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The Diagnosis and Treatment of Recurrent and Chronic Sinusitis in Children

*Rodney P. Lusk, MD, FAAP,**
Rande H. Lazar, MD, †
and Harlan R. Muntz, MD, FAAP‡

Pediatricians, family practitioners, pediatric allergists, and otolaryngologists are increasingly aware of recurrent and chronic sinusitis in children. Its incidence and natural history are not known and there is no general agreement on what symptom complex is actually indicative of sinusitis. The disease process is dynamic, probably multifactorial, and expressed with varying symptoms. It is now thought that most infections of the sinuses are rhinogenic in origin.[1, 2]

The importance of the drainage sites of the sinuses is being recognized again.[1–3] The frontal, anterior ethmoid, and maxillary sinuses drain into an area known as the *osteomeatal complex* (Fig. 1). This is a system of narrow channels in the anterior part of the nose that drain all the sinuses except the posterior ethmoid and sphenoid sinuses. Infection or allergic inflammation may cause obstruction of the natural ostium of the ethmoid infundibulum or sinuses. Messerklinger[3] noted that whenever two ciliated mucosal surfaces come into contact, there is localized disruption of mucociliary clearance with retention of secretions in the area of contact. Mucus is constantly produced in the sinuses and cleared by cilia through the natural ostia. When there is significant edema and inflammation of the nose there probably is inhibition of mucus clearance. The route of the secretions to the natural ostia is not necessarily the most direct. The frontal sinus is known to have significant reentry of secretions from the area of the frontal recess.[3] The cilia in the maxillary sinus may even beat in a circle and result

*Assistant Professor, Washington University School of Medicine, and Director, Division of Pediatric Otolaryngology, St. Louis Children's Hospital, St. Louis, Missouri
†Chief of Surgery, Le Bonheur Children's Medical Center, Memphis, Tennessee
‡Assistant Professor, Washington University School of Medicine, and St. Louis Children's Hospital, St. Louis, Missouri

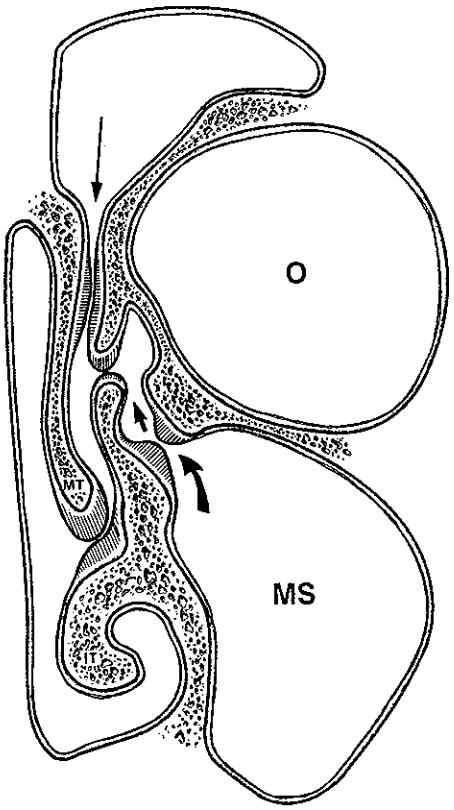

Figure 1. Coronal section through the osteomeatal complex. The shaded area depicts site of potential narrowing and obstruction. The short arrow indicates the area of the infundibulum, MT is on the middle turbinate, and IT is on the inferior turbinate. (The long narrow arrow depicts the drainage route of the frontal sinus, the larger curved arrow depicts the drainage route of the maxillary sinus, O indicates the orbit, and MS the maxillary sinus.)

in pooling of secretions. This stasis or pooling of secretions may cause secondary bacterial infections within the sinuses. Several factors can influence ciliary function. In ciliary dyskinesia or Kartagener's syndrome ciliary motility is markedly impaired and these patients have a high incidence of chronic sinusitis.[4-6] Purulent rhinorrhea and chronic sinusitis are associated with a higher incidence of abnormal cilia[7] that beat slower and clear mucus less efficiently[8, 9] so that clearance is inhibited and there is a much higher chance of developing recurrent and chronic infections.

