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Contents

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ORIGINAL ARTICLE

Retrospective Study

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Contents

ABOUT COVER

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The primary aim of *World Journal of Otorhinolaryngology* (*WJO*, *World J Otorhinolaryngol*) is to provide scholars and readers from various fields of otorhinolaryngology with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJO mainly publishes articles reporting research results and findings obtained in the field of otorhinolaryngology and covering a wide range of topics including adenoidectomy, audiology, auditory brain stem implantation, ciliary motility disorders, cochlear implantation, ear diseases, endolymphatic shunt, fenestration, labyrinth, laryngeal diseases, laryngectomy, laryngoplasty, laryngoscopy, middle ear ventilation, myringoplasty, nasal surgical procedures, neck dissection, nose diseases, ossicular replacement, otologic surgical procedures, otorhinolaryngologic diseases, otorhinolaryngologic neoplasms, otorhinolaryngologic surgical procedures, pharyngeal diseases, pharyngectomy, pharyngostomy, rhinoplasty, stapes surgery, tonsillectomy, tracheostomy, transtympanic micropressure treatment, and tympanoplasty.

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ORIGINAL ARTICLE

Retrospective Study

Endoscopic push through tragal cartilage tympanoplasty: A 10-year retrospective review of our technique and outcomes

K M Abidur Rahman, Khalid Majeed, Emma Finnegan, Ivan Keogh

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Abstract

BACKGROUND

Endoscopic ear surgery (EES) provides a magnified, high-definition view of the otological surgical field. EES allows otologists to avoid surgical incisions and associated postoperative complications. It is an ideal technique for the performance and teaching of tympanoplasty.

AIM

To examine the efficacy of total Endoscopic Push Through Tragal Cartilage Tympanoplasty (EPTTCT), at our institution over a 10-year period.

METHODS

A retrospective analysis of 168 cases of EPTTCT for closure of small to medium tympanic membrane perforations from 2013-2023 was conducted. Patient sex, age range (pediatric *vs* adult), etiology of injury, success rate, complications, and postoperative hearing status were collected.

RESULTS

Graft uptake results indicated success in 94% of patients, with less than a 2% complication rate. Postoperative pure tone audiometry demonstrated hearing status improvement in 69% of patients.

CONCLUSION

EPTTCT has been shown to be effective in tympanic membrane perforation closures with minimal complications. This study further demonstrates the efficacy and safety of these procedures in a single-center review.

Key Words: Total endoscopic ear surgery; Otology; Tympanoplasty; Hearing; Perforation;

Tragal cartilage graft

Core Tip: Endoscopic push through tragal cartilage tympanoplasty is an effective method for tympanic membrane perforation repairs with a high degree of success with a low complication rate. It is effective for all age groups and shows marginally better success rates in the pediatric population. It also exhibits good postoperative hearing outcomes in over two-thirds of the patients in this 10-year single-center review.

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INTRODUCTION

The use of microscopes for middle ear surgery has been prominent since the 1950s[1]. Historically, tympanoplasties have been performed using a post-auricular incision, end-aural incision, or a trans-canal technique, using a microscope to assist in the procedure[2,3]. Although post-auricular and end-aural techniques are effective in tympanic membrane perforation closures, the larger incisions and more extensive soft tissue dissection associated with the procedure leads to post-operative pain[1-4]. Microscopic trans-canal tympanoplasties avoid these aforementioned issues[1-4]. However, this technique is limited in its applicability to patients with perforations in the posterior half of the tympanic membrane, and in those with wider external auditory canals[2]. Furthermore, the microscope is limited to a straight-line view of the surgical field[5]. Technological innovation through the introduction of endoscopes has led to the improvement of surgical approaches to the middle ear cavity[1,4].

Endoscopic ear surgery (EES) has risen to prominence due to its minimally invasive nature avoiding external incisions and tissue dissections[6,7]. The endoscope offers a wider view of the surgical area and allows the user to navigate around corners, affording better visualization of difficult to access areas[5]. The angled view provided by endoscopes is particularly important in visualizing the anterior aspects of the tympanic membrane[8]. This view provides ease of navigation around anterior overhangs, allowing one to perform tympanoplasties more easily for anterior perforations that may normally require end-aural or post-auricular incisions.

