2017

BAHS Introduction

Barinder Samra BSc, MSc, CS (Aud)

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Agenda

- BAHS Principles
- BAHS Candidates
  - *Advantages of BAHS device*
  - *Contraindications for surgery*
- Bilateral Conductive and Mixed Hearing Losses
  - *Which Side to Fit?*
- *Ponto 3 Super Power*
  - *The Importance of Increased MFO*
- Methods of Sound Transmission
  - *Skin Drive and Direct Drive*

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Learning Goals

- To be able to calculate BAHS candidacy using the audiogram
- Identify the benefits of treating conductive/mixed and unilateral profound hearing losses using bone conduction devices.
- Define contraindications for BAHS surgery
- Ascertain whether a patient is a candidate for a bilateral or unilateral fitting using the audiogram.
- State the impact of low MFO on sound quality and explain why increasing the MFO of BAHS devices benefits all users.
- Indicate the affect different methods of sound transmission can have on output and outcome.

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BAHS Principles

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Components of BAHS Devices and Implant

Sound processor Coupling Screw Abutment Tri-Implant

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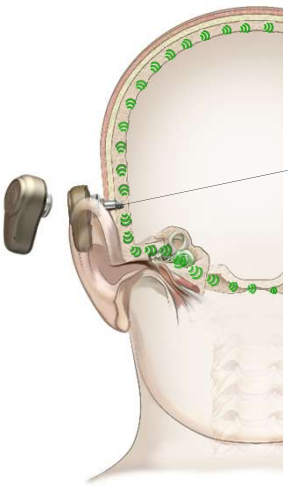
Osseointegration and Direct Bone Conduction



Osseointegration

Abutment (6, 9, 12, or 14 mm long)

Implant (3 or 4 mm long)

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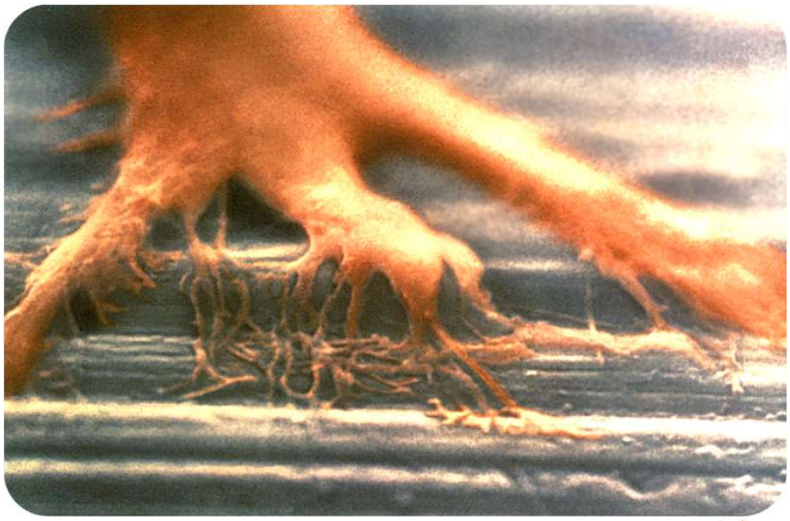
Osseointegration



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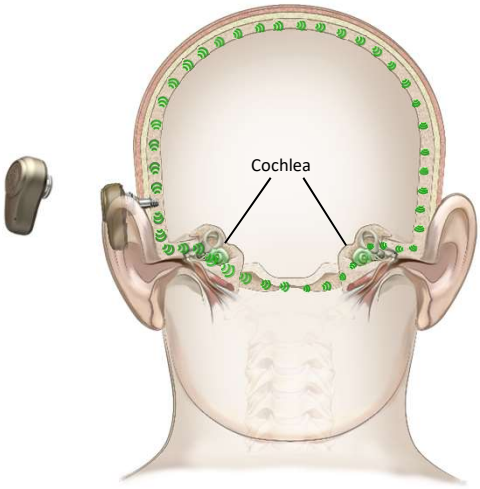
Direct Bone Conduction



Sounds are converted to vibrations, which are transmitted directly to both inner ears.

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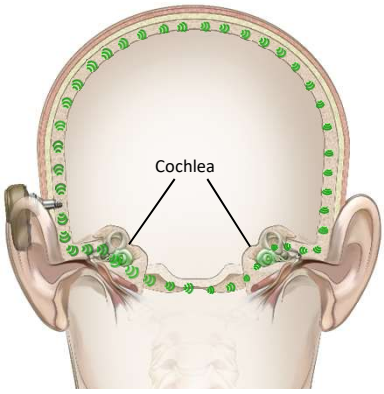
Ponto- The Bone Anchored System



Ponto (Latin) = Bridge

Cochlear owns the right to the name BAHA®; therefore we never write or call our system a BAHA (Bone-Anchored-Hearing-Aid).

