

# Posttraumatic Nasal Deformities: Correcting the Crooked and Saddle Nose

Dennis Yu Kim Chua, MD<sup>1</sup> Stephen S. Park, MD<sup>2</sup>

<sup>1</sup>Department of Otolaryngology, Tan Tock Seng Hospital, Singapore

<sup>2</sup>Department of Otolaryngology, University of Virginia, Charlottesville, Virginia

Address for correspondence Stephen S. Park, MD, Department of Otolaryngology, University of Virginia, Box 800713, Charlottesville, VA 22908 (e-mail: ssp8a@virginia.edu).

Facial Plast Surg 2015;31:259–269.

## Abstract

The nose is frequently traumatized in facial injuries and this often results from motor vehicle accidents, sports-related injuries, and altercations. Subsequently, posttraumatic nasal deformity is one of the most common reasons that patients seek consultation in the doctor's office. Depending on the type of nasal deformities, this can result in functional impairment and aesthetic problems. Two challenging problems to be addressed in the posttraumatic nose include the crooked nose deformity and the saddle nose deformity. The numerous publications on these two topics attest to the exacting surgical expertise required in its treatment. The key features in management of these conditions are discussed further.

## Keywords

- ▶ saddle nose
- ▶ crooked nose
- ▶ nasal deformity
- ▶ nasal trauma

The nose is frequently traumatized in facial injuries and this often results from motor vehicle accidents, sports-related injuries, and altercations. Subsequently, posttraumatic nasal deformity is one of the most common reasons that patients seek consultation in the doctor's office. Depending on the type of nasal deformities, this can result in functional impairment and aesthetic problems. Two challenging problems to be addressed in the posttraumatic nose include the crooked nose deformity and the saddle nose deformity. The numerous publications on these two topics attest to the exacting surgical expertise required in its treatment.<sup>1–9</sup> The key features in management of these conditions are discussed further.

## Relevant Anatomy

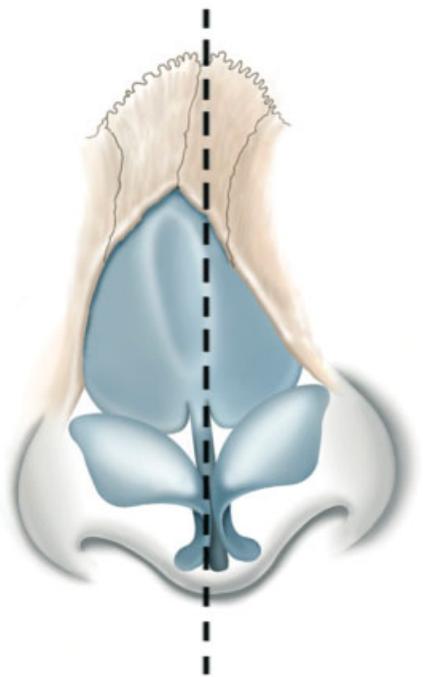
### Crooked Nose

It is crucial to identify the anatomical causes of the external deviation. The nose can frequently be divided into thirds with the upper third composed of paired nasal bones and bony septum. The nasal bones articulate with the frontal bones superiorly, the ascending process of the maxilla laterally, the upper lateral cartilage inferiorly, and deep to this the perpendicular plate of the ethmoid. The nasal bones are thickest superiorly at the nasion and become thinner caudally where

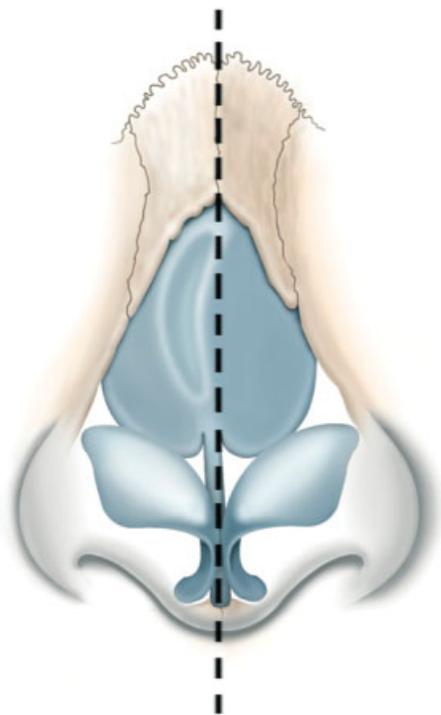
they are prone to fractures. Asymmetry of the upper third of the nose from nasal fractures is often combined with a deviation of the middle third (▶**Fig. 1**). Deflections of the bony pyramid are not all identical. It is important to delineate (1) the aberrant side, (2) the contour of the nasal bones, and (3) potential involvement of the bony septum. Bony deviations may involve only one side where an isolated segment is depressed medially from a direct traumatic injury. In this situation, a closed nasal reduction to elevate the segment may be unstable and this may require unilateral nasal packing. If a high deviated bony septum is present, this can potentially impede nasal bone movements during a closed nasal reduction and prevent a successful reduction.

The cartilaginous middle one-third consists of the upper lateral cartilages that articulate with the nasal bones superiorly and lower lateral cartilage caudally at the scroll region. Deep to this, it articulates with the cartilaginous septum, and a persistent deviation of the nasal septum with passive distortion of the upper lateral cartilages is a common cause of deviated middle third (▶**Fig. 2**). Releasing the fibrous attachments between the upper lateral cartilage and the dorsal septum will reveal the deflected dorsal septum and correction of the upper lateral cartilage deformity.

There are two instances of the twisted middle vault where the upper lateral cartilages are the primary culprit rather than



**Fig. 1** Dorsal deviation of the nose secondary to deflected nasal bones.



**Fig. 2** Twisted middle vault limited to the middle third and dorsal septum.

the dorsal septum. The upper lateral cartilage can be disarticulated off its supporting structure (usually the dorsal septum or occasionally the nasal bones) and this results in a gradual depression of the upper lateral cartilage medially. This disrupts the brow-tip aesthetic line on the affected side and gives an illusion of the twisted nose. The second scenario occurs in patients with intrinsic deformities of the upper lateral cartilages, with concavity or buckling of the upper lateral cartilage. These will have to be directly repaired or camouflaged with cartilage grafts.

The keystone area is an important anatomical landmark where the paired nasal bones, paired upper lateral cartilage, perpendicular plate of ethmoid and the quadrangular cartilage meets. Disruption of the keystone area during trauma results in instability and possibly a saddle nose deformity. A high dorsal septal deviation can result in a deviated middle one-third and this will have to be addressed to straighten the crooked middle third.

