Pediatric Rhinosinusitis

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Anatomy

- **Maxillary Sinus**
  - first to develop at day 65 of gestation
  - seen on plain films at 4-5 months
  - slow expansion until 18 years

- **Ethmoid Sinus**
  - develop in third month of gestation
  - ethmoids seen on radiographs at one year
  - enlarges to reach adult size at age 12

- **Sphenoid Sinus**
  - originates in fourth gestational month from posterior part of nasal cavity
  - pneumatization begins at age 3
  - rapid growth to reach sella by age 7 and adult size at age 18

- **Frontal Sinus**
  - begins in fourth month of gestation from superior ethmoid cells
  - seen on radiographs at age 5-6
  - grows slowly to adult size by adolescence
Definitions

- **Acute**: symptoms often inseparable from URI and include rhinorrhea, daytime cough, nasal congestion, infrequent low-grade fever, otitis media, irritability and headache. Key in diagnosis of sinusitis is persistence beyond 7-10 days or worsening of symptoms at around 7 days
  - Severe Acute Sinusitis: purulent rhinorrhea, high fever, periorbital edema

- **Recurrent**: complete resolution between episodes and 3 or more episodes in six months or more than 4 episodes in one year

- **Subacute**: signs and symptoms lasting three weeks to three months

- **Chronic**: signs and symptoms lasting longer than three months
Pathogenesis

- Ostia obstruction creates increasingly hypoxic environment within sinus
- Retention of secretion results in inflammation and bacterial infection
- Secretion stagnate, obstruction increases, cilia and epithelial damage become more pronounced
- Most common inciting event is viral URI
Diagnosis

- Physical Examination
  - Anterior rhinoscopy with otoscope in younger children
  - Tenderness over sinuses
  - Periorbital edema and discoloration
  - Flexible and rigid endoscopy in older child
  - Most specific-- mucopurulence, periorbital swelling, facial tenderness
Adjunctive Tests

- Imaging usually not indicated for uncomplicated patients. CT scan may be indicated if suppurative complications suspected, patient fails to improve after treatment or as pre-operative study.
  - Ideally should be obtained after several weeks of medical therapy.
  - Major bony anatomic abnormalities unusual in children.
  - Mucosal inflammation common incidental finding in children and strongly related to viral URI.
  - Incidence of sinus mucosal inflammation drops off after age 7 to 8.

- Sinus aspirate is indicated in severe toxic illness, acute illness not responsive to antibiotics within 72 hours, immunocompromised patients, suppurative complications and workup for fever of unknown origin.
  - Oropharyngeal/Nasopharyngeal swabs do not correlate with sinus aspirate.
  - Endoscopically guided middle meatus swab correlates fairly well with sinus aspirate.
Microbiology

- Similar to adults: *Streptococcus pneumoniae, Moraxella catarrhalis, nontypeable Hemophilus influenzae*

- ICU patients/cystic fibrosis: *Pseudomonas aeruginosa, Staphyloccus aureus*

- Resistant organisms more common in patients already treated with multiple rounds of antibiotics, children in day care, children who have received antibiotic therapy in the last 30 days

- Chronic pathogens may include
  - Alpha-hemolytic streptococci
  - *S. aureus*
  - Nontypeable *H. influenzae*
  - *M. catarrhalis*
  - Anaerobic bacteria
  - Pseudomonads
Medical Treatment

- **Acute Sinusitis:**
  - Young children with mild to moderate ARS, amoxicillin at normal or high dose
  - Amoxil-allergic patients, treat with a cephalosporin—severe allergy, treat with macrolide
  - Nonresponders, more severe initial disease, those at high-risk for resistant strep, treat with high dose amoxil/clavulanate
  - Parenteral ceftriaxone for children not tolerating oral meds
  - Duration of therapy is usually 10-21 days or until symptoms resolve plus 10 days
Medical Treatment

- Chronic Rhinosinusitis
  - 4 to 6 week course of beta lactam stable antibiotic
  - Adjuvant therapy with nasal steroids commonly employed
  - Antihistamines especially if underlying allergic condition suspected
  - Mucolytics may thin secretions
Refractory Rhinosinusitis

- Consider associated conditions
  - Allergy
  - Immune deficiency
  - Asthma
  - Gastroesophageal reflux disease
  - Cystic Fibrosis
  - Primary Ciliary Dyskinesia (Immotile Cilia Syndrome)
  - Allergic Fungal Sinusitis
Allergy

- Major contributing factor in rhinosinusitis
- Similar pathogenesis as viral etiology with obstruction -- mucostasis -- hypoxia -- colonization
- Itching mucous membranes, clear rhinorrhea, eczema, food intolerance, nasal congestion, stuffiness, fluctuating rhinorrhea, sneezing, cough, behavioral changes, headaches, facial pressure
- Avoidance
  - clean, allergy proof house, filter, no pets, air conditioning
- Pharmacotherapy
  - antihistamines, nasal steroids, mast cell stabilizers
- Immunotherapy
Immune Deficiency

- History of frequent otitis media, pneumonia and sinusitis may suggest a primary or secondary immunodeficiency state
- Serum immunoglobulins and IgG subclasses should be checked as well as ability to respond to capsular antigens of *S. pneumoniae* and *H. influenzae*
  - Must have laboratory with age-appropriate norms
  - Chronic pediatric sinusitis associated with IgG2 deficiency
  - Consistent low total immunoglobulin defines common variable hypoglobulinemia
- Treatment in primarily medical
- Patients may benefit from IVIG therapy
- Genetic counseling for patient and family may be appropriate
Asthma

