Chapter 18
Endoscopic Sinus Surgery for Pediatric Patients

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Introduction

The role of pediatric sinus surgery in the treatment of sinusitis continues to evolve. In the 1990s, there was growing enthusiasm that endoscopic sinus surgery (ESS) may represent a primary treatment for pediatric chronic rhinosinusitis (PCRS). Now, with a greater understanding of the role of medical management, the modality is utilized more selectively. ESS is considered a safe and effective intervention for a range of different acute and judiciously selected chronic pediatric sinus disorders.

Indications and Outcomes

The general indications for pediatric ESS fall into several distinct categories, including PCRS unresponsive to appropriate medical therapy, management of "complicated" PCRS (such as patients with comorbid immunodeficiencies, primary ciliary dyskinesia, and cystic fibrosis), symptomatic mucoceles, antrochoanal polyps,

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allergic fungal rhinosinusitis (AFRS), and complications of acute bacterial rhinosinusitis (ABRS). The outcomes of surgical intervention vary significantly based on these indications.

PCRS Unresponsive to Medical Therapy

PCRS, which affects approximately 8% of the pediatric population, represents the most common indication for ESS [1]. The condition is defined as at least 90 continuous days of two or more of the four cardinal pediatric rhinosinusitis symptoms (nasal obstruction, purulent nasal discharge, facial pain/pressure, or cough), *in addition to* endoscopic or radiographic evidence of disease in a patient 18 years of age or younger [2]. Medical management of PCRS is generally tailored to the individual patient and may include a combination of topical and systemic therapies; however, there is no overwhelming consensus defining "appropriate" or "maximal" therapy. In general, otolaryngologists should prescribe antibiotics of at least 3 weeks' duration (optimally culture-guided) in combination with at least a month of continuous daily nasal steroid spray and nasal saline rinses for difficult PCRS. This medical regimen often obviates the need for surgery, especially when topical steroids are administered effectively. Surgeons should also consider evaluation for both food and environmental allergies before surgery.

The pathophysiologic contribution of chronic adenoiditis to chronic sinusitis is well recognized, and therefore adenoidectomy plays a significant role in the surgical treatment paradigm for PCRS. Adenoidectomy alone can be an effective surgical treatment for the appropriate patient. In a 2008 meta-analysis, Brietzke and Brigger demonstrated that adenoidectomy alone led to an improvement in 70% of patient patients with a mean age of under 6 years [3]. Ramadan et al. reported the safety and feasibility of balloon catheter dilation (BCD) in which 51/56 sinuses were successfully dilated. Their group later demonstrated that BCD in conjunction with adenoidectomy led to a higher percent of children with ≥0.5 reduction in SN-5 than adenoidectomy alone (80% vs. 53%) at 1-year follow-up, although their adenoidectomy alone cohort was less symptomatic, leaving the results less persuasive for critics [4, 5]. A subsequent prospective, multi-institutional trial of BCD for the management of uncomplicated PCRS demonstrated a clinically and statistically significant improvement in symptom control without any related adverse events [6]. Despite evidence of efficacy, there remains no clear definition regarding which pediatric patients are more appropriate for BCD versus concomitant procedures such as adenoidectomy, turbinate surgery, or ESS [7]. Our experience has been that PCRS can be markedly improved by adenoidectomy alone in the vast majority of cases, especially when PCRS exists in the setting of chronic adenoiditis with or without adenoid hypertrophy, which is shown in Figs. 18.1 and 18.2. We do not typically combine adenoidectomy with any sinus surgery unless the adenoid appears minimally hypertrophic.

