Avoiding Complications in Functional and Aesthetic Rhinoplasty

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Abstract

Historically, nasoseptal surgery favoring functional considerations has compromised aesthetic ones, and vice versa, but modern techniques have evolved that allow symbiotic achievement of both goals. Nasoseptal surgery is among the most commonly performed plastic surgical procedures in the United States, and while it is generally well tolerated, there are a few surgical and aesthetic complications of which to be aware. Herein, we review surgical techniques that improve the nasal airway and nasal aesthetics in a top-down approach with a discussion of possible ensuing complications.

Keywords
- rhinoplasty
- revision surgery
- surgical complications
- facial plastic surgery

In practice, "rhinoplasty" is less of a specific term for a particular procedure and more of a general category that encompasses a range of operative approaches and techniques involving manipulation of the external nasal framework and septum. Broadly speaking, nasoseptal surgery can be divided into two categories: functional and aesthetic. While historically, favoring functional considerations meant compromising aesthetic ones and vice versa, modern techniques have evolved that allow symbiotic achievement of both goals. Male and female patients often present desiring a nose that both functions well and is aesthetically pleasing, which is frequently achievable by straightening a crooked dorsum and septum, placing spreader grafts, and reducing inferior turbinates. Similarly, patients often seek reduction of a dorsal hump, narrowing of the midvault, or refinement of the tip, all of which can be achieved without adversely affecting patency of the nasal airway and overall nasal function. Anyone contemplating undertaking a facial operation, and nasal surgery is no exception, must consider both the cosmetic implications of any maneuvers to be performed, as well as their functional implications, and the possible complications that can occur, which makes counseling a critical component of the preoperative process.

There are numerous techniques that have been described, the goal of which is to effect change without adding volume, and because comparatively little cartilage is required, they are also applicable in the setting of revision rhinoplasty, when septal cartilage is often unavailable. Often, the nose is conceptually and surgically approached in thirds, and each is addressed separately. Herein, we review surgical techniques that improve the nasal airway and nasal aesthetics in a top-down approach with a discussion of possible ensuing complications.

General Surgical Complications

There are numerous complications that can arise following rhinoplasty and nasoseptal surgery beyond aesthetic and functional issues. These surgical complications include but are not limited to persistent epistaxis, septal hematoma formation, infection, and, more severely, cerebrospinal fluid (CSF) leak.[1] First, hemorrhagic complications such as epistaxis

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and septal hematoma formation are among the most common complications following nasal surgery. Epistaxis, while common, is also typically mild and controlled with conservative measures and nasal sprays. Persistent bleeding is rarer but may require splint removal, nasal cautery, or placement of nasal packing, which carries the risk of disrupting the functional and aesthetic changes of the operation. Thankfully, serious bleeding requiring a return to the operating room occurs in less than 1% of cases.[1] Septal hematoma formation is also rare, but it requires urgent drainage to prevent infection or cartilage necrosis with subsequent nasal instability, septal perforation, and external nasal deformity.

Infectious complications following nasal surgery also vary from mild cellulitis to severe toxic shock syndrome. In general, infection is rare, however, likely owing to the highly vascularized nature of the nose and face, and many cases improve with conservative wound care and a course of oral antibiotics. A majority of surgeons performing nasoseptal surgery give prophylactive antibiotics at the time of surgery and prescribe a course of oral antibiotics to be taken afterward, though the literature does not demonstrate a significant reduction in infectious complications, even when nasal splints are placed, if postoperative antibiotics are taken.

Arguably the most severe complication following nasal septal surgery is leakage of CSF due to intracranial injury. CSF leak is very rare, but it can occur when surgical instruments inadvertently violate the cribriform plate or when bony manipulation of the perpendicular plate of the ethmoid causes a fracture along the skull base. The vast majority of traumatic CSF leaks will resolve on their own with conservative management including bed rest, sinus precautions (no sneezing, nose-blowing, straining), and elevation of the head, but some may require placement of a lumbar drain or surgical exploration and repair.

Aesthetic Considerations and Complications

Upper Vault

While comparatively little airflow passes through the upper third of the nose,[2] patients, especially with a history of trauma, will often present with crooked nasal bones and a desire to have the nose straightened. Straightening the bony vault with osteotomies, either bilateral lateral osteotomies with a percutaneous transverse osteotomy to shift the entire vault as a unit or bilateral medial and lateral osteotomies to move the two sides independently, will generally improve the nasal airway by reducing turbulence. There are a couple of potential pitfalls from osteotomies, however.

