Surgical Treatment And Hearing Rehabilitation In A Patient With Supralabyrinthine Cholesteatoma Of The Petrous Bone

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Abstract. Introduction. Cholesteatoma of the petrous bone occurs as a result of aggressive growth of keratinizing squamous epithelium and is localized in the petrous part of the temporal bone. It is quite rare and accounts for 4-9% of all pathological processes affecting the petrous bone. The main objective of surgical treatment of petrous bone cholesteatoma is its radical removal, which is a very difficult task due to the high risk of damage to vital structures located in this area: the cochlea, facial nerve (FN), dura mater and internal carotid artery. These difficulties previously did not allow otosurgeons to think about the possibility of hearing rehabilitation in patients with this condition while surgeries were limited to sanation and reconstruction of anatomical structures. Nowadays, new more gentle approaches and surgical techniques were introduced.

Objective. To describe a clinical case of successful cochlear implantation in a patient with supralabyrinthine cholesteatoma of the petrous bone.

Case presentation. Patient B., 23 years old, was admitted with complaints of persistent bilateral hearing loss. He has a history of numerous surgeries on both ears without a positive effect. According to the results of computed tomography and magnetic resonance imaging, supralabyrinthine cholesteatoma of the right petrous bone was revealed. Surgical treatment was performed in two stages: sanation and subsequent cochlear implantation with a positive clinical result.

Discussion. Surgical treatment with hearing preservation can be used in limited cholesteatomas of the petrous bone: supralabyrinthine and infralabyrinthine. CI is currently the only effective method of rehabilitation of patients suffering from high-grade sensorineural hearing loss and deafness. CI in supralabyrinthine cholesteatoma of the petrous bone can be performed both simultaneously with sanation, and in two stages. The authors' opinions on this issue still differ: some believe that two-stage surgery reduces the risk of meningitis and makes it possible to control the previous surgery, the so-called "second look", while others consider to perform CI, eradication of the cholesteatoma with subtotal petrosectomy in one stage. The lack of information provided does not allow us to come to a consensus. More representations of clinical cases and studies highlighting this problem are needed.

Conclusion. CI can be an effective method of hearing rehabilitation in patients with petrous bone cholesteatoma, provided that the cochlea structures are preserved and after complete removal of the cholesteatoma. CI can be performed simultaneously with the eradication of cholesteatoma, or in two stages. To our best knowledge, this is the first Russian language report of cochlear implantation in a patient with petrous bone cholesteatoma.

Key words: temporal bone, petrous bone cholesteatoma. cochlear implantation, hearing rehabilitation, otosurgery.

Introduction

Cholesteatoma of the petrous bone is a mass (epidermal cyst) resulting from an aggressive growth of keratinizing squamous epithelium and localized in the petrous part of the temporal bone. According to various authors, it is quite rare and accounts for 4–9% of all pathological processes affecting the petrous bone. Due to uncontrolled, aggressive growth, cholesteatoma destroys such structures as the middle and inner ear and can spread into the infratemporal fossa as well as mesocranial and postcranial fossas. [1,2].

Nowadays, there are several modern classifications of petrous bone cholesteatoma. According to the classification of Sanna et al. from 2011, there are 5 classes as they spread in the petrous part of the temporal bone: supralabyrinthine, infralabyrinthine, infralabyrinthine apical, massive, massive apical.

There can be 7 classes of cholesteatoma based on the classification of D. Moffat and W. Smith: supralabyrinthine, supralabyrinthine apical, infralabyrinthine, infralabyrinthine apical, apical, massive labyrinthine and massive labyrinthine cholesteatoma of the petrous bone with apical extension [4].

The main objective of surgical treatment of petrous bone cholesteatoma is its radical removal, which is a very difficult task due to the high risk of damage to vital structures located in this area: the cochlea, facial nerve (FN), dura mater and internal carotid artery. These difficulties previously did not allow otosurgeons to think about the possibility of hearing rehabilitation in patients with this condition while surgeries were limited to sanation and reconstruction of anatomical structures (reconstruction of the posterior wall of the auditory canal, options for mastoidoplasty, FN plasty). Nowadays, new more gentle approaches and surgical techniques were introduced. Although earlier cochlear implantat surgery was considered contraindicated for patients with chronic suppurative otitis media (CSOM) with or without cholesteatoma [5,6]. The improvement of surgical techniques and modern research methods have now begun to allow these patients to perform cochlear implantat surgery [6, 7, 8, 9, 10, 11, 12, 13].