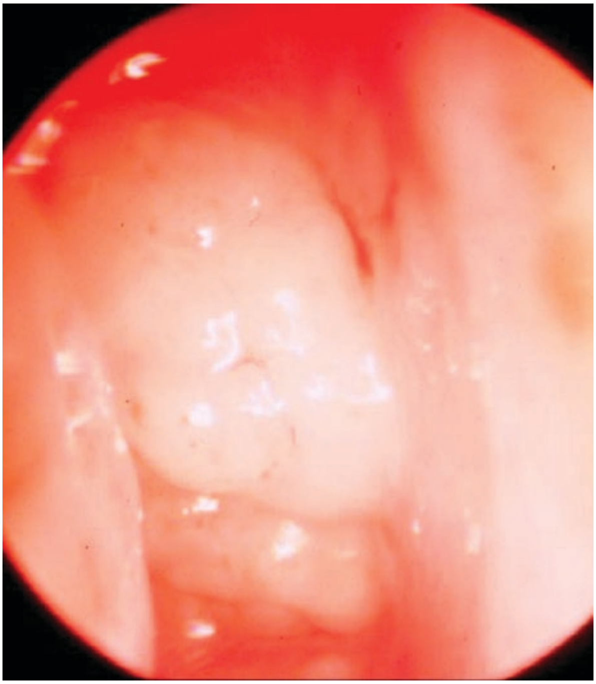

Fig. 18.1 Adenoid hypertrophy

Fig. 18.2 Lateral neck X-ray demonstrating adenoid hypertrophy

Several studies have also demonstrated that ESS is an effective surgical treatment for uncomplicated PCRS. In a 2013 systemic review, Makary et al. found that ESS has a success rate ranging from 82% to 100% in improving symptoms and/or quality of life with an extracted complication rate of 1.4% [8]. A separate systemic review and meta-analysis that focused on both patients with uncomplicated PCRS and those with disease complicated by comorbid conditions such as cystic fibrosis and primary ciliary dyskinesia demonstrated a similar success rate of 71%–100% [9]. One should recognize that these relatively favorable percentages apply to carefully selected patients who did not respond to extensive medical therapy and that surgery has no role as first-line treatment in PCRS.

Complicated PCRS

Certain conditions such as cystic fibrosis (CF), primary ciliary dyskinesia (PCD), and primary immunodeficiencies may predispose patients to PCRS and complicate both their surgical and medical management. Several studies have demonstrated that ESS is safe in pediatric patients with CF [10] and that combined ESS and medical therapy may help eradicate pathogenic bacteria from the sinuses of these patients and contribute to improved lung function status and delay in gram-negative lung infections [11, 12]. Similar studies have demonstrated similar ESS safety in patients with PCD, as well as the potential benefit of ESS in eradicating pathogens from the sinuses, which otherwise may serve as a bacterial reservoir that can contribute to secondary lung infections [13]. Despite these positive results, surgery will not rid the patient of their underlying vulnerability, revision surgery is commonly needed, and pernicious symptoms typically persist, so expectations should be adjusted accordingly.

Symptomatic Mucoceles, Antrochoanal Polyps, and Fungal Sinusitis

As with ESS in the adult population, there are several sinonasal diagnostic entities that are appropriate for primary surgical intervention with the addition of concomitant medical management. These include expansile mucoceles that can cause complications such as orbital and/or skull base erosion, large obstructive antrochoanal polyps, and AFRS (Fig. 18.3).

Complications of Acute Bacterial Rhinosinusitis

Complications of acute bacterial rhinosinusitis (ABRS) may result in devastating sequellae if not emergently managed. Emergent CT or MRI imaging should be ordered for any patient in whom there is clinical concern for either an orbital

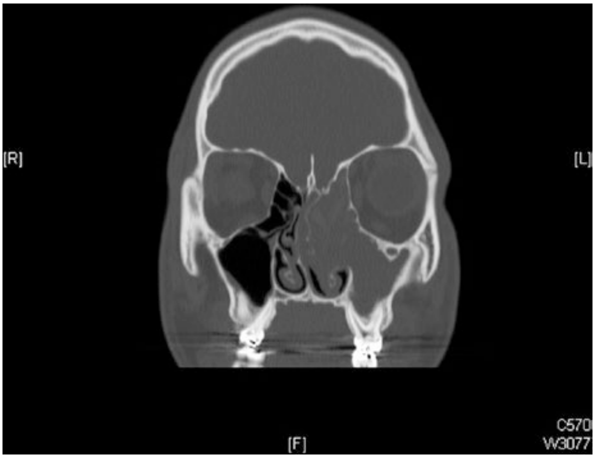

Fig. 18.3 Coronal CT consistent with left-sided AFRS

Table 18.1 Complications of sinusitis

Intracranial	Extracranial
Frontal bone osteomyelitis with abscess	Preseptal cellulitis
Epidural abscess	Orbital cellulitis
Subdural abscess	Subperiosteal abscess
Intraparenchymal abscess	Orbital abscess
Meningitis	Cavernous sinus thrombosis

complication (preseptal cellulitis, orbital cellulitis, subperiosteal abscess, orbital abscess, or cavernous sinus thrombosis) or intracranial complication (meningitis, epidural, subdural, or intraparenchymal abscess, frontal bone osteomyelitis, and abscess formation) (Table 18.1). The patient's clinical status, medical history, severity of infection, and imaging findings may help differentiate patients who require urgent surgical intervention from those who can safely undergo a trial of broad-spectrum intravenous antibiotics and possibly avoid or delay surgery. Several retrospective studies have demonstrated the safety and effectiveness of ESS in the setting of orbital complications [14, 15]. Interestingly, a database study from 2015 investigating trends in orbital complications of pediatric rhinosinusitis in the USA found that the prevalence of cases requiring hospitalization has decreased, while the proportion of cases undergoing surgical intervention has increased [16].

