

BONE-CONDUCTION HEARING AIDS

Introduction

Conventional hearing aids fit in the ear canal and amplify sounds, which the hearing aid user then hears in the normal way. However, these hearing aids are not suitable for everyone with a hearing loss. Some people cannot wear such aids or earmoulds in the ear canal because they have continual infections or eczema, or because part or all of their ear or ear canal is missing. Bone conduction hearing aids offer a solution for them.

Additionally, some people who have a conductive hearing loss – an obstruction in their outer or middle ear – may hear better if sounds pass directly through their skull to the cochlea by bone conduction, avoiding the outer and middle ear.

Hearing by bone conduction

In normal hearing, sound passes along our ear canal to the eardrum making it vibrate. These vibrations are passed to three small bones in the middle ear, the ossicles, a process called *air conduction*. These in turn pass the vibrations across the oval window to the cochlea and the fluid it contains. Movement in this fluid bends the tiny hair cells along the length

of the cochlea, generating signals in the auditory nerve. The nerve signals pass to the brain, which interprets them as sound.

A conventional hearing aid makes sounds louder and delivers them to the ear canal. The earmould or aid generally fits the ear canal very closely, so that only sound from the aid enters the ear. These amplified sounds are then heard through air conduction, in the normal way.

Figure 1: Cross-section of the ear

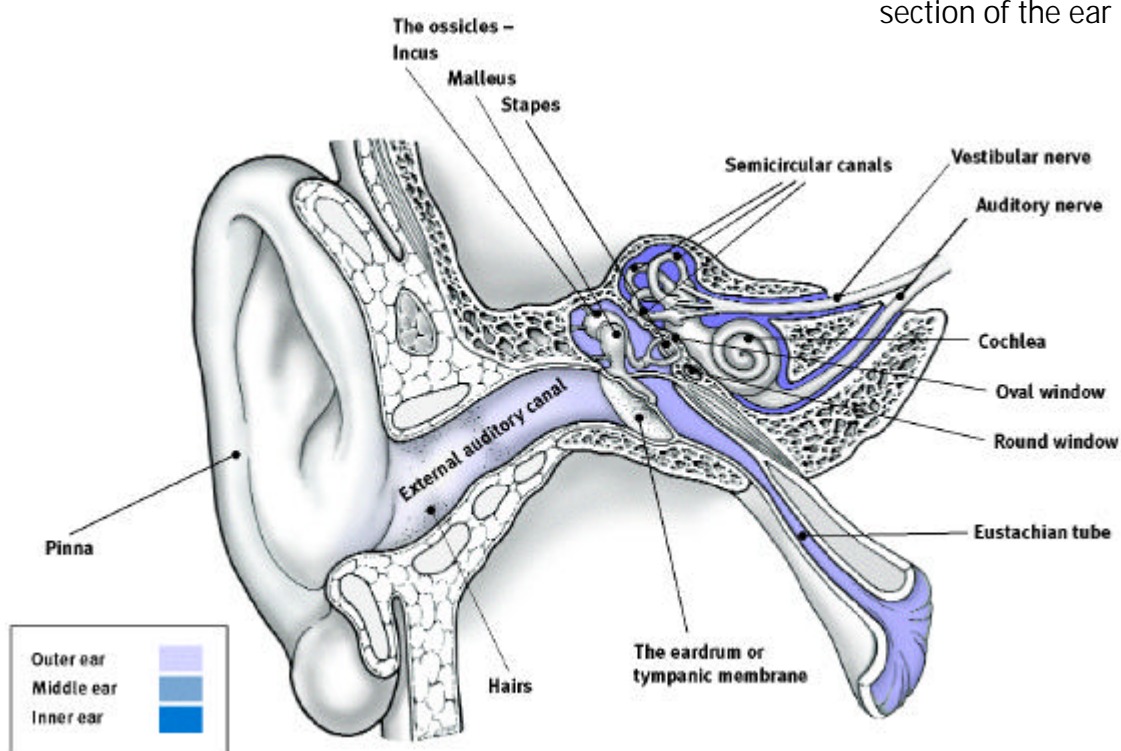


Diagram: Gillian Lee

You hear sounds by *bone conduction* when sound vibrations are transmitted directly from your skull and jaw bones to the cochlea, missing out your outer and middle ears. People always hear some sound – especially their own voices – in this way. If you ever wear earplugs, you will notice that your own voice still sounds fairly loud, because you hear it through bone conduction. Hearing through bone conduction is not as efficient as through air conduction but it is a possibility for people who cannot hear through air conduction.

