# Perilymphatic gusher in stapedectomy: demonstration of a fistula of internal auditory canal

## *Gusher nella stapedectomia: dimostrazione di una fistola del condotto uditivo interno*

P. CASSANO, N. DECANDIA[1], M. CASSANO[1], M.L. FIORELLA[1], G. ETTORRE[2]
Chair of Otorhinolaryngology, University of Foggia, Italy
[1] II Clinic of Otorhinolaryngology, University of Bari, Italy
[2] Clinic of Radiology, University of Foggia, Italy

Key words

Otosclerosis • Stapedectomy • Gusher • Perilymphatic fistula

Parole chiave

*Otosclerosi • Stapedectomia • Gusher • Fistola perilinfatica*

Summary

Gusher is a very rare phenomenon, generally associated with congenital stapes fixation or otosclerosis in adult age, that may present during stapedectomy. A sudden perilymph flow occurs following platinotomy, due to congenital malformation (abnormally wide cochlear aqueduct or internal auditory canal fistula), that causes an abnormal connection between subarachnoid and perilymphatic spaces. This report deals with a case of bilateral gusher, occurring during stapedectomy, caused by an osseous fistula between bottom of internal auditory canal and the osseous labyrinth later observed at computed tomography scan. The usefulness of a radiologic examination is stressed for a correct therapeutic approach in the even contralateral ear stapedectomy.

*Riassunto*

*Il gusher è un fenomeno molto raro che si verifica nel corso dell'intervento di stapedectomia, generalmente associato a fissazione congenita della platina della staffa o, eccezionalmente, ad otosclerosi dell'adulto. Consiste in un flusso di perilinfa improvviso all'atto della platinotomia, per la presenza di anomalie congenite (acquedotto cocleare abnormemente ampio o fistola del condotto uditivo interno), che determinano una comunicazione abnorme tra spazi subaracnoidei e perilinfatici. Gli autori descrivono un caso di gusher bilaterale, manifestatosi in un orecchio durante un intervento di stapedectomia, dovuto ad una fistola ossea, osservata successivamente all'esame TAC, tra fondo del condotto uditivo interno e labirinto osseo. Gli autori sottolineano l'importanza dell'indagine radiologica ai fini di una corretta strategia terapeutica in caso di intervento di stapedectomia nell'orecchio controlaterale.*

## Introduction

"Gusher" is considered as one of the most dramatic events during stapedectomy. As is well known, it is a sudden and profuse perilymphatic flow, that occurs immediately after platinotomy and often fills up the middle ear and external auditory canal. It is a rare complication (0.3% according to Causse and Causse) [1] combined with congenital stapes fixation (with deafness at birth) [2] or, more rarely, with otosclerosis in adult age.
The aetiology is a congenital malformation due to an abnormal connection between the subarachnoid and perilymphatic spaces [3].
The perilymphatic system may be directly linked to the sub-arachnoid space through two main ways: cochlear duct or perineural sheets of nerves located in the internal auditory canal. A third way is the vestibular duct crossed by the endolymphatic duct.
This abnormal connection can be revealed by otorrhoea, in the presence of a perforation of the tympanic membrane, or rhinorrhoea, both constituted by cerebrospinal liquid and, sometimes, associated with recurrent meningeal inflammations. Gusher may occasionally remain undetected for a long time and become evident during stapedectomy in patients with otosclerosis and congenital stapes fixation.
The picture and surgical findings are described as well as interesting computed tomography (CT) evidence of a bilateral osseous fistula between the bottom of the internal auditory canal (IAC) and the osseous labyrinth, observed in a patient with bilateral otosclerosis, after the first operation.