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BAHS Candidates

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BAHS Candidacy Categories

- Conductive & mixed hearing losses
- Single-sided deafness (SSD)
- Other

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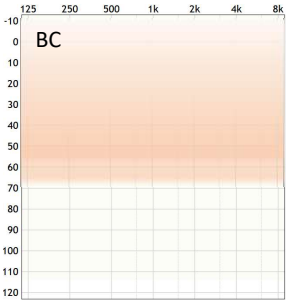
Conductive and Mixed HL Candidacy

- Can the device compensate for hearing loss in the inner ear?
  - Average BC thresholds now up to 65 dB HL



- Is a bone anchored device a better solution than a conventional hearing aid?
  - If ABG > 30 dB, speech recognition with BAHS will likely be better than with conventional hearing aids. [1, 2]

Rule of Thumb

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1) Mylanus et al. Intraindividual comparison of the bone-anchored hearing aid and air-conduction hearing aids. Otolaryngology- Head & Neck surgery. 1998; 124(3): 271-6
2) De Wolf et al . Better performance with bone-anchored hearing aid than acoustic devices in patients with severe air-bone gab. The Laryngoscope 121:613-616, 2011.

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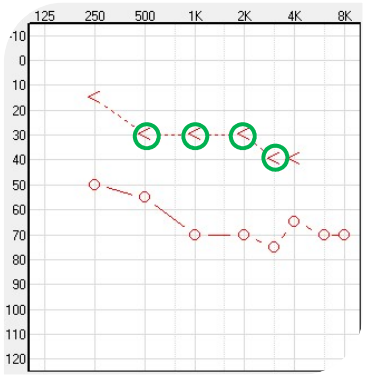
Calculating Candidacy

- Average BC threshold
  - Calculate average BC response at .5 kHz, 1 kHz, 2 kHz & 3 kHz
  - Average should be up to 65 dB HL



Average BC is less than 65 dB HL

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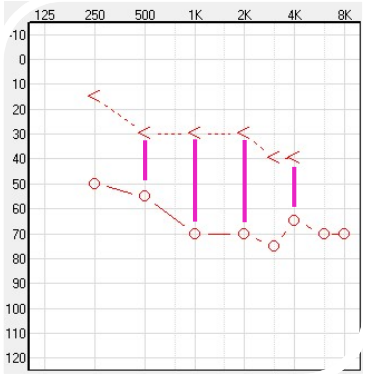
Calculating Candidacy

- Average air-to-bone gap
  - Calculate average between AC and BC responses at .5 kHz, 1 kHz, 2 kHz & 4 kHz
  - Average should be up to >30 dB HL



Av. ABG is larger than 30 dB

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Conductive and Mixed Hearing Losses

Advantages of a BAHS device

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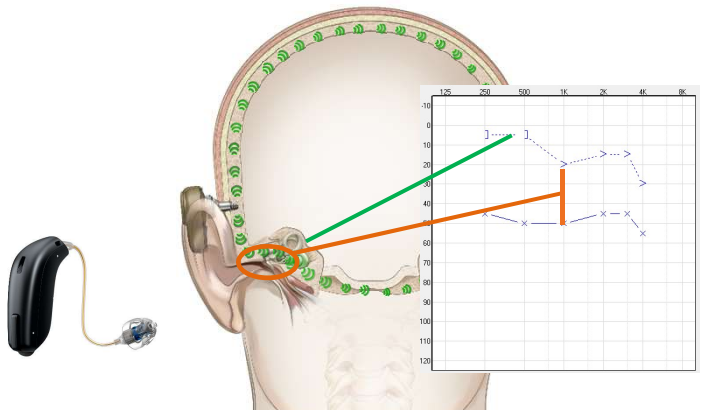
Bone Anchored Sound Processor



Middle ear hearing loss (ABG –air to bone gap)

The Ponto doesn't need to compensate for the air-to-bone gap (the conductive component of the hearing loss).

