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Pediatric Functional Endonasal Sinus Surgery: Preoperative Evaluation, Surgical Technique, and Postoperative Care

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ABSTRACT

Pediatric functional endonasal sinus surgery (FESS) requires significant surgical training and proficiency. Although the technique is essentially the same as for adults, children need different tactics in each step of the treatment. Preoperative assessment of children relies on the clinical manifestations and the findings of computer tomography scans of the sinuses. Because office nasal endoscopy is not well tolerated by children, the procedure must be done under general anesthesia. The intraoperative approach depends on obtaining adequate vasoconstriction and the surgeon's understanding of varied pediatric anatomy. Careful follow-up, including medical therapy and a nasal endoscopic examination under general anesthesia, is necessary to ensure a good outcome.

INTRODUCTION

FUNCTIONAL ENDONASAL SINUS SURGERY (FESS) has become a popular therapeutic modality for chronic sinusitis in the last 10 years. It is a functional, rather than ablative or exenterative, approach. The principle of FESS is supported by the anatomic and physiologic findings of Messerklinger,[1,2] who 15 years ago postulated that ostiomeatal complex obstruction was the basis for sinus disease. In the early 1980s, Kennedy et al.[3] applied the procedure to adults in the United States, and in 1986, we adapted the surgical procedure for treating pediatric patients.[4]

The goal of treating sinusitis is to restore the sinuses to their normal physiologic state. This is achieved by controlling infection, providing adequate aeration, and restoring mucociliary flow through patent sinus ostia. These goals are accomplished by medical therapy in most cases of acute sinusitis, but surgery is often required for chronic disease.

Based on our treatment of 500 cases of chronic sinusitis in the past 4 years, we delineate the preoperative measures, surgical technique, postoperative management plan, and complications of FESS. We also offer recommendations for surgical training in this procedure.

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PATIENTS AND METHODS

Preoperative evaluation

Sinusitis is a common disease that previously has been underdiagnosed in the pediatric age group. Most children with sinusitis respond to medical treatment. Surgery is entertained in cases of chronic or recurrent sinusitis that fail to respond to medical therapy (Fig. 1). Although several procedures have been used to treat chronic sinusitis, FESS is currently the surgical procedure of choice.

Chronic sinusitis symptoms in children consist of chronic cough, posterior and anterior rhinorrhea, nasal congestion, and recurrent otitis media. These symptoms differ from those reported for adults.[5] Chronic headache may also be a symptom in children who are older than 6 years of age. The diagnosis of chronic sinusitis may be suspected from the clinical manifestations, but radiographic studies are usually required for confirmation because the child is rarely able to describe clearly the existing complaints. Plain x-ray films of the sinuses traditionally have been used to detect sinus disease, but independent studies by McAlister et al.[6] and by Lazar and Younis[7] demonstrated that the radiographic findings were neither specific nor sensitive enough to diagnose sinusitis in children (Fig. 2).

Coronal computed tomography (CT) of the sinuses currently provides the diagnostic gold standard. High-resolution CT is an essential preoperative diagnostic tool. CT scans reveal the exact anatomy and existing pathology and aid in surgical planning. Pediatric FESS should not be entertained without a meticulous review of the coronal CT scan of the sinuses, and the CT scan should always be available in the operating room during surgery.

In adults, preoperative evaluation can be performed with office nasal endoscopy. Unfortunately, children rarely tolerate this office procedure, and nasal endoscopic examination is instead performed intraoperatively while the patient is anesthetized.

Preoperative investigations also include evaluating upper respiratory tract infections and allergies, which are the most common predisposing factors for sinusitis in children.[8] In a review of 210 pediatric patients with chronic sinusitis, we found that 46% of the patients tested positive for allergies.[9] Rachelefesky et al.[10] found that 70% of the 91 atopic children in their series had radiographic opacification of one or more sinuses. Consequently, we refer each patient with chronic or recurrent sinusitis for allergy testing by a pediatric otolaryngic allergist or pediatric allergist.