The lower one-third of the nose comprises the paired lower lateral cartilages, caudal nasal septum, and the nasal spine. Tip position is dependent on numerous forces that work in concert to hold the tip in midline. Deviation of the caudal septum from trauma is a common cause of the lower third nasal asymmetry (► **Fig. 3**). The nasal septum comprising the perpendicular plate of the ethmoid, quadrangular cartilage, vomer, and maxillary crest plays a crucial role in determining the deviations of the nose in all horizontal thirds as described previously. The adage “where the septum goes, so goes the nose” is especially applicable for the traumatic crooked nose.

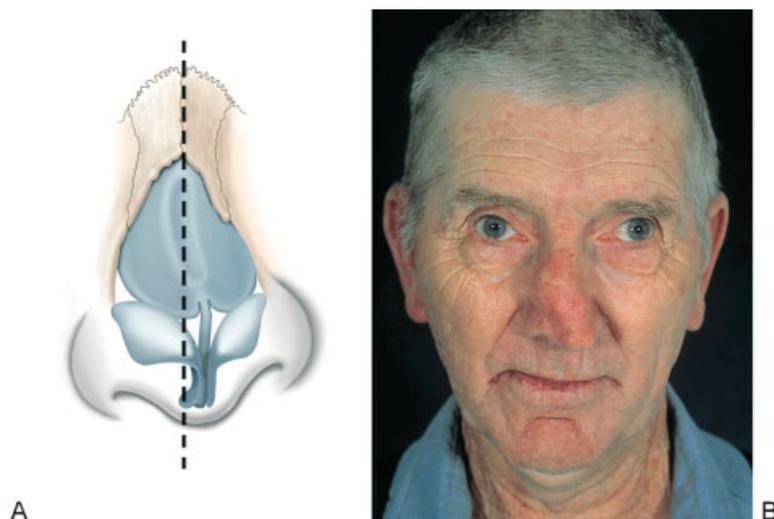
### Saddle Nose

A saddle nose deformity is one the most feared complication posttrauma. This frequently results from an untreated septal hematoma that becomes infected. The resultant septal abscess causes septal cartilage resorption and subsequently a saddle nose deformity over time. Alternatively, if the precipitating trauma disrupted the keystone area as mentioned previously, this can similarly result in a saddle nose deformity. The patient will appear to have an illusion of a widened nose on frontal view and on profile view, a scooped out appearance.

### Clinical Assessment

A comprehensive history should elucidate a detailed mechanism of injury, including the vector and magnitude of the force. Frontal impact injuries from motor vehicle collisions or projectiles are usually higher impact and result in a greater degree of comminution and septal injury. Sports-related injuries and assaults frequently result in a low impact laterally directed blow that typically results in an infraction of the ipsilateral nasal bone and outfracture on the contralateral side.<sup>10</sup>

The timeline is crucial for consideration of closed nasal reduction of a nasal fracture. It is generally advisable to reduce it within 3 to 5 hours of injury before edema sets in or delayed till after 5 to 7 days for the swelling to resolve. The



**Fig. 3** (A) Deviation of the caudal septum resulting in a twisted nose in the lower third. (B) Dorsal deformity involving the nasal tip.

edema impacts accurate clinical assessment of the nasal deformity and can impede mobilization of the nasal fragments. A closed nasal reduction should generally be attempted before 2 weeks as osseous union beyond this period will make reduction challenging.

A previous history of nasal injuries and deformities is important. Preinjury photographs are useful to obtain a baseline, and it is crucial to explain to the patient that preexisting deformity cannot be altered during the closed nasal reduction.

Beyond aesthetic considerations, functional impairments such as nasal obstruction or rhinorrhea should be characterized. The patient's concerns run the gamut between functional and aesthetic concerns, and this should be clarified prior to management. Functional impairment such as nasal obstruction should take precedence in the management and any other aesthetic issues that the patient has should be discussed at lengths before treatment. Occasionally, the desire for improvement in nasal breathing may be contrary to the patient's desire for a smaller nose and this should be highlighted to the patient.

Physical examination begins systematically with observation of the patient's nasal breathing at rest. Inspection in specific views, such as the frontal, profile, and basal views, provide information about anatomical abnormalities at rest and during inspiration. On the frontal view, one divides the nose into horizontal thirds and inspects for any deviations of the nasal bones, narrow middle vault, or a twisted tip. The brow-nasal tip aesthetic lines are made up of the medial orbital rims, nasal root, middle vault, and nasal tip, and should be symmetrical. The profile provides information about the height of the radix, saddle nose, tip projection, and rotation. If a saddle nose deformity exists, the area of maximal deficiency should be localized so as to aid in quantifying the degree of augmentation necessary. The basal view reveals the vestibular shape, columellar width, lateral crural recurvature, and fluctuations with inspiration. A deviated caudal septum can cause a twisted nasal tip.

Palpation of the nose cannot be overemphasized. One can get a sense of the resilience, degree of support and stability along the lateral nasal wall and nasal tip. The anatomy of the twisted middle vault can be elucidated from direct palpation and tightening the nasal skin over the nasal dorsum to outline the dorsal septum. Intranasal examination should be done with and without topical decongestant. Another useful tool is a stick or a cotton-tip applicator in the precise midline of the face which should traverse the glabella, philtrum, upper incisor, and menton, assuming facial symmetry in the patient. The nasal speculum should be used judiciously because it distorts the lateral wall. Deviations of the septum should be identified, and the presence of dorsal or caudal deviation may correspond to a crooked nose in either thirds.

## Management of the Crooked Nose

### Upper Third Deviations

The treatment of the deviated upper third can be broadly divided into acute management with closed nasal reduction or surgical reduction comprising surgical techniques such as osteotomies, septoplasty, or camouflage graft.

### Closed nasal Reduction

Closed nasal reduction can be performed when the nasal fracture presents within the first 2 weeks to the office, and the patient understands the limitations of closed nasal reduction and possible need for surgical correction of residual deformities at a later time. Topical anesthesia can first be applied using a mixture of oxymetazoline/lidocaine nasal spray. Next, a cotton soaked in the same mixture of oxymetazoline/lidocaine solution or the equivalent is tucked right up to the nasal vault of the concave deformity and approximates the position of where the Boies elevator will be placed during reduction. A local anesthesia comprising 1% lidocaine and 1:100,000 epinephrine is infiltrated in a suprapariosteal and subdermal plane along the bony vault. The patient is then

asked to massage the area with a sponge for 5 minutes prior to the reduction in order to allow the anesthesia to dissipate in the surrounding tissues. This allows a fairly painless reduction of nasal fractures. We have not found it necessary to infiltrate the submucosal plane in the nasal cavity as what has been occasionally described in the literature.

