



Endoscopic type 1 tympanoplasty; a composite graft technique for subtotal and total perforations

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Abstract

Objective Demonstrate feasibility of performing endoscopic transcanal type 1 tympanoplasty in total and subtotal perforations, using an underlay technique that minimizes the risk of anterior medialization of the graft. Compare audiometric and clinical outcomes of this technique with our series of endoscopic tympanoplasty with classical underlay grafts, and with previously reported outcomes of microscopic post-auricular lateral graft tympanoplasty and other transcanal techniques.

Methods We describe a surgical technique using an L-shaped cartilage and its perichondrium, with exclusive transcanal endoscopic approach. A retrospective review of patients undergoing this technique at the Centenario University Hospital of Rosario, Argentina between January 2017 and December 2019 was performed, and it was compared with a group of patients who underwent endoscopic tympanoplasty with classical underlay technique in a previous period of time. Patients with smaller perforations and other middle ear pathologies that required other techniques were not included in this study. Minimum follow up was 6 months. The main outcome measures were membrane closure rates and hearing results.

Results 73 patients with total or subtotal perforations undergoing endoscopic transcanal tympanoplasty between 2015 and 2019 were included. The group of patients that underwent the technique described showed no anterior medialization of the graft, and better graft take rates. The hearing outcomes were similar in all successful graft patients, with postoperative average air–bone gap of 10db (+ – 10 dB).

Conclusion Transcanal endoscopic tympanoplasty with the technique described is an excellent option for closure of total and subtotal tympanic perforations. The rate of perforation closure is better than endoscopic tympanoplasty with classical underlay graft with similar audiometric outcome.

Keywords Endoscopic ear surgery · Total and subtotal perforations

Introduction

Total and subtotal perforations of the tympanic membrane often present a reconstructive challenge for the otolaryngologist. Although there is not a universally accepted scheme to classify tympanic membrane perforations, it is considered a

subtotal perforation when it involves the four quadrants of the eardrum, and total perforation when there is no tympanic membrane remnant.

Microscopic overlay tympanoplasty with retroauricular approach has been the standard surgery for repairing these perforations since the 1950s [1]. Complications of this technique includes anterior canal blunting, graft lateralization and intratympanic keratin inclusion cysts. Therefore, the common need of canaloplasty, the postoperative healing time and the duration of the surgery are other disadvantages of this technique [1, 2].

On the other hand, the underlay techniques do not include these potential complications, but in anterior and subtotal perforations they have the risk of medialization of the anterior portion of the graft [3, 4]. This failure can also be seen in the under-over techniques, with fascia or perichondrium

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grafts placed medial to the tympanic membrane rest and lateral to the malleus [5].

The total or subtotal perforations, under microscopic view, often need a postauricular approach to see the anterior half of the membrane, as in smaller perforations with narrow external canals [6].

The use of endoscopes gives a major advance in this situation, providing a wider surgical view including the anterior annulus despite of the shape of the external canal [7, 8].

Along the last decade, the authors have tried different techniques in transcanal endoscopic surgery for closing large perforations. The one-piece composite cartilage-perichondrium graft [9–11] is an excellent choice, but authors find this technique more suitable with a retroauricular approach. Introducing a large piece of cartilage through the external canal can be challenging, especially in narrow canals and in pediatric patients. Besides, it often needs to separate the tympanic membrane from the malleus handle and umbo, with the potential trauma to the ossicular chain and the risk of cholesteatoma formation for incomplete removal of the epithelium of the handle. Otherwise, the palisade cartilage technique [12, 13], is another excellent option in large perforations. However, authors prefer this technique in type 3 tympanoplasty after ossiculoplasty and often aticotomy have been performed.

We describe a surgical modification of the perichondrium underlay technique using cartilage for the anterior half of the eardrum, and perichondrium for the posterior half. This reduces the risk of medialization of the anterior portion of the graft, in an area where it has a high risk of falling medially. The perichondrium for the posterior half avoids handling with a large piece of cartilage over an intact ossicular chain.

