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REVIEW ARTICLE

American Rhinologic Society Expert Practice Statement: Indications and Recommendations for Septoplasty in Children

Austin S. Rose MD, MBA[1] | **Chadi A. Makary MD**[2] | **Zachary M. Soler MD**[3] | **Adam J. Kimple MD, PhD**[1] | **Aaron N. Pearlman MD**[4] | **Uma S. Ramaswamy MD**[5] | **Michael Setzen MD**[4] | **David A. Gudis MD**[6]

[1]Department of Otolaryngology—Head & Neck Surgery, University of North Carolina School of Medicine, Chapel Hill, North Carolina, USA

[2]Department of Otolaryngology—Head & Neck Surgery, West Virginia University School of Medicine, Morgantown, West Virginia, USA

[3]Department of Otolaryngology—Head & Neck Surgery, Medical University of South Carolina, Charleston, South Carolina, USA

[4]Department of Otolaryngology—Head & Neck Surgery, Weill Cornell Medical College, New York, New York, USA

[5]Department of Otolaryngology—Head & Neck Surgery, Baylor College of Medicine, Houston, Texas, USA

[6]Department of Otolaryngology—Head & Neck Surgery, Columbia University School of Medicine, New York, New York, USA

Correspondence
Chadi A. Makary, Department of Otolaryngology-Head & Neck Surgery, West Virginia University School of Medicine, Morgantown.
Email: chadi.makary@hsc.wvu.edu

Abstract

The goal of this American Rhinologic Society Expert Practice Statement (EPS) is to provide recommendations and guidance through evidence-based consensus statements regarding pediatric septoplasty. This EPS was developed following the previously published methodology and approval process. The topics of interest included appropriate indications, safety and efficacy, timing, relevant quality of life instruments, and surgical techniques. Following a modified Delphi approach, six statements were developed, five of which reached consensus and one that did not. These statements and accompanying evidence are summarized along with an assessment of future needs.

KEYWORDS

children, nasal obstruction, nasal septal deviation, nasal septoplasty, pediatric

1 | INTRODUCTION

Despite decades of concern regarding the impairment of nasal and midfacial growth, more recent literature suggests that nasal septoplasty appears safe in children when indicated. A number of clinical studies from the late 1980s through the present have demonstrated minimal long-term effects on nasal or facial growth using anthropometric measurements and cephalometric data. A growing body of evidence suggests that septoplasty may be performed safely and effectively when necessary with minimal impact on craniofacial development if performed with meticulous surgical techniques.[1,2–11] Pediatric septoplasty may be indicated for congenital or traumatic deformity, nasal septal abscess, significant nasal obstruction due to septal deviation, and exposure when necessary during functional endoscopic sinus surgery (FESS) and endoscopic skull base surgery (ESBS) with evidence for improved quality of life (QOL) based on validated instruments.[12–17] Septoplasty in children may be more surgically challenging than in adults

patients and recommended techniques specific to children warrant review.

Pediatric nasal obstruction can significantly impact a child's QOL and contribute to other disease processes including obstructive sleep apnea. Historically, otolaryngologists were concerned that performing a septoplasty for deviated nasal septum (DNS) in the pediatric population could impact normal craniofacial skeletal development. However, evidence that nasal obstruction from any cause may lead to obligate mouth breathing, which has itself been associated with dental malocclusion and abnormalities of craniofacial development, may have offset prior concerns.[18–20] DNS specifically has also been shown to be associated with craniofacial and dental anomalies.[21,22] Recent evidence suggests that septoplasty, often along with an inferior turbinate reduction, is effective in treating pediatric nasal obstruction without resulting in significant craniofacial growth abnormalities.[1–11]

2 | MATERIALS AND METHODS

This EPS was developed with methodology previously described in a separate publication which involves the following steps: (1) declaration of intent and idea proposal approval; (2) creation of a working group; (3) systematic and transparent EPS production methodology to ensure consistency and high quality; (4) review and preliminary approval of EPS; (5) legal review; (6) opportunity for comments from the American Rhinologic Society (ARS) membership at large; (7) integration of public comments and final revisions; (8) final approval by the ARS Board of Directors; (9) submission for publication consideration in the International Forum of Allergy and Rhinology; and (10) public posting on the ARS website.[23] The workgroup for this EPS statement was comprised of eight ARS members, five of whom are members of the ARS Pediatric Rhinology Committee. Evidence was based in part on a 2020 systematic review, supplemented by an updated systematic literature search to capture recently published studies.[1] A series of six statements addressing septoplasty in children was initially drafted by the EPS workgroup. The choice of topics to address in the statements was decided based on the gaps and controversies in the literature and after discussion with the work group members. Each member was then asked to score each statement using a nine-point Likert scale: 1 = strongly disagree, 3 = disagree, 5 = neutral, 7 = agree, and 9 = strongly agree. The surveys were disseminated, responses were aggregated and analyzed, and results were distributed to the panelists for discussion via teleconference. A statement was considered to have reached consensus if a mean score of ≥7.00 was achieved with no more than one outlier (defined as any score ≥2.0 Likert points from the mean in either direction).[24] A statement was categorized as reaching near consensus if a mean score of ≥6.50 was achieved with no more than two outliers.[24] Those statements that did not meet the criteria of either category were classified as not having reached consensus.[24] After two iterations of this Delphi survey, five of the statements reached consensus and one did not (see Table 1). These statements and accompanying evidence are summarized below. Aggregate grade of evidence is based on the Agency for Healthcare Research and Quality scale of research grades and levels (see Addendum I).

