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Technical note

"Tumulus" stabilization of a total ossicular replacement prosthesis

T. Mom[a,*], C. Caburet[a], N. Saroul[a], L. Gilain[a], M. Gersdorff[b]

[a] Service ORL et chirurgie cervicofaciale, centre hospitalier universitaire, hôpital Gabriel-Montpied, université Clermont-Auvergne, 58, rue Montalembert, 63003 Clermont-Ferrand cedex 1, France
[b] Université catholique de Louvain, place de l'Université 1, 1348 Louvain-la-Neuve, Belgium

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ABSTRACT

Functional failure of total ossicular replacement prostheses (TORP) is often due to secondary displacement, ranging from simple subluxation to prosthesis extrusion following recurrence of severe tympanic membrane retraction. Several surgical techniques have been proposed to stabilize a TORP, mostly using superimposed non-organic or resorbable heterologous materials. We describe a simple so-called "tumulus" surgical technique that limits prosthesis displacement and extrusion, regardless of the type of TORP, by using a few fragments of autologous cartilage that are always available and perfectly tolerated at no cost. Review of 31 cases treated by this technique did not reveal any cases of prosthesis displacement and only one case (3.2%) of prosthesis extrusion with audiometric results comparable to the best results reported in the literature.

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1. Introduction

Secondary displacement of total ossicular replacement prostheses (TORP), sometimes related to recurrence of tympanic membrane retraction, constitutes one of the main causes of functional failure. Several methods have been proposed to prevent this displacement, such as overcorrected TORP placement [1], the use of a cartilage or titanium footplate shoe (e.g. Omega® connector) that maintains the TORP shaft on the stapes footplate [2,3], and the use of resorbable material to maintain the prosthesis in the correct position. Each of these techniques is associated with certain disadvantages. In the presence of tympanic membrane retraction, an excessively long TORP can induce intravestibular migration, responsible for impaired cochleovestibular function. Prostheses comprising a cartilage or titanium footplate shoe require perfect positioning of the shoe on the stapes footplate, which can sometimes be made more difficult by the irregular surface of the stapes footplate or a persistent fragment of stapedial arch. The addition of a silastic band, which can provide good results, remains at risk of long-term migration [4], while resorbable gelatins exert a stabilizing action for only a limited period of time.

2. "Tumulus" technique

The "tumulus" technique consists of placing several, generally at least 3, fragments of autologous cartilage around the shaft of the prosthesis. This pile of fragments must extend to the plate of the prosthesis, thereby ensuring stabilization of the prosthesis and palliating the consequences of possible tympanic membrane retraction. Fig. 1 illustrates tympanoplasty with cartilage graft after sacrifice of the handle of the malleus and the empty stapes footplate. Fig. 2 shows the classical positioning of the TORP (A: schematic view, B: intraoperative view), after resection of the handle of the malleus. The TORP may not be sufficiently stable due to lack of support by the handle of the malleus. The addition of a "tumulus" of cartilage around the shaft of the prosthesis is shown in Fig. 3A with an intraoperative view in Fig. 3B.

The TORP is selected or modelled to the desired dimensions and a titanium TORP must be covered by a cartilage plateau. We deliberately reduce the height of the prosthesis in order to limit the risk of intravestibular migration and allow interposition of an autologous cartilage plateau between the TORP and the tympanic membrane.

3. Results of a case series

Thirty-one consecutive cases of "tumulus" procedure were studied. A Variac® (Kurz) titanium prosthesis was used in 19 cases, a Xomed® (off-centered) hydroxyapatite prosthesis was used in 8 cases, and ossicular transposition (handle of the malleus or reshaped incus) was used in the other cases.

* Corresponding author.
E-mail address: tmom@chu-clermontferrand.fr (T. Mom).

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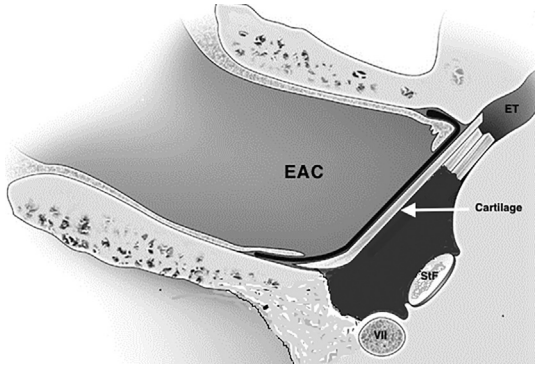

Fig. 1. Diagram of a middle ear cavity following cartilage tympanoplasty and sacrifice of the handle of the malleus (VII: facial nerve, EAC: external auditory canal, StF: stapes footplate, ET: Eustachian tube).