DIAGNOSIS

Children are frequently unable to express the important and most characteristic symptoms found in sinusitis. Rachelefsky[10] has summarized the signs and symptoms of sinusitis in children. In the young child purulent rhinorrhea and postnasal drip with a sore throat are frequently seen in bacterial sinusitis. There is frequently a low-grade fever and younger children do not complain of headaches but can be very irritable. Cough, especially at night, is a frequently noted complaint.[11] Older children may

complain of nasal obstruction, lack of smell, and a metallic taste. Headaches and facial pain are noted primarily in older children and are worse in the mornings. Signs include boggy erythematous nasal mucosa, yellowish or greenish purulent rhinorrhea of varying viscosity, purulent oropharyngeal drainage primarily in the lateral pharyngeal gutters, and rarely edema over the cheeks. Approximately 50 per cent of children with sinusitis also have otitis media.[10]

The allergic child has a high incidence of sinus disease.[12] Of 70 patients referred for chronic allergic rhinitis and asthma, 53 per cent had abnormal sinus radiographs and 27 per cent had near total opacification of the maxillary sinuses.[10] The more severe symptoms tend to occur in the younger child.

The pediatric literature on sinusitis has focused primarily on the maxillary sinus.[10, 13-23] This is due in part to its easy and consistent interpretation on plain films and to its ready accessibility for culture through a maxillary tap. The disease is rarely isolated to the maxillary sinus, however, and the anterior ethmoid sinuses are involved more frequently. It is important to realize that clearance of the maxillary sinus on radiographs does not ensure clearance of the ethmoid sinuses and indeed persistent ethmoid disease may account for recurrent sinusitis.

At St. Louis Children's Hospital we have thought for some time that the plain paranasal sinus films do not adequately document the extent of disease in the ethmoid sinuses and that coronal CT scans are more accurate. We therefore prospectively studied 70 children who had symptoms compatible with chronic sinusitis and compared plain films to coronal CT scans.[24] The two radiographs were obtained within a few hours of one another. The plain radiographs and CT scans were interpreted independently by pediatric radiologists and neuroradiologists. The results of their interpretations were compared and the discrepancies noted.

The CT scans showed some abnormality in 82 per cent of the patients. When all of the sinuses were considered together there was a lack of correlation between the two radiographs in 74 per cent of the patients (Fig. 2). Forty-five per cent of the normal plain radiographs showed abnormalities on CT scans and thirty-four per cent of the abnormal plain radiographs were actually normal. When the sinuses were examined separately, 67 per cent of the patients or 59 per cent of the ethmoid sinuses were abnormal on CT scans, with discrepancies in 29 per cent of the interpretations. The maxillary sinuses were abnormal in 64 per cent of the patients and in 59 per cent of the individual maxillary sinuses, with discrepancies in 23 per cent of the interpretations. If the sphenoid and frontal sinuses were considered together, 31 per cent were diseased, with 26 per cent of discrepancies in the interpretations. The frontal sinuses were partially developed in half of the patients with discrepancies in 16 per cent of the interpretations.

We therefore have found that the plain films both over- and underestimated the amount of sinus disease present. This does not negate the use of plain films in acute disease. We found good correlation between total opacification and air–fluid levels in the maxillary sinuses. The ethmoid sinuses most frequently are involved and most frequently are misinterpreted

