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Endoscopic middle ear exploration in pediatric patients with conductive hearing loss☆

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ABSTRACT

Objective: To describe our indications, findings, and outcomes for transcanal endoscopic middle ear exploration in pediatric patients with conductive hearing loss of unknown etiology, without effusions.
Methods: Prospective case series for all pediatric patients undergoing totally endoscopic transcanal middle ear exploration between April 2012 and October 2015 at a pediatric tertiary care referral hospital. Demographic data, operative findings, and hearing results were reviewed.
Results: 21 cases were performed in 20 ears (1 revision). Average age at surgery was 7.98 years and average follow up was 2.1 years. Middle ear pathology identified on CT imaging was confirmed in 55% of cases while identified in 45% of cases where pre-operative imaging was non-diagnostic. 6/20 patients (30%) had an ossicular deformity. 8/20(40%) had bony ossicular fixation. 5/20(25%) had ossicular discontinuity. 2/20(10%) had facial nerve dehiscence impinging on the stapes. 15% had adhesive myringosclerosis or severe granulation causing hearing loss. Prosthetic ossiculoplasty was done in 7/21 (33.3%) of the cases, with 1 TORP, 3 PORPs, and 3 IS joint replacements. Imaging was predictive of intraoperative findings in 13/20 cases (55%). Trainees assisted in 16/21(76%) of cases. The average improvement of PTA was 11.65 dB (range −10 to 36.25), and the average ABG improved 10.19 (range −11.25 to 28.75). There were no perioperative complications or adverse events.
Conclusions: The endoscopic transcanal approach for middle ear exploration offers excellent visualization and is one of the best applications for the endoscopes in pediatric otology cases. This is particularly helpful for "unexplained" conductive hearing loss where ossicular deformity/fixation/discontinuity is suspected. The etiology of the conductive hearing loss was definitively found in 100% of cases, and can be repaired in the same sitting when applicable.

1. Introduction

Middle ear exploration (MEE) is a useful procedure in the pediatric population for determining the etiology of conductive hearing loss (CHL) that is not explained by in-office clinical exam. It allows for diagnosis and treatment of the conductive hearing loss in the same setting.

Transcanal endoscopic ear surgery (TEES) has been rapidly increasing in popularity, and offers several advantages for pediatric MEE. Use of endoscopes allows for a dynamic high-definition view of the middle ear cleft, including "around corners" with the angled endoscopes. These can be used in patients with a stenotic canal or prominent anterior canal bony ridge, which can make transcanal approaches difficult with the microscope [2,3]. The ability to fully examine all structures and recesses within the mesotympanum, retrotympanum, epitympanum, and eustachian tube via a transcanal approach makes pediatric middle ear exploration particularly suited to endoscopic techniques.

We aim to present our experience with TEES for middle ear exploration in pediatric patients with conductive hearing loss of

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uncertain etiology, or with known etiology by history (e.g. trauma), or patients whose imaging is suggestive that ossiculoplasty may be of benefit. We hypothesize that the operation can be performed with similar safety and outcomes to microscopic MEE. In addition, we hypothesize that we will find a low rate of negative MEE in which no diagnosis was obtained.

2. Methods

Approval for this study was obtained from the institutional review board. The medical database was queried for any patient under the age of 18 who underwent MEE at Ann & Robert H. Lurie Children's Hospital Of Chicago from April 2012 to October 2015. All cases were performed by the senior author (SH), and all cases were performed entirely with the endoscopes. These would be defined as a Transcanal Endoscopic Ear Surgery (TEES) class 3 according to proposed grading system by Cohen & Lee [4].

Demographic data, operative findings, and pre- and post-operative audiograms were reviewed. Hearing levels, including pure tone average (PTA) for each patient were determined by averaging the hearing thresholds at 0.5, 1, 2, and 3 kHz. The air-bone-gap (ABG) was defined as the difference between air and bone conduction hearing levels, with an average derived from the ABG at 0.5, 1, 2, and 4 kHz, per the American Otological Society standard [5].