The closed nasal reduction is performed with the surgeon standing on the concave side of the deformity. A strong flat instrument such as the Boies elevator is sized externally on the nose prior to insertion to ensure its correct position intranasally (►Fig. 4). It should sit just deep to the depressed segment. Using a lifting and levering motion, the depressed segment is lifted up into place while applying pressure on the convex side of the deformity (►Fig. 5). Sometimes an audible or palpable “pop” signals the deviated fragments shifting back into its original location. Failure to achieve bony reduction can be due to early osseous union of the fragments or a high deviated bony septum that prevents nasal bone mobilization. Various techniques have been described regarding septum mobilization, but we have found this to be imprecise and can potentially result in further mucosa and septum injuries.<sup>5</sup> More severe nasal septum deviations may have to be treated operatively sometime later.

#### Osteotomies

The purpose of osteotomies is to create precise fracture lines to allow mobilization of the nasal bones to return to a favorable position. Medial, lateral, intermediate, and possibly transverse root osteotomies are performed to achieve this purpose. This procedure is performed relying more on tactile feedback than on visualization. The types of osteotomies used on the patient is dependent on the deformity present. For the patient with both nasal bones that are relatively straight but deviated to the same side, bilateral lateral osteotomies may suffice, allowing the bony pyramid to realign as a single unit.

The *lateral osteotomies* are performed in a “high-low-high” orientation in a subperiosteal plane beginning from the pyriform aperture, down toward the ascending process of the maxilla, and curving toward the medial canthus (►Fig. 6). It is important not to carry the osteotomy too high into the frontal bone to avoid a “rocker deformity.” The nasal specu-



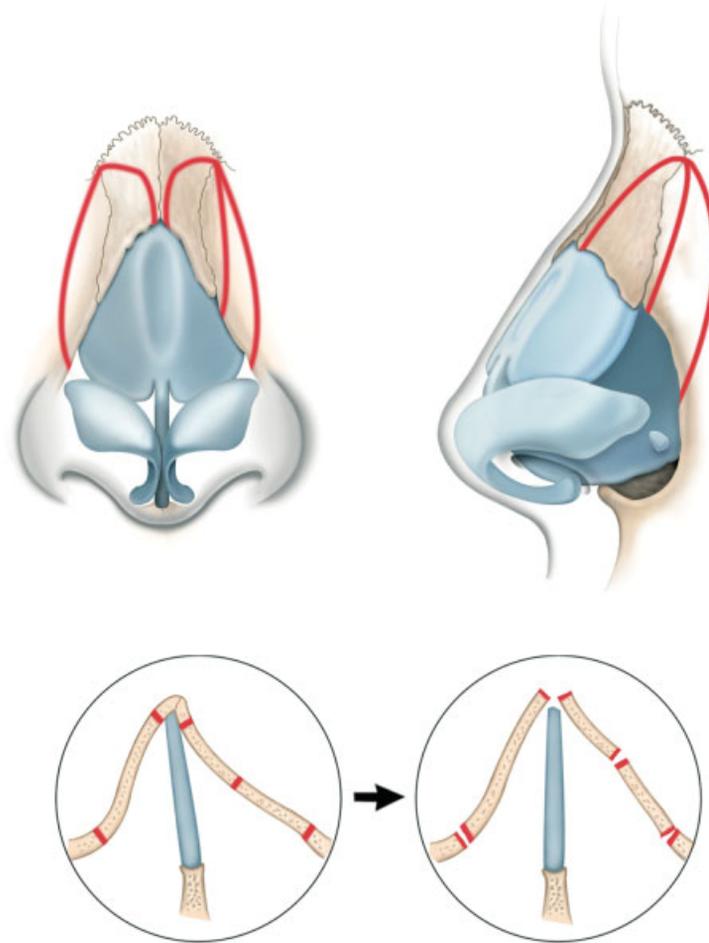
**Fig. 4** Sizing of the Boies elevator externally prior to insertion within the nasal cavity. This ensures the elevator sits accurately below the depressed segment.



**Fig. 5** The elevator is used in a lifting and levering motion on the concave side with pressure on the convex side applied using the left hand. The sizes of the arrow indicate the differential amount of movements at each site. A greater degree of movement is performed at the lower end of the elevator.

lum is used to straddle the pyriform aperture and a horizontal stab incision is made above just above the head of the inferior turbinate. It is important not to start the lateral osteotomy below the inferior turbinate as incorporating this into the medialized segment of bone can result in airway obstruction.<sup>11</sup> A Joseph periosteal elevator is used to create a subperiosteal tunnel along where the lateral osteotomy will be created. This preserves the overlying periosteum and increases stability of the nasal fragments created. A curved, guarded osteotome is then introduced and directed along the intended path toward the medial canthus. A mallet is used in a “tap-tap” fashion to advance the osteotome to create a controlled fracture cephalad. The surgeon uses the left hand to palpate the osteotome beneath the skin while the right hand is used to direct the osteotome. Just below the medial canthus, a gentle rotation of the osteotome medially is performed to create a back fracture toward the midline.

*Medial osteotomies* are performed for more significant deviations and this can be done usually with a 2-mm straight, unguarded osteotome beginning at the rhinion near the bony septum and nasal bones. This can be approached via an intercartilaginous incision or transnasally by engaging the caudal border of the nasal bone at its junction with the dorsal septum and upper lateral cartilage and this fades approximately 20 degrees laterally to avoid the nasofrontal area. If there is resistance in creating a back fracture to connect the medial and lateral osteotomies, a percutaneous osteotomy can be created using a 2-mm osteotome to aid in its formation. For severe upper third deviation, the sequence of osteotomies can be performed akin to flipping the pages of a book with the lateral osteotomy of the concave side performed followed by the medial osteotomy of the concave side, then the medial osteotomy and lateral osteotomy of the convex side follows.<sup>12</sup> This allows mobilization of the depressed segment on the concave side to create sufficient space so that the deviated segments on the convex side can be shifted over.



