

Functional Endonasal Sinus Surgery in Adults and Children

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Functional endonasal sinus surgery (FESS) is becoming the procedure of choice for the surgical treatment of chronic and recurrent sinusitis in adults and children. Retrospective analysis of the charts of 513 adult and 260 pediatric patients who underwent FESS after failing to respond to optimal medical treatment revealed an improvement rate of approximately 80% for both age groups. Although high response rates and low complication rates were found for both groups, there were significant differences in indications, preoperative evaluation, operative technique, and methods of postoperative follow-up for children.

INTRODUCTION

Affecting one of eight persons, sinusitis is now the No. 1 chronic illness in the United States, surpassing both arthritis and hypertension.¹ Etiologic factors range from upper respiratory tract infections to systemic disease, but the most common pathophysiologic process leading to sinusitis is obstruction of the ostiomeatal complex. Although most patients respond to medical treatment, surgery is considered for those with the intractable symptoms of chronic or recurrent sinusitis.

Twenty years ago, antrostomies and Caldwell-Luc procedures were the surgical approaches most often used to treat patients with chronic or recurrent sinusitis, and plain radiographs were the principal adjuvant diagnostic modality. In the late 1970s, Messerklinger^{2,3} developed the concept of the ostiomeatal complex and radically altered our understanding and management of chronic sinusitis. The practical result of his theories was the introduction by Kennedy, *et al.*⁴ during the 1980s of functional endonasal sinus surgery (FESS) for adults and the application of the procedure to children by Gross, *et al.*⁵ FESS gradually acquired the respect of American and European oto-

laryngologists and is now the surgical procedure of choice for treating chronic or recurrent sinusitis in patients of all ages.

Functional endonasal sinus surgery is a functional procedure that addresses the ostiomeatal complex by removing diseased tissues and restoring normal physiology. The authors' review of the charts of 773 patients showed that the procedure was equally effective for adults and children, but that there were important differences between the two groups in indications, preoperative evaluation methods, operative technique, and postoperative follow-up procedures.

MATERIALS AND METHODS

Patients

The charts of 800 consecutive patients who were evaluated and surgically treated for chronic or recurrent sinusitis were reviewed. Twenty-seven patients were lost to follow-up after surgery.

All of the 513 adults and 260 children were treated by members of the Otolaryngology Consultants of Memphis at LeBonheur Children's Medical Center and Methodist Hospital of Memphis. A physical examination was performed, and allergy history, past medical history, and family medical history were obtained for each patient. From June 1986 through January 1990, the authors evaluated and performed FESS for 773 patients, whose ages ranged from 14 months to 81 years at the time of surgery.

The follow-up periods ranged from 3 to 48 months (mean, 20 months). All pediatric patients had nasal endoscopic examinations under general anesthesia 2 to 3 weeks after surgery. Thereafter, they were seen every 2 to 3 weeks for 3 months and then every 3 to 4 months. Adult patients underwent nasal endoscopic examination in the office 1 to 2 weeks after surgery. They returned weekly for follow-up visits for 4 to 6 weeks, and nasal endoscopy was performed in the office if needed. Thereafter, follow-up evaluations were performed monthly for 3 months and then scheduled every 3 to 4 months as needed.

The diagnosis of chronic sinusitis was considered if signs and symptoms persisted for more than 3 months despite maximal medical therapy. Symptoms of chronic sinusitis included chronic cough, persistent headache, anteroposterior rhinorrhea, nasal congestion or obstruction, and facial pain or pressure. The signs of sinusitis included purulent nasal or postnasal drainage, erythematous boggy

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nasal mucosa, nasal polyposis, facial or periorbital swelling, and recurrent or chronic otitis media with effusion. The diagnosis of recurrent sinusitis was entertained if a patient presented with frequent attacks of acute sinusitis or if a patient with chronic sinusitis developed frequent exacerbations.