Bone-conduction hearing aids

There are two main types of bone-conduction hearing aid: the traditional type and the implanted Bone-Anchored Hearing Aid (BAHA).

Traditional bone-conduction hearing aids

Traditional bone-conduction hearing aids transmit sound to your ear through a vibrating pad placed on your head just behind the ear. Usually you wear a headband to keep the pad in place. Sometimes, the bone-conduction aid can be fitted inside a pair of spectacles. The vibrating pad must be held tightly to your head, so these aids are generally uncomfortable to wear. People get headaches and skin soreness because of the pressure from the vibrating pad. An additional problem is that the sound people hear with these devices is often distorted. They also tend to use up batteries quickly, and may be difficult to wear as they can slip.

Bone-anchored hearing aids

An alternative to traditional bone-conduction aids is an implanted Bone-Anchored Hearing Aid (BAHA). A BAHA consists of a small titanium fixture (implant) which is inserted into your skull in the mastoid bone, just behind your ear. The fixture is made of a special material so that the bone bonds with it in two to three months and it becomes securely attached. A small screw (called a 'percutaneous abutment') is connected to this fixture through your skin.

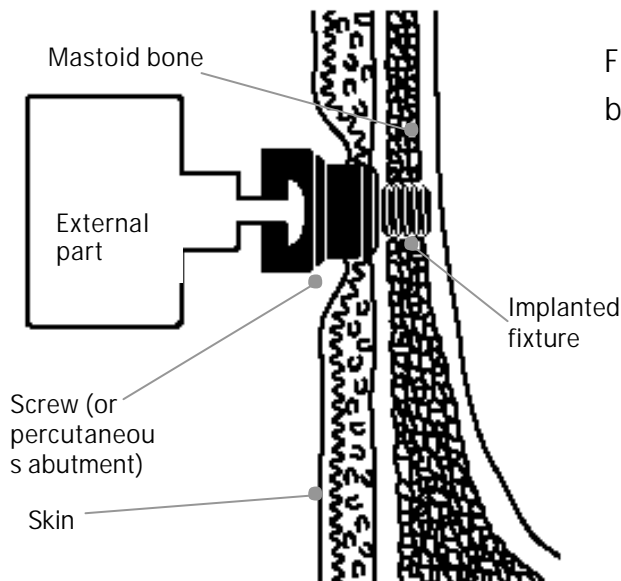


Figure 2: Cross-section of a bone-anchored hearing aid

The external part of the BAHA contains a microphone, battery and processor, and is attached to the screw. If you have a severe hearing loss, you will use the device with a body-worn amplifier, a small box that you wear on a belt or in a pocket. It is connected by leads to the external unit at your head. Sound vibrations are transmitted directly through the screw to your bone and from there to the cochlea. The sound is transmitted more efficiently through a BAHA, and research has shown that people using one hear more clearly than with a traditional bone-conduction aid. In addition to the improved sound quality, BAHAs are less visible, use fewer batteries, and are securely attached.

People using them report fewer ear-canal infections or soreness and very little feedback (whistling or squeaking) from the BAHA compared with a conventional air-conduction hearing aid. However, the BAHA may not be able to provide as much power or such a high sound quality as an ordinary air-conduction hearing aid. An air-conduction aid is therefore always the better option if possible. People who have used an air-conduction hearing aid previously may find that the sound quality and volume are quite different with the BAHA, and this may take some time to get used to.