Materials and methods

Patient selection and procedures

The study population includes 73 patients with total or subtotal eardrum perforations treated with endoscopic transcanal tympanoplasty between January 2015 and December 2019 at the Department of Otorhinolaryngology, Centenario University Hospital of Rosario, Argentina.

The group includes 31 pediatric patients (between 8 and 21 years old) and 42 adult patients. In all cases included, the etiology of the perforation was chronic otitis media, with a duration of more than 1 year before surgery. All patients were primary tympanoplasty cases with pure total or subtotal perforations (involving the four quadrants of the eardrum), intact ossicular chain, at least one month dry period and normal middle ear mucosa. Patients with smaller perforations and other middle ear pathologies that required other techniques were not included in this study.

This population was divided in two groups, according to the surgical technique used. The group A includes 36 patients that underwent endoscopic tympanoplasty with the technique described, between June 2017 and December 2019. The group B includes 37 patients operated with the endoscopic classical underlay technique between January 2015 and June 2017.

All patients were subjected to a clinical otological examination and a pure tone audiogram before and after surgery. A successful tympanoplasty was defined as a full take of the graft with the minimum follow-up period of 6 months after the operation. Hearing results were reported using a four-frequency (500, 1000, 2000, 4000 Hz) pure-tone average air bone gap (PTA-ABG).

Fig. 1 a–b Dissection of the grafts; the perichondrium is removed in one piece. **c** The cartilage is cut making an L shaped graft, 2 or 3 small pieces and a U shaped piece to replace the dome of the tragus

