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Criteria for Success in Pediatric Functional Endonasal Sinus Surgery

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Functional endonasal sinus surgery (FESS) is widely used in the treatment of chronic sinusitis in adults and children. Although success rates of 80% to 93% have been reported, no criteria for success or improvement have been suggested. Standardized measures are needed to assess the outcome of FESS and to compare the results obtained by different surgical teams and for various patient groups. After reviewing the charts of 500 pediatric patients who underwent FESS between July 1987 and June 1992, the authors of this study formalized criteria for assessing the outcome of surgery.

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INTRODUCTION

Sinusitis is a multifactorial disease that has become the number-one illness in the United States. Almost 31 million people suffer from this disease, and millions of health-care dollars are spent on its treatment.[1]

Functional endonasal sinus surgery (FESS) is the most widely performed procedure for the treatment of chronic or recurrent sinusitis in adults and children. Absolute and relative indications for this procedure are listed in Table I. The reported success rates for FESS have ranged from 80% to 93%, but no standard criteria for judging success or failure have been suggested.[2] Standardized measures are needed to evaluate the outcome of FESS and to provide a baseline reference for patients and surgeons.

After reviewing the charts of 500 children who underwent FESS between July 1987 and June 1992, we formalized criteria for assessing the outcome of the procedure. The variables that were analyzed included clinical presentation, radiographic findings, symptom duration, allergy, and systemic disease. Based on our results, we suggest a specific preoperative workup and classification system that can help predict the outcome of FESS.

MATERIALS AND METHODS

We retrospectively reviewed the charts of 500 children who underwent FESS for chronic or recurrent sinusitis between July 1987 and June 1992. The 334 boys and 166 girls were between 14 months and 16 years of age at the time of surgery, and they were followed for 1 to 5 years after FESS. For each patient, more than 30 data fields were collected, including information about symptoms, medical therapy, computed tomographic (CT) findings, systemic diseases, and nasal endoscopic findings.

RESULTS

After thoroughly reviewing the charts of 500 patients, we analyzed the contribution of each clinical variable to the overall results of surgery. The outcome of surgery was based on the physician's written assessment (a standard form) in the chart and on the patient's, parent's, or other caretaker's evaluation of the quality of life after surgery.

The quality of life of a patient with chronic or recurrent disease may be improved, the same, or worse after surgery. The quality of life can be assessed by judging the variables that may adversely affect the life of the child or caretaker. These include the number of days each month that the patient is symptomatic or sick, the frequency of required medication, the number of visits to the physician each month, and the number of days lost each month from day care, school, or work. These were measured according to a standard data form.

Three classes for the outcome of surgery were defined according to the subjective evaluation of the physician and parents or other caretakers (Table II). When this classification system was applied, 79% of the 500 patients achieved a type 1 outcome, 9% of patients had a type 2 outcome, and 12% had a type 3 outcome. This means that the overall postoperative rate for improvement (i.e., type 1 plus type 2) was 88%. The prognostic factors that could affect the outcome were analyzed individually.

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TABLE I.
Indications for FESS in Children.

Absolute indications
Sinusitis with complications
Symptomatic mucoceles
Systemic disease with chronic sinusitis
Recurrent or chronic sinusitis persisting for 6 months despite medical therapy
Relative indications
Persistent signs and symptoms and CT findings consistent with clinical manifestations
Symptomatic concha bullosa
Chronic headache
Chronic nasal drainage
Recurrent sinusitis episodes with relatively normal CT findings inconsistent with clinical manifestations

FESS = functional endonasal sinus surgery; CT = computed tomography.

Duration of Symptoms and Demographic Factors

Patients were categorized according to the duration of symptoms (Table II) to ascertain whether the outcome of surgery was adversely affected by prolonged symptoms. Patients who had symptoms for more than 3 years experienced major exacerbations 12 to 18 months before surgery, but there was no statistically significant difference in the influence of the three symptom duration categories on outcome. There was no significant difference in the outcome of FESS between boys and girls.

Severity of Disease

Because of the extent of disease, all 500 patients required bilateral ethmoidectomies and middle meatal antrostomies. Dissection was continued until all involved areas seen on the computed tomographic (CT) scans were inspected, and further dissection was performed to remove diseased tissue undetected by the CT scans. In 26% of patients, more extensive disease was found intraoperatively than was demonstrated by the CT scans. After a normal, clear layer of mucosa was reached, surgery was terminated. Sphenoidotomies were performed for 23 patients in whom disease was detected by the CT scan.

Presenting Symptoms and Systemic Diseases

The signs and symptoms associated with sinus disease were evaluated before and after surgery. The most common complaints were chronic cough (83% of patients), anterior or posterior rhinorrhea (83%), and otitis media (76%). A history of headache could be elicited from 61% of patients 5 years of age or older. All symptoms improved significantly after surgery.

