Auditory and Vestibular Research

Rapid Recovery of Speech Perception After Cochlear Implantation: A Case Report of Cochlear Implantation in Post-Meningitis Deafness

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- Extraordinary speech perception can be achieved rapidly after cochlear implantation
- Duration of deafness and precise mapping of speech processor are very important

Abstract

Background: It takes some time for a patient to adapt to the new hearing experience with a cochlear implant (CI) device. Usually, improvements of speech perception have been reported within 3 to 6 months after the CI surgery. Here, we described a child with post-lingual deafness due to meningitis who recovered considerable speech perception just a few days after CI activation.

The Case: A 14-year-old female with complaints of severe headache, delirium, unresponsiveness to sound, and agitation was diagnosed with meningitis. Pure tone audiometry showed total deafness in right ear and severe to profound sensorineural hearing loss in left ear. Seven months after onset of deafness, she received a Cochlear Nucleus CI512 implant in the right ear. The speech processor was activated 2 weeks after surgery. The first map was programmed using the advanced combinational encoder (ACE) speech coding strategy and behavioral measurement of T-levels and C-levels. Four days later, the audiometric evaluation revealed a pure-tone average (PTAve) of 35 dB HL, accompanied by a speech discrimination score (SDS) of 72%. The Bamford-Kowal-Bench (BKB) sentence test yielded a score of 80% in silence. Two weeks after device activation, PTAve was 20 dB HL, the SDS was 86% and the BKB sentence score in silence was 100%. There are numerous factors related to postoperative function with CI.

Conclusions: It seems that factors like short duration of deafness, precise mapping of CI speech processor, consistent device usage, and rich aural environment have led to extraordinary improvement within 2 weeks after device activation.

Keywords: Cochlear implant, post-lingual deafness, children, meningitis, case report

Introduction

Meningitis is one of the most common causes of profound hearing loss in children (1). The infection spreads to the cochlea through cochlear aqueduct which connects posterior fossa to the scala-tympani close to the round window membrane (2). Inflammation of the endocochlear tissue can lead to new bone formation inside the cochlea. Ossification of the cochlear lumen may occur in a wide range of degrees. In some cases, it may not happen at all. In instances, it may be limited to the first millimeters of the scala tympani or extend to the apical regions in varying extents (1). Cochlear implantation is the main treatment for profound hearing loss after meningitis and ossification of the cochlear lumen will be a problem for treatment of hearing loss.

It takes some time for a patient to adapt to the new hearing experience with a CI device. In post-lingual deaf patients, usually improvements of speech perception have been reported within 3 to 6 months after the CI surgery (3, 4). Performance in speech perception tests usually plateaus after 1 to 2 years (5). Here, we describe a case with post-lingual deafness due to meningitis who recovered extraordinary speech perception just a few days after CI activation.

Case Presentation

In February 2024, a 14-year-old female presented to Guilan Cochlear Implant Center (GCIC). A few weeks before that, she had been referred to children's hospital with complaints of severe headache, delirium, unresponsiveness to sounds, and agitation. After extensive examinations including abdominal and pelvic ultrasound scan, brain and thoracic and lumbar magnetic resonance tomography (MRI), lumbar puncture, blood and urine tests, she was diagnosed as having meningitis and post-meningitis vasculitis. She was prescribed with a high dose of oral corticosteroids for two weeks. Pure tone audiometry tests showed total deafness in the right ear and severe to profound sensorineural hearing loss with a speech discrimination score (SDS) of 48% in left ear. Auditory brainstem response and otoacoustic emissions were absent bilaterally. She and her parents were consulted for receiving cochlear implantation in right ear. Since they were shocked because of the quick loss of hearing and did not accept the emergency of the situation for cochlear implantation, they refused the suggested treatment and left the clinic. Six months later they came back to us frustrated and depressed because of deafness. Meanwhile, she had tried hearing aids with no satisfaction. Once more they were consulted for CI and accepted to proceed with this treatment. A high-resolution computerized tomography (HRCT) scan showed no sign of ossification through cochlear duct (Fig. 1). MRI reconstruction of inner ear also showed bony labyrinth is filled with fluids (Fig. 2).

