CASE REPORT

In the Wrong Place but Perhaps at the Right Time: A Cochlear Implant Electrode Impinging on Tympanic Membrane

Mohamad Najib Salleh[1], Nik Adilah Nik Othman[2], Suzana Mansor[3], Zulkiflee Salehuddin[4], Dinsuhaimi Sidek[5], Mohd Normani Zakaria[6]

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Abstract

Aim: This case report demonstrates the incidental finding of a cochlear implant (CI) electrode impinging on the tympanic membrane (TM).

Background: The cochlear implant is the most successful neural prosthesis that has been developed in the last few decades. It has helped thousands of profoundly deaf recipients to have better hearing and improved quality of life. Nevertheless, extracochlear electrode extrusion or migration would occur and this requires special consideration.

Case description: We report a case of a 4-year-old boy who was implanted with bilateral CIs for profound hearing loss postmeningitis at 1 year of age, with an incidental finding of the CI electrode impinging on the medial surface of his left TM. A computed tomography (CT) scan confirmed this finding, and the patient had revision surgery and reimplantation of CI.

Conclusion: It is advisable for patients to continue follow-up postimplantation in the otorhinolaryngology (ORL) clinic even after years of CI surgery. The early detection of electrode malfunction, extrusion, migration, or misplacement is mandatory to improve patients' quality of life and prevent further complications.

Keywords: Cochlear implant, Electrode migration, High resolution computed tomography, Meningitis, Postimplantation.

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Introduction

In line with technological advancements, many treatment options are now available to improve hearing abilities for individuals with permanent hearing loss.[1,2] Among others, a cochlear implant (CI) is a well-established neural prosthesis for those with severe-to-profound sensorineural hearing loss (SNHL). Due to the rapid technological improvements and proven benefits, the number of eligible candidates fitted with CI is on the rise worldwide. Moreover, CI is usually thought to be a safe operation with low risks of serious consequences. Due to its proven safety, the operation can be performed on children as young as 12 months of age.[3] The optimum outcomes for speech and language development come from implanting at young ages.

Nevertheless, as CI involves a surgical procedure, complications are inevitable. Facial palsy, meningitis, mastoiditis, skin-related infection, electrode misplacement, tinnitus, and vertigo are the early complications. While long-term consequences would include worsening hearing loss, device failure, electrode extrusion from the cochlea or skin, facial nerve twitching on stimuli, dysgeusia, partial or total facial nerve palsy, and cholesteatoma.[4]

It is worth mentioning that the first year of life is when the skull grows the most, and it then gradually becomes bigger until it reaches adult size.[5] The distance between the cortically anchored receiver–stimulator and the circular window is influenced by changes in head circumference and mastoid air cell proliferation. Surgical fixation procedures and lead wire redundancy should, in theory, alleviate the concerns of electrode migration and skull expansion.[5] Nonetheless, the electrode excursion would still occur, and this report highlights the incidental finding of a CI electrode impinging on the tympanic membrane (TM).

[1]Department of Otorhinolaryngology – Head and Neck Surgery, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia

[2]Department of Otorhinolaryngology, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia

[3]Department of Audiology and Speech Pathology, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia

[4]Department of Otorhinolaryngology – Head and Neck Surgery, Hospital Raja Perempuan Zainab II, Kota Bharu, Kelantan, Malaysia

[5]Department of Otorhinolaryngology – Head and Neck Surgery, International Islamic University Malaysia, Kuantan, Malaysia

[6]Department of Audiology, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia

Corresponding Author: Nik Adilah Nik Othman, Department of Otorhinolaryngology, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia, e-mail: adilahkk@usm.my

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Case Description

Bilateral CI was performed on a 4-year-old boy at the ages of 7 months on the left ear and 13 months on the right ear. He was diagnosed with meningitis at 3 months of age, and during that admission, his mother reported that he was not responding to calls. A hearing assessment was performed, and he was diagnosed with

bilateral profound SNHL. High-resolution computed tomography (HRCT) and magnetic resonance imaging (MRI) showed normal cochlear structures and patency. The electrodes were fully inserted during the surgery, and all electrode impedances were within the normal range. Regular follow-ups with the audiology team were established, and both CIs were functioning well.

However, due to the COVID-19 pandemic, the child was not brought to the otorhinolaryngology (ORL) clinic for nearly 1 year. Although the parents claimed the child had no symptoms, an attempt was made to contact them for a follow-up. Interestingly, during the otoscopic examination of the left ear, a part of the electrode of the CI was seen abutting the medial surface of the left TM (Fig. 1). No other abnormality or pathology was seen in both ears. Despite that, the mother claimed the child did not show any sign of CI malfunction. We referred this patient to the audiologist for reassessment of CI and noted that both electrodes are in good condition and functioning well (Fig. 2). We proceeded with the HRCT scan of the temporal bone to detect the electrode location and relation to the surrounding structures. The HRCT showed the displacement of the left extracochlear portion of the electrode into the hypotympanum, adjacent to the mastoid part of the temporal bone, and just before the electrode enters via the round window into the cochlea. The active electrode array was seen in the cochlea's basal and middle turns but not in the apical turn, which was rather unfortunate. On the other hand, the right electrode array was visible within all three cochlea turns, the basal, middle, and apical, respectively. There was no evidence of ossification in both cochleae (Figs 3A and B), while the coronal cut of HRCT showed the electrode abutting the left TM in the mesotympanum (Fig. 3C).

