

Safety and efficacy of pediatric functional endoscopic sinus surgery for the treatment of pediatric chronic rhinosinusitis

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Objective

The objective of this article is to evaluate the effectiveness and safety of pediatric endoscopic sinus surgery for the treatment of pediatric chronic rhinosinusitis (CRS).

Patients and methods

This study was of a retrospective observational clinical type and was carried in the tertiary referral center. A total of 90 patients with CRS refractory to medical treatment and operated with endoscopic sinus surgery were included in this study. Computed tomography scan of the nose and paranasal sinuses was done for all patients. Sinonasal outcome test-20 German adapted version was used for preoperative and postoperative symptoms evaluation.

Results

Among these 90 children, there were 62 males and 28 females, with mean age of 12.5 (7–16) years. A total of 84 (93.3%) patients had CRS without nasal polyps, and CRS with nasal polyps was present in the remaining six (6.7%) patients. Nasal obstruction and purulent nasal discharge were the most reported symptoms. The follow-up period ranged from 6 months to 5 years, with a mean of 3.7 years. The overall success of the procedure was 68.8%. The most significant improvement was noticed by patients with nasal obstruction and purulent nasal discharge (90.3 and 88.8%). The least improvement occurred in patients with hyposmia (36.3%).

Conclusion

Functional endoscopic sinus surgery is a safe and effective procedure in children. Proper preoperative selection of patients is mandatory. Limited surgical intervention is needed in children with control of the disease and preservation of the nasal mucosa. Second-look operation may be needed in some cases. Follow-up is essential for success of the procedure.

Keywords:

chronic rhinosinusitis, endoscopic treatment, second-look operation

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Introduction

Since Gross *et al.* [1] reported their experience with the application of functional endoscopic sinus surgery (FESS) in pediatric age, it has rapidly gained acceptance as the primary surgical procedure for the treatment of different sinonasal pediatric diseases. In 1994, Poole [2] suggested the term pediatric endoscopic sinus surgery (PESS) to mean FESS performed in pediatric population.

Chronic rhinosinusitis (CRS) is commonly seen in children and its effect has become more apparent as the awareness of the disease has increased [3]. Generally, most children can be cured by medical treatment, and surgery is only indicated when medical treatment fails [4].

This study was constructed to evaluate the effectiveness and safety of FESS in children.

Patients and methods

Ethical approval for this work was obtained by ethical committee board in our department.

The study was conducted between 2007 and 2013. A total of 90 patients with refractory CRS were included in this study. They were 62 males and 28 females, with mean age of 12.5 (7–16) years. Among these patients, we found CRS with nasal allergy in 50 patients, CRS without nasal allergy in 34 patients, and CRS with nasal polyps in six patients.

Preoperative assessment

The diagnosis of pediatric chronic rhinosinusitis (PCRS) is defined as at least 90 continuous days of symptoms of purulent rhinorrhea, nasal obstruction, facial pressure/pain, or cough with corresponding endoscopic and/or computed tomography (CT) findings in a patient who is 18 years of age or younger [5].

All patients underwent preoperative radiological assessment by CT scan of the nose and paranasal

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sinuses, both axial and coronal cuts, to document the extent of their disease. Any anatomical variants of the middle turbinate (MT), dehiscence of the lamina papyracea or skull base, relation to the optic nerve, or other significant variation were identified. Extent of sinus affection, that is, number of affected sinuses, was identified. Preoperative CT scans of the sinuses were staged using the Lund–Mackay scoring system [6].

Preoperative symptoms, external physical examination, endonasal examination by anterior rhinoscopy, office endoscopic examination ‘if possible’, and preoperative endoscopic evaluation were recorded. The diagnosis of nasal allergy was confirmed by clinical history, clinical examination, and positive skin test for certain allergen and elevated total serum IgE.

Preoperative questionnaire was obtained from patients or relatives. In this study, sinonasal outcome test (SNOT)-20 German adapted version (GAV) was used for preoperative and postoperative symptoms evaluation [7]. The SNOT-20 (GAV) contains 20 items (Table 1). Each symptom was analyzed and evaluated clinically as no (-), mild (+), moderate (++), and severe (+++).