Our work presents a clinical case of successful cochlear implantat surgery after the sanation in a patient with the petrous bone cholesteatoma.

Objective

To describe a clinical case of successful cochlear implantation in a patient with supralabyrinthine cholesteatoma of the petrous bone.

Case presentation

Patient B., 23 years old, was admitted with complaints of persistent bilateral hearing loss to surdity in December 2021. The anamnesis describes numerous sanations on both ears without a positive effect in the home area. Surgical treatment (radical surgery) was performed on the left ear, after which the patient noted strong hearing loss in 2011. Tectonic hearing-enhancing surgery was made on both ears without a positive effect in the home area in 2017, but his hearing deteriorated. Radical surgery was performed on the right ear at the place of residence in 2021. The patient noted severe rotational dizziness and strong hearing loss on the right ear 7 days after surgery. After 4-5 month, the dizziness was reserved without any therapy. A residual cholesteatoma of the right petrous bone was revealed upon repeated inspection. Due to the ineffectiveness of the surgical treatment in the home area, he was sent for repeated surgical treatment at the Federal State Budgetary Institution «The National Medical Research Center for Otorhinolaryngology of the Federal Medico-Biological Agency of Russia» in order to determine further treatment tactics.

On admission

Overall condition of the patient is satisfactory. The state of ENT- organs:

Nose and accessory sinuses of nose: During anterior rhinoscopy: the mucous coat is pale pink, colliquative, nasal passages are free, the nasal septum is along the middle line, nasal breathing is satisfactory.

Fauces: During mesopharyngoscopy: the posterior veil of soft palate is symmetrical, the pillars of fauces are of normal color, the palatine tonsils are without plaque, size is usual. The mucous coat of the posterior pharynx is pink and moist.

Larynx: breathing is free, the body of the larynx is not deformed, the hilar nodes are not enlarged. During indirect laryngoscopy: the vallecular sinuses and the pyriform sinus are free, the flap of the throat is expanded, mobile.

Ears: AD: the concha of auricle without features, the surgical scar in the postauricular area without signs of hypertrophic growth. During otoscopy: the acoustic duct is free, the neotympanic membrane is strong, thickened. (Fig.1)

AS: the concha of auricle without features, the surgical scar in the postauricular area without signs of hypertrophic growth. During otoscopy: the atrium after RO is dry, epidermized, the bony canal is high. (Fig.1)

The vestibular function and skull brain nerves function are not impaired.

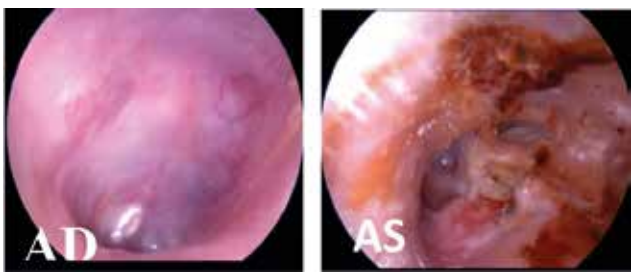


Fig. 1 Otoscopy of both ears

Data of audiological methods: IV bilateral sensorineural hearing loss, bordering with on deafness, was found on tone threshold audiometry in patient. Registration of short latency auditory evoked potentials (SLAEP): an accurate SLAEP response was not registered from two sides: bone conduction up to 60 dB, aerial conduction up to 100 dB.

Data of radiological methods: signs of postsurgical changes of the temporal bones and signs of cholesteatoma of the right petrous bone were revealed according to the results of computed tomography and magnetic resonance tomography (fig. 2-3)

