Risk factors for protracted sinusitis in pediatrics after endoscopic sinus surgery

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Received 13 March 2008; accepted 5 February 2009
Available online 2 May 2009

Abstract

Objectives: The goal of this article is to investigate the factors leading to protracted nasal discharge after pediatric endoscopic sinus surgery.

Methods: A retrospective chart review of all pediatric patients who had received endoscopic sinus surgery for chronic rhinosinusitis between January 2002 and September 2006 was conducted. The patients were assigned to the “protracted” group if they demonstrated persistent mucopurulent nasal discharge for more than 3 months after endoscopic sinus surgery, and otherwise to the “resolved” group.

Results: There were 21 “protracted” patients (39.6%) and 32 “resolved” patients (60.4%). Among these patients, age at diagnosis or operation, time from initial diagnosis to operation, and blood eosinophil count did not differ significantly between the “protracted” and the “resolved” groups. On the other hand, sinonasal polyposis (80.9% vs. 53.1%, P = 0.039), history of allergic rhinitis (52.4% vs. 12.5%, P = 0.002) and gender (male vs. female = 80.9% vs. 43.7%, P = 0.007) were more frequently observed in the “protracted” group than in the “resolved” group. These associations remained significant in a multivariate logistic regression (odds ratio = 9.36, 10.69 and 14.84, respectively).

Conclusion: Sinonasal polyposis, history of allergic rhinitis and gender were significant and independent risk factors for protracted nasal discharge after pediatric endoscopic sinus surgery. These risk factors should be taken into consideration during preoperative counseling.

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Keywords: Pediatric sinusitis; Endoscopic sinus surgery

Pediatric rhinosinusitis is estimated to complicate around 5–10% of upper respiratory infections in early childhood [1], with a prevalence of approximately 8% [2]. The diagnosis for pediatric chronic rhinosinusitis (CRS) has been controversial, and we regarded the patients as having CRS if they met the following criteria: (1) 12 weeks of persistent symptoms and signs (2) more than six times of recurrent episodes of acute rhinosinusitis per year, each lasting at least 10 days [3]. Surgical management was considered for persistent symptoms and signs despite continuous intensive medical treatment. Among a variety of surgical treatment modalities, functional endoscopic sinus surgery (FESS) has been accepted as a safe and effective treatment [4]. There have been various studies conducted on evaluating the outcome of FESS in pediatric patients [5,6]. Most of these studies made their arguments on the basis of symptoms improvement in an ordinal scale, subjectively judged by the patients or their parents, and there was little emphasis on surgeons’ findings during follow-up. In addition, there is no consensus with precise definition of what constitutes a “good” or “bad” outcome. Surgeons, patients or the parents may perceive the outcome in different ways, in conjunction with their experience or expectations. In the present study, we chose persistent purulent discharge revealed on physical examinations of more than 3 months following FESS as the primary outcome measurement.

Allergic rhinitis has been implicated in contributing to the development of CRS [7], and may have impact along with
other variables, such as age, gender, sinonasal polyposis, or blood eosinophil counts, on the postoperative wound healing or sinus re-ventilation. In addition, development of paranasal sinus reaches complete adult structural growth by age of 14 [8], therefore we were interested in how surgical outcomes would be affected by the sinus maturation. The aim of this study is to identify the risk factors in pediatric CRS that predispose children to protracted postoperative discharge, to integrate these factors in the preoperative counseling, and in search for any factors that could be addressed preoperatively.

1. Methods

1.1. Patients

We conducted a retrospective medical record review of 81 patients younger than 18 years who received functional endoscopic sinus surgery between January 2002 and September 2006. These patients have undergone surgical intervention due to persistent sinusitis refractory to prolonged medical treatment. The subjects in our patient population have each undergone at least 3 months of medical treatment, including empirical or culture directed systemic antibiotics (such as erythromycin, trimethoprim-sulfamethoxazole, cefadroxil, amoxicillin-clavulanate potassium, cefixime), decongestants, nasal corticosteroid, allergy management as well as thorough local treatment; however they were refractory to these medical treatments and their signs and symptoms persisted.