Most patients were initially referred for evaluation by an allergist. Asthmatic patients or patients with other systemic diseases were referred for assessment by their physicians. Patients with confirmed allergies received appropriate allergy treatment and followed the same medical protocol as the other patients.

All patients received optimal medical therapy consisting of a broad-spectrum oral antibiotic, beclomethasone dipropionate nasal spray, nasal decongestant spray, a mucolytic agent, and a decongestant. This regimen was administered for 3 to 4 weeks, except for the nasal decongestant spray (3 to 5 days).

For patients who improved, the medical treatment was continued for 2 to 3 weeks longer, for a total of 6 weeks. However, if signs and symptoms persisted after termination of medical therapy, a coronal computed tomography (CT) scan of the sinuses was obtained. FESS was used for patients with persistent sinusitis that resisted medical treatment and for whom evidence of disease was demonstrated by CT scan.

Technique

Many of the techniques and principles of FESS are the same for children and adults, but there are different steps in the preoperative assessment, type of anesthesia, and postoperative follow-up of pediatric patients.

Office nasal endoscopy is not tolerated well by children. The authors instead relied on the medical history, symptoms, and CT findings to formulate preoperative decisions. High-resolution coronal CT scans of the sinuses provided evidence of disease and guidance for surgery.

The initial step in FESS was optimal vasoconstriction, which improved visualization and minimized intraoperative bleeding. Immediately before surgery, the patient was administered a topical decongestant spray, either Neo-Synephrine® or Afrin®.

General anesthesia was used for all pediatric FESS, after which the surgical site was injected, using a 27-gauge, 3.8-cm needle and a 1.8-mL dental Carpule, with 2% lidocaine and 1:100,000 epinephrine for topical anesthesia and vasoconstriction. With extreme caution, 2% lidocaine with 1:50,000 epinephrine may be used instead. The patient's nose was then packed with neurosurgical cottonoid pledgets that were soaked in a 4% cocaine solution. Although a topical decongestant spray may be used, the authors found that cocaine provided the best vasoconstriction in addition to serving as a nerve block. The packs were left in place for at least 10 minutes.

Using the modified Messerklinger approach, the authors performed bilateral FESS for 773 patients (1546 procedures). All patients required bilateral surgery because of the evidence of bilateral disease provided by CT scans and significant, prolonged symptoms. Storz-Hopkins nasal endoscopes, xenon light sources, and television monitors were used in all procedures. The 4-mm 0° telescope was used for the ethmoid and sphenoid sinuses; the 4-mm 30° telescope

was used for the frontal recess and maxillary sinus; and the 4-mm 70° telescope provided superb visualization of the maxillary sinuses. Despite the smaller anatomy of the young patients, the procedures were easily performed with 4-mm endoscopes. Surgery began with a nasal endoscopic examination of the septum, middle turbinate, posterior nasal airway, and adenoids. If a deviated septum was revealed, a limited septoplasty usually was performed before FESS was started; this permitted better exposure during the procedure.

The mean blood loss was 20 mL (range, 10 to 50 mL) in the pediatric group and 45 mL (range, 30 to 100 mL) in the adults. The negligible loss of blood may be attributed to the excellent preoperative vasoconstriction achieved with injections of 2% lidocaine and 1:50,000 epinephrine and with 4% cocaine-soaked nasal packs.

At the conclusion of the procedure, 40 mg of methylprednisolone was deposited in the surgical site and the anterior surface of the inferior turbinate, and antibiotic-steroid ointment was applied in the ostiomeatal complex. Few patients required postoperative nasal packing with neurosurgical cottonoid pledgets soaked in a 4% cocaine solution. If used, packing was removed in the recovery room before the patient was transferred to the day-care surgery unit. The patient was usually discharged on the day of surgery.

Postoperative Procedures

Meticulous postoperative follow-up procedures were used. Each patient was started postoperatively on a steroid nasal spray, nasal decongestant, saline nasal mist, and broad-spectrum oral antibiotic. This regimen was used for 6 weeks. The patients were weaned from the steroid spray and other medications during the last 2 weeks of this therapy.

