CASE REPORT
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# Emergency Unilateral Cochlear Implantation in Sudden Bilateral Severe-to-Profound Sensorineural Hearing Loss After Temporal Bone Fracture: A Case Report

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**ABSTRACT**

We report the case of a 34-year-old male with bilateral deafness, acute vestibular syndrome, right-sided facial paralysis, cerebrospinal fluid leakage, and hemorraghic otorrhea after blunt high-impact temporal bone trauma. Imaging demonstrated a right-sided mixed temporal bone fracture with involvement of the otic capsule without disruption of the vestibulocochlear nerves while audiometric testing confirmed bilateral profound sensorineural hearing loss. An urgent subtotal petrosectomy was performed to control bleeding from the jugular bulb, manage the cerebrospinal fluid leakage, decompress the facial nerve in the tympanic segment, and perform cochlear implantation due to the risk of cochlear fibrosis. The short-term outcome with regard to hearing, speech understanding, and balance is reported.

**Key words:** Cochlear fibrosis, cochlear implantation, temporal bone fracture

## Introduction

A temporal bone fracture is a sign of high-energy trauma. Temporal bone fractures are traditionally classified as being transverse, longitudinal, or mixed. Loss of audiovestibular function is a common presenting symptom.[1] Consequently, patients with bilateral severe sensorineural hearing loss (SNHL), become candidates for cochlear implantation if the cochlear turns are not affected by dislocation or fibrosis. A cochlear implant (CI) is a surgically implanted neuroprosthesis. It consists of an external sound processor and an inside component, the actual implant, with a coil to receive signals and electrodes, placed into the cochlea, which directly stimulate the cochlear nerve. However, also other potential complications, including facial nerve paresis or paralysis and cerebrospinal fluid (CSF) leakage, must be considered. Facial nerve injury has been observed to occur in 10%-25% of longitudinal and 38%-50% of transverse fractures.[2] When the otic capsule is involved, the incidence of hearing loss is 25 times more likely.[3] New classification methods of temporal bone fractures have been proposed, according to the involvement of the otic capsule or the petrous bone, since it is a negative prognostic factor for outcome. This is however beyond the scope of the article.[4] We present the case of a patient with a unilateral temporal bone fracture, unilateral CSF leakage, facial nerve paresis, and bilateral deafness, receiving unilateral cochlear implantation within 48 hours after trauma.

## Case Presentation

A 34-year-old man sustained high-impact blunt head trauma and was transferred to the emergency department of the Antwerp University Hospital. An initial neurologic exam showed an E3M6V5 (Eye–Motor–Verbal response) mental status, with the patient being conscious, reactive to speech, and responsive to commands. His facial function was significantly impacted bilaterally, with bilateral House–Brackmann grade V. The patient suffered from bilateral deafness with no response to tuning fork tests. Right-sided vestibular hypofunction was revealed by a third-grade nystagmus to the left

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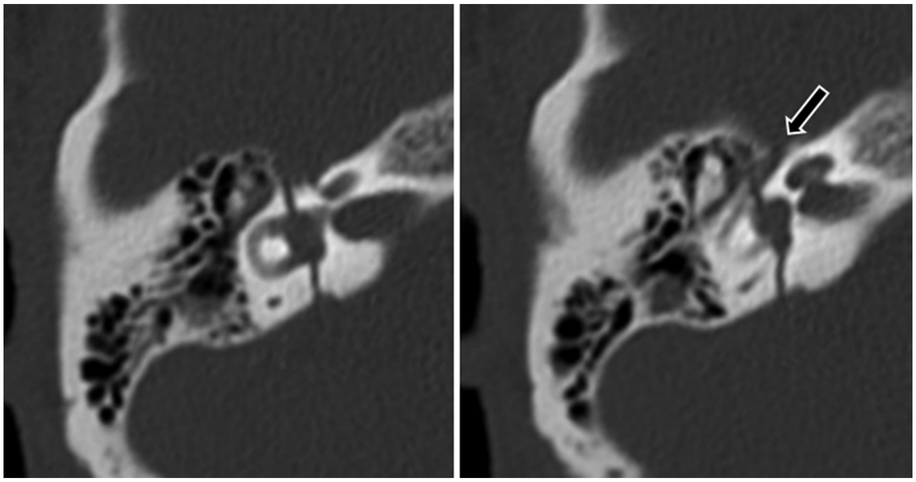

Figure 1. Axial computed tomography image of the right temporal bone demonstrates the fracture through the vestibule and the facial nerve canal (arrow); the cochlea was spared.

side and a catch-up saccade during the head impulse test to the right side. Otoscopy revealed a normal tympanic membrane on the left side and a tympanic membrane perforation and blood-stained otorrhea on the right side suggestive of CSF leakage and active venous bleeding. Immediate radiological examination by computed tomography scanning (Figure 1) demonstrated a mixed fracture of the right temporal bone. A longitudinal fracture line through the sphenosquamosal suture and pars tympanica of the petrous bone and a transverse fracture through the otic capsule and the oval window were demonstrated. A longitudinal fracture of the left temporal bone did not affect any of the crucial structures for hearing and balance, nor the facial nerve canal.

