A bone anchored hearing aid – what is that?
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©BATOD Magazine May 98 page 14-15

This article was written to help demystify the Bone Anchored Hearing Aid (BAHA).

Firstly, what it isn’t. It’s not:

- a hearing aid attached to a headband
- a relation of the cochlear implant
- a new experimental device which has yet to be proven effective
- a ‘Frankenstein’ type device attaching a hearing aid to the skull using nuts and bolts!

The concept behind the BAHA was discovered accidentally back in 1952 by a Swedish scientist Dr Per-Ingvar Branemark. He had inserted tiny Titanium cameras into animals in order to measure their blood flow. When he came to remove the cameras he found that living bone had grown around the Titanium holding the cameras securely in place. Instead of ignoring this discovery he set about finding an application for it, the process became known as osseointegration.

The first application was in the dental profession to secure dental prostheses to the jaw. This proved to be highly successful. Since these early beginnings, osseointegration applications continued to develop and now include a range of facial prostheses, securing of wigs and the BAHA. Future developments are likely to include fixation of digits and limbs (exciting times ahead).

The BAHA and its application for hearing-impaired children?

The BAHA is made up of four main components, titanium fixture (screw), abutment, insert and the hearing aid. The fixture and abutment are fitted, behind the ear, in two separate minor operations. A gap of three months is left between the operations to allow osseointegration to take place. The operation presents no risks other than those associated with a general anaesthetic (this procedure is done in one stage and under local anaesthetic in adults). The insert has two functions, firstly, it is the means by which the hearing aid connects to the abutment and subsequently it needs changing every six months to maintain a good connection. Secondly, by being removable it acts as a safety mechanism to protect the insert from trauma.

The insert and hearing aid are fitted approximately one month after the second stage operation. The hearing aid itself has most of the adjustments /accessories found on conventional hearing aids eg radio aid connection, loop system connection, frequency control etc. Cleaning of the skin surrounding the abutment is very simple but very important to prevent infection. It should be done, on a daily basis, by wiping around the abutment with a cotton bud dipped in tap water.

To summarise then, the BAHA is a hearing aid that amplifies using direct bone conduction, thus bypassing the outer/middle ear to stimulate the cochlea.

So who may benefit from the BAHA?

The BAHA is beneficial to patients with a permanent conductive/mixed hearing loss whose average bone conduction thresholds (average of 0.5 – 4KHz ) are better than 45dB for the ear level device, or 60dB for the body worn device. These patients can be split into two main groups:

- congenitally malformed/absent ears – this can include malformation of some or all of the outer and middle ear structures. This may be syndromal eg Treacher Collins or Goldenhars syndrome, or non syndromal.
- ear infection or skin irritation – this may be recurrent outer or middle ear infections or skin irritation due to ear mould allergy etc. This group includes problems often encountered with Down syndrome and therefore may offer a good habilitation option for some of these children.
Advantages
Most of these children will already be aided with conventional air or bone conduction hearing aids, so what benefits may be gained by having a BAHA and are the benefits sufficient to warrant an operation?

The main advantages of the BAHA are due to the hearing aid being in direct contact with the bone. These advantages are:

- all of the amplified sound is transmitted through the bone rather than being 'lost' through skin and tissue impedance, as is the case with a conventional bone conduction hearing aid
- the sound is constant and does not vary depending upon either the state of the ear as may occur with air conduction hearing aids in an infected ear, or the position/movement of the transducer with a conventional bone conduction hearing aid
- the comfort of the BAHA is a great improvement compared to conventional aiding as there is nothing in the ear to aggravate ear infections or irritations, nor is there any pressure exerted on the skull causing discomfort and headaches as can often be the case with the conventional bone conductors.
- as there is no headband the cosmesis of the BAHA is superior to a conventional bone conduction hearing aid
- as the bone conduction thresholds for these patients are better than the air conduction equivalents, less amplification is needed by the BAHA compared to a conventional air conduction hearing aid to overcome the hearing loss. This may then make sound more natural with less distortion thus benefiting speech discrimination.

There are of course some disadvantages with the BAHA as nothing can ever be perfect, and it is obviously up to the parents and child to decide whether the disadvantages are enough to outweigh the possible advantages.

The main disadvantages

- The procedure involves two minor operations.
- A person other than the patient (normally the parent) needs to help with the skin cleaning and with the replacing of the insert.
- The procedure may not be available locally.

Fitting a BAHA
There is wide variation around the country in the lowest age that a BAHA will be offered and implanted. This variation may be due to different protocols and different levels of experience in the fitting of the BAHA to children. In Birmingham we recommend that the BAHA is fitted as soon as possible, so optimum aiding is achieved as early during the child's development as is practically possible, this is especially vital for the maximisation of speech development. Since our programme began in 1988 we have gained more and more experience, and now fit children as young as two years old with great success.

It should be stressed that still the most important factor when considering a child's hearing loss is obviously the early diagnosis, quick fitting of a suitable conventional hearing aid and good follow up support for parent and child. Current NDCS guidelines recommend that diagnosis and fitting be completed by the age of six months for congenital hearing losses.

