Pediatric sinusitis: a widespread and debilitating disease

- 7.6% of children have chronic sinusitis.¹

- Sinusitis accounts for an estimated $1.8B in annual spend in children under 12.²

- Pediatric patients make up more than 20% of all office visits for chronic sinusitis.³

- The health impact of chronic rhinosinusitis as reported by pediatric patients and their parents as more severe than asthma and juvenile rheumatoid arthritis.⁴
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, Staphylococcus 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
Typical treatment pathway

1. Medical Management
2. Adenoidectomy
3. FESS
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
Medical Management is the frontline treatment

- ~25% of pediatric chronic sinusitis sufferers are not successfully treated with medical therapy.\(^5\)

- Endless cycles of medical management, beyond standard of care create other problems:
  - Up to 10% of medical therapy patients may experience disruptive complications or side effects\(^6-9\)
    - (nausea, diarrhea, vomiting, headache)
  - In 1995, 9% pneumococcal isolates was resistant to at least three different drug classes; in 1998, 14%\(^10\)
  - MRSA was detected in 28.3% of the Staph Aureus infections in the sinonasal head and neck group\(^11\)
Adenoidectomy

Success rates in pediatric CRS patients: literature review

- Takahashi 1989² - A retrospective chart review of prospectively collected data. Age range was 1-12 yrs (mean 4.4)
  - 45 patients - were improved 6 months following surgery compared to 8/33 (24%) non-adenoid pts (56%) success

- Vandenberg 1997³ - A retrospective chart review of prospectively collected data. Age range was 1-12 yrs (mean 4.4)
  - 43 patients - Complete or nearly complete resolution of CRS symptoms was reported in 25 (58%) success

- Ramadan 2007⁴ - A retrospective chart review of prospectively collected data in a tertiary pediatric otolaryngology service, over a 10 yr. period. Age range was 3-13 yrs (mean 6.9)
  - 121 patients – Resolved CRS symptoms in 61 (50%) success

Overall success rate of adenoidectomy in CRS treatment is ~50-60%
Adenoidectomy

Coincidence of sinus and adenoid bacteriopathology

- 2001 – Bernstein\textsuperscript{5} - Found that bacteria from adenoids correlated with lateral wall cultures in 89% of the cases

- 2007- Coticchia\textsuperscript{6} - 95% of adenoids in CRS had biofilm compared to 2% in controls

- 2008 – Shin\textsuperscript{7} - 79% correlation between bacteriology of adenoids and stage of CRS in children
Adenoidectomy follows failed medical management

- Adenoidectomy is effective in only 50-60% of cases.\textsuperscript{12-13, 21}
- Adenoids appear to act as a reservoir of infection.\textsuperscript{14}
  - The same pathogenic bacteria in the adenoids were cultured from the middle meatus near the anterior sinus drainage site.\textsuperscript{15}
- Diagnosed and performed under direct visualization
- Safe and relatively cheap procedure
- Requires general anesthesia
• Medical management fails ~25% of the time.\textsuperscript{5}
• Adenoidectomy fails 40-50% of the time.\textsuperscript{12-13, 21}
• When adenoidectomy fails, what is the next step?
Key Topics – Surgical Options in CRS

Surgical Options in CRS
- Adenoidectomy
- Adenoidectomy with sinus lavage
- FESS with balloon catheters
- Functional Endoscopic Sinus Surgery
A retrospective review of prospectively nonrandomized collected data.

60 children had adenoidectomy for CRS

32 had also sinus wash and culture via the middle meatus

All had post-op oral Abx for 2 weeks

Success = reduction in symptoms at 12 months

- Adenoidectomy only group had 60% success at 12 months follow up

- Adenoidectomy+sinus lavage group had 88% success rate at 12 months follow up

- Children with high CT score (>6) & asthmatics had better success with adenoidectomy + lavage compared to adenoidectomy alone
SN-5

• The SN-5 offers clinicians a simple and reliable tool for evaluating Health-Related Quality of Life (HRQoL) changes in children with persistent sinonasal symptoms.

