

The Current Management of Sinusitis in Children

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Summary: The paranasal sinuses are common sites of infection in children. The diagnosis of sinusitis may be challenging because the sinus cavities are small and variably contoured, the clinical manifestations are often nonspecific, and the radiologic findings may be equivocal. Because many local and systemic factors contribute to sinusitis in children, the therapeutic regimens vary. In addition to conventional medical approaches, new surgical procedures and improved anesthetic techniques have made functional endonasal sinus surgery an excellent management tool for selected patients with chronic or recurrent disease.

Introduction

Sinusitis is increasingly being diagnosed by pediatricians, otolaryngologists, and allergists. It has become the most common chronic illness in the United States, surpassing arthritis and hypertension, according to the National Center for Disease Statistics.¹ Approximately 12% of the entire population suffers from sinusitis at some time, with millions of days forfeited from work or school.

Sinusitis is a common disorder

in the pediatric population, although it has often been underdiagnosed or unrecognized in the past. We report the pathophysiology, diagnostic methods, and current management of sinusitis in children.

Pathophysiology and Etiology

The paranasal sinuses are four pairs of air-filled cavities that surround the nose. They are covered by pseudostratified ciliated columnar epithelium. Sinusitis may occur after obstruction of the sinus ostia or dysfunction of the mucociliary apparatus. The etiologic factors of sinusitis in children range from upper respiratory tract infections to major systemic abnormalities (Table 1).

Viral infections of the upper respiratory tract and allergic inflammatory disease are the most

common causes of acute sinusitis in the pediatric age group. Only an estimated 20% of children with acute rhinitis have patent sinus ostia.² Allergy appears to play an equally important role: 46% of the patients with chronic sinusitis in one pediatric series evidenced allergies.³ A study by Rachelefsky and colleagues⁴ demonstrated that 70% of the children with abnormal sinus x-ray films had allergies, although the possibility exists that professional bias contributes to the diagnosis of this group of children by pediatric allergists.

An inflammatory process, whether allergic or infectious, may produce thickening and engorgement of the subepithelial sinonasal mucosa, with capillary dilatation and acute inflammatory exudate. The resulting edema leads to ostial obstruction, pooling of sinus secretions, and secondary bacterial infection.

The mucociliary transport sys-

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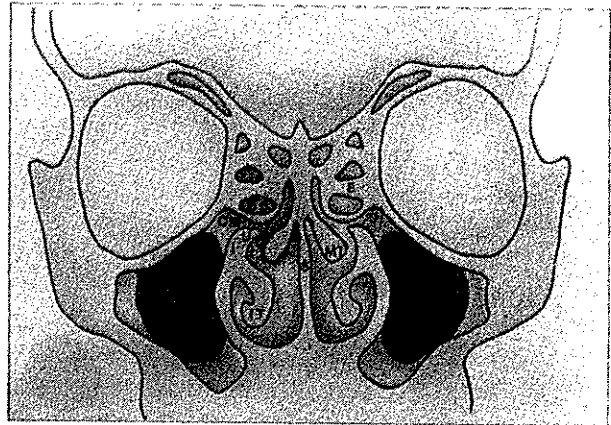
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tem normally constitutes a mucosal defense mechanism. Protection is achieved through the functions of the ciliary movement, mucous blanket, lysozyme, secretory IgA, and surface enzymes. Viral infection, medications, immotile cilia syndrome, cystic fibrosis, and many other conditions may hinder the protective functions and contribute to paranasal sinusitis.

The key to understanding sinus disease is the ostiomeatal complex. The modern concept of the ostiomeatal complex was introduced by Messerklinger.⁵ The anatomic region of the sinonasal system consists of the infundibulum, hiatus semilunaris, frontal recess, uncinate process, anterior ethmoid cells, ethmoid bulla, and the anterior wall of the middle turbinate (Figure 1). It is the pathway of mucociliary flow of the frontal, maxillary, and ethmoid sinuses. It follows that conditions in the frontal and maxillary sinuses depend substantially on the physiologic state of the anterior ethmoid sinuses. Any disease process affecting the ostiomeatal complex can hinder sinus drainage and create

Figure 1. Ostiomeatal complex (OM) anatomy: bulla ethmoidalis (BE), maxillary sinus infundibulum (I), uncinate process (U), hiatus semilunaris (curved arrow), inferior turbinate (IT), nasal septum (S), middle turbinate (MT), ethmoids (E).



the requisite condition for sinusitis.

