Otosclerosis During Pregnancy and The Postpartum Period

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37.1 Introduction

Otosclerosis is a human-specific otic capsule disease. First, in 1741, Valsalva, the Italian anatomist and surgeon, caught the attention of the lesion of otosclerosis in a deaf person's temporal dissection [1]. He observed that the ankylose of footplate occurred due to annular ligament ossification. In 1860, Toynbee first described stapes footplate ankyloses in his cadaveric studies [2]. Politzer, in 1894, described the otosclerotic temporal bone in the final stage of disease [3]. Siebenmann also first defined and used the term "otospongiosis" to show the active stage of disease [4].

Hearing loss due to otosclerosis is variable. It may cause usually a conductive hearing loss or a mixed conductive-sensorineural hearing loss and sometimes pure sensorineural hearing loss. The disease is bilateral in 70% of cases, and the hearing loss begins during the third decade of life. It occurs two times more often in women than in men [5]. The disease has a distinctly racial distinction. In blacks, the

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incidence of clinical otosclerosis is almost zero or rare in Asians and Native Americans. However, whites and mostly Caucasians have 10 times higher histological otosclerosis than clinical otosclerosis. The rate of histological otosclerosis is about 10% [6–9].

37.2 Etiology

Numerous studies have shown that there is a genetic inheritance. The chromosomal loci associated with otosclerosis have about nine possible genes: COL1A1, OTSC1, OTSC2, OTSC3, OTSC4, OTSC5, OTSC6, OTSC7, and OTSC8 [10–17] (Table 37.1). According to the literature review, the most possible theory about the genetic inheritance is the autosomal-dominant character with incomplete penetrance and variable expressivity [18].

Persistent measles virus infection has been blamed for years, and some studies support this theory [19–21]. In spite of vaccination of children in developed countries, otosclerosis is still common; however, in developing countries such as Africa, the prevalence of otosclerosis is very low and measles is highly endemic. Also, some endocrine factors have been researched, but there is no evidence to indicate that they play a role in the etiology of otosclerosis [22].

37.3 Histopathology

The most commonly involved area of the otic capsule is the area anterior to the oval window, fissula ante fenestram. The disease has early- and late-phase findings. The early phase is called otospongiotic phase. Multinuclear osteoclastic cells resorb the vessels around the normal lamellar bone of the otic capsule and perivascular spaces are formed. In the late phase, these spaces are replaced with a new bone by osteocytes, and this new bone takes up a larger space than before. In the following period, the new bone turns into lamellar bone, which is acellular and highly dense. Both active and inactive phases may act together at the same place [23].

The type of hearing loss depends on which part of the otic capsule is involved. The lesion begins from the anterior (most common) or posterior part of the oval

Table 37.1 Genetic studies associated with otosclerosis inheritance

Study	Year	Locus	Position
McKenna et al. [10]	1998	COL1A1	17q21.31–q21.32
Tomek et al. [11]	1998	OTSC1	15q25–q26
Van Den Bogaert et al. [12]	2001	OTSC2	7q34–q36
Chen et al. [13]	2002	OTSC3	6p21.3–22.3
Brownstein et al. [14]	2006	OTSC4	16q22.1–23.1
Van Den Bogaert et al. [15]	2004	OTSC5	3q22–24
Not published	–	OTSC6	–
Thys et al. [16]	2007	OTSC7	6q13–16.1
Bel Hadj Ali et al. [17]	2007	OTSC8	9p13.1–9q21

window around the margin of the stapes footplate and involves the anterior and posterior annular ligament so that it may result in stapedial fixation, thereby causing conductive hearing loss. Sometimes, otosclerosis may involve round window or other region in otic capsule and causes sensorineural hearing loss due to toxic fluids in the inner ear.

37.4 Symptoms, Signs, and Audiogram

Hearing loss is the most presenting symptom and usually begins in the 20s and progresses slowly. The disease is generally bilateral, and most of the patients have conductive hearing loss. Patients with otosclerosis hear well in noisy surroundings, and it is known as the Paracusis of Willis. Tinnitus and vertigo may accompany. Family history is frequent in most of the cases.

Otoscopic examination is quite normal and mobile. In some cases, a reddish spot may be seen, which is an active angiomatous otospongiotic focus reflection named as the Schwartze sign.

