The Evolution of Open Structure Rhinoplasty

Elizabeth G. Whitaker, MD; Calvin M. Johnson, Jr, MD

Modifications and innovations in open structure rhinoplasty that have occurred as this technique has evolved are discussed. In addition, the philosophy and fundamentals of open structure rhinoplasty are reexamined. A retrospective review of representative patients in a private practice setting was performed. All surgical procedures were conducted in a freestanding private surgery center. The preoperative and long-term results of each patient are compared to demonstrate the effectiveness of the described techniques. The fundamental philosophy of open structure rhinoplasty is the maintenance of the integrity and strength of the nasal skeleton. Modifications of tip grafting techniques, along with additional domal grafting techniques, and a stronger focus on domal suturing techniques result in a softer contour and lack of tip tensions while maintaining structural support.

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The concept of open structure rhinoplasty was introduced to address the loss of structural integrity frequently encountered with reductive rhinoplasty techniques. A combination of weakened nasal architecture and skeletal and skin–soft tissue envelope (S-STE) disparity can lead to distortions, lack of tip projection, and poor definition. With open structure rhinoplasty, greater emphasis is placed on recontouring rather than reducing the nasal skeleton.

The open technique allows definitive diagnosis of deformities and precise structural modifications with sutured-in-place autologous grafts. Tip projection can be controlled and altered via these techniques. Less dorsal reduction may, therefore, be necessary. Less disparity between the underlying nasal skeleton and the overlying S-STE allows for more ideal redraping and recontouring.
THE EVOLUTION OF THE OPEN STRUCTURE RHINOPLASTY APPROACH

The open structure rhinoplasty approach has evolved based on the tenets of conservative resection, structural support, softer contour, and lack of tension. Conservative cartilage resection facilitates maintenance of the inherent nasal support. Structural grafts, such as columnellar struts and tip grafts, are the foundation of restoring and augmenting nasal support.

Cap grafts are being more frequently used, along with domal suturing techniques, to soften contour changes in the tip. In addition, the profile of shield grafts has been softened. Additional domal support grafts have been incorporated, including the power strut and domal apex grafts, which in some cases may obviate the need for tip grafting.

Avoiding tensions in the nasal tip is an integral part of the open structure rhinoplasty techniques. Changes in contour, projection, and rotation achieved by placing significant tension in the dynamics of the nasal tip tend to distort with time and with scar contracture, leading to unpredictable and unstable results.

THE LOWER THIRD OF THE NOSE

Open structure rhinoplasty focuses on restructuring the lower third of the nose. The critical elements are restructuring the nasal skeleton and the composition of the S-STE. Many of the incisions and maneuvers performed during rhinoplasty weaken the major and minor tip support mechanisms. The weight of the overlying S-STE, combined with the forces of scar contracture, can result in distortion of the nasal skeleton if its structural integrity is compromised.

Overreduction of the nasal skeleton leads to a disharmony between the S-STE and the nasal skeleton. This can result in fibrosis and scar filling the disparity between the nasal skeleton and the S-STE, producing an amorphous undefined nasal tip. This is a particular concern in patients with thick sebaceous nasal skin. Thinning of the subcutaneous tissue of the supratip may facilitate redraping of the skin. This should be done conservatively, however, to avoid injuring the blood supply and potentially inducing further scarring. In contrast, thin nasal tip skin may reveal any irregularity in the underlying nasal skeleton. Contracture of the skin envelope with time may result in buckling or distortion of the cartilages if they are weak. Therefore, construction of a strong nasal skeleton is important whatever the quality of the overlying S-STE.1

THE TRIPOD CONCEPT

The dynamics of the skeleton of the lower third of the nose may be compared with a tripod. The central leg is formed by the conjoined medial crura, and the other 2 legs are formed by the lateral crura. Support of the cartilages of the tripod is also provided by ligamentous attachments, including those between the medial crura, the inferior septal angle, and the nasal spine and the inter-domal ligament between the lateral crura and the anterior septal angle. Alteration of any limb of the tripod affects tip position and rotation.2