The four clinical classifications of sinusitis are based on the duration of symptoms: acute, if symptoms last two to four weeks; subacute, if symptoms last two to three months; and chronic, if symptoms last longer than three months (Figure 2). The fourth category, recurrent sinusitis, is chronic sinusitis with frequent exacerbations.

The most common pathogens encountered in acute sinusitis in adults and children are *Streptococcus pneumoniae*, *Hemophilus influenzae*, and *Moraxella (Branhamella) catarrhalis*.⁶ Anaerobes may be encountered in chronic sinusitis.⁷ Viruses are rarely isolated as the sole pathogenic organism in sinusitis.⁸

rhalis.⁶ Anaerobes may be encountered in chronic sinusitis.⁷ Viruses are rarely isolated as the sole pathogenic organism in sinusitis.⁸

Diagnosis

In children, the clinical and radiologic diagnostic criteria of sinusitis vary. The young child is frequently unable to express most of the characteristic symptoms of sinusitis. Physical examination is usually difficult and unrevealing. Moreover, the findings on plain radiographs of the sinuses may be equivocal.⁹

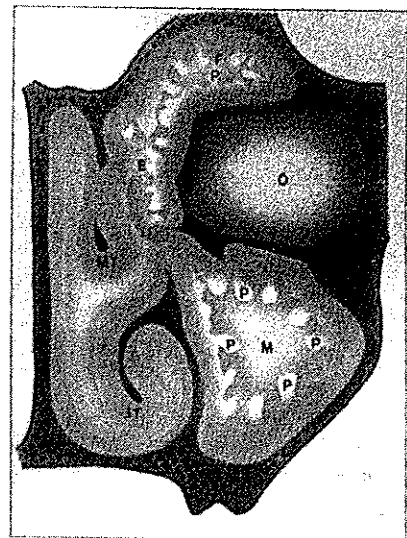
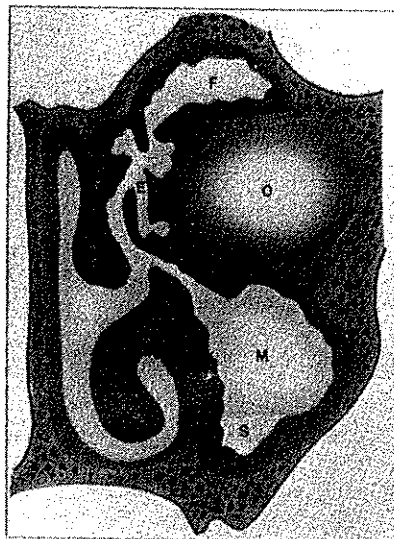
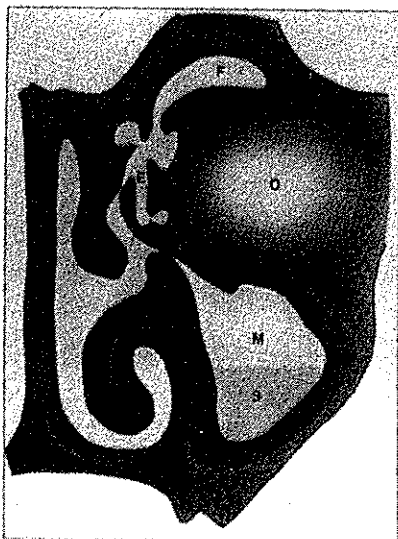


Figure 2. The different stages of sinusitis: a. (left) acute stage, b. (center) subacute stage, and c. (right) chronic stage. The illustrations depict the frontal sinus (F), ethmoids (E), orbits (O), and middle turbinate (MT).



Figure 3. Plain x-ray films of the sinuses. a. (left) Water's view of the sinuses shows opacification of the right maxillary sinus. b. (below) Caldwell view of the sinuses of the same patient shows left ethmoid opacification and right ethmoid sinus mucosal thickening.



Clinical Manifestations

There are substantial variations in the symptoms of sinusitis in the pediatric age group. Symptoms have a broad range of severity and usually differ with age. However, the most common clinical manifestations of sinusitis in children are chronic cough, otitis media with effusion, and anterior/posterior rhinorrhea.¹⁰ In contrast, adults usually present with headaches, facial pain, and fever.¹⁰

Sinusitis may be associated with a variety of local and distant complications. Not uncommonly, the complications of sinusitis may present as the initial symptom. Orbital complications are the most common; 75% of orbital problems occur in patients younger than 16 years of age.¹¹ Chandler¹² divided orbital complications into five different stages: inflammatory edema or preseptal cellulitis, orbital cellulitis, subperiosteal abscess, orbital abscess, and cavernous sinus thrombosis.