Inclusion criteria

The inclusion criteria were as follows:

- (1) Patients who were 16 years or younger.
- (2) Patients with different applications of PESS (CRS with and without nasal allergy and polyps) after failure or absence of other lines of treatment.
- (3) Positive preoperative CT findings (documenting extent of the disease).
- (4) Minimum postoperative follow-up period of 6 months.

Patients with CRS were initially treated with broad-spectrum antibiotics, decongestants, and nasal suction

Table 1 Items of sinonasal outcome test –20 German adapted version and NOSE questionnaires

Nasal obstruction	Sneezing	Runny nose
Postnasal discharge	Thick nasal discharge	Dry throat
Cough	Ear fullness	Ear pain
Loss of smell	Dizziness	Facial pain/pressure
Difficulty falling asleep	Wake up at night	Fatigue
Reduced productivity	Reduced concentration	Sad
Frustrated/restless/irritable		Embarrassed

NOSE, nasal obstruction symptom evaluation score.

and wash and antihistamines in ‘allergy group’; if poor response to the initial 2-week medical treatment was noted, antibiotics such as amoxicillin–clavulanate or cefixime were given instead. Cases that had associated adenoids underwent surgical excision first (six patients). Cases with persistent or recurrent CRS after adenoidectomy were included in this study group. Patients were included if they had CRS (at least 12 weeks of persistent symptoms) with positive preoperative CT findings.

Surgical technique

The procedures were done under general anesthesia in all patients with hypotensive technique. Different angled 4-mm rigid endoscopes (0°, -30°, and -45°) were used (2.7-mm endoscopes were not available).

Surgical technique for chronic rhinosinusitis without nasal polyps (84 patients)

The surgical technique was performed according to Messerklinger technique [8] for FESS, but some modifications and the extent of surgery were based on the sinuses involved. The operation is directed to the origin of the disease with preservation of the mucosa as possible.

The uncinate process was incised in its midportion with a dissector or backbiting forceps forming a small window. The uncinate bone and free mucosal edges of the lateral and medial mucosa of the uncinate process can then be removed. A ball tipped seeker was used first to place within the infundibulum to minimally displace the uncinate anteriomedially which will assist in getting the backbiting forceps.

Removal of the lower portion of the uncinate process was done by a forceps after dissection with a sickle knife. The upper portion of the uncinate process is removed by a sickle knife and forceps. Care was taken not to extend the dissection of the upper portion to the root of the MT.

After uncinectomy, 30° endoscope was used to identify the ostium of the maxillary sinus. If the ostium was patent, then it usually will not be dilated. However, if ostial dilation was indicated, it was done in the posterior and inferior areas. The superior and anterior margins of the maxillary ostium were not manipulated (Fig. 1).

The bulla ethmoidalis was identified, and its lower medial portion was removed creating a functional opening that includes its natural ostia. If there were continued mucosal abnormalities, more comprehensive surgery was performed on the anterior ethmoids. If a

posterior ethmoidectomy is to be performed (according to the score of the disease), the basal lamella is penetrated and the posterior cells were opened only without excision of the mucosa (Fig. 2).

If sphenoid sinus was needed to be entered, the identification of the natural ostium of the sphenoid sinus on the medial side of the superior turbinate was essential. Enlargement of the natural ostium was done using a curette taken down the lateral ridge in a posterior to anterior direction. Careful dissection of the diseased mucosa from the walls of the sphenoid sinus was done (Fig. 3). At the end of the surgery, intranasal merocele nasal packs were inserted.

Surgical technique for chronic rhinosinusitis with nasal polyps (six patients)

In cases associated with nasal polyps, the first surgical step was bilateral polypectomy until complete visualization of the MT and choanal arch was achieved. Then the surgical technique and preoperative, operative, and postoperative care were similar to the cases with CRS without nasal polyps.

Postoperative care and follow-up

The nasal packing was removed 3 days postoperatively, and the patient was discharged the next day. After surgery, a daily single dose of 20-mg prednisolone was prescribed for 10 days. Antibiotics and mucolytics were prescribed for 6 weeks, and topical nasal steroid spray was prescribed until 3 months after the procedure. Patients were instructed to use topical alkaline nasal wash frequently to minimize crusts formation. The follow-up period ranged from 6 months to 5 years with a mean of 3.7 years. Postoperative questionnaire was administered to all patients to grade the improvement of their symptoms. The questionnaire was completed at the end of the follow-up.