In tuning fork tests, with 512 Hz Weber test lateralizes to the ear with conductive or greater conductive (in bilateral cases) hearing loss and negative Rinne test with 256 Hz, later 512 Hz and 1026 Hz when the stapedial fixation is settled.

The immittance audiometry battery must consist of tympanometry, static compliance, and acoustic reflex testing. Tympanometry shows generally type A or later flattened curve As. Diphasic or absent stapedial reflex can be seen.

Pure tone audiometry shows loss of air conduction, more for lower frequencies when bone conduction is normal. Sometimes, there is an artificial depression in the bone conduction line centered on 2 kHz called Carhart's notch. After a successful stapes surgery, this notch disappears (Figs. 37.1, 37.2, 37.3, 37.4).

37.5 Otosclerosis and Pregnancy

Otosclerosis is more common in women than in men, and the ages of women getting the disease are their reproductive years. So, whether there is an endocrine factor or whether pregnancy is having any effects on the disease still remains unclear. In his study, Wakwick mentioned the role of pregnancy as the inhibition of the ovaries causing an increase in calcium metabolism. İnhibiting the ovaries made removal of the inhibiting effect of the ovarian secretion on the pituitary and thyroid glands, which, when not thus inhibited, normally cause an increase in the calcium content of the blood. He assumed that pituitary and thyroid glands had an active role in the process of deposition of calcium salts in various embryonic cartilaginous residues like labyrinthine capsule and in the footplate of the stapes in prepuberty [24]. Contrary to what is believed when the literature is reviewed from the past to present, it does not appear that pregnancy has a definite effect on reducing hearing in patients with otosclerosis. Because of the lack of successful surgical treatment prevention and later influenced by the popularity of eugenics, sterilization and abortion were the options to treat otosclerosis in pregnancy in the first half of the twentieth century [25].

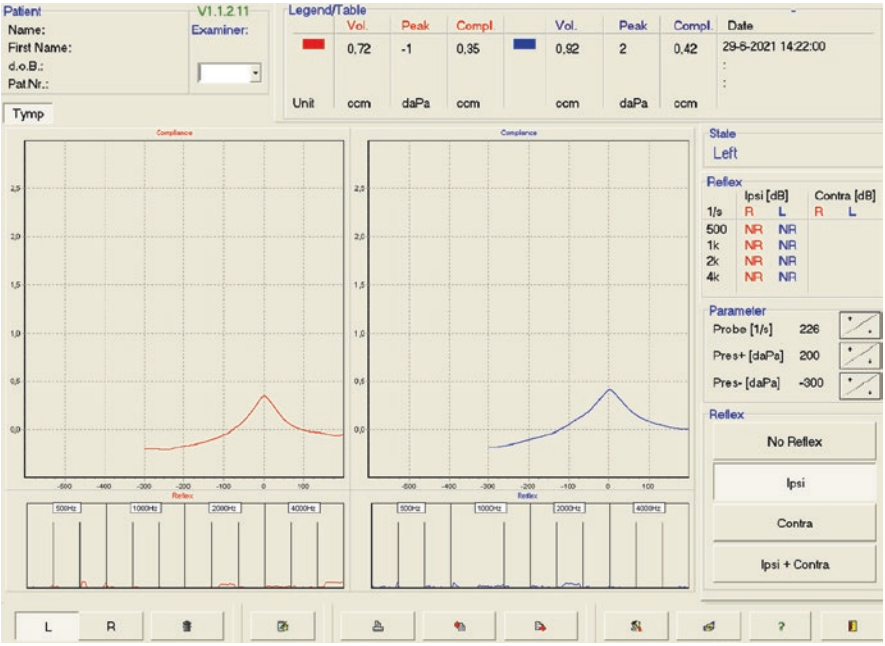

Fig. 37.1 Tympanometry shows generally type A. Acoustic reflex testing shows bilateral absent stapedial reflex

