Cochlear Implantation after Bilateral Otic Capsule-Violating Temporal Bone Fractures

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－ ABSTRACT －

Temporal bone fractures through the otic capsule can cause profound sensorineural hearing loss. Patients deafened by bilateral temporal bone fractures may benefit from cochlear implantation. We report a case of a 56-year-old man with bilateral profound sensorineural hearing loss caused by otic capsule-violating bilateral temporal bone fractures due to severe head injury. The patient achieved satisfactory auditory rehabilitation after cochlear implantation. Imaging studies before cochlear implantation provided important information to enable the decision for the surgery and to determine the side. Through careful evaluation of the imaging studies, we believe cochlear implantation in such a patient can be a very effective method for auditory rehabilitation. The safe time period for ossification of the cochlea will be discussed. The benefit of preoperative repeated magnetic resonance imaging is highlighted. **(J Clinical Otolaryngol 2017;28:90-93)**

KEY WORDS：Cochlear implantation · Hearing loss · Temporal bone fracture.

Introduction

Temporal bone fractures often cause a loss of audiovestibular function.[1)] Otic capsule-violating fractures are associated with a higher incidence of sensorineural hearing loss than otic capsule-sparing fractures.[2)] Patients with bilateral profound sensorineural hearing loss due to temporal bone fractures but who still have an intact auditory nerve may become candidates for cochlear implantation.[3,4)] However, due to post-traumatic fibrosis or ossification of the cochlea, surgery could be challenging and complicated. Therefore, it is essential to carefully evaluate imaging studies that include computed tomography (CT) and magnetic resonance imaging (MRI). We present a case of a 56-year-old man with bilateral profound sensorineural hearing loss caused by otic capsule-violating bilateral temporal bone fractures due to severe head injury who achieved satisfactory auditory rehabilitation after cochlear implantation.

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Case Report

A 56-year-old man was referred to the otology department with bilateral deafness. Two months before presentation, the patient had severe trauma after a traffic accident and was admitted to the neurosurgical department with subdural and subarachnoid hemorrhages for conservative treatment. After the patient recovered from his acute injury, he noticed bilateral hearing loss. An otoscopic examination was normal, and audiologic examination revealed bilateral profound sensorineural hearing loss. There was no response to pure tone stimuli at the maximum limits. Tympanometry

showed type A tympanograms on both sides. Auditory brain stem response and auditory steady state response showed no response at the maximum limits. Vestibular function testing revealed no caloric responses bilaterally. A high-resolution temporal bone CT revealed bilateral otic capsule-violating temporal bone fractures (Fig. 1). The fracture lines extended into the right carotid canal and jugular foramen.

Cochlear implantation was considered for aural rehabilitation. However, the patient decided to wait for natural revival of hearing. After two months the patient admitted his deafness and expressed a desire for cochlear implantation. Follow-up repeated evaluations were obtained four months after the trauma. A repeated audiologic evaluation revealed findings similar to those of the previous test. On the high-resolution temporal bone CT, obliteration and labyrinthitis ossificans were not detected, as in the previous scan. However, obliteration of the pathway from the right vestibule to the right basal turn was identified on the temporal MRI; this finding was not detected on a previous MRI obtained two months earlier (Fig. 2). The left ear was selected as the side for implantation four months after the trauma. A simple mastoidectomy, posterior tympanotomy, and round window approach were performed successfully. A Med-El Concerto Flex 28 (Med-El GmbH, Innsbruck, Austria) was used, achieving a full insertion of all electrodes without any difficulty. Intraoperative neural response telemetry tests were positive. After cochlear implantation, there was no evidence of infection or other complications.

Following mapping, programming, and aural rehabilitation, the patient's auditory performance was excellent with categories of auditory performance (CAP)

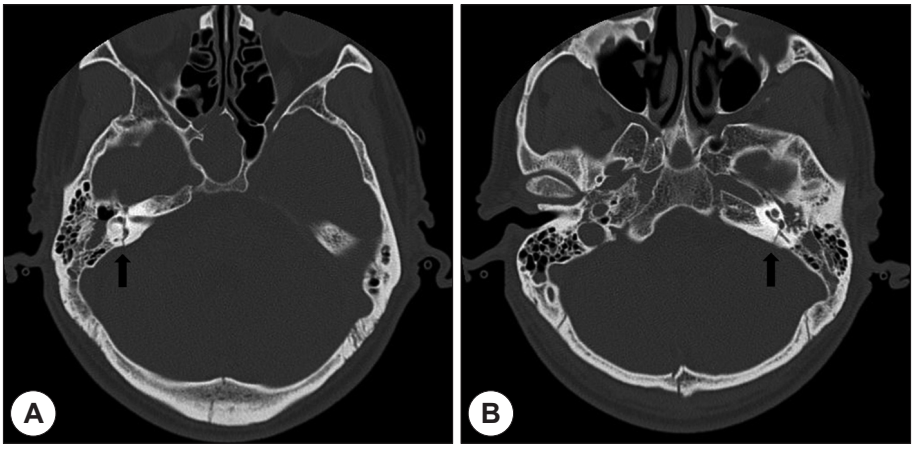

Fig. 1. A : Axial temporal bone computed tomography shows fracture lines passing through right otic capsule. B : Axial temporal bone computed tomography shows fracture lines passing through left otic capsule.