A Cochlear Nucleus CI512 implant was chosen to be implanted in the right ear. Through a 4 cm normal retroauricular incision, a mastoidectomy with facial recess approach was performed to access the cochlea. The round window niche was drilled away to provide visualization of the round window membrane. The round window niche was obliterated, and the opening of the cochlea was found to be obstructed (Fig. 3). The intraluminal line-of-sight bone was drilled out to bypass the obstruction and reach the open lumen distally. Full insertion of electrodes was done with a classic insertion method. Impedance testing and neural response telemetry (NRT) were performed to ensure the integrity of the device.

First mapping

The speech processor (Nucleus 7 SE) was activated 2 weeks after surgery. No complications occurred in relation to surgery. All electrode contacts had a normal impedance. The first map was programmed using the advanced combinational encoder (ACE) speech coding strategy. Other map parameters included stimulation mode: MP1+2, rate: 900 Hz, Maxima: 8, and pulse width: 25 µsec. Behavioral measurement of T-levels and C-levels was accomplished in 5 electrodes (i.e. numbers 1, 6, 11, 16, and 22) and interpolating electrodes in between. She was instructed to put on the processor all awake times and to return 4 days later for the next visit. In order to help improve listening skills and speech comprehension, she and her companions were advised to participate in listening exercises. The exercise comprised of: 1) listening to a large number of presentations of a short text from her school literature textbook in a position where the speaker's lips were visible. 2) try to identify and repeat two- to three-word phrases from the same text, presented to her without lip-reading. 3) do the exercise at least 3 times a day and each time for 20 minutes.

Second mapping

In the next mapping session, data logging showed an average usage time of 12 hours for the past 4 days. The second map was created by measuring the T-levels and C-levels using the same 5 electrodes as in the initial session, and interpolating results for other electrodes. She was very pleased with her hearing and mentioned that she can understand speech very well. Audiometric evaluation revealed a pure-tone average of 35 dB HL, accompanied by a speech discrimination score (SDS) of 72%. Additionally, the Bamford-Kowal-Bench (BKB) sentence test yielded a score of 80% in silence. All speech assessments were carried out in a sound field at a calibrated presentation level of 65 dB SPL (A-weighted). The following appointment was set for 10 days later.

Third mapping

Two weeks after device activation, she returns for the third mapping session. The average usage time was 14 hours. The average electrode impedances were decreased to 9 k□. The neural response telemetry was performed in the aforementioned five electrodes, and normal responses were recorded. The third MAP was created by behavioral measurement of the T-levels and C-levels at 9 electrodes (i.e. numbers 1, 3, 6, 8, 11, 14, 16, 19, and 22). She mentioned that she is fully recovered and does not need any more mapping sessions. In audiometric evaluation, pure-tone average was 20 dB HL, the SDS was 86% and the BKB sentence score in silence was 100%. Fig. 4 shows the details of the third map.

We have obtained written informed consent to publish the details from her parents.

Discussion

Meningitis is a serious infectious disease that affects different age groups. It is among the most prevalent causes of acquired profound sensorineural hearing loss in children, and can be associated with labyrinthitis ossificans (2) which can make electrode insertion difficult or even impossible (6).

Labyrinthitis ossificans usually can be diagnosed using HRCT, however, in some cases false negative results may occur (7). Moreover, fibrotic obstruction of the cochlea is difficult to identify with HRCT. It is recommended to use MRI to provide detailed images of the fluid compartments within the cochlea to identify any obstruction due to bacterial meningitis (8). The sensitivity and specificity of MRI predicting intraoperative cochlear obstruction have been reported to be 94.1 percent and 87.5 percent respectively (8). Combining HRCT and MRI findings will increase the accuracy of diagnosis of cochlear obstruction, nevertheless there may be some misdiagnosis. As in this patient, both HRCT and MRI failed to identify cochlear obstruction.

Speech perception in CI patients with post-meningitic deafness has been reported to be worse than CI patients with other etiologies. Mosnier et al. reported that in adults with post-meningitic profound hearing loss, speech performance did not improve after 6 months post-activation. They found that post-meningitic subjects had poorer speech scores in comparison to those of the control group. However, performance of post-meningitic deaf patients improved with new cochlear implant technologies (9). Helmstaedter et al. found that children with meningitis related deafness who received cochlear implants had poorer monosyllabic word understanding compared to control group (10).