Twenty-eight patients with asthma, antrochoanal polyps, significant congenital syndromes, craniofacial anomalies, cystic fibrosis, aspirin sensitivity, immunodeficiency and missing data were excluded, resulting in a total of 53 patients eligible for the present study. All the patients included have taken CT scan of the paranasal sinuses for preoperative evaluation of the disease extent and identification of the anatomic variations. Functional endoscopic sinus surgery was performed by the senior author (T.J. Lee). The limited approach of endoscopic surgery described previously [5] consisted of partial uncinctomy, maxillary antrostomy with or without routine dilatation of the ostium, partial ethmoid bullctomy, and creation of basal lamella window for posterior ethmoid sinus drainage. The frontal recess served as superior-anterior boundary of the dissection without manipulation. The suspicious polyoid tissue was confirmed by histopathological studies. These patients were regularly monitored weekly for the first month, bi-weekly for the second month and monthly for the third month and afterwards. More follow-up visits would be arranged based on physicians’ judgements. Detailed recordings of physical findings and local debridement of escar, crusted blood or granulation tissue from every patient were performed by the senior author at each follow-up visit.

1.2. Outcome assessment

The charts were reviewed to obtain the pertinent information, with regard to the history of allergic rhinitis, age at operation, gender, blood eosinophil count and local physical findings at the operation and during follow-up. The presence of sinonasal polyposis at operation and mucopurulent discharge 3 months postoperatively were sought from the chart. The diagnosis of allergic rhinitis was based upon patients’ history of recurrent symptoms, rhinologic examinations and a positive allergen-specific IgE radioallergosorbent test (ImmunoCAP RAST system). The relevant symptoms include sneezing, nasal obstruction, rhinorrhea, or itching. The senior author recorded the nasal discharge as “none”, “little”, “much or copious”; “much or copious” discharge indicated the condition that required diligent and prolonged local treatments, whereas “none” and “little” discharge represented rather clear sinonasal tract. Persistent nasal discharge was identified if it was documented as much or copious by senior author for more than 50% of visits throughout the 3-month period postoperatively and at least the next following visit.

Standard descriptive analysis was conducted on demographic, baseline clinical and outcome data. The bivariate analyses were performed to compare baseline or clinical variables between the “protracted” and the “resolved” group, using chi-square or Fisher exact test for binary variables, analysis of variance for repeated measured variable, and the Student’s two-tailed t-test for continuous variable. Multivariate logistic regression analysis was conducted to determine which baseline or clinical variables were independently associated with outcomes. A P-value of <0.05 was selected as the minimum level of statistical significance. SPSS version 10.0 software (SPSS Inc.) was used for statistical analysis.

2. Results

The demographic and baseline clinical characteristics of the study population are shown in Table 1. Fifty-three children aged 6–17 (mean: 14.6 ± 0.3) years were enrolled. There were 31 boys (58.5%) and 22 girls (41.5%). 18 patients (34.0%) were younger than 14-year old at the operation, whereas 35 patients (66.0%) were of age 14 years or above. The mean age at the time of initial diagnosis of CRS was 13.8 ± 0.3 years, ranging from 5 to 17 years. The mean time interval between the initial diagnosis of CRS and the operation was 7.8 ± 0.8 months, ranging from 2 to 30 months. 34 patients (64.2%) with sinonasal polyposis were diagnosed by postoperative histopathological exams, whereas no polyoid tissue was found in 19 patients (35.8%). Diagnosis of allergic rhinitis was made prior to the operation in 15 patients (28.3%) primarily on the basis of positive RAST. All these patients had received allergy treatment for varied time. Blood examinations were
performed on every patient before the operation and demonstrated the median eosinophil count (\(140.4\) μl) of 140.4 (range: 7.9–748.8).

There were 21 patients (39.6%) showing persistent mucopurulent sinonasal discharge for more than 3 months after endoscopic sinus surgery (the “protracted” group), whereas 32 patients (60.4%) were free of discharge at the time (the “resolved” group). The baseline and clinical variables were compared between the “protracted” group and the “resolved” group (Table 2). The two groups were not significantly different in terms of age at diagnosis and operation, time interval between initial diagnosis and operation, and blood eosinophil count. The proportion of patients with sinonasal polyposis was significantly higher in the “protracted” group than in the “resolved” group (80.9% vs. 53.1%, \(P = 0.039\)). A significant difference was also seen in history of allergic rhinitis and gender between the “protracted” group and the “resolved” group (52.4% vs. 12.5%, \(P = 0.002\); 80.9 vs. 43.7%, \(P = 0.007\), respectively).

