Surgical Intervention for Sinusitis in Children

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Pediatric rhinosinusitis represents a common endpoint of many potential etiologic factors, but fixed anatomic obstruction of sinus outflow is relatively unusual in pediatric patients. Surgical therapy is considered when medical therapy for underlying mucosal inflammation fails. Adenoidectomy is usually the first surgical intervention to be considered for young children, with the goal of improving sinus drainage and eliminating a potential source of bacteria. Endoscopic sinus surgery is considered for the small percentage of patients, most commonly those with underlying pulmonary disease, who fail less aggressive treatment measures. Every decision for surgery involves a risk-benefit analysis.

Introduction

Pediatric sinusitis is difficult to define, although most authors agree that the incidence appears to be increasing along with the incidence of other respiratory tract diseases such as asthma and allergic rhinitis. In pediatric patients, sinusitis is rarely isolated. The term rhinosinusitis is more descriptive of the usual imaging findings of diffuse nasal and sinus mucosal inflammation. Rhinosinusitis is not a specific disease but rather a potential outcome resulting from many interdependent predisposing conditions including viral illness, allergic rhinitis, physiologic immunodeficiency of childhood, gastroesophageal reflux disease, environmental irritants, adenoiditis, and nasal foreign body. Of interest, anatomic abnormality with fixed anatomic obstruction is relatively unusual in children. This obviously has a bearing on decision making and selection of surgical candidates because the principal purpose of direct sinus surgery is to relieve anatomic obstruction.

Aitken and Taylor [1] recently looked at prevalence of pediatric sinusitis using a parental survey of children aged 1 to 5 years presenting to their primary care physician for any reason. Sinusitis was defined as nasal congestion and daytime cough for greater than 9 days without clinical improvement. By this definition, 9.3% of all patients met the definition of rhinosinusitis, and almost one half of these had concurrent otitis media.

Clinicians who treat pediatric rhinosinusitis are often struck by the impact the disease has on families, even when patients are otherwise relatively healthy. Cunningham *et al*. [2••] recently reported on a series of pediatric patients selected for endoscopic sinus surgery after failing intensive medical therapy. Parents and children completed previously validated health questionnaires. Surprisingly, parents perceived more bodily pain and limits of physical activities in their children than previously reported in pediatric patients with asthma or juvenile rheumatoid arthritis. Of note, parents perceived significantly more pain and general behavioral effects relative to the child's own perception. It is not surprising, therefore, that parents often seek a surgical solution to the problem of their children's symptoms when medical therapy fails.

Radiographic Imaging

Sinuses cannot be visualized directly with a physical examination; therefore, clinicians are forced to rely on imaging studies to help with diagnosis and management decisions. Unfortunately, sinonasal symptoms and imaging findings of sinus mucosal thickening are very common in "normal" populations of young children [3–6,7•,8]. Prospective studies in adults have shown that viral illness results in evidence of mucosal inflammation in the maxillary and anterior ethmoid sinuses in over 70% of patients and that the changes will persist for up to 8 weeks, well after resolution of symptoms [9,10]. Because young children may have up to six to eight viral upper respiratory infections per year, it is not surprising that approximately 50% of young children undergoing head imaging for non–sinus-related reasons have evidence of mucosal thickening [4]. Cotter *et al*. [7•] found only a slightly increased incidence of mucosal thickening in children with sinonasal symptoms compared with those undergoing head imaging for other reasons.

Anatomic abnormalities are difficult to define, and findings such as extramural ethmoid cells (concha bullosa) are often seen in imaging studies with equal incidence between symptomatic and asymptomatic populations. Medina *et al*. [11•] looked at anatomic CT findings in 235 children with evidence of sinus mucosal inflammation and 145 children with clear sinuses. They found no significant

differences in their measurements of sinus anatomy and concluded that pediatric rhinosinusitis is not usually caused by anatomic abnormalities.

The finding of an air-fluid level within a sinus is relatively unusual in pediatric patients but probably correlates with clinical symptoms much more strongly than the finding of mucosal thickening. Also, the finding of sphenoid or frontal sinus disease correlates with more severe symptoms (*eg*, headache). However, the clinician must remember that imaging findings must be interpreted in light of clinical signs and symptoms. Also, the logical outcome goal for treatment should be clinical resolution of signs and symptoms rather than complete absence of mucosal inflammation on subsequent imaging.