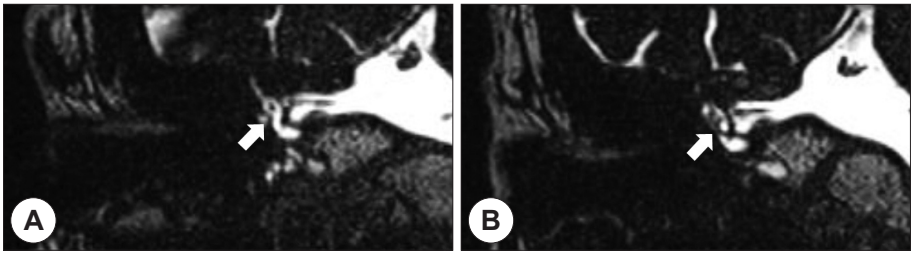

Fig. 2. A : An enlarged coronal T2 weighted magnetic resonance image two months after the trauma shows no visible obstruction in the cochlea and vestibule (white arrow). B : Preoperative repeated enlarged coronal T2 weighted magnetic resonance image four months after trauma shows obliteration from the right vestibule to the right basal turn of the cochlea (white arrow), not detected on the previous scan.

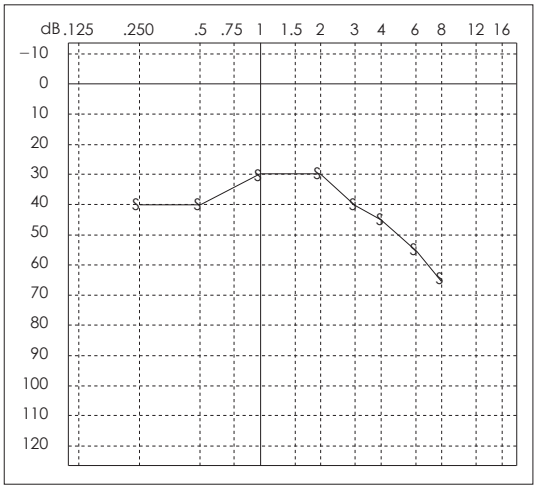

Fig. 3. Postoperative implant aided pure tone audiogram, 8 months after implantation.

of 7, and the patient was very satisfied with his listening skills to speech and environmental sounds. Eight months after implantation, aided pure tone audiogram showed a threshold level of 32 dB (Fig. 3). The patient scored 100% on open set sentence perception test and 100% on open set word perception tests with monosyllabic and bisyllabic words.

Discussion

Temporal bone fracture is one of the most common traumatic injuries that cause a loss of audiovestibular function.[1] Any fracture violating the otic capsule can lead to complete loss of auditory function. Even if a definitive fracture line is not identified on the CT, hearing loss can result from micro-fractures or cochlear concussion.[5] Patients with bilateral severe to profound hearing loss secondary to temporal bone fractures become candidates for cochlear implantation if the functions of the auditory nerves and brain are intact.[6] However, bilateral temporal bone fracture that requires cochlear implantation is an uncommon occurrence. Most trauma patients treated in intensive care units experience unconsciousness, and the diagnosis of hearing loss may be delayed.[4] The proper timing of cochlear implantation after trauma is still controversial.

In patients with bilateral severe to profound sensorineural hearing loss due to temporal bone fractures, the timing of performing cochlear implantation must be considered. First, temporal bone fracture may result in destruction and degeneration of hair cells, supporting cells, and ganglion cells.[7] The number of surviving spiral ganglion cells would seem to be an important factor in determining the success of electrical stimulation.[7] Cochlear implantation shortly after trauma would provide less time for spiral ganglion cell loss and would increase the chance of successful rehabilitation.[8] However, too early surgical intervention can eliminate the opportunity for natural revival of hearing. Second, labyrinthitis ossificans and secondary infections are another important point. The patency of the cochlea after trauma may determine the successful insertion of electrodes. Otic capsule-violating fractures may cause destruction of the organ of Corti and stria vascularis, hemorrhage into the inner ear, and subsequent labyrinthitis ossificans.[9] Although fractures usually heal by fibrosis, sometimes they may be complicated by cochlear osteogenesis and result in ossification of the cochlea.[10] The most frequent site of ossification is the basal turn of the cochlea.[9] Secondary infections also can accelerate the process of labyrinthitis ossificans. However, the exact time of ossification of the cochlea after a temporal bone fracture is not well known. Therefore, it seems that implantation shortly after the time of the temporal bone fracture would provide less time for cochlear osteoneogenesis to occur, and increase the rate of successful electrode insertion. To evaluate these points, preoperative CT and MRI are necessary. However, high-resolution CT may miss up to 22% of cases of cochlear luminal obstruction subsequently found at surgery.[11,12] T2 weighted MRI is a more useful method to determine the patency of the cochlea.[11,12]

In our case the initial CT and MRI, which were obtained two months prior to cochlear implantation and two months following the head trauma, failed to show a luminal obstruction. However, a preoperative repeated T2 weighted MRI showed obliteration of the right

cochlear basal turn.

Cochlear implantation provides effective aural rehabilitation in severe to profound hearing loss following temporal bone fractures. However, some points must be considered before performing cochlear implantation. Temporal bone fractures may lead to ossification of the cochlea. Therefore, we recommend cochlear implantation as soon as possible after a patient is deafened by bilateral temporal bone fractures. Also, when there is a significant time delay between the initial imaging studies (CT and MRI) and cochlear implantation, repeated imaging studies are essential to rule out labyrinthitis ossificans and other structural abnormalities that may inhibit successful placement of electrodes.

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