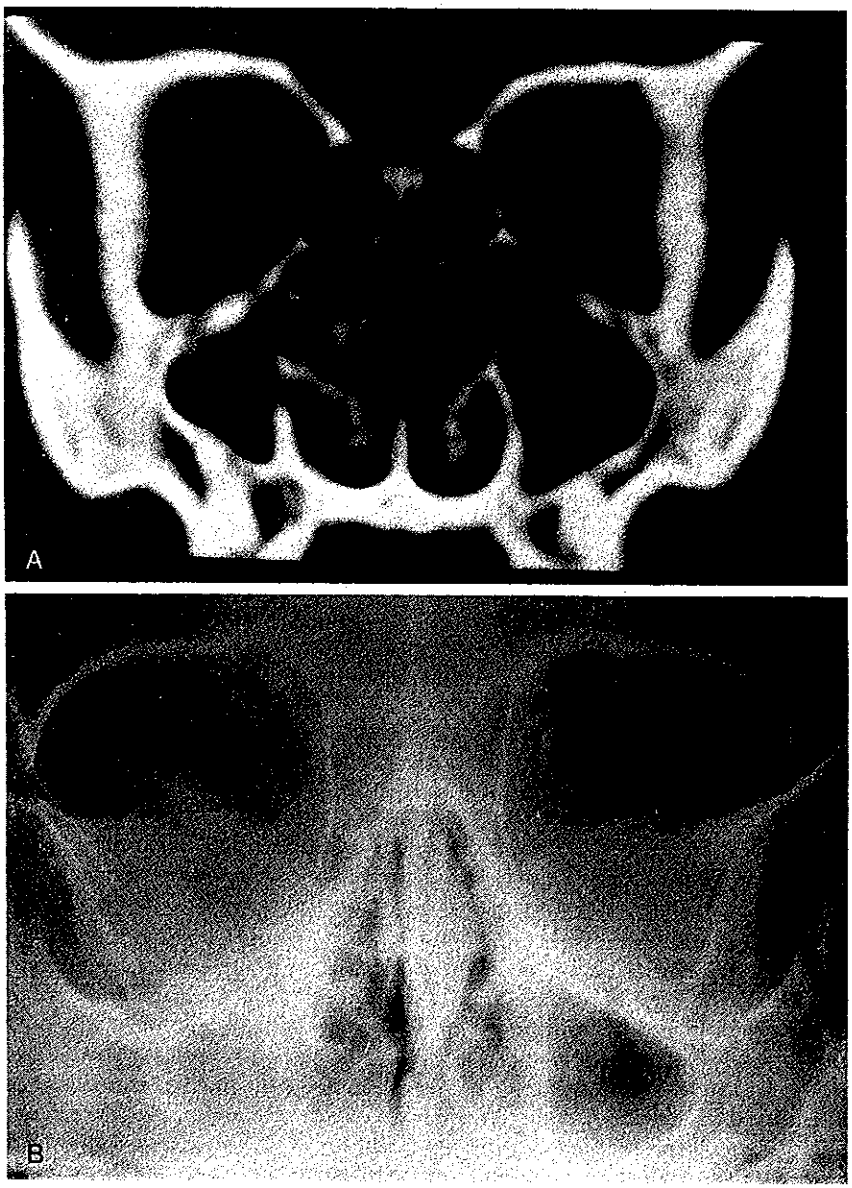

Figure 2. Comparison of plain film and CT scan of the same patient taken on the same day. *A*, Plain Waters radiograph showing what appears to be near total opacification of the ethmoid and right maxillary sinuses, and *B*, the coronal CT scan showing relatively minor disease around the osteomeatal complex.

in chronic sinusitis. The Caldwell view does not sufficiently localize ethmoid disease. Lateral films were of little use in children younger than 4 years as they frequently over-read sphenoid sinus opacification. From this data it can be seen that the ethmoid sinuses are as frequently involved in sinusitis as the maxillary sinuses and often are misinterpreted on plain films.