Medical Management

Because most children with rhinosinusitis have normal sinonasal anatomy, it is not surprising that the most common indication for surgical intervention is failure to respond to medical treatment rather than correction of sinus obstruction. Surgical intervention is generally considered to be at the bottom of a hierarchy of treatment options, which includes attempts at reducing viral exposure, appropriate antibiotic therapy and prophylaxis, and management of underlying allergies and gastroesophageal reflux (Table 1).

Acute sinusitis—defined as persistence of sinonasal symptoms longer than the usual 10-day course of viral illness but for fewer than 4 weeks—has a 40% spontaneous resolution rate [12,13]. True chronic symptoms, such as headache persisting beyond 3 months despite antibiotic treatment, may indicate nonsinus pathology (especially with unremarkable imaging findings). The problem that presents most commonly to the otolaryngologist is that of patients who improve with antibiotics only to experience recurrence of symptoms when antibiotics are discontinued. For these patients, the initial goal is to stay disease free long enough to allow for recovery of local mucosal immunologic defense. At least one course of antibiotic prophylaxis is usually recommended prior to considering surgical options. Some clinicians use topical antibiotic solutions such as gentamicin or mupericin to achieve antibiotic prophylaxis while reducing concerns of systemic side affects.

Buchman *et al*. [14•] describe treatment of 27 children with refractory rhinosinusitis with intravenous antibiotic therapy in lieu of endoscopic sinus surgery. Resolution of symptoms was achieved by 90%, and the treatment failures underwent sinus surgery. At follow-up, only 44% remained completely asymptomatic, but none of the initial treatment successes went on to require sinus surgery. In addition to its expense, the intravenous management carried the risk of complications including diarrhea, serum sickness, and thrombophlebitis.

A very large percentage of pediatric patients with rhinosinusitis have underlying allergic rhinitis [15–17]. Nguyen *et al*. [16], in a study of children presenting with chronic upper respiratory complaints, found that greater than 60% had sinus mucosal inflammation by CT, 60% had inhalant allergies by skin test results, and 25% had reactive airway disease. Obviously, for patients with allergic rhinitis as a predisposing cause, surgery is only considered when sinus disease persists despite appropriate medical management of allergies. Even then, surgery must be viewed as an adjunct to medical therapy.

Gastroesophageal reflux disease is becoming increasingly recognized as a predisposing cause for respiratory tract disease in young children [18•]. Yellon *et al*. [19] found an association between histologically proven reflux esophagitis and asthma, recurrent croup, cough, laryngomalacia, and sinusitis. Some clinicians who previously were exuberant proponents of endoscopic sinus surgery in young children have found that a large percentage of surgical candidates experience significant resolution of rhinosinusitis symptoms with medical management of gastroesophageal reflux [20]. When reflux is suspected by clinical history, some clinicians use an empiric trial of proton pump inhibitors (although not approved by the US Food and Drug Administration for children or available in pediatric liquid).

Surgical Management

Adenoidectomy

Adenoidal hypertrophy can potentially contribute to rhinosinusitis via mechanical obstruction and chronic adenoiditis (Table 2). Adenoidal hypertrophy may be associated with allergic rhinitis, and at least one prospective study has shown temporary reduction of adenoid size with the use of topical nasal steroid sprays [21]. The idea that adenoid tissue serves as a repository for bacteria that might subsequently involve the middle ear and sinuses is further supported by a qualitative and quantitative bacteriologic study by Lee and Rosenfeld [22]. The authors found a significant correlation between quantitative bacteriology of adenoid core samples and sinonasal symptoms, which was independent of the absolute size of the adenoid pad. Prospective studies comparing adenoidectomy with medical therapy are few, but they demonstrate a trend towards improvement with sinusitis defined by plain radiographs after adenoidectomy [23]. Adenoidectomy is relatively simple and safe and is generally considered as the first surgical option for young children who experience recurrent symptoms despite appropriate medical management.

Inferior meatus antrostomy and maxillary lavage

Maxillary sinus lavage is often combined with adenoidectomy. The strongest indication for lavage is probably for obtaining material for culture in immunocompromised patients [24]. Maes and Clement [25] reported on 50 children treated with either maxillary sinus lavage or medical therapy. They found no difference in sinusitis, defined by

Table 1. Predisposing conditions and therapeutic options in pediatric rhinosinusitis

Condition	Therapy
Viral illness	Smaller daycare size, hand washing
Allergy	Environmental control, nasal steroids, immunotherapy
Physiologic immunodeficiency of childhood	Prophylactic antibiotics (oral or topical)
Adenoiditis	Nasal steroids, adenoidectomy
Gastroesophageal reflux	Antacids, proton pump inhibitors

plain film radiographic findings, at 3 weeks between the two groups. In contrast to adults, copious purulent secretion within the maxillary sinus is a relatively unusual finding in pediatric patients.