THE ELEMENTS

Columella

The columella must be assessed from an aesthetic perspective, particularly in relation to the alar rim. This requires evaluation of the relationship between the septum and the medial crura. An excessively long septum pushes the columella caudally, resulting in a tension nose deformity. A tension nose deformity may also result from a prominent pedestal and may require excision of the nasal spine or anterior septal angle. The aesthetic result of this deformity is a blunting of the nasolabial angle and foreshortening of the upper lip. Excision of the caudal septum along with the membranous septum, if necessary, brings the medial crura in closer proximity to the caudal septum. Reduction of the nasal spine may also be required.3

Excessively long lateral crura can push the nasal tip and columella caudally, also affecting the relationship between the columella and the nasal septum. Reduction of the 2 lateral limbs of the tripod may be required to correct this deformity.

Finally, the medial crura themselves may result in a convexity of the columella, which is corrected by excising a caudal strip of medial crura. Placement of a tip graft may increase the profile of the columella. If this is aesthetically undesirable, then the caudal edge of the medial crura may be excised, laying the foundation for the tip graft.

Lateral Crura

The lateral crura constitute the lateral limbs of the tripod. If the lower lateral cartilages are inherently weak or have been weakened by reductive rhinoplasty, they should be supported with lateral crural grafts to prevent distortion and buckling. It is important in open structure rhinoplasty that there be no tension on the nasal skeleton. The lateral crura may be particularly susceptible to buckling or twisting if there is significant tension in the nasal tip. If the tension cannot be completely alleviated, reinforcement with lateral crural grafts may be required.

The shape and length of the lower lateral cartilages are major factors in tip aesthetics. They affect contour, rotation, and projection of the nasal tip. A bulbous nasal tip with a broad arch to the lower lateral cartilages may require excision of a wedge of intermediate crura to break the arch, flatten the lower lateral cartilages, and result in a more acute angle at the domes. Division of the domes and excision of a segment of intermediate crura may also be required in patients with excessively long lateral crura pushing the nasal tip inferiorly.

Domal division and excision weakens the nasal support and should be used cautiously. Further augmenting nasal support after this maneuver with a tip graft is
usually indicated. This also provides camouflage, particularly in thin-skinned patients. While cephalic trim may decrease the width and provide some flattening of the lower lateral cartilages, thereby narrowing the nose and producing some rotation, it does not significantly affect the intrinsic curvature of the cartilages. Therefore, domal division is a necessary technique when significant change in the intrinsic curvature of the lower lateral cartilages is required.

If the lower lateral cartilages are long, but without a broad arch or a convex curvature, then excising a wedge of cartilage laterally will shorten the lower lateral crura. This may be performed as a lateral crural overlay or a direct suture reconstitution of the edges of the lower lateral crura. This maneuver, while not affecting the strength of the domal unit, may weaken the lateral limb of the tripod. Placement of a lateral crural graft to provide further support may be desirable. It is important to perform this maneuver symmetrically.2,4

**Domal Unit**

Methods of providing definition and strength to the nasal tip include suturing techniques (single dome or transdomal), domal support grafts (power strut and domal apex grafts), and tip grafts (cap, shield, and buttress grafts). Our approach uses domal suturing techniques with greater frequency, especially in the thin-skinned patient requiring subtle tip definition. This may preclude the need for a tip graft in these particular patients. However, domal suturing should be used only when subtle narrowing or definition is required and can be achieved without adding significant tension.

If any domal division maneuvers are performed, tip grafts are usually required for camouflage. If significant projection of the nasal tip is required, then a shield graft is used. Particularly in thin-skinned patients, the cap graft provides excellent camouflage and a softer profile when significant tip projection is not required.

Domal strength can also be augmented using newer grafting techniques to support the existent domal units. Domal apex grafts are rectangular wedges of cartilage, ideally septal, placed directly beneath the dome. A pocket is developed between the cartilage and the vestibular skin, into which the graft is placed and secured with sutures. Domal apex grafts provide additional strength to the domes after domal suturing or domal division. In some instances, slight augmentation of domal projection can also be achieved. Domal apex grafts assist in maintaining domal projection against the forces of scar contracture, particularly in interrupted strip techniques.