PATHOGENS

Most etiologic studies of sinusitis have been performed in adults. In general nasal cultures have limited value in diagnosing the bacterial cause of the infection.[25, 26] Wald[22] found that *Streptococcus pneumoniae, Hemophilus influenzae,* and *Branhamella catarrhalis* were the most common organisms recovered in acute maxillary sinusitis. There are limited data available on the pathogens found in chronic sinusitis in children. Brook[21] analyzed the aspirates from 40 children who were believed to have chronic sinusitis, with 15 maxillary, 13 ethmoid, and 7 frontal sinuses cultured. It should be emphasized again that all of these sinuses drain into the osteomeatal complex as previously described. A total of 97 anaerobic and 24 aerobic isolates were recovered. Anaerobic organisms were found in all culture-positive specimens and 38 per cent had mixed aerobic cultures. The predominant anaerobic organisms were Bacteroides species and Fusobacterium species. The predominant aerobic organisms were alpha-hemolytic, streptococci, *Staphylococcus aureus,* and *H. influenzae.* All the anaerobes cultured were susceptible to penicillin. The role of viruses as pathogens has not been studied adequately.

PHYSICAL EXAMINATION

Unfortunately, the physical examination is not very revealing of the status of inflammation in the sinuses. The only portion of the organ system available for examination is the nose and effective examination in the pediatric population is difficult. Anterior rhinoscopy is of some use and the least threatening examination to the child. An otoscope provides adequate illumination and magnification for examination of the anterior portion of the nose. After the initial examination of the nose it is useful to shrink the nasal mucosa with 0.25 per cent Neo-Synephrine. The nose can then be examined for evidence of purulence. The inferior turbinate will readily be identified and the middle turbinate will be seen posteriorly and superiorly. Anterior septal deviations also can be easily noted. Usually this is all that can be evaluated with anterior rhinoscopy.

Flexible and rigid endoscopy can provide a more complete evaluation in the cooperative child. Flexible endoscopy allows good visualization of the nasopharynx and posterior nose. It is less likely to traumatize the nose if the child moves and children tolerate examination fairly easily. The rigid scope provides superior visualization, but it can be used in only the

most tolerant child with a well-anesthetized nose. The cost of these scopes is a major disadvantage.

TREATMENT

As indicated earlier, sinusitis is a dynamic disease with fluctuation in the severity of signs and symptoms of the disease. The most appropriate initial treatment of acute or chronic sinusitis is with appropriate antibiotics and topical or systemic decongestion of the nose. The use of topical or oral decongestants, antihistamines, topical steroids, and cromolyn sodium in the treatment of acute and chronic sinusitis has not been adequately evaluated.[10, 11] Topical decongestants should not be used for more than 3 to 5 days because of potential rebound. Oral decongestants can cause thickening of the secretions and the effect of this on mucus clearing from the sinuses is not known. From the available data it would appear that the appropriate treatment of acute sinusitis would be with amoxicillin (40 mg per kg per day) for 14 days.[21, 22, 27, 28] Scheld et al.[29] compared the use of cyclacillin to amoxicillin and found no difference in efficacy. Their study evaluated the concentrations of antibiotic in the serum and in the secretions of the sinus aspirates after 10 days of therapy. The serum concentrations for both drugs were between 2.5 and 2.7 mg per ml but no antibiotic was detected in the sinus aspirate. This raises the very real question of how effectively antibiotics treat bacteria within the lumen of the sinuses. The initial cure rate of acute sinusitis ranges from 81 per cent[18] to 67 per cent[16] with amoxicillin and an 83.7 per cent cure rate has been reported with penicillin V.[30] With the increasing prevalence of beta-lactamase positive and amoxicillin-resistant strains of bacteria, backup drugs such as amoxicillin-clavulanate potassium (40 mg per kg per day), cefaclor (40 mg per kg per day) or chloramphenicol (50–100 mg per kg per day, q6hr) should be considered. The role of ciprofloxacin in sinusitis has yet to be defined. Adequate controlled studies with all of these antibiotics in beta-lactamase–positive infections have not been performed. The effectiveness of chronic or prophylactic antibiotics has not been evaluated in the treatment of chronic or recurrent sinusitis.

