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Main Article

Posterior canal wall reconstruction with a composite cartilage titanium mesh graft in canal wall down tympanoplasty and revision surgery for radical cavities

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Abstract

Objectives: To investigate posterior external ear canal wall reconstruction with a composite cartilage titanium mesh graft in canal wall down tympanoplasty and revision surgery for open mastoids.

Study design: Retrospective case review.

Setting: Tertiary referral centre.

Methods: As a preliminary study, 15 selected patients underwent reconstruction of a posterior ear canal wall defect with titanium mesh. Large defects of the posterior external auditory canal wall, resulting from canal wall down tympanoplasty or present in revision surgery, were eliminated by reconstruction using a titanium mesh. The mesh was covered with conchal cartilage and attached to the cortical mastoid bone using 3-mm titanium screws.

Results: All patients maintained a normal contour of the external ear canal, without depression, extrusion or infection. There were no failures, based on short-term post-operative controls. However, two procedures had to be revised due to incomplete coverage of the titanium mesh.

Conclusions: This study shows that reconstruction of the posterior ear canal wall with a composite cartilage titanium mesh is a valuable method for preserving the morphology of the external auditory canal in selected cases. Problems occurring in canal wall down tympanomastoidectomy and radical cavities may therefore be avoided. However, long-term results have yet to be evaluated.

Key words: Otologic Surgical Procedures; Surgical Revision; Titanium; Ear Canal

Introduction

Canal wall down mastoid surgery usually produces a dry and trouble-free ear.[1,2] However, some patients with canal wall down tympanomastoidectomy or radical cavities may suffer from chronic symptoms related to the cavity, such as chronic otorrhoea, the need for frequent cleaning, poor hearing aid fitting, recurrent cholesteatoma, formation of granulation tissue and dizziness. Revision surgery is generally indicated in these patients.[3,4]

The specific revision procedure required is dependent on the intra-operative findings; the surgeon may undertake a simple revision, partial obliteration of the cavity or reconstruction of the posterior canal wall. Patients frequently undergo several surgical procedures to cure long-term problems of the cavity.[1] However, all forms of conservative management, as well as posterior canal wall reconstruction, primary mastoid cavity obliteration and secondary obliteration, may result in an unsatisfactory outcome. Soft tissue pedicles or vascularized flaps often contract or become atrophic, leading to shrinkage. Cartilage and bone grafts are often used, but this may be restricted by the availability of sufficient material. Additionally, there is morbidity at the donor site and a variable degree of resorption.[5]

In cases of extensive mastoid pneumatization, additional measures are required to reduce the size of the cavity. Above all, the cortex should be drilled down to the level of the sigmoid sinus. This will significantly reduce the size of the cavity. Bone that is not contaminated by cholesteatoma tissue can be collected for reuse, as it makes an excellent material for subsequent partial obliteration of the cavity.[2] Additionally, temporary removal of the posterior canal wall can be followed by reconstruction of the canal defect using cymba, tragal or conchal cartilage.[5] Different synthetic materials (e.g. ceramics and hydroxylapatite) have to be covered by vascularized flaps, but these may be affected by infection, incomplete integration, and early or late extrusion.[6–9]

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Titanium has proven biocompatibility and can be easily shaped. To date, there have been two reports of the use of titanium mesh: (1) for the reconstruction of mastoid cortex defects; and (2) for the reconstruction of the posterior wall with bone pate.[10,11] To our knowledge, there are no studies using a composite cartilage titanium mesh to reconstruct the posterior ear canal wall. In theory, this method should combine the features of titanium (stability, flexibility and biocompatibility) with the excellent covering qualities of cartilage.

Therefore, this pilot study was intended to evaluate the efficiency of posterior canal wall reconstruction using a composite cartilage titanium mesh. The indication was limited to extended defects, and a single-stage technique was used in different middle-ear procedures.

Patients and methods

This study was approved by the ethical committee of the University of Bochum, Medical Faculty (registration number 2363, 2003), and performed in the department of otorhinolaryngology, head and neck surgery, University of Bochum, Germany. All 15 adult patients (mean age 47 ± 16 years; seven men, eight women) underwent reconstruction of large defects of the posterior ear canal wall after different surgical procedures (10 extended recurrent cholesteatomas (all previously operated on using intact canal technique), four draining radical cavities and one extended external ear canal cholesteatoma), using a composite cartilage titanium mesh (Spiggle & Theis, Overath, Germany) (Table I). If necessary, the ossicular chain was reconstructed in a single-stage procedure. The tympanic membrane was closed with cartilage palisades, as described elsewhere.[12] All patients received 2 g cefazolin intra-operatively.