BAHA implantation

The operation to implant a BAHA is normally carried out in two stages and you may have either a local or a general anaesthetic. Each stage is a minor operation that takes about an hour at most.

First, a small titanium fixture about 3-4mm long is placed in the bone directly behind your ear. The consultant will usually pick the side where you have better hearing, though other factors may affect the decision. For example, if your hearing is similar in both ears and you drive a lot, it may be better to choose your left (passenger-side) ear. Alternatively, it may be better to choose the ear you usually use for the telephone.

The second stage takes place three or four months after the first operation, when the fixture should have bonded with your bone. The titanium screw is attached to the fixture through your skin. For a few weeks, the part of your head that has been operated on will have to be kept clean to reduce the risk of infection.

Sometimes the whole of the operation can be done at once.

About a month after the second operation – or longer if the whole of the operation was done at once – you will get the sound processor. You'll be shown how to attach and remove the processor and use all the controls. The clinic will also explain how to clean the area around the screw. This daily cleaning is very important and reduces the risks of infection.

Extras

Accessories and features may be available with some BAHAs. These include a directional microphone, an extra microphone for your other ear, direct audio input and a telecoil with a 'T' switch so that you can use induction loops. Processors are available in different colours.

Who might benefit from a BAHA?

Only those people most likely to benefit receive a BAHA. You must have one of the following:

- A malformation of the middle, outer or external parts of your ear.
- Chronic infection or inflammation of your ear, so that you cannot use an ordinary air-conduction hearing aid.
- Conductive hearing loss in both ears that neither an operation nor ordinary hearing aids would help.

The sound level at which you begin to hear using bone conduction must be better than or equal to 45dBHL, or 60dBHL for the body-worn BAHA (in tests at an average of 0.5, 1, 2 and 3 kHz). You must also be able to understand 60% or more of speech on a standard test. These were the levels in August 2000 but they may change.

You must be able to look after the part of your head where the screw is and keep it clean, either on your own or with help from other people. You must also be happy to use the device and realise that though it will help you, it will not give you perfect hearing. For example, if you have continual ear infections you are likely to notice they improve, but the sound quality you hear through a BAHA is unlikely to be better than with an ordinary air-conduction hearing aid. However, someone who previously used a traditional bone-conduction hearing aid should find that a BAHA is much more comfortable and gives them much better sound.

In another test used to decide who would benefit from a BAHA you may be asked to bite on to a test rod attached to a BAHA sound processor. If the sound you hear when you do this is useful, a BAHA is likely to work if you have the screw implanted in your skull, because sound conducts better through your skull than through your teeth.

Some bone diseases may mean that a BAHA is not an option for you.

Long term use

Researchers contacted the first 100 people to get a BAHA after they had been using the BAHA for between eight and 16 years. Most of the BAHAs – 90% – were stable and working well. In 5% of cases, people had had the implant removed because they had received a direct knock to their head. In the final 5%, the implant had come loose from the bone, though only after many years of use. To date, more than 7,000 people have received a BAHA. With better surgical techniques and knowledge about who should benefit from BAHAs, success rates are likely to be higher now.

Some people have small problems with their BAHA, such as the skin around the device being sore or infected. This is fairly common and happens to about a quarter of people with a BAHA, but can be easily treated and even avoided by careful cleaning.

BAHAs for children

Children as young as 18 months have received a BAHA. They are more likely to dislodge the fixture as they have thinner bone and a more active life than adults do, so some surgeons routinely implant two fixtures for children, making a spare available in case one fails. A new screw can then be inserted into the spare fixture.

Bilateral BAHAs

Preliminary research from both adults and children with the same bone-conduction thresholds in each ear, suggests that using a BAHA in each ear can improve your overall sound sensitivity and help you locate where sounds are coming from. However, it is not likely that people will receive two BAHAs as a matter of course until more evidence is available.

How to get a bone-conduction hearing aid

BAHAs are available free on the NHS throughout the UK to people if they're suitable for them. Your GP or ENT department should be able to refer you to the hospital nearest to where you live that implants BAHAs.

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