For those who fail the acute trial of medical therapy, another 10-day course of antibiotics to cover beta-lactamase–producing bacteria would seem appropriate. Many would recommend a 3 to 4 week course of antibiotics if this regimen failed.[11, 31] It also would be appropriate to consider the use of topical steroids such as flunisolide and beclomethasone. Therapy from this point has to be individualized. If the symptoms persist in spite of medical therapy, documentation of the extent of disease with a coronal CT scan is appropriate. A CT scan should be obtained only if the symptoms are severe enough to warrant surgical intervention and usually after evaluation by an otolaryngologist. Many of these children will require sedation for their scans and therefore are exposed to some risk of complications. The CT scan should be obtained after a 4- to 6-week course of an antibiotic that will cover the beta-lactamase–producing bacteria. The rationale for delaying the scan is that one wants to document residual disease.

Although studies evaluating the findings on coronal CT scans in acute sinusitis have not been done, one would expect to find a high incidence of sinus opacification that would rapidly resolve with adequate treatment.

Tonsillectomy, adenoidectomy, antral lavage, nasal–antral windows, and endoscopic ethmoidectomy have been proposed as appropriate surgical modalities for the treatment of chronic sinusitis in patients who fail medical management. It is probable that all these procedures have a place but the appropriate indications for each have not been adequately investigated. The CT scan now gives us a mechanism for accurately defining and staging the extent of the disease. Previous studies have not staged or accurately documented the disease and most are retrospective evaluations without adequate controls.

Adenoid and tonsillar hypertrophy have been associated with sinusitis in children.[32–34] The effectiveness of tonsillectomy or adenoidectomy in the treatment of sinusitis is not well documented with controlled studies. It would appear that near-total nasal obstruction by an adenoid pad would result in stasis of nasal and sinus secretions and thereby predispose the patient to recurrent or chronic sinusitis. An adenoidectomy and possibly a tonsillectomy in these patients would seem appropriate. In patients with recurrent sinusitis but without nasal obstruction, as documented by rigid or flexible endoscopy, the role of adenoidectomy is not known.

Antral lavage has been considered standard treatment for chronic maxillary sinusitis for some time. It also has been the "gold standard" for measuring the accuracy of noninvasive methods of diagnosing maxillary sinusitis.[15, 35, 36] The procedure is performed by placing a trocar under the inferior turbinate or through the anterior wall of the maxillary sinus.[37] The procedure is not risk free; trauma to the tooth buds and orbit are possible complications. It has been found to be successful by some investigators[38, 39] and not statistically significant by others.[15, 40, 41] The rationale for its use is to aspirate or irrigate the bulk of the infected material from the maxillary sinus. The preponderance of the evidence seems to indicate that antral lavage offers no significant advantage over antibiotics alone.

Another frequently performed procedure, nasal–antral window or antrostomy, is an extension of the antral lavage concept. This procedure attempts not only to clear the sinus but to aerate it as well. The importance of aerating the sinus is not known and it should be remembered that this procedure addresses only the maxillary sinus and not the ethmoid sinuses. Although the procedure is frequently performed there is a real paucity of supportive literature. There are no good prospective studies comparing the nasal–antral window and antibiotic therapy.

At St. Louis Children's Hospital we performed a retrospective study of 39 patients who had a total of 46 nasal–antral windows.[42] The mean age of the children was 6.3 years, and all patients had symptoms for longer than 3 months. All patients had failed medical management. Of the 39 patients, 9 had allergies, 9 had immune deficiencies, and 7 had asthma. The nasal–antral windows were performed using a rasp under general anesthesia. At the 1 month follow-up symptoms had improved in 40 per cent and at 6 months some had regressed and only 27 per cent showed improvement. Further surgery was done in 46 per cent of the patients.

