

The Efficacy of Transcanal Endoscopic Ear Surgery in Children Compared to Adults

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Abstract

Objectives: Using transcanal endoscopic ear surgery to manage middle ear disease in children remains a controversial topic. The aim of this study was to compare the efficacy of transcanal endoscopic ear surgery between children and adults. **Methods:** This study consisted of 20 children (31 ears) and 86 adults (102 ears) with chronic otitis media who underwent transcanal endoscopic ear surgery between January 2014 and August 2016 at Taipei and Hsinchu Cathay General Hospital. Among these patients, 13 children (23 ears) and 23 adults (34 ears) had chronic otitis media with effusion, 4 children (5 ears) and 46 adults (51 ears) had chronic otitis media without cholesteatomas, and 3 children (3 ears) and 17 adults (17 ears) had cholesteatomas. The two groups were compared with respect to (1) surgical outcome, which included the rates of surgical success, hearing restoration, and postoperative complications, and (2) surgical time. **Results:** We observed no significant difference between pediatric and adult patients with regard to the rates of surgical success, postoperative hearing gain, and postoperative complications in all surgical procedures. As for ventilation tube insertion, the pediatric patients had shorter surgical time compared to adult patients. With respect to tympanoplasty, the pediatric group had a longer surgical time than adults did. **Conclusions:** Our study showed that transcanal endoscopic ear surgery can be successfully applied to manage various middle ear diseases in children.

The Efficacy of Transcanal Endoscopic Ear Surgery in Children Compared to Adults

Running Title: The Efficacy of TEES in Children

Abstract

Objectives:

Using transcanal endoscopic ear surgery to manage middle ear disease in children remains a controversial topic. The aim of this study was to prove the efficacy of transcanal endoscopic ear surgery in children.

Design:

Comparing the efficacy of transcanal endoscopic ear surgery between children and adults by surgical outcome, which included the rates of surgical success, hearing restoration, postoperative complications, and surgical time.

Setting:

Among the patients recruited in this study, 13 children and 23 adults had chronic otitis media with effusion, 4 children and 46 adults had chronic otitis media without cholesteatomas, and 3 children and 17 adults had cholesteatomas.

Participants:

This study consisted of 20 children and 86 adults with chronic otitis media who underwent transcanal endoscopic ear surgery between January 2014 and August 2016.

Main outcome measures:

Between children and adults, two groups were compared with respect to surgical outcome, which included the rates of surgical success, hearing restoration, and postoperative complications, and surgical time.

Results:

As for ventilation tube insertion, the pediatric patients had shorter surgical time compared to adult patients. With respect to tympanoplasty, the pediatric group had a longer surgical time than adults did.

Conclusions:

Our study showed that transcanal endoscopic ear surgery can be successfully applied to manage various middle ear diseases in children.

Keywords:

Transcanal endoscopic ear surgery, Pediatric, Chronic otitis media, Cholesteatoma, Middle ear diseases

Key Points:

1. Transcanal Endoscopic Ear Surgery (TEES) has become one of the most influential methods in dealing with adult ear disease.
2. The surgical time for VTI in children was shorter than in adults. However, for tympanoplasty was significantly longer in the pediatric patients than in the adult patients.
3. No significant difference between children and adults with regard to rates of surgical success, postoperative complications, and postoperative hearing gain when VTI, tympanoplasty, or TEES management of cholesteatoma was performed.
4. The feasibility of transcanal endoscopic ear surgery for the management of pediatric middle ear disease is sufficient.
5. TEES can be successfully and effectively used in the treatment of middle ear disease in both adults and children, even in complicated cholesteatoma cases.

Objectives:

Microscopic ear surgery (MES) is a well-developed traditional surgical procedure for treating middle ear disease. However, the microscope provides only a straight-line view through the ear canal, and blind spots and hidden recesses can easily be missed using this transcanal approach. This problem is especially common in the management of cholesteatomas and can increase the risk of a residual cholesteatoma due to remnants of the matrix in the ear [1]. An otologist often must adopt the retroauricular transmastoid approach to overcome the limited surgical view of the microscope, which inevitably leaves an obvious surgical wound behind the ear.

Recently, transcanal endoscopic ear surgery (TEES) has been proven to be an effective alternative to traditional MES for treating middle ear disease in adults due to its wider and more flexible surgical view, better mastoid function preservation, smaller surgical wound, shorter surgical time, and shorter hospital stay [1-5]. However, the feasibility of TEES in pediatric patients is still debatable because children's external auditory canals (EACs) are narrower, shorter, and curvier than those of adults [1]. In this study, the surgical outcomes and surgical time (duration of surgery) were compared between adult and pediatric patients who underwent TEES, and we also discussed the feasibility of TEES in children.

