsal/radix elevation using an SDCG type B. The SDCG was positioned after complete release of her nasal bones (lateral, transverse, and radix osteotomies) and complete LKA release. **(A)** Preoperative frontal view (left). Ten-month postoperative frontal view (right). **(B)** Preoperative lateral view (left). Postoperative lateral view (right). **(C)** Preoperative oblique view (left). Postoperative oblique view (right). **(D)** Preoperative base view (left). Postoperative base view (right). Figure is copyrighted by the author, Dean M. Toriumi ©.

dorsal height. Narrowing the upper third of the nose using osteotomies can be problematic as it may create an unnatural appearing narrow dorsum that does not balance with the wide lower third of the nose. Dorsal grafting can result in visible grafts, warping, resorption, overaugmentation, and so on.[6]

In an effort to preserve some of the natural features of the ethnic dorsum, an SDCG was designed. The SDCG type B for radix augmentation has several unique features, including a uniquely shaped cranial end that integrates into and through the radix osteotomy site to sit on top of the frontal bone. This provides a reliable amount of radix augmentation while lifting the middle vault to balance with the tip projection. Because the SDCG is primarily below the nasal dorsum, minor deviations or imperfections are hidden and the natural contours of the native dorsum are essentially preserved. Minor defects in grafts that are placed on top of the dorsum can reveal defects over time.

The key feature is the natural transition from the nasal dorsum to the maxilla without the risk of skin contracture over an onlay graft or imperfections of a DCF graft. There is no alloplastic implant on the nasal dorsum that can become infected or extrude with time. Once the SDCG is set into place and the graft integrates to the undersurface of the bones and upper lateral cartilages, the upper dorsal vault acts as a barrier to the overlying skin envelope to camouflage minor changes in the graft.

This technique is complex and difficult and requires custom carving of the SDCG and fixation to a strong properly crafted caudal septal extension graft. Once the subdorsal cuts are made, you are committed to completing the reconstruction. In addition, extensive release of the middle vault and nasal bones is required to prevent loss of augmentation. We have found that the gaps between the bones and maxilla become calcified and the gap is stable. In fact, patients should be followed closely postoperatively to make sure a callous does not form along the gap between the bones and maxilla.

If for some reason you decide to abort the technique, you can move the bones back and then do a conventional onlay type of procedure. The surgeon should thoroughly understand and plan the operation beforehand and discuss the surgery with the patient preoperatively.

The SDCG is very effective in correcting the saddle nose deformity and is limited to the middle vault by definition. The graft used to correct the saddle nose deformity can be limited to the middle vault but still should be cantilevered under the bony dorsum for support purposes.[11] In these cases, the SDCG can be shorter and does not have to extend into the radix osteotomy site. The SDCG can also be used to salvage a failed dorsal preservation procedure, setting dorsal position irrespective of the status of the underlying septum. We are also using the SDCG to correct severely deviated noses by unlinking the dorsum from the underlying septum and setting the dorsum in the midline. Using the SDCG, one can design the graft to control the orientation of the dorsal aesthetic lines and profile contour.

The dorsal elevation technique using the SDCG type B with full push up bone cuts (lateral, transverse, and radix osteotomies) and bony elevation has a high level of difficulty. It is also recommended that the surgeon be experienced in dorsal preservation and the bone cuts associated with the push down. The surgeon should also be experienced in costal cartilage grafting in rhinoplasty. The SDCG type A is less complex and can be performed with less difficulty.

Elevation of the nasal dorsum from below provides the surgeon with precise control over positioning of the nasal dorsum as is the case with dorsal preservation methods for reducing the dorsal hump. Elevating the dorsum requires a robust segment of costal cartilage and careful carving of the SDCG. Because the SDCG is below the dorsum, the graft is a nonvisible graft as it is not adjacent to the skin envelope. Fine-tuning of the dorsal lines can be accomplished by placing small soft tissue grafts into a narrow tunnel along the nasal dorsum. However, if inadequate subdorsal support is created, the surgeon can place a moderate-sized graft on top of the dorsum to provide the proper dorsal contour. The advantage is that very large grafts are not placed on top of the dorsum that can shift, displace, resorb, or warp over time.

The limitation on dorsal augmentation using an SDCG is about 4–5 mm of elevation. If more augmentation is needed, a combination approach should be used with SDCG and soft tissue, cartilage graft, or other minor forms of augmentation.

Potential complications of the SDCG include a palpable radix prominence, some settling of the middle vault if the SDCG is not properly designed, deviation, or dorsal convexity. In one of our patients, a small dorsal convexity formed postoperatively, where a small onlay graft was placed that persists over a year postoperative. There were no instances of saddle nose deformity or loss of radix height. Nasal function is good in all of the patients as the SDCG acts to open the nasal valve and support the lateral nasal sidewalls.

Longer term follow-up will be needed to verify that this technique provides a stable change in dorsal height and favorable dorsal aesthetic lines.

Conclusions

The SDCG uses the principles of dorsal preservation and structure rhinoplasty and allows the surgeon to raise the radix and middle vault to align with increases in tip projection in the ethnic patient. The technique requires a 4–6 cm robust segment of stiff costal cartilage that is integrated with a strong caudal septal extension graft. If radix augmentation is needed, the distal end of the graft is fixed cranially through the radix osteotomy site and enables a cantilever effect, lifting the nasal dorsum to accommodate increases in tip projection. The technique is complex, but provides excellent outcomes and a very natural looking nasal dorsum.

Author Disclosure Statement

No competing financial interests exist.

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Supplementary Material

Supplementary Video S1
Supplementary Video S2
Supplementary Video S3
Supplementary Video S4

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