Technique

Surgical Technique

Pediatric ESS is performed under general anesthesia with the patient supine with the head elevated from 0° to 30°. Initial vasoconstriction is typically performed with topical oxymetazoline (0.05%) pledgets. Proper labeling and close care must be taken to not inadvertently inject topical solutions. The eyes must be protected from corneal abrasion by closing the lids with plastic tape or Tegaderm dressings; they should be kept in the surgical field when the face is prepped and draped, so that any movement, bruising, or swelling is immediately recognized. Sometimes gentle palpation of the eye helps define if the lamina papyracea remains intact. Injection of 1% lidocaine with 1:100,000 epinephrine is then typically performed with a 25-gauge needle in several areas, including the axilla of the middle turbinate, along the uncinate process and maxillary line, the face of the ethmoid bulla, and the region of the sphenopalatine artery. The extent of local anesthetic injection is largely dependent on the breadth of the planned surgery. Care should be taken to not exceed the total amount of local anesthetic in children (7 mg/kg of 1% lidocaine with epinephrine or 4.5 mg/kg for 1% lidocaine alone).

Maxillary Sinus

Surgery typically begins by addressing the maxillary sinus with a middle meatal antrostomy. This may be done with either a 0° or 30° rigid endoscope, with the latter permitting better visualization. Scope size is determined by the size of the nasal cavity—4 mm should be used unless they will not safely fit, in which case 2.7/3 mm scopes are necessary. Uncinectomy is the first step. Proper performance sets the tone for the remainder of the procedure and helps avoid surgical failure and orbital or lacrimal complications [17]. Most surgeons are comfortable with various techniques of uncinectomy, including the anterior-to-posterior "classical" technique described by Stammberger [18] or a posterior-to-anterior technique such as the "swing door" described by Wormald [19]. The former is performed by making an incision with the sharp end of an elevator or a sickle knife at uncinate's insertion into the lateral nasal wall, which should be softer in comparison to the firmer, most anterior lacrimal bone where the nasolacrimal duct is located. The latter technique is performed by identifying the free edge of the uncinate process and then introducing a backbiting instrument and cutting Blakesley forceps to first remove the midsection of the bone. The posterior-to-anterior technique should be utilized in the presence of atelectatic maxillary sinuses to avoid injury to the orbit. Once the uncinate is removed and the natural ostium is identified, the maxillary ostium can be enlarged to allow the surgeon to remove any maxillary sinus contents and easily irrigate the sinus when necessary.

In most ESS for PCRS, especially children in the first decade of life, the surgeon should be aiming to aerate the maxillary sinus only, possibly in combination with opening the anterior-inferior-medial surface of the ethmoid bullae. As such, it is not always typically worth removing the entire uncinate, in that the superior portion may remain intact. It is critical to remove the inferior uncinate to get an adequate opening of the natural maxillary sinus ostium. Furthermore, one must be very careful not to confuse a commonly seen patent posterior fontanelle ostium with the natural ostium. The natural ostium is difficult or impossible to visualize with a 0° telescope, whereas a posterior fontanelle ostium is not, so if one easily sees an opening into the maxillary sinus with a 0° telescope, it is probably not the natural ostium. To avoid injury to the lacrimal ducts, the natural ostium should be enlarged posteriorly or not at all. Often removing the uncinate alone is sufficient. If the surgeon chooses to enlarge the ostium posteriorly, this should be done with great care, as it is easy to inadvertently tear the sinus mucosa off the roof of the orbit, which will collapse the sinus and its opening in a way that can be difficult to rectify. To minimize this risk, the surgeon will often opt to sharply divide the mucosa in the posterior aspect of the ostium.

