Corrective Nasal Surgery in the Younger Patient

Eelam Adil, MD, MBA; Neerav Goyal, MD, MPH; Fred G. Fedok, MD

**IMPORTANCE** To describe clinical parameters for the management of the pediatric patient with nasal anatomical deformity or functional impairment.

**OBJECTIVES** To review the authors' experience with corrective nasal surgery in pediatric patients and make recommendations regarding indications for surgery and surgical techniques.

**DESIGN, SETTING, AND PARTICIPANTS** A retrospective medical chart review was performed for all male patients younger than 16 years and female patients younger than 14 years seen by the senior author (F.G.F.) at a tertiary referral center between August 1996 and August 2012. The database was searched for patients who underwent septoplasty or corrective nasal surgery by the senior author.

**EXPOSURES** Patients included in the study underwent either septoplasty or corrective nasal surgery by the senior author.

**MAIN OUTCOMES AND MEASURES** Age, indication for surgery, surgery performed, and last follow-up appointment was recorded for each patient. In addition, any complications or need for revision surgical or adjunct procedures were noted.

**RESULTS** Demographics and outcomes for 54 pediatric patients were included in the study. The most common indications for surgery were posttraumatic deformities (n = 36) and severe airway obstruction (n = 48). Fifteen patients with severe nasal airway obstruction did not have a documented history of trauma. The mean follow-up period was 646 days (approximately 21 months), with a range of 8 to 4062 days. Five patients underwent a staged procedure, and no patients underwent a revision procedure for unsatisfactory results.

**CONCLUSIONS AND RELEVANCE** Children with nasal obstruction and deformity can safely undergo nasal corrective surgery prior to adolescence. Special considerations include preserving normal structures and the judicious use of grafts. The recommended approaches to managing the pediatric septoplasty and nasal surgery patient are described herein through a series of representative cases.

**LEVEL OF EVIDENCE** 3.
Corrective Nasal Surgery in the Younger Patient

Methods

Background

Embryology

The bony nasal vault consists of the nasal processes of the frontal bones, nasal bones, and nasal processes of the maxilla. The midface bones originate from membranous structures, with the nasal processes of the frontal bones and nasal bones arising from the frontonasal process and the maxilla originating from the mandibular (first) arch. Between the fifth and seventh weeks of gestation, ossification centers arise for the maxilla and nasal bones. The vomer starts to ossify during the eighth week. During the third month, chondrification of the lateral nasal walls occurs in conjunction with the development of the cartilaginous portions of the nasal vault. By the sixth month, this single sheath of cartilage divides into the upper lateral, lower lateral, and septal cartilages. Nasal and midface growth continues until ages 14 to 17 years. It has been shown that the nasal septum continues to grow until age 36 years.3

Animal Studies

In the 1950s and 1960s, a series of experiments was performed using animal models to determine the impact of nasal surgery on midface growth. Sarnat and Wexler4 performed resections of septal cartilage in rabbits without preservation of the mucoperichondrium and noted significant retardation of maxillary and midface growth. In the 1970s, Hartshorn5 performed similar resections of nasal septal cartilage in canines and also demonstrated a difference in maxillary growth. Squier et al6 evaluated the canine snout after vomer resection and its impact on the anterior-posterior growth of the maxilla. When compared with controls, the canines with vomer resection were found to have retardation of the anterior-posterior maxillary dimension. In addition, histological examination revealed fibroblast and elastin fiber proliferation in the resected group, suggesting that this proliferation may lead to a difference in growth patterns.6 In each of these studies, extensive resections of the septal cartilage were performed.

In contrast, removal of septal cartilage from guinea pigs did not show significant changes to midface growth unless an extensive resection was performed.7 Bernstein8 subsequently removed nasal septal cartilage from 4- to 6-week-old canines, preserving the mucoperichondrium. In these canines, no appreciable change in growth was established, and cartilaginous autografts that were performed were found to be viable. Given these varied opinions and results, conservative recommendations regarding nasal surgery in children were advanced, and it was recommended that elective surgery be delayed until the teenage years, after the completion of nasal growth.

The Pediatric Patient

Controversy has endured on the topic of the timing of nasal surgery in pediatric patients. One side maintains that nasal surgery should be avoided in this population given its potential impact on nasal and midface growth; the other side points to evidence that suggests that delaying surgery can have functional, cosmetic, and social developmental consequences.

