

# Bilateral benefits with Baha®

Despite current evidence, questions regarding the efficacy of bilateral implantation for bone anchored systems such as Baha are debated.

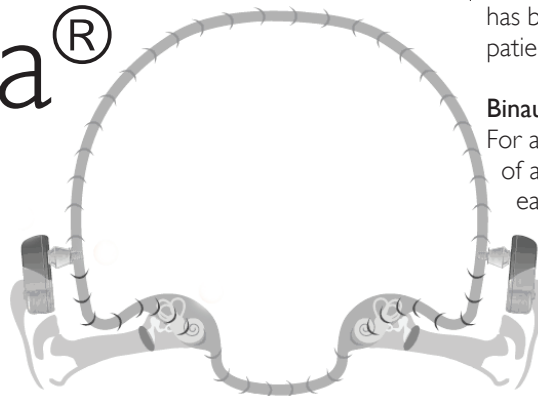
The key reason for questioning the efficacy of bilateral listening lies in the nature of bone conduction as both cochleae may actually hear the sound. This potentially raises two important questions.

## 1. Do both cochleae hear the same sound, at the same time, with the same intensity?

In 1981 Dr Nolan and Dr Lyon showed that the mean transcranial attenuation of bone conducted signals is 9.7 dB<sup>5</sup>, and they concluded that for general audiometric evaluations this was of no importance, however; this means that the intensity of a sound will not be at the same level in the two cochleae. Dr Stenfelt has shown that even though transmission of sound is faster in bone than air there is an inter cochlea time delay of 0.2 ms<sup>2</sup>. These factors may seem negligible but they will ensure that patients will be able to realise bilateral benefits with Baha.

## 2. If the sound arrives out of phase to the two cochleae, can it be cancelled out?

This same question has been raised earlier concerning bi-modal fitting of cochlear implants and conventional hearing aids. Seeing that there are several studies showing benefits from both bilateral Baha fitting and bi-modal fittings<sup>1,3,6,7</sup> and no reports of problems from sound cancellation, more research may be needed to fully understand this. However given the current clinical evidence this



does not seem to be an issue.

So, what are the most important benefits from bilateral fitting?

### 1. Speech in noise

Improving speech understanding in noise remains one of the key desires of all hearing impaired listeners. The bilateral benefits on the speech understanding in noise are provided through three main effects;

- Head shadow effect
- Binaural squelch
- Binaural summation

#### Head shadow effect

The head will mask sounds coming from the contralateral side to the ear. If the noise and speech come from different directions the level of speech will be greater in one ear and noise in the other. The brain will then pick the input with the best signal to noise (S/N) ratio. The magnitude of the head shadow effect is very large, enough in some cases to make speech totally understandable at one ear and incomprehensible at the other. For Baha, studies show that an improvement of the S/N ratio of around 3 dB can be expected with bilateral fitting<sup>1</sup>.

#### Binaural squelch

The auditory system can use the noise signal from the ear with the poorer S/N ratio to partially remove the impact

of noise from the ear with the more favourable S/N ratio. The result of this is similar to that of electronic adaptive noise reduction schemes. Binaural squelch has been shown in bilaterally fitted Baha patients with threshold shifts of 2-3 dB<sup>1,7</sup>.

#### Binaural summation

For a normal-hearing person, the loudness of a sound is greater if it is heard in two ears than if it is heard in one. On average this will increase the intensity of the sound by 5-6 dB. Bilateral fitting of Baha will enable the patient to benefit from binaural summation, and studies have shown binaural summation effects of 4,2 - 5,4 dB<sup>1,7</sup>.

## 2. Localization

The second benefit of a bilateral fitting is the ability to localize sounds and get a better appreciation of the surrounding soundscape. The process of localization relies on two main effects;

- Interaural time differences
- Interaural level differences

Of course you need two working cochleae to achieve true localization.

#### Interaural time differences

This effect is due to the fact that the speed of sound delays the input to the ear further from the sound. The auditory system will then detect this time difference and position the sound to the side that heard it first. With Baha the inter-cochlea time delay of 0.2ms discussed earlier is sufficient for the auditory system to localize low frequency sound sources<sup>2</sup>.

#### Interaural intensity differences

For high frequency sounds, the head shadow effect is more pronounced and this makes the level difference the most important cue when localizing. Research has shown that the interaural attenuation in bone conduction ensures that bilateral cues are not perceived similarly for each cochlea thereby giving patients the possibility of localizing high frequency sounds<sup>2</sup>.



Audiologic tests showed that the patients benefitted from bilaterally fitted Baha compared with unilateral in the areas of tone thresholds, sound localization and speech reception thresholds in quiet as well as in noise.

## The Articles

### Bilateral Bahas: an audiometric evaluation (1)

A study of 12 patients fitted with bilateral Bahas at Sahlgrenska.

#### Key statements:

- With a unilateral Baha the localization results are close to chance level. When bilateral Bahas are used there is a significant increase in the ability to localize the sound source.
- The patients report subjectively better hearing with two Bahas than one, and they are commonly using bilateral Bahas daily in most listening situations.
- Audiologic tests showed that the patients benefitted from bilaterally fitted Baha compared with unilateral in the areas of tone thresholds, sound localization and speech reception thresholds in quiet as well as in noise.

### Bilateral fitting of Bahas and Baha fitted in unilateral deaf persons: acoustical aspects. (2)

A theoretical acoustic analysis of the acoustical aspects of bilateral fitting of Bahas.

#### Key statements:

- It is clear that a patient benefits from bilateral Bahas in terms of better hearing thresholds, especially when the sound comes from the previously non fitted side.
- Since there is more cross-hearing with BC than with AC, the binaural processing of the sound delivered by the two Bahas is expected to be less than that achieved with AC transmission.
- Provided the Baha patient has a symmetrical cochlear sensitivity both clinical measurements and theoretic acoustic analysis show that the patient benefits from bilateral fitting in terms of greater stimulation level, better directional hearing and space perception and overall better speech perception in noise.

### Baha always bilateral (3)

Review of 40 patients fitted bilaterally of which 13 were children.

#### Key statements:

- Localization and space perception can be markedly improved with a bilateral fitting.
- The ability to localize sounds in traffic and noisy situations will be improved reducing the potential risk of injury.
- Children with bilateral conductive hearing loss that are fitted as early as possible with bilateral Bahas always use both Bahas even when they get older.

## REFERENCES

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## Questions and answers

**Q** Are there any recent studies on the use of different imaging techniques like MRI and CT in patients with a Baha implant?

**A** Yes, in 2007 an excellent article was published in the *Laryngoscope* describing the use of different techniques and their benefits. The fact that they used a 3 tesla MRI scanner is also worth noting as earlier publications have used less powerful scanners. We enclose a summary here:

### Imaging procedures after bone anchored hearing aid implantation (4)

The purpose of the study was to evaluate the feasibility and usability of three different radiologic methods on Baha patients;

- Computed tomography (CT)
- Magnetic resonance imaging (MRI)
- Rotational tomography (RT)

The evaluation was made using a 3 Tesla MRI scanner.

Differences in artifacts, visibility of the screw and size of artifacts were compared.

#### Key statements:

- RT appears to offer new possibilities for postoperative evaluation..This imaging technique enables you to determine whether a displacement of the implant has occurred.
- There are no restrictions of CT or MRI in terms of the image quality of the internal auditory canal and the brainstem, which is useful to exclude recurrent acoustical neuroma.