Learning how to process the auditory signals delivered by the cochlear implant usually requires about 6 months before entering a stable plateau phase (3). There is a handful of literature concerning the factors influencing speech perception in cochlear implant users. Studies have shown that precise and personalized mapping of CI speech processor has a crucial effect on speech perception abilities (11, 12). Durisin et al. showed that the duration of deafness after meningitis has a relationship with the auditory performance of implanted children. Patients implanted within 6 months after meningitis had a better performance and language control (13). Similarly, in postlingually deaf patients, duration of deafness is an important factor to predict speech perception after cochlear implantation (5). Oh et al. reported that postlingually deaf adults with less than 5 years of deafness had a faster rate of recovery of speech perception than those who had been deaf for more than 5 years (14). Continuous usage of hearing aids before implantation provides stimulation of the cochlea and neuronal elements and supports better speech comprehension with CI (15). In our case, high speech perception scores were achieved only two weeks after device activation. CI mapping was performed using meticulous behavioral measurement in 9 electrode locations across the cochlear duct. Although she did not have proper hearing aid usage, the duration of deafness was about 7 months. Short duration of deafness before CI probably has a role in speech perception outcomes.

The ossification was limited to the scala tympani in the region of the round window and she had a full insertion of precurved electrode via basal turn cochleostomy. A lower degree of cochlear ossification and the use of a precurved electrode array, as in this patient's case, were associated with better outcomes after implantation (6, 16). The number of active electrodes within the cochlea can affect speech perception outcomes of CI users (17).

Moreover, consistent device usage and rich aural environment are among other important factors involved in speech perception outcomes (18). In this case, she had 22 well-functioning intra-cochlear electrodes. Also, she had used her speech processor nearly 14 hours per day and she had a supportive family and friends who provides a rich listening experience for her. Such results recommend that fast recovery of speech perception may be achieved in post-lingual deaf patients. Especially if the duration of deafness is short, the patient is motivated and the family can support him/her through the CI process.

Conclusion

Considerable improvements of speech perception have been reported within 3 to 6 months after the CI surgery. However, in some patients, the rate of recovery of speech perception after cochlear implantation is higher. There are numerous factors related to postoperative function with CI. It seems that factors like the short time interval between postlingual deafness and cochlear implantation, precise mapping of CI speech processor, consistent device usage and rich aural environment have led to extraordinary improvement within 2 weeks after 7 months of deafness in this patient.

Declarations

Ethics Approval: The study approved by the ethics committee of Guilan University of Medical Sciences; approval ID: IR.GUMS.REC.1404.081.

Consent to Participate: Written informed consent was obtained from the parents of the patient for her anonymized information to be published in this article.

Consent for Publication: It has obtained from the patient

Availability of data and material: Not applicable

Competing Interests: The authors declare no competing interests.

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Code Availability: Not applicable.

Authors' contributions: SN: Study design, drafting the manuscript; RP: drafting the manuscript, interpretation of the results, preparation of the figures; MMJ: data collection, reviewing the manuscript.

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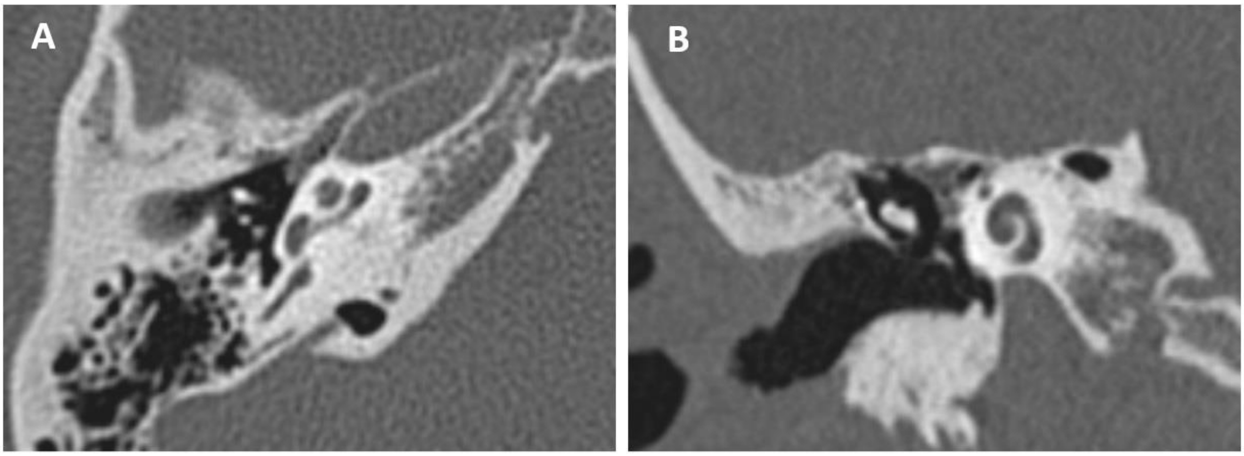