Intracranial complications include meningitis, epidural abscess,

subdural abscess, intracerebral abscess, and cavernous sinus thrombosis. Orbital and intracranial complications are the most common consequences of sinusitis warranting immediate intervention.¹³

Distant complications of sinusitis include the exacerbation of asthma.¹⁴⁻¹⁷ In a previous study, we found that 80% of asthmatic patients improved after sinusitis was treated.³

The only portion of the sinonasal system available for unaided physical examination is the nose. Unfortunately, it does not reveal the status of the sinuses. Boggy erythematous nasal mucosa, nasal or postnasal mucopurulent discharge, facial tenderness or edema, fetid breath, and fever should be sought during examination. Anterior rhinoscopy may be useful, and an otoscope can provide adequate visualization of the anterior nose. Flexible and rigid endoscopy enables a more complete evaluation in older children. Although the rigid scope provides

superior evaluation, it can only be used in extremely cooperative children. Pediatric transillumination, in our experience, does not have diagnostic value.

Sinus aspirates are only indicated in children who are toxic, fail to improve on appropriate therapy, have complications, or are immunocompromised. Nasal, nasopharyngeal, and throat cultures do not accurately reflect the causative organism in sinusitis.¹⁸

Radiographic Studies

Conventional plain radiography is an important diagnostic tool and offers support for the clinical diagnosis of sinusitis. Air-fluid levels, unilateral opacification, or significant mucosal thickening are common diagnostic findings of sinusitis on plain radiographs (Figure 3). However, there is disagreement about the interpretation and reliability of plain x-ray films of the sinuses in children. Caffey¹⁹ advised caution in interpreting sinus radiographs because he believed that within normal sinuses redun-

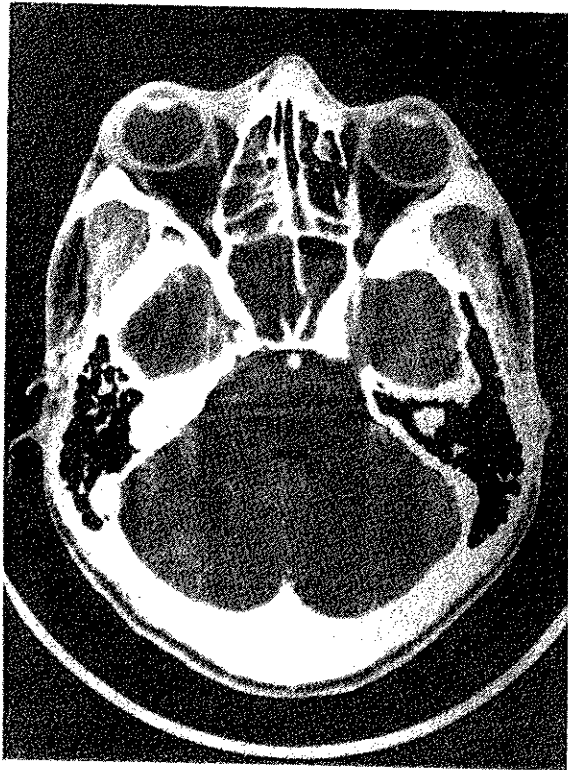


Figure 4. Computed tomography of the sinuses. Ethmoid sinusitis, right more than left with right proptosis.

dant mucosa in children or mucosal tears in infants may produce an opaque appearance. He likewise stated that asymmetry in facial bones or sinus development, overlying soft tissue, or both could produce differences in the apparent aeration of the sinuses and lead to misinterpretation of the radiographs. Other investigators demonstrated that radiographic abnormalities of the sinuses were similar in healthy children and those with suspected sinusitis.^{9,20} In independent studies, McAllister and Lusk²¹ and Lazar and Younis²² found that plain radiographs of the sinuses may underdiagnose or even overdiagnose sinus disease in children. Plain sinus radiographs do not adequately document the extent of paranasal sinus disease, and normal sinus radiographs do not prove that the sinus is free of disease.