Eighteen per cent had a second nasal–antral window and all remained symptomatic but declined further surgery. Twenty-eight per cent had endoscopic surgery. In general the older the child the better the results. In none of the children less than 4 years old and only one of 23 children less than 5 years old was the procedure successful at 6 months. The only patients who appeared to improve were five of the seven children who had asthma.

When one considers the ciliary function within the maxillary sinus, there is reason to expect failure. The cilia continue to move all the secretions toward the natural ostia even if there is a patent inferior meatal window. Patients with ciliary dyskinesia may benefit from nasal–antral windows because gravity can play a more important role in function. It is also possible that infected sinuses have an acquired ciliary dysfunction and nasal–antral windows could significantly improve the resolution of the sinusitis.

There is now good evidence that obstruction in the osteomeatal complex is a major factor in chronic sinusitis. As already discussed the CT scan allows more precise identification and localization of the sinus disease. Telescopes allow good visualization for diagnostic and surgical intervention. The logical next step is to attempt to remove the sites of obstruction in the osteomeatal complex. These three complementary developments are known as functional endoscopic sinus surgery[1, 2, 43] and have led to growing popularity of removing only sites of disease.

With the growing recognition of the disease in children there is a natural trend towards using this technology. For several reasons this surgery is more challenging and dangerous in children. The anatomic space in which the surgeon must work is usually not much larger than a 4-mm telescope. The orbit and the anterior fossa are in close approximation and these structures have been the site of significant complications.[44] Damage to the orbital muscles, blindness, and meningitis are possible surgical complications. The anatomy is variable and experience is crucial in making the judgments that prevent these complications. The single most important factor is good visualization and hemostasis. An appropriately conservative approach must be used and tissue must be removed only under direct visualization. The surgeon cannot be so conservative that the disease is not removed, however.

Experience has been gained at several centers around the country and endoscopic surgery appears to be a safe procedure in competent hands. Gross et al.[45] reported their experience in 57 patients. Lusk and Muntz[46] have reported their experience in 31 patients with a 1-year followup. There were no complications reported in these two series.

The results in these two pilot studies have been encouraging. The followup in the study by Gross et al.[45] ranged from 3 to 13 months. Even though the followup was short, they report initially encouraging results. In the pilot study by Lusk and Muntz 168 patients were evaluated for chronic sinusitis. A total of 31 patients (18 per cent) were found to have symptoms and disease on coronal CT scan severe enough to warrant surgical intervention. The average age of the patients was 6.6 years. Twenty-six per cent of the patients had asthma and 23 per cent had various immune deficiencies.

Adenoidectomy had been performed in 35 per cent, tonsillectomy in 25 per cent, lavage in 35 per cent, and nasal–antral windows in 48 per cent of the 31 patients in this study. All patients had failed prolonged medical management. The mean duration of symptoms was 26 months. Seven of the patients underwent revision procedures. Five of these seven patients had documented immune deficiencies, another was suspected of having a deficiency, and a third had cystic fibrosis. When the parents were asked to rate the success of the surgery after one year on a 10-point scale, 10 being the highest, 71 per cent were rated in the 8- to 10-range and were considered successful by the parents. Twenty three per cent were in the 5- to 7-range and six per cent 4 or less. There was also marked improvement but not resolution of purulent rhinorrhea, low-grade fevers, cough, and headaches.

CONCLUSION

The use of endoscopic techniques to treat sinusitis is in its infancy. Indications have not been defined, and potentially major complications can arise. Experience is required for the surgeon to be appropriately aggressive in eradicating the disease while staying within the boundaries of the sinus. Prospective studies comparing this technique to prophylactic antibiotics, adenoidectomy, antral lavage, and nasal–antral windows are required to establish appropriate indications and efficacy.