Finally, nothing in this article may be new you. Although after much time spent on the telephone liaising with professionals around the country it has become obvious that that there is still a lot of mystery surrounding the BAHA. The unscientific nature of this article is intended to help quash some of those mysteries and misconceptions which exist.

All associated professionals must become as confident at managing a BAHA as they are at dealing with conventional aiding. Annual modular courses covering the BAHA are available to offer individual, practical 'hands on' courses for small groups.
Living with my BAHA
Mary Fortune shares her experiences of obtaining and wearing her new BAHA
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A bone anchored hearing aid (BAHA) is one of many different hearing aids prescribed on the National Health Service, alongside digital hearing aids and cochlear implants. A titanium plug is surgically implanted into the mastoid bone, an abutment is connected to the plug and a sound processor is connected to the abutment. Titanium is used for the plug because the body osseointegrates the titanium and it conducts like bone – this is called the Branemark Principle.

When I was 11 years old, I had a perforated eardrum due to an infection I got from swimming. I was finally referred to an ENT consultant and 35 years later I am still under their care!

When I was 18, I had a radial mastoidectomy as I had an inflammation of the mastoid bone caused by an infection spreading from the middle ear to the cavity in the mastoid bone. This left me with a mild hearing loss and consequently I started to speak with a louder voice than before as I couldn’t monitor my voice properly. Over the years I have suffered from many ear infections, polyps growing in the middle ear, another perforation and catarrh, all of which are low grade things but make you feel off colour and certainly don’t help with hearing what is going on. My hearing thresholds have dropped over the years because of this, and about four years ago, they dropped to a moderate level (50dB loss) and my voice got even louder. Just ask my colleagues….

To compensate for this, I would always make sure people were on my right-hand side, and I’d sit at the front of any group, use my good ear for the phone, have the TV and car radio on loud and ask people to repeat things I had not heard or even misheard. I was also finding it much harder to hear my deaf students when supporting them in class if they were sitting on my left side as they would whisper and I couldn’t hear them.

One of my students had a BAHA and about two years ago the rep from the company came to talk to us about them as part of our professional development in audiology. When she had finished, some of my colleagues turned to me and said, ‘Mary, that’s what you need!’

It set me thinking, so I asked my ENT consultant to refer me to the specialist hospital that performed this procedure so I could find out if I was suitable or not. After assessment by audiology and another ENT consultant, I had to trial a post-aural digital hearing aid. I loved it.
but had a constant wet ear mould and ear. Finally it gave me a bad ear infection, which required antibiotic treatment. I tried a soft band BAHA one afternoon and that seemed better. After trying the alternative aids and listening to what was involved in acquiring a BAHA I decided to go ahead and a date for day surgery was set.

The procedure took about an hour under local anaesthetic and I chatted to the surgeon as he was working. It was like root canal work at the dentist, as you can hear and feel everything but it doesn’t hurt! Honestly!

I now have a titanium abutment in my skull just behind my left ear, up to the right and not in the way of my glasses. The measurements are very carefully drawn out on the skull and care is taken not to shave too much hair from around the site as they prepare it.

After three months, when the metal had embedded into the bone, I returned to get my digital hearing aid, which clipped into the abutment and was set to the lowest setting. The whole process from request to actually wearing the BAHA took about 12 months.

It took me a while to get used to clipping the digital aid in without getting my hair caught in it. It is dark in colour to match my hair so it is almost invisible. It has two microphones: one directional mic for all around sound and one omnidirectional mic for sound directly in front (for example, when I want to listen to my radio in the car it cuts out a lot of the surrounding car noise while driving). I enjoy using the volume control to adjust to different situations.

Initially I had the volume on 1 but as my brain got used to bilateral sound, it was reset to a higher level and I now wear it on volume 2. I hadn’t realised how my brain used to cross over sound, and what noise I had been missing. The BAHA also has a socket for an Ipod.

I was given a soft brush to brush off any dead skin that collects around the abutment, a box to keep it in and a transparent tube for others to test the aid by clipping the aid to it and placing it on their mastoid bone. The batteries seem to last a long time and just go dead suddenly. The NHS will replace it once if I lose it, will repair it when required and will upgrade it in three years.

On the plus side it has enabled me to regulate the volume of my voice and people have said I do speak more quietly than before. I can now hear whispers on my left-hand side and people talking in the back of the car more clearly. It is great to hear music and sound in stereo, especially at the cinema and theatre. I feel I can be a positive role model for my students and I completely understand how easy it is to forget your hearing aid in the morning when you are in a hurry!

On the down side, the abutment isn’t fully flush with my skull so I can feel it when I lie on my left-hand side in bed, so I have a special pillow I made with a little piece cut out. The hearing aid can flick off when taking a top off or when holding an umbrella too close to the head. I can’t wear a hat with the aid on as it just whistles too much when covered. And lastly, I had forgotten how much noise people can make when rustling paper and, when out walking, how noisy wind can be! However, I wouldn’t be without my new BAHA!

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