3 | EXPERT PRACTICE STATEMENTS WITH SUMMARY OF EXISTING EVIDENCE

3.1 | Pediatric septoplasty: effect on facial growth

3.1.1 | Statement 1 (consensus = mean score 8.50)

Septoplasty is both technically feasible and safe in children, with available evidence suggesting minimal significant impact on nasal and midfacial growth.

3.1.2 | Aggregate grade of evidence: grade B

Benefit: Improved and more timely treatment of nasal obstruction due to septal deviation in children. Avoidance of malocclusion associated with septal deviation, chronic sinusitis, obstructive sleep apnea, and facial asymmetry.

Harm: Possible minor reductions in nasolabial angle, dorsal length, and nasal tip protrusion, which are primarily associated with open surgical approaches. Possible need for further surgery, including revision septoplasty.

Cost: Surgical and anesthesia costs.

Benefit–harm assessment: Preponderance of benefit over harm.

Value judgment: Potential benefits of septoplasty in children outweigh the risks of minor impacts on nasal growth and associated costs and risks of surgery.

Early animal studies appear to have had an outsized influence on the otolaryngology community's understanding of nasal septal development. In 1858 in Germany, Fick demonstrated that nasal septal resection in growing animals resulted in a shortened hard palate.[25] In 1929, Landsberger found that nasal septal resection resulted in hard palate elevation.[26] In 1966, a study in growing rabbits found that resection of both the cartilaginous septum

TABLE 1 Expert Practice Statement (EPS) consensus statements.

EPS statements	Mean score	Final outcome
Impact on growth: Septoplasty is both technically feasible and safe in children, with available evidence suggesting no significant impact on nasal and midfacial growth	8.5	Consensus
Indication: Septoplasty is indicated in children with nasal obstruction due to significant septal deviation	8.5	Consensus
Surgical access: Septoplasty is indicated in pediatric endoscopic sinus and skull base cases where there is a need for better instrument access and improved visualization	8.75	Consensus
Impact of delayed or non-treatment: The impact of nasal airway obstruction due to septal deviation on midfacial growth, chronic mouth breathing, obstructive sleep apnea, malocclusion, and facial asymmetry should be considered when evaluating a pediatric patient for septoplasty	8.25	Consensus
Quality of life: There is strong evidence to support that septoplasty is effective in children including significant improvements in quality of life	8	Consensus
Specialized instrumentation and care: Septoplasty in children requires specialized instrumentation and perioperative care	5.5	No consensus

and mucoperichondrium resulted in underdevelopment of the nasal and premaxillary bones, with the extent and severity of deformity proportional to the extent of the septal defect.[27] However, more recent animal studies subsequently found that submucous cartilage resection did not seem to impact craniofacial development.[2,3]

In the subsequent decades following these early animal studies, emerging evidence in the otolaryngology literature began refuting the claim that pediatric septoplasty impairs craniofacial development. Several such studies were reported using an external open septoplasty technique. Jugo first reported that external septoplasty did not significantly alter craniofacial growth, although the analysis was limited to subjective visual assessment.[4]

More rigorous and objective anthropomorphic studies of external septoplasty outcomes had similar findings. Béjar et al. performed an anthropomorphic analysis of 28 children following external septoplasty compared to normative data, and reported minimal differences between the two groups.[5] El-Hakim et al. then reported pre- and postoperative anthropomorphic measurements of 26 children following external septoplasty. Postoperatively, the nasal dorsum length and tip protrusion were decreased but not to a statistically significant degree.[6] In a study of endonasal pediatric septoplasty, Tasca and Compadretti reported long-term anthropometric measurements in 44 children compared to normative values with a mean follow-up of 12.2 years (range: 6.5–14.4 years).[7] While no significant differences were noted for 10 of 11 measured parameters, there was a significant reduction in nasolabial angle for both male and female subjects that underwent extracorporeal septoplasty in which the quadrangular cartilage was removed and repositioned. Children that underwent a more conservative procedure, with minimal and more target resection of deviated septal cartilage, demonstrated no significant difference from controls (see Table 2).