Domal support and projection can also be augmented using a power strut. This graft is longer, wider, and thicker than a traditional columellar strut. The additional strength of this graft allows the domes to be pulled superiorly and medially onto the strut, providing narrowing of the interdomal distance along with increased projection and support. The power strut can be used in conjunction with domal suturing techniques to provide additional narrowing. The ability to achieve additional tip projection with the power strut may obviate the need for tip grafting, particularly in patients requiring significant increases in projection but without significant bulbous tip cartilages.3

**TECHNIQUES**

**Columellar Strut**

A columellar strut is placed between the medial crura to strengthen the central limb of the tripod. If there is any inherent buckling or weakening of the medial crura, the columellar strut provides a strong stable foundation. The ideal material is harvested septal cartilage, if available. Auricular cartilage may also be used, but is less rigid and possesses a curvature. A pocket is created between the medial crura, and the strut is sutured into position. The columellar strut may extend below the medial crura to lengthen the central limb of the tripod. However, care must be taken not to seat the strut directly on the nasal spine, because the graft may move from one side of the spine to the other, causing a disturbing click and columellar asymmetry. The caudal edge of the medial crura should overlap the strut, providing camouflage. Symmetry of the crura in relation to the columellar strut must be maintained to prevent distortion of the nasal domes.2,5

**Power Strut**

The power strut serves to similarly support the central limb of the tripod. It is thicker, longer, and wider than the columellar strut. It is similarly placed in a pocket between the medial crura, extending below the medial crural feet, but short of the nasal spine. The domes are then pulled superiorly and medially onto the strut, providing narrowing and projection of the domes (Figure 1). This allows augmentation and support of the domal units without use of tip grafting techniques. The ideal material for the power strut is septal cartilage because its rigidity provides the necessary support (Figure 2 and Figure 3).

Figure 3. Power strut placement. A, Domal division and suture reconstitution. B, Power strut sutured in position in a pocket between the medial crura. C, Domal units pulled onto the power strut. D, Operative diagram.
Domal Apex Grafts

Domal division and excision serves to weaken the nasal skeleton. Augmentation of nasal support after this maneuver with a tip graft is usually indicated. Another method of augmenting domal support is the placement of a rectangular cartilage wedge directly beneath the dome in a pocket developed between the vestibular skin and the cartilage (Figure 4). This provides support to the divided domal unit against the forces of scar contracture to prevent any distortion or loss of projection of the weakened domal unit. This may obviate the need for tip grafting for support in cases in which it is not needed for camouflage. Domal apex grafts may also be used in conjunction with domal suturing techniques to augment the support and projection of the domal units (Figure 5 and Figure 6).

Lower Lateral Crural Grafts

Lower lateral crural grafts are generally harvested from either sepal or auricular cartilage. Auricular cartilage is less rigid than sepal cartilage and possesses an inherent curvature, lending itself well to these grafts. Lateral crural grafts can be placed as onlay grafts to support weak or overly resected lower lateral cartilages to prevent or correct buckling of the crura. Onlay grafts can also be used to correct asymmetries and camouflage concavities in the lower lateral crura.

When division of the intermediate or lateral crura is required to change the convexity of the crura or decrease their length, lateral crural onlay grafts are used for support and camouflage. The lateral crural graft is sandwiched to the underlying lower lateral crura to eliminate dead space and stabilize the crura.

In cases of significant buckling or distortion of the lower lateral crura, the lower lateral crura may need to be excised and replaced. The domes are divided, and the lower lateral cartilage is carefully elevated off of the underlying soft tissue and vestibular skin. If the lower lateral crus in question is overly concave, it can be reversed after excision—its concavity can be reversed to a convexity. If there is significant concavity or buckling of both lower lateral crura, then a lower lateral crural exchange may be desirable. The lower lateral crura can be excised, shaped, reversed, and exchanged. As a result, the left concave lower lateral crus becomes a right convex one, and visa versa (Figure 7 and Figure 8). Further camouflage to correct any residual asymmetries of curvature can then be provided with lower lateral crural onlay grafts if needed. Alternatively, if the lower lateral crura are so severely buckled that even these maneuvers cannot compensate for the distortions of contour, a new lower lateral crus can then be fashioned of harvested cartilage, usually auricular, and sutured into position. Medially, it is sutured to the edge of the medial crura to reconstitute the domal unit. Laterally, it is sutured to soft tissue and further stabilizing sutures are placed along its length.