First, a reduction of internal nasal cross-sectional volume can accompany narrowing of the bony vault, which may reduce airflow under certain circumstances. To avoid this, some have advocated building up the dorsum with onlay grafting to produce a suitably narrow appearance to the nose without diminishing the internal volume. Onlay grafting should be executed with caution, however, as materials can shift, extrude, or lead to visible and palpable irregularities. Dorsal onlay grafting can be useful in the case of a dorsal hump combined with a deep radix, when complete reduction of the hump from the anterior septal angle all the way to the nasion will result in a noticeably low dorsum. A more aesthetically pleasing and functional solution is to perform a less aggressive dorsal hump reduction combined with grafting of the radix, resulting in a straight and appropriately projected dorsum when viewed in profile. The main caveat is to avoid excessive grafting of the radix to the extent that the nasofrontal angle becomes overly obtuse and inadvertently produces a "Greek nose" that flows directly into the forehead, as exemplified in the Venus de Milo and Myron's Discobolus. Many grafting materials have been described, including autografts, allografts, and synthetic materials. The senior authors (Y.D. and S.C.) prefer the use of allografts. In the case of dorsal onlay grafting, the senior authors advocate thin, pliable materials such as mastoid periosteum and temporoparietal fascia over cartilage, as they can easily be secured in position with suture to prevent shifting, are less prone to resorption, are not prone to extrusion, and will not cause visible contour irregularities or palpable bumps after healing has completed.

Next, failure to fully complete or properly execute bony hump reduction and osteotomies can lead to an open-roof and inverted-V deformities. In the first case, reduction of a bony hump with failure to then medialize the nasal bones can leave a palpable and visible widening of the bony dorsum and a gap between the nasal bones and septum. In the latter, disarticulation of the upper lateral cartilages from the nasal bones during osteotomy can create a palpable and visible transverse step-off, the inverted-V. In the case of an open roof, lateral and transverse osteotomies with completion of bilateral paramedian osteotomies will allow shifting of the nasal bones and closure of the gap. In the case of an inverted-V deformity, onlay grafting can camouflage the defect, but true correction requires resuspension of the upper lateral cartilages, often via an open approach.

Midvault

Since the original description of the spreader graft by Sheen in 1984,[3] interposing a piece of cartilage between the dorsal septum and the medial edge of the upper lateral cartilage has been the gold standard for restoring a straight contour to the midvault and airflow through the internal nasal valve. The internal valve is the region of the nasal cavity bounded by the septum, the head of the inferior turbinate, and the inferior margin of the upper lateral cartilage.[4] At the superior aspect of this triangle is an angle classically considered to measure 15 to 20 degrees, which is the narrowest portion of the nasal airway and, as such, both one of the greatest sites of airflow reduction and one of the most promising targets for intervention.[2] In practice, however, the angle is actually closer to 35 degrees when there is no septal swell body present to narrow the valve.[5] The swell body itself is a collection of submucosal glandular tissue on the superior septum of the middle third of the nose that is frequently thought to engorge and shrink with changes in blood flow, much like a turbinate, but does not actually consist of erectile tissue on histologic examination and therefore does not respond as effectively to vasoconstriction as is commonly believed.[5,6] Regardless, reduction of the septal swell

body with cold ablation or radiofrequency ablation appears to be an effective means of increasing airflow through the internal valve without resorting to cartilage grafting techniques.

The Nasal Obstruction Symptom Evaluation (NOSE) survey is a validated questionnaire evaluating patient's nasal breathing on a scale of 0 (no breathing problems) to 100 (severe breathing problems), and reduction of the septal swell body has been demonstrated to improve NOSE scores significantly by an average of 24 points.[7–9] In many cases, however, cartilage manipulation will be required either to improve contour or to further augment the nasal airway; spreader graft placement has also been shown to improve the nasal airway significantly, typically improving NOSE scores by 24 points more than septoturbinoplasty alone.[10] Unfortunately, traditional placement of spreader grafts, along the dorsum between the septal cartilage and the medial border of the upper lateral cartilage, often creates a wide and flattened appearance to the bridge of the nose, especially when performed bilaterally. For some patients with an overly pinched midvault, widening may be aesthetically advantageous. For most, however, widening should ideally be avoided; using grafts with a trapezoidal cross-section rather than the traditional rectangular cross-section or by recessing the spreader grafts 1 to 1.5 mm below the margin of the dorsal septum can alleviate undesired widening of the dorsum. The graft is placed with the narrow end of the trapezoid superiorly, which produces a slimmer and more rounded dorsum than seen with traditional spreader grafting, while still splaying the upper lateral cartilage outward in the internal valve.[11] Alternatively, the medial border of the upper lateral cartilage can be advanced up and over the spreader graft and then sutured to the contralateral upper lateral cartilage; this has a similar effect on the dorsal contour but possibly widens the internal valve angle more effectively.[12] A disadvantage to this technique, however, is that it can increase tension across the dorsal cartilaginous septum, particularly when the upper lateral cartilages are not broad, and this may rarely result in a saddle deformity if the dorsal septum is insufficiently robust. In revision cases or whenever there is not sufficient septal cartilage to make adequate spreader grafts, autologous ear or rib cartilage can be harvested. Appropriate spreader grafts are strong and straight pieces of cartilage, and therefore the authors prefer autologous rib harvest; ear cartilage is often short, thin, and flimsy, serving as a good source for other grafts or around the lower lateral cartilage but not as spreader grafts. We have previously published our boat technique of safe and efficient autologous rib harvest.[13]