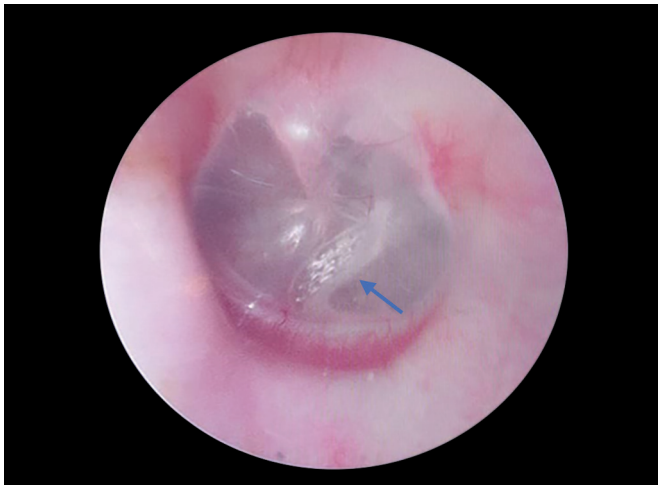


Fig. 1: Electrode is seen abutting the medial surface of the left TM (blue arrow). The TM is intact, and no middle ear pathology is detected

The left ear revision procedure was then performed on this patient. During the operation, it was discovered that the active electrode had about five channels that had protruded from the cochlea and were encircled by soft tissue. A part of the electrode was abutting the TM. Impedance was checked, and it was functioning well. A few attempts were made to release the electrode from the soft tissue and push it into the cochlea but failed. Owing to this, it was then decided to proceed with a new implant. The electrode was fully inserted up to 24 mm in length as a medium electrode was used. The impedance value was within the normal range, suggestive of good electrode condition after the insertion. The patient was discharged well postoperation without any complications. Upon review, the postauricular wound was well-healed, and both TMs were clear and intact (Fig. 4). Three weeks after the operation, the left CI was reactivated. Telemetry showed normal values for both electrodes. There was no sign of rejection towards the CI. The aided test also showed hearing responses within the speech spectrum. In terms of speech skills, the boy was able to detect almost all six Ling's sounds and produced a few meaningful words spontaneously.

Discussion

Cochlear implant is a well-established and safe surgical procedure that restores hearing for those with severe-to-profound SNHL. It is worth stating that the global complication rate of CI has continually dropped. In particular, the complication rate dropped from approximately 39% to 9%.[6] Late problems that arise years after the implantation are uncommon. Vestibular disorders, device malfunctions, and taste problems are the most prevalent delayed complications, accounting for less than 6% of all cases. On the

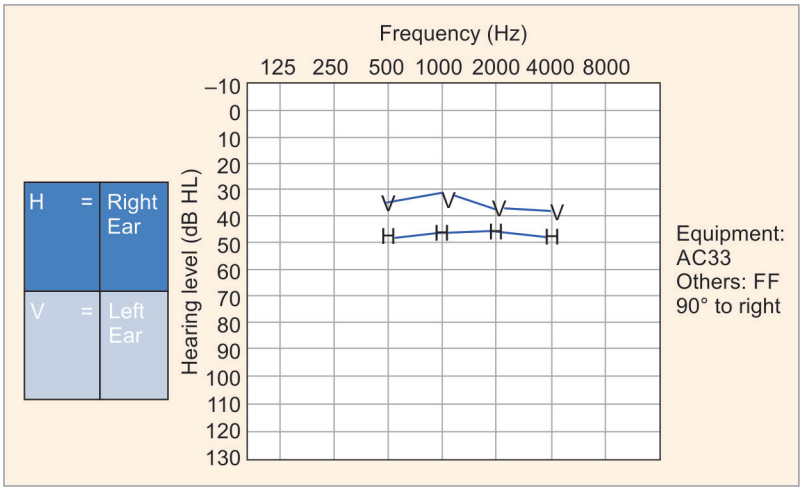
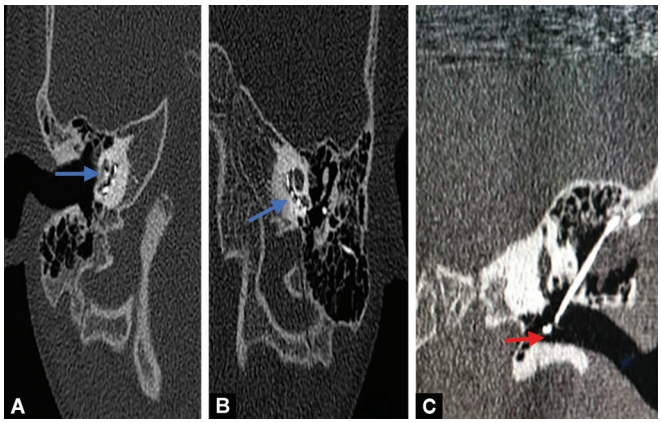
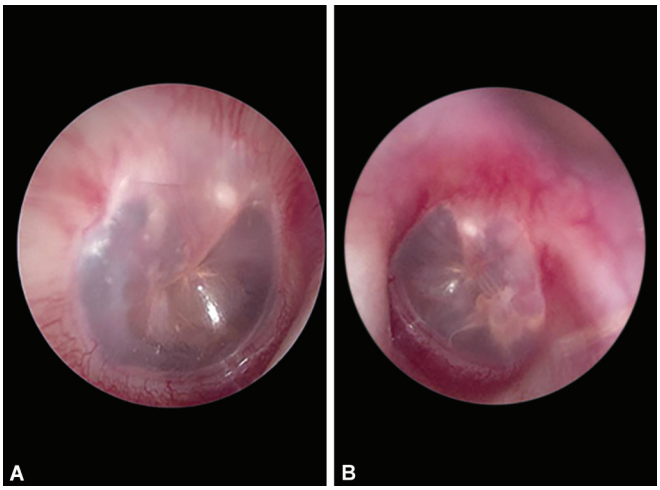


