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Transcanal endoscopic type 1 tympanoplasty in children: Cartilage butterfly and fascia temporalis graft

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ABSTRACT

Introduction: Endoscopic type 1 tympanoplasty is every day gaining numerous adepts for tympanic membrane repair. Due to the value of reducing postauricular approaches, decreasing postoperative morbidity and hospitalization time. The objective of this study is to present surgical results of endoscopic type 1 tympanoplasty in the pediatric population using fascia temporalis or cartilage butterfly graft.

Materials and methods: Prospective study regarding the pediatric population, mean age of 10.7 years old. Patients diagnosed with chronic otitis media without cholesteatoma and intact ossicular chain. Tympanic membrane reconstruction using inlay cartilage butterfly graft or underlay fascia temporalis graft according to surgical needs. Audiograms were evaluated preoperatively and 6 months after surgery. No postauricular approaches were performed.

Results: A total of 54 ears were operated, 25 utilizing underlay fascia temporalis graft and 29 using inlay cartilage butterfly graft. Six months following surgery, dry and closed tympanic membranes were obtained in 54 cases (92.6%). Preoperative and postoperative air conduction (AC) thresholds, bone conduction (BC) thresholds and air-bone gaps (ABG) were assessed. Preoperative AC of 24.6 dB, BC of 8.9 dB and an ABG of 15.5 dB. Postoperative AC of 16.3 dB, BC of 8.9 and an ABG of 6.9 dB. A postoperative ABG reduction of 8.5 dB was reached.

Conclusion: Transcanal endoscopic type 1 tympanoplasty can be achieved in every pediatric patient with chronic otitis media without cholesteatoma, and, is a safe and efficient procedure.

1. Introduction

Surgical repair of the tympanic membrane, commonly known as type 1 tympanoplasty according to Wullstein classification, persists controversial within otologists. This technique was first described in 1956 by Zollner and Wullstein, with time it has been widely modified. Many of the described techniques require raising a tympanomeatal flap followed by either an underlay or overlay approach. A variety of graft materials have also been employed, including adipose tissue, perichondrium, cartilage, fascia temporalis or allograft materials. Classic overlay or underlay approaches have demonstrated tympanic membrane perforation closure rates of up to 96% and reductions in the air-bone gap (ABG) ranging from 8.3 to 23.6 dB [1,2].

In the recent years, a growing number of surgeons support for the use of endoscopes in middle ear surgery, with an increasing number of reports showing a benefit in type 1 and even cholesteatoma surgery [3–5]. By providing a wide angle of view and illumination near to the tympanic membrane (TM), endoscopes overcome the limitation of the operating microscope, in which the direct line of sight is blocked by ear canal morphology. Although endoscopes were first recommended for tympanoplasty in the 1990s [6], even reasonably recent reports have revealed misgivings about a totally endoscopic technique for tympanoplasty [7]. With the expanding availability of instruction courses dedicated to endoscopic ear surgery, surgical experiences have been shared internationally allowing endoscopic techniques to be developed to the point where totally endoscopic tympanoplasty has now become a very feasible option, reported even in children's ears [3,8–11].

The objective of this study is to present surgical results of endoscopic type 1 tympanoplasty in the pediatric population utilizing fascia temporalis or cartilage butterfly graft.

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2. Materials and methods

2.1. Study design

A prospective study was designed with a protocolized surgical technique, pediatric patients treated surgically for chronic otitis media without cholesteatoma and with an intact ossicular chain.

2.2. Patient criteria

Patient inclusion criteria required to be under 18 years old, diagnosis of chronic otitis media without cholesteatoma who required TM repair. Patients with ossicular chain (OC) disruption who needed ossicular chain reconstruction (OCR) were excluded from the study. The AAO- HNS pure tone audiometry (PTA) criteria for hipoacusia assessment was employed. Mean audiometric results at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz at air and bone conduction thresholds were acquired preoperatively and 6 months after surgery. Preoperative and postoperative air-bone gap (ABG) were calculated, as well as the ABG reduction following surgery.

2.3. Surgical technique

Transcanal endoscopic ear surgery (TEES) was used as a surgical approach in every case. A 0° angle, 3 mm width and 14 mm long Karl-Storz endoscope was used connected to a 4 K resolution Karl-Storz camera and screen. Two distinct grafts were utilized depending on the location and size of the perforation. Inlay butterfly graft was considered as the first option in every case. In cases where the TM perforation was marginal with annulus affection or the perforation affected the malleus area, underlay fascia temporalis graft was utilized. Every external auditory canal was packed with Silastic bands and a dry sponge overflowed with local ciprofloxacin drops. Seven days after surgery the dry sponge and the Silastic band were withdrawn. Local ciprofloxacin drops were administered until day 30 after surgery. No postauricular approaches were performed.

3. Results

3.1. Surgical assessment (Table 1)

A total of 54 ears were treated, 29 with inlay cartilage butterfly graft and 25 with underlay fascia temporalis graft. Mean age was 10.7 years (range 7–16). Mean perforation size of 44.4% (SD 22). Location quadrants were estimated, anteroinferior quadrant affectation of 88.9%, anterosuperior quadrant of 61.1% posteroinferior quadrant of 46.3% and posterosuperior quadrant of 20.1%.

Table 1
Surgical assessment.