**Fig. 6** Medial, lateral, and transverse root osteotomies that are used to correct a deviated upper third.

The intermediate osteotomy is used to correct a deviated nose with one sidewall much longer than the other. This can occur in patients with nasal deformities sustained at a young age and the differential growth of the nasal bones on either side results in a different length of the nasal bones. It is also used to straighten a distinctly convex or concave nasal bone. Simple realignment of the nasal bones to the midline can leave a persistent deformity to the dorsal or sidewall. Third, it can also be used to narrow the extremely wide nose with good height. It may be difficult to narrow these broad noses with just medial and lateral osteotomies. The intermediate osteotomy is placed parallel to the lateral osteotomy along the midportion of the nasal sidewall and is created before the lateral osteotomies are made (→**Fig. 6**). This ensures a stable platform for the intermediate osteotomies to be made. Occasionally, the nasal fragments are immobile despite these osteotomies due to a deviated high bony septum or a deviated central nasal bony segment between the two medial osteotomies. A percutaneous transverse root osteotomy will be necessary to mobilize this central bony segment or a deviated high bony septum. This can be performed with the 2-mm osteotome over the nasal root just below the nasion to ensure it sits below the cribriform plate.

Immediately after the osteotomies and reduction is performed, pressure with a sponge is held over the nasal bones for 2 to 3 minutes to minimize swelling and ecchymosis. External tape with a splint is placed over the nasal bones for 1 week after.

#### Bony Septal Deviations

The perpendicular plate of ethmoid attaches to the undersurface of nasal bones and can result in a crooked upper third. If the deflection of the perpendicular plate of ethmoid is severe, this has to be corrected with a septoplasty by fracturing the ethmoid and gently reducing it to the midline. More severe deviations can be treated with a 2-mm percutaneous root osteotome to create a controlled fracture in this bony septum in order to allow movement of the deviated upper third.

#### Camouflage Grafts

This is a direct and simple way to improve the twisted upper third. They are often used in patients with a unilateral depression with a normal contralateral side. These grafts can be used placed under the periosteum with theoretical advantage of better camouflage of the edges and improved security. The grafts can also be placed in the supraperiosteal

plane, and this can potentially increase viability by enhancing vascularity from both sides of the graft. However, a supra-periosteal graft runs the risk of migration and can appear more prominently under the nasal skin.

### Middle Third Deviations

There can be persistent deviations of the middle third of the nose despite correction of the upper third. Correcting the twisted middle vault is challenging and useful techniques include septoplasty, spreader grafts, or a camouflage onlay grafts. Frequently a high dorsal septum deviation can be a cause of the crooked middle third. As the upper lateral cartilages are attached to the septum by firm fibrous attachments, a full release of the upper lateral cartilages from the septum can be performed in milder deviations and this can help straighten the middle vault asymmetry. A formal septoplasty may be necessary in more severe septal deviations. Spreader grafts or camouflage onlay grafts can be used in an asymmetric fashion for middle vault asymmetry. It is important to assess for airflow obstruction especially on the convex side as the internal nasal valve is narrowed, and this helps decide whether a camouflage onlay graft or spreader graft is necessary.

### Septoplasty

During a septoplasty, a stepwise approach consists of detaching the upper lateral cartilages from the septum bilaterally. This releases the *extrinsic binding structures* that can potentially be causing the deformity. Next, a full release of the mucoperichondrial flap on the concave side relieves the *intrinsic tension forces* resulting in the deformity. These two maneuvers can correct milder deviations. The deviated dorsum may be a linear deformity to one side. When the dorsal strut is straight but misaligned, it may need to be detached from the posterior bony septum and maxillary crest to allow it to be swung back to the center. The keystone area should be preserved to avoid destabilization and future saddle nose deformity.

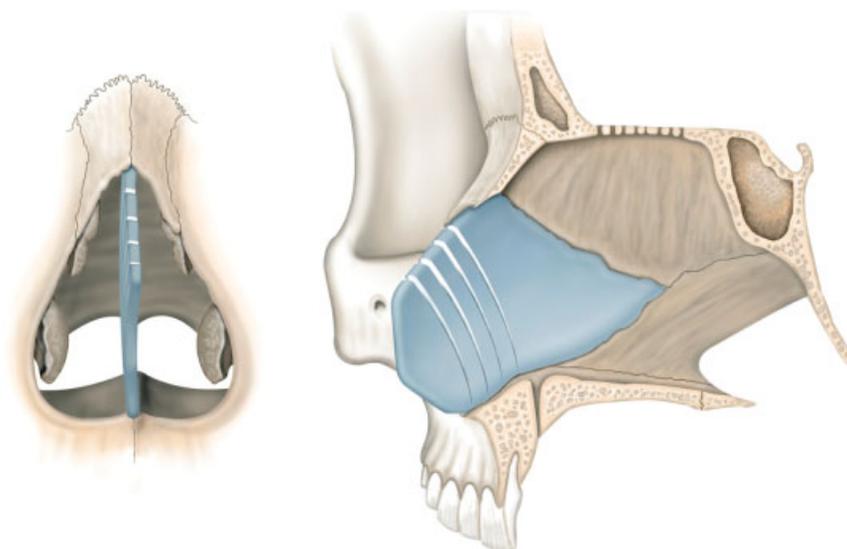
Combinations of scoring the cartilage, resecting deviated portions or placement of batten grafts can help straighten any further septal deformities.<sup>3</sup> Scoring involves placing partial thickness incisions on the concave side of the cartilage. This releases the forces holding the cartilage in its deformity and is akin to releasing the string on a bow. However, relying solely on scoring may not achieve the long-term result one desires in straightening the deviated septum. The scoring results in wedge-shaped spaces created that eventually heals with scar tissue and subsequent wound contracture that can result in a relapse of septal deformity (► Fig. 7). A batten graft may be necessary to hold it in place. A permanent suture placed in a horizontal mattress with the knot on the convex side can help bend the cartilage in a favorable manner and serve to reinforce the dorsal strut.

