Management of the Middle Vault
Ira D. Papel

Management of the middle vault in rhinoplasty was for many years considered little more than removal of a hump deformity. The traditional reduction rhinoplasty often included sharp resection of the middle vault apex (cartilage and mucosa) with little regard to nasal function or long-term sequelae. In the 1980s, surgeons began to describe long-term complications of this approach and modified rhinoplasty techniques to avoid these problems. Reconstructive rhinoplasty techniques were also developed to repair damaged middle vaults. Nasal valve pathology is often overlooked as a source of nasal obstruction. Many surgeons concentrate on the septum, turbinates, and presence of mucosal abnormalities before considering the lateral nasal wall as a problem. Although it is important to rule out inflammatory, immunologic, septal, and other abnormalities in the nose, it is also important to consider the internal and external nasal valves in a differential diagnosis. In this chapter we will describe these techniques and identify patients who are at risk of middle-vault pathology in rhinoplasty.

MIDDLE-VAULT ANATOMY

Beneath the nasal skin and soft tissue, the middle vault is composed of the paired upper lateral cartilages and attached mucosa. At the cephalic end the upper lateral cartilages are fused with the nasal bones, inserting just under the caudal end of the bones. Medially the cartilages fuse with the cartilaginous septum, the caudal end separating from the septum and lying fairly mobile. The caudal end of the upper lateral cartilages may have a recurvature or scroll that has attachments to the lower lateral cartilages. Laterally the upper lateral cartilages approach the pyriform apertures, fusing with dense fibrous tissue. Mucosa is tightly attached to the internal surface of the cartilages and is continuous with the lining of the septum and lateral nasal wall (Fig. 35–1).

The caudal margin of the upper lateral cartilage, the septum, the floor of the nose, and possibly the anterior head of the inferior turbinate define the internal nasal valve. This is generally regarded as the narrowest point of air flow through the nose. The angle between the septum and the upper lateral cartilage has a normal range of 10 to 20 degrees, and narrowing of this angle due to trauma, surgery, or disease can cause significant nasal obstructive symptoms. The nasal valve has a cross-sectional area of 55 to 83 mm² and represents the narrowest area of the nasal passage. The nasal valve is the site of greatest nasal resistance (Fig. 35–2).

SIGNIFICANCE OF MIDDLE VAULT ANATOMY IN RHINOPLASTY

Rhinoplastic surgeons must be able to evaluate and address the middle-vault region to provide acceptable functional and cosmetic results. Many patients present with a wide middle vault and internal nasal valve where hump reduction and narrowing of the internal valve do not cause later problems. This is particularly true in the African American population. However, the surgeon, must be able to identify patients in whom further narrowing is ill advised. In addition, repair of the incompetent internal nasal valve, with appropriate nasal width, must be part of the rhinoplastic surgeon’s capabilities.

Hump reduction is probably the most common maneuver in rhinoplasty. In traditional hump reduction surgery, the cartilaginous hump is excised as a block with the underlying mucosa. This separates the upper lateral cartilages from the natural attachment to the septum and usually interrupts the continuity of the mucoperichondrium. This leads to inferomedial collapse of the upper lateral cartilages, which is worse if the mucosa is also severed. This may not be apparent immediately after rhinoplasty but may present gradually over a period of years, with tell-tale deformities. The capacity of the middle vault to withstand the inward pressure of inspiration may be reduced. Chronic nasal obstruction due to valve narrowing may develop gradually or be apparent immediately. There are other conditions that may precipitate internal nasal valve obstruction. Facial paralysis can lead to ptosis of the lateral nasal soft tissues and narrowing of the valve, causing symptomatic obstruction. Cancer resection of the lower two thirds of the nose may lead to scar contraction and distortion of the valve. Senile tip ptosis can also cause significant narrowing and congestion (Fig. 35–3).
Figure 35–1  Nasal cartilage anatomy, with relationship of upper lateral cartilage to other structures.

Figure 35–2  Clinical appearance of internal nasal valve, which is the narrowest cross-section of the nasal airway.