An urgent magnetic resonance imaging scan of the brain, performed within 24 hours after trauma, confirmed continuity of the vestibulocochlear nerves bilaterally (Figure 2). A decreased T2 signal and increased fluid-attenuated inversion recovery (FLAIR) signal was observed on the right side in the vestibular and semicircular canals. No structural abnormalities were retained in the left labyrinth.

Facial nerve function on the left side recovered spontaneously after 12 hours; however, subjective hearing loss remained present. Pure-tone audiometry, speech audiometry, and auditory-evoked brainstem recording confirmed bilateral profound SNHL. Informed consent was obtained to manage the CSF leakage and venous bleeding accordingly, explore and decompress the facial nerve, and perform cochlear implantation since fibrosis of the cochlea was inevitable due to the location of the fracture and the diastasis between cochlea and vestibular system. Cochlear duct length was calculated to be 37.1 mm using Otoplan software (Figure 3A). A subtotal petrosectomy, blind sac closure, and obliteration with an abdominal fat graft were performed according to Fisch and Mattox to control the hemorrhage from the jugular bulb and CSF leakage. The bony canal of the facial nerve was displaced, without severing the nerve, and decompressed. Cochlear implantation was performed via the round window using a MED-EL Mi1250 PIN Flex 28 electrode. Full insertion was achieved (Figure 3B) and the dehiscent scala vestibuli (due to the fracture) was obliterated with fibrous tissue. Normal impedance and electrically evoked compound action potentials were observed across all electrode bands. Following the programming of the speech processor and aural rehabilitation, the patient demonstrated excellent short-term auditory performance (Table 1). No facial nerve stimulation was reported.

With regard to acute vestibular syndrome, individualized vestibular rehabilitation was started as soon as possible.[7] Data relevant to the posttraumatic recovery of balance can be found

**Main Points**

- Temporal bone computed tomography and magnetic resonance imaging of the cerebellopontine angle should be performed as soon as possible in case of bilateral deafness after temporal bone trauma.
- Emergency cochlear implantation in case of temporal bone fracture should be considered in case of severe-to-profound sensorineural hearing loss because the cochlea is at risk for ossification.
- The complication rate is higher than in cochlear implant cases without a history of temporal bone trauma and includes implant infection, meningitis, wound dehiscence, facial nerve stimulation, and implant failure.
- Hearing and balance outcomes can be favorable if managed by an experienced interdisciplinary team of surgeons, audiologists, and physical therapists.

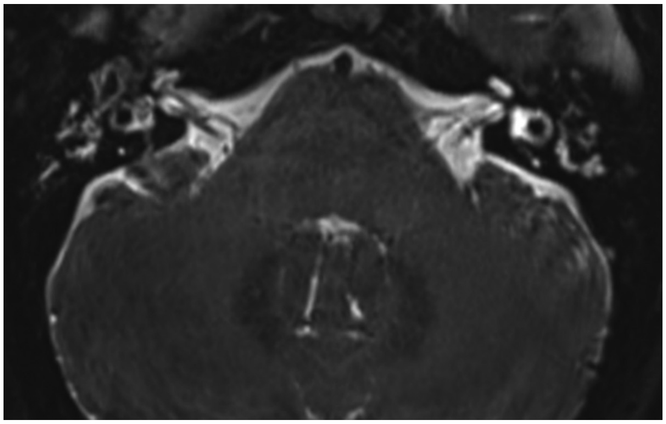

Figure 2. Axial heavily T2-weighted magnetic resonance image of the labyrinth shows a decreased T2 signal intensity of the fluid in the right-sided cochlea, vestibulum, and semicircular canals.

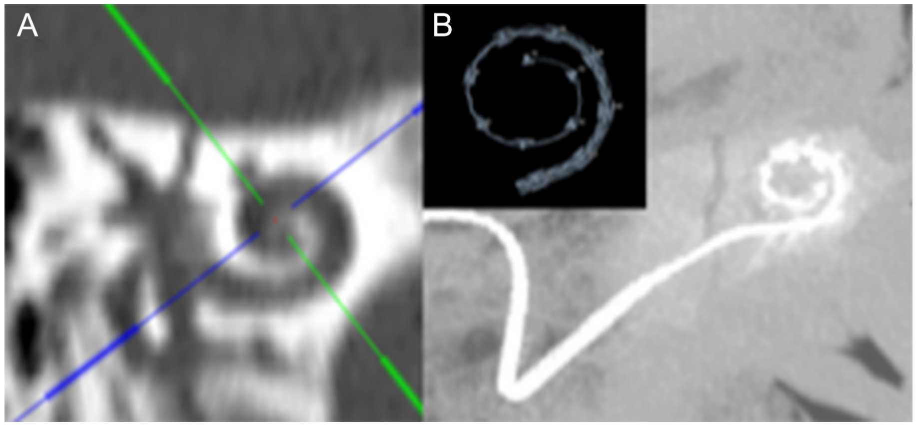


Figure 3. Preoperative and postoperative Otoplan evaluation. (A) Preoperative cochlear view using Otoplan to calculate cochlear duct length. Note the fracture through the vestibule. (B) Postoperative reconstruction of electrode insertion using Otoplan software (box left upper corner) and maximal intensity projection of the temporal bone visualizing the cochlear implant electrode array and fracture line.