The first follow-up appointment was 7 days after surgery, and patients were then scheduled for nasal endoscopy. Postoperative nasal endoscopy, performed under general anesthesia for children and as an office procedure for adults, permitted inspection of the surgical site and removal of the instilled ointment, crust, blood clots, granulation tissue, or adhesions. The recently created ostium was assessed, cleaned, and reenlarged if necessary. The maxillary sinus was then lavaged with normal saline solution. The approach and instruments used in the second-look surgery were the same as those used for the primary FESS.

RESULTS

Of the 773 patients with chronic or recurrent sinusitis treated with FESS, 513 were adults and 260 were children. The sex distribution is furnished in Table I, and the age distribution is displayed in Figure 1. The clinical manifestations varied in different age groups. In the pediatric age group, persistent cough, nasal drainage, and recurrent or chronic otitis media were the most common complaints. In adults, chronic headache, nasal congestion, nasal drainage, and facial pain were the most frequent grievances (Table II).

Computed tomography findings were comparable in the two age groups. The most common finding was pansinusitis with ostiomeatal complex obstruction. Concha bullosa existed in 14% of the cases. In 10

Age Group	No. of Patients	No. of Males (%)	No. of Females (%)
Pediatric	260	170 (65)	90 (35)
Adult	513	232 (45)	281 (55)
Total	773	402 (52)	371 (48)

Signs and Symptoms	% of 260 Children	% of 513 Adults
Chronic cough	90	83
Anteroposterior rhinorrhea	91	93
Chronic otitis media	76	0
Nasal congestion	63	84
Chronic headache	53	78
Nausea and vomiting	2	18
Dizziness	0	13

children and 17 adults, the CT scans were normal, but the clinical manifestations were persistent enough to recommend FESS. All 17 patients were found intraoperatively to have significant disease.

Allergy testing results were available for 727 of the 773 patients. Forty-nine percent of the children and 50% of the adults had positive test results. Moreover, 20% of the children and 18% of the adults were asthmatic. Among the asthmatic patients, 80% of the adults and 81% of the children were switched from continuous, daily treatments for their asthma to occasional treatments 4 to 6 weeks after FESS. These improvements were reported by their attending physicians.

Many patients had previous surgeries. In the pediatric age group, tonsillectomy and adenoidectomy accounted for 55% of the prior operations. Insertion of pressure-equalizing tubes had been performed in 51%, nasal antral windows in 30%, septoplasty in 11%, inferior partial turbinectomies in 9%, and intranasal ethmoidectomies in 2% of the pediatric cases. In adults, the most common previous operations were nasal antral windows or Caldwell-Luc procedures, accounting for 35% of the cases. Septoplasty had been performed in 29%, intranasal ethmoidectomy in 18%, and inferior partial turbinectomies in 15% of the adults.

Concomitant surgery was performed in many patients. In children, 25% had pressure-equalizing tubes inserted, 18% had concomitant tonsillectomy and adenoidectomy, 8% had partial resection of the middle turbinate, and 9% had conservative septoplasty. Among the adults, 45% had concomitant septoplasty, and 18% had partial resection of the middle turbinate.

There were few postoperative complications. Syn-

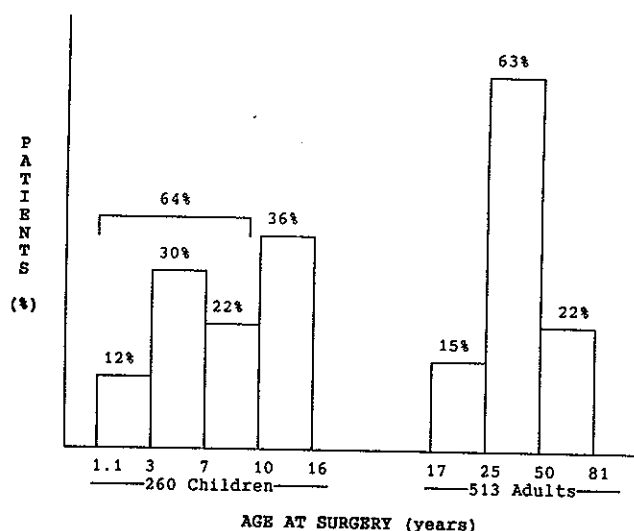


Fig. 1. Age distribution of pediatric and adult patients at the time of functional endonasal sinus surgery.