### Spreader Grafts

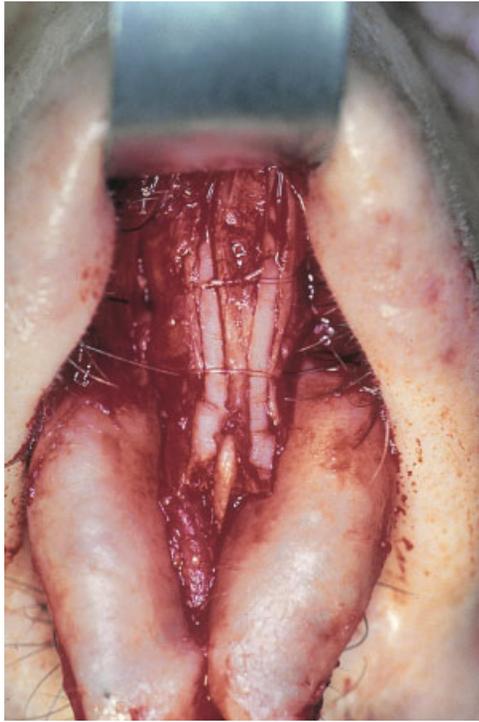
Spreader grafts placed between the upper lateral cartilage and septum can help correct middle vault asymmetry by laterally displacing the depressed upper lateral cartilage if placed on the concave septum and also improve a narrowed internal nasal valve with increased airflow. Typically, spreader grafts are placed bilaterally to aid in splinting of a high deviated septum and it is fashioned thicker on the concave side to match the middle vault asymmetry. Edges of the spreader grafts are beveled to prevent show through the skin. Dimensions of the spreader grafts vary, but they usually range from 6 to 12 mm in length, 3 to 5 mm in height, and 2 to 4 mm in thickness. They usually span the entire vertical length of the upper lateral cartilage and are secured in a mattress fashion (► Fig. 8).

### Camouflage Grafts

Occasionally in patients without airflow problems and small depressions on the middle vault, a camouflage onlay graft can be used. This is created typically from a small-sized crushed



**Fig. 7** Scoring of cartilage on the concave side results in multiple wedge-shaped spaces. These areas get filled with scar tissue over time and can result in relapse of the deformity.



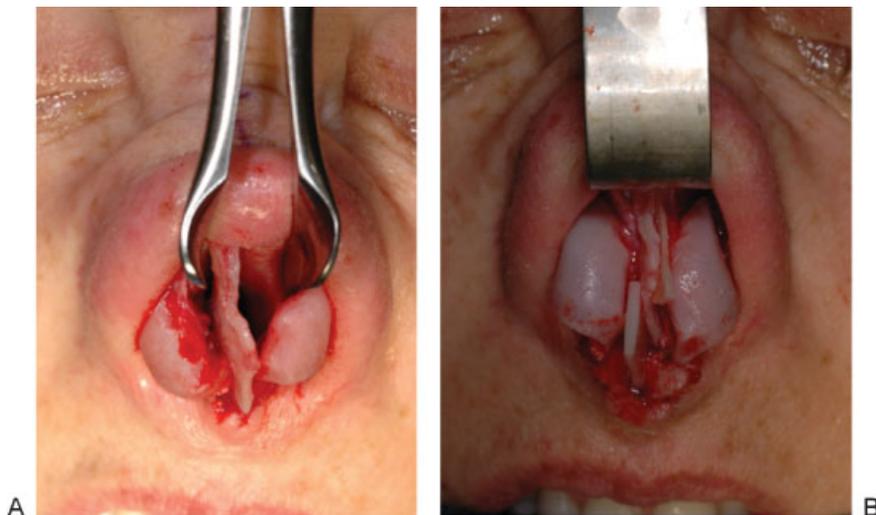
**Fig. 8** Spreader grafts placed bilaterally to aid in straightening the deviated dorsal septum.

septal cartilage. The septal cartilage is hammered till it loses its memory but not overtly traumatized as this can potentially result in increased resorption of the graft. It is placed on the concave side of the deviation in a precise dimension over the perichondrium, and the skin is redraped over it and assessed to ensure it does not show too prominently. Marking the skin should be done prior to infiltrating local anesthesia. Securing the graft in place can be performed although this is usually not necessary if a snug pocket is created for its placement.

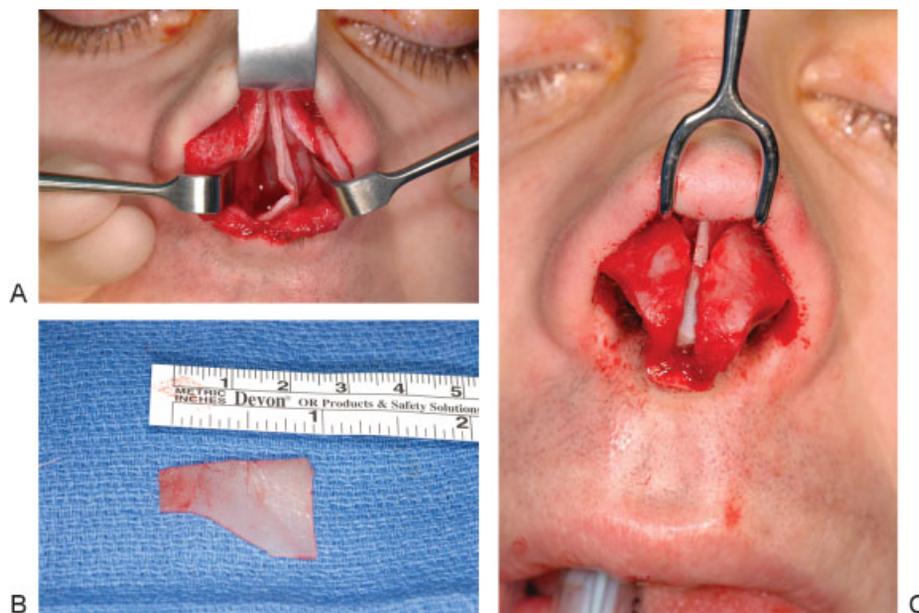
**Lower Third Deviations**

The techniques commonly used to correct nasal tip asymmetry include septoplasty for the deviated caudal septum, tip suture techniques, or camouflage tip grafting. For mild to moderate deviations of the caudal septum, a septoplasty via a hemitransfixion incision allows mucoperichondrial flaps to be fully released on both sides of the septum. Occasionally this is sufficient to allow straightening of the caudal septum. Scoring of the deviated caudal septum on the concave side can be performed to decrease memory of the cartilage and further straightening of the septum. Cartilage grafts in the form of a caudal septal batten graft can also be used to splint the caudal septum to keep it straight and provide additional stability (→Fig. 9). If the posterior septal angle is dislocated off the nasal spine, the septum can be trimmed inferiorly in a conservative fashion and then brought over to the midline and resutured to the spine in a figure-of-eight manner with a 5-0 clear nylon to keep the septum in the midline.