The titanium mesh was bent by manual manipulation and cut using special wire scissors (Spiggle & Theis), correcting the size in order to cover the defect of the posterior ear canal wall. The mesh was placed slightly anterior to the facial ridge and extended depth-wise to the former bony tympanic annulus (Figure 1). The correct size was judged by intra-operative, microscopic control of fitting, occasionally supported by use of a 30° angled endoscope. It was found to be helpful to drill small ridges into the bone to facilitate stabilization of the titanium mesh. Once the titanium mesh had been formed into its final shape, it was removed from its future position and covered with cartilage, generally adequately harvested from the cavum conchae. In cases of revision, it was found to be helpful to split the cartilage in half, to obtain sufficient material, or to harvest cartilage from the contralateral side. The perichondrium was left attached to the cartilage.

The following steps were performed on the operating table. The conchal cartilage was secured with clamps and fixed onto the mesh with two resorbable sutures (Vicryl® 4.0, Fa Ethikon, Norderstedt, Germany) in order to prevent movement. The knots were positioned towards the mastoidal segment of the titanium mesh. Uncovered titanium areas were strictly avoided and excess material excised. The composite titanium mesh was then attached to the remaining parts of the adjacent superior and inferior cortical bone and secured with two 3 mm titanium screws (Figure 2). The mesh was subsequently covered with temporalis fascia and retroauricular split thickness skin grafts. The canal was then packed with (Curaspon®, Curamedical, Amsterdam, NL) with an antibiotic ointment. The postauricular incision was closed in the usual manner. The packing was removed 21 days after surgery. Patients were followed for a period of nine to 14 months (being seen at three and six weeks and if possible at 12 months).

The pre- and post-operative audiometric data were presented as pure tone average air–bone gaps (PTA–ABGs) calculated for 500, 1000, 2000, 4000 and 6000 Hz. A statistical comparison between pre- and post-operative hearing results was performed using Student's *t*-test.

TABLE I

SUMMARY OF 15 CASES

Case	Age (years)	Sex	Indication	Follow up (months)	Complications	Re-epithelialization (weeks)	X-ray
1	32	M	DC, DZ	13	None	6	Regular, TM
2	24	F	DC, DZ	13	None	6	Regular, TM
3	51	F	DC, DZ	14	2 revisions	12, 12	None
4	82	F	DC, DZ	12	None	7	Regular, TM
5	57	M	ECC, TE	12	1 revision	12	Regular*, TM
6	48	M	RC, CHL, DZ	12	None	7†	None
7	65	F	RC, CHL	13	None	6	Regular, TM
8	53	F	RC, CHL	13	None	6	Regular, TM
9	28	M	RC, CHL, DZ	10	None	6	Regular, TM
10	55	F	RC, CHL	12	None	6	Regular, TM
11	28	F	RC, CHL	14	None	7	Regular, TM
12	59	F	RC, CHL	9	None	6	Regular, TM
13	41	M	RC, CHL	9	None	6	None
14	38	M	RC, CHL	9	None	6	Regular, TM
15	42	M	RC, CHL, DZ	13	None	7	Regular, TM

All patients underwent posterior canal wall reconstruction with a composite cartilage titanium mesh graft. Follow-up time equals exposure of mesh. *See Figure 4; †see Figure 3. DC = draining cavity; DZ = dizziness; ECC = ear canal cholesteatoma; TE = tumour exclusion; RC = recurrent cholesteatoma; CHL = conductive hearing loss; TM = titanium mesh