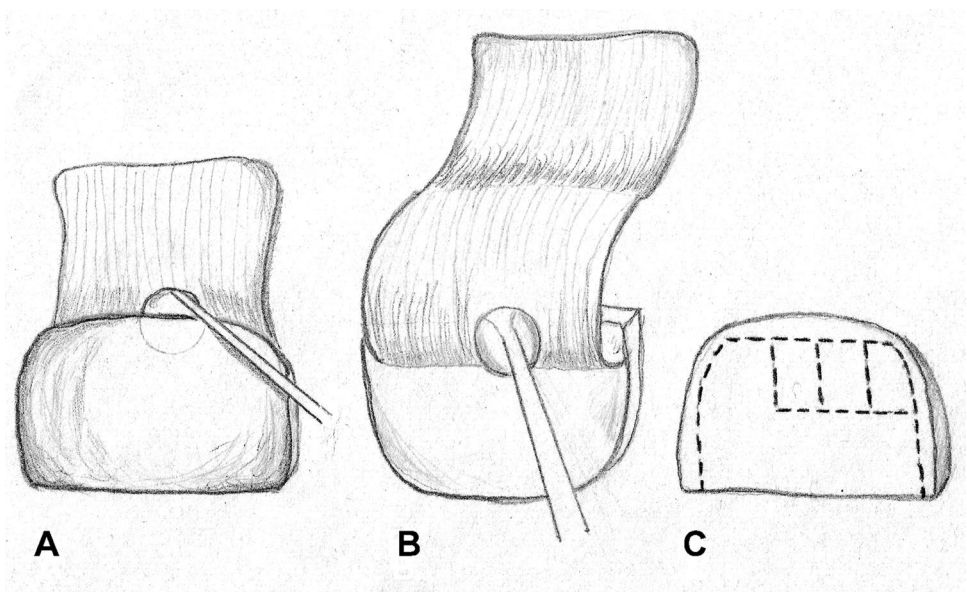
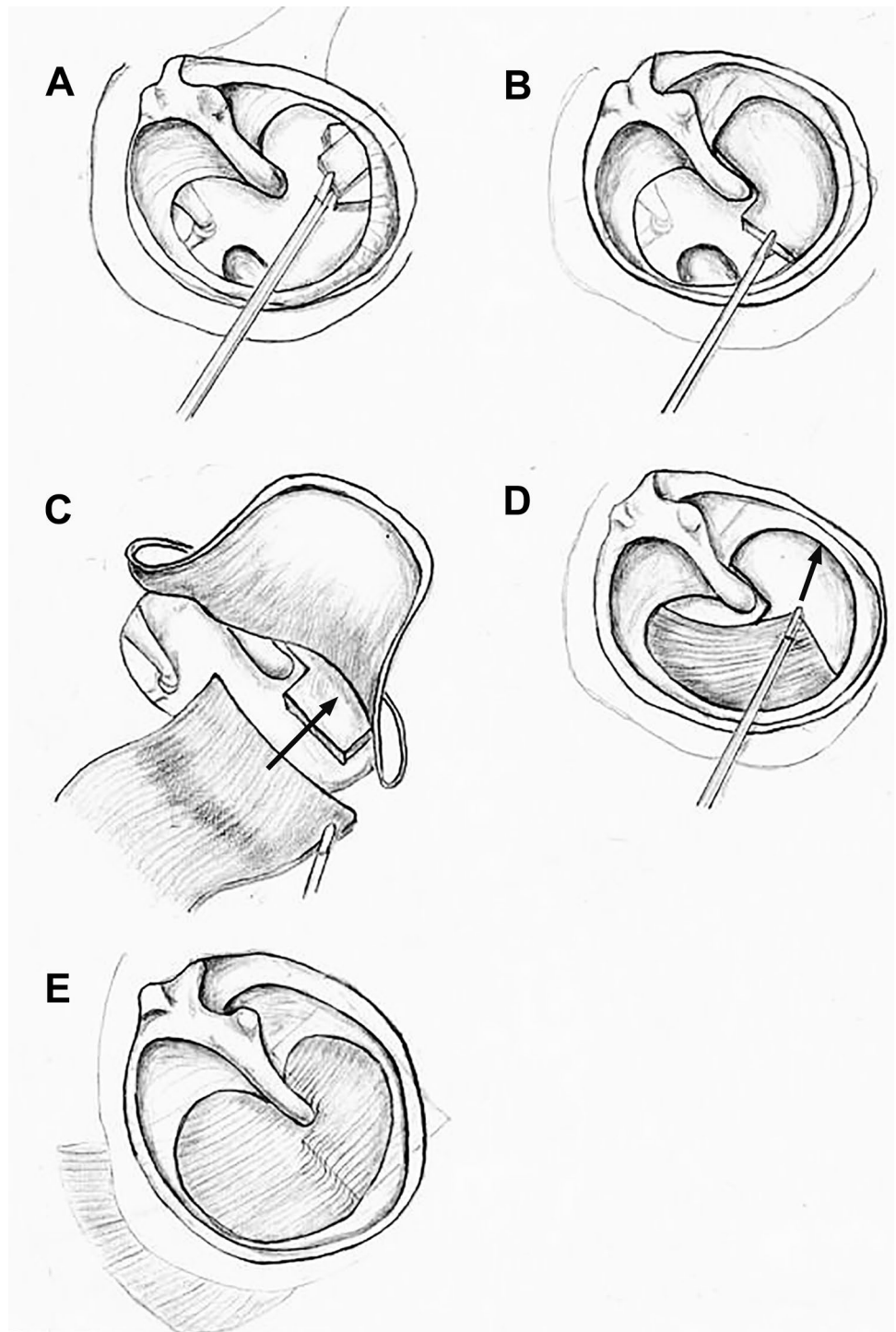


Fig. 2 **a** Two small pieces of cartilage are placed in the hypotimpanum. **b** An L shaped Cartilage piece is placed covering the anterior and inferior quadrants of the eardrum. **c** A tympanomeatal flap is elevated, and the inferior portion of the L shaped cartilage is seen; the perichondrium graft is placed over the cartilage and slipped anteriorly. **d** The tympanomeatal flap is repositioned, and the graft is taken forward medial to the anterior margin of the perforated eardrum. **e** All the perforation is covered, the posterior portion of the graft lies over the posterior wall of the canal



All surgeries were performed by the first author and residents, under direct supervision of the author.