• This tool has been validated to quantify the impact of medical and surgical interventions on a child's health status. The SN-5 correlates with CTs in children with CRS. \(^1\)
Assess Your Patients

SN-5 at a Glance

- Validated for children 2-12 yrs. of age.
- A quick evaluation completed by the child’s direct caregiver.
- 5 Domains assessed by a single item listing several ways in which sinonasal symptoms might affect each domain. (Table 1)
- A direct measure of global HRQoL is obtained using a 10-point visual analog scale at the bottom of the form.
- The SN-5 score is the average of all 5 domain scores (1-7). Higher scores reflect poorer disease-specific HRQoL. The visual analog scale does not contribute to the SN-5 score.
- Change scores aid in quantifying the impact of medical and surgical interventions. This score is calculated as the difference between scores at the follow-up and initial visits. (Table 2)
- A SN-5 Score > or equal to 3.5 had a sensitivity of 74% and a specificity of 90% for a CT LMK score of 5 or greater (true pediatric sinus disease). The positive predictive value was 95% and the negative predictive value was 56%.

Table 1. Sample question for sinus infection domain

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>None of the time.</td>
</tr>
<tr>
<td>2</td>
<td>Hardly any time at all.</td>
</tr>
<tr>
<td>3</td>
<td>A small part of the time.</td>
</tr>
<tr>
<td>4</td>
<td>Some of the time.</td>
</tr>
<tr>
<td>5</td>
<td>A good part of the time.</td>
</tr>
<tr>
<td>6</td>
<td>Most of the time.</td>
</tr>
<tr>
<td>7</td>
<td>All of the time.</td>
</tr>
</tbody>
</table>

Change scores

 Improvement is coded as positive value, and worsening is coded as a negative value.

<table>
<thead>
<tr>
<th>Change</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trivial improvement</td>
<td>0.55</td>
</tr>
<tr>
<td>Small to Moderate improvement</td>
<td>~1</td>
</tr>
<tr>
<td>Large improvement</td>
<td>~2</td>
</tr>
</tbody>
</table>

SN-5 score well-correlated to CT score in pediatric CRS
Terrell 2009¹

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Correlation Between SN-5 and Computed Tomography in Children with Chronic Rhinosinusitis

Andrew M. Terrell, MD; Hassan H. Ramadan, MD, MSc, FACS

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td># patients</td>
<td>32</td>
</tr>
<tr>
<td>Mean age - years (SD)</td>
<td>6.5 (2.5)</td>
</tr>
<tr>
<td>Male/female</td>
<td>20/12</td>
</tr>
<tr>
<td>Mean CT score</td>
<td>8.1 (4.1)</td>
</tr>
<tr>
<td>Prior adenoidectomy</td>
<td>18 (56%)</td>
</tr>
</tbody>
</table>

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$r_s = 0.67$
$p<0.0001$
Balloon Sinuplasty: a minimally invasive option

<table>
<thead>
<tr>
<th>Study Performed</th>
<th>Ramadan 2008&lt;sup&gt;16&lt;/sup&gt;</th>
<th>Ramadan et al 2010&lt;sup&gt;17&lt;/sup&gt;</th>
<th>Ramadan, Terrell 2010&lt;sup&gt;18&lt;/sup&gt;</th>
<th>Thottam et al 2012&lt;sup&gt;19&lt;/sup&gt;</th>
<th>Ramadan et al 2012&lt;sup&gt;20&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Success</td>
<td>91%</td>
<td>94%*</td>
<td>96%*</td>
<td>Not available</td>
<td>91%*</td>
</tr>
<tr>
<td>Clinical Success</td>
<td>Not available</td>
<td>87%*</td>
<td>80%*</td>
<td>80%</td>
<td>81%*</td>
</tr>
</tbody>
</table>

- “A higher percentage of children were improved at 12 months after operation in the BCS group than in the group that underwent adenoidectomy alone.”<sup>18**</sup>

*Acclarent Balloon Sinuplasty is indicated for the dilation of pediatric maxillary sinuses. These studies also include limited use of products in the frontal and sphenoid sinuses. Maxillary only data used where possible.

Clinical Success indicated as defined by studies

**Patients were not randomized between the Balloon Sinuplasty+Adenoidectomy group and the Adenoidectomy alone groups.
Study design, Patient & Setting:
A nonrandomized, controlled, prospective review of children with failed CRS medical management who underwent BCS or adenoidectomy. Outcomes were assessed at 1 year of follow-up and were based on SN-5 scores and the need for revision surgery.
49 patients / 30 BCS patients in a tertiary care, university affiliated, pediatric institution.