REFERENCES

1. Kennedy DW, Zinreich SJ, Shaalan H, et al: Endoscopic middle meatal antrostomy: Theory, technique, and patency. Laryngoscope 97: 1987
2. Stammberger H: Endoscopic endonasal surgery—concepts in treatment of recurring rhinosinusitis. Part II. Surgical technique. Otolaryngol Head Neck Surg 94:147–156, 1986
3. Messerklinger W: On the drainage of the normal frontal sinus of man. Acta Otolaryngol (Stockh) 63:178–181, 1967
4. Eavey RD, Nadol JB Jr, Holmes LB, et al: Kartagener's syndrome: A blinded, controlled study of cilia ultrastructure. Arch Otolaryngol Head Neck Surg 112:646–650, 1986
5. Karja J, Nuutinen J: Immotile cilia syndrome in children. Int J Pediatr Otorhinolaryngol 5:275–279, 1983
6. Mygind N, Pedersen M, Nielsen MH: Primary and secondary ciliary dyskinesia. Acta Otolaryngol (Stockh) 95:688–694, 1983
7. Fontolliet C, Terrier G: Abnormalities of cilia and chronic sinusitis. Rhinology 25:57–62, 1987
8. Wilson R, Sykes DA, Currie D, et al: Beat frequency of cilia from sites of purulent infection. Thorax 41:453–458, 1986
9. Afzelius BA, Gargani G, Romano C: Abnormal length of cilia as a possible cause of defective mucociliary clearance. Eur J Respir Dis 66:173–180, 1985
10. Rachelefsky GS: Sinusitis in children—diagnosis and management. Clin Rev Allergy 2:397–408, 1984
11. Shapiro GG: Sinusitis in children. J Allergy Clin Immunol 81:1025–1027, 1988
12. Rachelefsky GS, Goldberg M, Katz RM, et al: Sinus disease in children with respiratory allergy. J Allergy Clin Immunol 61:310–314, 1978