In summary, although early animal studies showed potential negative impacts of septoplasty on facial growth, data from more recent studies in humans are more reassuring with minimal negative impact mostly associated with external septoplasty approaches.

3.2 | Indications for pediatric septoplasty: Nasal obstruction

3.2.1 | Statement 2 (consensus = mean score 8.50)

Septoplasty is indicated in children with nasal obstruction due to significant septal deviation.

3.2.2 | Aggregate grade of evidence: grade B

Benefit: Improved treatment of significant nasal obstruction due to septal deviation in children. Recognition of nasal obstruction due to significant septal deviation as an important indication for septoplasty in children.

Harm: Possible minor reductions in nasolabial angle, dorsal length, and nasal tip protrusion, which are primarily associated with open surgical approaches. Possible need for further surgery, including revision septoplasty.

Cost: Surgical and anesthesia costs.

Benefit–harm assessment: Preponderance of benefit over harm.

TABLE 2 Evidence summary table—septoplasty in children (Oxford Centre for Evidence-Based Medicine Levels of Evidence, 2009—see Addendum II).

Study	Year	LOE	Study design	Study group	Clinical endpoint	Conclusion
Fick[25]	1858	4	Animal surgery to resect caudal septal cartilage; autopsy	Dogs, cats, pigs, and goats	Palate measurements	Resection of septum results in shortened palate in animals
Landsberger[26]	1929	4	Dog surgery to resect caudal septal cartilage; autopsy	Dogs	Palate measurements	Resection of septum results in higher hard palate in dogs
Sarnat and Wexler[27]	1966	4	Rabbit septal resection and autopsy measurements	Rabbits	Snout measurements	Extent of septal cartilage resection correlates to extent of facial deformity
Bernstein[2]	1973	4	Dog septal resection and autopsy measurements	Dogs	Snout and midface measurements	Septal resection does NOT impact snout/midface growth
Cupero et al.[3]	2001	3B	Ferret septal resection and cephalometry	Ferrets	Cephalometry	Septal resection does NOT impact facial growth
Jugo[4]	1987	4	Total septal reconstruction (extracorporeal septoplasty) in children	Children	Descriptive functional and cosmetic outcome without defined metrics	Total septal reconstruction in children yields good functional/cosmetic outcomes
Béjar et al.[5]	1996	3B	Cephalometry in children who had undergone external septoplasty	Children	Cephalometry	External septoplasty does not affect most measurements of nasal and facial growth, but may shorten nasal dorsum
El-Hakim et al.[6]	2001	3B	External septoplasty with pre- and postoperative cephalometry	Children	Cephalometry	External septoplasty does not affect development of the nose and midface
Tasca and Compadretti[7]	2011	3B	Cephalometry in people who had undergone endonasal septoplasty during childhood	Mostly adults (mean f/u following surgery of 12.2 years)	Cephalometry	Endonasal septoplasty does not affect development of the nose and midface
Calvo-Henríquez et al.[1]	2020	2A	Systematic review assessing outcomes (anthroposcopy and anthropometry) of nasal and midfacial growth in children undergoing septoplasty or septorhinoplasty	Children	Anthroposcopy and anthropometry	None of the eight selected papers found major disturbances in facial growth after septoplasty or septorhinoplasty in pediatric patients

Value judgment: Potential benefits of septoplasty in children outweigh the risks of minor impacts on nasal growth and associated costs and risks of surgery.

Nasal obstruction is one of the most common indications for septoplasty in adults and children. A comprehensive history and physical examination are the first steps in identifying patients who might benefit from surgery. In children, history should include laterality of symptoms, timing of symptoms, history, and laterality of epistaxis, sleep function (snoring, frequent arousals, enuresis, etc.), cough, recurrent respiratory infections, and growth and development. The work-up and indications for septoplasty in the pediatric population differ from adults and may change during development.

Specifically in neonates and children less than 2 years old, congenital causes of pediatric nasal obstruction should be ruled out including: choanal atresia (unilateral or bilateral), pyriform aperture stenosis, midline nasal masses, and nasolacrimal duct cysts.[28] Septal deviation can be noted in neonates due to birth trauma and studies have demonstrated a higher rate of septal deviation in vaginal deliveries than in cesarean sections.[29] Typically, neonatal septal deviation is managed with observation but in more severe cases with respiratory

or feeding difficulties, early closed reduction may be beneficial.[30]

In children older than 2 years of age, congenital causes of nasal obstruction become less likely while inflammatory and infectious etiologies become more common. Despite this shift in prevalence, it remains important to rule out congenital causes. A complete head and neck examination should be performed specifically assessing for epiphora, external asymmetry, adenoid facies, or lymphadenopathy. Anterior rhinoscopy and nasal endoscopy should ideally be performed to determine the cause of the nasal obstruction, assess adenoid hypertrophy, and evaluate for any component of inferior turbinate hypertrophy as a contributing factor. A plain lateral radiograph of the neck may also be considered to, if necessary, to rule out significant adenoid hypertrophy as a contributing factor. Optimizing management of allergic rhinitis when indicated prior to considering surgical interventions is warranted.