Figure 35–3  Appearance of patient after rhinoplasty with narrowing of the middle vault causing nasal obstruction.
**RISK FACTORS IN RHINOPLASTY**

Several risk factors have been identified as predisposing to middle-vault problems in rhinoplasty. Not recognizing these warning signs may inadvertently result in physical signs, such as inverted-V deformity, middle-vault collapse on inspiration, overly narrow radix line, dorsal asymmetry, and eventual nasal obstruction.

The inverted-V deformity has been recognized as the classic sign of middle-vault pathology following rhinoplasty. The cause seems to be posterior displacement of the nasal bones and upper lateral cartilages after osteotomies, combined with overresection or posterior displacement of the upper lateral cartilages. If dorsal reduction involves mucosal interruption or detachment of soft tissue over the nasal bones and upper lateral cartilages, these structures have little to support them after osteotomy.

Specific risk factors associated with middle-vault postoperative problems include short nasal bones, long and weak upper lateral cartilages, thin skin, tall and narrow noses, and previous trauma or surgery.

**PREVENTION OF MIDDLE-VAULT PROBLEMS**

Proper preoperative evaluation and planning can prevent most middle-vault complications. This allows preventive rhinoplastic techniques to be employed and improves functional and aesthetic results. These techniques include preservation of middle-vault support structures, judicious use of spreader grafts, use of conservative osteotomies, and replacement of cartilage support in revision rhinoplasty cases. Every rhinoplasty patient deserves individual assessment and operative planning. Many middle-vault characteristics may not be appreciated on the initial physical examination. Good-quality photographs can be invaluable in preoperative evaluation and should be studied prior to surgery.

Toriumi and Johnson have demonstrated that preservation of the middle-vault mucosa helps to minimize posterior displacement of the upper lateral cartilages during hump removal. This mucosal bridge between the septum and upper lateral cartilages can be preserved by the creation of junction tunnels under the attachment area of the septum and upper lateral cartilage. Preserving this mucosa also helps to maintain a blood-free surgical field.

When performing dorsal reduction a conservative resection should be done. Maintenance of a strong dorsal line is usually desirable for both aesthetic and functional reasons. In a patient with dorsal convexity and a narrow vault, it may be necessary to reduce the dorsum minimally, widen the middle vault with spreader grafts, and increase tip projection to achieve nasal harmony.

A common postoperative problem is overnarrowing of the nose due to medial displacement of the nasal bones after aggressive complete osteotomies. Although many rhinoplasty patients desire a narrower nose, narrowing can be excessive and detrimental to both aesthetics and function. By maintaining the soft tissue attachments of the nasal bones and upper lateral cartilages, excessive medial and posterior displacement can be prevented. Internal splinting can also prevent excessive narrowing in the early postoperative period.

**CORRECTION OF MIDDLE-VAULT PATHOLOGY**

Surgical correction of middle-vault problems can be preventive or corrective. When the risk factors identified are present, preventive action may be required. In a revision rhinoplasty multiple modalities may be utilized. These techniques may include cartilage grafts, precise structural realignment, and fixation of nasal valve structures.

Spreader grafts are probably the most common corrective modality used for middle vault rehabilitation. First described by Sheen and Sheen, these are rectangular cartilage grafts placed between the junctions of the upper lateral cartilages and septum to widen the nasal valve. These cartilage grafts not only lateralize the upper lateral cartilages but add rigidity to the middle vault to resist inward motion on inspiration. They can be placed either through open or closed rhinoplasty techniques, but are easier to stabilize with direct sutures via the open approach. Septal cartilage is the most frequently used grafting material, but auricular cartilage may be used if septum is not available. Spreader grafts can also be utilized for aesthetic purposes. For patients with unilateral middle-vault depressions due to congenital, traumatic, or iatrogenic causes, a single spreader graft can elevate and lateralize the upper lateral cartilage and restore symmetry.

The surgical technique for placement of spreader grafts varies with the surgical approach. Sheen and Sheen describe placing the grafts in precise submucoperichondrial tunnels along the dorsal edge of the septum without separation of the existing upper lateral cartilages from the septum. This is accomplished through a closed rhinoplasty approach.