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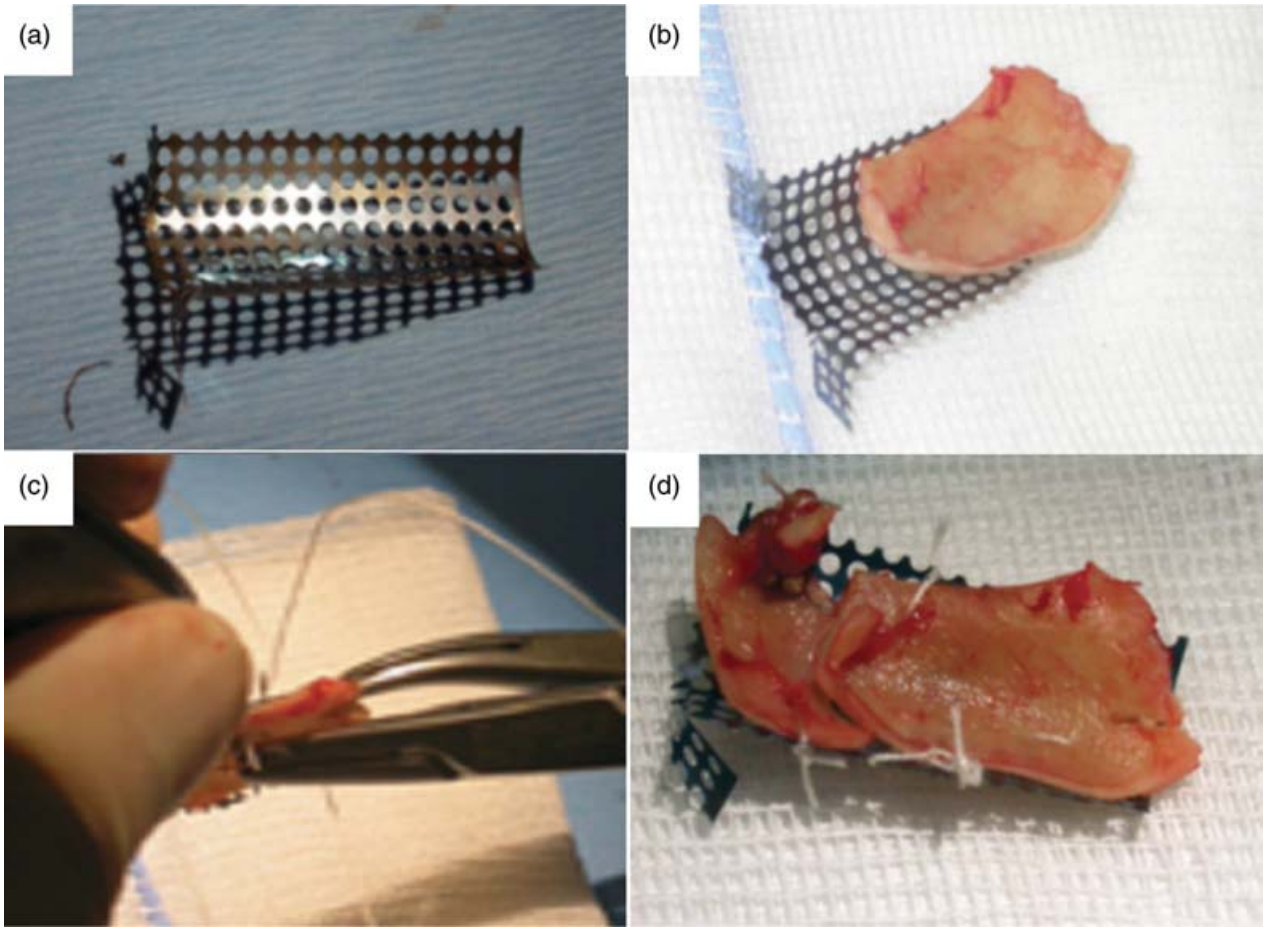

FIG. 1
(a) The titanium mesh is bent and cut into the final shape. (b) Conchal cartilage is placed on the shaped titanium mesh. (c) The cartilage is secured by a clamp and fixed with resorbable sutures to the mesh. (d) The composite cartilage titanium mesh prior to final shaping. Uncovered titanium areas must be avoided and excess material excised.

Results

Complete reconstruction of the posterior ear canal wall was achieved in all patients. Because the technique involved contouring the mastoid cavity, the usual problems (such as drainage or debris collection) were alleviated. A dry cavity was achieved in 13 of 15 patients (Figure 3). Complications, such as wound infection, depression in the postauricular site or extrusion of the titanium mesh, were not observed nine to 14 months post-operatively. However, two patients' procedures had to be revised due to incomplete coverage of the titanium mesh at the entrance of the external ear canal and consequent formation of granulation tissue. Both patients' procedures were successfully revised (one patient twice), ensuring complete cartilage coverage of the exposed titanium mesh. No statistically significant changes in hearing ($p < 0.05$) were obtained, with the mean pure tone average air–bone gap decreasing to 28.1 dB from 35.4 dB. There were no evident failures, based on short-term post-operative controls. Twelve of the 15 patients underwent post-operative Schuller's projection of the temporal bones, which showed an air-filled mastoid cavity and titanium mesh in the position of the posterior ear canal wall (Figure 4).

Discussion

Titanium has been widely used in maxillofacial, otolaryngological and surgical reconstructive procedures.[10,11,13,14] It has been shown to be biocompatible and osteointegrative.[15] Another potential benefit of titanium was revealed by the investigations of Suzuki and Frangos, who found that titanium has an anti-inflammatory effect.[16] This is potentially important, since the introduction of alloplastic materials into the middle ear and mastoid may cause specific and deleterious reactions within different tissues, including inflammation, granulation, fibrosis and formation of new bone.[17]

Titanium mesh has been safely used for the reconstruction of craniofacial fractures and tumour defects.[13] It is a malleable material which can be easily shaped and folded according to the surgical need. Zini *et al.* used a titanium micro-mesh with bone pate for reconstruction of the posterior canal wall after radical mastoidectomy in nine patients.[11] They reported that no patients developed major complications and that, at the second-look operation, the posterior canal wall was stable in all cases and the deep surface of the titanium micro-mesh was lined with normal mucosa.[11] Titanium has recently been shown to be accepted by the middle-ear mucosa

