The Journal of Laryngology & Otology

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Pseudo mastoid obliteration with conchal cartilage may be a safe alternative technique for cochlear implantation in canal wall down mastoidectomy with large meatoplasty

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Main Article

Dr C Carnevale takes responsibility for the integrity of the content of the paper

Cite this article: Carnevale C, Til-Pérez G, Arancibia-Tagle D, Tomás-Barberán M, Sarría-Echegaray P. Pseudo mastoid obliteration with conchal cartilage may be a safe alternative technique for cochlear implantation in canal wall down mastoidectomy with large meatoplasty. *J Laryngol Otol* 2020;**134**:493–496. https://doi.org/10.1017/S0022215120001139

Accepted: 12 April 2020

Key words:
Cochlear Implantation; Mastoid

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Abstract

Objective. Safe cochlear implantation is challenging in patients with canal wall down mastoid cavities, and the presence of large meatoplasties increases the risk of external canal overclosure. This paper describes our results of obliteration of the mastoid cavity with conchal cartilage as an alternative procedure in cases of canal wall down mastoidectomy with very large meatoplasty.

Methods. The cases of seven patients with a canal wall down mastoidectomy cavity who underwent cochlear implantation were retrospectively reviewed. Post-operative complications were analysed. The mean follow-up duration was 4.5 years.

Results. There was no hint of cholesteatoma recurrence and all patients have been free of symptoms during follow up. Only one patient showed cable extrusion six months after surgery, and implantation of the contralateral ear was needed.

Conclusion. Pseudo-obliteration of the mastoid cavity with a cartilage multi-layered palisade reconstruction covering the electrode may be a safe alternative in selected patients with a large meatoplasty.

Introduction

Cochlear implantation in patients with a canal wall down mastoid cavity is challenging, especially in patients with persistent or recurrent inflammation due to underlying inflammatory middle-ear disease such as chronic otitis media or cholesteatoma. In such cases, there is an increased risk of labyrinthitis, meningitis and electrode array extrusion into the external auditory canal through the soft tissue cover of the mastoid cavity.[1,2] A variety of surgical techniques have been described to minimise peri- and post-operative complications, including maintenance of the cavity with soft tissue coverage of the electrode, overclosure of the external auditory meatus with and without mastoid obliteration or Eustachian tube plugging, reconstruction of the posterior external auditory canal wall, as well as middle fossa approaches to the cochlea.[3–8]

Subtotal petrosectomy with external auditory canal overclosure is considered a safe procedure amongst the various proposed surgical techniques. However, overclosure of the external auditory canal is associated with several complications, such as post-operative infections, meningitis due to masked cavity infection because of residual or recurrent cholesteatoma, as well as fat necrosis, and dehiscence of the meatoplasty.[2,9–12]

For this reason, in patients with a stable cavity after a canal wall down mastoidectomy and a large meatoplasty, a multi-layer obliteration of the mastoid cavity with conchal cartilage and temporal fascia plus a two-layer closure technique of the post-auricular incision, when feasible, may be considered a safe and reliable option.

This study evaluated the results obtained with this technique in seven patients where cochlear implantation was performed after a canal wall down mastoidectomy with a large meatoplasty.

Materials and methods

We reviewed a retrospectively acquired database of all surgical procedures for cochlear implantations performed at Son Espases University Hospital between January 2011 and December 2018. A total of 296 surgical procedures were performed, but only those patients who had previously undergone canal wall down mastoidectomy and a large meatoplasty because of cholesteatoma or chronic otitis media were included in the study. In all cases, cochlear implantation was performed at least two years after the canal wall down mastoidectomy. Physical examination and magnetic resonance imaging (MRI) (in the case of cholesteatoma surgery) had been used to rule out cavity disease recurrence in

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all patients prior to cochlear implantation surgery. The mean follow-up duration was 4.5 years (range, 3–7 years).

We analysed the characteristics of patients, length of hospital stays, and rates of post-operative complications (such as cochlear implant exposure or extrusion) and revision surgery. Our preferred surgical technique is described.