All patients with systemic diseases, such as cystic fibrosis and immotile cilia syndrome, or immunodeficiencies had 100% improvement of their sinusitis symptoms after surgery. However, all patients with cystic fibrosis or immotile cilia syndrome and 83% of patients with immunodeficiencies required repeat surgery within 3 to 5 years after the first operation.

Allergy

Allergy is a major contributory factor to sinusitis. Before July 1988, patients suspected of having allergies were evaluated by an allergist. After July 1988, all pediatric patients presenting with chronic or recurrent sinusitis were referred for allergy evaluations. Of the 413 patients evaluated between July 1988 and June 1992, 219 (53%) tested positive for allergies. Testing was performed by a pediatric allergist using prick and intradermal skin tests for inhalation and food allergies. There was no statistically significant difference in the results of surgery between the groups of patients with or without allergies who were operated on between July 1988 and June 1992 (88% success rate).

Smoking

Seventy-seven (15%) of the 500 children in our study were considered to be passive smokers because one or more family members were tobacco smokers or because they often were in a smoke-filled environment. These passive smokers had a significantly worse outcome than patients from relatively smoke-

TABLE II.
Types of Outcome After FESS and the Effects of Symptom Duration and Age at Surgery on the Outcome of FESS in 500 Children.

Type of Outcome (% of 500 Patients)	Criteria	Duration of Symptoms			Age at Surgery			
		6–18 mo (n=90)	18 mo–3.0 y (n=265)	3–5 y (n=145)	<3 y (n=70)	3–7 y (n=155)	7–11 y (n=195)	11–16 y (n=80)
Type 1 (79%)	Total improvement; no recurrent symptoms; improved quality of life	87%*	89%	88%	67%†	88%	90%	92%
Type 2 (9%)	Postoperative improvement with intermittent recurrence of symptoms; quality of life somewhat improved							
Type 3 (12%)	No significant improvement; recurrence of symptoms; quality of life unchanged	13%	11%	12%	32%	12%	10%	8%

*The type 1 and type 2 results are combined to show the total success rates.

†Of the 70 patients 1 to 3 years of age at the time of FESS, 50 were in day care; 67% of these children had a type 1 or type 2 outcome.

FESS = functional endonasal sinus surgery.

free environments (i.e., 65% vs. 91% improvement rates).

Previous and Concurrent Surgery

Related surgeries were performed before FESS in 290 of the children in our study. Of the total of 500 children, 275 (55%) had tonsillectomies and adenoidectomies, 133 (26%) had inferior antrostomies and lavage, 45 (9%) had limited septoplasty, and 10 (2%) had intranasal ethmoidectomies and polypectomies. The other 210 children (42%) had no prior surgeries.

There was no significant difference between the results in patients who had concurrent surgery and those who had only FESS. At the time of FESS, 95 patients (19%) had tonsillectomies and adenoidectomies with or without ethmoidectomies and polypectomies, 90 (18%) had partial middle turbinectomies, 45 (9%) had limited septoplasty, and 365 (73%) had no other surgery.

Postoperative Endoscopic Findings

Patients who had recurrence of disease or significant amounts of granulation tissue 2 to 3 weeks after surgery had worse outcomes than those who did not have these factors. No stents were used. We think that stents do not offer an advantage, and they are difficult to use in children. The 115 patients with postoperative findings of significant granulation, active infection, or polypoid disease had a significant difference in the rate of successful outcomes (48%) compared with the 315 patients who had no disease, synechiae, or granulation tissue (97%) or the 70 patients who had minimal granulation tissue or synechiae (93%).

Extent of Treatment and Physician's Experience

In our initial use of FESS, the frontal recess was not addressed in all patients. In July 1988, we began inspecting the frontal recess in every case of chronic or recurrent sinusitis. The improvement rate in the 87 patients who had FESS between July 1987 and June 1988 was 63%, but increased to 88% in the patients who underwent surgery after July 1988.

Of our 500 bilateral FESS procedures, 113 were performed by a physician in training. No statistically significant differences in outcome were found in the patients operated on by physicians in training or staff physicians. However, compared with patients treated by staff physicians, patients operated on by physicians in training had higher rates of minor complications, such as postoperative nasal bleeding (8% vs. 2%) and synechial formation (24% vs. 12%). Major complications developed in 4 patients (equally distributed between staff doctors and physicians in training): 2 had meningitis, 1 had periorbital ecchymosis, and 1 had bleeding requiring transfusion.

