The term rhinoplasty is used to denote a procedure which alters the appearance of the nose. In common usage, however, this term encompasses almost any procedure which alters the structure or function of the nose. Some now advocate the term septorhinoplasty to denote a procedure which changes both form and function. Regardless of the terminology used, it is important to remember that any procedure on the structure of the nose can lead to an alteration of its function, and patients should be evaluated and counseled in this regard prior to any surgical intervention.

In some cases, improvement of nasal function is the primary for seeking treatment. In others, cosmetic deformities may be the only concern. In either situation, the patient is unlikely to be pleased if one is improved at the expense of the other. This review is designed to cover several key issues in the evaluation, diagnosis, and treatment of common functional nasal disorders.

Evaluation

The most important portion of the patient evaluation is the history and physical examination. Factors such as onset, timing, frequency, and modifying factors should be elicited. Patients may have a very specific onset of symptoms, such as facial trauma, which may result in nasal obstruction. If the onset is vague, a history of timing, progression, and modifying factors should be taken. Patients that have periodic bilateral obstruction, especially seasonal or associated with specific triggers, may have an allergic component that can be treated medically. Those that report a slowly progressive, unilateral obstruction that may be associated with numbness, pain, or bleeding warrant further workup for malignant causes of obstruction. Most patients with an anatomic nasal obstruction will complain of both fixed and fluctuating components. These people often report one side is worse, but also report alternating obstruction from side to side during sleep. This is due to the natural nasal cycle complicating an already limited nasal airway. Another important factor to elicit is change with activity. Some people have an obstruction that presents when they exercise or attempt to breathe forcefully through their nostrils. This is often due to collapse of the ala during inspiration. The final concern to
establish during any history is that of severity. The condition may be profound, and prohibit the use of respiratory devices for obstructive sleep apnea, or the patient may be content with a severe obstruction, and not wish surgical intervention.

After the history is completed, a full external and internal nasal examination should be performed. There are several methods of external nasal analysis commonly used for cosmetic purposes. These are dictated by the surgeon’s preference, and are not covered here. However, several portions of the external examination are important to the functional outcome of the nose. The most obvious is the nasal dorsum. The dorsum should be evaluated in both its bony and cartilaginous segments for any deviation. If a dorsal deviation or twist is present, the location of this deformity relative to the rhinion should be noted. This will impact the method of repair of the dorsal septum. On the base view, any displacement of the caudal septum or columella should be noted. This will also impact the type of repair, as well as choice of incisions. When analyzing the columella, it is also important to note whether the columella is abnormally wide at its base, or whether the medial footplates are excessively curved and protrude into the nasal airway. If either of these situations exist, they may require separate repair. Finally, the patient should be evaluated while breathing deeply through the nose. If the original complaint was functional in nature, you may see collapse of the ala during forced inspiration.

Once the external examination is complete, a detailed examination of the internal nasal anatomy should be performed. This is commonly done using a nasal speculum. Other tools such as an otoscope or a nasal endoscope may be utilized, but they tend to provide a distorted view of the internal structures. Endoscopes are useful, however, when analyzing the posterior nasal septum for bony deviations, or when the history suggests possible malignancy. If the internal view is limited, it is often due to hypertrophy of the turbinate mucosa. Decongestion with oxymetazoline or neosynephrine may allow for better visualization. In addition, if the initial exam was severely obstructed by congested turbinate mucosa, the patient may be a candidate for medical management with nasal steroids or antihistamines. If decongestion is ineffective, a simple palpation maneuver can elicit whether the obstructing turbinate is primarily bone. If the turbinates do not decongest, the patient may be an excellent candidate for a turbinoplasty.

Four key components to the nasal exam are discussed here. Each area has separate elements which make up its borders, and therefore, have separate causes for obstruction.