EES can be classified according to Cohen's classification, as outlined in Table 1[9]. Total EES are Cohen Class 3 surgeries[9]. Endoscopes can be used for a variety of procedures, such as myringotomy, grommet insertion, exploration of the middle ear, and ossiculoplasty[8,10,11]. Although there is a steep learning curve associated with EES, this technique allows the primary surgeon to train others actively during the procedures.

There are several sources of autologous grafts that have been employed for perforation closures in tympanoplasties [12]. These include temporalis fascia, tragal perichondrium, cartilage, fat, and fascia lata[12]. Although all of these are viable graft sources, a temporalis fascia graft is usually preferred due to its proximity to the surgical site[12]. However, cartilage grafts have become popular due to their significantly higher graft integration rates while providing improvements in postoperative hearing outcomes[13]. Also, harvesting tragal cartilage graft for repair of tympanic membrane perforations allows for optimal cosmesis due to the small size and location of the incision[14].

The aim of this paper is to outline how Endoscopic Push Through Tragal Cartilage Tympanoplasty (EPTTCT) is performed at University Hospital Galway and to evaluate the clinical outcomes, graft uptake, hearing change, and surgical complications over a 10-year period.

MATERIALS AND METHODS

Study design

A single-center retrospective cohort study was performed. Ethical approval was obtained from the research ethics committee of University Hospital Galway. Patients who underwent EPTTCT between 2013 and 2023 were identified. Patients were included if they underwent Total Endoscopic Tympanoplasties (Cohen Class 3) for small (< 25% of the tympanic membrane) to medium (< 50% of the tympanic membrane) perforations using a tragal cartilage graft. Patients were excluded as follows: (1) If they underwent complicated tympanoplasties (*e.g.*, palisades technique); (2) had large perforations (> 50% of the tympanic membrane); (3) alternate graft harvest sites were utilized (*e.g.*, conchal cartilage graft); (4) if additional surgical interventions were required (*e.g.*, raising the tympanomeatal flap, ossicular chain reconstruction, canalplasty, or usage of microscope to complete the surgical intervention); and (5) if incomplete patient follow-up post-surgery occurred. Patient information, including demographics, and surgical and clinical outcomes were collected using theater registers and electronic health records. Measured outcomes included assessment of perforation

Table 1 Classification of endoscopic ear surgery according to Cohen's classification[9]

Class	Extent of endoscope usage
0	None
1	For inspection only
2a	< 50% of the surgical dissection
2b	> 50% but < 100% of the surgical dissection
3	Entire surgery

closure at 6-month follow-up, post-surgical hearing outcomes, and post-surgical complications. Post-surgical hearing was assessed based on pure tone audiometry averages at 500, 1000, and 2000 Hz frequencies.

Operative procedure

All patients underwent EPTTCT as an elective day case procedure under general anesthetic. A 3-mm, 14-cm, 0° Hopkins rod rigid endoscope with a triple chip high-definition camera was used for all surgical procedures. The ear canals were prepared by injecting local anesthetic into the tragus. Exocin© antibiotic ear drops were also used in the canals prior to the start of each surgery. The cartilage graft used for the repairs was harvested from the ipsilateral ear through a 1-cm incision made on the inner aspect of the tragus. A 6-mm punch biopsy was used to harvest the tragal cartilage grafts, as shown in Figure 1. This technique is efficient and allows preservation of the integrity of the tragus. The cartilage graft was then shaved using a Kurtz knife. The edges of the tympanic membrane perforation were freshened to optimize graft uptake and healing. The cartilage grafts were sized according to the perforation dimensions, allowing for at least a 1-mm support rim around the edges. The edges of the cartilage grafts were also beveled to allow for optimal placement on the medial aspect of the perforation in the middle ear. Gelfoam© was used as a supporting underlay material for the graft in the middle ear, ensuring that the cartilage graft remained in contact with the tympanic membrane. The cartilage graft was placed in the middle ear using an endoscopic push through technique with the perichondrium side facing toward the external auditory canal. The ear canal was further packed with Gelfoam© soaked in Exocin©. The tragus was closed with an absorbable suture. BIPP© ribbon gauze was used to pack the remaining external auditory canal. The dressings were kept in place for 3 week, after which they were removed in the outpatient department and topical antibiotic drops were started for 7 days.