When indicated, it is important to optimize management of any component of allergic rhinitis prior to considering surgical interventions. A trial of nasal saline spray/rinse, intranasal corticosteroids, and intranasal and/or systemic antihistamines are generally recommended. While this treatment is well tolerated in adults, compliance with topical regimens in pediatric populations is generally lower. If there is no improvement after optimal medical management and nasal endoscopy is unable to be performed in the clinic, it may be necessary to perform nasal endoscopy in the operating room potentially in conjunction with an inferior turbinate reduction and/or adenoidectomy. In patients who are unable to tolerate nasal endoscopy in the clinic setting, especially young children, this allows one to assess for response to other treatments prior to considering a septoplasty. In older, cooperative children, clinic-based nasal endoscopy should be used to help guide a surgical plan. There are no universally agreed upon objective measures to use as an indication for septoplasty in either adults or children. However, a higher degree of septal deviation and associated reduction of nasal airway on examination is likely to correlate with more significant benefit postoperatively.

3.3 | Indications for pediatric septoplasty: surgical exposure in FESS and ESBS

3.3.1 | Statement 3 (consensus = mean score 8.75)

Septoplasty is indicated in pediatric endoscopic sinus and skull base cases where there is a need for better instrument access and improved visualization.

3.3.2 | Aggregate grade of evidence: grade C

Benefit: Better visualization and access, with improved safety and effectiveness in pediatric endoscopic sinus and skull base surgery.

Harm: Possible minor reductions in nasolabial angle, dorsal length, and nasal tip protrusion, which are primarily associated with open surgical approaches. Possible need for further surgery, including revision septoplasty.

Cost: Surgical and anesthesia costs.

Benefit–harm assessment: Preponderance of benefit over harm.

Value judgment: Potential benefits of septoplasty in children for improved safety and effectiveness in pediatric endoscopic sinus and skull base cases outweigh the risks of minor impacts on nasal growth and associated costs and risks of surgery.

Recent literature largely supports the safety of FESS and ESBS in the pediatric population. Prior concerns of these surgeries affecting midface growth and development in children have been allayed.[8–11]

Clinical practice guidelines recommend FESS in pediatric patients with chronic rhinosinusitis or recurrent acute sinusitis who have failed appropriate medical therapy with or without adenoidectomy.[31] It is well accepted that septoplasty in the setting of FESS helps improve visualization and instrumentation, as well as postoperative care.[32] Although concurrent septoplasty and sinus surgery does not affect chronic sinusitis health-related QOL or symptom outcomes in the adult population, septoplasty is commonly performed when concurrent correction of DNS or resections of septal spurs help with instrumentation, visualization, and postoperative nasal patency.[33] High septal deviations can inhibit access to the frontal sinus making instrumentation in an already complex procedure increasingly difficult. In cases of allergic fungal sinusitis, septal spurs or deviations can make adequate evacuation of inspissated, eosinophilic mucin from the sinuses more burdensome. Similarly, if left unaddressed, septal deviation can make postoperative debridement more difficult, especially in an office setting where pediatric patients are already apprehensive of nasal endoscopy. When the septum is addressed for these purposes, it is usually performed endoscopically, without an increase in complication rates compared to a traditional open approach.[34]

For both benign and malignant pediatric skull base lesions, there has been an increasing shift in endoscopic approaches, as these have been shown to be a safe and minimally invasive alternative to open craniotomy. As in FESS, septoplasty during ESBS can help improve visualization and instrumentation. Highly complex cases requiring a two-surgeon, four-handed technique can be challenging when considering the already small pediatric nose, a

challenge that may be further compounded by septal deviation. DNS may also be a contributing factor in limiting access and achieving gross total resection for some skull base tumors, which is essential for adequate treatment of many skull base pathologies. Therefore, septoplasty is an important adjunct in cases where there is a need for better instrument access and improved visualization during pediatric endoscopic sinus and skull base surgery.

3.4 | Recommendations regarding timing in pediatric septoplasty

3.4.1 | Statement 4 (consensus = mean score 8.25)

The impact of nasal airway obstruction due to septal deviation on midfacial growth, chronic mouth breathing, obstructive sleep apnea, malocclusion, and facial asymmetry should be considered when evaluating a pediatric patient for septoplasty.

