Int. Adv. Otol. 2013; 9:(1) 110-114

CLINICAL STUDY

Medialization of Total Ossicular Replacement Prosthesis in Mastoid Obliteration

Ali Sanei-Moghaddam, Sanjiv Kumar, Neil Donnelly, Patrick Axon

ENT, Medway Maritime Hospital (ASM)
University Hospital of North Staffordshire (SK)
Cambridge University Hospitals NHS Trust (ND)
Cambridge University Hospitals NHS Trust (PA)

Background: Titanium prostheses have been successfully used in the reconstruction of ossicular chain to restore or improve conductive hearing loss. Medialization of the titanium prosthesis is a potential complication of ossicular reconstruction which can lead to profound sensorineural hearing loss (SNHL).The risk of such complications is higher in patients with previous middle ear surgeries probably due to distorted anatomy.

Methods: Case Series

Results: We report three cases that either had prior mastoid obliteration or masoitd oblitration at the same time as ossiculoplasty who developed medialization of the titanium prosthesis leaving one patient profoundly deaf. CT scans in two patients confirmed the medialization of prosthesis into the labyrinthine vestibule.

Conclusion: We suggest that total ossicular replacement titanium prosthesis should be used with caution in the reconstruction of the ossicular chain in mastoid obliteration.

Submitted : 19 December 2012 *Revised : 17 January 2013* *Accepted : 22 January 2013*

Introduction

The management of a chronically draining cavity after mastoid surgery continues to be one of the most challenging problems in otology. The socioeconomic impact of a foul-smelling discharging ear can frequently cause patients to become socially withdrawn and professionally inhibited. In addition, the costs associated with the treatment of a draining cavity can be staggering. The frequent clinic visits for aural toilet, the plethora of topical medications necessary for treatment and in some cases multiple surgeries.

Although canal wall down mastoid surgery, usually results in a dry problem-free ear, it can occasionally result in a chronically draining cavity. Patients with a discharging ear can defy all attempts at conservative management in the out patient setting leaving revision surgery as the only option. Surgical management in revising these cases previously centered around performing an adequate meatoplasty, saucerizing the mastoid cavity and lowering the facial ridge. However, this technique has its pitfalls such as water precuations during swimming and also decreasing the depth of the middle ear space, making ossicular reconstruction difficult and resulting in less than-optimal hearing [1].

Various improvisations to surgical techniques have been described in the literature and have sucessfully shown to yield good results. The combined approach tympanoplasty and mastoid obliteration are accepted procedures to prevent open cavities. Cartilage and cortical bone have been used to reconstruct the posterior canal wall while bone dust/pate, hydroxy-apatite, muscle and pedicled vascularised fascial grafts are used to obliterate the cavity.

Our current practice in a long standing discharging cavity is to remove any residual disease and use pinna or tragal cartilage to reconstruct the defect in posterior ear

Corresponding address:
Ali Sanei-Moghaddam
Medway Maritime Hopsital
Gillingham, Kent, UK
E-mail:ali.sanei-moghaddam@nhs.net

canal wall and obliterate the cavity using hydroxy-apatite granules. A vascularised pericranial flap is then swung over the cartilage palisade and the residual cavity lining laid over the flap. A resulting shallow middle ear is addressed by using a composite cartilage graft to reconstruct the tympanic membrane and total or partial ossicular replacement prosthesis (TORP/ PORP) to sit between the footplate and undersurface of the cartilage or stapes superstructure and tympanic membrane. The advantage of such a technique is to manage any future retraction pockets, reinforce the tympanic membrane and support the prosthesis to establish the ossicular continuity to improve the hearing.

Metallic ossicular prostheses are good replacement for establishing the ossicular continuity and their usefullness has been accepted by numerous publications in the literature[2-7]. The complications of the titanium prosthesis include infection, migration of prosthesis and extrusion leading to loss of ossicular continuity. In cases where cartilage was used to obliterate the mastoid cavity with total ossicular replacement prosthesis (TORP) placed on the stapes footplate we have encountered increased risk of medialisation of the titanium prosthesis through the foot plate into the labyrinthine vestibule. We describe a set of cases to highlight this complication. The presentation, diagnosis, and management are reviewed. The mechanisms of erosion are discussed, and strategies for prevention of this undesirable and potentially significant complication are examined.