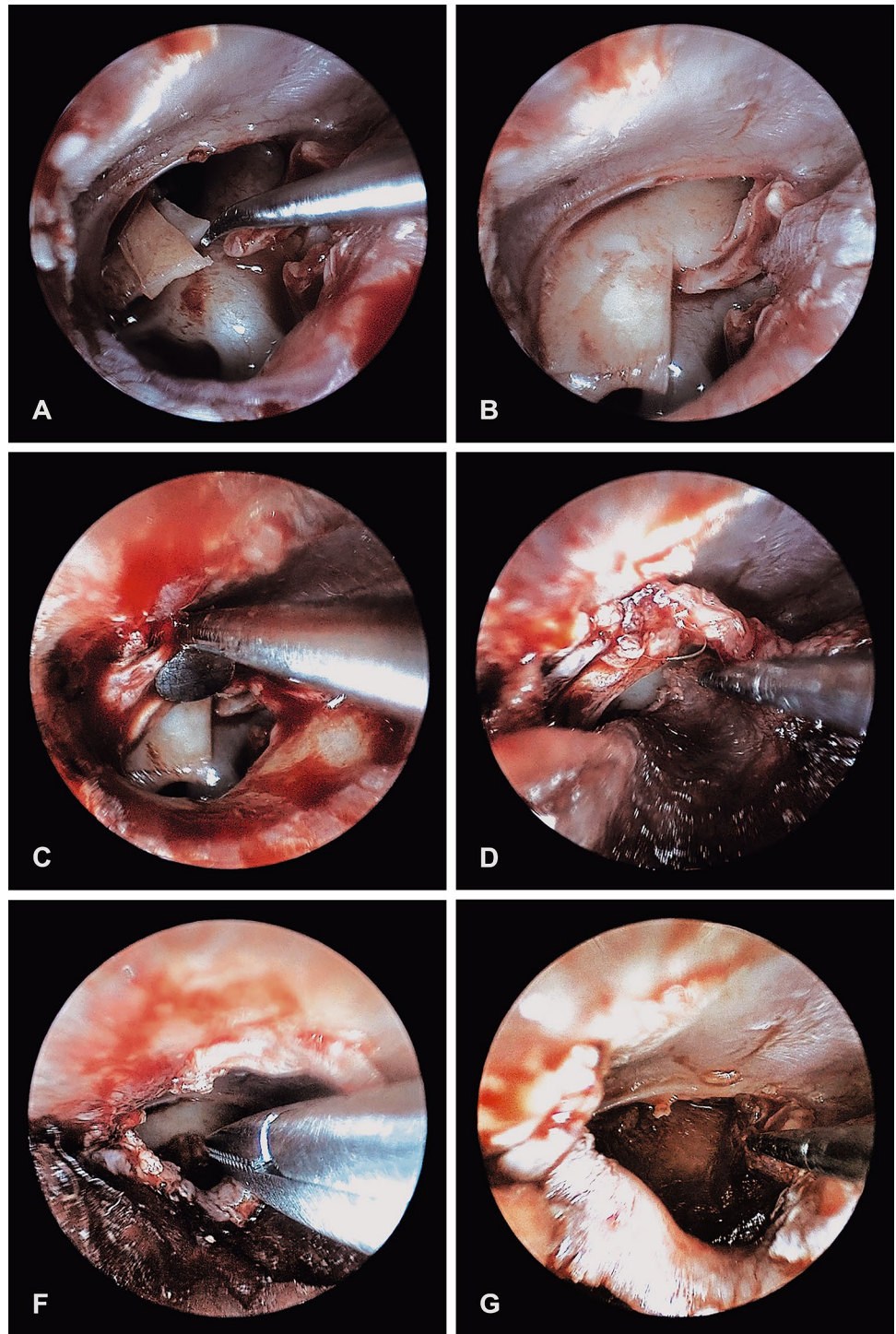
Surgical technique

All operations were performed with patients under general anesthesia. Straight and angled telescopes of 3 mm in diameter were used (Karl Storz Hopkins 7220AA and 7220FA) in

most of the surgeries, and a 4 mm 30° telescope (Karl Storz Hopkins 7230BWA) also was used in wide canal patients. Surgical loupes (Carl Zeiss EyeMag Pro, 3.2×50) were used in the harvest and preparation of the grafts.