13. Otten FW, Grote JJ: Treatment of chronic maxillary sinusitis in children. Int J Pediatr Otorhinolaryngol 15:269–278, 1988
14. Rachelefsky GS, Katz RM, Siegel SC: Chronic sinusitis in the allergic child. Pediatr Clin North Am 35:1091–1101, 1988
15. Maes JJ, Clement PA: The usefulness of irrigation of the maxillary sinus in children with maxillary sinusitis on the basis of the Water's X-ray. Rhinology 25:259–264, 1987
16. Wald ER, Chiponis D, Ledesma-Medina J: Comparative effectiveness of amoxicillin and amoxicillin-clavulanate potassium in acute paranasal sinus infections in children: A double-blind, placebo-controlled trial. Pediatrics 77:795–800, 1986
17. Kovatch AL, Wald ER, Ledesma-Medina J, et al: Maxillary sinus radiographs in children with nonrespiratory complaints. Pediatrics 73:306–308, 1984
18. Wald ER, Reilly JS, Casselbrant M, et al: Treatment of acute maxillary sinusitis in childhood: A comparative study of amoxicillin and cefaclor. J Pediatr 104:297–302, 1984
19. Shapiro ED, Milmoe GJ, Wald ER, et al: Bacteriology of the maxillary sinuses in patients with cystic fibrosis. J Infect Dis 146:589–593, 1982
20. Rachelefsky GS, Katz RM, Siegel SC: Chronic sinusitis in children with respiratory allergy: The role of antimicrobials. J Allergy Clin Immunol 69:382–387, 1982
21. Brook I: Bacteriologic features of chronic sinusitis in children. JAMA 246:967–969, 1981
22. Wald ER, Milmoe GJ, Bowen A, et al: Acute maxillary sinusitis in children. N Engl J Med 304:749–754, 1981
23. Herz G, Gfeller J: Sinusitis in paediatrics. Chemotherapy 23:50–57, 1977
24. Lusk RP, Muntz HR, McAlister WH: Comparison of paranasal sinus radiographs and coronal CT scans in children. Unpublished data, 1989
25. Kessler L: Bacterienflora der Nasenhaupt und nassene Benhohlen bei chronischen Sinvitiden und ihre Bezienhung zvenander. Hals-Nos-Ohrenartz 16:36, 1968
26. Axelsson A, Grebelius N, Chidekel N: The correlation between the radiological examination and the irrigation findings in maxillary sinusitis. Acta Otolaryngol (Stockh) 69:302–306, 1970
27. Evans FO Jr, Sydnor JB, Moore WE, et al: Sinusitis of the maxillary antrum. N Engl J Med 293:735–739, 1975
28. Frederick J, Braude AI: Anaerobic infection of the paranasal sinuses. N Engl J Med 290:135–137, 1974
29. Scheld WM, Sydnor A Jr, Farr B, et al: Comparison of cyclacillin and amoxicillin for therapy for acute maxillary sinusitis. Antimicrob Agents Chemother 30:350–353, 1986
30. Helin I, Andreasson L, Jannert M, et al: Acute sinusitis in children—results of different therapeutic regimens. Helv Paediatr Acta 37:83–88, 1982
31. Shapiro GG: The role of nasal airway obstruction in sinus disease and facial development. J Allergy Clin Immunol 82:935–940, 1988
32. Paul D: Sinus infection and adenotonsillitis in pediatric patients. Laryngoscope 91:997–1000, 1981
33. Noyek AM, Holgate RC, Wortzman G, et al: Sophisticated radiology in otolaryngology. II. Diagnostic imaging: Non-roentgenographic (non x-ray) modalities (ultrasound, nuclear medicine, thermography). J Otolaryngol (Suppl) 3:95–117, 1977
34. D'Arcy F: Chronic sinusitis in children. Ir Med J 67:456–458, 1974
35. Kay NJ, Setia RN, Stone J: Relevance of conventional radiography in indicating maxillary antral lavage. Ann Otol Rhinol Laryngol 93:37–38, 1984
36. Watt-Boolsen S, Karle A: The clinical use of radiological examination of the maxillary sinuses. Clin Otolaryngol 2:41–43, 1977
37. Ritter FN: A clinical and anatomical study of the various techniques of irrigation of the maxillary sinus. Laryngoscope 87:215–223, 1977
38. Revonta M, Suonpaa J: Diagnosis and follow-up of ultrasonographical sinus changes in children. Int J Pediatr Otorhinolaryngol 4:301–308, 1982
39. Grote JJ, Kuijpers W: Middle ear effusion and sinusitis. J Laryngol Otol 94:177–183, 1980
40. Revonta M, Suonpaa J, Meurman OH: [Ultrasound testing in the diagnosis and management of maxillary sinusitis in children (author's transl)] [Original] Die Verlaufskontrolle des Heilungsprozesses der kindlichen Kieferhohlenentzundung mit der Ultraschalldiagnostik. HNO 28:91–96, 1980
41. Pothman R, Yeh HL: The effects of treatment with antibiotics, laser and acupuncture upon chronic maxillary sinusitis in children. Am J Clin Med 10:55–58, 1982

42. Muntz HR, Lusk RP: A retrospective study of nasal-antral windows. Unpublished data, 1989
43. Stammberger H: Personal endoscopic operative technic for the lateral nasal wall—an endoscopic surgery concept in the treatment of inflammatory diseases of the paranasal sinuses. Laryngol Rhinol Otol (Stuttg) 64:559–566, 1985
44. Stankiewicz JA: Complications of endoscopic intranasal ethmoidectomy. Laryngoscope 97:1270–1273, 1987
45. Gross CW, Gurucharri MJ, Lazar RH, et al: Functional endonasal sinus surgery (FESS) in the pediatric age group. Laryngoscope 99:272–275, 1989
46. Lusk RP, Muntz HR: Endoscopic sinus surgery in children with chronic sinusitis—a pilot study. Unpublished data, 1989

Division of Pediatric Otolaryngology
St. Louis Children's Hospital
St, Louis, MO