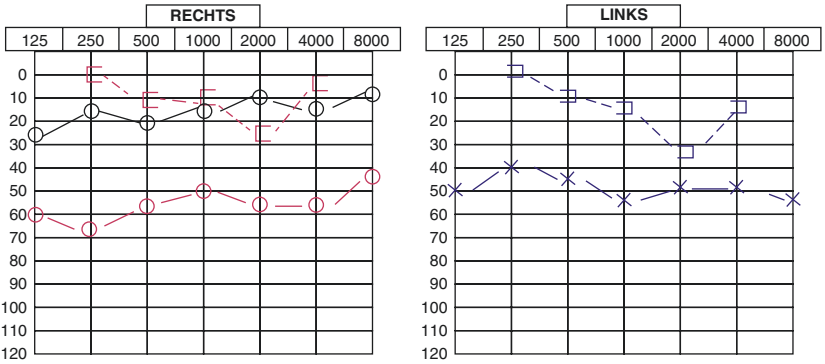

Fig. 37.2 Blue: conductive hearing loss in the left ear with Carhart's notch on 2 kHz in the bone conduction line. Red: conductive hearing loss on the right side with Carhart's notch: preoperative measurement. Black: 3 months after successful stapes surgery, the "artificial" Carhart's notch disappears

In the nineteenth century, eugenic science and social movement were quite fashionable. It was accepted that eugenic sterilization or abortion was the solution for genetic disorders that had inheritance for the following generation. In 1918, Arturo Blohmke did a survey of different German clinics to find out whether pregnancy had a negative effect on hearing and whether it ending of pregnancy was indicated or not [26].

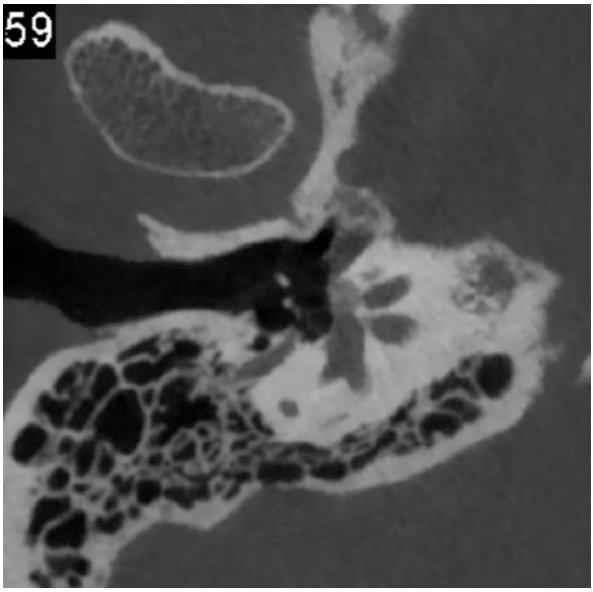

Fig. 37.3 Cone beam CT scan of the right ear. Oblique reconstruction: fenestral otosclerosis with stapedial fixation; hypodensity in contact with the ottic capsule

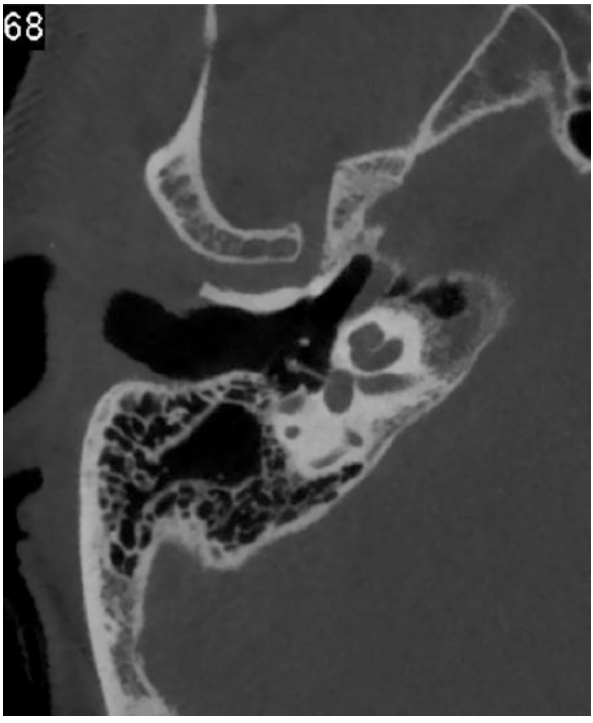

Fig. 37.4 Cone beam CT scan of the right ear. Oblique reconstruction: Teflon piston centered in oval window