## Case report

A 60-year-old male, with bilateral and progressive hearing loss and high tonality tinnitus for 3 years. The otoscopic picture was normal; a functional acoustic test revealed a bilateral symmetric mixed hypacusia at all frequencies, with air conduction of ~60 dB (mean 0.25-0.50-1-2-4 KHz) and bone conduction of ~30 dB for the same frequencies. Acoustic-impedance measurements showed normal

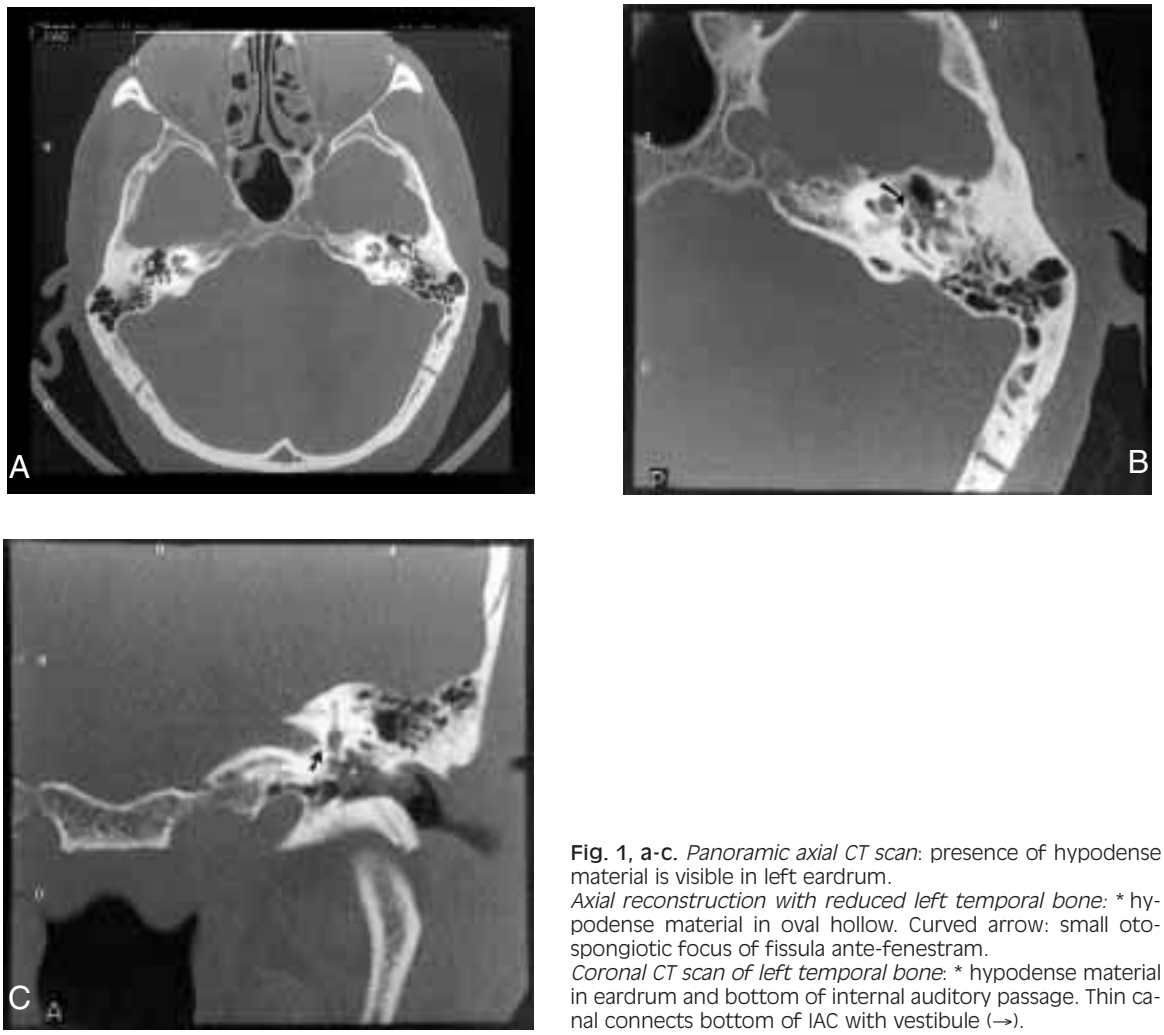


**Fig. 1, a-c.** *Panoramic axial CT scan*: presence of hypodense material is visible in left eardrum.
*Axial reconstruction with reduced left temporal bone:* * hypodense material in oval hollow. Curved arrow: small otospongiotic focus of fissula ante-fenestram.
*Coronal CT scan of left temporal bone*: * hypodense material in eardrum and bottom of internal auditory passage. Thin canal connects bottom of IAC with vestibule (→).

