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CASE REPORT

Pneumolabyrinth After Otic Capsule-Disrupting Temporal Bone Fracture without Direct Connection with the Middle Ear Space

Guen-Ho Lee, Dong-Hee Lee

Department of Otolaryngology-Head and Neck Surgery, College of Medicine, The Catholic University of Korea, Seoul, Korea

Pneumolabyrinth or pneumocochlea is an uncommon condition in which the vestibule or cochlea is filled with air. Although there have been several reports on pneumolabyrinth after stapes surgery, it has been rarely observed after temporal bone fracture. Air within the inner ear can be found even in the case having otic capsule-disrupting temporal bone fracture without definite connection with the middle ear space, which suggests the possible connection between the inner ear and the air-filled mastoid or middle ear cavities. We present a rare case of a 45-year-old male with a pneumolabyrinth that resulted from blunt head trauma and resolved spontaneously.

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Introduction

Temporal bone fractures are traditionally divided into longitudinal and transverse fractures; this designation indicates the orientation of the fracture line relative to the long axis of the petrous part of the temporal bone. A new classification scheme for temporal bone fractures refers to 'otic capsule-sparing' fractures and 'otic capsule-disrupting' fractures; this classification offers the advantage of radiographic utility and stratification of clinical severity. The otic capsule-disrupting fracture is associated with a higher incidence of facial nerve paralysis, CSF leak, intracranial injuries and delayed meningitis, when compared with otic capsule-sparing fractures.[1]

Pneumolabyrinth or pneumocochlea is an uncommon clinical entity in which the vestibule or cochlea is filled with air. It is a rare finding even in otic capsule-disrupting fractures or in transverse fractures of the temporal bone. It has been described in only a few reports.[2-6] Although the effect of the air itself on the inner ear is not clear, air inside the cochlea often results in an irreversible effect on hearing.

We experienced a rare case of a 45-year-old man with an otic capsule-disrupting temporal bone fracture, which was complicated by a pneumolabyrinth and a permanent hearing loss. We present this case with a review of the relevant literature.

Case Report

A 45-year-old Korean man presented with hearing impairment in his left ear, which developed after blunt head trauma at the workplace 1weeks ago. He complained of profound hearing impairment and tinnitus in his left ear. He told that vertigo developed right after the accident but disappeared rapidly. On a visit to our clinic, there was no vertigo or facial paralysis. The area of trauma was the left temporal portion of the skull.

A physical examination revealed that the left external auditory canal and tympanic membrane were intact.

Corresponding address:
Dong-Hee Lee
Department of Otolaryngology-Head and Neck Surgery,
Uijeongbu St. Mary's Hospital, College of Medicine, The Catholic University of Korea,
271 Cheonbo street, Uijeongbu city, Gyeonggi-do, 480-717, Korea.
Telephone : +82-31-820-3564 / Fax : +82-31-847-0038
E-mail : leedh0814@catholic.ac.kr

There was no evidence of bloody otorrhea or middle ear effusion. In a spontaneous and gaze nystagmus test, nystagmus was not identified, and a fistula test was negative. The high resolution, thin sliced temporal bone computed tomographic scan revealed an otic capsule-disrupting temporal bone fracture and multiple areas of air in the cochlea and vestibule in his left temporal bone. Except for a collection of fluid in the mastoid antrum, there was no evidence of CSF leakage into the middle ear cavity (Fig. 1). In addition, multiple fractures of skull base and airs within the intracranial cavity were observed. A puretone audiogram showed that the left hearing thresholds of both air and bone conductions were scaled out; however, the right air conduction threshold was 28 dB (Fig. 2). No auditory brainstem response was recordable in left ear.

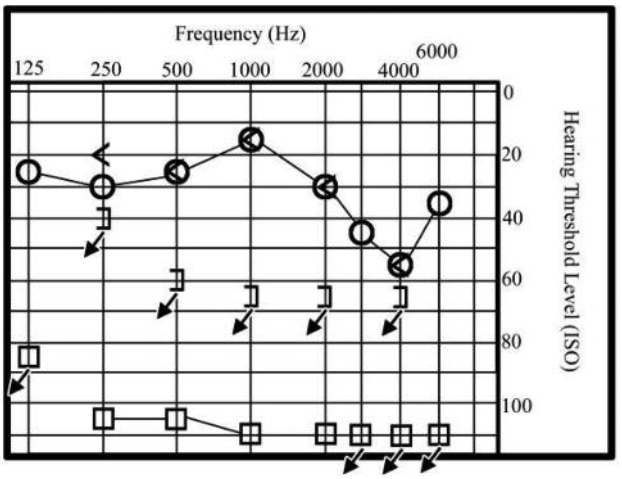

Figure 2. The puretone audiogram showed a profound sensorineural hearing loss in the left ear.