- Sinusitis and asthma frequently associated: same underlying disease process or causal relationship?
  - Sinonasal/bronchial reflex
  - Aspiration

- Treatment of sinusitis whether medical or surgical reduces use of bronchodilators, improves pulmonary symptoms
Gastroesophageal Reflux Disease

- Many pediatric patients experience improvement in their chronic sinonasal symptoms after a trial of antireflux medicine.
- GERD theorized to have direct effect on nasal mucosa, initiating inflammatory response with edema and impaired mucociliary clearance.
- Phipps in 2000 reported a prospective trial in which 63% CRS patients were found to have esophageal reflux by pH probe; 32% demonstrated nasopharyngeal reflux.
- Bothwell in 1999 reported 89% of pediatric candidates for FESS avoided surgery with treatment for GERD.
Cystic Fibrosis

- Autosomal recessive disease
- Mutation of CFTR protein
- Patients develop chronic pulmonary disease in childhood; also affected with sinusitis and nasal polyposis, pancreatic insufficiency and biliary cirrhosis
- If surgery contemplated, check coags
- Recent studies suggest heterozygous mutations in the CFTR gene are associated with chronic rhinosinusitis
  - Raman found that 12.1% of CRS patients harbored CFTR mutations compared with the expected rate of 3-4%
  - Wang found a 7% incidence of CFTR mutation in 123 CRS patients compared to 2% in a control group
Primary Ciliary Dyskinesia

- History of chronic otitis media, chronic sinusitis and chronic bronchitis or bronchiectasis
- Kartagener’s syndrome: sinusitis, situs inversus, bronchiectasis and male infertility
- Diagnosis established with inferior or middle turbinate or tracheal biopsy
Allergic Fungal Sinusitis

- Allergic reaction to aerosolized fungi, usually of the dematiceous species
- Treatment is surgical with perioperative oral steroid and post-operative topical steroids
- High recurrence rate, requires close follow up
- Findings in children different than adult findings
  - Children more frequently have abnormalities of their facial skeleton
  - More likely to have unilateral disease
Complications

- **Orbital:**
  - Orbital complications more common in children than adults
  - Most common is medial subperiosteal abscess

- **Intracranial:**
  - More common in adolescents/adults
  - Include meningitis (most common), epidural abscess, subdural abscess, intracerebral abscess, cavernous sinus thrombosis
Orbital Complications

- Classified by Chandler:
  - I. Preseptal cellulitis
  - II. Orbital cellulitis
  - III. Periorbital abscess
  - IV. Orbital abscess
  - V. Cavernous sinus thrombosis

- Spread by direct extension via osseous structures or indirectly via valveless venous plexuses

- Obtain CT scan with contrast if orbital involvement suspected
Stage I—Preseptal Cellulitis

- Eyelid edema, erythema and normal globe movement
- Stage I in children more likely due to cutaneous lesions or hematogenous seeding rather than sinusitis
Stage II—Orbital Cellulitis

- Proptosis, Chemosis, Edema, Pain
  - Dilated pupil
  - Visual loss
  - Ophthalmoplegia
  - Afferent pupillary defect
Stage III—Periorbital Abscess

- Proptosis with globe displacement inferolaterally, decreased EOM, vision decreased
- IVAbx with external or endoscopic drainage of abscess and involved sinus
Stage IV—Orbital Abscess

- orbital abscess
- severe proptosis and chemosis
- usually no globe displacement
- ophthalmoplegia present
- Impaired visual acuity
Stage V—Cavernous Sinus Thrombosis

- Progressive symptoms
- Proptosis and fixation
- CN II, IV, VI
- Meningitis
- High mortality
- High fever, bilateral symptoms
Intracranial Complications

- Meningitis, Epidural Abscess, Intracerebral Abscess, Pott’s Puffy Tumor
- Neurosurgical Consultation, high-dose antimicrobial therapy, drainage of intracranial abscess planned in concert with drainage of affected sinus
- Frontal sinus is most implicated sinus: venous drainage of the frontal sinus via small diploic veins extending through sinus wall; these communicate with venous plexi of dura, periorbita and cranial periostuem
Surgical Management

- Adenoidectomy
- FESS
  - Only after maximal medical therapy has failed and patient has been screened and treated for any underlying conditions
  - Concern for developing nasal and sinus anatomy in children and possibility of altering facial growth

**TABLE 2: Relative Indications for Pediatric Sinus Surgery**

<table>
<thead>
<tr>
<th>Suppurative complications</th>
<th>Fixed obstructions</th>
<th>Sinusitis aggravating pulmonary disease</th>
<th>Chronic sinusitis</th>
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</thead>
<tbody>
<tr>
<td>Medial subperiosteal orbital abscess</td>
<td>Refractory polyps (CF, AFS)</td>
<td>Asthma</td>
<td>Impact on quality of life, school attendance</td>
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<tr>
<td>Complicated sphenoid or frontal sinusitis</td>
<td>Antrochoanal polyp</td>
<td>Cystic fibrosis</td>
<td>Persistent mucosal disease in sinus outflow tracts on CT after maximum medical therapy</td>
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<tr>
<td>Inverted papilloma</td>
<td>Other suspected tumor</td>
<td>Immunodeficiency</td>
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CF, cystic fibrosis; AFS, allergic fungal sinusitis; CT, computed tomography.
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