With the ability to visualize the middle meatus endoscopically, inferior meatus antrostomies have largely fallen out of favor [26]. Lund [27], in a study with serial nasal examination, demonstrated that inferior meatus antrostomies tend to close significantly with time. This is partly explained by the fact that the natural mucociliary flow is via the middle meatus. However, Lund found that a significant percentage of his patients improved clinically after surgery. He hypothesized that temporary drainage and ventilation allowed for mucosal recovery.

Caldwell-Luc

The classic Caldwell-Luc operation involves an incision in the gingival-buccal sulcus with removal of the anterior bony face of the maxillary sinus. It also involves a complete removal of maxillary sinus mucosa. For young children, concerns with Caldwell-Luc include potential for injury to developing teeth and sinus hypoplasia. With the advent of endoscopic techniques, the role of Caldwell-Luc has been reduced principally to that of maxillary tumor biopsy or excision. Some authors still advocate Caldwell-Luc approaches for treatment of antrochoanal polyps.

Nasal septoplasty and inferior turbinoplasty

Ancillary surgical procedures such as septoplasty and turbinoplasty are used relatively infrequently in pediatric patients. Severe nasal-septal deviation is relatively unusual in young children. However, when present, severe septal deviation with airway obstruction may be associated with decreased nasal and maxillary growth rates. Conservative septoplasty carried out in a submucosal plane is appropriate for children with deviated septums that are causing significant fixed nasal obstruction. It may also be necessary to achieve access for surgical approaches for chronic sinusitis [28].

Reduction of hypertrophic inferior turbinate tissue can be carried out with direct surgical excision, cryotherapy, electrical cautery, or radio-frequency ablation. Persistent inferior turbinate hypertrophy refractory to medical therapy including topical steroids is unusual in the pediatric population, with the possible exception of teenage asthmatic patients. Reduction of inferior turbinate size can improve symptomatic nasal obstruction and can also allow for more efficient management of underlying allergies with topical nasal steroids. There are no published reports of outcomes of inferior turbinate reduction in pediatric patients.

Endoscopic sinus surgery

The development of better visualization with endoscopes has led to a shift in surgical approaches over the past 20 years. The usual approach for direct sinus surgery at present is a focused enlargement of the natural outflow tracts through the middle meatus. Maxillary sinus outflow through the infundibulum is enlarged by removing a portion of the uncinate and the lateral nasal wall posterior to the hiatus semilunaris. Diseased ethmoid cells are opened to the middle meatus by taking down bony septations. Development of improved instrumentation, especially the microdebrider, has allowed for more precise limited surgery with more rapid healing.

The strongest indications for endoscopic sinus surgery are sinus drainage in the face of suppurative complication, nasal polyposis refractory to medical therapy, and biopsy of suspected tumor [22,24]. The most common indication, however, is recurrence of symptoms with imaging evidence of persistent sinus disease despite medical therapy (Table 3) [29–31].

Early reports of endoscopic sinus surgery in pediatric patients have been largely uncontrolled and noncomparative. These studies have generally shown the procedure to be relatively safe and effective in the short term as defined by postoperative parental questionnaire. Stankiewicz [32] reported on results of 77 children undergoing endoscopic sinus surgery for chronic sinusitis with a minimum 2-year follow-up. He found that on subjective evaluation 38% were "cured" and 55% were improved at an average 3.5-year follow-up. He noted that these results were worse than those of other descriptive studies, possibly due to his longer follow-up. He also found a high rate of middle meatus maxillary sinus ostium closure on subsequent endoscopic examination. Similarly, Chan *et al.* [33] have described a high rate of recurring symptoms in pediatric patients from a tertiary care center who had undergone multiple prior endoscopic sinus surgery procedures.

There are few reports comparing results of pediatric endoscopic sinus surgery with those of other techniques. Duplechain *et al.* [34] compared results of endoscopic

Table 2. Ancillary surgical procedures for treatment of chronic/recurrent pediatric rhinosinusitis

Procedure	Comments
Myringotomy and tubes	Association between sinusitis and otitis in young children
Adenoidectomy	Younger children, more effective when adenoid tissue is prominent?
Maxillary sinus lavage	Can provide material for culture, no proven long-term efficacy
Septoplasty	For unusual problem of severe deviation with airway obstruction
Turbinoplasty	For turbinate hypertrophy refractory to nasal steroids with persistent obstruction

sinus surgery with results of other traditional techniques for patients with chronic disease including cystic fibrosis. The number of patients was small, and they were unable to determine any outcome difference. Ramadan [35] recently described a group of 66 pediatric patients undergoing either adenoidectomy or endoscopic surgery for chronic rhinosinusitis. The endoscopic sinus surgery group had greater improvement in overall symptom scores.

