Conventional behind-the-ear hearing aids after subtotal petrosectomy with blind sac closure

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OBJECTIVE: **To overcome the limitations of monaural hearing resulting from a subtotal petrosectomy and blind sac closure by fitting of a behind-the-ear hearing aid.**

STUDY DESIGN: **Three patients were fitted with aids. Patient satisfaction and the decision to buy the aids were recorded.**

RESULTS: **Three patients reported good hearing result despite the absence of the middle ear structures.**

CONCLUSION: **For patients troubled by the limitations imposed on hearing with a unilateral conductive loss following a subtotal petrosectomy and blind sac closure, a behind-the-ear aid is a simple and easy option to try, if the residual canal allows fitting of the aid.** (Otolaryngol Head Neck Surg 2004;131:926-9.)

Subtotal petrosectomy with blind sac closure is a complete exenteration of all air cell tracts lateral to the otic capsule.[1] The cochleovestibular function remains intact. The ear canal, tympanic membrane, and the ossicles are removed, leaving only the stapes footplate intact. The eustachian tube is obliterated. The ear canal is closed as a short blind sac. The space between this "blind sac" and the otic capsule is packed with abdominal wall fat, resulting in a maximal conductive hearing loss of approximately 60 decibels. This procedure is often carried out as part of a lateral skull base procedure for tumor removal.

The limitations of monaural hearing have been well documented in the literature.[2] These patients are unable to localize sounds and have difficulties in groups, especially in background noise.

A bone conduction hearing aid was the option considered for a conductive hearing loss in the absence of middle ear structures and/or an ear canal.[3] These hearing aids are very effective in improving hearing capabilities, but their cosmetic appearance and discomfort due to pressure on the skull are not always acceptable to patients. Bone-anchored hearing aids (BAHA) were not yet available in Australia at the time of seeing these patients.

Three patients with monaural hearing difficulties had declined a bone conduction hearing aid because of the poor cosmetic appearance and a conventional behind the ear hearing aid was tried. This consideration was based on previous experiences with "transcranial CROS" (fitting of a power hearing aid in the "dead ear") in patients with unilateral profound sensorineural hearing loss.[3] This was found to improve patient's auditory capabilities through sound transmission from the non-hearing ear across the skull to the contralateral intact inner ear.

CASES

Patient 1 was a 40-year-old woman who had a paraganglioma of the right jugular foramen removed via a subtotal petrosectomy, blind sac closure of the ear canal, and anterior transposition of the facial nerve. She was referred 15 months postoperatively to the audiology clinic because her monaural hearing was affecting her work and social life.

Patient 2 was a 59-year-old man who had a left vagal paraglanglioma extending into the jugular foramen removed via a subtotal petrosectomy, blind sac closure of the ear canal, and anterior transposition of the facial nerve. He presented to the audiology clinic 18 months later troubled by his monaural hearing.

Patient 3 was a 40-year-old woman who had a solitary fibrous tumor of the meninges in the floor of the right middle cranial fossa removed by a subtotal petrosectomy and blind sac closure, combined with an orbito-zygomatic approach. She was referred to the audiology clinic 6 months after the operation with hearing difficulties.

Figs 1 to 3 show the postoperative audiograms of patients 1 to 3 respectively.

METHOD OF HEARING AID FITTING

For each patient an impression of the residual ear canal was taken and a shell style ear mould was made of Medisil (flexible nonallergenic material) with standard tubing and no vent. A digital power behind the ear hearing aid was selected with a 2-cc coupler frequency/