For more severe caudal septal deviations, the caudal septum may have to be replaced with a straight L-shaped autologous cartilage graft, commonly from the septal cartilage (→Fig. 10). A stable dorsal strut is left in situ for the new graft to be sutured to and the other end is anchored to a remnant of cartilage at the posterior septal angle for to the periosteum around the nasal spine. The lower lateral cartilage can then be sutured to this newly constructed L-strut with horizontal mattress for further stability. This newly constructed L-shaped cartilage graft determines the optimal position of the anterior septal angle, caudal septal margin, and posterior septal angle. Changes in graft length, position, and relative position of the medial crura stabilization on the graft will affect the nasal tip position, rotation, and projection. For more severe caudal and dorsal septal deviations, similar principles apply and a subtotal septal reconstruction can be performed. The deviated cartilage is resected and a longer straight L-shaped autologous cartilage graft can be used in the same manner. In situations where there is



**Fig. 9** (A) Deviated caudal septum with concavity on the left. (B) Caudal septal batten graft used to straighten the septum and provide additional stability. A left spreader graft was also used inserted for additional middle vault stability.



**Fig. 10** (A) Severe septal deviation. (B) Septal cartilage can be harvested and reshaped to be used as a septal replacement graft. (C) Caudal septal replacement with an autologous cartilage. The superior aspect is sutured to a remnant dorsal strut, and the inferior end is anchored to a cartilage left in situ or to the periosteum of the nasal spine.

insufficient autologous septal cartilage, double-layered auricular cartilage can be sutured together for use after scoring the concave surface although this is less ideal. Auricular cartilage is not as strong as septal cartilage in providing tip support and its intrinsic curvature makes it challenging for use at this site. Rib autologous cartilage can be considered although it has added donor site morbidity. Also, rib cartilage is prone to warping and is thicker than septal cartilage.

#### Pediatric Nasal Injuries Resulting in a Crooked Nose

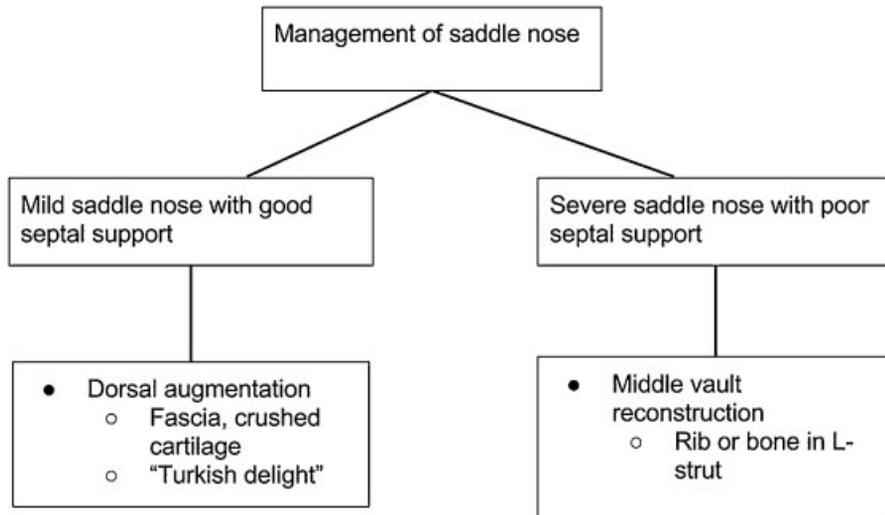
An estimated half of all nasal fractures occur in the pediatric population.<sup>13</sup> There are important anatomical differences between the nose in a pediatric patient compared with an adult. The nose in a young child is more cartilaginous, has less projection from the face, and is characterized by suture lines that have not yet fused. The soft, compliant cartilage bends easily during blunt trauma. The resilient nasal bones are also more prone to “greenstick” fractures and less likely to comminute when compared with adults.<sup>14</sup> Importantly, the nose is still growing and two potential growth centers have been described along the nasal septum.<sup>15</sup> The *sphenodorsal zone* extends from the sphenoid to the nasal dorsum and the *sphenospinal zone* extends from the sphenoid to the anterior nasal spine. Vertical growth in the sphenodorsal zone results in increased length and height of the nasal dorsum whereas sagittal growth in the sphenospinal zone contributes to anterior projection of the nose and maxilla. Injury to either of these growth centers may lead to a loss of vertical height and sagittal projection of the nose or even the midface, as the developmental organization provided by the nasal septum suffers.

When the patient presents acutely within 1 to 2 weeks of the injury, a closed nasal reduction in the nasal fracture can be

performed under general anesthesia in the operating room similar to that described for adults above. If the patient presents in the nonacute phase with a severely deviated upper third, careful consideration of osteotomies can be used to straighten the upper third. In the author’s opinion, this can be performed safely without disrupting the growth centers on the nasal septum. Septoplasty in the pediatric population is generally delayed till adolescent except for patients with severe deviated nasal septum and nasal obstruction resulting in obstructive sleep apnea. In these cases, a conservative approach is key with minimal cartilage resection and attempts to preserve the bony-cartilaginous junction if possible. One should approach management of pediatric nasal injury in a conservative fashion to avoid disrupting the growth centers on the nasal septum.

#### Management of the Saddle Nose

The treatment of saddle nose deformities depends on the degree of saddling and the presence of structural septal support. Various classifications for saddle nose deformities have been described in the literature for mild to severe deformities, but none has been universally accepted.<sup>8,16–18</sup> We describe a simple algorithm in the management of saddle nose that we believe is applicable for majority of these patients (→Fig. 11). They can be broadly divided into two groups. The first group comprises patients with mild saddle nose deformity with intact dorsal and caudal septal support and without nasal obstruction. These can be treated with dorsal augmentation to camouflage the deformity. The only grafts used consist mostly of autografts such as the temporalis fascia graft, septal cartilage, auricular cartilage, or the “Turkish Delight.”<sup>19</sup> Alloplasts can be considered as a last resort.