timpanometry (A-type) in both ears, with absence of acoustic reflexes.

A diagnosis of stapedial-cochlear otosclerosis was made on the basis of anamnestic, clinical and instrumental data and stapedectomy was programmed.

During platinotomy, using a perforator bit, a sudden, abundant leakage of a clear, citrine liquid occurred rapidly filling up the middle ear and external auditory canal, despite aspiration. The procedure was interrupted due to persistence of perilymphorrhoea and failure of any attempt to arrest the flow.

The oval window was sealed with fat taken from the earlobe, and the eardrum was filled with spongostan until the flow stopped. The endomeatal strip was then replaced on the osseous canal, adding spongostan and cotton flock, that was gradually soaked with a small quantity of citrine liquide over the next few hours.

The patient was placed in a half-standing position to reduce hydrostatic encephalic pressure and, within a few hours, leakage of the liquid gradually stopped. The patient was kept under observation for 7 days with no other complications being detected. A high resolution dye CT scan of the petrosa was later performed. In coronal sections, this test clearly revealed a bilateral osseous fistula between the bottom of the IAC and the osseous labyrinth.

CT scan was performed with a 4$^{th}$ generation equipment (Picker P1-CT 2000, Cleveland, OH, USA), using a high resolution programme to study the bone structures with a thin layer 1 mm and increasing by 1 mm, with iodate contrast. Axial and coronal sections on the petrosa demonstrated the presence of hypodense tissue in the left eardrum and external auditory canal (EAC), related to the material (Spongostan) placed during surgery. In both sides, small otospongiosis focus in fistula ante-fenestram involving the front edge of oval window were observed; the most important finding, emerging during coronal section, was ev-

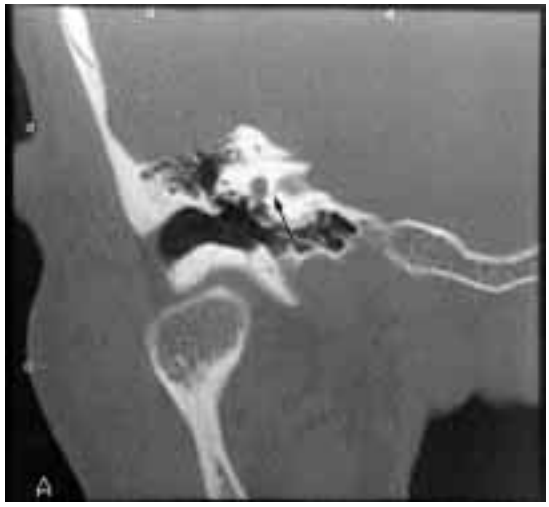

Fig. 2. *Coronal CT scan of right temporal*: thin osseous canal is visible between bottom of IAC and visible (→).

idence of a small osseous canal connecting the bottom of the IAC with the vestibular cavity (Figs. 1, 2).
The patient was then submitted to casualty audiometer checks: 1 year after surgery cochlear degenerative phenomena were evident, with hypoacusia in acute frequencies in the operated ear (disappearance of 8 KHz, bone conduction of 60 dB on 4 KHz and 45 on 2 KHz). Surgery on the other ear was considered inadvisable on account of the risk, due to the anomalous connection between the liquoral spaces and the labyrinth, supported by radiological findings. The patient was, therefore, advised to proceed with application of a prosthesis.