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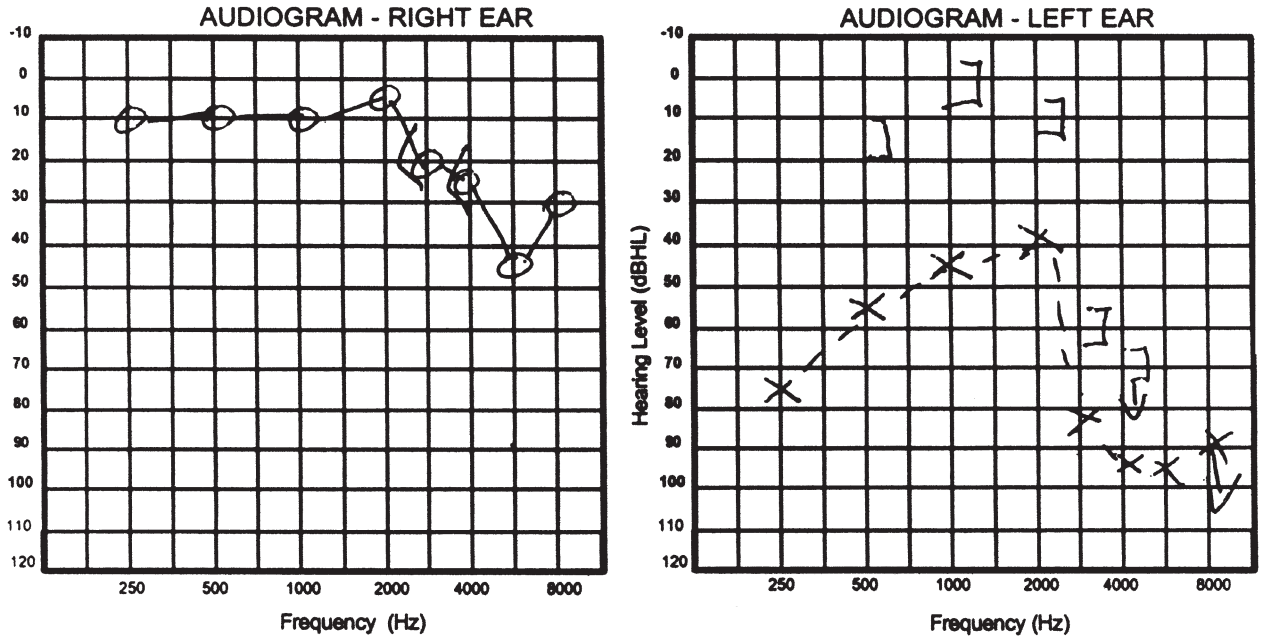

Fig 1. Postoperative audiogram of patient 1.

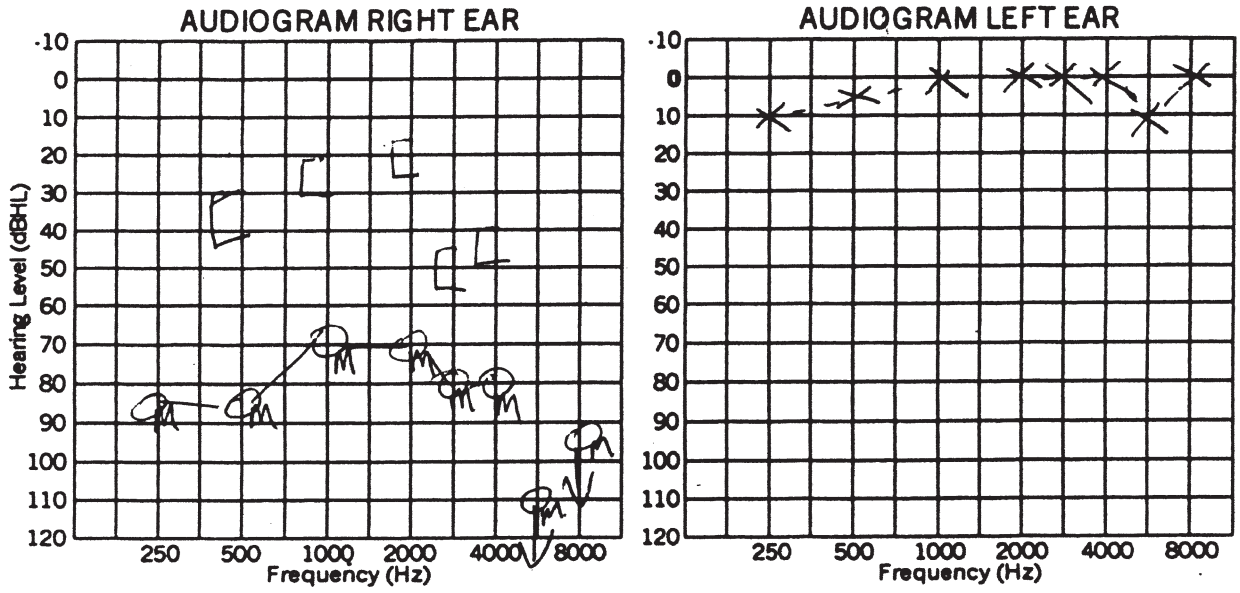

Fig 2. Postoperative audiogram of patient 2.