Local infiltration of Epinephrine-lidocaine in the tragus and the external canal was performed, as hair removal when necessary.

Fig. 3 **a** Two small pieces of cartilage are placed in the hypotimpanum. **b** An L shaped Cartilage piece is placed covering the anterior and inferior quadrants of the eardrum. **c** A tympanomeatal flap is elevated, and the inferior portion of the L shaped cartilage is seen. **d** The perichondrium graft is placed over the cartilage and slipped anteriorly. **e** The tympanomeatal flap is repositioned, and the graft is taken forward medial to the anterior margin of the perforated eardrum. **f** All the perforation is covered



Cartilage graft was obtained from the tragus, and the complete perichondrium was removed of both sides in one piece (Fig. 1a–b). The piece of cartilage, typically 15 mm length and 10 mm in width in children and somewhat larger

in adults, was cut making a L-shaped graft. The rest of the cartilage was cut in one U shaped piece that was used later to replace the dome of the tragus, and other small pieces to support the graft (Fig. 1c).

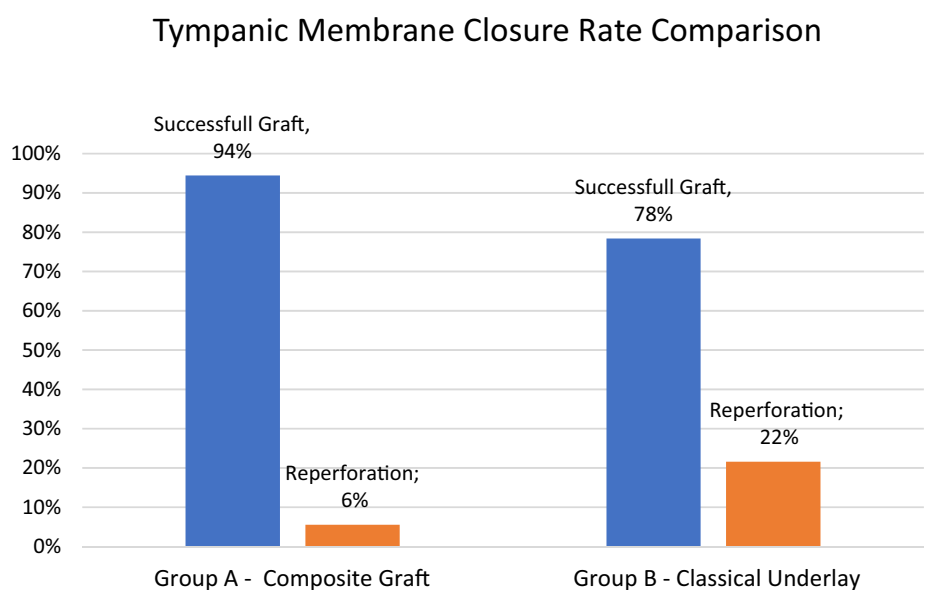
Table 1 Comparison of audiological results in patients with successful grafts

ABG (dB HL)	0–10 dB	11–20 dB	21–30 dB	31–40 dB	40–50 dB
Group A composite graft technique					
Preop. patients	0	2	10	23	1
Postop. patients	24	12	0	0	0
Group B endoscopic classical underlay technique					
Preop. patients	0	3	8	26	0
Postop. patients	23	14	0	0	0

The audiological findings in our study. Patients are divided into five groups on the basis of the value of the air bone gap (ABG). Preop indicates preoperative; Postop, postoperative