Second-look endoscopic examination (30 patients)

Second-look endoscopic examination was indicated when there was difficulty in examination of an uncooperative child or with the presence of abnormal nasal cavity by clinical nasal examination (extensive crustations, adhesions, or polyps). Second-look endoscopic examination included the following: (a) removal of debris, crusts, or any polypoidal tissues, (b) reventilation of the sinuses, (c) thorough irrigation of the maxillary sinus if mucopurulent discharge is present, and (d) cutting of any synechiae.

Statistical analysis

Data were processed using SPSS 14.0 statistical software for Windows (SPSS Inc., Chicago, Illinois,

Figure 1



Polyps in middle meatus.

Figure 2



MMA and sphenoidotomy.

Figure 3



Complete ethmoidectomy.

USA). The significance level was set at a *P* value less than 0.05.

Results

This study was a retrospective one that included 90 children with refractory CRS [84 (93.3%) without nasal polyps and six (6.7%) with polyps]. There were 62 male and 28 female patients, with age ranged from 7 to 16 years, with mean age of 13.4 years.

Patients exhibited diverse preoperative symptoms. From SNOT-20 (GAV), the main preoperative symptoms in CRS were nasal obstruction (92.2%), purulent nasal discharge (90%), postnasal drip (73.3%), and headache and facial pain (57.7%). Hyposomia and chronic cough were found in 54.4 and 24.4%, respectively (Table 2).

Postoperative symptoms improvement at the end of the follow-up period was assessed. The overall success of the procedure was 68.8%. Postoperative improvement was judged primarily by reduced symptoms, reduced frequency of exacerbations and hence the need for antibiotics, and fewer doctor visits during the follow-up period. The most significant improvement was noticed by patients with nasal obstruction and purulent discharge (90.3 and 88.8%, respectively). The least improvement occurred in patients with chronic cough (36.3%) (Table 2).

Among the 90 patients, many anatomical variants and pathology were detected (Tables 3 and 4). The most common was persistent adenoids in spite of previous adenoidectomy; 10 patients had nasopharyngeal adenoids, three patients had choanal adenoids, 11 patients had deviated septum, eight patients had concha bullosa, five patients had bronchial asthma, five patients had diabetes mellitus, and two patients had chest diseases (bronchiectasis and recurrent chest infection).

The second-look operation of 30 (33.3%) patients was because of synechiae in 11 (12.2%) patients, owing to

recurrent polyposis in one (1.1%) patient, and owing to uncooperative children with the presence of extensive crustation, adhesions, polyps, or discharge during nasal examination in 18 (20%) patients.

Complications

No major complications were detected. Nasal synechiae was the most common complication reported in five (5.5%) patients. A total of two patients had synechiae between the MT and the septum, and three children had synechiae between the MT and lateral nasal wall. The synechiae was managed by cutting of adhesion and insertion of nasal stent between the septum and MT in two patients and by partial middle turbinectomy in the remaining patients. Significant nasal bleeding was reported in two (2.2%) patients. Orbital fat prolapse was reported in one patient. It was discovered during surgery, and the patient was managed conservatively without any sequelae (Table 5).

Discussion

The diagnosis of rhinosinusitis is primarily a clinical diagnosis based on the duration of illness and complex of signs and symptoms [9]. CRS represents a heterogeneous spectrum of diseases.

The definition of CRS has largely been accepted as the persistence of characteristic signs and symptoms beyond 12 weeks [10]. Most children with sinus disease can be well cured with medical management. However, there are some children who still require surgical intervention. Endoscopic sinus surgery is a worldwide standard surgical procedure for CRS that does not respond to conservative therapy [11].