Surgical technique

The surgery is conducted under general anaesthesia and, in all cases, an orotracheal tube and facial nerve monitoring is used. The patient is placed in a supine position with their head turned to the contralateral side. Local infiltration with lidocaine and adrenaline (1:100 000) is used for anaesthesia. A post-auricular incision is made, 1 cm posterior to the retroauricular sulcus. If possible, two flaps are prepared: a superficial flap that includes the skin and subcutaneous tissue, and a deeper fascio-muscular flap to reduce the risk of device extrusion.[13] Haemostasis is achieved with monopolar or bipolar electrocautery. However, once the implant is in the surgical field, bipolar electrocautery is mandatory.

The cartilage palisade used for tympanic membrane reconstruction and mastoid obliteration is removed, and the cavity is explored. If necessary, the posterior border of the round window niche is drilled and the cavity is irrigated with dexamethasone. Then, the bone bed for the cochlear implant is drilled and prepared below the temporal muscle. The array is inserted through the round window membrane, which is always sealed with temporal fascia and fibrin glue. Then, the implant is fixed into the exact position with a suture.

After confirming the correct introduction of the electrode by intra-operative radiography, the conchal cartilage plates are used for partial obliteration of the cavity, for covering of the array and for eardrum reconstruction in an overlapping fashion (Figure 1). The reconstruction is buttressed with two or three thin, overlapping (1.3 mm) blue silicone sheets, before the cavity is packed with gelatine sponges (Gelita Medical, Eberbach, Germany) soaked with ciprofloxacin solution.

Finally, the meatoplasty is restored and the incision is closed by suturing the two previously described flaps and applying a pressure dressing to the wound.

Results

Between 2011 and 2019, a total of seven patients who had previously undergone canal wall down mastoidectomy underwent cochlear implantation in our hospital.

Aetiology of hearing loss and characteristics of the patients are described in Table 1. There were two cases of chronic otitis without cholesteatoma and five cases of cholesteatoma.

The cochlear implantation procedures were performed after at least two years of follow up and were uneventful in all cases. There were four males and three females, with a mean age of 46.8 years (range, 28–71 years). There were two left side and six right side ears (one patient needed revision surgery).

In all cases, the array was inserted in the scala tympani of the basal turn of the cochlea, through the round window membrane. Patients were discharged 2 days after surgery, and the cochlear implant was activated after 3 weeks.

No post-auricular abscess or skin infection was observed in this series during a follow up of at least three years (range of three to eight years). No cases of otorrhoea due to superficial inflammation of the mastoid cavity skin cover were observed after implantation. There was no hint of cholesteatoma recurrence, and all patients have been free of symptoms and infection during follow up. Only one patient (patient 5) showed cable extrusion six months after surgery, and implantation of the contralateral ear was needed (Figure 2).

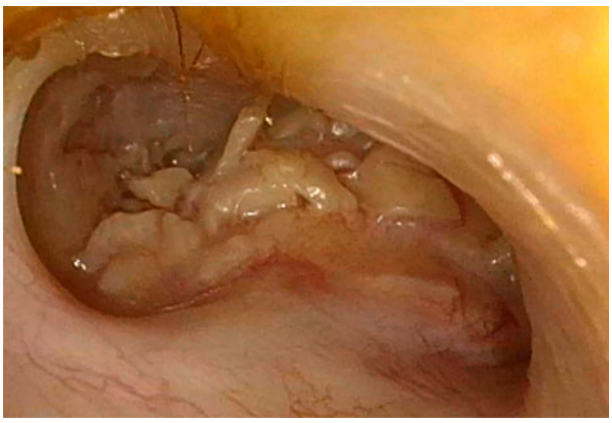

Fig. 1. Cochlear implantation and cartilage multi-layered palisade reconstruction in the right ear of patient 4, who had previously undergone canal wall down mastoidectomy.

Discussion

In the context of cochlear implantation, the presence of a canal wall down mastoid cavity represents a challenge for peri- and post-operative management, especially when there is a large meatoplasty. Many surgical techniques and different approaches have been developed to obtain good results with low complication rates, but no technique is currently considered the 'gold standard'.