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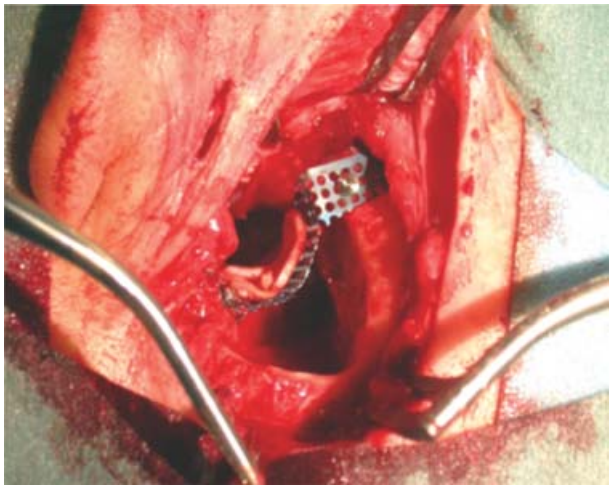

FIG. 2

Large mastoid bowl after removal of a recurrent cholesteatoma. The facial ridge has been lowered. The composite cartilage titanium mesh is in place. It will subsequently be covered with free temporalis fascia and retroauricular split skin graft.

when placed both as an ossicular prosthesis and as a free implant.[18,19] Jung and Park described the reconstruction of the mastoid cortex defect after intact canal wall mastoidectomy to prevent excessive depression in the postauricular area and to prevent filling the mastoid cavity with soft fibrous tissue, in 14 patients.[10]

In our study, all patients who underwent reconstruction of a mastoidectomy defect with titanium mesh maintained a normal contour of the postauricular area, without depression or infection. This method may be useful in order to avoid a troublesome mastoid cavity. Patients with pre-operative dizziness due to irritation of the vestibular system benefitted especially from the reconstruction of the posterior wall.

However, we suggest that this method should not be used when there is active infection or a severe ventilation problem of the middle ear. Additionally, it is supposed to be limited to cases of large posterior wall defect with extensive mastoid pneumatization. Patients with smaller defects or small mastoid cavities should be treated with different surgical techniques.[20]

FIG. 3

Recurrent, right-sided cholesteatoma in a 48-year-old patient; post-operative view approximately seven weeks after removal of ear package.

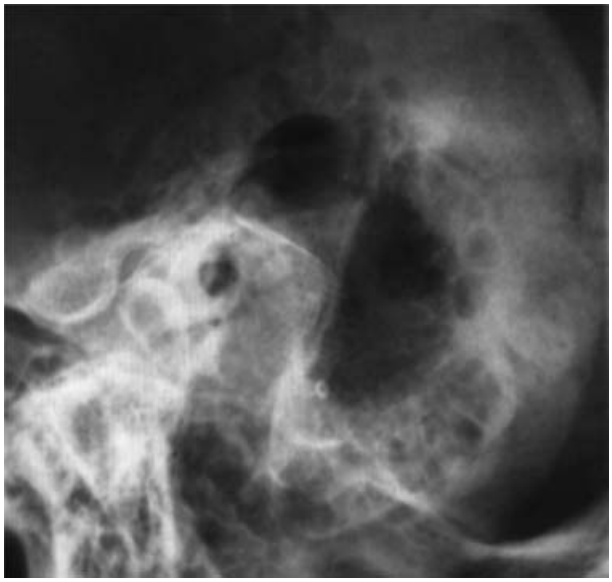

FIG. 4

Schuller's projection for a patient (case 5) who underwent reconstruction of the posterior wall with a composite cartilage titanium mesh. The mastoid is extensively pneumatized.

Conclusions

This short-term study revealed that the reconstruction of large posterior ear canal wall defects with composite cartilage titanium mesh is a valuable method for preserving the morphology of the external auditory canal in selected cases. This technique provides a useful tool in the surgical management of large posterior wall defects. Nevertheless, long-term results have yet to be observed.

- **This study investigated posterior external ear canal wall reconstruction with a composite cartilage titanium mesh in canal wall down tympanoplasty and revision surgery for open mastoids. This was a preliminary study of 15 patients**
- **All patients included in this study maintained a normal contour of the external ear canal, without depression, extrusion or infection. There were no failures, based on short-term post-operative controls. However, two patients had to be revised due to incomplete coverage of the titanium mesh**
- **Reconstruction of posterior ear canal wall with a composite cartilage titanium mesh is a valuable method for preserving the morphology of the external auditory canal in selected cases**

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