- The first is the nostril valve. The borders of this structure include the columella, medial footplates, the alar rim and lobule, and the nasal sill. Common areas of obstruction in this region include divergent footplates, wide columella, and functional alar collapse. Deviations of the caudal septum may be apparent on base view examination and cause obstruction.
- The next segment, the vestibule, consists of the premaxilla, the septum, and the lateral crura. This region may be affected by septal deviations, premaxillary spurs, vestibular webbing, or alar collapse.
- The third area is the internal nasal valve. This area is bounded by the septum, the upper lateral cartilages at the valve angle, and the head of the inferior turbinate. This area can be obstructed by turbinate hypertrophy, central septal deviation, a spur at the septal-vomer junction, or collapse of the upper lateral cartilages.
• The last area is the **bony nasal valve**. This is comprised of the nasal bones and the perpendicular plate of the ethmoid. The most common causes of obstruction here are bony deviations from trauma or prior rhinoplasty.

**Treatment**

**Septoplasty**

The septum is the one structure common to all four areas of the nasal airway. Anatomic changes in any of the segments may cause obstruction of airflow and lead to breathing problems. The septum may be divided into several parts based on the maneuvers required to repair the deviation. These parts are the central body, caudal strut, and dorsal strut. The bony septum, or perpendicular plate of the ethmoid is a separate entity, but in terms of repair may be considered as part of the central septum. In general, deformities of the central septum are the simplest to repair, with repairs of the caudal strut becoming more involved, and repair of the dorsal strut being the most extensive.

The central septum may cause obstruction via deflection from its inferior attachment to the vomer or pre-maxilla. These deflections are often the simplest repair. The approach may be done in a closed manner, with the Killian-type incision providing excellent exposure. If the deflection of the cartilage is accompanied by a hypertrophic spur of the vomer or pre-maxilla, the Killian incision may be extended onto the floor of the nose to widen exposure. Prior to incision, the septum is injected with 1% lidocaine with 1:100,000 epinepherine for hemostasis and hydrodissection. If turbinate mucosal swelling occludes adequate visualization, oxymetazoline or cocaine soaked nasal pledgets may be inserted and allowed to sit for several minutes. The incision is made several millimeters behind the caudal edge of the septum. It is carried down through perichondrium onto cartilage, and then is elevated in an anterior to posterior fashion in a sub-mucoperichondrial plane. Once this elevation is done over the cartilaginous septum, the bony septum is encountered posteriorly, and elevation should continue over the mucoperiosteum in this location. Elevation onto the vomer should be carried out for visualization of the deflection. If a tear is likely during this dissection, then the original incision can be carried onto the floor of the nose, and the tunnels can be connected in an anterior to posterior fashion to preserve mucosal integrity. Once elevation has been completed on one side, the cartilage should be dislocated from the perpendicular plate of the ethmoid posteriorly, and from the vomer inferiorly.

At this point a decision should be made regarding the **method of repair**. If the defect is a simple deflection, the cartilage overlying the vomer can be resected, and the remaining cartilage swung back over the vomer in the midline. If a central septal resection is planned, an incision in the cartilage should be made approximately 6mm to 1 cm behind the caudal edge of the cartilage. Care should be taken not to violate the contralateral mucosa. This incision is extended to the pre-maxilla inferiorly and approximately 6 mm to 1 cm from the dorsal edge of the cartilage superiorly. The mucosa on the contralateral side is then elevated to the perpendicular plate of the ethmoid. At this point, a swivel knife or double action scissors can be used to resect the central septum, taking care to leave an adequate dorsal strut. After removal of the obstructing cartilage, the vomer should be assessed for spurs. If any are present, removal of these spurs with an osteotome should be considered. Once all obstructing lesions are removed,
the septum is then closed anteriorly with monocril or chromic suture. The septal mucosa can be held together with either septal splints sutured together or with a quilting stitch.