3.4.2 | Aggregate grade of evidence: grade B

Benefit: Potential avoidance of associated facial asymmetry, malocclusion associated with septal deviation, chronic mouth breathing, chronic sinusitis, and obstructive sleep apnea in delayed or nontreatment of significant nasal airway obstruction due to septal deviation in children.

Harm: Possible minor reductions in nasolabial angle, dorsal length, and nasal tip protrusion, which are primarily associated with open surgical approaches. Possible need for further surgery, including revision septoplasty.

Cost: Surgical and anesthesia costs.

Benefit–harm assessment: Preponderance of benefit over harm.

Value judgment: Potential benefits of septoplasty in children outweigh the risks of minor impacts on nasal growth and associated costs and risks of surgery.

Septal deviation is a common cause of nasal obstruction in the pediatric population.[35] Although septal deviation may be corrected surgically, concerns of disturbing growth centers of the nose must be weighed against the fact that septal deviation is also associated with chronic mouth breathing, obstructive sleep apnea, malocclusion, and facial growth asymmetry.[18–20,22] Thus, there has been great interest in the past few decades to determine the safest age at which this procedure can be performed in the pediatric population.

Insight can be gained through studies of the natural course of nasal growth in children. The common practice of deferring elective septorhinoplasty until age 16 years has been supported by studies such as that by van der Heijden et al. in 2008 in which growth velocity curves began their steepest descending slope at 13.1 years for girls and 14.7 years for boys.[36] Regarding the nasal septum more specifically, van Loosen et al. reported in 1996 their findings from the study of 30 postmortem specimens from birth to 62 years. A rapid growth phase was described for the total septum immediately after birth and lasting until age 2 years. There was then a gradual deceleration of growth plateauing at age 36 years. From their measurements, the authors further concluded that the cartilaginous septum reaches adult dimensions at age 2 years while subsequent growth is due to the expansion of the bony perpendicular plate.[37] While these studies provide some initial basis in determining the best timing for septoplasty in children when possible, further work has explored the impact of the procedure on nasal and midfacial growth more directly.

A recent systematic review looking at the effects of septoplasty on midfacial growth was performed.[1] A total of eight studies met inclusion criteria and were reviewed.[5–7,38–42] The sample size of each study ranged from 16 to 64 patients with an age range from 4 to 17 years. Mean follow-up was between 2 and 12.9 years. The proportion of patients lost to follow-up was reported as 6%–40%. Six out of the eight studies used anthropometric methods to evaluate facial growth, while two solely used anthroposcopy. The specific anthropometric measurements (linear and angular measurements, indexes) were heterogeneous between studies. No study reported delays in midface growth or major disturbances, defined as a disruption not easily corrected by surgery. When looking at nasal growth specifically, no major disturbances were reported. However, minor disturbances, defined as alterations easily correctable by surgery, were noted. Two studies reported significant changes in the nasolabial angle.[7,39] However, when procedures were stratified into open and endoscopic approaches, endoscopic septoplasties did not appear to change the nasolabial angle.[7] Two other studies described reduction in dorsum length.[5,6] Béjar et al. also reported reduction in dorsum indexes, while El-Hakim et al. reported reduction in tip protrusion. Despite a lack of well-designed cohort or case–control studies, the authors of the systematic review conclude that there is currently enough evidence to challenge the idea that septoplasty leads to midface growth anomalies.

A 2018 best practice paper in the Laryngoscope regarding timing of septoplasty in the pediatric population included an additional anthropometric study looking at the normal development of the nose.[43] This study of 140 male and 140 female patients suggests that the nose reaches maturity at the age of 15 years in males, and 13 years in females. In males, the nasal height, bridge length, and nasal tip protrusion were the last elements to reach maturity, while in female patients, nasal tip protrusion was the last aspect of the nose to fully develop. Furthermore, the review article

highlights evidence that treating pediatric nasal obstruction with a septoplasty is associated with increased QOL as measured by the visual analogue scale.[12] Given that the youngest patient who underwent septoplasty in the reviewed articles was 6 years old, the best practice recommendation was that septoplasty could be a reasonable option in patients with congenital anomalies, trauma, and symptomatic nasal airway obstruction in patients as young as 6 years of age. Thus, although the pediatric nose may not reach maturity until adolescence, in some case it may not be appropriate to defer septoplasty until this age. Further studies were encouraged.