Methods

Case 1

A 60 year male patient underwent a left combined approach tympanoplasty (CAT) stage I for recurrent ear discharge and hearing loss. Initial examination showed a deep attic retraction pocket with erosion of scutum with a conductive hearing loss (Figure 1). A high resolution CT showed large posterior mesotympanic opacity with eroded incus. The tegmen, otic capsule and lateral semi-circular canal were all normal. The patient underwent staged ossiculoplasty at 12 months with a partial ossicular replacement prosthesis (PORP) interposed by cartilage. Unfortunately his hearing did not improve and revision surgery showed a disease recurrence with fractured superstructure of stapes covered in fibrous adhesion and eroded posterior canal wall which needed canal wall down mastoidectomy with obliteration of the mastoid cavity. The patient had a 4.75 mm Tubingen Aerial titanium prosthesis with a cartilage boot on the stapes footplate and interposed cartilage between the tympanic membrane and prosthesis. The patient had a good improvement in hearing function for 12 months but started having motion provocked dizziness thereafter. The patient had positive fistula test and a subsquent exploration revealed that the prosthesis had migrated through the footplate causing a perilymph fistula. The prosthesis was removed relieving the patient of dizzy spells but left him profoundly deaf in that ear (Figure 2).

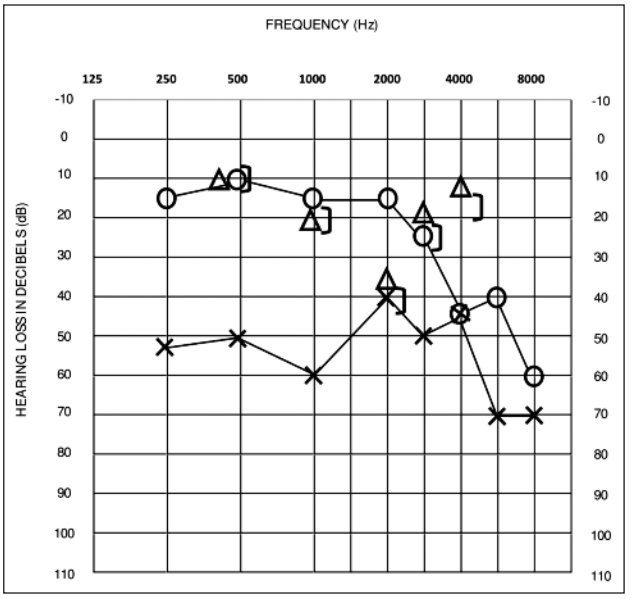

Figure 1. Pure tone audiogram of left ear at intial presentation (Case 1)

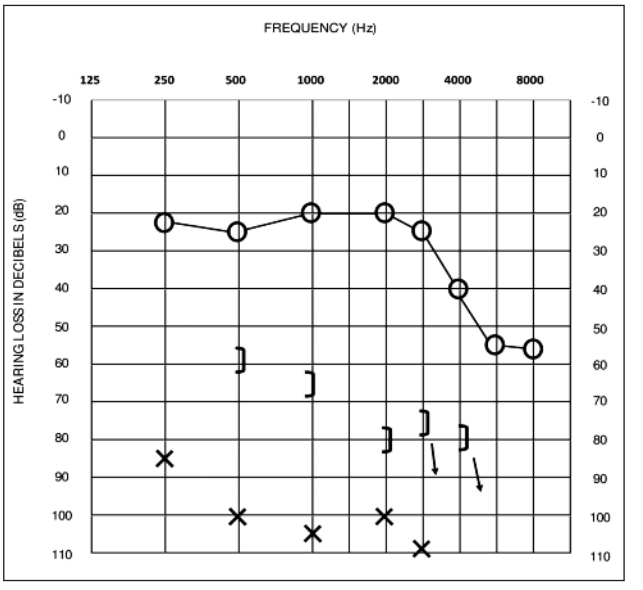

Figure 2. Pure tone audiogram of left ear after mastoid obliteration and removal of submerged prosthesis.(Case 1)

Case 2

A 40 year old male with right "auto-atticotomy", chronic discharging ear and erosion of head of malleus and body of incus underwent a modified radical mastoidectomy. The ear drum was atelectatic with evidence of mesotympanic cholesteatoma and a significant conductive hearing loss. 11 months after his intial procedure, He underwent a staged mastoid obliteration with ossiculoplasty using 4.5 mm Tubingen Aerial titanium prosthesis due to lack of hearing improvement. 12 months after the second surgery the patient reported unsteadiness when lying on his operated ear. An audiogram revealed worsening conductive hearing loss (Figure 3). Examination revealed positive fistula sign and a CT scan showed the total ossicular replacement prosthesis (TORP) had pushed through the footplate (Figure 4). Because of the risk of causing profound hearing loss, the prosthesis was left untouched but the middle ear was closed as a blind sac to prevent fistulous effect of sound and pressure transmitting to the labyrinth leaving him a moderate conductive hearing loss (Figure 5).

