Case Report

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Cerebrospinal Fluid Leak During Stapes Surgery: The Importance of Temporal Bone CT Reconstructions in Oblique Anatomically Oriented Planes

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Abstract

Stapes gusher is a massive flow of perilymph and cerebrospinal fluid leak that fills the middle ear immediately after surgical opening of the labyrinth, such as during stapedectomy. Stapes gusher usually occurs as the result of a congenital malformation that causes an abnormal communication between the perilymphatic space and the subarachnoid space involving the internal auditory canal or the cochlear duct. To date, the potential risk of stapes gusher cannot be assessed preoperatively, as there are not pathognomonic signs suggestive of this complication. However, high-resolution computed tomography scan (HRCT) of the temporal bone can provide information that may help recognizing patients at risk. Recently, an anatomic evaluation of the inner ear with oblique reformation at HRCT has been described. This reformation offers a new and more detailed topographic vision of temporal bone structures compared to the classic axial and coronal planes and may help identifying anatomical alterations otherwise not visible. In this article, we present a case of stapes gusher and the role of preoperative HRCT with oblique reformation in its prevention.

Keywords

stapes surgery, cerebrospinal fluid leak, computed tomography scan, middle ear, labyrinth

Introduction

Cerebrospinal fluid leak (CSF) is an uncommon complication of stapes surgery. A stapes gusher is a massive flow of perilymph and CSF that fills the middle ear suddenly after surgical opening of the labyrinth, such as during stapedectomy immediately after platinotomy. Stapes gusher usually occurs as the result of congenital malformation that causes an abnormal communication between the perilymphatic space and the subarachnoid space involving the internal auditory canal (IAC) or the cochlear duct.[1,2] Stapes gusher has a reported incidence that ranges between 1 in 500 and 1 in 3300 surgeries.[3,4]

Several cases of stapes gusher have been reported in the literature; however, only a few authors have discussed and highlighted the importance of a targeted high-resolution computed tomography (HRCT) scan to prevent this complication.[5,6] Recently, an anatomic evaluation of the inner ear with oblique reformation at HRCT has been described.[7] This reformation offers a more detailed topographic vision of temporal bone structures compared to the classic axial and coronal planes and may help identifying anatomical alterations otherwise not visible.[7]

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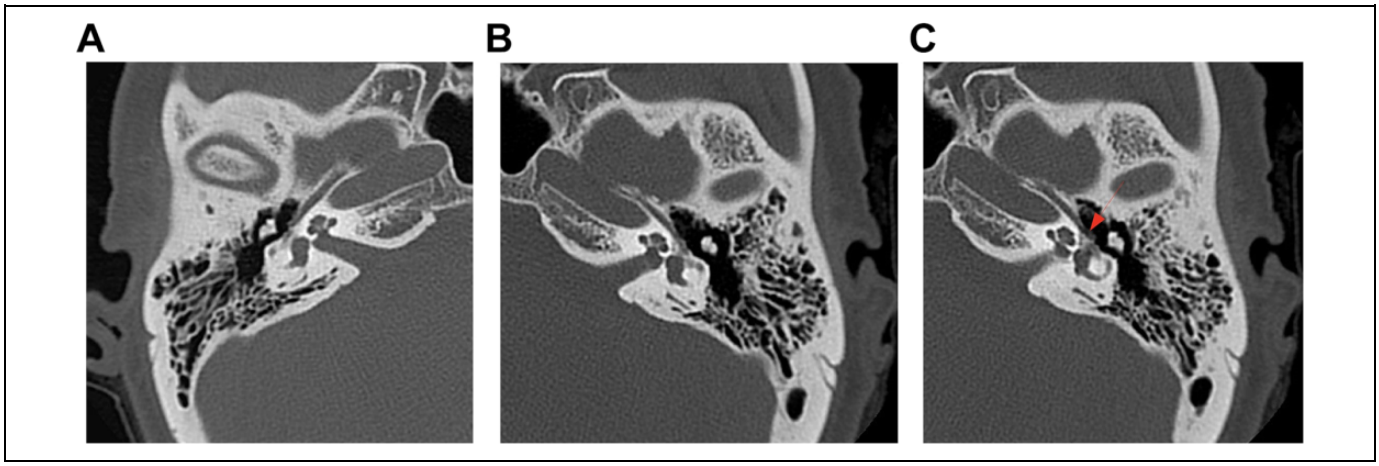

Figure 1. High-resolution computed tomography scan of the temporal bone with bone algorithm of right (A) and left (B, C) petrous and mastoid bone. In both sides, bilateral morphology of the internal ear and in particular of the cochlea and internal auditory canal is apparently normal. A left fenestral otospongiotic area is evident (red arrow).