Design:

A retrospective review of medical records was conducted in this study. Preoperative and postoperative evaluations included otoscopic examination and audiometric assessment. Furthermore, for patients with

cholesteatomas, preoperative imaging was performed using temporal bone high-resolution computed tomography (HRCT). We recorded the surgical outcome, postoperative complications, preoperative and postoperative audiometric results, and surgical time in detail to carry out the comparison.

Setting:

The TEES was performed using 0- or 30-degree wide-angle endoscope with a 3-mm diameter and 14-cm length (HOPKINS® Telescopes, Karl Storz, Germany). All operations were conducted by the same surgeon (senior author). Three different TEES procedures were adopted in order to manage different diseases.

Ventilation tube insertion (VTI) for OME

Ventilation tube insertion was performed under general anesthesia in pediatric patients and under local anesthesia in adults. The procedure included myringotomy on the anterior-inferior quadrant of the tympanic membrane, followed by drainage of the middle ear fluid and interposition of the ventilation tube through the ear drum. Different ventilation tubes (Sheehy-Type Collar Buttons, Medtronic, USA, Inc) with diameters of 1.02 and 1.27 mm were selected for pediatric and adult patients, respectively. Irrigation with ofloxacin (3 mg/mL) (Tarivid; Daiichi Sankyo, Japan) was performed following ventilation tube stabilization.

Tympanoplasty for COM without cholesteatoma

Tympanoplasty was also performed under general anesthesia for children and under regional local anesthesia for adults (2% lidocaine hydrochloride and 1:50000 epinephrine) with injection on the skin of the tragus and ear canal. The graft material (including the perichondrium and cartilage) was harvested from the meatal surface of the tragus, and the wound was sutured with Vicryl 5-0 (Coated VICRYL® polyglactin 910 Suture, Ethicon, US). After denuding the perforated edge of the ear drum, a transmeatal incision (straight upward) was made to elevate the tympanomeatal flap. All the inflammatory tissue in the tympanic cavity was then completely removed, and the tympanic cavity was cleaned using saline irrigation. Furthermore, the ossicular chain was checked, and ossiculoplasty was simultaneously performed if such was deemed necessary. The skin of the anterior canal and the annulus were elevated, and surgifoam (Spongostan Gelatin Hemostatic Sponge, Ethicon, US) soaked with ofloxacin (3 mg/mL) (Tarivid; Daiichi Sankyo, Japan) was placed in the middle ear cavity. The perichondrium graft was introduced underneath the perforated ear drum; then, the tympanomeatal flap was repositioned. The ear canal was then packed with surgifoam soaked with ofloxacin.

TEES for Cholesteatoma

For this condition, the graft tissue, including the perichondrium and cartilage, was also harvested from the meatal surface of the tragus. Then, an elongated transmeatal incision was made to elevate the tympanomeatal flap. Next, the scutum was drilled to expose the attic area. The dissection was extended along the cholesteatoma to the bottom of the matrix until the cholesteatoma could be completely removed. If the ossicular chain was involved and destroyed by the cholesteatoma, ossiculoplasty was performed simultaneously as necessary. The reconstruction procedure was slightly modified according to the extent of the dissection in each case. In patients who had limited cholesteatomas confined within the attic, the tympanic cavity and scutum were reconstructed using the composite cartilage and perichondrium (close cavity procedure) (Figure 1) [20]. In patients who had advanced disease involving the mastoid cavity proper, we reconstructed only the tympanic cavity and left the mastoid antrum as an open cavity in the ear canal (open cavity procedure).

The performance of all of the above TEES procedures left no surgical wound outside the ear canal. After the operations, patients were regularly followed up in the outpatient clinic for 18 to 48 months. For patients who underwent tympanoplasty, successful surgery was defined as complete healing of the tympanic membrane; for those with cholesteatomas, it was defined as complete removal of the cholesteatoma without any residual or recurrent disease during the postoperative follow-up.

Participants:

This study was conducted from January 2014 to August 2016. We enrolled a total of 31 ears of 20 pediatric patients (aged 3-18 years) and 102 ears of 86 adult patients (aged 24-78 years) with chronic otitis media

(COM) who underwent TEES in this study. Among the subjects, 13 children (23 ears) and 23 adults (34 ears) had chronic otitis media with effusion (OME), 4 children (5 ears) and 46 adults (51 ears) had COM without cholesteatomas, and 3 children (3 ears) and 17 adults (17 ears) had cholesteatomas.