Case 3

A 56 year old male was referred for a right recurrent cholesteatoma following small cavity mastoidectomy. The patient had modified radical mastoidectomy with obliteration at our unit. 10 months later a 4.75 mm total ossicular replacement prosthesis (TORP) ossiculoplasty was performed for residual conductive loss with good results. 24 months after the mastoid obliteration, the patient started experiencing hearing loss (Figure 6) and unsteadiness on pressing the ear. A positive fistula sign was elicited and a CT scan of the temporal bone revealed a submerged total ossicular replacement prosthesis (TORP) into the labyrinthine vestibule (Figure 7). The patient was counselled and the risk of profound hearing loss on manipulation of total ossicular replacement prosthesis (TORP) was explained. The patient is being managed

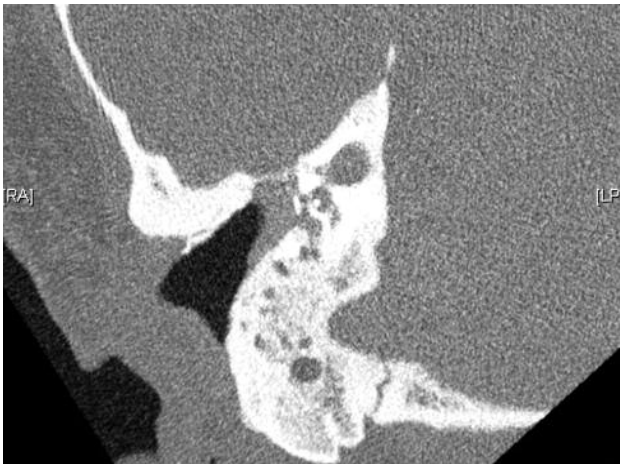

Figure 4. Reconstructed CT scan of right ear showing medialization of the TORP through the foot plate into the labyrinthine vestibule (Case 2)

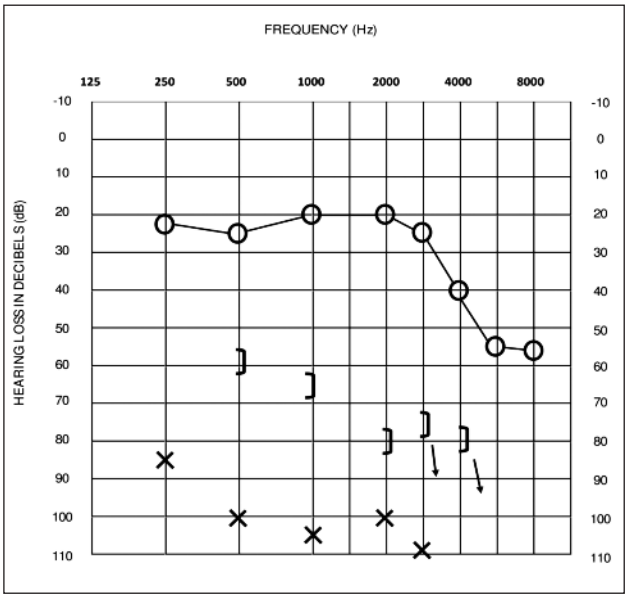

Figure 3. Pure tone audiogram of right ear at intial presentation (Case 2)