Ethmoid Sinuses

The need for and extent of ethmoidectomy in pediatric patients is largely dictated by the extent of disease as demonstrated by CT scan findings and patient symptoms. Often the uncinate is plastered against and occluding the ethmoid's drainage pathways, and uncinectomy alone alleviates ethmoid congestion. In other instances, simply opening an approximate 5–10 mm window into the bullae provides adequate drainage. In young children, it is rarely necessary to dissect back to the basal lamella of the middle turbinate and even less necessary to perform posterior ethmoid surgery.

The full extent of the ethmoid bulla should be visible following complete uncinectomy. The bulla can be entered with a J-curette or similar instrument, usually inferomedially along the natural drainage pathway (Fig. 18.4). Anterior ethmoid

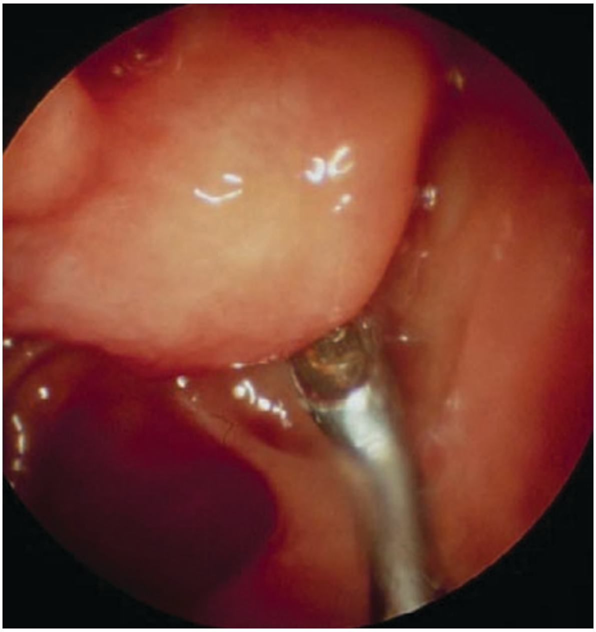

Fig. 18.4 Ethmoid bullectomy

cells are then removed with either hand instruments such as an up-biting Blakesley forceps or carefully with a powered instrument such as the microdebrider. Retro and/or supra-bullar cells can then be addressed if indicated, as may be the case in adolescents or unusual cases. In the unlikely event that posterior ethmoidectomy is performed, a J-curette or similar instrument may be placed through the basal lamella. Care must be taken to ensure that an adequate middle turbinate strut is maintained inferiorly to prevent instability that could contribute to postoperative turbinate lateralization. The lamina papyracea is identified laterally. The skull base is identified posteriorly and then is traced superiorly and anteriorly toward the area of the frontal recess. Septations may be left along the lamina and skull base, although the extent of removal is determined largely by the preference of the operating surgeon. Typically, the only reason to be performing comprehensive ethmoid surgery in children would be for AFS or polyposis.

Sphenoid Sinus

The sphenoid sinus rarely needs to be addressed during ESS, even when there is involved disease based on the CT scan. Particularly in young children, the sphenoid is very small and is affected by dependent drainage from the more anterior sinuses. For children under 10 years of age, unless they have fungal debris in their sphenoid or a suppurative complication, the sphenoid should not be addressed during initial sinus surgery. Adolescent patients sometimes follow patterns seen with adults, in that they may have chronic or acute sphenoid disease requiring targeted surgical intervention. In these cases, a sphenoidotomy may be performed either through a transnasal or transethmoidal technique. The latter is typically employed when an ethmoidectomy is also being performed as part of the surgery. The former is performed by first lateralizing the middle turbinate and identifying the superior turbinate. The sphenoid os is found just inferomedially to this structure. After identification through either technique, the ostium is enlarged using instruments such as a mushroom punch, which may necessitate partial removal of the inferior aspect of the superior turbinate. Removal of contents and irrigation of the sinus can then be performed. Care is taken to avoid damage to vital structures such as the carotid artery and optic nerve, which are typically located laterally. It is critical to review imaging and check for bony dehiscence of either structure preoperatively.

Frontal Sinus

The frontal sinus is fully developed by the age of 15. As a result, pediatric patients will have variable degrees of sinus pneumatization and development. Frontal sinusitis is usually not a problem in most children with uncomplicated CRS under the age of 12 [20]. If the sinus is involved, as with the sphenoid, uncinectomy, possibly with maxillary antrostomy and limited anterior ethmoidectomy, will often allow the frontal sinuses to drain and aerate spontaneously. In these cases, one would want to take care to remove the uncinate up to its most superior attachment, in addition to the part that obstructs the maxillary and ethmoid sinuses. In the atypical cases when directed frontal sinusotomy is indicated, conservative opening with either Draf I or Draf IIA sinusotomy is typically sufficient.