Multivariate logistic regression was used to identify which risk factors remained significant for the presence of persistent sinonasal discharging after adjusting for other factors. In order to control for significant and potentially important risk factors, we include sinonasal polyposis, history of allergic rhinitis, gender, age at operation and blood eosinophil count in the regression model (Table 3). The odds of suffering persistent sinonasal discharge for 3 months or longer after operation were significantly higher among male patients (OR: 12.79; 95% CI: 2.15–76.04) and among those with sinonasal polyposis (OR: 9.21; 95% CI: 1.61–52.71) or those with a history of allergic rhinitis (OR: 9.18; 95% CI: 1.65–51.08). The age at operation and blood eosinophil count did not demonstrate statistic significance in the regression model.

### 3. Discussion

There are a variety of treatment modalities for pediatric rhinosinusitis, including watchful waiting, medical management and surgical treatment. Surgery is considered for patients who failed conservative management. Pediatric FESS is accepted as a salvage treatment for refractory pediatric CRS, and its effectiveness and safety were generally recognized [9]. Many authors have documented favorable surgical results after pediatric FESS, declaring an average success rate of above 80% for FESS in pediatric population [4,6,10,11]. However, the argument of good result in these studies mostly relied on the patients or parents based outcome evaluation. The health-related quality of life questionnaires, such as SN5, rating several sinonasal symptoms on an ordinal scale by parents, are frequently performed for pediatric FESS outcome measurement. However, they are subjective and may be biased with confounding factors, such as frequent episodes of URI or allergy attacks occurring at the time of survey assessment. In 2005, Sobol et al. [12] stressed that the studied symptoms, the description of change in symptoms, the scoring systems in the questionnaires, and the time of the survey might vary considerably among different studies, resulting in a potential

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**Table 1**

<table>
<thead>
<tr>
<th>Variables</th>
<th>(n^a) (%)</th>
<th>Mean (±SD)</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total population</td>
<td>53 (100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At operation (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(&lt;14)</td>
<td>18 (34.0%)</td>
<td>14.6 (0.3)</td>
<td></td>
</tr>
<tr>
<td>(\geq 14)</td>
<td>35 (66.0%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age at diagnosis (years)</td>
<td></td>
<td>13.8 (0.3)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td>31 (58.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girl</td>
<td>22 (41.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to operation(b) (months)</td>
<td></td>
<td>7.8 (0.8)</td>
<td></td>
</tr>
<tr>
<td>NP(c)</td>
<td>34 (64.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-NP</td>
<td>19 (35.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allergic rhinitis</td>
<td>15 (28.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-allergy</td>
<td>38 (71.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood eosinophil count ((\mu l))</td>
<td></td>
<td>140.4</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Number of subjects.
\(^b\) Time interval between initial diagnosis of CRS and the operation.
\(^c\) NP = sinonasal polyposis.

**Table 3**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Odds ratios (95% confidence interval)</th>
<th>(P)-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>14.84 (2.36–93.24)</td>
<td>0.004</td>
</tr>
<tr>
<td>Allergy</td>
<td>10.69 (1.82–62.85)</td>
<td>0.009</td>
</tr>
<tr>
<td>Polyps</td>
<td>9.36 (1.66–52.80)</td>
<td>0.011</td>
</tr>
</tbody>
</table>

\(^a\) Other variable in the model include age at operation and blood eosinophil count, but both were not significant.
source of bias to the interpretation of results and difficulties in quantifying surgical outcomes across studies. Therefore, we adopted persistent purulent discharge revealed on sequential physical examinations for more than 3 months following FESS as the primary outcome measurement for a more objective postoperative evaluation. The reason for a 3-month postoperative observation being cut-off point in outcome measurement is mainly because the re-epithelialization process after sinus surgery usually requires around 3 months. Based on previous study, most of the antral mucosa in children with chronic maxillary sinusitis recovered within 2 months of having FESS [13]. Therefore, persistent nasal discharge for 3 months post-operation or longer implies unresolved pathology of sinonasal tract and may signify FESS failures. As a result, we conceive this clinical finding as an important outcome measurement and a more pathognomonic way of assessing surgical outcomes in our pediatric patients.