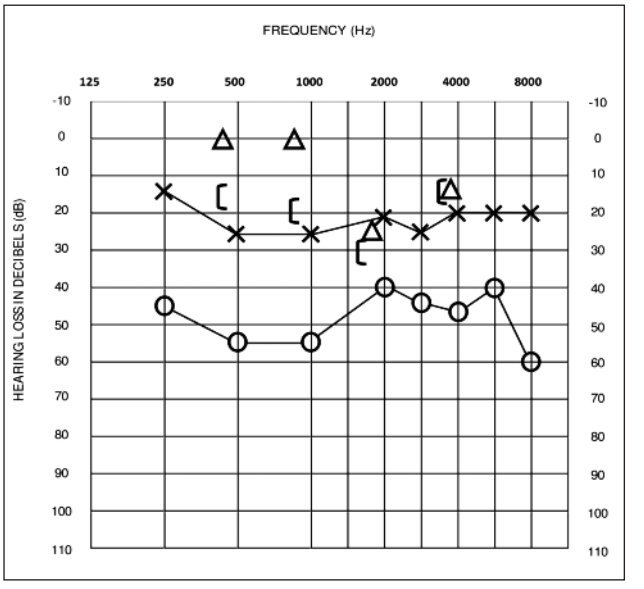

Figure 5. Pure tone audiogram after blind sac closure of ear canal with medialized prosthesis

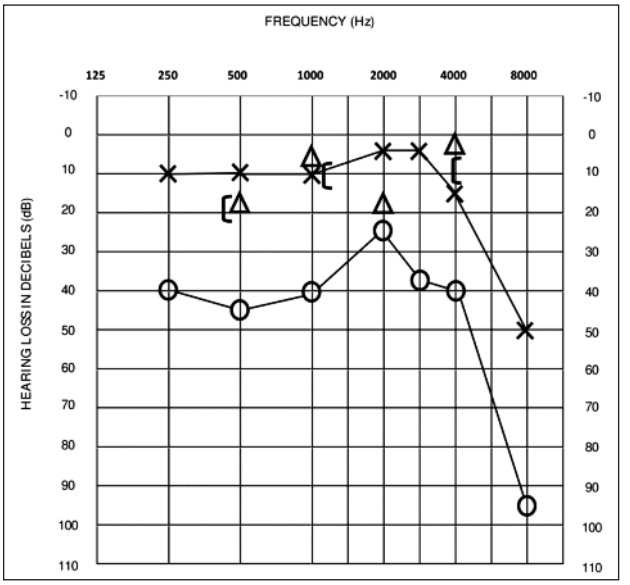

Figure 6. Audiogram at 24 months after the mastoid obliteration and ossicular reconstruction when patient started having motion provocked imbalance.(Case 3)

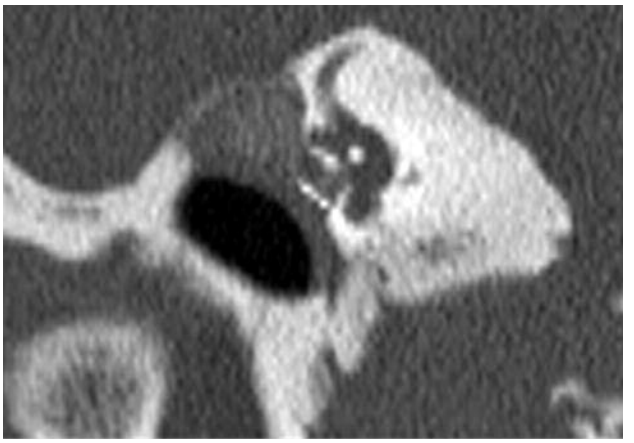

Figure 7. Right temporal bone CT scan showing medialization of the TORP through the foot plate into the labyrinthine vestibule in a different patient (Case 3).

conservatively with hearing aid rehabilitation with no significant drop in hearing at the last follow up 12 months later (Figure 8).

Discussion

Reconstruction of the middle ear space and ossicular chain can be a challenge in revision mastoid surgery because of the shallow depth of the middle ear. Hearing reconstruction with only a mobile foot plate require cartilage interposition on top of a total ossicular replacement prosthesis (TORP). The total ossicular replacement prosthesis (TORP) with the cartilage interposition also acts as a scaffolding over which vascularised pericranial flap, mastoid periosteum and tympanic membrane remnant can be draped to improve vascularity and healing. Without the support of the scutum, the facial ridge and the anterior butress, the weight of the scaffolding is transmitted to the stem of total ossicular replacement prosthesis (TORP) which acts like a lever increasing pressure on the on the foot plate. We think this fulcrum effect of the total ossicular replacement prosthesis (TORP) on the foot plate increases the risk for the prothesis medializing through the footplate (Figure 9).