Data collection

All cases of EPTTCT that met the inclusion criteria were included in the study. All cases were followed up for at least 6 months post-surgery, with the vast majority followed for at least 1 year. Age, sex, post-surgical complications, type of surgery (revision *vs* primary surgery), and post-surgical outcomes were recorded. Patient data was also stratified to assess pediatric *vs* adult population outcomes and complications.

RESULTS

Four hundred and fifty-six cases of tympanoplasties were reviewed. One hundred and sixty-eight cases met the inclusion criteria (2013-2023), with 92 male patients (55%) and 76 female patients (45%), as shown in Table 2. Age ranged from 8 years to 64 years, with a mean age of 25.76 (± 16.93) years (standard deviation). Just over half the patients (n = 86) were pediatric cases (age < 18 years). Perforations in 83% of the cases were secondary to a history of otitis media. Although most cases were primary surgeries, a small percentage of revision surgeries (n = 8) were included in the final data collection and analysis.

Surgical outcomes

An overall graft success rate of 94% (n = 159) was achieved on postoperative follow-up at 6 months (Table 3). The success rate for primary surgeries was 95% (n = 152), which was higher compared to revision surgeries (87%). Both pediatric and adult populations had very high success rates for perforation closure: 96% for pediatric surgeries and 93% for adult surgeries.

Surgical complications were also analyzed. In total, 5% of patients (n = 9) presented with persistent perforations after initial EPTTCT attempt at closure. Three cases developed postoperative tragal wound infections, requiring additional medical treatment. No tragal hematomas were recorded. No postoperative vertigo, tinnitus, or hearing loss was noted.

Hearing outcomes

Pre- and postoperative audiograms for all patients were assessed. Postoperative pure tone audiometry was conducted at 3 and 6-mo follow-up appointments. None of the patients included in the study displayed a decrease in hearing post-surgery. An average of a 12.37-dB improvement in hearing (air-bone gap) was noted on postoperative pure tone audiometry. Over two-thirds of patients (n = 117, 69%) displayed an improvement in their postoperative hearing outcomes.

Table 2 Descriptive parameters

Parameter	Value
Male	92 (54.8)
Female	76 (45.2)
Pediatric, < 18 years	86 (51.2)
Adults	82 (48.8)
Etiology	
Otitis media	140 (83.3)
Traumatic injury	28 (16.7)
Left ear	81 (48.2)
Right ear	87 (51.8)
Age range	8–64
Age, mean ± SD	25.76 ± 16.93
Primary cases	160
Revision surgeries	8

Data are *n* (% of *n* = 168) unless otherwise indicated.

Table 3 Operative outcomes and complications

Characteristics	Value
Graft success	159/168 (94.6)
Adult	76/82 (92.6)
Pediatric, < 18 years	83/86 (96.5)
Primary surgery	152/160 (95)
Revision surgery	7/8 (87.5)
Persistent perforation	9/168 (5.4)
Primary, *n* = 160	8/160 (5)
Revision surgeries, *n* = 8	1/8 (12.5)
Complications	
Surgical site infection	3/168 (1.8)
Hearing improvement	117/168 (69.6)
Adults	53/82 (64.6)
Pediatric	64/86 (74.4)
Overall air-bone gap improvement	12.37 ± 11.42
Pediatric	12.27 ± 10.08
Adult	12.5 ± 13.2

Data are *n* (% of *n* = 168) unless otherwise indicated.

