
Radiologic outcomes in children with chronic rhinosinusitis and ostiomeatal complex obstruction after medical management

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Background: The presence of ostiomeatal complex obstruction can be a key component in chronic rhinosinusitis, and the medical management of this condition has not been well studied, particularly in children.

Objective: To compare the effectiveness of antibiotics, intranasal topical corticosteroids, and oral systemic corticosteroids on radiologic outcomes in children with chronic rhinosinusitis and ostiomeatal complex obstruction.

Methods: We reviewed the reports of 1,741 computed tomography scans performed on children at Alfred I. duPont Hospital for Children, Wilmington, Delaware, from October 1, 2001, through February 28, 2007, identifying those patients who had 2 scans performed at least 2 weeks apart but no more than 6 months apart. Forty-five instances involving abnormal ostiomeatal complex anatomy documented on the initial study with obtainable treatment information were selected for further review.

Results: Of the 3 treatment modalities examined, only oral systemic corticosteroids ($P = .03$) and intranasal topical corticosteroids ($P = .03$) were found to provide significant independent contributions to predicting treatment outcome, with the former promoting a positive outcome and the latter predicting a negative outcome. The model that contained just these 2 factors also provided a significant fit to the outcome data ($P = .01$), producing a diminished rate of improvement expected from a combination of positive and negative influences. Neither antibiotics nor any other combination of modalities contributed to a significant improvement in model fit.

Conclusion: The use of oral systemic corticosteroids was found to be the only beneficial intervention, with regard to radiologic improvement, in the treatment of ostiomeatal complex obstruction in children.

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INTRODUCTION

Chronic rhinosinusitis (CRS) is one of the most common presenting complaints of patients seeking treatment at an allergist's office, comprising 20% of all visits.¹ It is estimated that CRS occurs in 14% of Americans younger than 45 years² and constitutes a significant health care expense, totaling almost \$6 billion in 1996.³ Approximately one-third of this amount was spent on children younger than 12 years.³ CRS has been previously defined as an episode of paranasal sinus inflammation that lasts longer than 90 days,⁴ although the 2005 American College of Allergy, Asthma and Immunology/American Academy of Allergy, Asthma and Immunology Practice Parameter update on sinusitis considered an 8-week duration of symptoms sufficient for diagnosis of CRS.⁵ The

most common symptoms in this condition are rhinorrhea, nasal congestion, and cough, whereas other symptoms include sore throat, halitosis, hyposmia, intermittent fever, general malaise, poor appetite, and sleep disturbance.

CRS is often multifactorial in origin, and causal factors may include infection, allergy, environmental irritants, gastroesophageal reflux, cystic fibrosis, abnormal ciliary function, and immunodeficiency. Anatomical abnormalities may contribute to CRS symptoms. An increasingly significant nasopharyngeal structure is the ostiomeatal complex (OMC), an area located between the middle and inferior turbinates that comprises the common outflow tract of the frontal, maxillary, and anterior ethmoid sinuses. Obstruction of the OMC, identified on sinus computed tomography (CT), is thought to be a major contributing cause of CRS, and sinus CT scans are indicated for those patients with CRS symptoms not responsive to medical management.^{4,6,7}

Medical management of CRS typically involves multiple treatment modalities. The Sinusitis Practice Parameter Update Committee summarized the best available evidence regarding the most common treatments for CRS, including antibiotics, antihistamines, decongestants, and corticosteroids.⁵ The use of antibiotics for bacterial sinusitis received the committee's strongest recommendation, whereas antihistamines were believed to be useful in cases that involve environmental allergies. Intranasal topical corticosteroids, de-

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congestants, saline nasal rinses, mucolytic agents, and expectorants were considered adjunctive therapies, and aspirin desensitization and intravenous immunoglobulin were indicated for specialized cases that involve aspirin-associated respiratory disease and specific forms of immunodeficiency, respectively.