Granted, such maneuvers are not often indicated. However, in a few cases, the lower lateral crura may be so malformed that support grafts alone may be inadequate to compensate for the distortions of the lower lateral cartilages and the tensions they place on the nasal tip. In these instances, excision and replacement of the lower lateral crura can be invaluable for restoring normal contour and support while reducing tension of the nasal tip.

Tip Grafting

Placement of a tip graft allows control of nasal tip projection and shape. It also provides camouflage of the underlying nasal tip skeleton, particularly useful when dome division has been performed. The tip graft allows the surgeon to set the nasal tip at the desired projection and then modify the nasal dorsal height accordingly.

The ideal material for tip grafting is autologous nasal septum because of its stiffness and relative flatness. Conchal cartilage may also be used, but is less ideal because of its lack of rigidity and its inherent curvature. The graft is then carved into the appropriate shape for either a cap graft or a shield graft.

The shield graft is a 3-dimensional structure. The graft is carved with carefully beveled edges to blend in with the cartilage of the nasal tip. The graft is thickest at the tip and thinnest over its base, where the elongated columnellar extension is secured to the medial crura. The general dimensions are 11 to 15 mm in length, 7 to 12 mm in width, and 1 to 4 mm in thickness. Nasal tip projection can be set by altering the position of the graft on the medial crural/columnellar complex. Nasal length can be affected by the thickness and position of the graft. Ideally, the shield graft should override the dome slightly (1-2 mm), with approximately 0.5 mm of overcorrection. Avoiding overprojection of the tip graft is important for preventing a tombstone deformity. The columnellar complex should be completely flat and symmetric to serve as a foundation for a tip graft, and trimming of the medial crura may be required. Once the tip graft is in place, it is further carved in situ to obtain the ideal projection and contour (Figure 9 and Figure 10).

The shield graft is carved with a smooth curvature rather than a strong bidomal shape to provide softer definition to the tip (Figure 11). Care must be taken to bevel the edges and avoid any sharp angles or prominent edges. This is particularly important in the nasal tip with a thin overlying S-STE. The shield graft can be further camouflaged by placing a buttress graft immediately behind the tip graft to smooth the transition.

Figure 6. Domal apex graft placement. A, Pocket between cartilage and vestibular skin being developed. B, Domal apex graft being placed in the pocket. C, Domal apex graft being sutured into position. D, Operative diagram.

Figure 8. Lower lateral crural exchange and cap graft placement. A, Severely buckled lower lateral crura. B, Cartilage division and elevation of lower lateral crura off of underlying vestibular skin. C, Replacement of right lower lateral crura with the flipped left lateral crura to provide convex contour. D, Lower lateral crura sutured in position after exchange and after cap graft placement for camouflage. E, Operative diagram.

The buttress graft is a rectangular or quadrangular piece of either septal or conchal cartilage carved with beveled edges and sutured in place behind the shield graft. The buttress graft can also support and prevent retrodisplacement of the tip graft. This is particularly important when the tip graft projects significantly above the underlying nasal tip skeleton or in patients with a heavy S-STE. When auricular cartilage is used, this double-layer technique helps to strengthen the tip graft.

The contour of the shield graft can be tailored to the desired effect. Aggressive beveling to thin the leading edge allows the tip graft to bend slightly and more directly overlie the domal units. Suturing directly to the apex of the domes generally creates tension in the nasal tip and should not be done unless the graft abuts the domes, tension free. Less beveling and thinning should be used if significant projection of the shield graft above the domal units is required. A buttress graft is often used in this instance for support and contour.