Patient characteristics are summarized in Table 1; 53% of the subjects were male. The mean ages of the pediatric and adult patients were 8.4 and 49.5 years, respectively. The most frequent procedure among the pediatric patients was VTI (74%), followed by tympanoplasty (16%), and mastoidectomy (10%); among adult patients, the majority underwent VTI (33%), followed by tympanoplasty (50%), and mastoidectomy (17%).

Main outcome measures:

Comparison of TEES in children and adults

To determine the feasibility of TEES in children, these two groups were compared with respect to (1) surgical outcome, which included the rates of surgical success, hearing restoration (postoperative hearing gain), and postoperative complications, and (2) surgical time (duration of surgery).

Result:

Surgical Outcomes

No complications were noted following the surgery in either of our study groups. Regardless of the surgical procedure, all patients demonstrated improvement in the air-bone gap after the surgery. The results showed no significant difference between the pediatric and adult groups with respect to the rates of surgical success and postoperative hearing gain; the same was observed whether VTI, tympanoplasty, or cholesteatoma TEES management was performed. Both VTI and mastoidectomy had 100% success rates in each group. All patients recovered well, with the patients having either satisfactory ventilation tube function after VTI or no residual or recurrent cholesteatoma after mastoidectomy. We found no significant difference between children and adults regarding to the success rate of tympanoplasty, although the rate was lower in the pediatric patients (80% in children vs. 96% in adults, $p=0.253$) (Table 2).

We observed no significant difference between these two groups with regard to rates of surgical success, postoperative complications, and postoperative hearing gain when VTI, tympanoplasty, or TEES management of cholesteatoma was performed. All patients achieved improved air-bone gap, and none experienced residual or recurrent disease during the 18- to 48-month postoperative follow-up after the management of cholesteatoma. Therefore, we believe that TEES may also have a satisfactory surgical outcome in children as well as in adults.

Surgical time

The surgical time for VTI in children was shorter than in adults (pediatric group, 11.7 min; adult group, 19.1 min; $p<0.05$). Because the procedure was performed under local anesthesia in adults; the injection of the local anesthesia in the ear canal may account for the longer surgical time. (Table 3)

The average surgical time for tympanoplasty was 89.6 min in all cases and was longer in the pediatric patients than in the adult patients (pediatric group, 118 min; adult group, 86.6 min; $p<0.05$). (Table 3)

Our study results revealed that the surgical time for tympanoplasty was significantly longer in the pediatric patients than in the adult patients. Children's ear canals are narrower than those of adults at the orifice and isthmus, which increases the difficulty of endoscopic transcanal manipulation; these factors may have also increased the surgical time [21]. However, the average surgical time in the pediatric group still fell within satisfactory limits.

The management of cholesteatoma required the longest surgical time (average of all cases, 156 min); this was not surprising due to it being a more sophisticated procedure. However, no difference was observed between the pediatric and adult groups with regard to the surgical time (pediatric group, 158.3 min; adult group, 155.6 min; $p=0.897$). (Table 3)

In the treatment of cholesteatoma, no statistically significant difference was found between these two groups with respect to surgical time because the TEES management of cholesteatoma is quite a sophisticated and complicated procedure in both children and adults; therefore, it generally has a longer surgical time regardless of the group.

Discussion:

The feasibility of TEES in pediatric patients

In recent years, an increasing number of studies have proven the benefits of TEES in managing middle ear diseases [10-20]. For the management of cholesteatoma, better visualization of the residual cholesteatoma in the hidden space can be provided by an endoscope [1, 5, 6, 10-20]. Such an endoscope can also provide a high-resolution image in order to clearly identify the tympanic segment of the facial nerve. The facial recess can be easily explored using an endoscope with an angle-view without curetting or drilling the surrounding structure around the facial nerve [4, 9]. Furthermore, with the transcanal endoscope-assisted middle ear surgery, most of the healthy structures and mastoid air cells, as well as the mucosal gas exchange and mastoid buffer, can be preserved, which are crucial for restoring middle ear function and reducing post-surgical morbidity [1, 2, 6, 20]. Muaaz et al. have also suggested that the time needed for endoscopic ear surgery is shorter than that required for traditional microscopic ear surgery. Using the endoscopic transcanal approach facilitates faster access to the pathologic lesion directly through the ear canal without drilling the mastoid cavity, which may thus significantly reduce the surgical time [4].