Surgical intervention is commonly considered in the adult population after medical management fails, and the Practice Parameter Update Committee determined that functional endoscopic sinus surgery might be particularly helpful in cases that involve OMC obstruction. Despite the 2 large pediatric retrospective studies that found treatment outcomes to be better after functional endoscopic sinus surgery than combination medical therapy,^{8,9} sinus surgery is not commonly performed in children. Even Chan et al⁸ acknowledged that although surgical intervention was the most effective option, its cost and invasiveness did not necessarily make it the most desirable one. Our study compares the effectiveness of antibiotics, intranasal topical corticosteroids (NCSs), and oral systemic corticosteroids (OCSs) on radiologic outcomes in children with CRS and OMC obstruction.

METHODS

The reports of 1,741 sinus CT scans performed on children up to the age of 21 years at Alfred I. duPont Hospital for Children, Wilmington, Delaware, from October 1, 2001, through February 28, 2007, were reviewed. The cutoff age was 21 years because that was the upper range of children cared for at our institute. Those patients who had at least 2 scans performed at least 2 weeks apart but no more than 6 months apart were identified. Those who had abnormal OMC anatomy of sufficient magnitude (Fig 1) documented on the initial study and obtainable treatment information were selected. Use of OCSs was defined as any dose regimen of an OCS that consisted of 5 or more days; there were no standardized amounts, and dosing regimens varied greatly from 5-day pulse-dosing to alternate-day regimens that lasted weeks in the case of several patients with concurrent oncologic issues. Similarly, the use of NCSs was defined as any regular use of an NCS, whereas the use of antibiotics was defined as a course of antibiotics of any length. Each sinus CT report reviewed in this study was assigned a score based on the radiologist's evaluation of the OMC anatomy, using the following point system. For each side (left and right), a fully patent OMC equaled 0 points, a partially obstructed OMC equaled 1 point, and a fully obstructed OMC equaled 2 points. Thus, a score of 0 to 4 points was possible for each study. This scoring system was developed since Lund-Mackay staging,¹⁰ currently the most widely accepted gauge of sinus inflammation, does not address the patency of the OMC structure. An improvement in OMC anatomy was defined as a 2-point or greater decrease in score, and therefore treatment opportunities in which the score of the initial sinus CT study equaled 1 point were eliminated. Also eliminated were 3 patients in whom endoscopic sinus surgery was performed before the second sinus CT scan.

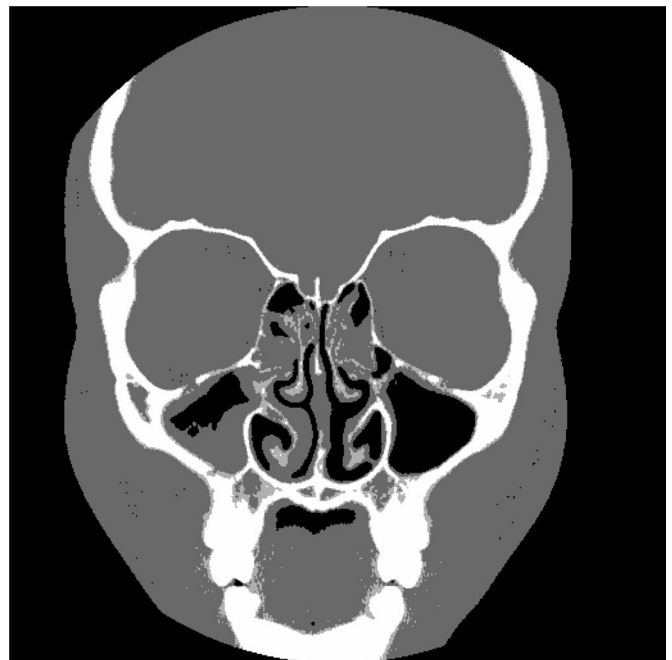


Figure 1. Abnormal sinus computed tomographic scan showing pronounced mucosal thickening with complete ostiomeatal complex obstruction bilaterally.