DISCUSSION

The use of FESS in the United States has increased dramatically during the past decade, and the results continue to be encouraging. Kennedy[2] reported a success rate of 97.5% in 120 patients who had FESS, while Levine[1] reported a success rate of 89%. Schaefer, et al.[3] had a success rate of 83%, Lazar and Younis[4] reported a success rate of 79% (210 children), and Lusk and Muntz[5] achieved a success rate of 80%. However, it is difficult to compare the results achieved by these surgical teams, because the criteria for success or failure often vary and because of limited knowledge about prognostic factors.

Kennedy, et al.[6] used patient symptoms and the patency of the antrostomies as the criteria for determining the success of their FESS procedures. Friedman and Katsantonis[7] based their success rate for 584 ethmoidectomies on the absence of recurrent disease and diminished steroid requirements. Hoffman, et al.[8] used symptom improvement as the criterion for success.

Although many factors appear to affect the ultimate outcome of FESS, neither the duration of symptoms before surgery nor the age of the patient at the time of surgery was found to be significant (Table II). When we first reviewed the surgical outcomes, it appeared that children who required surgery before 3 years of age had less favorable results than those who were older at the time of surgery. However, instead of age, regular attendance at a day-care facility was found to be the determining factor. Patients attending a day-care facility with at least seven other children had a postoperative success rate of 67%, while patients in the same age group who did not attend day care had a success rate of 92%.

All 500 patients in this series required bilateral ethmoidectomies because of the extent of their disease. Patients were categorized in groups A through D according to the severity of disease (Table III), which was assessed by preoperative CT scans and intraoperative pathologic findings. In 23% of patients, the intraoperative findings were more extensive than the preoperative CT scans had indicated. Patients in group D had worse postoperative outcomes than patients in groups with less severe disease.

In a study of 120 patients, Kennedy[2] concluded that the only relevant prognostic factor is the extent of disease. While our study results concur with Kennedy's results, we think other factors also influence the outcome of FESS in children. Although neither the patient's sex nor the age at which surgery was performed had any effect on outcome, day-care attendance was linked to a higher rate of disease recurrence. This finding parallels that of Wald[9] for the recurrence of otitis media.

Systemic diseases and immunodeficiencies may have unfavorable prognostic effects. Although all patients with these conditions (or their parents) reported complete improvement of sinusitis-related symptoms

TABLE III.
Influence of Severity of Disease on the Outcome of FESS in 500 Children.

Severity of Disease	Criteria	Patients With Successful Outcomes*	Patients With No Improvement†
Group A (n = 40)	Unilateral ethmoid disease; anatomic abnormalities	97%	3%
Group B (n = 165)	Bilateral ethmoid disease; disease of one dependent sinus	93%	7%
Group C (n = 220)	Bilateral ethmoid disease; disease of more than one dependent sinus	92%	8%
Group D (n = 75)	Pansinusitis or diffuse polyposis	61%	39%

*Patients with type 1 or type 2 outcome as defined in Table II.
†Patients with type 3 outcome as defined in Table II.
FESS = functional endonasal sinus surgery.

after surgery, every patient with cystic fibrosis or immotile cilia syndrome required repeat surgery 3 to 5 years after the first operation. Patients with immunodeficiencies were placed on prophylactic antibiotic therapy and intravenous immunoglobulin therapy, and they were followed closely by an immunologist. Nonetheless, 83% of these patients required revision surgery within 3 to 5 years after the first FESS.

Allergy may also play an important role in the pathogenesis of sinusitis in adults and children. Kennedy[2] found that 57% of his 120 patients had positive skin test or radioallergosorbent test results. Of the 500 patients in our study, 53% had positive allergy test results. Like Kennedy, we found that if allergy was identified and treated, it did not influence the outcome of treatment.

Genetic and emotional factors play a role in the etiology of chronic sinusitis. Stress may be a pathogenic factor in cases of nasal mucosa hyperreactivity. In selected patients, Wolff[10] demonstrated mucosal hypertrophy, increased secretions, and eosinophilic infiltrates in response to stress. Some reports have linked nasal allergies to certain human leukocyte antigens (HLA).[11,12] In one study in Japan,[13] HLA-Bw54 strongly correlated with sinobronchial symptoms.

Asthmatic patients may have more severe disease than other patients, but asthma did not seem to affect the prognosis following FESS in our patients. Kennedy[2] reported similar findings. However, Lawson[14] found that asthma was the most important predictive factor for surgical outcome. In his study, the failure rate was 50% for the asthmatic group but only 12% for the nonasthmatic group.

Smoking may also contribute to the development of sinusitis. Of our 500 patients, 77 (15%) were considered to be passive smokers. Despite surgery and maximal medical treatment, these patients had poorer outcomes than patients who were not exposed to smoke. A Swedish study of 5300 school children[15] showed significantly higher rates of asthma and hay fever in children living close to an air-polluting paper factory had a significantly than in those living 40 km away. Although Kennedy[2] did not find any evidence that tobacco smoke precipitated sinusitis, our results indicate that passive smoking may be a major disadvantage to patients with sinusitis.