gain response to match the NAL (1986) prescriptive formula.[3]

Aided audiogram was performed to verify the real ear responses with a view to closely match the NAL-aided response target. This was carried out in free-field with the hearing aid set at preferred volume in one ear and an earplug on the opposite ear as suggested by Valente et al.[4] However, a precise aided response could not be obtained as the ear plug would not provide sufficient attenuation to isolate the good ear, especially in the lower frequencies (Table 1). It remains, therefore, uncertain if the prescribed gain and frequency response used were the optimum for these cases.

Acoustic feedback (hearing aid whistle) was the main concern when attempting these fittings. It usually occurs as amplified high frequency sound leaks from

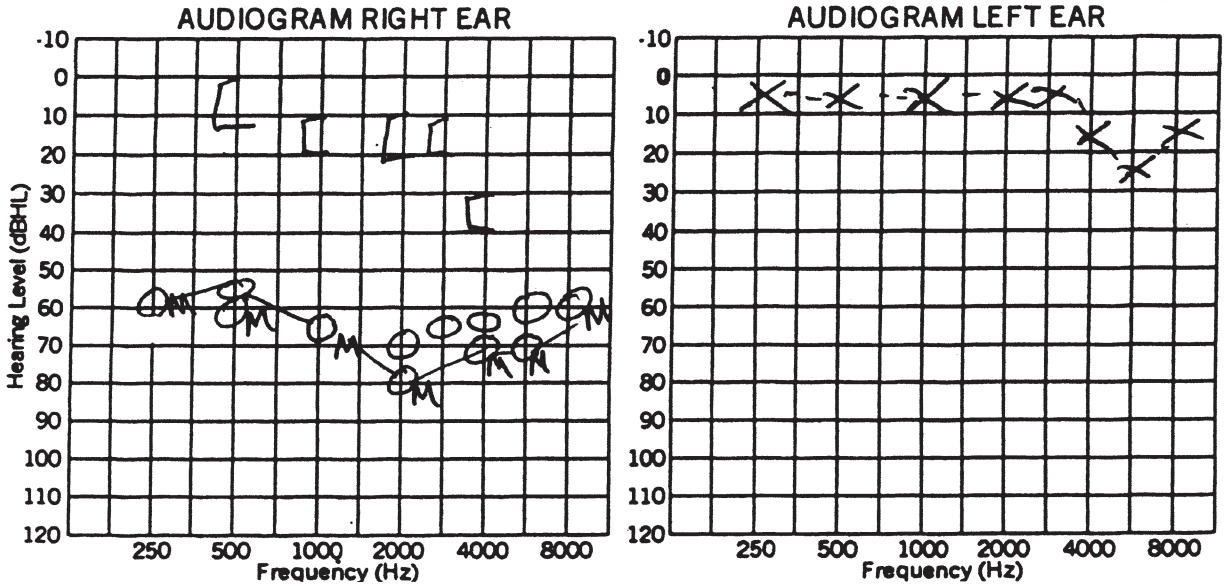

Fig 3. Postoperative audiogram of patient 3.

Table 1. Attenuation by plug used during aided audiogram

250 Hz	500 Hz	1000 Hz	2000 Hz	3000 Hz	4000 Hz	6000 Hz	8000 Hz
5 dB	5 dB	10 dB	20 dB	25 dB	50 dB	45 dB	45 dB

the ear mould.[3] In all cases, however, the Medisil moulds provided a very good seal of the residual ear canal and feedback did not prove to be a significant problem.