Most of the previous studies were conducted in adult patients, while few were conducted in pediatric patients. Studies on the applicability of TEES in pediatric patients are lacking, and thus the efficacy and feasibility of TEES in children remains controversial. The external auditory canal (EAC) in children is shorter and narrower than that of adults, and whether this may limit the application of TEES in pediatric patients with middle ear disease is still under investigation. In a study by Sun et al. on the anatomical applicability of TEES in children, the authors provided anatomical evidence and suggested that TEES can be a safe and effective alternative in the treatment of middle ear disease in children with appropriate endoscopes and instruments [21]. Some authors have already reported the successful clinical application of endoscopes in middle ear surgery in children [22-24].

Our study showed that the pediatric patients can have as good surgical outcomes (including the rates of surgical success, postoperative complications, and postoperative hearing gain) as adult patients, regardless of the surgical procedure. The surgical time required for TEES management of cholesteatoma was similar in both the pediatric and the adult patients. Although the surgical time of tympanoplasty was longer in children, it still fell within an acceptable range.

Study limitations

We have only begun to adopt TEES for the management of middle ear disease in recent years. The number of patients in our study was still limited, especially in the pediatric group. Furthermore, the follow-up period was not long enough (18-to 48 months) to obtain long-term results. We think that additional studies with more patients and long-term follow-up may be required to generate more definitive conclusions.

Conclusion:

We believe that TEES can be successfully and effectively used in the treatment of middle ear disease in both adults and children, even in complicated cholesteatoma cases. However, further studies involving a larger number of patients are warranted to confirm our hypothesis.

Data Availability Statement:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Tables:

Table 1

Patient characteristics

Variable	VTI Children	VTI Adults	Tympanoplasty Children	Tympanoplasty Adults	Mastoidectomy Children	Mastoidectomy Adults
Ears (number)	23	34	5	51	3	17
Mean age (years)	7.6	50.1	11.2	50.5	10	45.1
Age range (years)	3-18	24-78	6-15	27-78	5-16	26-60
Male sex (%)	60.9%	82.4%	20.0%	42.0%	33.3%	35.3%

Table 2

Comparison of surgical outcome of TEES between pediatric and adult patients

Variable	VTI Children (23)	VTI Adults (34)	VTI P	Tympanoplasty Children (5)	Tympanoplasty Adults (51)
Hearing gain (dB)	18.3	17.8	0.932	7.4	10.3
Preoperative air-bone gap	23.5	24.3	0.783	21	24.8
Postoperative air-bone gap	4.8	9.9	0.051	13.7	14.5
Success rate (%)	100	100	-	80	96
Postoperative complication rate (%)	0	0	-	0	0

Table 3

Comparison of surgical time of TEES between pediatric and adult patients

Variable	VTI Children (23)	VTI Adults (34)	VTI P	Tympanoplasty Children (5)	Tympanoplasty Adults (51)	Tympanoplasty P
Surgical time (min)	11.7	19.1	< 0.05	118	86.6	< 0.05

Figures:

Figure 1

Congenital cholesteatoma removal using TEES in a 5-year-old girl : A) After elevating the tympanomeatal flap, the cholesteatoma behind the corda tympani was visible. Co = cholesteatoma; C = corda tympani nerve; Tm = tympanomeatal flap; B) After drilling the scutum, the surgeon carefully removed the cholesteatoma; C) The incus was destroyed, and the stapes could not be identified during surgery. Therefore, the destroyed incus was removed. I = destroyed incus; D) The residual cholesteatoma at the sinus tympanum and the matrix at the oval window were removed. O = oval window; E) Water irrigation of the middle ear; F) Identification of the location of the foot plate and facial nerve. Fp = foot plate; Fn = facial nerve; G) The scutum was reconstructed using tragus cartilage. Meanwhile, the ossicular chain was restored using total ossicular replacement prosthesis. T = tragus cartilage; To = total ossicular replacement prosthesis (TORP); H) Replacement of the tympanomeatal flap



Permission of citation

As the illustrator of “*Transcanal Endoscopic Ear Surgery for Congenital Cholesteatoma: A Preliminary Report*,” I grant the authors the right to publish the material both online and in print in a scientific medical journal regarding the figures in the article “*A Comparative Study of Transcanal Endoscopic Ear Surgery in Pediatric and Adult Patients*” submitted to *Otolaryngology-Head and Neck Surgery*.