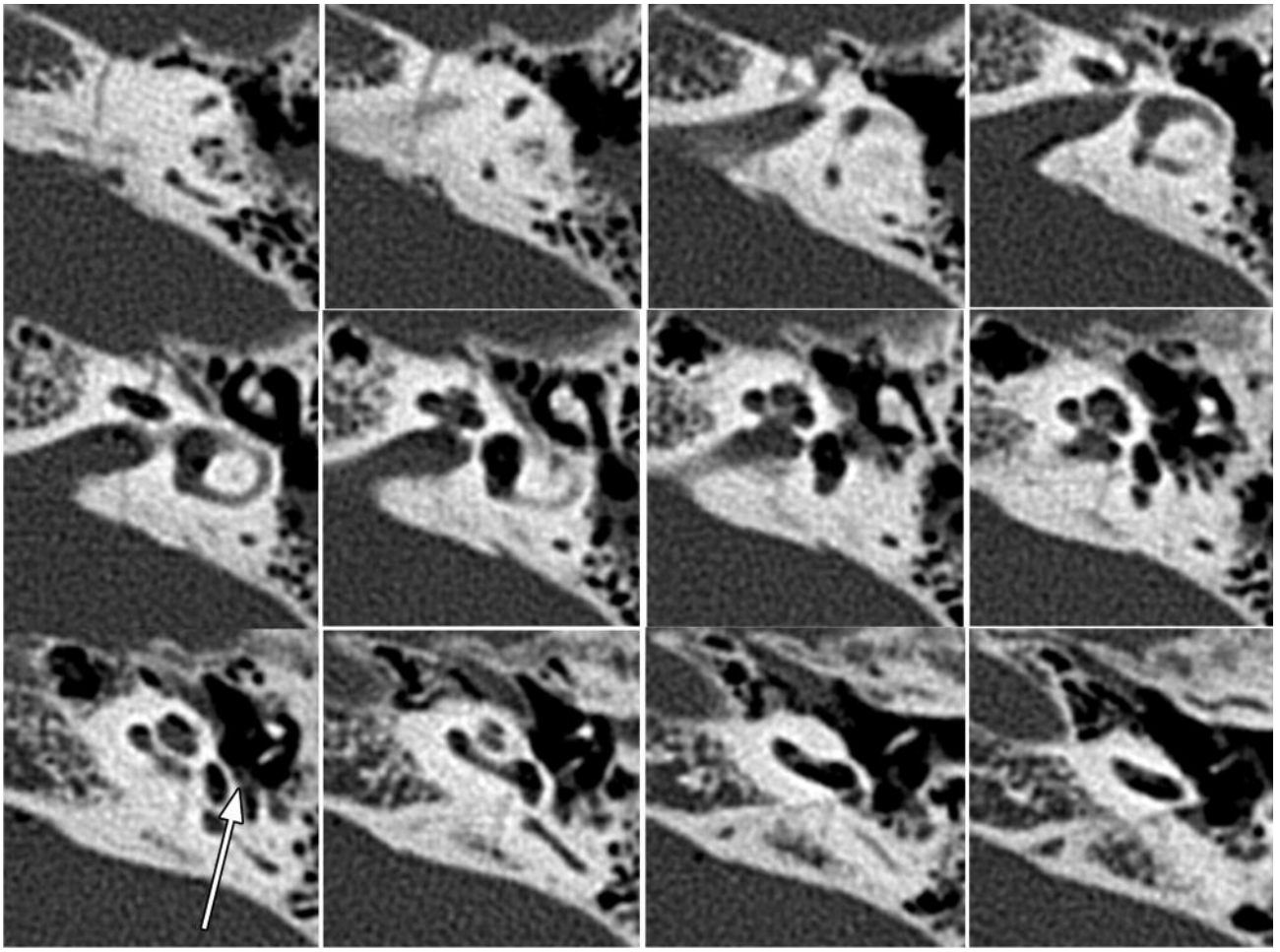

Figure 1. High-resolution coronal CT-scan of the left temporal bone shows air inside the cochlea as well as the vestibule. An otic-capsule-disrupting fracture connecting the inner ear and the middle ear cavity allows air to enter the inner ear (pneumolabyrinth). Stapes (arrow) is in the correct position without any fracture or dislocation.