Systemic diseases must be considered in evaluating a child with persistent sinusitis. Immotile cilia syndrome, Kartagener's syndrome, and immunodeficiencies should be suspected. A sweat chloride test may help in ruling out cystic fibrosis. A nasal mucosa biopsy or tracheal mucosa biopsy may be required to diagnose immotile cilia syndrome, and an immunoglobulin assay is commonly performed to evaluate immunodeficiencies.

After chronic sinusitis is diagnosed, the patient is treated medically. Maximal medical therapy consists of broad-spectrum oral antibiotics, steroid nasal spray, and occasional systemic decongestants with or without antihistamines. Medical therapy is employed for 3–4 weeks. If symptoms persist, a coronal CT scan of the sinuses is obtained, and if the scan confirms persistent sinus disease, surgery is scheduled.

FESS is also indicated for children with acute, complicated sinusitis. In complicated sinusitis, FESS can be used to drain a subperiosteal orbital abscess, thereby treating the disease and managing the associated disorder (Fig. 3).[11]

Surgical technique

We follow the modified Messerklinger approach. Although the pediatric FESS technique is essentially the same as that for adults, there are noteworthy differences. Because the anatomy in children is smaller and variable, the surgical landmarks may be changed. The tissues are more vulnerable to trauma, demanding judicious manipulation.

Vasoconstriction must be achieved before surgery begins. It allows optimal visualization, secures a dry