	Mean	SD
Age	10.7	2.9
Perforation size (%)	44.4	22.0
Affected Quadrants	**N**	**%**
AS	33	61.1
AI	48	88.9
PS	13	20.1
PI	25	46.3
Graft	**N**	**%**
Cartilage Butterfly	29	54.7
Fascia temporalis	25	46.3

SD: Standard deviation. AS: anterosuperior. AI: anteroinferior. PS: posterosuperior. PI: posteroinferior.

Table 2
Surgical outcomes.

	Ears	Closed TM	%
Total	54	50	92.6
Cartilage Butterfly	29	28	96.6
Fascia temporalis	25	22	88
	Mean	**SD**	
Preop AC (dB)	24.6	6.3	
Preop BC (dB)	8.9	2.8	
Preop ABG (dB)	15.5	5.5	
Postop AC (dB)	16.3	5.8	
Postop BC (dB)	10	2.1	
Postop ABG (dB)	6.9	4.8	
ABG reduction (dB)	8.5	6.3	
Post op ABG < 20 dB	54		100

AC: Air conduction. BC: Bone conduction. ABG: Air-bone gap. TM: Tympanic membrane. SD: Standard deviation.

3.2. Surgical outcomes (Table 2)

Of the total of 54 ears, 29 ears were operated using inlay cartilage butterfly graft. After 6 months, dry and sealed tympanic membranes were obtained in 28 cases (96.6%). 25 ears were operated utilizing underlay fascia temporalis graft. After 6 months postoperatively, dry and closed tympanic membranes were achieved in 22 cases (88%). An overall surgical success of 50 ears was obtained (92.6%). Preoperative and postoperative air conduction (AC) thresholds, bone conduction (BC) thresholds and ABG were evaluated. Preoperative AC of 24.6 dB (SD 6.3), BC of 8.9 dB (SD 2.8) and an ABG of 15.5 dB (SD 5.5). Postoperative AC of 16.3 dB (SD 5.8), BC of 10 dB (SD 2.1) and an ABG of 6.9 dB (SD 4.8). A postoperative ABG reduction of 8.5 dB (SD 6.3) was reached.

4. Discussion

Until the last several years, all type 1 tympanoplasties were performed with an operating microscope. Easily accessible perforations can be repaired with a transcanal approach, but, using a microscope the external auditory canal (EAC) is frequently too narrow or too arched to provide a complete and clear view of the perforation, particularly when surgical instruments are placed into the straight vision field. There is when an external incision is then required for adequate access, constantly adapting to a postauricular approach. This requirement is of particular significance in children, where the EAC can scar becoming further narrow, and adding the morbidity of an open surgery [3].

The first report of endoscopic tympanoplasty was in 1998 and manifested a high success rate in 64 ears [6]. The main interest is on how TEES decreases the rate of postauricular approach from 42% in the microscopic era to 0% with the introduction of endoscopic ear surgery (EES), all of it without diminishing the overall success rate and without rising the complications rate. Numerous surgeons have not performed any postauricular or endaural incisions for type 1 tympanoplasties since that report [12].

A recent systematic review and meta-analysis by Tseng C. et al., in 2016 revealed that the graft intake and TM closure rates between microscopic and endoscopic type 1 tympanoplasties had no statistical difference with an 86.4% and 85.1% respectively. Hearing outcomes were also comparable between groups. These results also agree with earlier studies [13].

Endoscopic inlay butterfly type 1 tympanoplasty has been described recently as a safe and efficient approach, with a graft intake and TM closure rate of 97.8% and an ABG reduction of 9.4 dB at 6 months

postoperatively and a mean surgical time of 25.7 min [14]. 93.7% of graft intake was observed in the pediatric population with an ABG closure rate to ≤20 dB of 100% and a mean surgical time of 31 min [15]. Several otologists are favoring this technique and presumably with time, it will suit the gold standard for MT repair in central perforations without OC alterations.

That is the principal reason why inlay butterfly technique was chosen as the first-line method in this study. For marginal perforations, underlay fascia temporalis approach was selected, as it has been the favored technique for type 1 tympanoplasties in our department for an extended period of time.

In relation to the age and ear canal size, we would prefer to express that the youngest patient was 7 years old, as we would rather not to operate patients before the age of 6–7, as the middle ear could be still unstable, with a greater rate of long term reperforation. At 4–5 years of age, the size of the ear is approximately 85% the size of an adult [16]. It was observed in this series that the older the patient becomes, the EAC becomes wider but also longer. It is important to understand that when operating with endoscopes when the EAC is shorter, it becomes simpler to work, as the angle between the endoscope and your operating tool grows wider. Same happens to longer canals, the longer the canal remains, it becomes more challenging to maneuver because the angle between the endoscope and the instrument becomes narrower. Following that idea, in younger children, the canal is more narrow, but also shorter, not matching a limitation for surgery.

This study was designed to evaluate minimally invasive surgical correction not only for central perforations but, also for each class of chronic otitis media without cholesteatoma in the pediatric population. Inlay butterfly approach was the first line approach in cases of central perforations, while underlay fascia temporalis graft was the choice graft in cases of marginal perforations or in cases where the perforation affected the OC.

5. Conclusion

To the date EES has been growing more adepts between otolaryngologist, it has been proved that this minimally invasive technique has at least equal results than classic otology approaches while reducing associated surgical morbidity. We conclude that transcanal endoscopic type 1 tympanoplasty can be achieved in every pediatric patient with chronic otitis media without cholesteatoma, and is a safe and efficient procedure.

Compliance with ethical standards

All Authors declare that they have no conflict of interest. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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