Obstructive nasal septal deformity can lead to chronic mouth breathing, which has been shown to affect craniofacial development9-12 because it requires an open mouth and lips and a lowered or anterior tongue. It also results in decreased maxillofacial muscle tone. This lack of normal developmental forces causes narrowing of the maxilla, micrognathia, retrusion, and protrusion of the maxillary incisors. Overall, anterior lower vertical face height is increased in these patients, and posterior facial height is decreased.13 In addition, it has been shown that uncorrected septal deformities will continue to worsen and can have an impact on the frequency of sinusitis and otitis media.14

Support for the safe performance of septal surgery in pediatric patients comes from the literature on transseptal skull base surgery in children.15-18 Transseptal surgery via sublabial transseptal and transseptal transphenoidal approaches for access to the middle cranial fossa has been described for hypophyseal and other skull base anomalies in children 4 years and older, with no reports of nasal or craniofacial deformity following these procedures in this population.

The pediatric nose is relatively underprojected and shortened compared with the adult. The pediatric nose responds to trauma differently than the adult because it is more cartilaginous and less prominent. This results in a higher incidence of greenstick fractures and avulsed cartilage. The pediatric nasal bones frequently disarticulate and splay, rather than fracture, in response to trauma. The nasal bone dorsum flattens and widens, the septum disarticulates and flattens, and the nose shortens. As is true for other facial fractures in children, it has also been observed that the extent of injury is frequently underappreciated.19 These deformities should not be left untreated because they can lead to soft-tissue contracture and distortion that can make future reconstructive nasal surgical procedures much more difficult. Similarly, functional effects of the
crooked nose, tumor, and cleft nose deformity warrant early surgical intervention. In addition, the psychosocial effects of an untreated deformity can lead to difficulties at school and with peers. Therefore, it is the opinion of the senior author (F.G.F.) that corrective nasal surgery can be prudently performed on properly selected pediatric patients.

Retrospective Medical Chart Review
This study received approval from the Penn State Hershey Medical Center Institutional Review Board. A retrospective medical chart review was performed for all male patients younger than 16 years and female patients younger than 14 years seen by the senior author at a tertiary referral center between August 1996 and August 2012. The database was searched for patients meeting the age criteria who underwent septoplasty or corrective nasal surgery by the senior author as defined by a series of Current Procedural Terminology codes including 21325, 21330, 21335, 21336, 30400, 30410, 30420, 30435, 30462, 30465, and 30520. Patients for whom medical records could not be obtained were excluded from the study. Age, sex, indications for surgery, the surgery performed, site of cartilage harvest (if any), and the last follow-up appointment were recorded. In addition, any adjunct procedures (such as needle rasping or steroid injections) or revision surgical procedures were noted, as well as the time between the initial surgery and any secondary surgery. Patients who underwent planned staged operations were not considered to have undergone a revision. From the database of patients, representative cases were selected for further discussion to highlight the clinical parameters used in managing this population.

Table 1. Pediatric Nasal Surgery Sample Demographics

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Male (n = 39)</th>
<th>Female (n = 15)</th>
<th>Total (n = 54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD) [range], y</td>
<td>12.61 (2.47)</td>
<td>11.18 (2.20)</td>
<td>12.22 (2.46)</td>
</tr>
<tr>
<td>Indication for surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posttraumatic</td>
<td>29</td>
<td>7</td>
<td>36</td>
</tr>
<tr>
<td>Nontrauma-related nasal obstruction</td>
<td>8</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Postsurgical deformity</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2. Different Surgical Procedures Performed

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>% Of Total No. of Procedures Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septoplasty</td>
<td>43</td>
</tr>
<tr>
<td>Osteotomies</td>
<td>34</td>
</tr>
<tr>
<td>Vestibular stenosis repair</td>
<td>8</td>
</tr>
<tr>
<td>Spreader grafts</td>
<td>7</td>
</tr>
<tr>
<td>Dorsal onlay</td>
<td>6</td>
</tr>
<tr>
<td>Septal perforation repair</td>
<td>2</td>
</tr>
</tbody>
</table>

Results

Patient Demographics and Procedures
Demographics and outcomes for 54 pediatric patients were included in the medical chart review. There were 39 male (72%) and 15 female (28%) patients. The mean age of the patient population was 12.2 years, with an age range of 5.6 to 15.3 years. Table 1 describes the basic demographics of our study sample. The most common indications for surgery were posttraumatic deformities (n = 36 [67%]) and airway obstruction (n = 48 [89%]). Fifteen patients (28%) had reported severe nasal obstruction without documented trauma. Forty-three patients (80%) were noted to have a significant septal deviation (occluding at least 70% of the airway) on clinical examination. Six patients (11%) had evidence of a saddling of their nose on examination.