Rosenfeld [36] described a prospective cohort of 41 children without obstructive adenoids with imaging-documented sinusitis who had failed prolonged antibiotic therapy. All patients were treated with antibiotics initially, and 15 children in the study were treated with antibiotics alone. Those who did not respond to initial antibiotics with adenoid tissue present underwent adenoidectomy. Nonresponders with minimal adenoid tissue underwent endoscopic sinus surgery. Overall, the endoscopic sinus surgery group had the highest preoperative symptom scores. Patients were assessed at 1 year with an unblinded oral survey of symptom response, caregiver expectations, and quality-of-life measures. Overall, caregiver expectations were met in 88% of patients at 1 year. They were more often exceeded in patients undergoing endoscopic sinus surgery, although this was the sickest cohort initially. The endoscopic sinus surgery group showed improvement in all major symptom categories compared with 67% of symptom categories for the group treated with antibiotics alone and 75% for the group treated with antibiotics plus adenoidectomy. Overall, complete symptom resolution was seen in only 27% of the cohort. This underscores the presence of multiple predisposing conditions to recurrent sinusitis in children (*eg*, viral illness and allergies).

Outcomes using validated instruments

Reports using validated outcome instruments are beginning to appear for adult series, and it is tempting to generalize some findings to the pediatric population. Jones *et al*. [37] examined a cohort of 49 adult patients selected for surgery in one practice. An independent panel looking at symptoms, history of response to medical treatment, and CT findings rated "appropriateness" of the decision for surgical therapy. Patients were evaluated with a validated instrument preoperatively and 6 months after surgery. Overall, the patients demonstrated a statistically significant improvement of 38% on the outcome test scores. However, there was little relationship between appropriateness rating for surgery and the change in outcome scores. In fact, patients with an "equivocal" rating for surgery had the greatest percent of improvement. Patients deemed to have the strongest indication for surgery had the greatest incidence of persistent significant symptoms postoperatively.

Gliklich and Metson [38] reported on a large cohort of adult sinus surgery patients evaluated with their own sinusitis instrument and a validated instrument of general health. With regard to the sinus outcome instrument, 82% of patients had improved 12 months after surgery. However, the patients with the worst initial sinus scores had the worst postoperative scores and also had the smallest rate of improvement. Of interest, sinus symptom scores improved in a nonsurgical cohort at 12 months, although to a lesser degree; however, this group had better initial scores. For the surgical group, improvement was also seen in most of the general health categories, especially physical role functioning. Taken together, these two studies might indicate that adults with chronic sinusitis have at least some tendency towards spontaneous resolution with time and that one should predict the least improvement in sinus symptoms after surgery in those patients with the most severe symptoms preoperatively.

Osguthorpe [39••] recently published an overview of available outcome studies. He points out that outcome studies are hampered by the lack of a universally accepted sinus disease staging system, the lack of uniformity in reporting results, and the lack of reliability of objective measures such as rhinomanometry and olfactory testing. He concluded that preoperative predictors of sinus disease recurrence included a history of recurrence after previous surgery, aspirin allergy, nasal polyps, history of asthma and allergic rhinitis, and history of cigarette smoking. The highest rates of recurrence were seen in patients with documented immunodeficiency, cystic fibrosis, and allergic fungal sinusitis.

Special Considerations

Asthma and cystic fibrosis

The job of the nose is to process air for the lungs. Therefore, it is not surprising that patients with chronic lung disease often present with a history of sinusitis acting as a trigger or aggravating condition. The desire to resolve sinusitis is often strongest in patients with asthma and cystic fibrosis. Unfortunately, no studies have demonstrated

Table 3. Relative indications for endoscopic sinus surgery*

Suppurative complications
Medial subperiosteal orbital abscess
Brain abscess
Refractory frontal or sphenoid disease
Nasal polyposis
Suspected malignancy
Antrochoanal polyp
Cystic fibrosis
Sinusitis triggering or aggravating pulmonary disease
Asthma
Cystic fibrosis
Immunodeficiency (immotile cilia)
Chronic or recurrent sinusitis in an otherwise healthy child
Small percentage of patients with recurrent or persistent symptoms after medical therapy (and adenoidectomy)

*Stronger indications at top to weaker indications at bottom.

consistent improvement in pulmonary function test results after sinus surgery for these patients. However, studies of pediatric patients have demonstrated improvements in overall asthma management after endoscopic sinus surgery [35,40]. In the adult outcome study by Gliklich and Metson [38], asthmatic patients had the greatest improvement in overall health measures postoperatively. The otolaryngologist must remember that a significant percentage of pediatric patients with chronic sinusitis have occult reactive airway disease, and perioperative stress may trigger an asthma attack.