Many authors advocate subtotal petrosectomy with overclosure of the external auditory canal, combined with Eustachian tube plugging and fat obliteration, for managing radical cavities prior to cochlear implantation. This technique was introduced in the late 1950s, and Ugo Fisch introduced the term 'subtotal petrosectomy' in 1965.[14] In the early years, subtotal petrosectomy was considered hazardous in light of increased incidences of recurrent disease, and there was a general hesitancy amongst surgeons in adopting this procedure. However, over the past couple of decades, there has been a growing interest in subtotal petrosectomy, and the indications for the procedure have also increased. In fact, with the development of MRI and diffusion-weighted MRI in particular, and refinements in the surgical techniques and better microscopes, a significant reduction in residuals and recurrences has been observed.[14] The rationale for using subtotal petrosectomy in these cases is to obtain an isolated cavity with a low risk of infections, and to diminish the risk of extrusions.[5,15,16]

Polo *et al.*,[15] in an interesting series with 110 cases, described their vast experience with subtotal petrosectomy. A very low rate of array extrusion (4.55 per cent) is reported, but only 33 patients had previously undergone canal wall down mastoidectomy and the percentage of array extrusion in this subgroup of patients is not specified. Previously, Vincenti *et al.*[17] reported the long-term results of 12 patients after subtotal petrosectomy and one- or two-stage cochlear implantation after open cavity surgery. They reported one patient with residual cholesteatoma and one with wound breakdown at the external meatus. Good results were also reported by Szymanski *et al.*;[18] these authors did not observe any complications in seven patients where a subtotal

https://doi.org/10.1017/S0022215120001139 Published online by Cambridge University Press

Table 1. Characteristics of patients

Pt no.	Surgical indication	Sex	Age (y)	Side	Hospital stay (days)	Follow-up duration	Complications	Revision surgery?	Revision side	Subsequent follow-up duration
1	Cholesteatoma	F	51	R	2	3 y		No		
2	Cholesteatoma	M	46	R	2	5 y		No		
3	COM	M	28	R	2	4 y		No		
4	Cholesteatoma	F	37	R	2	6 y		No		
5	Cholesteatoma	M	71	R	2	6 mo	Extrusion	Yes	L	3 y
6	COM	F	54	L	2	4 y		No		
7	Cholesteatoma	M	41	R	2	7 y		No		

Pt no. = patient number; y = years; F = female; R = right; M = male; COM = chronic otitis media; mo = months; L = left

Fig. 2. Cable extrusion following cochlear implantation in the right ear of patient 5, who had previously undergone canal wall down mastoidectomy. Implantation of the contralateral ear was needed.

petrosectomy was performed after previous open cavity surgery. In the largest series of subtotal petrosectomy cases reported in the literature, published in 2017, Prasad *et al.*[14] analysed the results of 460 patients. In 91 cases, subtotal petrosectomy and cochlear implantation was performed, with a very low rate of electrode extrusion of 1.1 per cent. A previous surgical procedure was the indication for cochlear implantation with subtotal petrosectomy in only 48.3 per cent of cases. The type of surgery performed and the exact number of patients with a previous large meatoplasty is not specified.

Those who advocate maintaining a canal wall down mastoid cavity following cochlear implantation refer to the simplicity of the procedure, the improved post-operative visualisation and the ability to clean the cavity. Furthermore, maintaining the canal wall down cavity decreases the risks related to external auditory meatus overclosure, such as post-operative infections, dehiscence of large pre-operative meatoplasties, development of residual cholesteatomas, fat necrosis, mucoceles, cavity infections, meningitis and complications related to the fat donor site.[5,9,12,19] In particular, the development of residual or recurrent cholesteatomas causing a masked cavity infection with meningitis is a dreaded complication. Thus, early detection of a residual or recurrent cholesteatoma can be considered a priority. For this, maintaining the otoscopic view into the external auditory canal after pseudo mastoid obliteration may be beneficial during the required long-term follow up of patients with cholesteatoma. It is especially important in patients with a cochlear implant, where MRI follow up is limited.