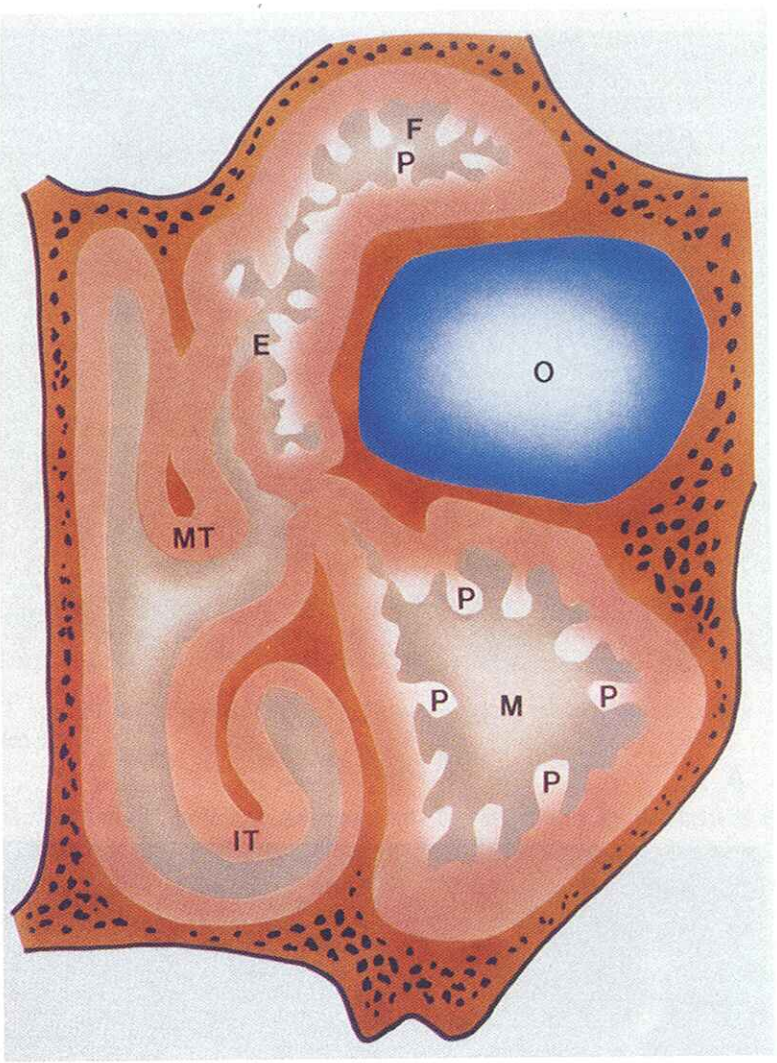


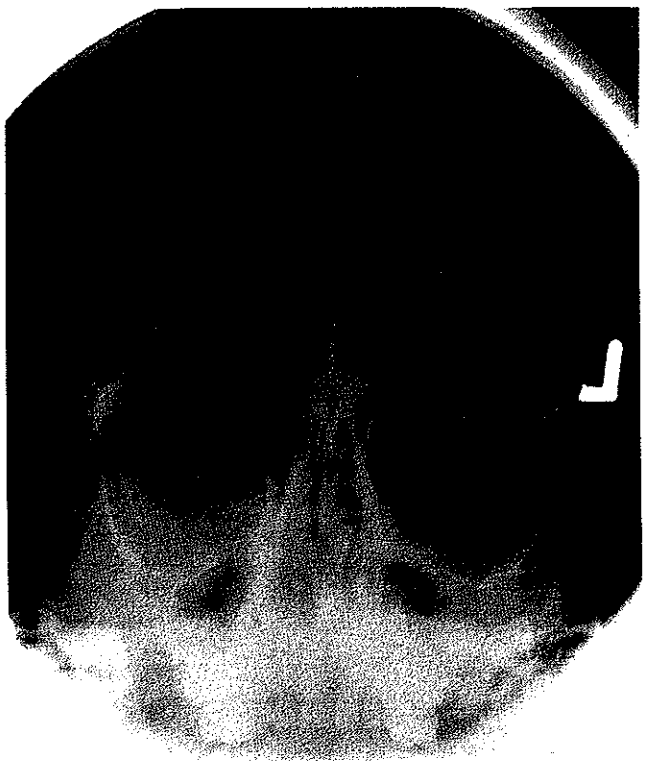
FIG. 1. Schematic presentation of chronic polypoid sinusitis. F, frontal sinus; E, ethmoid sinus; P, polyp; O, orbit; MT, middle turbinate; IT, inferior turbinate; M, maxillary sinus.

surgical field, and improves eventual outcome. Immediately before surgery, the patient's nose is sprayed with a local decongestant. Neo-Synephrine®, Afrin®, or Otrivin® may be used.

After administering general anesthesia, the vasoconstrictive efforts are cautiously continued. Teamwork is required between the surgeon and anesthesiologist. With extreme caution, the surgical site is injected, using a 22-gauge, 3.8-cm needle, and 1.8-ml dental Carpule, with 2% lidocaine and 1:100,000 epinephrine solution, can be used. The patient's nose is then packed with neurosurgical cottonoid pledgets soaked in 4% cocaine solution. These packs are left in place for a minimum of 10 min. We have been using this vasoconstrictive technique successfully for the past 8 years with no major side effects.

After maximal vasoconstriction is achieved, surgery begins with a nasal endoscopic examination. In children, this is typically the first endoscopic examination. The turbinates, septum, posterior choana, and adenoids are assessed using the 4-mm 0° Storz-Hopkins nasal endoscopic telescope with a xenon light source and television monitor.

An incision is made using a sickle knife along the anterior border of the uncinate process, from the superior to the posterior-inferior edge. In children, the uncinate process is usually located more anteriorly than in adults. After creation of an infundibulotomy, the bulla ethmoidalis is identified and entered. The anterior ethmoid cells are cleaned, and the basal lamella is identified. The posterior ethmoids are then inspected,