Fig. 1. Pre-operative computerized tomography scan images of the right ear from axial (A) and coronal (B) views.

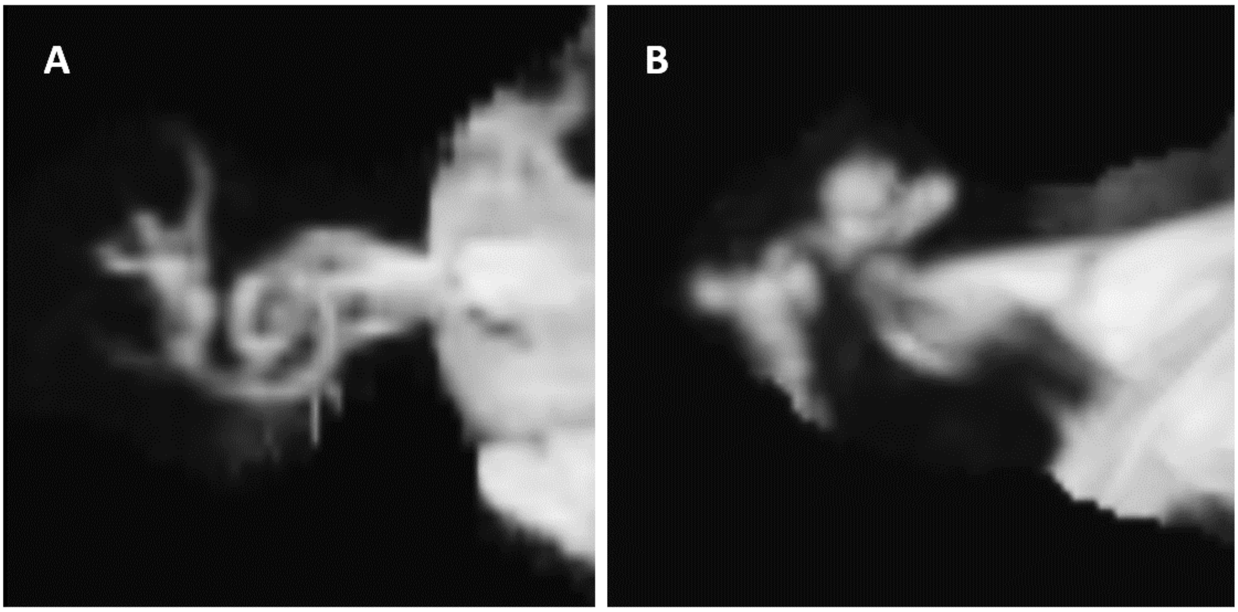

Fig. 2. T2-weighted 3-dimensional magnetic resonance tomography reconstruction of right ear labyrinth from anterior (A) and inferior (B) views.