At the beginning of this study, we thought that patients who had prior related surgeries or longer durations of symptoms might have worse prognoses, but the results did not support that hypothesis. Concurrent surgery or the presence of a mucocele also did not affect the outcome of FESS.

Nasal endoscopic examination and close postoperative follow-up are other prognostic factors. The outcome of FESS was found to be worse when significant granulation tissue or recurrent disease was found during the nasal endoscopic examination after surgery. Patients who did not receive close follow-up or did not fully comply with postoperative treatment had a higher failure rate than those who received good postoperative care (i.e., 73% vs. 12% failure rate).

Most patients who have FESS and concurrent medical therapy with close follow-up and nasal endoscopic examinations can expect improvement. Of the 500 patients in this study, 88% had improvement of symptoms at the final follow-up visit after surgery. This overall result compares well with the results of other sinus surgery studies, especially if no patients were excluded because of extent of disease or prior surgery.[1–5]

Before July 1988, the frontal recess was not addressed in all patients during FESS. In July 1988, we began inspecting the frontal recess in every case of chronic or recurrent sinusitis. Analysis of the results shows that 63% of the 87 patients who had FESS between July 1987 and June 1988 improved. The patients who underwent surgery after July 1988 had an improvement rate of 88%.

We encountered no major irreversible complications. Complications such as blindness, extraocular movement impairment, cerebrospinal fluid leakage, orbital hematoma, brain abscess, or intracranial injury did not occur in any of our 500 patients. Maniglia[16] reported three cases of intracranial injury, two cases of orbital injury, and one death.

Intimate knowledge of anatomy, minimal intraoperative bleeding, and adequate training are important factors in reducing complications and ensuring a good outcome for FESS. In our study, patients operated on by physicians in training had a higher rate of postoperative bleeding or synechiae formation than those treated by more experienced staff physicians. Our emphasis on strict vasoconstrictive technique to secure minimal bleeding enables good visualization and ensures minimal complications. Early detection

TABLE IV.
Staging of Chronic Sinusitis in Children.

Stage	CT Findings	Etiologic Factors	Nasal Endoscopy Findings
I	No anatomic abnormalities	Unilateral sinus disease; bilateral disease limited to ethmoid sinuses	No disease or granulation tissue found at postoperative endoscopy
II	Bilateral ethmoid disease with involvement of one dependent sinus		Minimal granulation tissue or adhesions found at postoperative endoscopy
III	Bilateral ethmoid disease with involvement of two or more dependent sinuses on each side	Day-care attendance; passive smoking	Significant granulation tissue, active infection, or polypoid disease found at postoperative endoscopy
IV	Diffuse sinonasal polyposis	Cystic fibrosis, immunodeficiency, or immotile cilia syndrome	No postoperative medical therapy or nasal endoscopy

and lysis of adhesions and a short course of systemic and local steroids may reduce adhesion formation. There is some indication that additional training, continuing association with other surgeons, and operating consistently with the same assistant may accelerate the learning process and reduce complication rates.

Based on a review of 120 patients, Kennedy[2] recommended an initial staging system for sinusitis. He concluded that this staging system had strong prognostic value and allowed valid comparisons independent of other factors. Based on our study of 500 young patients, we suggest a modification of Kennedy's system that can serve as a staging system for the pediatric age group (Table IV).

Certain limitations of this study should be recognized. In most cases, the symptoms and the degree of improvement depended on the subjective interpretation of parents or other caretakers, rather than reports of improvement supplied by the patients themselves. Most of our patients were too young to understand the concepts involved or to express themselves adequately.

In most of our patients, nasal endoscopic examination was performed only once after surgery. Adults can tolerate frequent examinations under local anesthesia, enabling better assessment and cleaning of the sinonasal complex. Although a patient may have no symptoms, the endoscopic examination may detect persistent disease. The issue of asymptomatic persistent disease has been described by Vleming and deVries,[17] who found that 52% of patients with subjectively "good results" had persistent or recurrent disease demonstrated by nasal endoscopy. Before being referred to our care, most of the patients in this study were treated several times by their pediatricians or primary care physicians.

CONCLUSION

There is more to pediatric sinusitis than anatomic abnormalities and osteomeatal complex obstruction. Factors such as allergy, systemic disease, smoking, stress, and genetic predisposition must also be considered. The following factors may affect the outcome of FESS in children: *1.* the extent of disease; *2.* day-care attendance; *3.* significant exposure to a smoke-filled environment; *4.* postoperative nasal endoscopy findings; and *5.* the presence of associated systemic disease.

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