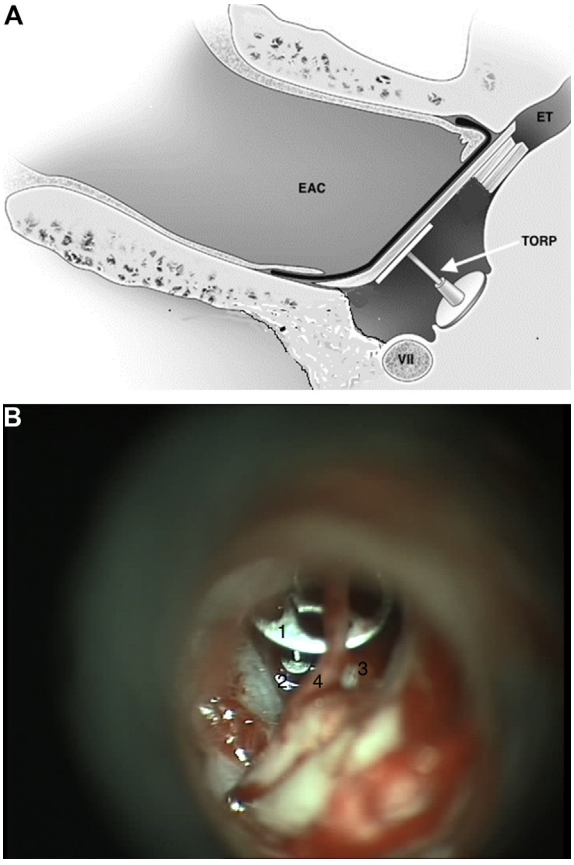

Fig. 2. A: Diagram of TORP placement in an empty stapes footplate after cartilage tympanoplasty and sacrifice of the handle of the malleus (VII: facial nerve, EAC: external auditory canal, ET: Eustachian tube); B: Intraoperative view of a titanium TORP placed on a mobile stapes footplate on the left side. 1: TORP, 2: stapes footplate, 3: facial nerve, 4: chorda tympani.

The series comprised 17 men and 14 women with a mean age of 36 years (range: 12–80). Figs. 4–6 show the mean preoperative and postoperative audiometric results of the cases of this series. The mean hearing gain by air conduction calculated on a frequency range from 250 to 4000 Hz, with a mean follow-up of 23 months (range: 12–60 months) was 16.5 dB ± 14 dB, regardless of the underlying disease, with a mean improvement of the air-bone gap of 17.1 ± 12 dB. An audiometric air-bone gap < 20 dB was recorded in 21 cases (70%). No case of prosthesis displacement was observed, as the absence of prosthesis displacement was verified by either computed tomography of the petrous temporal bones

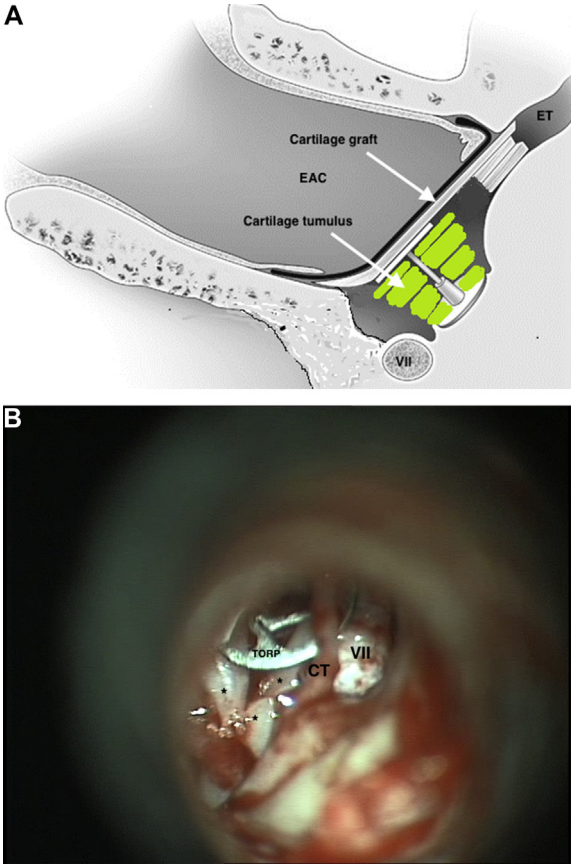

Fig. 3. A: Diagram of the cartilage tumulus created with several cartilage fragments placed around the shaft of the prosthesis, after cartilage tympanoplasty and sacrifice of the handle of the malleus (VII: facial nerve, EAC: external auditory canal, ET: Eustachian tube); B: Final intraoperative appearance of the cartilage tumulus (fragments of cartilages marked by *): note that the tumulus ascends as far as the plateau of the TORP in order to limit the risk of tympanic membrane retraction around the prosthesis (VII: facial nerve, CT: chorda tympani).