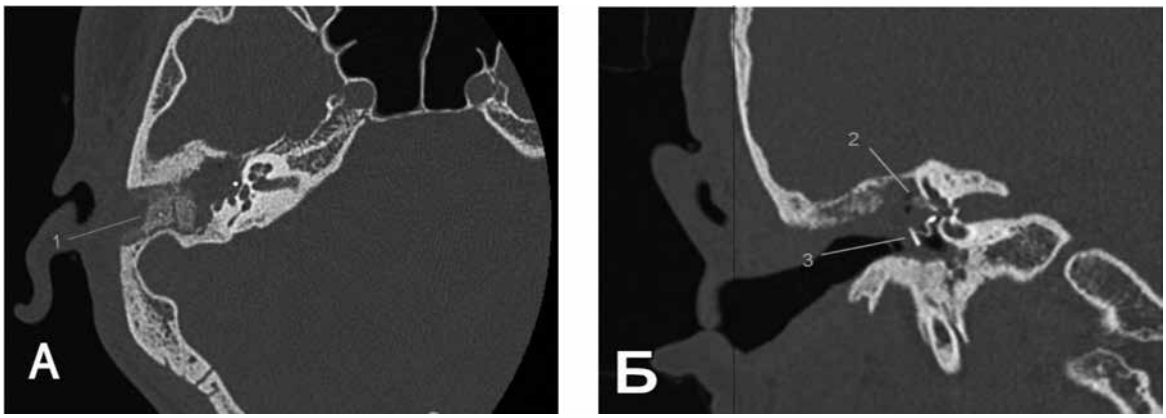


Fig. 2 Computed tomography of the right temporal bone pre-operation (А- axial scan, Б- coronal scan). Post-operative changes are detected: middle ear is completely filled with soft-tissue substrate that is eroding the lateral semicircular canal (LSC) and spreading into supralabyrinthine air cell tract. Ossicular prothesis positioned correctly. Orange arrow: 1- soft-tissue substrate; 2- defect of the LSC; 3- ossicular prothesis placed in the previous surgery

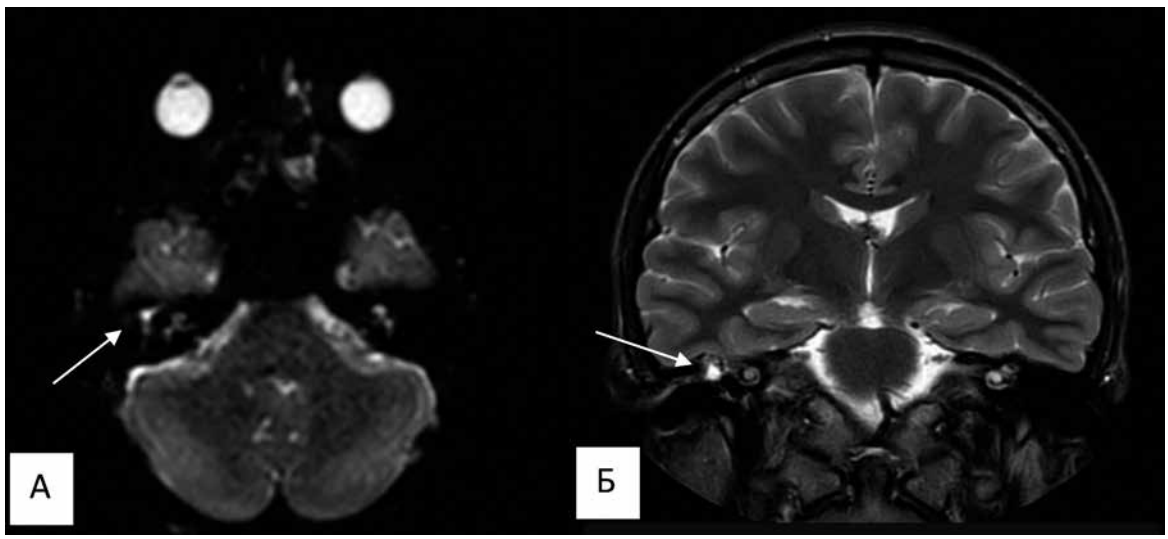


Fig. 3 Pre-operative MRI. (А)- Axial scan, non epi DWI sequence. (Б)- Coronal scan, T2 secuence. White arrow- hyperintensive signal

Based on the patient`s complains, anamnesis of the disease, data from an examination of the result of the audiological and radiological research methods, diagnosis was established: chronic bilaterial atticoantral suppurative otitis media. The condition is after repeated sanations with bilaterial tympanoplasty. There is (residual) cholesteatoma of the right petrous bone, supralabyrinthine generalization. Built on the lack of the effect from previous treatment, continued growth of cholesteatoma, significant defect of hearing, it was decided to realize surgical treatment in 2 stages. The first stage is the sanation of the temporal bone, reconstruction of anatomical organization, preparation for the second stage. The second is the audio-verbal rehabilitation.