In this article, we present a case of stapes gusher and the role of preoperative HRCT with oblique reformation in its prevention.

Case Presentation

A 49-year-old woman without family history of deafness presented to the otolaryngology unit of our hospital with a medical history of a left-side progressive hearing loss that was first diagnosed in 2006. Otoscopy revealed normal tympanic membranes and auditory canals, while a mild to moderate sloping left-side conductive hearing loss with an average air-bone gap of 40 dB was found at pure tone audiometry. Acoustic impedance measurements showed a normal tympanometry (A-type) in both ears, with the absence of ipsilateral and contralateral acoustic reflexes in the left ear. The patient did not have otorrhea, rhinorrhea, fever, headache, vertigo, or tinnitus.

A diagnosis of otosclerosis in the left ear was made, and stapedectomy was programmed. During platinotomy performed using a perforator bit, a sudden leakage of a citrine liquid occurred and rapidly filled up the middle ear. The procedure was interrupted due to the massive flow of CSF that did not allow prosthesis insertion. The oval window was then closed using an autologous vein graft, and the middle ear was filled with spongostan until the flow stopped. The endomeatal strip was replaced and the external auditory canal was filled with Spongostan (Ferrosan A/S).

The patient was placed in a half-standing position to reduce hydrostatic encephalic pressure and was kept under observation for 3 days with antibiotic therapy. There were no postoperative vestibular symptoms nor other complications. The postoperative audiometric evaluation at 10, 30, and 90 days did not show changes in hearing threshold and no deterioration of bone conduction.

High-resolution computed tomography scan of the temporal bone was performed after 1 month with a 64-section computed tomography (CT) scanner (Optima CT660, GE Medical System), using a high-resolution spiral program and bone algorithm. The thinnest available image section thickness (0.6 mm) was used, overlapped of 0.3 mm. Images were closely reviewed for signs of congenital dysplasia, especially those associated with X-linked perilymphatic gusher (PLG). No findings suggestive of PLG were appreciated in axial images. However, the IAC fundus did not show a clear separation from the basal turn of the cochlea in standard coronal reconstructions. To better examine the interface between the cochlea and the IAC, oblique coronal image reformatting was performed parallel to the long axis of the IAC and perpendicular to the long axis of the basal turn of the cochlea. The images in oblique-oriented planes showed a clear communication (area of bony dehiscence) bilaterally between the fundus of the IAC and the basal turn of the cochlea (Figures 1–2).

Discussion

A stapes gusher is a rare but dramatic event that may occur during stapes surgery. In these cases, a congenital malformation, usually an enlargement of the cochlear duct or a defect of the fundus of the IAC with abnormal communication between the perilymphatic and subarachnoid spaces, replaces the physiological communication between the subarachnoid space and the perilymphatic space.[4,8]

A recent systematic review of the literature on 76 cases of intraoperative CSF during stapes surgery revealed that 21 (27.6%) patients were diagnosed with congenital anatomical anomalies such as X-linked progressive mixed deafness at postoperative or preoperative CT scans.[5] The majority of anomalies (76%) affected the IAC, its cochlear end and/or the cochlea. Since X-linked progressive mixed deafness is significantly associated with gusher during stapes surgery, an accurate preoperative diagnosis is recommended.[9]

Causse et al[10] described 2 intraoperative anatomic alterations that may suggest the risk of stapes gusher: a congenital reduced vascularization of the middle ear and an abnormal anterior