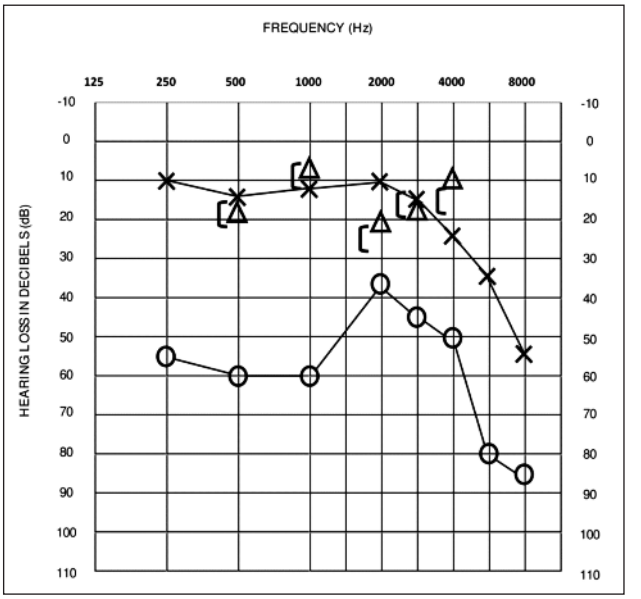

Figure 8. Audiogram at 12 months follow up with proven medialized prosthesis(Case 3)

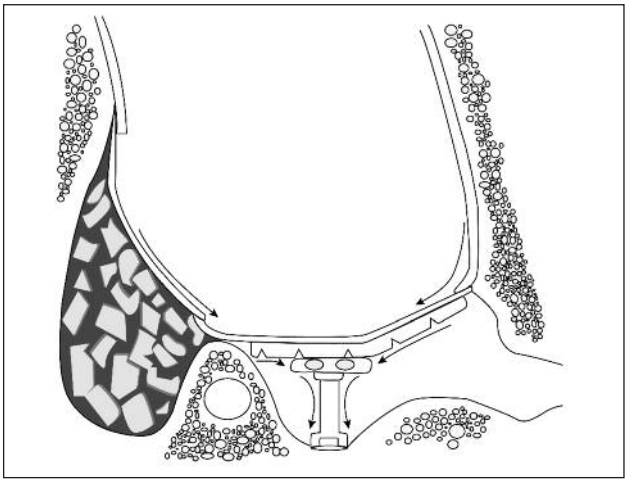

Figure 9. Diagrammatic representation of the obliterated mastoid cavity with a TORP reconstruction with arrows showing the direction of the weight on the foot plate by the stem of the prosthesis.

It is difficult to ascertain if this is the main cause of the medialization. Factors such as the thickness of the foot plate, the blood supply to the footplate, status of the middle ear mucosa, the aeration of the middle-ear, previous ear surgeries and the relative size of the total ossicular replacement prosthesis (TORP) to the middle ear cavity also add to the risk of the footplate erosion. A study of motion of the total ossicular replacement prosthesis (TORP) during changes in the static middle pressures in fresh human temporal bones showed a lateral to medial displacement of prosthesis with changes in static middle ear pressures [8].

There is paucity of evidence in the literature to explain such a complication and the factors causing footplate erosion. It is perfectly plausible to have such a complication when more robust reconstruction techniques using cartilage, cortical bone and vascularised flaps have been used . Schmerber et.al described a case of medialisation of total ossicular replacement prosthesis (TORP) in his paper describing hearing results with the titanium ossicular replacement prostheses [9]. Similar case series on total ossicular replacement prosthesis (TORP) have not reported any medialization [4,10]. A medline review of both English and non English literature in last 10 years using keyword 'total ossicular replacement prosthesis' showed 28 papers with no reported erosion of foot plate.

One of the contributing factors to the medialisation in our current series could be the technique, the use of titanium total ossicular replacement prosthesis (TORP) and the fact that all our patients had multiple procedures which may have affected the blood supply to the middle ear mucosa and the foot plate making it less likely to withstand persistent footplate pressure. Our current practice after the above cases is to avoid performing a primary total ossicular replacement prosthesis (TORP) reconstruction at the time of mastoid obliteration. We recommend that patients who lack scutum and anterior butress support should have an additional reinforcement to the footplate in form of an omega connector or use of cartilage shoe to reduce the risk of medialization. Patients who had multiple ear surgeries should be explained of the impact of total ossicular replacement prosthesis (TORP) medialization and the possible longterm effects.

This case series is important as it highlights the potential risk of ossicular medialization and a subsequent hearing loss which have implications on patient information, choice and consent.

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