The physical findings were recorded by the same senior author at each clinic visit for every patient in order to maintain consistence. In our observation, many patients and/or parents were dissatisfied with persistent purulent drainage post-operation, perceiving the outcome as “perhaps improved, but not as good as expected”, and some patients failed to commit to their regular follow-up and treatment. We regarded this physical finding in such time frame as an objective and meaningful criterion in the indication as poor surgical outcome.

Currently conclusion of allergic rhinitis as a risk factor associated with poor surgical outcomes of FESS has not yet been reached. Ragheb and Duncavage [14] declared that nasal allergy had negative impact on the surgical outcome following FESS, yet Friedman found that allergy was not more commonly seen in patients with poor outcome [15]. Furthermore, in our literature review, there was no study investigating the effect of allergic rhinitis on the outcome of pediatric FESS using objective measurements. In the present study, our data indicated that pediatric patients with allergic rhinitis had a statistically greater chance of protracted mucopurulent discharge after FESS. Allergic rhinitis (AR) has long been considered as a risk factor for developing chronic rhinosinusitis. Prevalence of allergic rhinitis in patients with CRS is estimated to be 62.5–84%, comparing to that of 5–22% in general population [7,16]. Some possible mechanisms linking these two disease entities have been proposed [7,17]. Allergic inflammation of the sinonasal mucosa may result in mucosal congestion leading to impaired mucus drainage at ostiomeatal complex and mucociliary clearance may be delayed. In addition, the cytokine milieu present in allergic rhinitis could augment bacterial infection. Gutman have found a significant association between perennial allergy and chronic rhinosinusitis or recurrent acute rhinosinusitis, with dust mite and mold species being the most problematic allergens [7].

The inflammatory process of nasal allergy that led to the development of CRS probably impaired the postoperative wound healing by mucosal congestion, poor-functioning mucociliary clearance, and recurrent sneezing that posed pressure on the denuded mucosa. Abundance of secretion and an itchy sensation may result in frequent blowing or manipulation of their nostrils, which probably predispose to bleeding or delayed wound healing.

Inarguably sinonasal anatomic anomalies can also facilitate the development of CRS, such as septal deviation, bony spurs, concha bullosa, paradoxical middle turbinate, Haller cells and polyp formation. The incidence of nasal polyposis (NP) was quite high in our patient population. It primarily was owing to that pediatric patients with CRS and NP were more willing to undergo the operation or more symptomatically indicated for the surgical intervention. NP is a chronic inflammatory disease of sinonasal mucosa. The inflammatory response gives rise to mucosal swelling and protrusion of the sinonasal mucosa into the nasal cavity. Both AR and NP demonstrate many similarities, in terms of infiltrating cells, e.g. eosinophils, as well as mediators, e.g. IL-5 and leukotrienes. In our series, there was no discrepancy of AR between NP and non-NP patients (32.6% vs. 21.1%, \( P = 0.381 \)). Adjusting for other variables in logistic regression, NP remained significant as an independent risk factor leading to poor surgical outcome.

To date the reasonable treatment for severely obstructing NP remains a combination of medical and surgical approach. Our patients with polypoid chronic rhinosinusitis were given intranasal steroid spray for 2–3 weeks prior to the surgery. The uncertain nature of its etiology made it a challenge to otolaryngologists. We speculate that recurrence of NP or mucosal abnormalities impaired the created drainage pathway that resulted in mucus stagnation and compromised re-ventilation of the sinus. Stankiewicz [18] has shown 70% or more patients with nasal polyposis demonstrating recurrent polyposis or other postoperative mucosal pathology, and he concluded that polypoid rhinosinusitis patients tended to require more revision surgery than nonpolypoid patients. Our result identified sinonasal polyposis as one of the risk factors leading to protracted sinusitis after endoscopic sinus surgery that seems in line with Stankiewicz’s findings.