Nine patients (17%) underwent a septoplasty alone; while another 32 (59%) underwent septoplasty in combination with other procedures. Nineteen patients (35%) required an open approach, 10 patients (19%) underwent osteotomies alone, and 23 (43%) underwent osteotomies with a septoplasty. Auricular cartilage was used for grafting in 7 patients (13%), septal cartilage in 10 patients (19%), and rib cartilage in 5 patients (9%). Eight patients (15%) underwent tip work with revision of the ala to help address vestibular stenosis. All 6 patients with saddling had dorsal onlay grafts placed. Table 2 gives the different surgical procedures performed on our sample as a proportion of the total number of rhinoplasty procedures (n = 97) performed.

The mean follow-up period was 646 days (approximately 21 months), with a range of 8 to 4062 days. No patients underwent revision surgery, though 5 patients (9%) underwent a second surgery as part of a staged operation for more complicated reconstructions. During the follow-up period, nasal growth appeared to continue as anticipated for the patients.

Report of Cases

Case 1: Acute Saddle Deformity
This 10-year-old girl had an acute saddle nose with left septal deviation secondary to being struck by a softball. External examination revealed comminution of her nasal bones with loss of central nasal support. Intranasal examination revealed significant buckling of the septum with loss of dorsal and caudal support and impingement of the left nasal airway. Her operative repair was performed approximately 17 weeks after the injury. Through an open approach, the patient underwent septoplasty and restoration of dorsal height and length with the placement of bilateral extended spreader grafts and dorsal augmentation with auricular cartilage and osteotomies. Figure 1 shows the preoperative and postoperative photographs.
Case 2: Atraumatic Patient with Severe Septal Deviation, Airway Obstruction, and a Crooked Nose

This 14-year-old boy was referred by a pediatric otolaryngologist for nasal obstruction and correction of severe septal deviation. On examination, the patient was noted to have a leftward deviation of his nasal bones with a severe rightward deviation of the septum, the cartilaginous nasal middle vault, and the nasal tip. Intranasal examination confirmed a severe rightward deviation of his septum with impingement onto his right nasal sidewall and presentation into his right nares. Via an open approach, the patient underwent bilateral nasal bone lateral osteotomies and a septrhoplasty with placement of bilateral spreader grafts to “brace” the septum. The patient’s preoperative and postoperative photographs are shown in Figure 2.

Discussion

Clinical Situations Warranting Intervention

The senior author recommends corrective surgery in the pediatric patient (age <14 years in female patients and <16 years in male patients) in cases of deformity and dysfunction after nasal trauma; for severe crooked nose with functional impairment or severe deformity; following tumor resection; and for cleft nose deformity. Clinical examination with anterior rhinoscopy is essential to assess the degree of septal deformity, if present. Occasionally, flexible fiberoptic rhinoscopy can aid with the evaluation. Computed tomographic imaging is rarely necessary unless one is concerned about a more posterior anatomic abnormality.
The decision to offer surgical management for younger patients is considered when deformity and impairment of function is of significant concern, just as it is in other age groups. In general, patients are selected for surgical intervention if they have significant deformity or functional impairment, most frequently obstruction. The goals of surgery depend on the problem being corrected. Following nasal trauma, the goal is to restore the preinjury appearance and function of the nose. With a severely crooked nose, the aim is to straighten the dorsum and septum, as well as restore the airway. After tumor resection and with cleft nose deformity, the goal is to reconstruct a normal-appearing nose without obstruction. An endonasal approach can be used for many of these problems in pediatric patients. Conservation of the nasal septum and tip support is important to maintain the structure and foundation of the growing nose. Grafting materials should be used judiciously because children have less grafting material available given their smaller size. Auricular cartilage is used sparingly, and submucous resection of the septum for graft materials is usually avoided. A small amount of septal grafting material is at times available after conservative septoplasty. Alloplasts can be considered in these patients on a temporary basis. However, there is a lifetime risk of extrusion and infection. In general, the goal is to preserve structure, especially of the midline nasal support, including the bony and cartilaginous septum. This is facilitated through the use of spreader grafts (Figure 3).

For most nasal surgery, but especially in the case of a child, prudence should be exercised. Preservation of structure is a critical principle. To improve form and function, structure may be augmented, sculpted, or otherwise changed. Removal or resection of nasal structure should be done very conservatively. In this patient population, the goal is not to create a highly sculpted adultlike rhinoplasty result. It is, instead, to restore structure to an age-appropriate normal appearance and improve function. Septal surgery is performed with the maximal maintenance of both bone and cartilage in the septum. Septal structures are freed from their surrounding attachments and restored to the midline. Palatal crest bone may be osteotomized and repositioned back into the midline. The only bone or cartilage to be removed is only the minimal amount necessary to allow straightening of the septum and improvement of the airway (Figure 4).