echiae were the most common complications (Table III). These were usually detected in pediatric and adult patients during postoperative follow-up nasal endoscopy. In symptomatic pediatric patients, synechiae were lysed under endoscopic visualization with the patients under general anesthesia. Adhesions were lysed in most of the adult cases in the office at the time of nasal endoscopic examination. In some cases, significant adhesions were associated with recurrence of disease, and during subsequent revision FESS, the adhesions were lysed and nasal splints were inserted. In adult and pediatric patients with significant adhesions, oral steroids were also administered.

Forty-eight patients bled after FESS. For 44 patients, bleeding was controlled by packing the nose for 1 to 2 hours with cottonoid pledgets soaked in a 4% cocaine solution. Four adult patients had significant postoperative bleeding that required readmission, and 3 of these 4 patients had undergone concomitant partial middle turbinectomy. Other complications included polyposis, orbital ecchymosis, headache, and severe ear pain (Table III). Some patients had two or more complications (e.g., adhesion and stenosis) concurrently. Epiphora is commonly caused by extensive anterior widening of the maxillary sinus ostium, resulting in nasolacrimal duct injury. The complication can be avoided by minimizing anterior widening of the maxillary ostium. Dacryocystorhinitis occurred in 2% of the pediatric and 1% of the adult patients. These patients were referred to an ophthalmologist for further management.

One adult had meningitis, although no cerebrospinal fluid rhinorrhea was found intraoperatively or postoperatively. The authors surmise that meningitis developed after violation of the cribriform plate while operating in the frontal recess area. Manage-

ment consisted of broad-spectrum antibiotics, diuretics, and bed rest. This treatment was adequate, and no sequelae occurred.

Two adults had dural tears, which were successfully patched with temporalis muscle fascia and a turbinate mucosal free flap. No patient developed the severe complications of blindness, cerebrospinal fluid rhinorrhea, or extraocular muscle injury.

Revision FESS, performed for 71 patients within 1 year of the initial surgery, was indicated only if a patient failed to respond to primary FESS and additional optimal medical therapy during the follow-up period. The most common cause of revision FESS was significant adhesion resulting in ostiomeatal occlusion and stenosis of middle meatus anrostomies. Recurrent polypoid disease was another common finding in the revision cases. Patients with severe postoperative headache were treated medically for sinusitis for 3 to 4 weeks. If symptoms were unimproved and the nasal endoscopic examination was unrevealing, CT scans of the sinuses and head were obtained. If these findings were negative, the patient was referred to a neurologist. If the CT scan showed recurrent disease or stenosis that was unresponsive to medical treatment and office endoscopic management, the patient was scheduled for revision surgery.

Of the 773 patients who had one or more FESS procedures, 642 (83%) were successfully treated for chronic or recurrent sinusitis. This included 210 (81%) of the children and 432 (84%) of the adults in this retrospective investigation. Among patients with previous sinus surgeries, 66% of the children and 72% of the adults improved after FESS. Overall, chronic nasal obstruction improved in 85% of the cases, cough in 86%, nasal discharge in 83%, and headaches in 84% of the patients with these initial complaints. Postoperative improvement was based on the patients' or parents' feedback during the follow-up office visits. The treatment was considered a success if the preoperative symptoms improved or disappeared. If the symptoms remained unchanged or worsened, the treatment was considered a failure.

