Active vs. Passive
Transcutaneous Bone Conduction Systems

All the same?
In June 2011, the first Bonebridge was implanted in a patient, opening a new chapter in bone conduction stimulation. The Bonebridge is the world’s first active bone conduction implant. It consists of an audio processor and an active implant (BCI). The BONEBRIDGE transmits sound waves via the cranial bone directly to the inner ear, where they are perceived as natural sound. The implant is completely invisible under the intact skin. In contrast to existing bone conduction systems which have been available up until now, this minimizes the risk of skin irritations, and the direct stimulation of the bone achieves optimal sound transmission results. In recent times, other intact skin bone conduction devices have been introduced into the market, often referred to as passive bone conduction systems.

What are the differences between active and passive bone conduction systems? Does it make a difference?

Actually, while the names are similar, active and passive bone conduction systems are completely different concepts. Figure 1 shows the categorization of different bone conduction systems from a conceptual viewpoint. Bone conduction systems can be divided into those that directly stimulate the bone versus those where the vibration is applied to the skin. This graph shows that passive bone conduction systems are actually more similar to hearing glasses as they share the same way of stimulation. The difference to hearing glasses is that passive bone conduction systems are held by an implanted magnet rather than by the arm of a spectacle.

**BONE CONDUCTION HEARING DEVICES**

![Bone Conduction Hearing Devices Diagram]

Figure 1

Figure 2 shows a comparison between the active BC system – the Bonebridge and passive BC systems in more detail.
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<tr>
<th>SYSTEM</th>
<th>ACTIVE (BONEBRIDGE)</th>
<th>PASSIVE</th>
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<tr>
<td><strong>STIMULATION</strong></td>
<td>Implant generates vibrational stimulation that is directly applied to the bone (&quot;direct drive bone conduction stimulation&quot;). Optimum BC sound transmission.</td>
<td>Sound processor generates stimulation that is applied from outside onto the skin (like hearing glasses or BC-head-bands). Skin attenuates sound before it reaches the bone.</td>
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<td><strong>CONCEPT</strong></td>
<td>Audio processor picks up sound and generates signal that is transmitted to the implant.</td>
<td>Sound processor picks up sound and generates vibration that is applied onto the skin. Sound processor needs transducer and plate that adds to the sound processor size and weight.</td>
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<tr>
<td><strong>Implant</strong></td>
<td>Implant accepts signal and BC-FMT generates vibration (&quot;active implant&quot;) that is applied directly to bone. Implant consists of a receiving coil, a holding magnet, electronics and a BC-FMT (transducer).</td>
<td>Implant's main function is to hold vibrating sound processor in place and generate skin pressure (&quot;passive implant&quot;). Implant consists mainly of a magnet.</td>
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<td><strong>Transducer</strong></td>
<td>Transducer (&quot;BC-FMT&quot;) is part of the implant and is directly attached to the bone.</td>
<td>Transducer is part of the sound processor and drives a plate that sits on the skin. The plate is held by an implanted magnet.</td>
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<td><strong>OUTPUT</strong></td>
<td>Average output up to 14.5 dB higher (average of 500 Hz, 1 kHz, 2 kHz and 4 kHz). In the higher frequencies, output 43 dB – 55 dB higher (6 kHz and 8 kHz, respectively).</td>
<td>Lower output due to skin attenuation.</td>
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<td><strong>Application</strong></td>
<td>Conductive hearing loss (CHL) Mixed hearing loss down to 45 dB BC Single-sided deafness (SSD).</td>
<td>Due to reduced output, use is mainly restricted to CHL limiting its application in mixed hearing loss and SSD.</td>
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<td><strong>WEARING COMFORT</strong></td>
<td>Low pressure on skin, enough to hold the audio processor in place. Stimulation output is independent of skin pressure or skin thickness.</td>
<td>Sound transmission is related to skin thickness, hair thickness, hair length, and skin pressure. Necessary skin pressure around 4 times higher than for active system.</td>
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<td><strong>Skin considerations</strong></td>
<td>Low weight audio processor: 8 g (incl. battery) High wearing comfort and longer daily use most likely due to low skin pressure. 50% longer wearing time (an extra 3.5 hrs per day) compared to passive systems.</td>
<td>Sound processor weight: 15 g – 23 g (incl. plate and battery, depending on system) Limited wearing time.</td>
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<td><strong>Wearing Comfort</strong></td>
<td>Low profile of audio processor: Amadé BB audio processor: 9 mm. (see Figure 2)</td>
<td>Higher profile due to magnetic plate plus sound processor: 16 mm – 20 mm (depending on system).</td>
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<tr>
<td><strong>AESTHETICS</strong></td>
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1 OFL-60 data (6 mm skin, no hair). Bonebridge: MED-EL internal measurements. (Baha Attract data: Cire and Flynn, presentation at AAA, Orlando, Florida, March 2014.)

2 Skin pressure of the Bonebridge audio processor Amadé BB ranges between 0.1 – 0.15 N/cm² (MED-EL internal measurements). For the Baha Attract, a skin pressure range of 0.4 – 0.6 N/cm² has been reported (Wigren, Osseo 2013, Newcastle, June 2013).

3 Average wearing time in the Bonebridge clinical study was 10.6 hrs/day. For the Baha Attract an average wearing time of 7 hrs was reported (Cochlear product presentation, LION Broadcast, 10 December 2013).
It is indisputable, that directly stimulating the bone is more effective than stimulating through the skin. For this reason, some decades ago, bone anchored hearing aids were seen as a step forward compared to hearing glasses. There is a general agreement that transcutaneous intact skin solutions are preferable in maintaining the protective function of the skin.

**Why doesn't everyone offer a system like the Bonebridge?**

With nearly 20 years of experience with implantable Floating Mass Transducers (FMTs), MED-EL is able to build highly effective, power efficient implantable transducers with extremely high quality and long-term reliability. This is the prerequisite for offering an active bone conduction system such as the Bonebridge. Accelerated life tests (lab tests that simulate the aging of a product) of the Bonebridge BC-FMT predict that 96.8% of all BC-FMTs will still work in 20 years. This excellent reliability has been confirmed in the market experience of the Bonebridge so far.

The combination of intact skin technology and effective direct drive bone conduction is the key to excellent audiological results, low number of complications, and high user satisfaction. With these advantages the Bonebridge sets a new standard in bone conduction stimulation.

**Summary**

In summary, the Bonebridge offers the following advantages over passive devices:

- The Bonebridge provides more output, making it more suitable for mixed hearing loss and single-sided deafness.
- The Bonebridge provides stable output, independent of skin thickness and hair growth.
- The Bonebridge does not require skin pressure for stimulation.
- The Bonebridge is comfortable to wear, leading to 50% longer wearing time per day (extra 3.5 hrs/day). This adds up to over 1250 hours more aided hearing per year.
- The Bonebridge audio processor has a much lower profile and is therefore more inconspicuous.
- Published and presented clinical experience shows excellent results and high user satisfaction. Very low complication rates have been confirmed.

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4 An excellent long-term reliability of FMTs as shown with nearly 20 years of experience with one of MED-EL’s other products, the Vibrant Soundbridge.

5 See also: MED-EL, FocusOn „Bonebridge – Experience after Year One”, referencing 18 studies on the clinical experience with the Bonebridge.