A transverse temporal bone fracture, involving the otic capsule, which was complicated by the pneumolabyrinth, was diagnosed. There was no need for surgical exploration because the patient did not complain of progressive or fluctuating hearing loss or persistent vertigo, and there was no evidence of CSF leakage or perilymphatic fistula on the computed tomographic scan. The patient was observed for four weeks with conservative management. The treatment provided included: physical and psychological rest, an absolute bed rest, avoidance of a nose blowing, stool softening, pain control and prophylactic antibiotic therapy. There was no sequela except for the left hearing impairment, which was not improved on the puretone audiogram performed one month later after the accident. The second computed tomographic scan performed one month later after the accident confirmed that the air which had been trapped in the cochlea and vestibule had been completely absorbed.

Discussion

Temporal bone trauma usually results from blunt head injury. Injury to the temporal bone may result in fracture, hemorrhage, or disruption of the inner ear structures. Usually, fracture of the temporal bone requires the application of great force. Associated intracranial injuries, including extra-axial hemorrhage and brain contusion, are common. Fracture of the temporal bone may be associated with potential complications, including infection (meningitis), hearing loss, facial nerve injury, and perilymphatic fistula. Early identification is essential for proper management and the avoidance of complications.[1]

The high resolution, thin sliced temporal bone computed tomographic scan provides sections of 1 mm with extremely high resolution. It is superior to other radiological studies for identifying air, soft tissues and bone. Therefore, it is the procedure of choice for evaluating the temporal bone and widely used for evaluating cholesteatoma and fractures.

Traditionally, temporal bone fractures are described with reference to the long axis of the petrous bone and are classified as either longitudinal (parallel with the axis) or transverse (perpendicular to the axis). In fact, most fractures have both components and are termed mixed or oblique. Recently, a new classification with 'otic capsule-sparing' and 'otic capsule-disrupting' fractures has been introduced. This classification has the advantage of providing an accurate description of the relation between the complex fracture lines and the vital structures inside the temporal bone.[1]

Pneumolabyrinth has been rarely demonstrated on computed tomography after temporal bone fracture, although several cases of pneumolabyrinth were reported in association with perilymphatic fistula resulting from barotrauma[7] and stapedial footplate fracture after mastoid surgery or stapes surgery.[8-10]

The presence of air within the inner ear is a sign of a pathologic connection between the inner ear and the air-filled mastoid or middle ear cavities. In our case, the fracture disrupted the otic capsule and membranous labyrinth, allowing air from the middle ear cavity to enter the inner ear. Fracture or dislocation of the stapedial footplate, as occurs in stapes surgery, may also allow air to enter the inner ear through an oval window. It is also possible for the passage of the air to occur as a result of a spontaneous connection between the inner ear and the air-filled mastoid or middle ear cavities in cases with no trauma (perilymphatic fistula).

The effect of air on inner ear remains controversial. Sensorineural hearing loss was induced in animal models when air bubbles were introduced into the labyrinthine system. Kobayashi et al.[11] reported that the bubbles disturbed the propagation of the traveling wave of the basilar membrane and that initial decrease of hearing acuity after introduction of air into the scala tympani resulted from interference in cochlear microphonic and action potential generation mechanisms. In another study,[12] it was reported that the magnitude of hearing loss depended on the location of the air within the inner ear. Air inside the scala vestibule had a greater impact and often an irreversible effect on hearing, if the pneumolabyrinth was involved in the pathophysiology of perilymphatic fistula.

The treatment options for a pneumolabyrinth due to a temporal bone fracture are observation, or surgical exploration with closure of the connection between the inner ear and the air filled mastoid or middle ear cavities. Surgical exploration is recommended for patients who show progressive sensorineural or fluctuating hearing loss, or persistent vertigo.

Hidaka et al.[13] reported meta-analysis of 51 cases, comparing the hearing outcome. They found that there was no significant difference of a hearing outcome between penetrating trauma and blunt trauma. They did not show any significant difference of a hearing outcome

between conservative treatment and surgery. They found that a hearing outcome was significantly better in cases with stapes lesions including fracture, subluxation into the vestibule, and PLF from the oval window than in cases without stapes lesions. In addition, they found that cases with pneumolabyrinth limited to the vestibule or semicircular canals showed significantly better hearing outcome than cases with pneumolabyrinth extending from the vestibular organs to the cochlea did.

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