The nasal bones may be osteotomized to allow straightening, especially after previous trauma. Micro-osteotomes should be used to minimize trauma to the surrounding structures. A familial dorsal convexity is only taken down after consideration of the patient’s age and further growth potential. However, in this younger population, a dorsal convexity is uncommon. All of the native length and dorsal projection of the nose is preserved.

Saddling of the nose following trauma may require grafting to restore nasal dimensions. Although a columellar strut may be placed to assist in the reprojection of a tip and intra-
domal and interdomal sutures may be placed to restore the shape of the tip that has been flattened after trauma, dome division, complete strips, or any form of lower lateral cartilage division is usually not carried out unless it is necessary to create symmetry.

The following scenarios are commonly encountered. In a nose with acute trauma, saddling, significant crookedness, or a significant septal deviation with airway obstruction, we have been able to perform relatively atraumatic osteotomies on the nasal bones and conservative septoplasty. In general, this has been more reliable than carrying out only a traditional closed reduction.

In patients who present with severe septal deviation (ie, with the septum approximating the nasal sidewall), airway obstruction and septal deviation has been corrected with an open approach for the placement of spreader grafts to brace the septum in the midline. Frequently, attempts to correct this functional problem without the use of spreader grafts have led to a recurvature of the septum.

After tumor surgery, when there has been a disruption of the patient’s nasal growth centers, either secondary to the tumor or the subsequent surgical treatment, the patients have been followed over the course of several years. When the size of their nose has resulted in social issues because of a lack of growth, the nasal deformity has been addressed with rhinoplasty maneuvers.

**Long-term Impact**

All of these patients and their parents are counseled that given the influence of aging, growth, and the impact of the previous trauma and surgery, there is the probability that residual or new asymmetries will become apparent over time. In those cases, the patient is counseled that further surgical correction may be required as the patient continues to age and grow.
situations, the patients will need a second surgery during their late teens or early twenties.

This study supports corrective surgery in the younger patient presenting with significant deformity and obstruction. This study is not meant to support aesthetic or corrective rhinoplasty for lesser aesthetic concerns in the younger patient. The minimal ages that elective aesthetic rhinoplasty may be considered in this report secondary to a number of factors, the most specific selected to be under these age ranges and to be at ages when nasal and midface growth was generally considered to be incomplete.

A significant limitation of this study is the relatively short follow-up period compared with the lifespan an individual. A more thorough review would be to include 5- and 10-year follow-up periods to examine nasal growth. That was not included in this report secondary to a number of factors, the most common of which was patients being lost to follow-up.

Conclusions

On the basis of the senior author’s experience, as well as the information obtained from our retrospective review, we believe that nasal surgery can be performed safely in select younger pediatric patients. Patients should undergo physical examination including anterior rhinoscopy and possible flexible fiberoptic examination, especially in those presenting after trauma. Occasionally, imaging may assist in identifying the cause of nasal obstruction. Goals of surgery should be conservative and aim to maintain the pre-existing structural framework, to restore form and function, and to maintain or reconstruct the projection of the nose including dorsal height and the tip projection and position. Cartilage grafts, obtained from the ear or rib, can be used to strengthen the framework through spreader grafts. With more significant trauma or congenital defects, staged reconstructions may be necessary.

REFERENCES

ARTICLE INFORMATION

Accepted for Publication: September 9, 2013.
Published Online: February 6, 2014.

Author Contributions: Drs Goyal and Fedok had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Adil, Goyal, Fedok.
Acquisition of data: Adil, Goyal, Fedok.
Analysis and interpretation of data: Adil, Goyal.
Drafting of the manuscript: Adil, Goyal, Fedok.
Critical revision of the manuscript for important intellectual content: Adil, Goyal, Fedok.
Statistical analysis: Goyal.
Administrative, technical, and material support: Fedok.
Study supervision: Adil, Fedok.

Conflict of Interest Disclosures: None reported.

Additional Contributions: We thank Kim Gordon, Pennsylvania State University, for her keen editing skills and her assistance in assembling the manuscript. She received no financial remuneration for her work on the manuscript.

Correction: This article was corrected on February 11, 2014, to correct an institution name in the affiliations and corresponding author address.