In some cases, particularly when there is a dorsal hump and an excess of upper lateral cartilage, the upper lateral cartilages can be disarticulated from the dorsal septum and their medial edges can be turned inward to create what is known as "autospreader" grafts or flaps.[14] This technique requires elevation of the mucosa off the undersurface of the medial upper lateral cartilage and gentle scoring of the superficial surface of the cartilage about 2 mm lateral and parallel to the dorsal septum to determine the location of the fold. The upper lateral cartilage is typically thinner than septal cartilage, and therefore there is not usually much widening of the dorsum when the upper lateral cartilage is folded on itself and resuspended to the septum, but the folding of the upper lateral cartilage also results in its splaying outward, opening the internal nasal valve and improving airflow. This technique can often also be employed in revision rhinoplasty, when there may no longer be sufficient septal cartilage remaining to create spreader grafts. Lastly, if a minimally invasive technique is required due to patient preference or if a high risk–benefit ratio of reopening the nose in a multiple revision case precludes a surgical option, percutaneous placement of resorbable polymer struts such as Latera (Stryker ENT) may reduce collapse of the nasal valve, although evidence for the efficacy of these implants in the setting of revision rhinoplasty is lacking, and the authors do not advocate this technique for any situation as, in their experience, they have not improved nasal breathing and are prone to extrusion.

Lower Third

The nasal vestibule contains the external valve, which is bounded by the caudal edge of the lateral crus of the alar cartilage, the ala, the membranous nasal septum, and the nasal sill.[15] Numerous problems arise in this area, with both functional and cosmetic ramifications. While a deflection of the nasal septum away from the midline at any point can decrease airflow, a caudal septal deflection is often a presenting cosmetic complaint. Deflection of the caudal septum can also cause lateral malposition of the medial crural footplate of the alar cartilage, which may further narrow the external valve. There are many options available to straighten the caudal septum, including disarticulation of its attachments to the nasal spine and suturing to the contralateral side of the spine, the so-called "swinging" door technique described by Metzenbaum in 1929.[16] Occasionally, scoring the concave side of the cartilage will permit the septum to return to its midline position by releasing the perichondrium, but this maneuver is more effectively combined with other techniques, such as tongue-in-groove suturing of the caudal septum between the medial crura of the lower lateral cartilages.[17] The tongue-in-groove technique is particularly powerful because it also allows the surgeon to reestablish the position of the nasal tip relative to the septum, thereby controlling the projection and rotation with a high degree of precision. The drawback to the tongue-in-groove technique, however, is that it tends to decrease columellar show. In some cases, the caudal septum is too fractured or misshapen from prior trauma or surgery to be straightened without additional support. A septal batten graft may prove useful in this scenario, but this requires that a moderately large piece of straight cartilage be available, and it necessarily doubles the thickness of the cartilaginous septum, which may have an adverse impact on the nasal airway.[18] Rigid polydioxanone (PDS. Ethicon, Bridgewater, NJ) plating can provide substantial long-term support to the caudal septum while minimizing the addition of bulk, as it is only 1 mm or less in thickness, depending on the product selected.[19,20] Once the caudal septum is returned to midline, the medial crural footplates often follow, but if they do not—or if they

happen to be wide congenitally—a medial footplate narrowing suture can be placed. This suture is placed through the medial crural footplates and across the columella in a mattress fashion using small stab incisions just through the skin on either side of the columellar base to allow the suture, typically a 6–0 polypropylene, to bury itself as the stitch is tightened. When placing this suture, it is critical not to overtighten it, otherwise the angle between the base of the columella and the nasal sill will sharpen, resulting in an operated appearance.

On the superolateral surface of the external nasal valve, recurvature of the lateral crura of the alar cartilages can contribute to narrowing, as can excessive thickness that may result from lateral crural strut grafting.[21] Some surgeons will avoid placement of lateral crural strut grafts because of their tendency to narrow the nasal airway and instead elect to use alar batten grafts,[22] which stent open the external valve against dynamic collapse, but often add visible width to the supratip region and may subsequently migrate, causing noticeable asymmetry. The fact that many patients also present for primary rhinoplasty complaining of a wide supratip or for secondary rhinoplasty because of visible grafts should trigger the surgeon to identify a means of providing relief from dynamic collapse, straightening recurved lateral crura if necessary and avoiding noticeably widening the nose. A technique that often accomplishes this goal is the extended alar contour graft,[23] which is a combination of the lateral crural strut graft and the alar contour, or rim, graft.[21,24] This maneuver involves placing a long and thin, roughly 1.5 × 20 mm, piece of cartilage along the undersurface the lateral crus of the lower lateral cartilage just lateral to the dome, similar to a lateral crural strut, extending laterally along the margin of the ala, like a rim graft. By placing the graft in this configuration, the required amount of cartilage is minimized, which is useful in the revision setting, and the risk of adding bulk to the nasal tip is reduced. Additionally, tip and alar irregularities can be corrected at the same time the external valve is reinforced to reduce collapse during inspiration.