COMMENT

The goal of FESS is to establish normal drainage and ventilation of the paranasal sinuses by removing diseased tissue and opening the obstructed ostiomeatal complex, which is the anatomic region of the middle meatus where mucociliary flow converges from the frontal, maxillary, and ethmoid sinuses.⁶ Although the obstruction can be initiated by anatomic changes or systemic diseases, upper respiratory tract infection and allergy are the most common causes.^{6,7}

Sinusitis is rarely an isolated process. Adenotonsillar hypertrophy or infection and chronic otitis media with effusion are commonly associated with sinusitis in children. In adults, septal deviation and turbinate hypertrophy are common. Allergy plays an

TABLE III.
Complications After Functional Endonasal Sinus Surgery.

Complications	% of 260 Children	% of 513 Adults
Minor Complications		
Synechiae	20	27
Polyposis, persistent or recurrent	9	14
Bleeding	5	7
Ecchymosis	3	5
Maxillary ostium stenosis	2	6
Dacryocystorhinitis	2	1
Severe ear pain	1	2
Severe headache	0	11
Major complications		
Dural tear	0	0.4
Meningitis	0	0.2

important role in both age groups.^{8,9} Sinusitis may exacerbate asthma in patients of any age, and treatment of sinusitis often improves asthmatic symptoms.

The diagnosis of sinusitis is usually based on the clinical manifestations, but children rarely demonstrate the characteristic adult symptoms of sinusitis. Cough, rhinorrhea, and chronic otitis media are common in children, but adults usually present with chronic headache, nasal congestion, and drainage.

Radiographic studies are essential for the diagnosis of sinusitis. Plain radiographs offer quick and accessible diagnostic assessment, especially for cases of acute sinusitis, but CT is considerably more reliable in documenting cases of chronic or recurrent sinusitis.^{10,11} Coronal CT scans of the sinuses, essential for every patient before FESS, aid in surgical planning, reveal pathologic changes, and display anatomic variations.

In adults, preoperative nasal endoscopy performed in the office can be an important diagnostic adjunct to CT. However, the procedure is rarely tolerated by children, and their first endoscopic examinations are usually performed during surgery. Preoperative evaluation in children is based on history, clinical presentation, and CT findings.

During FESS, the authors had no difficulty in using the "adult" instruments on young patients, and these 4-mm telescopes provided better depth of field and degree of vision than the smaller 2.7-mm endoscopes. Even with the direct visualization and clear illumination supplied by the fiberoptic light source of the endoscope, the surgeon must use extreme care in manipulating tissue. In children, tissues are more vulnerable to trauma, and the smaller anatomy makes atraumatic surgery more challenging.

Postoperatively, patients in both age groups are placed on maximal medical therapy for 6 weeks. For adults, second-look nasal endoscopy is performed under local anesthesia in the office 1 to 2 weeks after FESS, but in children, endoscopy is performed under

general anesthesia 2 to 3 weeks after surgery.

Results of FESS were comparable in both age groups. Significant improvement of symptoms was achieved by 81% of the pediatric patients and 84% of the adults. These results parallel the conclusions of other investigators.^{8,12-14} The success and safety of FESS was also reflected by the low morbidity rates. No major complications occurred in the 260 pediatric patients. Among the 513 adults, 2 patients had dural tears and 1 patient developed meningitis.

Adhesions or synechiae formation were the most common minor complications in both age groups (Table III). These conditions were most often the cause of recurrent sinusitis and revision FESS.^{15,16} To avoid

adhesions, the authors recommend applying methylprednisolone at the end of surgery and postoperative use of steroid spray for 6 weeks. Minimal manipulation of tissues intraoperatively can further diminish the formation of adhesions, but if they do occur, close follow-up, lysis, and treatment with topical steroids are indicated. Failure was more likely to occur in patients with long-standing refractory sinusitis, extensive postoperative adhesion formations, or systemic abnormalities (e.g., cystic fibrosis, immotile-cilia syndrome, immunodeficiencies).

Results of this review suggest that FESS is a successful surgical procedure for treating chronic or recurrent sinusitis in children and adults.

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