**Relation of Age to Outcome After Endoscopic Sinus Surgery in Children**

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**Objective:** To determine whether endoscopic sinus surgery (ESS) in children has a better outcome at a certain age.

**Design and Setting:** Cohort study in a tertiary care children's hospital.

**Patients:** Ninety-nine children who underwent ESS between January 1994 and June 1999.

**Main Outcome Measures:** Determining ESS outcomes was based on answers to a questionnaire mailed to the caregivers at least 1 year after surgery. Outcomes were considered failures if children required revision surgery or if their symptoms were not improved.

**Results:** The overall ESS success rate was 82%. Univariate analysis of age and surgery outcome revealed that children older than 6 years had an 89% success rate but that children younger than 6 years had a 73% success rate ($P = .04$). Of the 99 patients, 11 (9%) required revision surgery. Among them, 9 were younger and 2 were older than 6 years ($P = .008$). Of the 4 children younger than 3 years, 3 (75%) required revision surgery.

**Conclusions:** Endoscopic sinus surgery in children younger than 3 years was not successful but it was beneficial in children older than 6 years. It may be beneficial at any age if a complication from chronic sinusitis occurs; however, for children younger than 6 years, revision surgery may later be necessary.


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**Since its description in 1989, endoscopic sinus surgery (ESS) has gained acceptance as a surgical procedure for the treatment of chronic sinusitis in children.** Parents, pediatricians, and primary care physicians have been seeking the help of otolaryngologists for the treatment of children with chronic sinusitis that persists despite aggressive medical treatment, and surgical treatment has been increasingly requested. Because of new surgical techniques, most children who undergo ESS are now relieved of their symptoms. Herbert and Bent recently performed a meta-analysis of the outcomes of pediatric ESS and concluded that it is a safe and effective treatment for chronic sinusitis.

The role and treatment of gastroesophageal reflux in pediatric chronic sinusitis are well defined. However, the role of adenoidectomy in children with symptoms of chronic sinusitis continues to be debated, especially when long-term success or patient selection are concerned. Children are not young adults. Knowledge by sinus surgeons of the anatomy and development of the nose and paranasal sinuses is extremely important when they operate on children. Wolf et al. studied the development of the paranasal sinuses in the skulls of 100 pediatric cadavers and divided it into 4 stages corresponding to 4 age groups. The first group includes newborns and infants to 1 year of age; the second group, children from 1 to 4 years; the third group, children from 4 to 8 years; and the fourth group, children from 8 to 12 years. These authors noted certain characteristics specific to each group. They also described the clinical importance of pediatric paranasal sinus surgery, and Manning warned that ESS was more difficult in children than in adults because of children's smaller features. Yet, to our knowledge, ESS outcomes in different pediatric age groups were not systematically evaluated before the present study.

The purpose of this study was to evaluate the outcome of ESS in children of the 4 different age groups and to determine whether the procedure has a better outcome at a certain age.
OUTCOME ASSESSMENT

After surgery, all children were followed up at 3-month intervals for at least 12 months (median, 24 months). A questionnaire mailed to parents or caregivers at least 12 months (range, 12-36 months) after surgery was used to assess the preoperative symptoms of each child and the degree to which these symptoms had changed since surgery. Major preoperative symptoms included nasal obstruction or stuffiness, rhinorrhea, cough, and headache. Parents or caregivers ranked the symptoms as cured, improved, same, or worse, and also stated their satisfaction with the surgery. In children whose symptoms were cured or improved, ESS was considered successful; in children who needed further surgery or whose symptoms were the same as or worse than before surgery, it was considered a failure.

Children were grouped according to age, and univariate statistical analysis was performed using a $\chi^2$ test in the analysis of binary outcomes. For continuous variables a t test was performed. Multivariate analysis was performed using logistic regression analysis with SAS software (SAS Institute Inc, Cary, NC).

RESULTS

Of the 112 patients who were identified as possible study participants, 99 satisfied the criteria of having at least 12 months of follow-up and a completed questionnaire. Age range was 2 to 13 years (mean, 6.5 years).

There were 63 boys and 36 girls, and 18 of the 33 preschool children were in day care. Other characteris-

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**Table 1. Characteristics of the Patients Who Underwent ESS**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Children Younger Than 6 y</th>
<th>Children Older Than 6 y</th>
<th>Total (N = 99)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex, No. (n = 44)</td>
<td>30</td>
<td>33</td>
<td>63</td>
</tr>
<tr>
<td>Allergies, No. (%)</td>
<td>20 (46)</td>
<td>29 (53)</td>
<td>50 (50)</td>
</tr>
<tr>
<td>Asthma, No. (%)</td>
<td>19 (43)</td>
<td>27 (49)</td>
<td>46 (46)</td>
</tr>
<tr>
<td>Smoking in household, No. (%)</td>
<td>7 (17)</td>
<td>21 (38)</td>
<td>29 (29)</td>
</tr>
<tr>
<td>CT score, mean</td>
<td>11.6</td>
<td>10.9</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Abbreviations: CT, computed tomography; EES, endoscopic sinus surgery.