In this study, 90 children with refractory CRS were included. These patients have been meticulously evaluated and selected after appropriated stepwise treatment protocol including medical treatment with broad-spectrum antibiotics with or without

Table 2 Main preoperative symptoms and results of pediatric endoscopic sinus surgery

Symptom	Preoperative [N (%)]	Postoperative improvement [N (%)] ^a		
		Improvement	No change	Worse
Nasal obstruction	83 (92.2)	75 (90.3)	8 (9.7)	0
Purulent rhinorrhea	81 (90)	72 (88.8)	9 (12.2)	0
Postnasal drip	66 (73.3)	49 (74.2)	17 (25.8)	0
Headache	52 (57.7)	31 (59.6)	21 (40.4)	0
Hyposomia	49 (54.4)	19 (38.7)	30 (61.3)	0
Chronic cough	22 (24.4)	8 (36.3)	14 (62.7)	0

^aThe percentage was calculated based on the total number of patients who presented each specific symptoms.

adenoidectomy [3]. Adenoid hypertrophy represents a very common etiology of nasal obstruction and rhinorrhea in children. Identification and management of adenoid hypertrophy is the cornerstone in management of these symptoms and in assurance of successes of surgical intervention in term of long-lasting results and recurrence prevention. Patients with failed medical treatment with persistent symptoms and having positive CT findings of sinus affection were only included in this study.

Basically, there were two major goals of surgery: (a) to re-establish a patent physiologic communication between the diseased paranasal sinuses and the nasal cavity with the least invasive procedure and (b) to preserve normal anatomy of nasal and sinus mucosa as possible. So, the aim of PESS was drainage procedure rather than extirpation procedure [12].

To achieve these objectives, limited PESS technique was used. This technique has many advantages: can re-establish the ventilation and drainage of the sinuses through the natural pathway, optimize wound healing, prevent unnecessary growing bone removal, and simplify postoperative care [13].

Anatomy in pediatric age has specific criteria and so does the pathological disease process. For these reasons, some factors are highly important to consider and should be applied effectively to guarantee safe and effective PESS. These factors include the following: solid orientation of paranasal sinuses (PNS) anatomy with all

possible variations, thorough preoperative analysis of patient radiological information, strict application of hemostatic procedures including preoperative medical treatment of acute infection, preoperative decongestants, meticulous surgical techniques, appropriate management of intraoperative bleeding with packing and warm saline irrigation or cautery as required, and optimum surgical training through training courses including cadaver dissection, good illumination, and visualization tools.

Uncinectomy and middle meatal antrostomy were done in all cases (Table 2), whereas frontal recess approach was not done in any case in this study because of the delayed development of the frontal recess and sinus.

The results of PESS have been shown in several studies [14–17]. Most of the reported outcomes are based on the levels of symptomatic relief and do not include objective measures such as nasal endoscopy or CT scans. Giger *et al.* [14] proved that endoscopic scores correlate significantly with subjective satisfaction ratings ($P > 0.001$). Jiang and Hsu [16] and Fakhri *et al.* [18] observed postoperative improvement in 84%. A meta-analysis performed by Hebert and Bent [15] including 832 children (eight clinics) revealed a positive outcome from 88 to 92% after average follow-up of 3.7 years. In this study, the overall success of the procedure was 68.8%. Nasal obstruction and purulent nasal discharge were the most improved postoperative symptoms (90.3 and 88.8%, respectively) (Table 2).

One of the difficulties of PESS is to assess the preoperative or postoperative symptoms. In this

Table 3 Surgical intervention

Surgical steps	N (%)
Uncinectomy	
Partial	71 (78.8)
Total	19 (21.2)
Middle meatal antrostomy	
Patent	64 (71.1)
Dilatation	26 (28.9)
Ethmoidal bulla	
Partial excision	80 (88.8)
Total excision	10 (11.2)
Posterior ethmoidectomy	12 (13.3)
Sphenoidotomy	3 (3.3)
Frontal recess approach	0 (0)

Table 4 Concurrent nasal anomalies or diseases

Pathology	N (%)	Management
Choanal adenoids	13 (14.4)	Endoscopic adenoidectomy
Septal spur	11 (12.2)	Localized endoscopic excision
Choncha bullosa	8 (8.8)	Partial excision
ITH	7 (7.7)	Partial turbinectomy or diathermy
Diabetes mellitus	5 (5.5)	Medical control
Recurrent chest infection	2 (2.2)	Medical control

Table 5 Mortality and complications

Complication	N (%)	Treatment
Synechiae	5 (5.5)	Nasal stent or partial middle turbinectomy
Nasal bleeding	2 (2.2)	Nasal pack and bipolar diathermy
Orbital fat prolapse	1 (1.1)	Conservative treatment
Mortality	0 (0)	

study, a questionnaire SNOT-20 (GAV) was used to assess the patient symptoms, either preoperative or postoperative. This SNOT-20 (GAV) is a well-validated German translation of the American SNOT-20. It assesses the health status and health-related quality of life in sinonasal disease. The German version includes changes in three items of the initial version and introduces the items 'nasal obstruction', 'dry throat/need to harrumph', and 'loss of smell' [9].