In 2022, Raghavan and Carr published the largest cohort of pediatric patients undergoing septoplasty to date.[44] This retrospective study, using the ACS NSQIP pediatric database, examined a total of 2290 patients undergoing septoplasty between 2012 and 2019. Here, the average age of patients undergoing septoplasty was 14.2 years. When stratifying the age of patients according to the primary procedure being performed, patients undergoing cleft lip repair were found to be the youngest, followed by patients undergoing sinus surgery. The average ages were 9 and 14 years, respectively. Although this study does not give any insight on the outcomes of the procedure on midfacial growth, the authors do paint a proper representation of the patient characteristics. It should be noted, however, that the specific procedures performed in different age groups and for different indications likely differ. For example, septoplasties performed in young children at the time of cleft repair are more likely to involve repositioning of the septum to the midline rather than the resection of significant septal cartilage. This study also suggests that surgeons are becoming more comfortable performing septoplasties in younger patients, a change that may reflect progressive acceptance of both the safety and efficacy of the procedure, as well as greater experience in technical capability.

In summary, the paradigm that septoplasty should always be deferred until the pediatric craniofacial skeleton has fully developed appears worthy of further review. Evidence suggests that, in some cases, septal surgery including septoplasty is being performed as early as the age of 1 year in the context of cleft lip repair and sinus surgery. Studies examining the effects of septoplasty on nasal and midfacial growth suggest that few significant disturbances of growth are associated with the procedure when performed in patients as young as 4 years of age, although there may be possible minor nasal disturbances which require surgical correction at a later stage. Moreover, endoscopic techniques may minimize the effects of the procedure on nasolabial angle changes. Ultimately, the negative effects of nasal airway obstruction on midfacial growth and QOL should be weighed carefully against any potential risks for each individual patient depending on the severity of DNS regardless of age. Given that most studies on the subject are level 3 or 4, further examination is required to determine the optimal age for septoplasty in the pediatric population. Currently, the literature does not support consensus on a minimum age for septoplasty across all possible indications for the procedure.

3.5 | Quality of life after pediatric septoplasty

3.5.1 | Statement 5 (consensus = mean score 8.00)

There is strong evidence to support that septoplasty is effective in children including significant improvements in QOL.

3.5.2 | Aggregate grade of evidence: grade B

Benefit: Improved QOL resulting from treatment of nasal obstruction due to significant septal deviation in children.

Harm: Possible minor reductions in nasolabial angle, dorsal length, and nasal tip protrusion, which are primarily associated with open surgical approaches. Possible need for further surgery, including revision septoplasty.

Cost: Surgical and anesthesia costs.

Benefit–harm assessment: Preponderance of benefit over harm.

Value judgment: Potential benefits of septoplasty in children, including QOL improvement, outweigh the risks of minor impacts on nasal growth and associated costs and risks of surgery.

Multiple studies have evaluated QOL in children after septoplasty, including some which are based on validated patient-reported outcome metrics (PROMs). In 2019, a review article was conducted to evaluate QOL after septoplasty or functional septorhinoplasty (FSR) in the pediatric population.[45] While the methodology of this article did not meet the criteria for a systematic review, the authors did include five studies published between 2014 and 2018, including two prospective studies.[12–16] Different subjective assessment tools were used, including the Nasal Obstruction Symptom Evaluation (NOSE) scale in three of the included studies.[46] A total of 267 patients were included. While no pooled analysis was performed in this review, an improved QOL was reported in all five studies. Complications included one patient who developed a nasal abscess and two patients requiring revision septoplasty. Other minor complications reported included minor synechiae formation, residual septal deviation, pain, and hypersensitivity.

The NOSE scale is a PROM tool that has been extensively studied and utilized in the adult population, and recently

TABLE 3 Evidence summary table—quality of life after pediatric septoplasty (Oxford Centre for Evidence-Based Medicine Levels of Evidence, 2009).

Study	Year	LOE	Study design	Study group	Clinical endpoint	Conclusion
Anderson et al.[13]	2016	4	Retro cohort	29 pediatric patients (mean age 13 years)	PedsQL, GCBI	Positive postoperative GCBI score of 35.1, and total mean of child PedsQL of 95.2
Lee et al.[12]	2017	4	Retro case series	28 pediatric patients (mean age not reported)	SN-5 and VAS	Significant improvement in SN-5 from 3.5 to 2, increased VAS from 5 to 8
Manteghi et al.[16]	2018	2B	Prospective cohort	136 pediatric patients (mean age 15.7 years), mean follow up 3.6 months	NOSE score	Significant improvement in NOSE from 75 to 20 (septoplasty group) and 15 (septorhinoplasty group)
Yilmaz et al.[14]	2014	4	Retro cohort	35 pediatric patients (mean age 13.4 years), follow-up at 3 and 12 months	NOSE score and VAS	Significant improvement in NOSE from 71 to 22.6 at 3 months and 23.7 at 12 months, VAS increased to 7.9 at 12 months
Fuller et al.[15]	2018	4	Retro cohort	39 pediatric patients (mean age 15.9 years), mean follow-up 8.5 months	NOSE score, EuroQOL five-dimension, PNIF	Significant improvement in NOSE from 59 to 21.2, increased PNIF from 66.2 to 90.8
Kawai et al.[17]	2021	4	Retro cohort	38 pediatric patients (mean age 16.7 years)	NOSE score	Significant improvement in NOSE from 96.7 to 8.8