The answers to this survey were many case reports on hearing loss and severe tinnitus due to pregnancy. Some abortions were done to stop hearing loss. Guggenheim stated that over 50% of otosclerotic women had hearing loss following childbirth and during the latter half of pregnancy [27]. In Germany, in 1933, there was a sterilization law written by Ernst Rüdin, the president of the International Federation of Eugenics Societies, named in English as the "Law on the prevention of offspring with hereditary diseases," that had been modeled before in 1922 in the United States by Laughlin [28, 29]. During the Nazi regime, it was assumed that there were hundreds or thousands of pregnant women who were treated by sterilization and/or abortion. After about 10 years later, the abortion or sterilization treatment argument for the otosclerotic women began to change. In 1945, Allen reported in an article that he collected the cases from the literature and personal communication and analyzed the data on their age, family history about deafness, and obstetric history. He concluded that if a therapeutic abortion was decided the patient had to be informed that this disease is progressive even without pregnancy and the patient would have to learn lip reading and need to wear hearing aids [30]. In 1948, Smith reported in a study that he collected 73 cases. The data for each patient were the age at the time of examination; the age at the onset of symptoms; the presence or absence of a history of familial deafness; the number of term pregnancies; the number of incomplete gestations; and whether the deafness was associated with, or increased by, pregnancy, or was not associated with, or increased by, pregnancy. He found that 37% (28 women) of deafness was associated with, or increased by, pregnancy, but 63% women reported that pregnancy had no effect on their hearing loss. The average age of the patients at the time deafness was first noted was 25 [31]. Till the 1950s, all studies were based on patients' discourses. Walsh had reviewed 243 consecutive cases that had otosclerosis with pregnancy history, of which 139 described no effect but 104 (43%) stated having worse hearing in pregnancy. He needed more reliable information about the subject, meaning audiogram. In 1954, Walsh found great worsening hearing thresholds in two operated patients and 7 of 40 patients' hearing loss progressed in the unoperated ear after pregnancy in 3–5 years verified with audiograms. Hence, he concluded this situation to be the nature of the disease [32]. A survey by Goethals at Mayo Clinic was also remarkable. He found that 211 of 375 patients (56.2%) had loss of hearing initiated or increased by pregnancy. In total, 158 of 211 patients' hearing loss were at the initiation or during pregnancy (42.1%). Of these, the first pregnancy experience number was 106, the second was 35, and the third was 17. The number of patients having hearing loss prior to gestation and increased by pregnancy was 53 (14.1%). Of these, 35 patients had the first gestation experience, whereas the remaining 18 patients had second pregnancy and 8 had association with it [33]. There were no audiograms done.

Podoshin et al. reported oral contraceptives (OC) and otosclerosis communication. They reviewed 600 women between the ages 16 and 30 using OCs during 12–36 months. There were three cases pointing to otosclerosis with pathological audiometry after excluding the other ear disease. They did not find a correlation between the chemical composition of the OC, age of the women, duration of OC use, and clinical otosclerosis [34]. In 1983, Gristwood and Venables' studied 362 female patients with otosclerosis who had at least one pregnancy, according to the

Table 37.2 Studies on hearing loss in pregnancy

Author	Year	Hearing loss	
		Cases	%
Allen [30]	1945	72	48
Smith [31]	1948	73	37
Walsh [32]	1954	243	43
Goethals [33]	1960	375	56.2
Gristwood [35]	1983	362	43.3

laterality of conductive deafness and its aggravation by pregnancy. This was also a study done without using audiograms. They found that at least one pregnancy caused 33% hearing impairment in bilateral cases, reaching up to 63% after the sixth pregnancy [35]. All these studies had poor strength of evidence, and most did not include appropriate control groups or were without statistical analyses. Lippy's study in 2005 was a milestone on this topic. It included 94 patients and two groups as having children or not. Due to the fact that some cases were bilateral, a total of 128 ears were investigated. All the patients underwent stapedectomy. Women with children were paired with each other according to their ages with childless women, and their preoperative and postoperative tests were compared. They found no deleterious effect of pregnancy on otosclerosis [36]. Like Lippy's findings, Marchese et al. obtained similar findings [37]. Qian's study is the most recent study done on this topic. Qian's hypothesis states that if pregnancy progresses the hearing loss and then gender affect the relationship between the number of children and age of stapedectomy. They found that the age at initial stapedectomy was significantly lower in females than males, women with children than childless women, and males with children than childless males. They concluded that the initial stapedectomy age is getting younger with parenthood [38].