**Table 2. Multivariate Model of All Covariables Analyzed in Children With Successful ESS**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Point Estimate (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (=6 y and ≤6 y)</td>
<td>4.1 (1.1-15.7)</td>
<td>.04</td>
</tr>
<tr>
<td>Smoking in household</td>
<td>3.6 (0.87-14.7)</td>
<td>.08</td>
</tr>
<tr>
<td>Sex</td>
<td>1.47 (0.39-5.6)</td>
<td>.57</td>
</tr>
<tr>
<td>Asthma</td>
<td>0.63 (0.18-2.25)</td>
<td>.47</td>
</tr>
<tr>
<td>Allergies</td>
<td>1.44 (0.4-5)</td>
<td>.57</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; EES, endoscopic sinus surgery.

Univariate analysis of age and outcome of surgery showed that the success rate in children 6 years and older was 89%, compared with 73% in children younger than 6 years ($P= .04$). Of the 11 (11%) children who required revision surgery, 9 were younger than 6 years and only 2 were 6 years or older. The time from surgery to revision is shown in the tabulation.

Analysis of the data was also performed with children divided into 3 age groups. In group 1 were children younger than 4 years; in group 2, children from 4 to 8 years of age; and in group 3, children older than 8 years. There were 11 children in group 1, 60 in group 2, and 28 in group 3. The ESS success rate was 36% (4 children) for group 1, 88% (53 children) for group 2, and 86% (24 children) for group 3 ($P=.002$).

Multivariate logistic regression analysis using age as an independent variable and outcome as success of ESS was performed. Other variables in the model included sex, asthma, allergies, exposure to cigarette smoke at home, and CT score. The analysis using different age groups showed that ESS was statistically more successful in children older than 6 years (Table 2). In children younger than 3 years ESS had a high failure rate, with a 75% incidence of revision surgery.

Currently, ESS is one of the treatments available to children with chronic sinusitis. The consensus is that surgery should be performed on children for whom maximal medical management has failed. The role and benefit of adenoidectomy in children with chronic sinusitis continues to be a matter of debate. Some physicians suggest that the inflammation of the adenoids (adenoiditis), rather than their size, is what matters, whereas others believe...
that size is important.\(^7,^12\) Adenoidectomy has been effective in reducing the symptoms of chronic sinusitis, sometimes without confirmation of sinusitis by a CT scan.\(^13,^14\) The only prospective study comparing adenoidectomy and ESS showed that adenoidectomy alone was helpful in children with a low CT scan score but not in children with a high CT score and asthma.\(^6\)

Yet, the consensus is that surgery may be necessary in some children to improve their quality of life and prevent complications. A recent study showed that the quality of life of children with chronic sinusitis is worse than that of children with asthma.\(^15\) A recent meta-analysis showed that ESS was successful in 88% of children with chronic sinusitis.\(^5\) Although some reports suggest that surgical treatment of chronic sinusitis is not appropriate for children younger than 7 years,\(^12\) to our knowledge, the age at which ESS should be considered has not been addressed.

In many studies the term \textit{child} refers to a person younger than 18 years and, in some studies, younger than 21 years. We believe that treatment outcomes for chronic sinusitis in children should be restricted to persons younger than 13 years because, by that age, children’s sinuses have reached adult development.\(^9\) Also, the role of adenoidectomy in children older than 13 years is very limited because adenoids have involuted by that age; thus, excluding from studies children older than 13 years will eliminate the adenoid factor that otherwise may affect study findings and treatment results.\(^17\)

This study was conducted on patients between 2 and 13 years of age, most of whom were referred to us by the pediatric allergy service of our hospital because at least 6 months of medical treatment had failed to improve their symptoms. All patients had undergone testing for allergy, immunodeficiency, and cystic fibrosis. In all, a CT scan performed at the end of at least 26 weeks of treatment showed persistent evidence of sinusitis. When children required revision surgery, ESS was considered a failure. Children who did not require further surgery were evaluated using a questionnaire at least 12 months after surgery, and ESS was successful in 82% of them. Children older than 6 years had the best success rate and required revision surgery the least. We only had 4 patients younger than 3 years because we rarely perform ESS in that age group except in the case of complications. In spite of this, 3 (75%) of 4 children required revision surgery. We believe that when children with chronic sinusitis are younger than 3 years, ESS should be reserved for those with complications of sinusitis.

This study confirms what many believe, that the results of ESS are age dependent; and we believe that there are several reasons for this. The anatomy of children makes the procedure technically more difficult and limits postoperative debridement of the surgical field. Children also have an immature immune system and are prone to more frequent upper respiratory tract infections. Minimal swelling in a child’s nose causes significant obstruction of the outflow tract of the sinuses and facilitates secondary bacterial infection.

Limitations of this study include the use of a questionnaire to measure outcomes in the patients who did not require further surgery. As with all questionnaires about symptoms, responses were subjective; and other unknown factors may also have biased the parents’ responses.

Our sample population was made up of children who were referred from the allergy service of our tertiary care hospital because of the failure of at least 6 months of medical treatment. Our sample, with its high incidence of asthma and allergy, may not represent the larger population of children with chronic sinusitis seen by primary care physicians. Our results, then, should be interpreted in that context.

CONCLUSIONS

Endoscopic sinus surgery for chronic sinusitis in children is still in its developmental stages and its role continues to be defined. The procedure was not very successful in children younger than 3 years but it was beneficial in children who were 6 years and older. Surgery, however, may have a role at any age if a complication from chronic sinusitis occurs. Although ESS can be performed at any age if necessary, children younger than 6 years may later need revision surgery.

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REFERENCES