Septum

Septoplasty is only performed in the case of significant obstruction, preventing access to the sinuses or causing significant nasal obstruction. We proceed with targeted and conservative septoplasty, either through an open or endoscopic technique, but in most cases we are able to leave mild to moderate septal deviation untreated and still obtain excellent results. Although there are favorable results of large series of septoplasty in children, such as from Crysdale et al. who modified in the quadrangular cartilage through an open rhinoplasty approach, there is no consensus regarding the risks of the surgery, and therefore many are reluctant to perform the surgery given that nasal growth centers are at risk, at least hypothetically. There is no evidence to suggest that isolated septoplasty will be helpful for PCRS.

Concha Bullosa

Resection of concha bullosa cells (pneumatization of the middle turbinate) may be performed by removing the lateral aspect of the cell with either hand or powered instruments. The surgeon should take care to sharply divide the lateral component prior to removal to avoid trauma to the middle turbinate's medial component or its vertical attachment to the skull base. Similarly, one should use sharp techniques in detaching the posterior extent of the concha bullosa to avoid tearing more tissue than desired and risk bleeding where sphenopalatine branches course across the lateral nasal wall.

The indication for concha excision correlates with size. Removal of the lateral extent of the concha bullosa, especially larger cells, leads to markedly easier sinus surgery. The concha functions like an intranasal space expander, and with its lateral wall gone, the middle meatus can be several times larger than usual, which greatly enhances visibility and maneuverability. Because removal of smaller concha bullosa cells may not add much advantage and could risk middle meatal adhesions, they should be approached judiciously. However, it should be noted that there is no evidence to suggest that concha bullectomy contributes to improved outcomes.

Image Guidance

Image-guided surgery (IGS) is an important adjunct tool that may help surgeons perform safer and more comprehensive sinus surgery. While it is not a substitute for sound knowledge of anatomy, critical decision-making, or technical experience, for well-trained otolaryngologists, it may help increase surgeon confidence and reduce fear of complications involving the orbit or brain. Although the technology has become commonplace, the use of image guidance is not mandatory or standard of care. It is therefore used on a case-by-case basis at the discretion of the operating surgeon. The American Academy of Otolaryngology lists seven relative indications for use of image guidance, including the presence of distorted anatomy (Table 18.2). Given the varying degrees of development and pneumatization of pediatric sinuses, IGS may be particularly useful for these cases. Furthermore, complications of ABRS such as orbital complications should also necessitate use of the tool. On the other hand, the most common and appropriate pediatric ESS procedures, uncinectomy with conservative middle meatal antrostomy and anterior ethmoidectomy, benefit relatively less from image guidance. We usually do not use IGS for these procedures and find that the challenge is not anatomic orientation but rather a very narrow space that often bleeds easily as a result of chronic inflammation.

Postoperative Care

Patients should be instructed to start nasal saline irrigations shortly after surgery. The use of postoperative antibiotics and steroids should be tailored to the patients based on the clinical situation and the indication for surgery. Survey studies have demonstrated wide variation in surgeon preferences in regard to prescribing patterns [21].

Table 18.2 Position statement: Intraoperative use of computer-aided surgery (approved 2002, revised 2014)

1. Revision sinus surgery
2. Distorted sinus anatomy of development, postoperative, or traumatic origin
3. Extensive sinonasal polyposis
4. Pathology involving the *frontal,* posterior ethmoid, and sphenoid sinuses
5. Disease abutting the skull base, orbit, optic nerve, or carotid artery
6. CSF rhinorrhea or conditions where a skull base defect is present
7. Benign and malignant sinonasal neoplasms

Follow-Up

Postoperative care of the sinonasal cavity is critical for optimal surgery outcomes. This includes postoperative debridement, which may help prevent undesired sequellae such as synechiae and early ostia closure. The main aims of debridements are to lyse early adhesions and remove blood clot, spacers, packing, or stents placed at the time of initial surgery. Whereas adults can frequently tolerate this procedure in the office setting, most pediatric patients cannot. Surgeons should therefore be prepared to debride pediatric patients in the operating room under general anesthesia if recovery is not proceeding as planned and prepare parents for this possibility as part of the preoperative consent. These "second look" procedures, typically performed 2–3 weeks following the initial surgery, were at one time common but are not frequently necessary and therefore have fallen out of favor [22–24]. If patients allow for adequate examination in the office and the sinonasal cavity appears to be healing well, allowing "biological dressings" to remain in place may be the best option with continued use of moisture and irrigations to facilitate nasal hygiene and healing. Furthermore, Ramadan et al. demonstrated that treatment with intravenous dexamethasone during initial ESS may reduce maxillary mucosal edema, ethmoid scarring, and incidence of maxillary ostia closure, thus decreasing the need for second-look procedures [23].