After general clinical research, the patient underwent stage 1 surgical treatment, which was aimed at the sanation of the temporal bone, reconstruction of anatomical organization of the middle ear and mastoid process in preparation for subsequent cochlear implantation.

The operation was done under general endotracheal anesthesia by a breech approach, receding from the postaural ruga 1 cm along the old postoperative cicatrix. The soft tissues are separated to the sides by dilators. The mastoidal segment formed during previous operations was open. The posterior wall of the external auditory canal was missing. During the revision: the mastoidal segment is of medium size, partially obliterated by cartilages and bone chips. After removing them, fibrous tissue was found, passing into an extending cholesteatoma, which spreads into tectum of the antrum and attic into the tube pocket. The bony canal is quite high and lop sided. The anterior areas of the neotympanic membrane are preserved, strong in the tympanic segment, located at the level of tympanic ring. The posterior areas of the neotympanic membrane are indrawned, round the exserted the protruding contours of the facial nerve (FN) in the tympanic segment. They are brazed to the fundus of the tympanic and subtympanic atriums. There is a defect in the tectum area of the antrum and attic, covered with scabs and cholesteatomic masses. Conducted: the neotympanic membrane was separated from the medial paries of the tympanic cavity lifted along with the skin of the external auditory canal from the tympanic ring. Its middle and frontal segments are preserved for following myringoplasty. Fibrotic scar tissue was trimmed in the tympanic segment. Cholesteatomic masses were removed from the area of the windows of the labyrinth, subtympanic, tympanic and facial sinuses. After that, the epidermal matrix was separated from tympanic segment of the FN deficient of a bone wall. This segment is surrounded by the epidermis from the level of the beginning of the labyrinth section to the level of facial nerve. A defect of the bone wall of the lateral semicircular canal (LSC) was found. Cog was filed away by diamond bur. The tube pocket has been opened and sanated. The tectums of the attic, antrum and additus are equalized, all bony prominences are smoothed. The removal of cariously modified bony tissue was made along the generalization of the cholesteatoma into the supralabyrinthine cellular canal and towards the internal acoustic meatus (IAM). The cholesteatoma obduced the entire tympanic and labyrinthine segments of the facial nerve and the geniculate ganglion. Also, cholesteatoma reached the IAM capsule. There was a slight liquorrhea which was stopped intraoperatively after the removal of the epidermal masses from the IAM area. Next, the mastoidal segment of the atrium is completely sanated, all rugosities are smoothed. The peripheral, perilabirinth, sinodural and apical cells are fully dissected. The height of the bony canal has been preserved. A canal with a diameter of 4 mm was drilled out from the mastoid section towards the direction of the cochlear window (as a posterior tympanostome during cochlear implantation) in the bone mass of the bony canal above the mastoid segment of the facial nerve. Next, the reconstruction of the anatomical structures was made: the aditus to the IAM is covered with autofascia. The otoliquorrea has been reserved. The hemostatic material «Surgicel» is settled. The FN is additionally covered with a perichondrium. The defect of the LSC is covered with cartilageses and a fragment of the periosteal coverage. The «Surgicel» material is placed in the mastoid atrium. The neotimpanic membrane was plasticized with periosteal transplantates using the «Underlay» technique. The neotimpanic membrane is laid at an anatomic level. Plastic surgery of the chondral part of the external ear canal. The skin wrapped on the inner surface of the chondral part was dissected. A part of the chondral part of the external ear canal was excised. The formed integumentary flaps are directed towards the mastoid atrium for further adequate epidermization of the mastoid section of the trepanation atrium. The fate of the operation is favorable. The postoperative period is no abnormalities. Nominal antimicrobial therapy and daily bandages were done. The patient was dismissed on the 7th day for further monitoring by an ENT specialist at the home area.

The patient was rehospitalized at the FSBI «The National Medical Research Center for Otorhinolaryngology of the Federal Medico-Biological Agency of Russia» for the second treatment stage in April 2022. The cochlear implantation was done in the right ear with the installation of Cochlear CI 512 implantat.