Another difficulty of PESS is the tiny and thin intranasal anatomy of children. Important structures are at great risk of injury during PESS such as optic nerve, extraocular muscles, and lacrimal drainage system [13]. Availability of the 2.7-mm telescope with a high-intensity light source is often suggested. For our patients, we performed all FESS procedures without any difficulties and with a better feeling of depth using a 4.0-mm telescope. However, owing to the precarious and fragile anatomy in children, proper control of bleeding and meticulous handling of the instrumentation are mandatory [19].

The second-look operation could be required or not depending upon the ability of the child and parents to use nasal irrigation to clean debris from the surgical field to get a clean smooth cavity for proper healing. The advantages of postoperative endoscopic examination under general anesthesia include a detailed inspection of the surgical field and removal of any blood clots, granulation tissues, or adhesions. It is usually done 2–4 weeks after surgery to allow adequate healing of the operative field without maturation of the scar tissue and subsequent synechiae formation [13,20]. However, Mitchell *et al.* [21] reported that second-look procedure has no value on the clinical outcome of PESS.

Adhesions are the consequence of mucosal damage to adjacent surfaces. According to Lazar *et al.* [20], postoperative synechiae are the most common postoperative complication irrespective of the age of the patient and constitute about 43%. To overcome this problem, dental wax plates [22], silastic stent [23], and mitomycin C [24] have been advocated.

In this study, there were no major surgical complications, but only 14 children experienced operative complications. Injury to lamina papyracea with periorbital fat prolapsed was noticed in one child and resulted in periocular swelling and temporary diplopia. This complication occurred in a child with nasal polyposis. It was noticed early during surgery by floating of the fat in the saline. This child

was managed conservatively with measures to decrease edema and avoidance of nose blowing together with watchful observation, and there was no need for any intervention.

Techniques to minimize and control intraoperative blood loss are critical in pediatric patients owing to their overall lower blood volume compared with adult patients [25]. Significant bleeding was noticed in two children but did not require postoperative blood transfusion. This bleeding was from aspirin intake in a child with rheumatic fever in the first case and from injury of the anterior ethmoid artery in the second child. The bleeding was controlled by nasal pack for 3 days in the first child and by bipolar cautery in the other.

Postoperative simple synechiae (either between MT and septum or between MT and lateral nasal wall) were the most common complications encountered in 11 patients after surgery. The adhesions were easily divided under local or general anesthesia with insertion of nasal stents in the cases of adhesion between the MT and the septum. However, in cases of adhesion between the MT and lateral nasal wall, the adhesions usually resulted from lateralized MT. In these cases, adhesions were managed by partial resection of the MT.

Partial middle turbinectomy was proposed by Stammberger [8] in an attempt to decrease synechiae formation with subsequent closure of the middle meatal antrostomy, frontal recess, or ethmoid fossa. However, in this study, partial middle turbinectomy was not an essential step in the routine procedure. It was indicated only in cases of choncha bullosa or during the second-look operation where the adhesions between the MT and the lateral nasal wall were found.

A controversy exists regarding the effect of sinus surgery on the facial growth. Mair *et al.* [26] showed that any surgery – even limited surgery – in the anterior ethmoid region could affect the sinus and facial growth in their animal study. On the contrary, Stankiewicz [27] revealed that no notable hemifacial deformity had been reported among children who underwent endoscopic sinus surgery, but sinus hypoplasia has been noted on CT examination. Moreover, Bothwell *et al.* [28] revealed no effect of PESS on facial growth.

Conclusion

FESS is a safe and effective procedure in children. Proper preoperative selection of patients is mandatory.

Limited surgical intervention is needed in children with control of the disease and preservation of the nasal mucosa. Second-look operation may be needed in some cases. Follow-up is essential for success of the procedure.

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Conflicts of interest

There are no conflicts of interest.

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