For a definitive diagnosis, computed tomography (CT) is usually required. Coronal CT with 4-mm

cuts at 3-mm intervals and appropriate bone windows are our standard diagnostic modality for chronic sinusitis if surgery is contemplated. The CT scans can demonstrate disease that is not routinely seen on plain radiographs, and they assist in evaluating inaccessible structures, revealing abnormalities of the ostiomeatal complex, and delineating anatomic variations before planning medical or surgical therapy (Figure 4).

Ultrasonography is another diagnostic modality that has been used to evaluate sinus disease.^{23,24} This technique has the ability to discriminate between mucosal thickening and retained sinus secretions. In children younger than three years, ultrasonography may be of limited value.²⁵ Our limited experience with this modality does not support its use in pediatrics for the diagnosis of sinusitis.

Magnetic resonance imaging (MRI) may be used in the diagnosis

of sinus disease. However, it often adds to the complexity and expense of making a diagnosis without conferring any tangible advantage over CT. MRI may be reasonably employed if a sinus tumor or fungal infection is suspected.

Treatment

The objective of treatment of sinusitis is rapid sterilization of sinus secretions and reestablishment of normal sinus drainage. This objective may be achieved by medical and surgical therapies.

Medical Therapy

Acute sinusitis in the vast majority of patients resolves completely with conservative medical treatment.²⁶ Therapy consists of antibiotics, decongestant nasal spray, systemic decongestants, steroid nasal spray, mucolytic agents, and occasionally, antihistamines (Table 2).

The cornerstone of any medical therapy is antibiotics. Amoxicillin (40 mg/kg/day) or oral ampicillin (100 mg/kg/day) are the initial antibiotics of choice for acute cases and for patients who have not been treated previously. An alternative to amoxicillin or ampicillin may be trimethoprim/sulfamethoxazole, erythromycin, or erythromycin/sulfisoxazole, which are of special value in treating patients allergic to penicillin. The increasing prevalence of β -lactamase-positive and amoxicillin-resistant strains of bacteria may lead to failure of these antibiotic regimens. In that case, cefaclor (40 mg/kg/day), amoxicillin-clavulanate potassium (40 mg/kg/day), or cefuroxime axetil (125 mg b.i.d) may form an effective third line of antibiotic management.

The aim of any antibiotic ther-

apy is to control infection and sterilize, if possible, the sinus cavity. Based on our experience, the antibiotic regimen should be continued for 21 days. Many pediatricians generally treat acute otitis media or acute tonsillitis with a 10-day regimen of antibiotics; however, relapses are commonly seen. In sinusitis a three-week course of antibiotics is recommended.

Topical decongestants, systemic decongestants, and topical steroids theoretically aid in reestablishing the patency of the natural sinus ostia. The use of a topical pediatric nasal decongestant for a period of three to five days may be beneficial in promoting drainage and aeration of the sinuses. Systemic decongestants and antihistamines are occasionally used, but their role is unresolved. Antihistamines may dry the secretions and hinder mucociliary clearance. Topical steroids are effective in reducing mucosal edema and promoting the patency of the sinus ostia. They may also ameliorate the child's allergy or asthma.

Patients are considered to have chronic sinusitis if the symptoms persist despite repeated regimens of medical therapies. Most are referred to a pediatric allergist for an allergy evaluation.

Surgical Treatment

Surgical treatment is contemplated for patients with chronic or recurrent sinusitis who have failed repeated trials of prolonged medical therapy.

Modified or limited septoplasty, tonsillectomy, adenoidectomy, and partial turbinectomies may have had significant therapeutic value in some cases, but the effectiveness of these procedures in the treatment of chronic or recurrent sinusitis has not been substantiated.

Antrostomy and lavage is an-

other frequently performed traditional procedure. Antrostomy, by providing an opening between the maxillary sinus and nasal cavity through the inferior meatus, permits dependent, not physiologic, drainage of the maxillary sinus. However, the ostiomeatal complex and the other sinuses are not addressed through this technique, and the long-term effectiveness of antrostomies has been questioned. Lazar and Younis²⁷ found that only 23% of the patients who underwent bilateral intranasal antrostomies were improved after one year of follow-up. Muntz and

Lusk²⁸ reported the ineffectiveness of this procedure in treating 39 pediatric patients with chronic sinusitis. Antrostomies may be beneficial in treating patients with immotile cilia syndrome or Kartagener's syndrome, in which dependent drainage is desired.