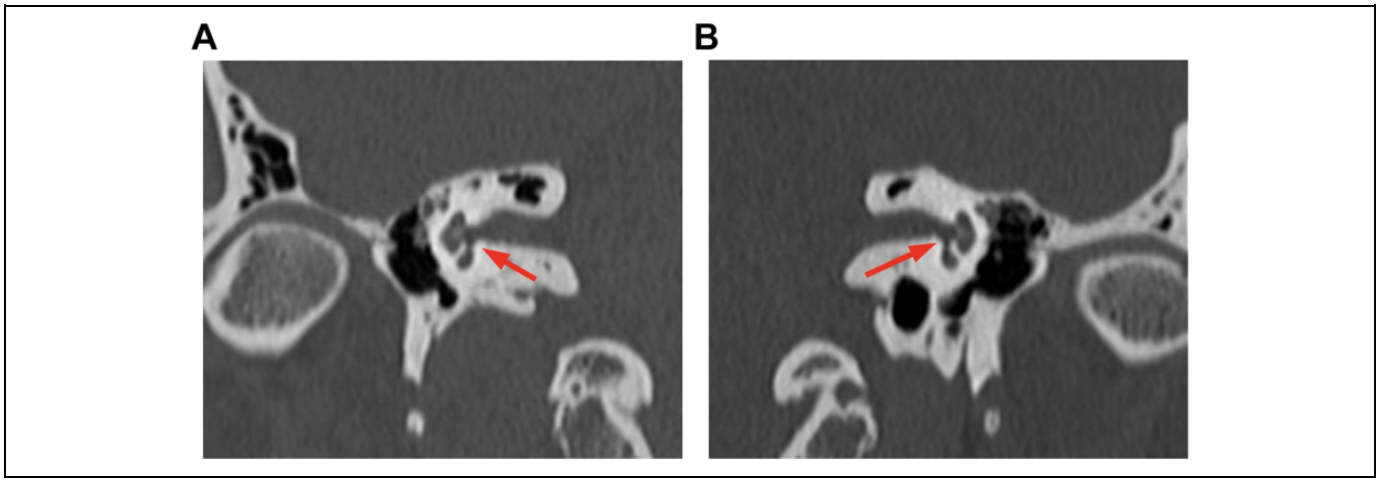

Figure 2. Reformatted computed tomography scan images in oblique planes, parallel to the long axis of the internal auditory canal and perpendicular to the long axis of the cochlear basal turn in the right (A) and left (B) side. The presence of an anomalous communication between the floor of the internal auditory canal fundus and the basal turn of the cochlea is bilaterally detected (red arrow). This bone defect represents in this case the anatomical basis of stapes gusher.

insertion of the posterior crus into the footplate. However, these signs are too unspecific, and only a diagnosis of congenital stapes ankyloses can suggest a high risk of gusher. In these cases, a preoperative temporal bone HRCT should be performed even if, in case of suspected otosclerosis, the diagnostic sensitivity of HRCT is difficult to evaluate and ranges from 34% to 95%, with several limitations.[9]

Recently, a new anatomic evaluation of the inner ear with oblique reformation of HRCT has been described.[7] Oblique anatomically oriented reconstructions in CT imaging of the temporal bone could be an additional tool to evaluate complex temporal bone structures and may help surgeons evaluate and prevent stapes gushers. Suggestive signs of a possible gusher are dilation of the IAC fundus, dilation of the vestibule, widening of the cochlear aqueduct, widening of the vestibular aqueduct, cochlear dysplasia, and dilation of the first portion of the facial canal.[11-13] These findings may be identified upon close examination of the standard axial and coronal images.[11] However, in the vast majority of gusher cases, radiological findings such as small defects at the base of the cochlea in otherwise normal inner ear morphology[14] are hardly detectable. These defects may be better identified using anatomically oriented reformatted images.

In the present case, the HRCT scan of the temporal bone performed after 1 month did not show findings suggestive of PLG in the standard plane; however, examination of the interface between the cochlea and the IAC in coronal reconstructions and upon reformatting in coronal anatomically oriented planes showed a clear communication between the fundus of IAC and basal turn of the cochlea. This sign can have a role in the preoperatively identification of cases at risk for stapes gusher.

Conclusion

To date, the potential risk of stapes gusher cannot be assessed preoperatively, as there are not pathognomonic signs suggestive of this complication. However, HRCT of the temporal bone can provide information that may help identifying patients at risk of developing this complication. If the inner ear appears normal in the standard CT scan, images should be examined using anatomically oriented planes, which in addition to better assessing the middle ear structures, allow to better visualize the interface between the IAC fundus and the basal turn of the cochlea.

Authors' Note

M.R. contributed to conceptualization and writing. M.G. contributed to materials and critical review. A.S. contributed to data collection and supervision. C.C. contributed to design and critical review. M.R. contributed to materials and supervision. P.D.L. contributed to data collection and analysis. T.A. contributed to design and materials. P.V. contributed to analysis and supervision. F.M.G. contributed to analysis and literature review. S.S.F. contributed to writing and supervision.

Declaration of Conflicting Interests

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