In conclusion, the negative effect of pregnancy on hearing loss in patients with otosclerosis was supported in the nineteenth and twentieth centuries with political reasons and by some studies that had low-level evidence. In the twenty-first century, this hypothesis seems to have expired. Studies with a large-size cohort and statistical analyses and high-level evidence show that pregnancy has no negative effect on hearing loss in patients with otosclerosis. So, further prospective studies need to be done (Table 37.2).

37.6 Treatment

Medical curative treatment of otosclerosis is not possible today. Sodium fluoride and bisphosphonates have been used for this purpose. Studies on treatment using sodium fluoride showed that it slows down the progression of sensorineural hearing loss by neutralization of enzymes that have a toxic effect on hair cells. It does not make any change such as converting an active spongiotic focus to an inactive focus [39]. Because of its teratogenic adverse condition, it is contraindicated in pregnancy. Although the mechanism is unknown and controversies exist in

bisphosphonate therapy, the current prospective randomized studies have found safety for the proper management of this therapy in cases of otosclerosis [40].

Surgical treatments of otosclerosis include stapedotomy or stapedectomy. Patient choice is important. Air conduction hearing threshold should be 30 dB or worse. Average air–bone gap should be at least 15 dB with Rinne test and negative for 256 and 512 Hz. Speech discrimination score should be 60% or more. Although it is a low risk, the patient must be informed about total sensorineural hearing loss and also other complications such as vertigo, facial paralysis, tinnitus, taste disturbance, tympanic membrane perforation, and perilymph fistula.

Stapedectomy was first described by Shea and House. In the Shea technique, total stapedectomy is performed and oval window is covered with a vein graft and interposition of a polyethylene strut [41]. Similarly, in the House technique, after a total stapedectomy is performed a gel foam and steel wire prosthesis are replaced [42]. More recently, stapedotomy has become common. This procedure includes only a small fenestra in the footplate [43–45]. Stapedotomy technique shows slightly better results in early and late postoperative air conduction thresholds at 4 kHz than stapedectomy [46].

37.6.1 Steps of Stapedotomy

1. Local anesthesia of four quadrants of external ear.
2. Incision and elevation of tympanomeatal flap.
3. Exposure of stapedial area. If there is a posterosuperior bony overhang canal, it must be removed (Fig. 37.5).
4. Ossicular chain palpation.
5. Making a small fenestration hole in the footplate (Fig. 37.6).
6. Incision of stapedial tendon.
7. Removal of the suprastructure.
8. Replacing the titanium, Teflon, or nitinol piston prosthesis (Fig. 37.7).
9. Supporting the footplate hole small amount of blood.
10. Replacing the tympanomeatal flap.

Since stapedotomy is more preferred, some other techniques have been developed. Classical operation has been performed under local anesthesia and microscopy for years, and although it is still performed, mostly authors prefer general anesthesia and endoscopic stapes surgery. Current studies support that endoscopic stapes surgery is a good alternative technique compared to microscopic ones in regard to operating time, chorda tympani nerve injury, and postoperative audiological results [47–49].

To make a small fenestration, a vehicle-like microdrill, fine pick, or laser use is needed. Generally, two types of laser are used: visible green light lasers such as the argon or potassium-titanyl-phosphate (KTP-532) and infrared carbon dioxide (CO_2) lasers [5]. Perkins first described argon laser as multiple small vaporized holes forming a rosette in the footplate [50]. When KTP laser can be carried through the