An alternative tip grafting technique, particularly in the thin-skinned patient, is a cap graft. Cap grafts can be used to provide slight projection and definition. It is a quadrangular cartilage graft, with the wider aspect of the graft overlying the domes and the narrower aspect tapered over the lower lateral crura. The graft edges are carefully beveled, and it is sutured in position overlying the domes to provide definition to the tip (Figure 12). Again, it is further carved in situ to obtain the ideal contour. Because of its softer profile, it is well camouflaged even in the thin-skinned patient (Figures 7 and 8). It can also be used for camouflage after domal division. However, when significant tip projection is required, a shield graft is usually necessary.2,5

THE UPPER TWO THIRDS OF THE NOSE

Nasal skin varies in thickness along the length of the nose. It is thinnest over the rhinion, then becomes progressively thicker in the region of the supratip. It is also thicker in the region of the nasion. As a result of the varying thickness of the nasal skin, a slight skeletal hump should exist at the rhinion to maintain a straight dorsal profile. Unlike the skin of the nasal tip, the skin overlying the upper two thirds of the nose is relatively thin and mobile, containing little subcutaneous fat and sebaceous glands.

Care must be taken to avoid overresection in the area of the rhinion, where the nasal bones are more delicate. The thicker bone more superiorly in the region of the nasofrontal angle must be adequately addressed to produce a smooth dorsal profile. The dorsal hump, if present, can be removed by rasping or with a Rubin osteotome in the case of a larger hump. Care must be taken to resect the dorsal hump submucosally, so there is no communication with the nasal cavity.

Narrowing of the nasal dorsum is achieved with osteotomies. If minimal reduction of the nasal dorsum was required and the width of the dorsum is proportional to the nasal base, then no narrowing may be needed. However, decreasing the dorsal height results in an apparent widening of the nose, because the width of the nose is viewed in relation to its height. Reducing the width of the nose may restore the apparent nasal proportion.

Whenever significant dorsal reduction has been performed, however, osteotomies are required to prevent open roof deformities. Lateral osteotomies medialized the lateral nasal walls. Back-fracture ideally takes place between the thin and the thick areas of the nasal bones. If the fracture takes place through the thicker superior bone, a rocker deformity may result, requiring an additional osteotomy in the appropriate back-fracture location. If minimal hump resection has been performed, medial osteotomies are required to control the back-fracture and alter the position of the nasal bones. Medial osteotomies are directed superolaterally and performed before lateral osteotomies.

Through the open structure approach, a narrow middle third of the nose can be addressed. Spreader grafts can be sutured into position between the upper lateral cartilages and the septum to widen the middle third of the nose. This may be required for pure aesthetics or to provide structural support in the case of nasal valve pathology.

Once the height of the nasal dorsum has been set, tip projection can be altered to fit appropriately with open structure techniques, as previously outlined. This differs from the traditional rhinoplasty approach, in which
the tip height is initially determined and the nasal dorsal height adjusted to fit it.\textsuperscript{2}

CONCLUSIONS

The philosophy of open structure rhinoplasty emphasizes recontouring, rather than reduction, of the nasal skeleton. Maintenance or augmentation of structural integrity through grafting techniques facilitates aesthetic results able to resist the forces of scar contracture and remain stable over time. The evolution of open structure rhinoplasty has been based on the triple tenets of softer contour, increased structural support, and lack of tip tensions. Thus, open structure rhinoplasty techniques have evolved to a greater focus on domal suturing techniques, softer contouring of tip grafts, and additional structural grafting techniques providing support to the existent domal units without tip grafting. The goal of structural strength is unchanged, but with additional grafting and suturing techniques, along with modifications of tip grafting techniques, we can achieve a softer more natural contour while maintaining the structural and skeletal integrity that is the foundation of open structure rhinoplasty.

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Corresponding author and reprints: Elizabeth G. Whitaker, MD, Northwest Facial Plastic Surgery, 780 Canton Rd, Suite 330, Marietta, GA 30060 (e-mail: elizwhita@aol.com).

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