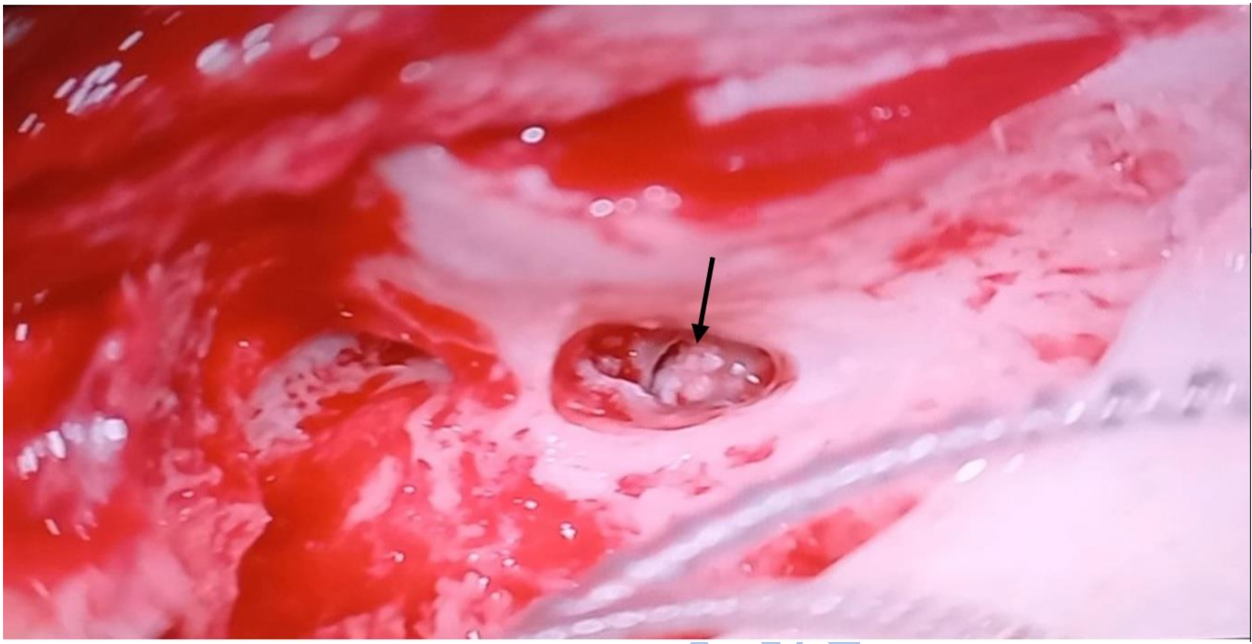

Fig. 3. Surgical view of the right ear round window through the facial recess indicates bone formation

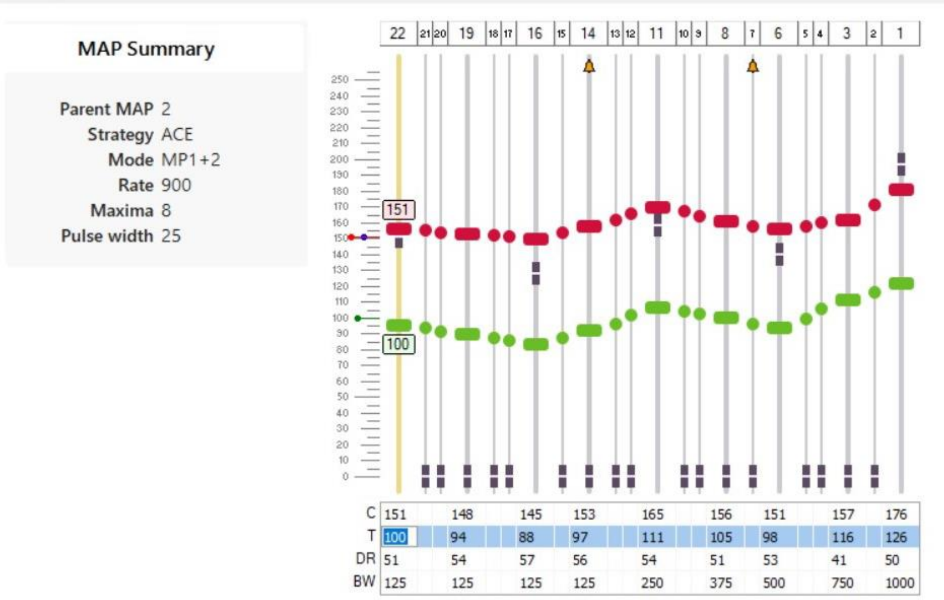

Fig. 4. The last mapping parameters of the patient