Abbreviations: GCBI, Glasgow Children's Benefit Inventory; NOSE, Nasal Obstruction Symptom Evaluation; PedQL, pediatric Quality of Life Inventory; PNIF, peak nasal inspiratory flow; VAS, visual analog scale.

validated in the pediatric population.[46] In 2020, Din et al. showed that the NOSE scale is a robust tool that can evaluate the severity of nasal obstruction in children undergoing septoplasty or FSR.[47] The authors studied the psychometric properties of the NOSE scale and showed that it has good reliability and validity in the pediatric population. Another study in 2021 by Kawai et al. also confirmed the validity of the NOSE scale in children, demonstrating significant improvement in the NOSE score from 96.7 preoperatively to 8.8 postoperatively.[17]

In conclusion, there is strong evidence to support that septoplasty in the pediatric population is associated with significant improvements in QOL postoperatively (see Table 3). Since its validation in the pediatric population, more studies are expected to use the NOSE scale to report QOL outcomes.

3.6 | Recommendations regarding surgical techniques in pediatric septoplasty

3.6.1 | Statement 6 (no consensus = mean score 5.50)

Septoplasty in children requires specialized instrumentation and perioperative care.

Pediatric septoplasty can be a technically challenging procedure due to the constraints in the size of the nasal vestibule, pyriform aperture, and space within the nasal cavity. While several of the surgical techniques developed for adult patients prove useful, there are a number of recommended modifications, instruments, and steps in perioperative care that are unique to safe and successful septoplasties in children.[48]

Septoplasty can be performed with open or endonasal approaches. Open techniques generally involve a skin incision through the columella, allowing for improved visualization and access to the structures of the anterior nose including the caudal septum and medial crura of the lower lateral cartilages. For pathology located more posteriorly (generally posterior to a line joining the anterior nasal spine and the anterior projection of the nasal bones), an endonasal approach may be preferred. As in adult patients, the endonasal approach may be carried out through either a hemitransfixion incision if the caudal septum is significantly deviated or a Killian incision in cases of more posterior septal deviation. In either an open or endonasal approach, a headlight, rigid fiberoptic endoscopes, or a combination of the two may be used.

As in adult patients, septoplasty requires the elevation of opposing mucoperichondrial flaps posterior to the initial incision. In the case of a hemitransfixion incision, care

must be taken to preserve sufficient caudal and dorsal cartilage (also known as the L-strut) to allow for adequate support of the nose postoperatively. Although the mucosal incision is made along the leading edge of the nasal septum, the cartilaginous incision is carried out at least 1 cm more posteriorly. The caudal deviation of septal cartilage in these cases is often corrected through elevation of mucoperichondrial flaps on either side, scoring, sutures anchoring the caudal septum to the anterior nasal spine, and the careful removal of a small wedge of cartilage inferiorly to allow the anterior nasal septum to approximate in the midline over the nasal spine. Deformities of the anterior nasal spine and septal spurs can also be safely corrected by removing deviated bone along the floor of the nose with rongeurs or osteotomes. When using a Killian incision, one of the mucoperichondrial flaps is raised first (often with a suction Freer elevator), followed by the septotomy incision. This vertical incision through the septal cartilage should be staggered by a few millimeters such that it is not directly opposing the mucosal incision, thus reducing the risk of septal perforation formation. Next, the opposing-side flap is raised and deviated septal cartilage freed from the bony–cartilaginous junction with a Cottle elevator and removed. Deviated bone of the vomer and perpendicular plate of the ethmoid can also be removed at this time if necessary, though care should be taken as this junction has been proposed as a possible center of nasal septal growth in children.[49]

While the basic techniques for septoplasty have been well described in previous literature, there have also been a number of recommended modifications for use in children. Pediatric nasal specula, along with a headlight, may be necessary for adequate visualization of the nasal vestibule and anterior nasal cavity in an open approach or when creating a hemitransfixion incision along the caudal septum. As this location is so anterior and the incision often requires two hands, it can be challenging to perform endoscopically. Endoscopes may be introduced later, however, into the subperichondrial space for improved visualization once the dissection has been carried more posteriorly. While 4 mm 0° endoscopes are commonly used for adult endoscopic septoplasty, 3 mm and smaller endoscopes are available and often easier to introduce and maneuver in smaller noses. In addition, endoscope irrigating sheaths often used during adult sinus surgery and septoplasty may prove cumbersome as they add an additional 1–2 mm in diameter, and thus may be better if avoided in pediatric patients; this difference is enough to significantly decrease maneuverability and visualization in pediatric endonasal surgery. Other, low-profile instrumentation may also prove useful in septoplasty performed in children. This may include the use of microsurgical knife, such as a Crescent Ophthalmic Micro Surgical Knife (Crescent Manufacturing Company), instead of the 15-blade classically described. The tip of a microsurgical knife can also be bent with a hemostat at a 90° angle, 2 mm from the end, to reduce the risk of cartilage injury during incision, or cutting through the opposing mucoperichondrial flap during the septotomy following a Killian incision. In addition, a number of commonly used instruments, including regular and through-cut Blakesly forceps as well as suction tips, can be obtained in smaller sizes for easier use in pediatric septoplasty.