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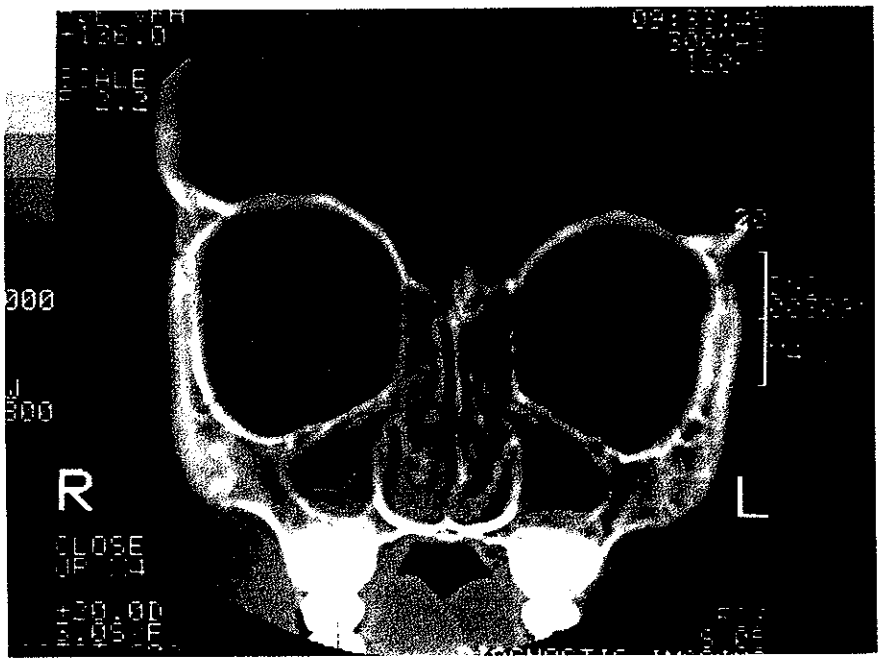

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FIG. 2. (A) Routine plain sinus radiograph. (B) CT scan of the same patient 1 h later, delineating inaccessible anatomic structures and demonstrating disease not shown on the radiograph.

FIG. 3. Axial CT scan of the sinuses, showing right subperiosteal abscess (arrow), right proptosis, and right ethmoiditis and sphenoiditis.

and they are exenterated only if there is disease present. The sphenoids are not usually entered in children unless there was evidence of disease demonstrated on the CT scans.

Switching to a 4-mm 30° telescope, the frontal recess is inspected. Diseased tissues are removed using the upbiting forceps and right-angled suction. The natural ostium of the maxillary sinus is then enlarged threefold to fivefold using Greenwald, upbiting, and side-biting forceps. Care is taken to protect the lacrimal duct anteriorly and the sphenopalatine artery posteriorly. The maxillary sinus is then irrigated with normal saline solution.

At the end of the procedure, 40 mg of methylprednisolone may be injected into the surgical site and the anterior surface of the inferior turbinate. Antibiotic-steroid ointment may be used to fill the surgical defects. We do not usually use any stents or packs after surgery.

The surgery requires 30–60 min to complete, and during the procedure, 10–50 ml of blood is lost. A few patients may have minimal postoperative bleeding, which is controlled by temporary nasal packing with neurosurgical cottonoid packs soaked in a solution of 4% cocaine or a 1:1000 solution of epinephrine. The packs are removed in the recovery room. Patients are discharged the same day of surgery.

Postoperative care

Postoperative care begins immediately after surgery. The patient is maintained on maximal medical treatment consisting of broad-spectrum oral antibiotics, saline nasal washes, steroid spray, and occasionally systemic decongestants and antihistamines. This regimen, except for local decongestant spray, is continued for 6 weeks. If the patient was found to have an allergy during the preoperative evaluation, allergy treatment is initiated or continued.

The first postoperative visit is scheduled 7–10 days after the surgery. A follow-up nasal endoscopic examination under general anesthesia is usually scheduled 2–3 weeks after surgery. Postoperative nasal endoscopy, which employs the same technique as the primary procedure, is an indispensable component of pediatric FESS, permitting a second look to assess the results of surgery. During the postoperative endoscopy, the sinonasal cavities are cleaned of ointment, blood clots, crusts, and granulation tissue or adhe-

TABLE 1. NASAL ENDOSCOPY FINDINGS AFTER PEDIATRIC FESS

Postoperative findings	*% of 500 patients*
Blood clots	14
Significant crusting	11
Granulation tissue	10

sions. Any persistent pathologic tissues are removed during this procedure. Over the past 2 years, we have not been performing postoperative nasal endoscopy routinely. This is now performed based on clinical manifestations. Only patients with systemic disease, persistent postoperative infection, or revision surgery are scheduled for routine postoperative nasal endoscopy under general anesthesia.