A tympanomeatal flap was performed and elevated from 6 to 12 o'clock and the ossicles were examined for integrity and movement. The flap was not separated from the malleus to avoid trauma that could risk hearing outcomes. Then it was repositioned in its original position to work firstly transtympanic. After resection of the perforation edges was performed, usually two small pieces of cartilage were positioned in the hypotympanum, below the lumen of the Eustachian tube (Fig. 2a). Over this two pieces, the L-shaped cartilage is placed transtympanic through the perforation, medial to the tympanic membrane remnant so that the anterior half of the perforated eardrum is covered (Fig. 2b). It is crucial to make sure that the cartilage is almost in contact to the anterior margin of the perforation. In cases when the umbo was medial than the remaining membrane, the cartilage is placed lateral to it, and medial to the annulus.

Table 2 Tympanic membrane closure rate comparison



The tympanomeatal flap is then elevated and the inferior side of the L-shaped cartilage is seen. This will be used as a slide to the perichondrium, that is placed over it and slipped anteriorly with curved forceps and a Wullstein needle (Fig. 2c). The posterior part of the perichondrium lies over the posterior wall of the external canal. The tympanomeatal flap is then repositioned and the perichondrium is seen over the cartilage, in the anterior half of the eardrum. This perichondrium usually needs to be taken forward and positioned medially to the anterior margin of the perforation, through transtympanic view (Fig. 2d). The perichondrium often stays medial to the malleus umbo, except when the umbo was medialized due to the middle ear pathology (Fig. 2e).

Gelfoam is placed lateral to the grafts. A piece of U shaped cartilage is repositioned through the tragus incision and one or two stiches were performed Fig. 3.

Results

During the study period, this technique was used in 51 patients with total or subtotal perforations, of which only 36 (group A) had the hospital chart available for inclusion during the period of data assessment, and postoperative follow up could be done. The endoscopic classical underlay technique was performed in 43 patients, of which only 37 (group B) could be included in the study. Otoendoscopy and audiograms were performed before and after surgery. The average preoperative PTA-ABG in both groups was 33 + - 10 dB (Table 1).

At 6 months, in the group A 34 patients had successful grafts (94.4%), while 2 patients presented persistent perforation after surgery. In the graft take group, the average postoperative PTA-ABG was 10 + - 10 dB. In the group B,

29 patients had successful grafts (78.3%) and 8 patients had persistent perforation after surgery due to anterior fall of the graft (Table 2). The hearing outcomes were similar in both take graft groups (Table 1).

Discussion

There are several factors that influence the success rate of tympanoplasty, such as perforation size, Eustachian tube function, age, postoperative otorrhea and poor visualization of the entire membrane. In the transcanal approach, endoscopy provides a wider surgical view than microscopy, particularly in the cases of anterior bony overhangs of the external auditory canal and subtotal or anterior perforations of the tympanic membrane [14].

As mentioned, the underlay techniques using exclusively fascia or perichondrium have the risk of anterior medialization of the graft. In this technique, the placement of the L-shaped cartilage can be done in a one-hand maneuver with the endoscope and provides stability for the anterior portion of the perichondrium graft, which covers the entire membrane reaching the posterior wall of the canal.

A limitation of the study is the follow-up period. The last follow-up with audiometric data was at 6 months after surgery, but it should be ideally longer. It has become difficult to follow most of this patients for a longer period of time, especially those without complaints, because they frequently come from a great distance and wish to have follow up closer to home.

Conclusion

Transcanal endoscopic tympanoplasty with the technique described is an excellent option for closure of total and subtotal tympanic perforations. The rate of perforation closure is better than endoscopic tympanoplasty with classical underlay grafts with similar audiometric outcomes.

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Compliance with ethical standards

Conflict of interest Conflict of interest to disclose.

Ethics approval All procedures performed in this study involving human participants were in accordance with the regional ethical stand-

ards (Comité de Ética en Investigación Hospital Provincial del Centenario; Comité de Bioética de la Provincia de Santa Fé), the National Research Comitee and with the 1964 Helsinki Declaration with its later amendments.

Informed consent Informed consent was obtained from all patients included in this study.

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