Fig. 2: Aided hearing responses of the patient (that are within the speech spectrum, i.e., 25–50 dB HL)



Figs 3A to C: Axial cut of HRCT showing (A) the electrode array from the base until the apex of the right cochlea and (B) the electrode array is only present in the basal and middle turn of the left cochlear (blue arrow); (C) Coronal cut of HRCT showing the electrode abutting the left TM in the mesotympanum (red arrow)



Figs 4A and B: (A and B) Both TMs are intact and (B) with no more redundant electrode seen behind the left TM

other hand, facial nerve palsy, chronic otitis media with or without cholesteatoma, and electrode array extrusion are less common.

Various parameters influence the extrusion and migration of electrode arrays, not all of which can be assessed using skull circumference. Electrode extrusion is also associated with intracochlear conditions, including tissue fibrosis or cochlea ossification, which can force electrodes out of the scala tympani. Furthermore, fibrous tissue in the mastoid and middle ear cavity causes sticky bands and electrode adhesion, which may affect CI electrode migration.[5]

In this report, because the boy wore bilateral CIs, his family members may not have recognized any differences in his hearing. Herein, it seems not easy to detect the difference between one CI that works well and another that does not. Furthermore, the mother reported that his speech development was improving (i.e., his speech development was not "seen" impaired because the other ear had a well-functioning CI).

The incidence of electrode migration following CI ranged from 7.4% to 29%.[5] In postimplantation, electrode migration and extracochlear electrodes are not often noticed, especially with traditional telemetry. The current gold standard for detecting the extracochlear electrodes or electrode migration is computed tomography (CT) scan.[7] Holder et al. found that 60% of the CI recipients with extracochlear electrodes, as identified by the CT scan, were not identified by any audiology measures such as contact impedances, evoked compound action potentials (ECAPs), or auditory mapping. Only 6% of the cases were identified during the CI itself.[8] Furthermore, even when contact impedances are low, Stimulation-Current-Induced Non-Stimulating Electrode Voltage Recordings (SCINSEVs), also known as "transimpedance measurements (TIMs)" or electric field imaging (EFI), could be used to detect extracochlear electrodes.

In this case, the CI electrode migration was discovered by chance during the otoscopic examination after a long period of delayed follow-up due to the COVID-19 pandemic and travel restrictions. After the CT scan confirmed this finding, the patient had revision surgery and CI reimplantation. A long-term routine follow-up is required for post-CI patients for proper monitoring of hearing and speech development, as well as device maintenance. Continuous monitoring even after years is necessary after CI to prevent undesirable complications such as extrusion or device migration.

According to current data, 3–8% of all CI surgeries require revision for various reasons, including device failure, electrode array or receiver–stimulator migration/extrusion, infection/wound complication, and infection/wound complication.[9] The electrode migration out of the cochlea accounted for only a small percentage of revision procedures, ranging from 1 to 15%.[10] In this case, we proceeded with the revision surgery, explantation of the CI, and reinsertion of a new CI to avoid further complications.

Clinical Significance

Extracochlear electrodes are frequently passed unnoticed, especially in bilateral CI cases. In this report, the extracochlear electrode was found in the wrong place (impinging on the TM) but perhaps the incident was discovered at the right time. Hence, it is advisable for patients to continue follow-up postimplantation in the ORL clinic even after years of CI surgery (to avoid a similar presentation as in this case). The early detection of electrode malfunction, extrusion, migration, or misplacement is mandatory to improve patients' quality of life and prevent further complications. The gold standard for detecting postoperative CI extrusion or migration is a CT scan. Audiological tests are also required to determine how well the CI is working. Revision CI surgery is common among pediatric CI recipients, and one of the common reasons is electrode extrusion or migration.

Orcid

Mohd Normani Zakaria https://orcid.org/0000-0002-3694-3460

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