All surgeries were performed entirely using endoscopic techniques without the use of a microscope. 0, 30, 45, and 70° 3 mm diameter endoscopes (Karl Storz, Germany) were used, with the large majority of the surgery performed with the 0 or 30° scope. In all cases, a standard posteriorly based tympanomeatal flap was raised endoscopically. Middle ear pathologies were managed by various techniques depending on the pathology, including removal of bony fixation or ossiculoplasty, among others. Ossicular chain integrity/fixation was determined through palpation of the ossicular chain.

3. Results

3.1. Demographics

21 cases were performed in 20 ears (1 revision). Average age at surgery was 7.98 years (range 4–15 years). 17 patients presented with conductive hearing loss of unknown etiology, without effusions. Three patients presented after trauma involving the ear or temporal bone. Two of the trauma patients had a temporal bone fracture (fall down an elevator shaft, television falling on head), and one was from a cotton swab injury.

3.2. Pre-operative imaging findings

20/21 (95%) cases underwent preoperative non-contrasted CT temporal bone imaging. Imaging was predictive of intra-operative findings in 11/20 cases (55%). Predictive findings seen on CT included malformed ossicles (7), ossicular malrotation (3), congenital ossicular fixation by a bony bar (2), ossicular discontinuity (1), soft tissue in the middle ear (1), TM retraction with ossicular erosion (1), stenotic external auditory canal (1), canal cholesteatoma (1).

3.3. Operative findings

Middle ear pathology contributing to the conductive loss was found definitively in 100% of cases. Operative findings deemed as cause for conductive hearing loss can be seen in Table 1. 3/21 cases (15%) were performed through a stenotic ear canal. A canal cholesteatoma was present in 1 case (5%), in a patient with a complex ear history including microtia, external auditory canal stenosis with subsequent cholesteatoma, and malformed middle ear with conductive hearing loss. Preoperative small TM perforation was present in 1 case (5%). Facial nerve dehiscence was found in 2 cases (10%). No case required conversion to traditional microscopic ear surgery (see Fig. 2).

3.4. Surgical therapy

The average operative time was 113.1 min (range 25–238 min). Trainees (residents and/or fellows) assisted in 16/21 (76%) of cases. Endoscopic intervention within the middle ear was attempted in 12/21 cases (57%) This includes prosthetic ossiculoplasty, release of fixation, and resection of tissue. Prosthetic ossiculoplasty was performed in 6/20 (30%) of the ears, with 1 TORP, 3 PORPs, and 2 incudostapedial joint replacements. There were no perioperative complications or adverse events.

3.5. Hearing outcomes

The average follow up was 2.02 years. Hearing outcomes can be seen in Fig. 1. 8/12 (67%) cases in which a middle ear intervention had an ABG < 20 dB postoperatively, improved from 2/12 (16%) with ABG < 20 dB preoperatively. However, only 1 patient that underwent endoscopic intervention improved to an air-bone gap less than 10 dB.

Table 1
Displays the various finding found on middle ear exploration. Some patients had multiple findings.

Operative Middle Ear Findings and Pathology	*n* (%)*
Ossicular Deformity	6 (30)
Stapes	2
Incus	4
Malleus	1
Ossicular fixation	8 (40)
Bone spicule to malleus from scutum/ossified posterior or anterior malleolar ligament	5
Footplate fixation	2
Incudomalleolar fixation	1
Ossicular discontinuity	5 (25)
IS joint erosion/discontinuity	4
Superstructure dehiscent from footplate	1
Malleus rotated from trauma	1
Adhesive Myringosclerosis	1 (5)
Facial nerve dehiscence	2 (10)
Severe granulation (and fungal otitis media with erosion in 1 pt with immunosuppression)	2 (10)
Hypoplastic oval window	1 (5)