**Fig. 11** Working algorithm for management of saddle nose deformity.

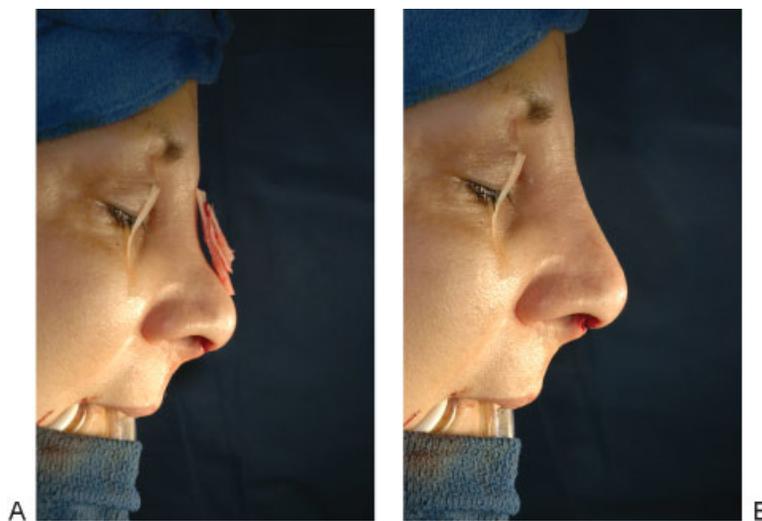
Common implants include silicone, high-density porous polyethylene (Medpor, Stryker Corporation, Kalamazoo, MI), and expanded-polytetrafluoroethylene (Gore-Tex, W.L. Gore Associates, Inc., Newark, DE). Generally, alloplasts are prone to infection and extrusion with rates of up to 8% after 10 years,<sup>20</sup> especially when used as a rigid structural graft that imparts tension on the overlying skin, such as a large tip graft. The porous nature of these grafts allows tissue ingrowth that can help with fixation but also makes retrieval more challenging. They remain widely used, especially in Asia, as dorsal augmentation grafts.

The second group consists of patients with severe saddle nose deformity and who are usually associated with poor septal support mechanism. They usually require middle vault reconstruction to reconstitute the dorsal and caudal septal support mechanism in addition to a dorsal onlay graft. A rib or

bony autograft in an L-strut fashion is commonly used for this purpose.

**Mild Saddle Nose with Intact Structural Septal Support**

For mild saddle nose where augmentation of 1 to 2 mm is needed, deep temporalis fascia can be used for dorsal augmentation. The advantages are the pliability of the temporalis fascia. It can be easily contoured to fill the mild saddling and almost never shows through the skin. It can be harvested from a small, 3 cm incision hidden within the temporal hair. The mobility and stretchability of the temporal skin allows an almost 5 × 5 cm size of temporalis fascia to be harvested with minimal donor site morbidity. To achieve more dorsal augmentation, diced cartilage can be used wrapped in temporalis fascia. Diced cartilage are believed to have longer survivability than crushed cartilage and are believed to fuse together with



**Fig. 12** (A) Poor dorsal support with scooped appearance on side view. (B) Dorsal onlay graft comprising of septal and auricle cartilage sutured together. This is carefully tucked into a tight periosteal pocket created to minimize chance of migration postoperatively. Sutures can be used to anchor this to the upper lateral cartilage to enhance its stability.

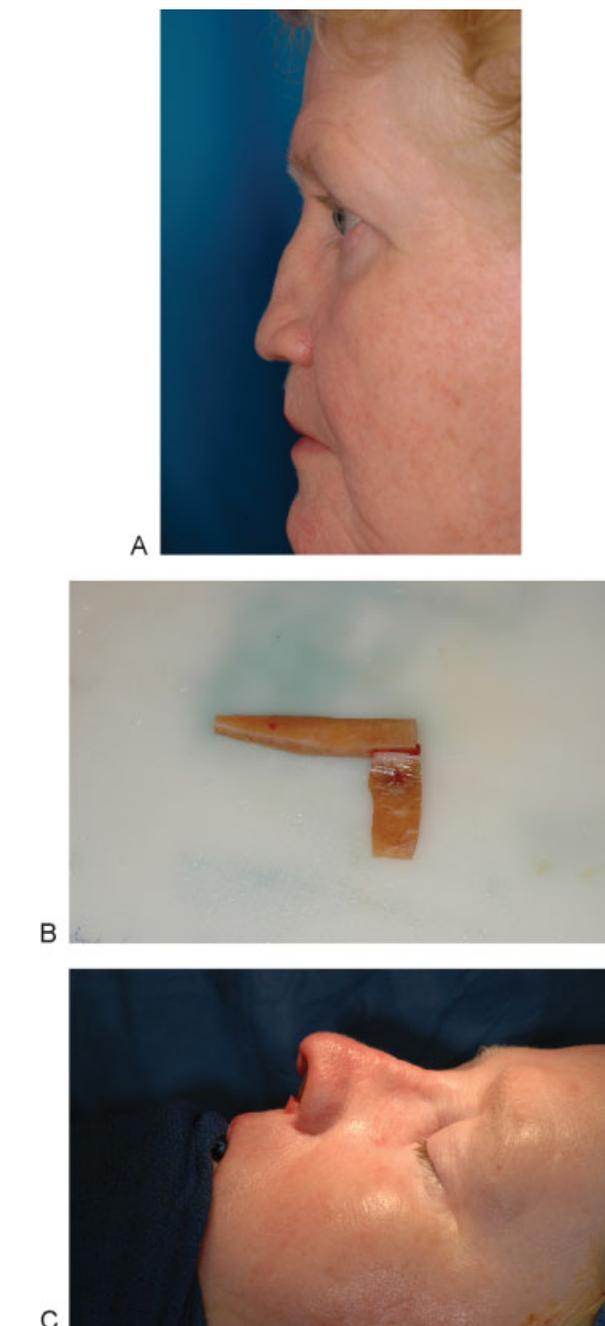
time to form a self-containing conglomerate.<sup>21</sup> This is believed to be an improvement of the “Turkish Delight” as described by Errol who wrapped the diced cartilage in Surgicel (Ethicon, Somerville, NJ), a resorbable oxidized regenerated cellulose product frequently used as an intraoperative hemostatic adjunct.<sup>19</sup> Diced cartilage wrapped in temporalis fascia is believed to have longer survivability as the Surgicel can potentially incite an inflammatory reaction resulting in increased cartilage resorption.<sup>22</sup> Cartilage obtained from the septum, concha, or rib can be diced into 0.5-mm cubes with fresh size 11 blades. The temporalis fascia can be used to wrap the diced cartilage and closed with a 4-0 plain gut. This can be used as a dorsal augmentation much like a silicone implant. It can be secured in place with a percutaneous stitch running through the graft and through the skin of the glabella. The stitch can then be removed 1 week postoperatively.

Septal cartilage is advantageous due to its resilience compared with auricular cartilage. It is relatively straight, lacks of donor site morbidity, has less chance of warping compared with costal cartilage, and has ease of harvest. However, it may be deficient in revision rhinoplasties and in patients with large nasal septal perforations. Auricular cartilage, commonly from the concha bowl, is an alternative option though its intrinsic curvature makes it less ideal. The septal and conchal cartilage can be used together with the straight septal cartilage sutured firmly to the conchal cartilage to splint it and keep it straight (→ Fig. 12). It is crucial to ensuring that the edges of this graft are gently beveled laterally to minimize chance of show through the skin.