Table 1. Evolution of Auditory Performance After Cochlear Implantation

| | 2 Months Post CI Scores | | | 3 Months Post CI Scores | | |
|---|---|---|---|---|---|---|
| | Unaided Right | Unaided Left | CI Only (Right) | CI Only (Right) | HA Only (Left) | Best-Aided (CI and HA) |
| Pure-tone average (PTA) | >120 dB HL | 82 dB HL | 35 dB HL | 35 dB HL | 40 dB HL | 33 dB HL |
| Speech in quiet (SPIQ)[a] | / | / | 70% | 76% | 61% | 85% |
| Speech in noise (SPIN)[b] | / | / | / | +1.66 dB SNR | / | +1.66 dB SNR |
| A§E® phoneme discrimination test | / | / | / | 95% | 70% | 90% |

CI, cochlear implant.
[a]SPIQ was measured using the Nederlandse Vereniging voor Audiologie list at 65 dB SPL in the sound field.
[b]SPIN was measured with the Leuven intelligibility sentence test using the adaptive procedure (speech adaptive and noise fixed at 65 dB SPL) in the sound field.[5,6]

Table 2. Evolution in Vestibular Testing at 2, 4, and 10 Weeks After the Acute Event

| | Score at 2 Weeks | Score at 4 Weeks | Score at 10 Weeks | Score at 6 Months | Interpretation and General Evolution |
|---|---|---|---|---|---|
| Video head impulse test (vHIT) | /* | Gain right LC: 0.68; Gain left LC: 0.87 | Gain right LC: 0.66; Gain left LC: 0.89 | Gain right LC: 0.77; Gain left LC: 0.70 | Increase in gain value of the right lateral canal |
| Static balance tests | /* | 34 seconds | 52 seconds | 43 seconds | Increase in static balance performance until 10 weeks |
| Tandem gait | /* | 3 steps | 12 steps | 13 steps | Increase in dynamic balance performance |
| Timed up and go | /* | 7.4 seconds | 6.7 seconds | 6.5 seconds | Increase in dynamic balance performance |
| Level of physical activity | 78% sitting/lying; 17% standing; 5% physical activity | / | 77% sitting/lying; 15% standing; 8% physical activity | / | Increase in the level of physical activity |
| Dizziness Handicap Inventory | 20/100 | 14/100 | 6/100 | 6/100 | Lower values indicate less handicap due to dizziness |
| Vestibular Activities Avoidance Instrument | 29/54 | 21/54 | 14/54 | 8/54 | Lower values indicate less presence of avoidance behavior |

LC, lateral canal.
*During the acute phase, the vHIT and balance examination were not performed due to the risk of cerebrospinal fluid leakage; Static balance tests: 4 standing positions with eyes closed (Romberg, standing on foam, tandem stance, and standing on 1 leg) with a maximum score of 120 seconds.

in Table 2.[8,9] A decrease in static balance performance was seen from 10 weeks until 6 months. The patient's adherence to the vestibular rehabilitation program decreased as well between both measurements, possibly explaining the worse static balance performance.

## Discussion

Temporal bone fractures often produce SNHL and may lead to cochlear obliteration (fibrosis and ossification) due to intracochlear hemorrhage and subsequent neo-osteogenesis, most frequently in the basal turn of the cochlea but potentially all cochlear turns.[10] Cochlear obliteration may then prevent successful electrode insertion in case of cochlear implantation.[1] Evaluation through preoperative imaging is an essential step of planning for cochlear implantation in case of temporal bone trauma to identify potential contraindications or surgical challenges. Aspects to be considered include the integrity of the vestibulocochlear nerve, the location of the fracture line, the status of cochlear fluid signal, and whether the cochlea is displaced. Greenberg et al.[11] however, suggested that cochlear nerve disruption is rare, although based on a rather small sample of 25 patients.Eastwood et al[3] have recently reported a systematic review of the literature available on the audiological outcomes of cochlear implantation in patients with temporal bone trauma. Overall, the postoperative hearing outcome was comparable to CI users without a history of temporal bone trauma, but the level of evidence is relatively low (evidence-based medicine grade IV) because most are case reports and non-controlled case series. However, complications were reported in 14 cases with 10 of these being major, including implant infection, meningitis, wound dehiscence, facial nerve stimulation, and implant failure. This emphasizes the need for a dedicated and experienced interdisciplinary team of otologic and neurotologic surgeons, physical therapists, and audiologists to manage this patient population in an emergency setting.[3] Emergency cochlear implantation in case of temporal bone fracture should thus be considered in case of severe-to-profound SNHL when the cochlea will be unable to recover from trauma and is at high risk of obliteration, which would preclude future electrode insertion.

**Informed Consent:** Informed consent was obtained from the patient before publishing.

**Peer-review:** Externally peer-reviewed.

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