Midface Growth

Although 12% of sinus surgeons in one study reported that they avoid performing ESS in pediatric patients out of concern for facial growth retardation [25], several contemporary studies have refuted this concern [26–28]. Early concern likely stemmed from older evidence that other facial surgeries, such as septoplasty, cleft palate repair, and repair of mandibular fractures, may lead to such issues [29–31]. A 1995 study by Mair et al. then demonstrated that, in piglets undergoing unilateral sinus surgery, the ipsilateral maxillary and ethmoid sinuses reached only 57% and 65% of the size of the nonoperated side, respectively [32]. Fortunately, more recent investigations have provided reassurance that these risks do not apply to humans. Specifically, prospective studies have demonstrated that there is no statistically significant change in sinus volumes or cephalometric parameters in patients who underwent ESS compared to those who did not [26–28].

Conclusions

Pediatric endoscopic sinus surgery (ESS) is a safe and effective intervention for select pediatric sinus disorders, including both chronic and acute conditions. Outcomes and rates of success vary significantly, largely due to a lack of consensus on indications, technique, concurrent medical therapy, as well as postoperative management. While adenoidectomy plays a critical role in the surgical treatment of PCRS, and, more recently, BCD has generated interest and encouraging preliminary results, further study is necessary to standardize an evidence-based surgical paradigm and to identify which pediatric patients would benefit most from surgical intervention.

References

1. Kay DJ, Rosenfeld RM. Quality of life for children with persistent sinonasal symptoms. Otolaryngol Head Neck Surg. 2003;128(1):17–26.
2. Brietzke SE, Shin JJ, Choi S, et al. Clinical consensus statement: pediatric chronic rhinosinusitis. Otolaryngol Head Neck Surg. 2014;151(4):542–53.
3. Brietzke SE, Brigger MT. Adenoidectomy outcomes in pediatric rhinosinusitis: a meta-analysis. Int J Pediatr Otorhinolaryngol. 2008;72(10):1541–5.
4. Ramadan HH. Safety and feasibility of balloon sinuplasty for treatment of chronic rhinosinusitis in children. Ann Otol Rhinol Laryngol. 2009;118(3):161–5.
5. Ramadan HH, Terrell AM. Balloon catheter sinuplasty and adenoidectomy in children with chronic rhinosinusitis. Ann Otol Rhinol Laryngol. 2010;119(9):578–82.
6. Soler ZM, Rosenbloom JS, Skarada D, Gutman M, Hoy MJ, Nguyen SA. Prospective, multicenter evaluation of balloon sinus dilation for treatment of pediatric chronic rhinosinusitis. Int Forum Allergy Rhinol. 2017;7(3):221–9.
7. Gudis DA, Soler ZM. Update on pediatric sinus surgery: indications and outcomes. Curr Opin Otolaryngol Head Neck Surg. 2017;25(6):486–92.
8. Makary CA, Ramadan HH. The role of sinus surgery in children. Laryngoscope. 2013;123(6):1348–52.
9. Vlastarakos PV, Fetta M, Segas JV, Maragoudakis P, Nikolopoulos TP. Functional endoscopic sinus surgery improves sinus-related symptoms and quality of life in children with chronic rhinosinusitis: a systematic analysis and meta-analysis of published interventional studies. Clin Pediatr (Phila). 2013;52(12):1091–7.
10. Tumin D, Hayes D Jr, Kirkby SE, Tobias JD, McKee C. Safety of endoscopic sinus surgery in children with cystic fibrosis. Int J Pediatr Otorhinolaryngol. 2017;98:25–8.
11. Aanaes K, von Buchwald C, Hjuler T, Skov M, Alanin M, Johansen HK. The effect of sinus surgery with intensive follow-up on pathogenic sinus bacteria in patients with cystic fibrosis. Am J Rhinol Allergy. 2013;27(1):e1–4.
12. Alanin MC, Aanaes K, Hoiby N, et al. Sinus surgery postpones chronic Gram-negative lung infection: cohort study of 106 patients with cystic fibrosis. Rhinology. 2016;54(3):206–13.
13. Alanin MC, Aanaes K, Hoiby N, et al. Sinus surgery can improve quality of life, lung infections, and lung function in patients with primary ciliary dyskinesia. Int Forum Allergy Rhinol. 2017;7(3):240–7.
14. Segal N, Nissani R, Kordeluk S, et al. Orbital complications associated with paranasal sinus infections - a 10-year experience in Israel. Int J Pediatr Otorhinolaryngol. 2016;86:60–2.
15. Sciarretta V, Dematte M, Farneti P, et al. Management of orbital cellulitis and subperiosteal orbital abscess in pediatric patients: a ten-year review. Int J Pediatr Otorhinolaryngol. 2017;96:72–6.
16. Capra G, Liming B, Boseley ME, Brigger MT. Trends in orbital complications of pediatric rhinosinusitis in the United States. JAMA Otolaryngol Head Neck Surg. 2015;141(1):12–7.
17. Richtsmeier WJ. Top 10 reasons for endoscopic maxillary sinus surgery failure. Laryngoscope. 2001;111(11 Pt 1):1952–6.