## Discussion

As already mentioned in the introduction, two main factors have been held, in the recent literature, to play a role in the pathogenesis of gusher: extreme patency of the aqueduct of the cochlea or a permeable internal auditory canal [4].
Wlodyka by means of anatomic preparations confirms the first hypothesis which is supported also by Shea [5], Farrior and Endicott [6], Allen [7] and Suzuki [8], who observed recovery after surgical ablation of the cochlear aqueduct. The possibility of an internal auditory canal fistula, revealed by dye cisternography, is reported by other Authors [10-18].
The impossibility to define a clinical diagnosis, prior to surgery, due to absence of pathognomonic signs, is one of the main problems regarding gusher, when combined with otosclerosis, is that gusher does not add anything to the symptomatology, the objective and functional features of the disease already present. Causse et al. [19] described two clues that may alert the surgeon of the possible presence of a gusher before the footplate is opened: an avascular congenital middle ear and an abnormally anterior insertion of the posterior crus to the footplate. Albeit, these signs are, of course, too aspecific to be sure of the diagnosis.
Obviously, only congenital stapes ankylosis will suggest a gusher and, for this reason, it is useful to carry out radiologic investigations; in fact, in our experience, high resolution dye CT has reliably demonstrated, particularly in the coronal sections, the internal auditory canal fistula.
In cases of congenitally fixed stapes with gusher, management differs between the various Authors. Some suggest a small-hole stapedotomy, and placement of a tissue graft prior to insertion of the prosthesis in contrast to packing the ear and terminating the surgery [20], since further surgical manoeuvres are considered dangerous for uditive function and control of perilymphatic flow. In this regard, the study of Wolferman [21] is particularly significant in that he used gelfoam in the management of gusher to cover the oval window, middle ear and external auditory canal. The persistence of perilymphatic leakage required a revision of the stapedectomy with fat plug at to seal the oval window. Further failure suggested the use of a cerebrospinal fluid lumbar drain which stopped the perilymphatic leakage.
Of the various studies suggesting how to complete the procedure, it is worthwhile stressing that of Causse and Causse [1]; their technique consists in a two-stage operation; first, creating small-hole stapedotomy and placement of a tissue graft and, after 4-6 months, inserting a very thin prosthesis. Regardless of the method used in the surgical management of gusher, functional results are often disappointing, since, in most cases, patients develop progressive sensorineural hearing loss. In this respect, it is worthwhile recalling the results of House and Graham, in 6 cases of gusher, that were successfully operated upon without significant improvement in hypoacusia [22]. Even more frequent are reports of cases of sudden or progressive sensorineural hearing loss after surgery, above all in the presence of congenital footplate fixation, as can be seen from data of Olson and Lehman [23] and Glasscock [14].
Personally, we did not consider the hypothesis of surgical revision on account of the progressive labyrinthine degeneration in the operated ear, despite immediate oval window sealing.

## Conclusions

From an analysis of the case described here, it is possible, in the light of the more recent literature, to draw some conclusions:

1. in the pre- and per-operative phase, no predictive signs of gusher can be found;
2. when, under pressure, cerebrospinal fluid flow is profuse, it is impossible to insert the prosthesis and to complete the procedure. An eventual surgical revision depends on the amount of perilymphatic flow and the behaviour of uditive function over time (a sensorineural hearing loss is obviously a contraindication for surgical revision);
3. in the presence of a bilateral problem, it is necessary, before planning surgery on the other ear, to perform a high resolution dye CT, that above all, in the coronal sections, shows, without any doubt, congenital abnormalities (in particular, a defect in the bottom of the internal auditory canal); in this case, it is recommended to avoid the operation or, when it is possible, to plan a therapeutic strategy that will limit the damage to the internal ear and, at the same time, also lead to partial recovery of uditive function.

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■ Address for correspondence: Prof. P. Cassano, via F. Crispi 34/C, 70123 Bari, Italy. Fax +39 080 5211318. E-mail: michcass@tiscali.it