However, maintaining an open cavity is not without risk, and both electrode exposure and extrusion have been reported, including electrode extraction with mastoid cavity cleaning, which is needed in these patients once or twice a year.[2] In order to reduce the risk of extrusion, many surgical techniques emphasise the meticulous elevation of the cavity's fibroepithelial lining, minimising the risk of leaving residual squamous tissue, while providing adequate soft tissue coverage of the electrode. Several different techniques have been described for electrode coverage, using combinations of bone pâté, fibrin glue, bone cement, perichondrium, bone matrix, cartilage, abdominal fat and local musculoperiosteal flaps.[20–22] The principal limitation is that most published data relative to these techniques are based on small case series, and thus a definitive conclusion about outcomes cannot be obtained.

This retrospective study shows that partial mastoid obliteration with the cartilage palisade technique may be a safe option for cochlear implantation when a large meatoplasty exists and closure of the external auditory meatus is not easy to perform. The decreased blood supply surrounding the open cavity, and the tension placed on the double layer closure of a large meatoplasty, increase the risk of complications related to external auditory canal blind sac closure.

This study's findings are in line with reports on cochlear implantation regarding subsequent and simultaneous reconstruction of the posterior bony canal wall and obliteration of the mastoid cavity.[23,24]

- Cochlear implantation is challenging in canal wall down mastoidectomy cases
- Several techniques have been described to reduce the risk of post-operative complications
- Subtotal petrosectomy, with external auditory canal overclosure and Eustachian tube plugging, is considered safe but not without risk
- In large meatoplasty cases, blind sac closure of the external canal may be difficult and the risk of dehiscence is higher
- This paper describes partial obliteration of the mastoid cavity with cartilage multi-layered palisade reconstruction covering the electrode
- This technique is a feasible alternative in selected patients with a large meatoplasty and stable mastoid cavity

We recognise that there are several limitations to our study. In a similar way to all retrospective reviews, ours is limited by the availability and accuracy of medical records, and we recognise that we are reporting on a small cohort of patients. Despite this, we consider that pseudo-obliteration of the

https://doi.org/10.1017/S0022215120001139 Published online by Cambridge University Press

canal wall down mastoid cavity with a cartilage multi-layered palisade reconstruction covering the electrode can be advocated as a feasible alternative technique in selected patients who present with a large meatoplasty and a stable mastoid cavity.