Gender has not been demonstrated as a risk factor influencing outcome in the relevant studies [6]. Nonetheless, our data revealed that male patients had higher risk for recalcitrant discharge after adjusting for other risk factors. A possible explanation to this was boys tend to be involved in more physical activities or more careless to their post-operative care, which resulted in worse wound healing than that in girls. There may be other confounders underlying this anecdotal causal relationship, for example, the uneven distribution of disease severity among two gender groups. However, there is currently no definitive classification system for severity of pediatric sinusitis. Further stratification of gender by including more variables may be the key to answer this discrepancy.
Chan et al. [19] have identified that surgery performed at a younger age was associated with persistent rhinosinusitis after FESS. Ramadan’s study conveyed the similar idea that FESS was beneficial in children older than 6 years but deemed unsuccessful if the patient was younger than 3 years [20]. Our observation did not reveal that the age at operation played a significant role in surgical outcome; but in our study subjects, there was only one patient at age of 6 and the others were older than 6. In addition, there was no statistically significant difference in surgical results between the age-of-14-or-above group and the younger group. One of Hassan’s proposed reasons for such a surgical outcome was age-dependent along with prevalent technical difficulties associated with limited surgical field. However, these difficulties could be addressed with an increasing understanding of pediatric sinus anatomy, expanding experience in surgical techniques and advancement in surgical instruments. This progression might make the age a negligible factor for surgical outcome.

It is recognized that blood eosinophil counts are significantly elevated in allergic rhinitis patients than control subjects [21]. Hoover et al. [22] stated that blood eosinophil count has a highly significant correlation with the extent of chronic sinusitis, which was defined radiographically using CT scan. But he did not mention the correlation between extent of disease and postoperative course. Although we did observe that AR patients have higher blood eosinophil count than non-AR patients (200.9 ± 47.1 vs. 132.7 ± 12.3, \( P = 0.06 \)), we found no difference in this serum marker between the “protracted” group and the “resolved” group, suggesting that blood eosinophil count is not a predictor for protracted postoperative discharge.

There are several limitations in our study that require further investigations. First, our study did not categorize the allergy patients into the “persistent” and the “intermittent” allergic rhinitis subgroup, in order to see if persistent nasal allergy associated with worse outcome than the intermittent form. In addition, we did not specify the patients with allergic rhinitis as under regular medical treatment or not, leaving the effect of allergy treatment on the pediatric FESS outcome unknown. Second, a second look into endoscopy was only performed in selected cases in our series [5]. Therefore the early mucosal abnormalities may not be identified initially. Further studies of effects of recurrent nasal polyposis on pediatric FESS outcome are mandatory, and a more delicate office-based postoperative examination for children should be included. Third, the physician’s findings as primary outcome measurement would not allow parents’ opinions to be fully reflected on the surgical results. Therefore we could only argue that in the presence of any risk factors shown here would result in protracted nasal discharge, rather than indicating good or failed outcome. However, as previously discussed, how parents feel may not be the single best determinant of the overall success or failure of the operation. Future studies could be carried out to assess the correlation between physicians’ finding and parents’ satisfaction ratings, and to develop a clinically sound outcome measurement using information from both of these sources for further outcome assessment studies.

By comparing different clinical characteristics between the “protracted” and the “resolved” group in this study, we investigated the possible risk factors predisposing to protracted mucopurulent discharge that compromised patients’ quality of life or school performance after endoscopic sinus surgery. Identification of these risk factors could help refine preoperative counseling and identify pediatric patients that may be at higher risk of intensive and longer postoperative follow-up visits and local debridement/medical treatment.

4. Conclusion

There is a significant relationship between protracted nasal discharge after pediatric endoscopic sinus surgery and nasal polyposis, along with a history of allergic rhinitis and gender. These are also independent risk factors for unsatisfying surgical outcome. Allergy test or treatment may be important before the operation. Our results may aid surgeons when discussing with parents about the postoperative course, and emphasize the need for prolonged management if the patients demonstrate these risk factors.

References