In accordance with accepted standards for research involving human subjects, approval for this study was granted by our institutional review board. To determine if treatment outcomes were significantly associated with any of the 3 treatment modalities, either singly or in combination, a series of logistic regression models were fitted to the data. These analyses used treatment outcome (improved vs not improved) as the dependent class variable and treatment modalities (OCSs, NCSs, antibiotics, and their 2- and 3-way interactions) as possible independent variables. To account for multiple cases associated with some individuals, case weights inversely proportional to the number of times an individual was treated were applied. Data were analyzed by the Nemours Biomedical Research Department's Bioinformatics Core Facility using the R statistical programming environment (<http://www.R-project.org>).

RESULTS

During the study period, there were 45 treatment opportunities for 35 patients who had CT scans performed 2 weeks to 6 months apart along with obtainable information regarding OMC disease. The characteristics of these treatment opportunities are given in Table 1. Ten cases involved multiple CT evaluations of the same child, including 1 patient who was treated 6 times (during a period of 3 years), 1 patient who was treated 3 times (during a period of approximately 1 year), and 3 patients who were each treated twice (within a period of 4 to 6 months). In each of these 10 cases, treatment modalities varied from one treatment opportunity to another. The aver-

Table 1. Group Characteristics

Characteristics	Finding
No. of treatment opportunities	45
Sex, No.	
Male	25
Female	20
Age, mean (range), y	9.6 (1–20)
Interval between sinus CT scans, mean (range), mo	2.75 (0.75–6)

Abbreviation: CT, computed tomography.

age time between initial and follow-up sinus CT studies was 2.75 months. As indicated in Table 2, antibiotics were the most commonly used therapeutic modality (84%), followed by NCSs (56%) and OCSs (44%). Sixty-two percent of patients were treated with 2 or more modalities. Only 2 treatment modalities (NCSs and OCSs) were found to provide significant independent contributions to predicting outcome. The model that contained just these 2 factors provided a significant fit to the outcome data ($R^2 = 0.245$, $P = .01$) as did each factor (OCSs: Wald $z = 2.22$, $P = .03$; NCSs: Wald $z = -2.15$, $P = .03$). Neither antibiotics nor any other combination of factors contributed to a significant improvement in the model fit.

As suggested by the signs of the Wald statistics for OCSs and NCSs, the former was associated with a significant increase in the likelihood of improvement, whereas the latter was associated with significantly decreased likelihood of improving. As indicated in Table 3, listed are the number of treatment opportunities that use each specific modality or combination and whether there was improvement in the OMC on CT. One hundred percent of the cases (8 of 8) improved when OCSs but not NCSs were administered. Only 31% of the cases (4 of 13) improved when NCSs were administered without OCSs. Improvement was seen in 67% of the cases (8 of 12) when neither OCSs nor NCSs were administered. When both OCSs and NCSs were administered, 67% of the cases (8 of 12) improved.

DISCUSSION

Summarizing the results of these analyses, OCSs significantly increased the likelihood of observing improvement,

Table 2. Comparison of Therapeutic Choices for Treatment of Chronic Rhinosinusitis and Ostial Complex Disease

Therapeutic modality	No. (%) of opportunities using the modality (N = 45)
Oral corticosteroids	20 (44)
Just oral corticosteroids	2 (4)
Nasal corticosteroids	25 (56)
Just nasal corticosteroids	2 (4)
Antibiotics	38 (84)
Just antibiotics	11 (24)
No treatment	1 (2)

Table 3. Comparison of the Improvement in CT Scan Findings of Different Treatment Modalities

Treatment opportunities of specific modality	Improved	Not improved
OCSs	2	0
NCSs	0	2
Antibiotics	7	4
OCSs and NCSs	1	1
OCSs and antibiotics	6	0
NCSs and antibiotics	4	7
OCSs, NCSs, and antibiotics	7	3
No treatment	1	0
Total No. of treatment opportunities	28	17

Abbreviations: CT, computed tomography; OCSs, oral corticosteroids; NCSs, nasal corticosteroids.

NCSs significantly decreased the likelihood of observing improvement, the effects of OCSs and NCSs were independent (that is, the combined effect of using both was predictable simply from their individual effects), and finally the use (or nonuse) of antibiotics had no significant effect on outcome likelihoods whether administered alone or in combination with 1 or more additional treatment modalities.