The operation was executed under general endotracheal anesthesia by a breech approach. The tissues were infiltrated by a 0.9% (normal) saline with addition of 0.1% Adrenalinum hydrochloricum (2

drops of Adrenalinium per 20 ml of saline) before the incision. The soft tissues were separated to the sides after making an incision of the skin and hypodermis tissue. The postoperative atrium opened after executing a linear incision of the skin of posterior wall of auditory canal. During the revision: the mastoidal segment is of medium size, smooth and well epidermized. The bony canal is high and smooth. The neotympanic membrane is strong in tympanic segment. In the anterior section is at the level of the tympanic ring. In the posterior section is at the lever of bone canal. The entire epidermal matrix with the neotympanic membrane was lifted up and removed anteriorly (starting from the mastoid segment and further). The cochlear implant was settled intraperiosteally in the temporal region in a prepared bed. A bone groove was formed for the electrode to fix it from the bed to the entrance to mastoid atrium. The proximal part of the electrode was laid in the groove. The roof of the cochlear niche was smoothed with microbore. The membrane of the cochlear window became visible. The membrane of the cochlea window was opened with the microneedle. The tympanic duct of a basal coil of the cochlea became visible. The distal end of the electrode (the area of the electrode array) is passed through the posterior tympanostomy formed earlier (during the previous operation), then trough the cochlea window into the tympanic duct. The supralabyrinthine area is isolated from active electrode by autocartilage plate (the area of greatest destruction by the choleastomic process, identified during the previous operation). The active electrode in the tympanic atrium is covered by two fragments of autocartilage. Osteomatrrix plates are placed in the trepanation atrium, almost completely covering its volume. The posterior wall of the external ear canal was reconstructed with osteomatrix. Intraoperative monitoring of the cochlear implant was made: telemetry is within normal limits. Osteomatrix was covered by several fragments of autofascia and periosteal coverage. The neotympanic membrane and the separated matrix were laid into position on the formed posterior wall of the auditory meatus. The surgical wound is sutured in layers. The postoperative period is no abnormalities. The function of the facial nerve was not impared. A computed tomography (CT) of the temporal bones was made to the patient on the second day after the operation. The correct location of the electrode array in the cochlea can be visualized on CT (Fig. 3)

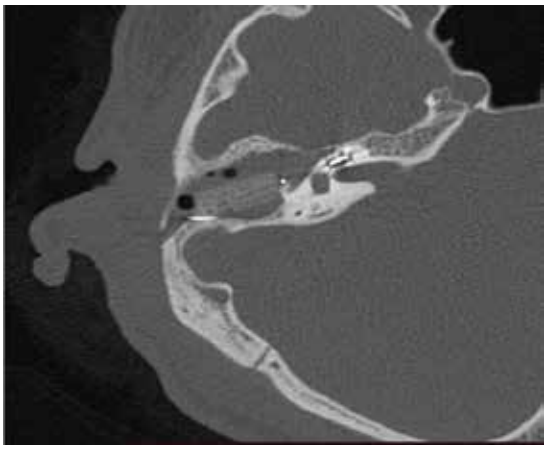


Fig. 4 CT of the right temporal bone after CI (axial scan) confirming the correct positioning of the electrode array in cochlea

Antibacterial therapy was executed during the postoperative period. Analgesics were used for pain. The patient was dismissed on the 7th day in satisfactory condition.

The speech processor Cochlear CP 910 adjustment on the right side was made to the patient at the FSBI «The National Medical Research Center for Otorhinolaryngology of the Federal Medico-Biological Agency of Russia» in the June 2022. The interelectrode resistance was normal on all electrodes. The patient began to hear sounds with the operated ear. Subsequently, the patient noted an improvement in intelligibility and audibility through a cochlear implant during staged adjustments.

Discussion

The main aim of the surgical treatment of the cholesteatoma of the petrous bone is its radical removal in which it is not always possible to improve the patient`s hearing ability due to the destructive consequences of cholesteatoma on the middle and inner ear structures. Surgical operation with hearing conservation can be used for circumscribed petrous bone cholesteatomas: supralabyrinthine and infralabyrinthine [2]. Analyzing the contributions of authors engaged in audio-verbal rehabilitation, cases of cochlear implantation (CI) in patients with the cholesteatoma of the petrous bone have not been previously described in the native literature.