or redo surgery in all cases with poor hearing results. Only one case of extrusion (3.2%) was observed four years after surgery, in a patient with severe tympanic membrane retraction with ossicular lysis in a context of Goldenhar oculo-auriculo-vertebral syndrome. No case of calcification of the cartilage tumulus was observed in any of the cases of redo surgery, for whatever reason (verification of cholesteatoma or redo ossiculoplasty, for example).

4. Discussion

The "tumulus" technique is very easy to perform, as it uses autologous cartilage, which is always available and remains stable over time at no cost. It not only ensures lasting stabilization of the prosthesis, but also prevents tympanic membrane retraction around the TORP.

The functional results obtained can be considered to be satisfactory, and comparable to those reported in the literature with other techniques. For example, House et al., in 2001, based on a series of 560 patients undergoing TORP placement, reported that 62.9% of cases had an audiometric air-bone gap < 20 dB, which they considered to be a very satisfactory result [5]. The technique appears to effectively limit prosthesis extrusion, as only one case of extrusion (3.2%) was observed in our study, corresponding to a lower rate than that reported by House et al. in their series (4%) [5]. The prosthesis extrusion rates reported in the literature range from 1% [4] to 8% [6].

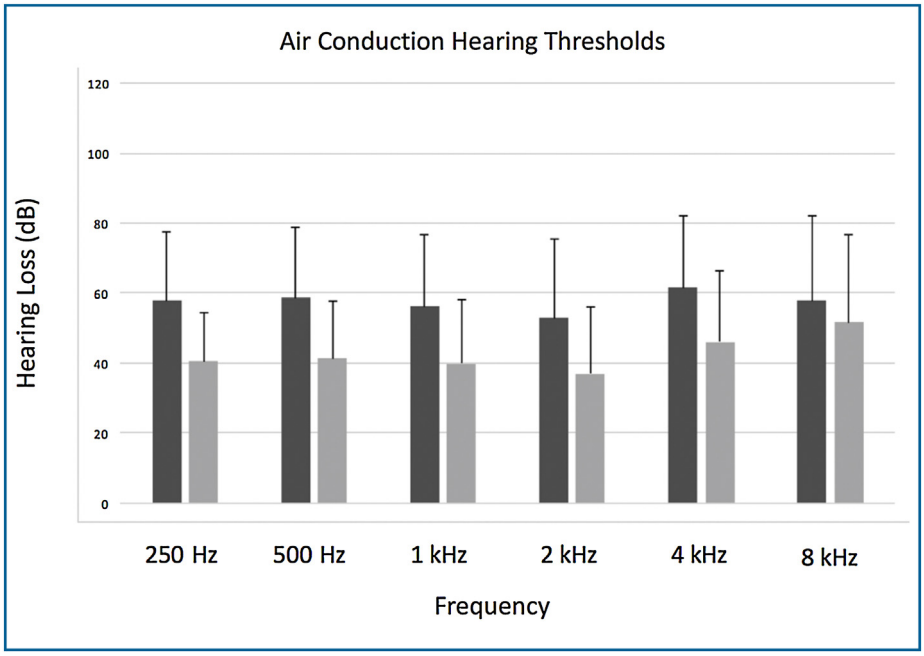

Fig. 4. Mean preoperative (black columns) and postoperative (gray columns) air conduction hearing thresholds for each frequency. Vertical bars represent standard deviations.