18. Stammberger H. An endoscopic study of tubal function and the diseased ethmoid sinus. Arch Otorhinolaryngol. 1986;243(4):254–9.
19. Wormald PJ, McDonogh M. The 'swing-door' technique for uncinectomy in endoscopic sinus surgery. J Laryngol Otol. 1998;112(6):547–51.
20. CA M. Pediatric sinus surgery for chronic rhinosinusitis. Oper Tech Otolaryngol Head Neck Surg. 2018;29(2):89–93.
21. Fang CH, Fastenberg JH, Fried MP, Jerschow E, Akbar NA, Abuzeid WM. Antibiotic use patterns in endoscopic sinus surgery: a survey of the American Rhinologic Society membership. Int Forum Allergy Rhinol. 2018;8(4):522–9.
22. Walner DL, Falciglia M, Willging JP, Myer CM 3rd. The role of second-look nasal endoscopy after pediatric functional endoscopic sinus surgery. Arch Otolaryngol Head Neck Surg. 1998;124(4):425–8.
23. Ramadan HH. Corticosteroid therapy during endoscopic sinus surgery in children: is there a need for a second look? Arch Otolaryngol Head Neck Surg. 2001;127(2):188–92.
24. Younis RT. The pros and cons of second-look sinonasal endoscopy after endoscopic sinus surgery in children. Arch Otolaryngol Head Neck Surg. 2005;131(3):267–9.
25. Beswick DM, Ramadan H, Baroody FM, Hwang PH. Practice patterns in pediatric chronic rhinosinusitis: a survey of the American Rhinologic Society. Am J Rhinol Allergy. 2016;30(6):418–23.
26. Senior B, Wirtschafter A, Mai C, Becker C, Belenky W. Quantitative impact of pediatric sinus surgery on facial growth. Laryngoscope. 2000;110(11):1866–70.
27. Bothwell MR, Piccirillo JF, Lusk RP, Ridenour BD. Long-term outcome of facial growth after functional endoscopic sinus surgery. Otolaryngol Head Neck Surg. 2002;126(6):628–34.
28. Van Peteghem A, Clement PA. Influence of extensive functional endoscopic sinus surgery (FESS) on facial growth in children with cystic fibrosis. Comparison of 10 cephalometric parameters of the midface for three study groups. Int J Pediatr Otorhinolaryngol. 2006;70(8):1407–13.
29. Verwoerd CD, Urbanus NA, Nijdam DC. The effects of septal surgery on the growth of nose and maxilla. Rhinology. 1979;17(2):53–63.
30. Bernstein L. The effect of cleft palate operations on subsequent growth of the maxilla. Laryngoscope. 1968;78(9):1510–65.
31. McGuirt WFSP. Mandibular fractures: their effect on growth and dentition. Arch Otolaryngol Head Neck Surg. 1987;113(3):257–61.
32. Mair EA, Bolger WE, Breisch EA. Sinus and facial growth after pediatric endoscopic sinus surgery. Arch Otolaryngol Head Neck Surg. 1995;121(5):547–52.