Results/Conclusion:
• 80% BCS+adenoidectomy patients showed improvement of their symptoms after 12 months of follow-up, compared with 52.6% who underwent adenoidectomy. (p=0.04)

• The mean change in SN-5 score in children who underwent BCS+adenoidectomy was from 4.2 to 3.0 (p<0.0001). For the adenoidectomy group, the preoperative SN-5 score of 3.8 improved to 2.9 after operation (p<0.01).

** Patients were not randomized between the Balloon Sinuplasty+Adenoidectomy group and the Adenoidectomy alone groups.
Thottam et al 2012
A comparative outcome analysis in pediatric chronic rhinosinusitis

Study design, Patient & Setting: Two-group, retrospective cohort with blinded chart review comparison. 31 patients (15 Balloon and 16 FESS) in a tertiary care, university affiliated, pediatric institution.

Results/Conclusion:
- Both groups had similar pre-surgical Lund–Mackay CT CRS scores
- BSP and FESS resulted in significant improvement in sinus complaints at an average of 37 weeks post-op.
- Statistically greater number of patients experienced headache improvement after FESS when compared to BSP.
- When compared to FESS, BSP resulted in a statistically significant improvement in sinus congestion and required significantly fewer antibiotics post-operatively for CRS related disease.

“Non-validated outcome measures used.”
Study design, Patient & Setting: Prospective review of children who had surgery for CRS. 26 Children (4 to 12 years) with persistent symptoms after adenoidectomy, despite medical treatment, as documented by the sinonasal 5 (SN-5) score and the Lund-Mackay computed tomography (CT) score, in a tertiary health care system.

Results/Conclusion:

• Postoperative follow-up was 13 (3.0) months.
• Significant change in SN-5 score at 1 yr. was achieved in 21 children (81%)
• Study demonstrates that balloon dilation is effective in children for whom previous adenoidectomy has failed.
Surgical intervention in pediatric CRS
Ramadan 2004 – Retrospective Analysis

Study Design

• Prospective nonrandomized study in a pediatric otolaryngology tertiary service

• 183 patients over a 10 year period.

• Children had either Adenoidectomy, ESS, or ESS/Adenoidectomy

Patient Population

1850 patients evaluated

202 surgical candidates (11%) 18 lost during follow-up (9%)

183 patients analyzed
Success of surgical Intervention

Ramadan 2004 – Retrospective Analysis

Any child who needed another procedure or who had a revision procedure was considered as a failure.
Pediatric FESS

• FESS, either alone or concurrent with adenoidectomy (FESS + A), is more efficacious than adenoidectomy alone.¹³*
  • 87% of FESS + A patients experienced symptom improvement.¹³

• Considering its efficacy, why isn’t FESS + A done more within the pediatric population?

*Study not randomized
Sinus videos
Surgical Technique for Pediatric BSP
Questions an ENT must now ask

• If you could achieve a similar benefit of FESS+Adenoidectomy using a technology that is arguably less invasive than the adenoidectomy you have already decided to do –

• How would parents respond to BSP+Adenoidectomy as an option, given it’s minimally invasive?
QUESTIONS?
References

3. Benninger, M. Adult chronic rhinosinusitis: Definitions, diagnosis, epidemiology, and pathophysiology. Otolaryngol Head Neck Surg 2003;129S:S1-S32. Figure 2; approximately 5 million visits are for patients ages 0-19, out of a total number of office visits of approximately 17 million.
8. Clarithromycin (Biaxin / Biaxin XL) prescribing information: http://www.rxabbott.com/pdf/biapi.pdf, p. 14. Side Effects: Abnormal taste (3%); diarrhea (3%); headache (2%); nausea (3%); dyspepsia (2%); abdominal pain (2%) for Biaxin. For Biaxin XL: Diarrhea (6%), abnormal taste (7%), nausea (3%). Contraindicated with certain anti-arrhythmics.
9. Amoxicillin-Clavulanate prescribing information (Augmentin): http://us.gsk.com/products/assets/us_augmentin.pdf. Side Effects: Diarrhea (9%); nausea (3%); rash (3%), vomiting (1%), vaginitis (1%).
References


13. Ramadan, HH. Sinus Balloon Catheter Dilation After Adenoidectomy Failure for Children With Chronic Rhinosinusitis, ARCH OTOLARYNGOL HEAD NECK SURG/VOL 2012; 138, 635-637


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