The repair of a central septal angulation or bowing is performed similar to the deflection. The preparation and approach are similar. However, the septum must be freed from mucosa bilaterally, which requires an incision in the cartilage anteriorly. Once the cartilaginous septum is isolated, several methods of repair are available. The simplest is the central septal excision as described before. The second is similar, except that the central septum is excised, reconstructed ex-vivo into a flat layer, and then re-inserted prior to closure. While this method is more time consuming, its proponents note that it makes future reconstructions easier, and preserves a plane of dissection should a trans-sphenoidal approach ever be required. Another method of repair is the septal scoring procedure. This procedure involves two steps. First, the concave side is scored in a horizontal fashion with a knife, taking care not to cut through the cartilage. This scoring is done for almost the entire height of the cartilage. Second, small horizontal wedges are sliced out of the cartilage from top to bottom. This procedure creates an accordion effect, where the cartilage then becomes very pliable, and able to resume an upright position. Unfortunately, even with multiple releases in the cartilage, many feel that the cartilage still retains adequate “memory,” and will resume a central bowed shape after the removal of the splints. Once the cartilage is repaired or resected, the perpendicular plate of the ethmoid should be inspected for posterior spurs or deflections. These can be removed with forceps, taking care not to pull excessively due to the bony attachments to the skull base. Spurs along the vomer or pre-maxilla are also addressed at this time. Closure is the same as listed above.

Caudal septal defects make up the next class of repairs. The approach to these defects are somewhat different, with many people preferring an open approach since visualization must include the anterior nasal spine, caudal septum, and dorsal septum for most defects. If the defect is localized to an inferior caudal deflection, a closed approach through a hemitransfixion incision may still be utilized. This incision is needed to provide visualization of the deflection at the anterior nasal spine. Tunnels on either side of the cartilage along the floor of the nose should be elevated. Repair may either include a septal swing or a partial excision. The septal swing involves dislocating the septum from the pre-maxilla and vomer, and then flipping the deflected cartilage over the bone onto the other side of the anterior nasal spine. It can then be sutured to the peristomeum or through a drill hole in the nasal spine. A simplified procedure may be accomplished by resecting the excess cartilage so that the remaining cartilage sits on the ANS. The caudal strut should then be sutured to the ANS using a figure of eight stitch to fix it in the center. Closure of these repairs is similar to the previous types.

Deformities of the caudal strut require more involved repair. Since the structural and cosmetic framework of the nose is fundamentally altered, this must be re-created. This can be accomplished in two ways. The first method is the Galloway technique. This is may be done through a transfixion type incision. The caudal edge of the cartilage is freed from mucosa, and the entire caudal strut and deformity is excised. A straight piece of cartilage, either from the excised caudal segment or from the central septum, is then fashioned and trimmed into a new caudal strut. Once the new strut is created, a pocket is created between the medial footplates from behind. Chromic suture is then passed through the new strut at its superior and inferior aspects. These sutures are then driven into the pocket from behind and out the skin of the columella. The sutures are used to provide tension and hold the new strut in place while the
incision is closed. The incision is closed with chromic or monocril sutures by going through mucosa, strut, contralateral mucosa, and back again across the incision line. After several of the stitches are placed, the incision is closed and the strut is secure in the pocket. No other fixation of the strut is required. The second, and more common, type of caudal repair involves an open septoplasty approach through marginal incisions connected to an anterior inverted-v incision. After the soft tissue elevation is performed, the caudal deformity is excised. A new strut can be fashioned from the deformed cartilage or from a portion of the central septum. The new caudal strut is designed to overlap the dorsal strut superiorly and touch the anterior nasal spine. This new caudal strut is then sutured to the nasal spine and dorsal strut using permanent suture such as nylon, prolene, or PDS. This incision is closed using absorbable suture on the marginal incision, and then small nylon suture on the inverted-v anteriorly.

Deformities of the dorsal septum require the most extensive repairs. While these deformities often have a component of nasal obstruction, many patients seek treatment for cosmetic, rather than functional concerns. The open approach is used for dorsal deformities, since visualization must include the entire septum from anterior nasal spine to the nasal bones. Usually, the deformity begins after the junction of the cartilage and the nasal bones. In this case, the repair is similar to an L-strut replacement for columellar deformities. The dorsal strut must be cut back to normal cartilage, and then the entire remaining septal cartilage is removed. A template is designed for the replacement strut, and then carved out prior to replacement. The new strut should be designed to overlap the remaining dorsal cartilage, to appropriately locate the new nasal tip, and to attach to the anterior nasal spine. Once this is done, the new strut is sutured in place with permanent suture, taking care to overlap the dorsal remnant on the contralateral side from the original deviation. Many authors support the placement of spreader grafts at this point. The spreaders serve several purposes. One, they provide for re-attachment of the upper lateral cartilages in a manner that prevents secondary valve collapse. Two, they can balance out the width of the cartilaginous septum at the point of fixation. Last, they can be placed as needed on each side to recreate the dorsal lines of the nose and improve cosmetic outcome. Once the spreader grafts have been placed, the marginal and columellar incisions are closed as described above.