Although the American Academy of Pediatrics released a clinical practice guideline in 2001 on the management of acute sinusitis in children,⁴ this document did not address CRS to any extent other than a statement that suggested that its cause was more likely of a noninfectious nature than a bacterial infection. Therefore, the objective remains to identify an optimum medical management strategy for CRS in children. Adappa and Cotichia¹¹ recently demonstrated the possible benefit of intravenous antibiotics in children with CRS who were not responsive to oral antibiotics. One potential modality for the treatment of CRS that is only marginally addressed in the pediatric literature is the use of OCSs. Wald¹² and Steele¹³ both mentioned the possibility of using OCSs for the treatment of CRS in children, but neither elaborated with respect to dose or duration. In a 2005 survey of practice patterns, 12% of 175 pediatric otolaryngologists self-reported the use of OCSs in their management of CRS, but outcome data were not available.¹⁴ OCSs have been used successfully in the treatment of nasal polyps and allergic fungal sinusitis in adults,^{15,16} and Hamilos¹ includes the use of OCSs in his proposed medical management strategy directed primarily toward adults with CRS. Oral systemic corticosteroids can theoretically exert their anti-inflammatory effects deep into the ostia and interior sinus mucosa, where NCSs will not penetrate, particularly when the ostia are completely obstructed. In 2002, Subramanian et al¹⁷ published a retrospective study of 40 patients (primarily adults) with CRS who showed clinical and radiologic improvement after 1 month of antibiotics, nasal irrigations, NCSs, and a short course of OCSs. No similar study has been performed in children, however.

Our data show that OCSs were the only beneficial intervention, based on radiologic improvement, in the treatment of

OMC obstruction in children. Patients receiving OCSs without the use of NCSs all showed improvement. To our knowledge, this represents the first study in which the benefits of OCSs have specifically been shown to be beneficial in the treatment of CRS in children. In the study by Lieu et al,⁹ their definition of "maximum medical therapy" did not include the use of OCSs, and only 3 of 217 patients (1.4%) in the study by Chan et al⁸ were treated with OCSs. Only 2 patients in our study received NCSs exclusively, neither of which showed any improvement. NCSs are believed to have a role in controlling the inflammation of CRS.¹⁸ It seems logical that mucosal swelling and generally smaller nasal passages might prevent adequate penetration of NCSs into the ostial areas, and therefore systemically administered corticosteroids would be expected to reach their target areas more effectively. As yet unexplained is the fact that the use of NCSs had a negative impact on radiologic outcomes; specifically, those who were not treated with NCSs had a greater rate of improvement than those who were treated. Sharp et al¹⁹ recently showed that the use of NCSs in acute rhinosinusitis was not rare, though of undetermined benefit. Although the use of antibiotics provided some benefit, its effect was not statistically significant, suggesting that CRS symptoms in our population were more likely resulting from sources of chronic inflammation other than bacterial infection. Unfortunately, radiologic findings could not be correlated with the severity of symptoms or clinical status during this medical record review because record-keeping differences did not permit consistent assessments. Another limitation to this study was the indication for the CT scan performed. Because CT scans are indicated for those patients with CRS symptoms not responding to medical management, we believe that most of the CT scans were performed for these symptoms and not for acute sinusitis.^{4,6,7,20}

A prospective study that used validated symptom and quality-of-life scores, as recommended by a 2004 consensus group,⁶ would correlate radiologic appearance with clinical status, whereas standardized dosing regimens and the presence of control groups would more clearly demonstrate drug effectiveness. A new sinus CT scoring system that incorporates grading of ostial patency, such as that proposed by the consensus group, could be used for more complete staging of sinus CT abnormalities. In addition, evaluation of other potentially confounding factors, such as the presence of specific allergen sensitivities, cigarette smoking in the household, gastroesophageal reflux, and daycare or school attendance, might prove beneficial. Finally, larger sample sizes are needed to further elucidate our findings.

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