After the follow-up endoscopy, the patient is seen every 2 weeks for 3 months and then every 2 months for 1 year.

RESULTS

We reviewed the charts of 500 pediatric patients who had FESS performed between June 1990 and June 1995. The ages of the patients at the time of surgery ranged between 14 months and 16 years. All patients had symptoms of chronic or recurrent sinusitis and had failed to respond to optimal medical treatment. Evidence of chronic sinusitis was documents by coronal CT scans of the sinuses in 487 of these patients.[7] The other 13 patients were recommended for FESS on the basis of their clinical findings. They were found to have significant disease intraoperatively despite normal CT scans.[7] The follow-up periods ranged from 3 months to 36 months.

The 500 patients had bilateral FESS, for a total of 1000 procedures. The most common findings during follow-up nasal endoscopy are summarized in Table 1. No major postoperative complications occurred (Table 2). Synechiae developed in 20% of the patients. Persistent or recurrent polyposis and minor bleeding were reported to a lesser degree.[12] Chronic or recurrent sinusitis improved in 82% of these cases after FESS.

TABLE 2. COMPLICATIONS AFTER PEDIATRIC FESS

Complication	*% of 500 patients*
Minor complications	
Synechiae	20
Polyposis, persistent or recurrent	9
Bleeding	5
Ecchymosis	3
Maxillary ostium stenosis	2
Dacrocystorhinitis	2
Severe ear pain	1
Orbital hematoma	0
Emphysema	0
Major complications	
Blindness	0
Rhinorrhea, cerebrospinal fluid	0
Meningitis	0
Significant bleeding	0
Extraocular muscle injury	0

COMMENTS

The introduction of lens-rod telescopes, and fiberoptic light sources and the ostiomeatal complex theory of Messerklinger[1] have completely transformed the surgical management of chronic sinusitis. In adapting and developing the endoscopic procedures for treating children, we have emphasized the delicacy of the procedure and its specific preoperative, intraoperative, and postoperative requirements.

Preoperative evaluation must be thorough. Currently, this can be achieved only with a high-resolution coronal CT scan. We emphasize that maximal preoperative vasoconstriction is necessary to ensure good results.

During endoscopy, we used the 4-mm telescope at all times, even for our youngest patient (14 months). Compared with a 2.7-mm telescope, a 4-mm telescope provides a wider field of vision, superior visualization, and optimal illumination. We have had no difficulty using the regular adult instruments in pediatric operations. We strive to minimize trauma and manipulation during the procedure to decrease the incidence of postoperative edema and adhesion tissue formation.

Associated surgeries are sometimes performed with FESS. For example, a modified septoplasty, limited to the deviated part and avoiding the bony septum, should be performed if severe septal deviation exists because it may contribute to chronic sinus disease and can impede the FESS procedure. Tonsillectomy, adenoidectomy, installation of pressure-equalizing tubes, or partial middle turbinectomy may also be performed with FESS.

For FESS, with or without another procedure, postoperative care is characterized by maximal medical therapy and close follow-up.

Pediatric FESS is safe and effective when performed by well-trained surgeons. Although instruction may start with a survey course describing the principles and practice of FESS, this is insufficient training for performing the delicate procedure.

The sinuses are near crucial structures, such as the optic nerve, globe, and internal carotid artery, and a thorough knowledge of anatomic landmarks can minimize serious complications. In addition, the surgeon must become familiar with current instrumentation and operative strategies that employ CT scans and television monitors. This experience is acquired by performing nasal endoscopic examinations, assisting experienced surgeons, and working under the supervision of experienced surgeons during initial FESS surgeries.

If all these requirements are met, the success rate for pediatric FESS ranges between 80% and 92%.[9,13–16] There are, however, 10–20% of the patients in every series who do not improve despite exploiting all the available therapeutic modalities. This indicates that there are still unidentified and important factors contributing to chronic sinusitis that deserve investigation.

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