The life expectancy of patients with cystic fibrosis has almost tripled over the past 25 years because of tremendous advances in medical therapy, including DNase and aerosolized tobramycin. Nasal mucus is up to 50-times more viscous in patients with cystic fibrosis, and, as a result, cilia cannot efficiently propel the overlying mucus layer. The maxillary sinus is almost always the most seriously diseased sinus in patients with cystic fibrosis, perhaps because of its uphill mucociliary flow toward the middle meatus. Characteristic imaging findings in patients with cystic fibrosis include expansion of the maxillary sinus with medial bowing of the lateral nasal walls and widening of the outflow tract through the infundibulum. Polyps result when hypertrophic maxillary or ethmoid mucosa prolapses into the middle meatus. Polyps usually appear as pale fleshy masses in contrast to the underlying pinker, denser nasal mucosa.

Patients with cystic fibrosis and recurrent sinusitis or nasal polyps are initially treated with topical nasal steroids. Surgery is indicated for refractory polyposis with nasal airway obstruction, obstruction due to significant medial bowing of the lateral nasal walls, or recurrent sinusitis refractory to medical treatment [41]. Nishioka *et al*. [42] described a 2- to 3-year follow-up of 21 cystic fibrosis patients who underwent sinus surgery. They found improvement in symptoms of congestion and recurrent sinusitis. Cuyler [43] has demonstrated that patients with cystic fibrosis will continue to have evidence of significant sinus mucosal inflammation on subsequent imaging. The realistic goal for patients with cystic fibrosis is to improve sinonasal symptoms, and surgery probably has no overall effect on health for most patients.

Immunodeficiency states

Primary ciliary dyskinesia is an autosomal recessive disease with a frequency of one in 16,000 live births. Fifty percent of patients will have Kartagener's syndrome (situs inversus). The disease is characterized by respiratory tract infection and male infertility. Virtually all pediatric patients will have a history of severe refractory rhinorrhea and middle ear effusions. Most patients will have a history of chronic cough and recurrent pneumonia. Twenty to thirty percent of patients will have nasal polyposis. Diagnosis ultimately depends on an adequate biopsy specimen read by an experienced electron microscopist. A brush biopsy of the mucosa on the undersurface of the inferior turbinate can usually be performed in the office setting with pediatric patients. Brush biopsies can demonstrate ultrastructural defects such as absence of dynein arms or radial spikes. However, a full thickness biopsy is necessary to demonstrate misalignment of the basal footplates. When the patient is receiving anesthesia for other reasons (*eg*, adenoidectomy) it is possible to obtain a biopsy specimen from an uninfected site such as the subglottis to avoid acquired ciliary defects from acute infection. Sinus surgery is reserved for patients with debilitating symptoms despite medical therapy, but overall results with surgery are poor [44].

Over 40,000 bone marrow transplants were performed worldwide in 1997, and the number of bone and stem cell transplants continues to grow as indications broaden. Rhinosinusitis develops in approximately 30% of transplant patients, usually during the immunologic nadir following transplant. A wide variety of organisms accounts for sinus infection, and fortunately the incidence of invasive fungal sinusitis remains very low in most transplant centers. In a recent review of over 16,000 bone marrow transplant patients, 1.7% developed invasive fungal sinusitis [45]. The average onset of symptoms was 21 days posttransplant,

and the diagnosis was usually made 3 to 4 days later. Initial symptoms included facial pain, congestion, and rhinorrhea. Five patients were relatively asymptomatic except for spiking fevers. The principle treatment was systemic amphotericin B. The mortality rate from initial infection was 62%, and another 27% subsequently died from other causes for an overall mortality rate of 89%. Surgery was used for diagnostic biopsy and debridement of devitalized tissue. Of note, survival was not correlated with extent of surgical excision. Overall, the role of surgery in invasive fungal sinusitis appears to be shifting towards that of endoscopic serial debridements.