Competing interests. None declared

References

1 Hunter JB, O'Connell BP, Wanna GB. Systematic review and metaanalysis of surgical complications following cochlear implantation in canal wall down mastoid cavities. *Otolaryngol Head Neck Surg* 2016;**155**:555–63
2 Issing PR, Schonermark MP, Winkelmann S, Kempf HG, Ernst A. Cochlear implantation in patients with chronic otitis: indications for subtotal petrosectomy and obliteration of the middle ear. *Skull Base Surg* 1998;**8**:127–31
3 Kojima H, Sakurai Y, Rikitake M, Tanaka Y, Kawano A, Moriyama H. Cochlear implantation in patients with chronic otitis media. *Auris Nasus Larynx* 2010;**37**:415–21
4 El-Kashlan HK, Arts HA, Telian SA. External auditory canal closure in cochlear implant surgery. *Otol Neurotol* 2003;**24**:404–8
5 Free RH, Falcioni M, Di Trapani G, Giannuzzi AL, Russo A, Sanna M. The role of subtotal petrosectomy in cochlear implant surgery: a report of 32 cases and review on indications. *Otol Neurotol* 2013;**34**:1033–40
6 Olgun L, Batman C, Gultekin G, Kandogan T, Cerci U. Cochlear implantation in chronic otitis media. *J Laryngol Otol* 2005;**119**:946–9
7 Bento RF, Bittencourt AG, Goffi-Gomez MV, Samuel P, Tsuji RK, de Brito R. Cochlear implantation via the middle fossa approach: surgical and programming considerations. *Otol Neurotol* 2012;**33**:1516–24
8 Colletti V, Fiorino FG, Carner M, Sacchetto L, Giarbini N. New approach for cochlear implantation: cochleostomy through the middle fossa. *Otolaryngol Head Neck Surg* 2000;**123**:467–74
9 Casserly P, Friedland PL, Atlas MD. The role of subtotal petrosectomy in cochlear implantation. *J Laryngol Otol* 2016;**130**(suppl 4):S35–40
10 Bernardeschi D, Nguyen Y, Smail M, Bouccara D, Meyer B, Ferrary E *et al*. Middle ear and mastoid obliteration for cochlear implant in adults: indications and anatomical results. *Otol Neurotol* 2015;**36**:604–9
11 Hamzavi J, Baumgartner W, Franz P, Plenk H. Radical cavities and cochlear implantation. *Acta Otolaryngol* 2001;**121**:607–9
12 Postelmans JT, Stokroos RJ, Linmans JJ, Kremer B. Cochlear implantation in patients with chronic otitis media: 7 years' experience in Maastricht. *Eur Arch Otorhinolaryngol* 2009;**266**:1159–65
13 Carnevale C, Tomás-Barberán M, Til-Pérez G, Sarría-Echegaray P. The bonebridge bone conduction system: a fast and safe technique for a middle fossa approach. *J Laryngol Otol* 2019;**133**:344–7
14 Prasad SC, Roustan V, Piras G, Caruso A, Lauda L, Sanna M. Subtotal petrosectomy: surgical technique, indications, outcomes, and comprehensive review of literature. *Laryngoscope* 2017;**127**:2833–42
15 Polo R, Del Mar Medina M, Aristegui M, Lassaletta L, Gutierrez A, Aranguez G *et al*. Subtotal petrosectomy for cochlear implantation: lessons learned after 110 cases. *Ann Otol Rhinol Laryngol* 2016;**125**:485–94
16 Karatzanis AD, Chimona TS, Prokopakis EP, Kyrmizakis DE, Velegrakis GA. Cochlear implantation after radical mastoidectomy: management of a challenging case. *ORL J Otorhinolaryngol Relat Spec* 2003;**65**:375–8
17 Vincenti V, Pasanisi E, Bacciu A, Bacciu S, Zini C. Cochlear implantation in chronic otitis media and previous middle ear surgery: 20 years of experience. *Acta Otorhinolaryngol Ital* 2014;**34**:272–7
18 Szymanski M, Ataide A, Linder T. The use of subtotal petrosectomy in cochlear implant candidates with chronic otitis media. *Eur Arch Otorhinolaryngol* 2016;**273**:363–70
19 Lyutenski S, Schwab B, Lenarz T, Salcher R, Majdani O. Impact of the surgical wound closure technique on the revision surgery rate after subtotal petrosectomy. *Eur Arch Otorhinolaryngol* 2016;**273**:3641–6
20 Himi T, Harabuchi Y, Shintani T, Yamaguchi T, Yoshioka I, Kataura A. Surgical strategy of cochlear implantation in patients with chronic middle ear disease. *Audiol Neurootol* 1997;**2**:410–17
21 Manrique M, Cervera-Paz FJ, Espinosa JM, Perez N, Garcia-Tapia R. Cochlear implantation in radical cavities of mastoidectomy. *Laryngoscope* 1996;**106**:1562–5
22 Craig M, Lavy J. How I do it/short communication: the middle temporal artery flap for coverage of an exposed cochlear implant cable in the mastoid cavity. *Cochlear Implants Int* 2006;**7**:214–18
23 Tamura Y, Shinkawa A, Ishida K, Sakai M. Cochlear implant after reconstruction of the external bony canal wall and tympanic cavity in radically mastoidectomized patients with cholesteatoma. *Auris Nasus Larynx* 1997;**24**:361–6
24 Balk M, Schwarz D, Wolber P, Anagiotos A, Gostian AO. Cochlear implantation after canal wall down mastoidectomy. Outcomes after partial mastoid obliteration. *Auris Nasus Larynx* 2019;**46**:487–92

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