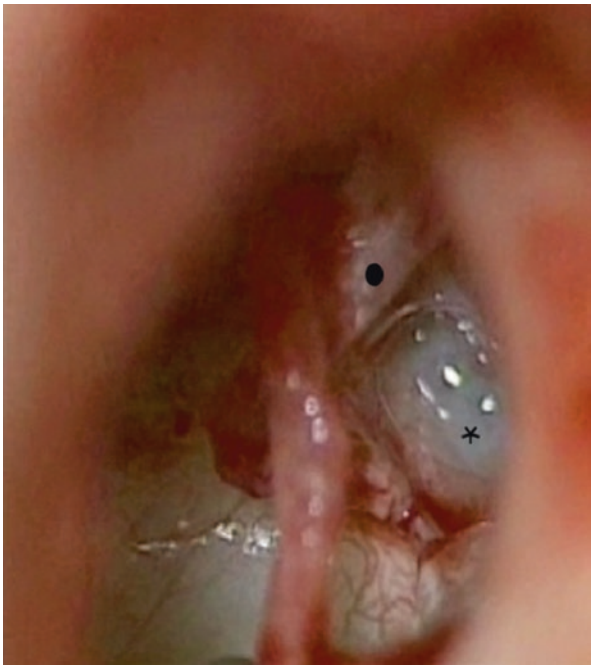

Fig. 37.5 Stapes footplate with otosclerosis (star). Circle shows the incus

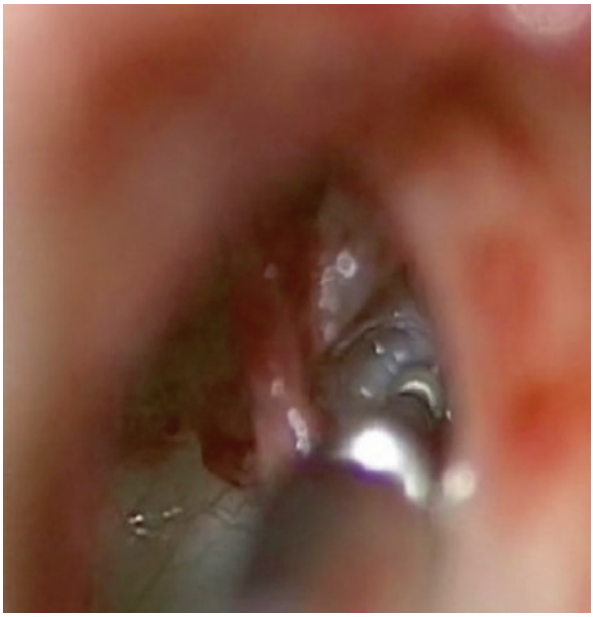

Fig. 37.6 Drilling the footplate

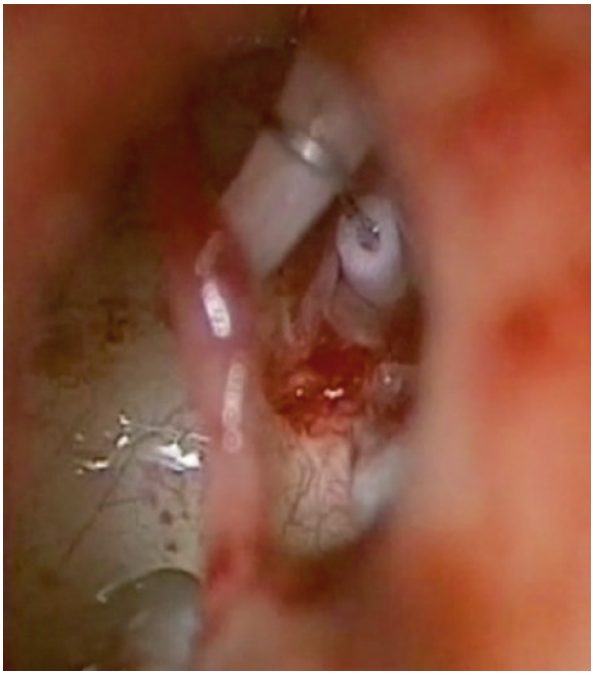

Fig. 37.7 Replacement of titanium prosthesis

fiber optic cables, CO_2 laser needs mirrors and lenses. Lesinski and Palmer [51] published CO_2 laser system that could be used for stapes surgery. Both lasers seem to be safe, but Vincent et al. reported in their study that postoperative air–bone gap closure within 10 dB was more effective in CO_2 laser than KTP laser [52]. Another alternative method for fenestration is micro drill technique. The latest meta-analysis study shows that there is no clinical or statistically significant difference between the use of drills or lasers in regard to postoperative hearing outcomes [53].

37.7 Hearing Aids

Hearing aids as always can be used in patients with conduction hearing loss due to otosclerosis. In patients not willing to be operated or having failed stapes surgery and in cochlear otosclerosis causing sensorineural hearing loss, hearing aids are quite an effective alternative option.

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