The introduction of pediatric functional endonasal sinus surgery (FESS) in the 1980s revolutionized the surgical approach to sinusitis in children.²⁹ FESS is a functional, rather than exenterative or ablative, procedure. In addressing the problems of the entire ostiomeatal complex, pathologic tissues are removed, and the normal tissues are left in place. FESS can surgically correct anatomic obstructions and reestablish conditions that enhance normal mucociliary clearance.

FESS is considered for patients with chronic or recurrent sinusitis who fail to respond to repeated, prolonged trials of medical therapies. Coronal CT is used to demonstrate pathologic anatomic changes, document sinus disease, and plan surgery.

For children, the surgery is performed under general anesthesia. The modified Messerklinger approach is employed, and the same instruments and operative telescopes used in adults are used in children.^{30,31}

Postoperatively, the patient is kept on a maximal medical therapy consisting of broad-spectrum antibiotics, saline nasal washes, nasal decongestant spray, and beclomethasone nasal spray. Except for the nasal decongestant spray, the regimen is maintained for six weeks.

The patient is scheduled for nasal endoscopic examination under general anesthesia two to three weeks after FESS. The postoperative treatment and follow-up nasal endoscopy are important portions of the treatment, ensur-

Table 1

ETIOLOGIC FACTORS IN PEDIATRIC SINUSITIS

- Inflammatory
 - Upper respiratory tract infections
 - Allergy
- Mechanical
 - Nasoseptal deformity
 - Ostiomeatal complex obstruction
 - Septate hypoplasia
 - Polyps
 - Tumors
 - Large adenoids
 - Foreign bodies
 - Hard palate
 - Cranial affections
 - Posterior nasal stenosis
- Systemic
 - Cystic fibrosis
 - Immunodeficiency syndrome
 - Kartagener's syndrome
 - Immunodeficiency
 - Cyanotic congenital heart disease
- Miscellaneous
 - Swimming during infancy

ing adequate hygiene and close assessment of the surgical site.

Since 1986, we have used this procedure to treat more than 300 pediatric patients with chronic or recurrent sinusitis. Eighty percent of patients were cured or experienced significant improvement of their sinus complaints. The duration of follow-up was between three months and three years.

The most common postoperative minor complication was adhesion formation. Major complications of surgery, such as blindness, extraocular muscle injury, or meningitis, did not occur. The most common findings on follow-up nasal endoscopy were granulation tissue formation, clots, and crusting. Eight percent of patients

required revision FESS. Patients who had persistent symptoms despite medical and surgical (FESS) treatment were referred for systemic disease evaluation. Cystic fibrosis, immotile cilia syndrome, and immunodeficiencies were suspected in these cases.

Other investigators have obtained equally successful results with FESS. Levine¹ reported success rates of 80% to 90%; Kennedy and Zinreich³² reported successful outcomes for 92% of their patients; Lusk and Muntz³³ achieved a rate of 80%; and Schaefer and associates³⁴ had an 83% success rate. FESS is proving to be a safe and effective surgical procedure for pediatric patients with chronic or recurrent sinusitis.

Conclusion

Sinusitis is a complex inflammatory process that results from sinus ostial obstruction and mucociliary dysfunction. The diagnosis is based on patient history, clinical findings, and radiographic examination. Treatment is initially medical, but surgery becomes necessary after medical therapy has been exhausted. An understanding of pathophysiology and the application of innovative treatments have created significant refinements in the current management of sinus disease in children, and FESS appears to be an effective surgical procedure for treating most patients with chronic or recurrent sinusitis. However, many questions about sinus disease in children remain unanswered, and the goal of treating successfully all children with this disease demands further investigation.

Table 2

MEDICAL TREATMENT PROTOCOLS FOR SINUSITIS IN CHILDREN

Medications	First-line Treatment	Second-line Treatment	Third-line Treatment
Antibiotics	Ampicillin Amoxicillin	Erythromycin Erythromycin sulfisoxazole Trimethoprim/ sulfamethoxazole	Amoxicillin- clavulanate Potassium Clotrimazole Cefuroxime axetil
Decongestants (local)	Pediatric nasal spray and drops	Pediatric nasal spray and drops	Pediatric nasal spray and drops
Decongestants (systemic)	Yes	Yes	Yes
Antihistamines	No	No	Occasionally
Mucolytics	Yes	Yes	Yes
Steroid (local)	No	Beclometasone	Beclometasone
Steroid (systemic)	No	No	Occasionally

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