After the graft has been fashioned, a tight periosteal pocket is created over the nasal bones just sufficient to admit the graft and to minimize chance of lateral migration postoperatively. The sides of this graft can be sutured to the upper lateral cartilage to further minimize chance of movement.

### Severe Saddle Nose with Poor Septal Support

Middle vault reconstruction with the use of rib cartilage of calvarial bony autograft in the form of an L-strut is used to treat patients with severe saddle nose and poor septal support. This autograft provides both dorsal augmentation and dorsal and caudal support (→ Fig. 13). The rib autograft is commonly harvested via a 3- to 5-cm incision over the seventh, eighth, or ninth rib. A subperichondrial dissection especially on the deep surface of the rib prevents pleural injury, and a central segment of a relatively straight costal cartilage is obtained. This helps prevent subsequent warping of the rib. Soaking the rib graft in saline at regular intervals during the carving phase will allow it to warp and the carving of the rib graft can be tailored accordingly. The greater rigidity of the rib mandates judicious contouring, especially of the edges, and is necessary to avoid show of the autograft below the skin. The site where the caudal strut meets the dorsal strut correlates to the ideal anterior septal angle for the patient and the base of the strut is suture-fixated to the periosteum of the nasal spine. The cephalic end of the rib autograft is tucked snugly into a conservative subperiosteal pocket to minimize chance of migration. Calvarial bone grafts from the parietal



**Fig. 13** (A) Preoperative photograph of a patient with severe saddle nose and poor septal support. (B) A L-shaped autologous rib graft can be fashioned and used to provide dorsal augmentation and structural support. (C) Postoperative photograph of the patient with the rib graft in place.

bone have been described for the same uses as above; however, it carries a potential risk of intracranial injury during the harvesting process, albeit a small one.<sup>23</sup> The benefits of a calvarial bone graft is its longevity, superior strength, and relative abundance. It is much less prone to resorption compared with cartilages graft.<sup>23</sup> Because of its strength, calvarial bone can be thinned to 1 mm and arranged in a hinged, interlocking fashion with an L-configuration for caudal and dorsal support of the nose.

## Conclusion

Management of the posttraumatic crooked and saddle nose is a challenging problem the surgeon faces in his practice. A careful preoperative assessment of the patient and a thorough understanding of the underlying anatomical causes for the deformity are important for surgical planning. The crooked and saddle nose can have varying degrees of functional and aesthetic concerns to the patient, and it is vital to elucidate this clearly prior to embarking on a definite treatment plan.

## References

- Larrabee WF Jr, Murakami C. Osteotomy techniques to correct posttraumatic deviation of the nasal pyramid: a technical note. *J Craniomaxillofac Trauma* 2000;6(1):43–47
- Porter JP, Toriumi DM. Surgical techniques for management of the crooked nose. *Aesthetic Plast Surg* 2002;26(Suppl 1):S18
- Foda HM. The role of septal surgery in management of the deviated nose. *Plast Reconstr Surg* 2005;115(2):406–415
- Roofe SB, Murakami CS. Treatment of the posttraumatic and post-rhinoplasty crooked nose. *Facial Plast Surg Clin North Am* 2006;14(4):279–289, v
- Kim DW, Toriumi DM. Management of posttraumatic nasal deformities: the crooked nose and the saddle nose. *Facial Plast Surg Clin North Am* 2004;12(1):111–132
- Frodel JL. Primary and secondary nasal bone grafting after major facial trauma. *Facial Plast Surg* 1992;8(4):194–205
- Frodel JL Jr. Management of the nasal dorsum in central facial injuries. Indications for calvarial bone grafting. *Arch Otolaryngol Head Neck Surg* 1995;121(3):307–312
- Daniel RK, Brenner KA. Saddle nose deformity: a new classification and treatment. *Facial Plast Surg Clin North Am* 2006;14(4):301–312, vi
- Christophel JJ, Hilger PA. Osseocartilaginous rib graft rhinoplasty: a stable, predictable technique for major dorsal reconstruction. *Arch Facial Plast Surg* 2011;13(2):78–83
- Higuera S, Lee EI, Cole P, Hollier LH Jr, Stal S. Nasal trauma and the deviated nose. *Plast Reconstr Surg* 2007;120(7, Suppl 2):64S–75S
- Webster RC, Davidson TM, Smith RC. Curved lateral osteotomy for airway protection in rhinoplasty. *Arch Otolaryngol* 1977;103(8):454–458
- Larrabee WF Jr. Open rhinoplasty and the upper third of the nose. *Facial Plast Surg Clin North Am* 1993;1:23–38
- Goode RL, Spooner TR. Management of nasal fractures in children. A review of current practices. *Clin Pediatr (Phila)* 1972;11(9):526–529
- Kaban LB, Troulis MJ, Eds. *Pediatric Oral and Maxillofacial Surgery*. 2nd ed. Philadelphia, PA: Saunders; 2004
- Verwoerd CDA, Verwoerd-Verhoef HL. Rhinosurgery in children: basic concepts. *Facial Plast Surg* 2007;23(4):219–230
- Dyer WK II, Beaty MM, Prabhat A. Architectural deficiencies of the nose: treatment of the saddle nose and short nose deformities. *Otolaryngol Clin North Am* 1999;32(1):89–112
- Tardy ME Jr, Schwartz M, Parras G. Saddle nose deformity: autogenous graft repair. *Facial Plast Surg* 1989;6(2):121–134
- Alsarraf R, Murakami CS. The saddle nose deformity. *Facial Plast Surg Clin North Am* 1999;7:303–310
- Erol OO. The Turkish delight: a pliable graft for rhinoplasty. *Plast Reconstr Surg* 2000;105(6):2229–2241, discussion 2242–2243
- Tham C, Lai YL, Weng CJ, Chen YR. Silicone augmentation rhinoplasty in an Oriental population. *Ann Plast Surg* 2005;54(1):1–5, discussion 6–7
- Daniel RK, Calvert JW. Diced cartilage grafts in rhinoplasty surgery. *Plast Reconstr Surg* 2004;113(7):2156–2171
- Calvert JW, Brenner K, DaCosta-Iyer M, Evans GR, Daniel RK. Histological analysis of human diced cartilage grafts. *Plast Reconstr Surg* 2006;118(1):230–236
- Sajjadian A, Rubinstein R, Naghshineh N. Current status of grafts and implants in rhinoplasty: part I. Autologous grafts. *Plast Reconstr Surg* 2010;125(2):40e–49e