As in FESS, perioperative care in septoplasty can present unique challenges in children. Adequate physical examination, including sinonasal endoscopy, may not be possible in all children. To this point, Crysdale recommends deferring septoplasty until at least 6 years of age.[50] Imaging such as CT scan when needed and examination during endonasal surgery may allow for improved evaluation. While nasal splints, nasal packing, and/or sprays and irrigations have all been described in adult patients, each poses certain challenges in children. Certainly, a whip-stitch or through-and-through quilting of the opposing mucoperichondrial flaps with a 4-0 plain gut or chromic suture may be better than placement of nasal packing that will require removal later in an awake child in the clinic setting. Nasal saline sprays, rather than irrigations, may be helpful in the prevention of crust formation and better tolerated. Nasal splints, or thin (0.25 mm) silicone sheeting cut to size, secured with an anterior septal suture may be necessary if there is significant tearing of mucoperichondrial flaps during the case or when submucosal resection of turbinates is performed simultaneously (rare in young children). While these can be removed without difficulty in older children, perhaps 12 years and older, removal in younger children may require a second brief anesthesia at the appropriate time—commonly at 1 week.

Complications are similar in pediatric septoplasty when compared to adults. These include postoperative epistaxis, septal hematoma, septal perforation, and the need for revision septoplasty. In a review of 194 patients, Bishop et al. reported septal perforation in 0.52% of cases.[51] While no septal hematomas were described, there were episodes of postoperative epistaxis in 12.4%. Interestingly, the need for revision septoplasty was found to be significantly higher in a younger cohort (0–14 years), when compared with older children (14–18 years). Perhaps, this might be explained by the need for more directed or limited septoplasty in younger patients whose smaller nasal anatomy requires a focus on the deviated portions of septal cartilage that can be adequately visualized, accessed, and safely removed. This may also explain a more recent retrospective, observational cohort study of septoplasty by Shah et al. in 2022, that found pediatric patients were more likely to undergo revision surgery than their adult counterparts.[52]

4 | NEEDS ASSESSMENT

The goal of this EPS is to provide recommendations and guidance through evidence-based consensus statements regarding the safety, efficacy, appropriate indications, timing, QOL impact, and surgical techniques for pediatric septoplasty. Importantly, the most recent systematic review from 2020 suggests the procedure is both technically feasible and safe, with little significant impact on nasal and midfacial growth and development.[1] In addition, septoplasty may be indicated in children with significant nasal obstruction due to septal deviation and potentially for improved instrument access and visualization during FESS and ESBS. Furthermore, concerns regarding chronic mouth breathing, obstructive sleep apnea, dental malocclusion, and impairment of normal facial growth and development associated with delay in treatment of significant nasal obstruction due to septal deviation appear justified. Finally, septoplasty in children appears effective, with significant improvements in QOL postoperatively based on validated instruments.

Certainly, further data in the form of controlled studies and additional systematic review will prove helpful in either strengthening, or challenging, the above recommendations regarding pediatric septoplasty. Multi-institutional cooperation could lead to studies with enough power for significant conclusions and further evidence-based recommendations. Further research is also vital on the aspects of DNS in children for which any recommendations cannot be currently supported by available data. These include the possible benefit of specialized instrumentation and technique, challenges in preoperative evaluation, and perioperative management unique to children. The number and type of complications following surgery, as well as the rate of revision procedures, appear to be additional areas where further investigation will add to a more complete picture regarding the differences in septoplasty outcomes between adults and children.

5 | QUALIFYING STATEMENT

This EPS should serve only to help guide the thoughtful judgement of otolaryngologists in the treatment of nasal obstruction due to septal deviation in children. Ultimately, medical and surgical care should be individualized for each patient and their contextual situation.

6 | EXPIRATION

This EPS should be reviewed within 5 years from the date of publication and updated if current evidence and common practice has significantly changed.

CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest.

ORCID

Austin S. Rose MD, MBA https://orcid.org/0000-0003-3753-2329
Chadi A. Makary MD https://orcid.org/0000-0001-9967-4045
David A. Gudis MD https://orcid.org/0000-0002-1938-9349

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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