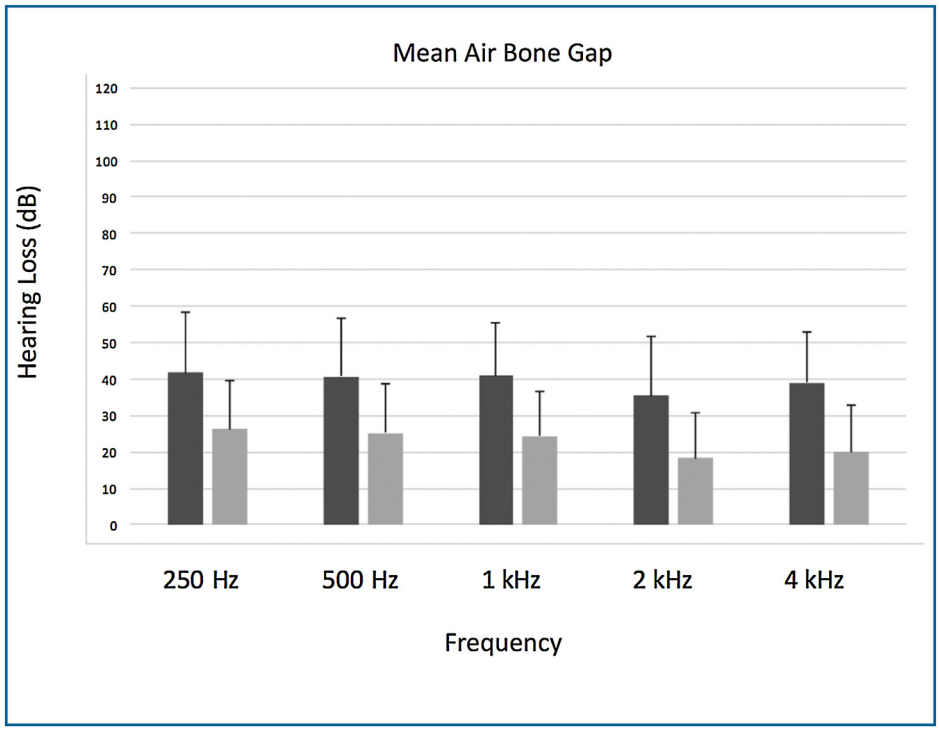

Fig. 5. Mean preoperative (black columns) and postoperative (gray columns) air-bone gap for each frequency. Vertical bars represent standard deviations.

5. Conclusion

The "tumulus" technique, using constantly available autologous cartilage at no additional cost is a simple, reliable technique ensuring excellent prosthesis stability. In the light of the functional results as well as prevention of prosthesis extrusion, this technique can be recommended when TORP stability appears uncertain, for example in the case of an irregular surface of the stapes footplate, absence of the handle of the malleus, and when there is a risk of tympanic membrane retraction.

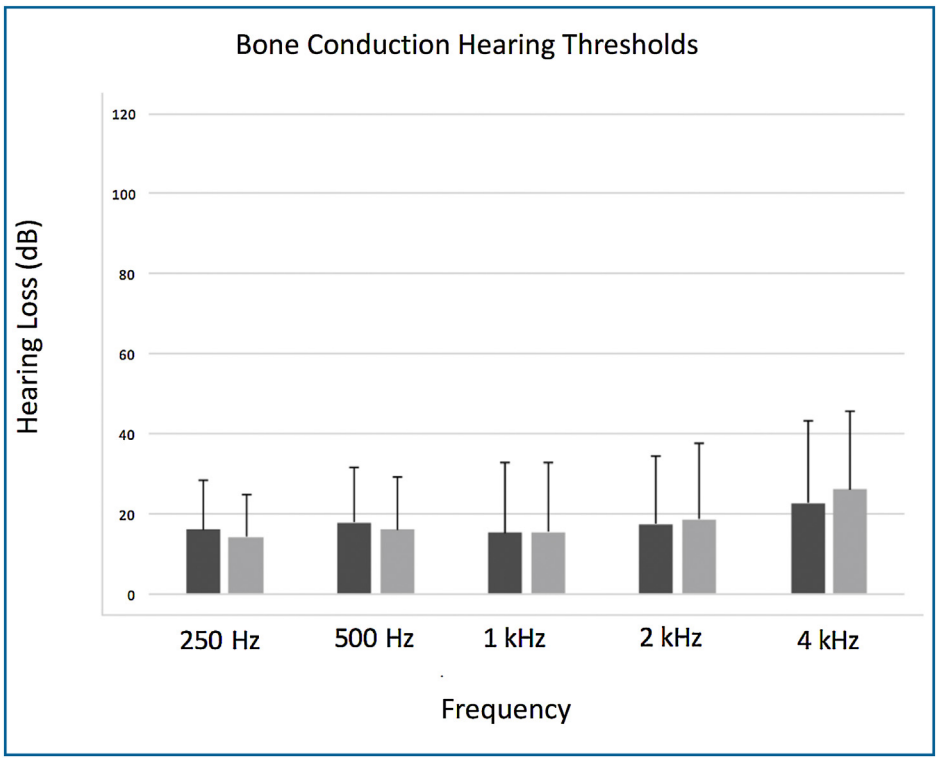

Fig. 6. Mean preoperative (black columns) and postoperative (gray columns) bone conduction hearing thresholds for frequencies of 250 Hz to 4 kHz. Vertical bars represent standard deviations.

Disclosure of interest

The authors declare that they have no competing interest.

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