Almost 1 million people in the United States are HIV positive, and life expectancy with AIDS has increased significantly with newer antiviral drugs. The incidence of rhinosinusitis is increased in HIV-positive patients, especially with *Staphylococcus aureus* and *Pseudomonas* species [46,47]. Opportunistic infections are usually not seen until CD4 counts are below 50. HIV-positive patients seem also to suffer more from allergic rhinitis symptoms. For patients who fail medical therapy, including topical nasal steroids and culture-guided antibiotics, endoscopic sinus surgery can improve symptoms such as facial pain and congestion in up to 75% of patients [48].

Surgical risks

Every decision for surgery involves a risk-benefit analysis. Endoscopic sinus surgery overall is extremely safe, and technologic advances such as intraoperative imaging systems should result in a continued drop in the incidence of significant operative complications. Children probably have lower overall complication rates than do adults, perhaps owing in part to the fact that they usually undergo more limited surgery. For adults, the incidence of serious operative complications—including blindness, injury to extraocular muscles, intracranial injury, cerebral spinal fluid leak, and brain abscess—is estimated to be 0.2% to 5% [36]. The incidence of lesser complications, such as scar formation, bruising from injury to orbital fat, and temporary epiphora from nasolacrimal duct injury, is higher. When sinusitis itself poses a threat to health, such as with suppurative complication or with a clear history of sinusitis triggering pulmonary disease, then decisions for surgical intervention are obviously easier. The risk-benefit analysis becomes more difficult with otherwise healthy patients in whom the goal is to alleviate sinonasal symptoms with surgical intervention.

Although no studies to date have shown any conclusive evidence of noticeable changes in facial appearance after pediatric sinus surgery, concerns persist that surgery at a young age may affect subsequent facial bony growth. Mair *et al*. [49] found decreased growth on the side of surgery in piglets undergoing unilateral endoscopic sinus surgery. The authors concluded that woven immature facial bone might respond to surgical trauma with subsequent decreased growth potential. They recommended that surgeons pay particular attention to the overall risk-benefit ratio in decision making for patients aged less than 7 years because of concerns about facial growth.

Although endoscopic techniques have allowed for relatively safe surgery focused on the natural outflow tracts of the sinuses, published reports indicate that increased prevalence of sinus surgery has led to an increase in complications of iatrogenic cerebrospinal fluid leak and chronic frontal sinus disease [50,51]. Given concerns about subsequent facial growth and inducing chronic obstruction through scarring, the pendulum in pediatric endoscopic sinus surgery appears to be swinging back towards more focused minimal approaches.

Technical aspects of surgery and new frontiers

The biggest technical innovation in the past 10 years has been the application of microdebrider technology to sinus surgery. This has allowed for safer and less traumatic surgery with less need for postoperative nasal packing and quicker recoveries. In fact, with the development of more atraumatic techniques, many surgeons are shifting to an approach of minimal or no stenting or packing [52]. Tom *et al*. [53] recently compared gelatin film stents in the middle meatus with no stenting in a pediatric series and found a trend towards worse healing on the stented side.

The most common suppurative complication of pediatric sinusitis is medial subperiosteal orbital abscess. A large percentage of young patients can be effectively treated with intravenous antibiotics [54]. For patients requiring surgical drainage because of progression of signs and symptoms, the trend is away from external approaches towards more endoscopic management [55]. The frontiers of endoscopic sinus surgery are also expanding to include cases of intranasal gliomas, small encephaloceles, and small tumors such as angiofibromas.

Conclusions

Pediatric rhinosinusitis is increasing in incidence and is a source of frustration for parents. Most rhinosinusitis is due to mucosal factors rather than to anatomic obstruction. The natural history of pediatric rhinosinusitis is towards spontaneous resolution with maturation of systemic immunity [56]. Every decision for surgery involves a risk-benefit analysis, and patients with suppurative complications, suspected tumor, or refractory polyposis present the strongest indications [57]. Patients with underlying pulmonary disease, such as asthma or cystic fibrosis, with sinusitis refractory to medical therapy represent the most common surgical candidates in pediatric tertiary care settings. Adenoidectomy is relatively safe with low morbidity and documented effectiveness for reducing rhinosinusitis symptoms in a large percentage of younger children. For otherwise healthy children, endoscopic sinus surgery is usually considered last when medical treatment has failed and when imaging studies demonstrate persistent sinus

disease. With advances in understanding of etiologic factors such as gastroesophageal reflux, the percentage of pediatric patients ultimately selected for endoscopic sinus surgery should continue to decrease.

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