DISCUSSION

Tympanic membrane perforation closure through graft integration is the primary goal when performing tympanoplasties [1]. Secondary goals for this procedure include improvements in postoperative hearing outcomes, decreasing the operative time, and reducing postoperative complication rates[1]. A recent meta-analysis of randomized controlled trials conducted by our institution has shown that endoscopic tympanoplasties have significantly shorter operative times compared to microscopic tympanoplasties[1]. Endoscopic tympanoplasties have also been shown to have less posto-

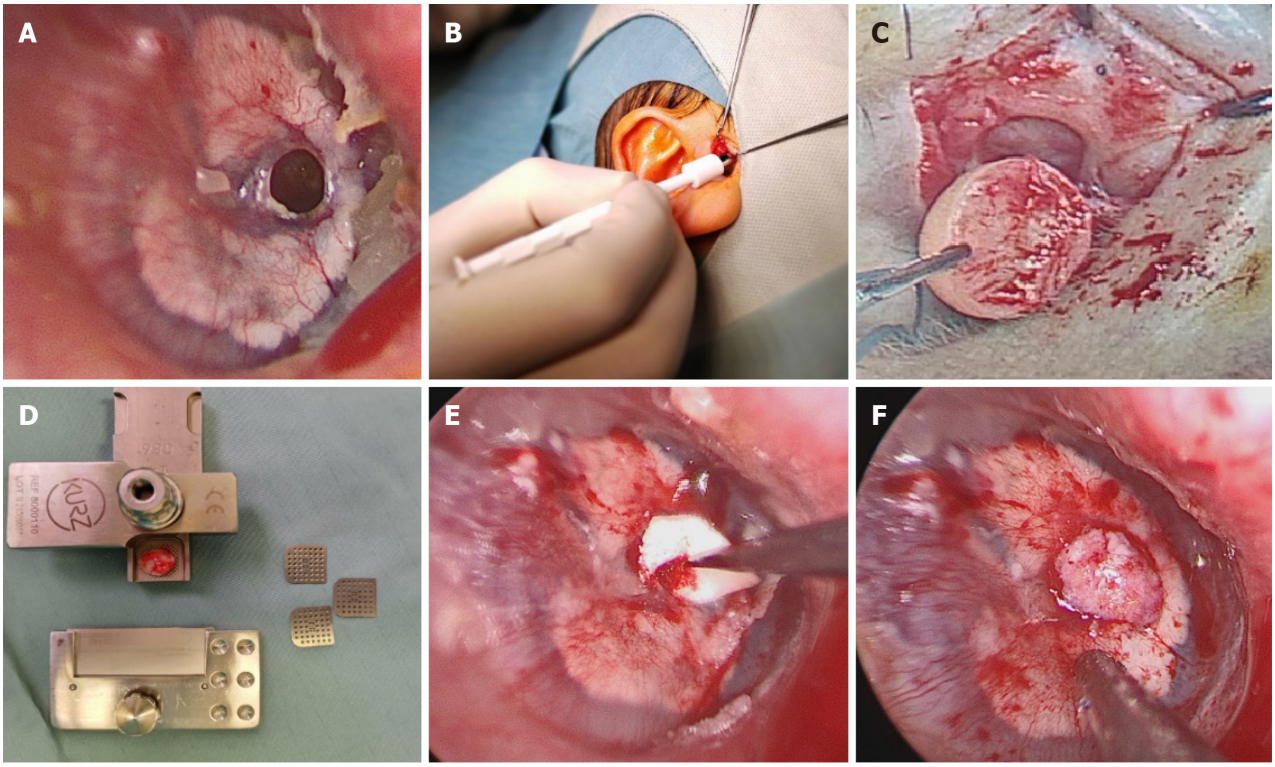

Figure 1 Schematic diagram of Endoscopic Push Through Tragal Cartilage Tympanoplasty. A: Anterior tympanic membrane perforation; B: Usage of a 6-mm punch biopsy for autologous tragal cartilage graft harvest; C: Harvesting of graft prior to preparation; D: Usage of Kurtz knife to thin the graft to appropriate thickness; E: Placement of Gelfoam© into the middle ear for stability and graft support; F: Cartilage graft after placement medial to the tympanic membrane for closure.

perative surgical complications, including decreased postoperative pain and recovery time[1]. Further meta-analyses have shown improved cosmetic outcomes for endoscopic *vs* microscopic tympanoplasties, while providing similar graft integration rates and postoperative hearing outcomes[3,15]. It is also important to note that the senior author for this paper is the first otologist to publish a hierarchical task safety analysis for Totally Endoscopic Tragal Cartilage Tympanoplasties, emphasizing the procedure's safety and suitability as a teaching and introductory procedure for novice endoscopic surgeons[16].