**Alar collapse**

Collapse of the ala represents a functional defect of the nose. This may occur as a normal process of aging, or from paresis of the dilator muscles. Surgical correction is done by reinforcing the natural cartilage in the area to resist the collapsing forces which occur during inspiration. The batten grafts are designed to overlie the lower lateral cartilages at their anterior extent, and then to extend laterally to rest on the bone of the pyriform aperture. By spanning these two regions, the cartilage graft is placed over two relatively fixed points, and will thus be able to resist collapsing forces. The natural curvature of the ala in this region is not well suited for straight septal cartilage. Many authors note that the curve of the concha or cymba nicely approximates the natural curve of the ala, and recommend harvesting of these cartilages for use in alar batten grafts.

**Wide columella**

The widened columella may result from several anatomic variances, such as diastasis of
the medial foot processes, divergent footplates which protrude into the nasal airway, or excess of columella soft tissue. In general, these deformities are simple to repair. If the footplates are divergent and curve into the nose, simple incisions overlying the footplates may be made. The portion of the cartilages which are divergent can be either removed, or the point of angulation may be scored to allow for a more natural straight line. In many cases, there is also an excess if fibro fatty tissue in this area. The soft tissue is then removed, and the wound is then closed with a through and through suture to narrow the remaining tissue.

**Turbinate procedures**

In many cases of nasal obstruction, the cause may be multifactorial. One common cause for obstruction is turbinate hypertrophy. While this may often occur as a single entity, it also occurs frequently with septal deviation. If the septum is severely deviated, the turbinate on the contralateral side from the deviation may hypertrophy with time to “fill the defect.” This is problematic when attempting repairs of significant septal deviation, since a straight septum would likely impact on the hypertrophied turbinate and worsen nasal obstruction. In these cases it is important to address the turbinates during the procedure, usually before the septal work. Several procedures are available. The most simple procedure involves an outfracture of the inferior turbinate. This moves the turbinate into a lateral position, and should allow for straightening of the septum. While it is simple and does not carry a risk of bleeding, it is also the most transient procedure, and does not address the mucosal hypertrophy of the turbinate tissue. The second type of turbinate reduction is through submucous bipolar cauterization. The problem with this procedure in conjunction with septoplasty is that no acute change in size is achieved.

More long-lasting procedures involve resection of mucosa and bone. The most common type is the submucous resection. This is technically the most difficult, and may be associated with significant post-operative bleeding. It involves elevating the mucosa of the turbinate free from the turbinate bone, and then resecting the majority of the turbinate bone. The medial-superior mucosa is preserved, and folded back over the turbinate stump to provide for quicker healing. This procedure generally has good long-term outcomes, but patients may experience recurrence of the turbinate hypertrophy several years later. The last procedure is the inferior turbinectomy. This involves en-bloc resection of the entire mucosa and bone of the inferior turbinate from anterior to posterior edge. This procedure is also associated with a chance of significant post-operative bleeding. Most authors strongly advocate against this procedure due to the uncommon but devastating complication of atrophic rhinitis. This condition results from drying of the nose after loss of mucosal tissue. These patients may loose their middle turbinates and develop massive septal perforations, as well as chronic sinus crusting, drainage, and a fetid odor which is difficult to control.

**Conclusion**

Nasal function is an important consideration when evaluating a rhinoplasty patient. History and physical examination are key to assessing the pre-operative state of the patient, and for operative planning and consent. If done correctly, this can greatly improve the subjective outcome of rhinoplasty patients, and ensure they are satisfied with both the form and the function of their nose.
**Bibliography**