Nowadays, CI is the only effective method of the rehabilitation for men suffering from high degree

sensorineural hearing loss and surdity. CI was quickly improved over the time after their initial implementation by W.House in 1972 [7].As a result, the indications for their use have broadened [8]. In the past, cochlear implantation was contraindicated for patients with CSOM (with or without cholesteatoma) due to the risk of intratemporal and intracranial accidents, tympanic membrane perforation, relapse of cholesteatoma and exposure of the active electrode of the cochlear implant passing in the mastoid atrium [9]. Nevertheless, Parnes et al. reported the first case of CI in a patient with chronic suppurative otitis media in 1993 [10] and Husseini et al. reported the first CI in a patient with supralabyrinthine cholesteatoma of the petrous bone in 2011 [11].

CI with supralabyrinthine cholesteatoma of the petrous bone can be executed simultaneously with sanation and in two stages. The authors' opinions on this issue still differ: some believe that two-stage surgery reduces the risk of meningitis and makes it possible to control the previous surgery, the so-called "second look" [12, 13], while others consider to perform CI, eradication of the cholesteatoma with subtotal petrosectomy in one stage [11].

The lack of information provided does not allow us to come to a consensus. More representations of clinical cases and studies highlighting this problem are needed.

Conclusion

CI can be an effective method of hearing rehabilitation in patients with petrous bone cholesteatoma, provided that the cochlea structures are preserved and after complete removal of the cholesteatoma. CI can be performed simultaneously with the eradication of cholesteatoma, or in two stages. To our best knowledge, this is the first Russian language report of cochlear implantation in a patient with petrous bone cholesteatoma.

References

1. Diab H.M., Mikhalevich A.E., Kuznetsov A.O., Pashchinina O.A., Hassan B., Bakaev A.A. Difficult Cases in Otosurgery. The Cholisteatomic Pyramid of The Temporal Bone. Moscow Surgical Journal. 2019;(3):40-54. (In Russ.)
2. Diab Kh.M., Paschinina O.A., Kondratchikov D.S., Panina O.S. Surgical treatment of the patients with petrous pyramid cholesteatoma (supralabyrinthine and supralabyrinthine-apical forms). Head and neck. Russian Journal. 2020;8(4):60–66 (In Russian).
3. Sanna M; Pandya Y; Mancini F; Sequino G; Piccirillo E. (2011). Petrous Bone Cholesteatoma: Classification, Management and Review of the Literature. Audiology and Neurotology, 16(2), 124–136. doi:10.1159/000315900
4. Moffat D., Jones S., Smith W. Petrous temporal bone cholesteatoma: a new classification and long-term surgical outcomes. Skull Base. 2008;18(2):10–15. doi: 10.1055/s-2007-991112.
5. Belal Jr A. Contraindications to cochlear implantation. Am J Otol 1986;7:172–5.
6. Catharine A. Hellingman; Erwin A. Dunnebier (2009). Cochlear implantation in patients with acute or chronic middle ear infectious disease: a review of the literature., 266(2), 171–176. doi:10.1007/s00405-008-0828-0
7. House WF. Goals of the cochlear implant. Laryngoscope 1974; 84:1883–7
8. Arístegui M, Denia A. Simultaneous cochlear implantation and translabyrinthine removal of vestibular schwannoma in an only hearing ear: report of two cases (neurofibromatosis type 2 and unilateral vestibular schwannoma). Otol Neurotol 2005;26: 205–10
9. Yoo, Myung Hoon; Park, Hong Ju; Yoon, Tae Hyun (2014). Management options for cochlear implantation in patients with chronic otitis media. American Journal of Otolaryngology, 35(6),703–707. doi:10.1016/j.amjoto.2014.08.001
10. Parnes LS, Gagne JP, Hassan R. Cochlear implants and otitis media: considerations in two cleft palate patients. J Otolaryngol 1993;22:345–8
11. Husseini, S T; Guida, M; Negri, M; Falcioni, M (2011). Bilateral cochlear implantation in a patient with petrous bone cholesteatoma in the only hearing ear: case report. The Journal of Laryngology & Otology, 125(12), 1272–1274. doi:10.1017/S0022215111002362
12. Donnelly MJ, Pyman BC, Clark GM. Chronic middle ear disease and cochlear implantation. Ann Otol Rhinol Laryngol Suppl 1995;166:406–8
13. Gray RF, Ray J, McFerran DJ. Further experience with fat graft obliteration of mastoid cavities for cochlear implants. J Laryngol Otol 1999;113:881–4

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