Surgical outcomes

Our overall tympanoplasty success rate of over 94% for EPTTCT exemplifies the efficacy of this procedure in closing small to medium tympanic membrane perforations. These success rates for Cohen Class 3 tympanic membrane repairs over a decade are comparable to other published literature for similar surgical techniques[17,18].

Endoscopic tympanoplasties have the benefit of wide, high-definition views of the surgical field, allowing for optimal graft placement and adjustment[6]. The optimal view also ensures ideal underlay placement of the graft, and appropriate contact with the tympanic membrane[6]. Compared to other established techniques, such as microscopic tympanoplasties, our endoscopic technique had superior outcomes[1,19-21]. However, it is important to acknowledge that microscopic tympanoplasties were preferentially used in cases where the perforations were significantly larger, or the external auditory canals were narrower in size, requiring canalplasties to allow for improved surgical field visualization [19,22]. It is important to take these differences in procedural complexity into account when comparing differences in graft uptake rates.

Children had a marginally higher success rate (96% *vs* 93%). Advanced age is known to directly impact in the healing process, which may have contributed to this difference[23,24].

Revision procedures also had a lower success rate when compared to primary interventions (95% *vs* 87%). Repeated procedures are known to lead to increased scar tissue formation at the surgical site, which can hinder the integration of the autologous graft with the host tympanic membrane[25]. Only a small number of revision cases (n = 8) underwent EPTTCT for our institutional study; however, the surgical success rates were similar to other institutional outcomes[26]. Similar graft uptake rates for revision surgeries have been published, ranging from 78%-93% success for revision tympanoplasties[27-29].

Hearing outcomes

Although the primary function of tympanoplasties is to create a barrier between the external auditory canal and middle ear, an improvement in hearing outcomes is also an additional positive outcome[20,28,30]. In total, 69% (n = 117) of the cases that were examined exhibited an improvement in hearing outcomes following EPTTCT. On average, a 12.37 ± 11.42-

dB improvement in the air-bone gap was noted, similar to established literature values for both endoscopic and microscopic tympanoplasties[19,27,29]. When stratified according to age, the average improvement was noted to be similar in both pediatric and adult populations (12.27 ± 10.08 *vs* 12.5 ± 13.2). However, a larger proportion of the pediatric cases demonstrated a post-surgery hearing improvement compared to the adult population (74% *vs* 64%). This data is similar to our previous finding of higher graft closure rates in the pediatric population compared to the adult population.

This study was limited by several factors. This is a retrospective study, carried out in a single institution. In addition to this, a specific subtype of endoscopic surgeries was analyzed, rather than the efficacy of the technique as a whole. Certain nuances to the surgical technique are particular to the senior author, with a primary aim being to share our technique. Although this study exemplifies the high success rates of EPTTCT, future studies should look toward prospective analyses to better understand outcome and complication rates of this procedure.

CONCLUSION

This study demonstrates that EPTTCT is effective in repairing small to medium tympanic membrane perforations with minimal complications, demonstrating a 94% closure rate and 69% improvement in hearing outcomes. It is particularly effective in children and in primary cases. This study reaffirms the findings in recent published literature that exemplify the efficacy and minimally invasive nature of endoscopic tympanoplasty. In addition, we describe and provide further evidence to support the effectiveness of our technique of performing EPTTCT.

FOOTNOTES

Author contributions: Rahman KMA, Majeed K, and Keogh I designed the research study, performed the research; Rahman KMA, Majeed K, Finnegan E, and Keogh I analyzed the data; Rahman KMA, Finnegan E, and Keogh I wrote the manuscript; All authors have read, edited, and approved the final manuscript.

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