Dynamic collapse of the external valve is normal to some extent, with most patients demonstrating some degree of narrowing above the alae during forced inspiration due to the Bernoulli effect: the rapid flow of a fluid—in this case, air—causing a decrease in pressure that then draws in the lateral nasal wall. Excessive or asymmetric dynamic collapse is abnormal, however, and should be addressed by attempting to identify whether the problem stems from insufficient support against the pull from low-pressure airflow (more common when the collapse is bilateral) or whether the issue is a narrow external nasal valve (more common when the collapse is unilateral). In the latter case, opening the vestibule by correcting a caudal septal deflection or narrowing the medial crural footplates will decrease the velocity of airflow and ameliorate the negative pressure phenomenon. In the former, supporting the lateral crura of the alar cartilages and the nasal alae themselves may be necessary. Because cartilage grafting may lead to a visible increase in the size of the nose, especially in thin-skinned Caucasian females, techniques that avoid placement of additional cartilage may be preferable in certain cases. One particularly effective technique that both reinforces the lateral nasal wall and straightens the lateral crura of the alar cartilages is the cephalic turn-in flap, which was described in 2009 by Murakami et al.[25] The technique involves scoring the lateral crura of the lower lateral cartilage in the same location where one would make an incision for a classic cephalic trim and then reflecting the caudal portion inferiorly into a pocket developed between the medial surface of the cartilage and its underlying vestibular mucosa. The effect is that the thickness of the cartilage is doubled and the crura reinforced, but they are still thinner overall than they would be after grafting with septal cartilage. Additionally, abnormal curvatures of the lateral crura are reduced when the curvature in the superior portion of the lateral crus is reflected downward and opposed to the mirror-image curvature in the inferior portion of the crus, which allows the contours to cancel each other out. Lastly, the technique also debulks the scroll region, just as a cephalic trim does, which often produces a favorable cosmetic result; the doubling of the lateral crural thickness may also mean that a more aggressive maneuver can still be safe, instead of having to leave an intact strip of at least 6 mm in width, as is necessary in a cephalic trim to prevent alar notching.[26] Ultimately, however, after supporting the nasal valves, the surgeon must not overlook the contribution of the septum and turbinates to nasal airflow obstruction.

Turbinoplasty

Turbinoplasty is an oft-neglected aspect of nasal surgery because of its simplicity and rapidity compared with other components of rhinoplasty, but its importance to nasal airflow should not be underestimated, particularly when other nasal maneuvers being performed for cosmetic reasons may compromise nasal breathing. In the practice of authors M. H. and A. V., patients undergoing turbinoplasty noted a mean improvement in the NOSE score of 37 points (unpublished data) comparable to what is seen with spreader graft placement and reduction of the septal swell body. There are probably almost as many different methods of performing a turbinoplasty as there are surgeons who practice it, but the main goal of the procedure is to reduce the size of the inferior turbinate while minimizing disruption of the mucosa. Some methods, such as microdebridement, cold ablation, radiofrequency ablation, and bipolar electrocautery, attempt to reduce the size of the erectile submucosal tissue through necrosis and scarring while leaving the overlying epithelium intact.[27–29] A more traditional approach involves incising the turbinate and removing the conchal bone to allow the soft tissue to contract into a smaller volume, and this can be combined with the aforementioned modalities as well.[30] Some surgeons go so far as to remove large segments of the inferior turbinates outright, and generally have good results, but this approach carries with it the risk of causing atrophic rhinitis, also known as ozena or "empty nose syndrome," a difficult-to-treat situation in which nasal airflow is excellent but damage to sensory mucosa leaves patients unable to feel that airflow, causing a sensation of chronic, severe nasal obstruction that can be extremely distressing for some people.[31–34]

Conclusion

Overall, nasoseptal surgery is commonly performed and, with modern techniques, can symbiotically improve nasal breathing and appearance. In general, placement of synthetic materials in the nose should be avoided. When there is insufficient septal cartilage for grafting material, autologous rib and ear are excellent donors.

Disclosures
The authors have no financial disclosures. The work herein does not necessarily represent the views of the United States Army or Department of Defense.

Conflicts of Interest
None declared.

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