OUTCOMES

All three patients noticed an improvement in their hearing with the hearing aids, which was confirmed by the free field-aided audiograms that showed improved thresholds (Tables 2-4). The results with the hearing aid were very satisfactory for patients 1 and 2. After a trial period of 4 weeks, both decided to purchase them. At an 8-week follow-up visit both patients reported wearing the hearing aids all day. They claimed a significant improvement in sound localization, speech understanding in group, and background noise situations.

The third patient also reported great satisfaction with the improved localization of sounds and ability to hear in background noise situation. However, 2 days after the fitting the patient reported a severe episode of vertigo that she attributed to the use of the hearing aid and decided not to wear it again.

DISCUSSION

It has been the senior author's (P.F.) surgical aim over the years to make the "blind sac" as shallow as possible. In the 3 cases described, the sac was a little deeper than planned, serendipitously allowing the fitting of a hearing aid.

All 3 patients reported that the behind-the-ear aid improved their monaural hearing disability. Patient 2 wears the hearing aid on a daily basis but reports a brief episode of vertigo every time she inserts the mould in the remaining ear canal. She also reports "tightness" on the facial muscle while wearing the hearing aid but these occurrences do not prevent her from wearing the hearing aid. Patient 1 did not report any vestibular or facial symptoms associated with the hearing aid usage. Patient 3 declined further trial of the hearing aid following a vertiginous episode that she attributed to wearing the device and so it remains unknown whether this was related or not.

Audiological improvement in the free field was seen in the aided audiograms. Sound localization and the ability to hear in the presence of background noise were noticed and reported subjectively by the patients. More study is necessary to develop appropriate verification methods to establish the objective results of such fittings and to establish a prescription gain/frequency responses formula to fit hearing aids in this population.

Table 2. Aided audiogram of patient 1

Patient 1	250 Hz	500 Hz	1000 Hz	2000 Hz	3000 Hz	4000 Hz	6000 Hz
Left-aided thresholds with plug in the right ear	25 dBHL*	25 dBHL*	20 dBHL*	15 dBHL	35 dBHL	45 dBHL	60 dBHL
NAL-aided target	53 dBHL	38 dBHL	21 dBHL	15 dBHL	38 dBHL	45 dBHL	54 dBHL

*Responses likely to be from the right ear.

Table 3. Aided audiogram of patient 2

Patient 2	250 Hz	500 Hz	1000 Hz	2000 Hz	3000 Hz	4000 Hz	6000 Hz
Right-aided thresholds with plug in left ear	20 dBHL*	25 dBHL*	30 dBHL	30 dBHL	25 dBHL	25 dBHL	N/A
NAL-aided target	53 dBHL	41 dBHL	31 dBHL	28 dBHL	27 dBHL	27 dBHL	N/A

*Responses likely to be from the left ear.

Table 4. Aided audiogram of patient 3

Patient 3	250 Hz	500 Hz	1000 Hz	2000 Hz	3000 Hz	4000 Hz	6000 Hz
Right-aided thresholds with plug I the left ear	15 dBHL*	15 dBHL*	15 dBHL*	30 dBHL	25 dBHL	25 dBHL	30 dBHL
NAL-aided target	39 dBHL	35 dBHL	32 dBHL	32 dBHL	21 dBHL	21 dBHL	26 dBHL

*Responses likely to be from the left ear.

Many patients with a conductive unilateral hearing loss after a subtotal petrosectomy with blind sac closure adapt to monaural hearing and cope well. However, some do find it a significant disability that can cause problems at work and in social situations. A search of the literature shows that the bone-anchored and bone-conducting hearing aids have been tried in circumstances of a unilateral conductive hearing loss with some success.[5,6] However, we did not find any mention of fitting patients with an absence of an ear canal with a conventional hearing aid in the affected ear. A conventional behind-the-ear aid is better tolerated than a bone-conducting aid and is easier to fit than a bone-anchored aid. The mechanism of audiological improvement may be via transmission through the soft tissue to the stapes footplate or to the inner ear. For patients troubled by the limitations imposed on hearing with a unilateral conductive loss after a subtotal petrosectomy and blind sac closure, a behind-the-ear aid is a simple and easy option to trial.

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