In many revision rhinoplasty cases involving middle-vault pathology, separation of the septum and upper lateral cartilages has occurred due to hump removal. There is usually fibrous tissue instead of a fusion of cartilage at the internal nasal valve. Therefore, preservation of the mucoperichondrium and creation of a pocket for the graft placement through an open approach is usually preferred. If the upper lateral cartilages are fused with the septum, sharp dissection from the internal side with an elevator will preserve the mucoperichondrial flap attachments and preserve stability. At times the upper lateral cartilages may have been almost completely resected. In this situation, conchal cartilage grafts may be necessary to provide lateral support in addition to spreader grafts. The grafts are carved, aligned, and fixed in position with 5-0 PDS (Polydioxonone, Ethicon, Somerville, NJ) mattress sutures. Most spreader grafts are 1.5 to 2.5 cm in length and 1 to 3 mm in width. In general, the grafts should run along the dorsal septum from below the bony–cartilaginous junction to the anterior septal angle. In severe cases the grafts may be layered to provide additional bulk. Grafts of unequal width may be used to accommodate asymmetries in the middle vault. Spreader grafts may also be used as internal stents to help straighten a caudal septal deflection. The technique of spreader graft placement and fixation is demonstrated in Figs. 35–4 to 35–7. Placement of a 30-gauge needle through the cartilage complex makes placement of the sutures much easier (Fig. 35–8).

Grafts that are wide at the end may lateralize the caudal portion of the upper lateral cartilages, creating fullness in the lateral supratip area. Releasing the lateral crura from
**Figure 35-4** Ideal placement of spreader grafts between septum and upper lateral cartilages.

**Figure 35-5** Placement of spreader graft lateralizes and elevates the upper lateral cartilage widening the middle vault.

**Figure 35-6** Spreaders grafts in place and fixed with mattress sutures. The original dorsal height is identified.

**Figure 35-7** Demonstration of mattress suture technique for fixation of spreader grafts.
the scroll area allows for free motion, some overlap, and prevents distortion. In some cases it may be advisable to place a graft of crushed cartilage over the dorsum and spreader grafts to smooth the profile. AlloDerm (LifeCell Corp., Branchburg, New Jersey) may also be used for this purpose.

In an effort to further support the nasal valve, Schlosser and Park described the use of flaring sutures to improve the cross-sectional area of the internal nasal valves. The additional treatment here is a 5-0 nylon clear mattress suture that spans the upper lateral cartilages and the nasal dorsum horizontally. Tightening the suture increases the angle of the nasal valve, theoretically improving nasal function. Park’s study indicated that flaring sutures used concomitantly with spreader grafts increase air flow more than spreader grafts alone (Fig. 35–9).

Patients with saddle-nose defects may have middle-vault collapse with no support for the soft tissue. Fixated of a dorsal graft may help support the inferior soft tissues and stabilize the nasal valve. The use of cranial bone grafts combined with lag-screw fixation has been very helpful in these patients. The cranial bone can serve as an anchor for reconstructive grafts and provide vertical height to the middle vault (Fig. 35–10).

Nasal obstruction in rhinoplasty may have multiple causes. The middle vault may present with congenital, traumatic, or iatrogenic pathology that must be addressed during rhinoplasty. Specific physical signs and symptoms should alert the surgeon that middle-vault intervention is necessary to prevent unwanted sequelae later. This will lead to better functional and aesthetic rhinoplasty results.

**PATIENT EXAMPLE**

The patient shown in Fig. 35–11 presented with a history of previous rhinoplasty and increasing nasal obstruction for 10 years. The symptoms had gotten progressively worse and were not relieved by multiple medications. Examination revealed internal valve collapse bilaterally, with physical
evidence of significant upper lateral cartilage resection. The residual middle-vault cartilage was inferomedially displaced, causing narrowing of the middle vault. The cartilage edges and bone were also irregular and asymmetric. The lower lateral cartilages were also asymmetric with a bossa on the right. The preoperative condition is exhibited in Fig. 11A–D.

Figure 35–11  (A–D) A patient with significant middle-vault pathology from previous rhinoplasty causing internal nasal valve obstruction. (E–H) Surgical correction following revision rhinoplasty with spreader grafts and tip correction.

This patient underwent an open rhinoplasty procedure with use of spreader grafts, reduction of tip projection, interdomal sutures, columellar strut, and smoothing of the dorsal bone. The 2-year postoperative photographs are shown in Fig. 11E–H. The middle vault is more symmetrical and has appropriate width for function and cosmesis.
REFERENCES