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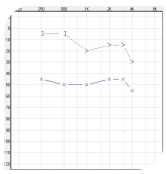
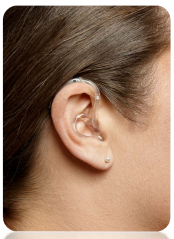
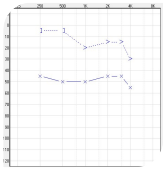
Traditional HA Versus Bone Anchored HA





Traditional HA

- High gain
- Likely problems with feedback
- Tight earmould



Bone anchored HA

- Low gain
- Better sound quality
- Ear canal is open

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Example Candidates

- Chronic otitis media

BAHS helps to reduce discharge[4]

Reduction in infection = Fewer outpatient visits [5]

Occluding earmoulds are contraindicated

Chronic ear discharge can lead to sensorineural loss[3]

3) Papp, Z., et al. (2003). "Sensorineural Hearing Loss in Chronic Otitis Media." Otology & Neurotology **24**(2): 141-144.

4) McDermott, A. L., et al. (2002). "An intra-individual comparison of the previous conventional hearing aid with the bone-anchored hearing aid: The Nijmegen group questionnaire." J Laryngol Otol Suppl(28): 15-19.

5) Hol, M. S., et al. (2004). "The bone-anchored hearing aid: Quality-of-life assessment." Archives of Otolaryngology–Head & Neck Surgery **130**(4): 394-399.

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Example Candidates

- Otitis media w/ effusion
- Chronis otitis media
- Aural atresia/Microtia

Air-bone gap of 30 dB or less

57% fulfilled this criteria after 1 year post op [6]

patients can still need amplification post surgery[7]

Fewer follow up visits and fewer complications with BAHS when compared to surgery [6]

6) Nadaraja, G. S., et al. (2013). "Hearing Outcomes of Atresia Surgery Versus Osseointegrated Bone Conduction Device in Patients With Congenital Aural Atresia: A Systematic Review." Otology & Neurotology **34**(8): 1394-1399.

7)Evans, A. K. and K. Kazahaya (2007). "Canal atresia: "surgery or implantable hearing devices? The expert's question is revisited"." Int J Pediatr Otorhinolaryngol **71**(3): 367-374.

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Example Candidates

- Otitis media w/ effusion
- Chronis otitis media
- Aural atresia/Microtia
- Otosclerosis
- Traumatic injury to middle ear structures
- Ossicular disease
- Cholesteotoma

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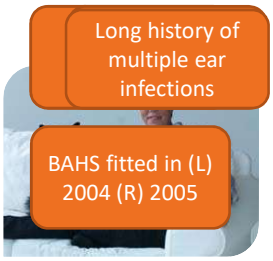
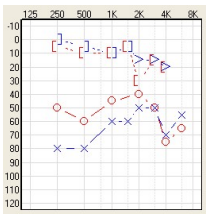
Case Study Patient BV



Long history of multiple ear infections

BAHS fitted in (L) 2004 (R) 2005



Since BAHS fitted ear infections reduced, less visits to clinic

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Candidacy Categories

- Conductive & mixed hearing losses
- Single-sided deafness (SSD)
- Other

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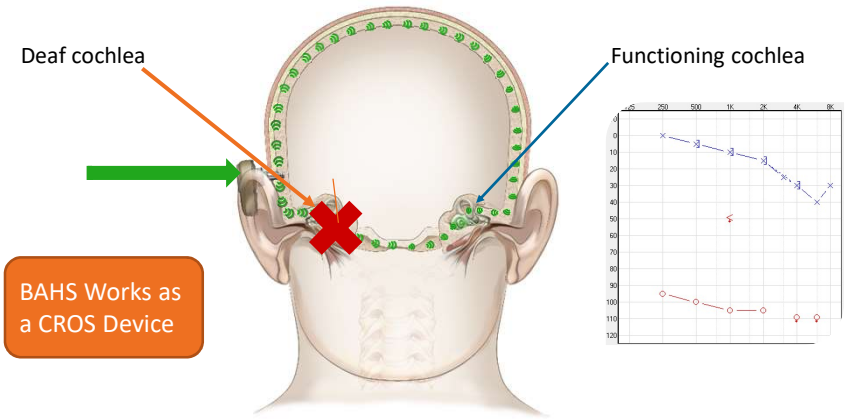
Single-Sided Deafness (SSD)
(Profound Unilateral Sensorineural HL)



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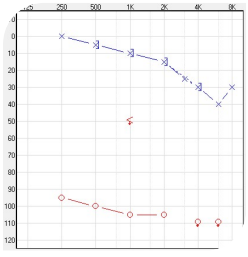
Single Sided Deafness (SSD) Candidacy

- Does the better ear have normal or near-normal hearing?
  - Average air conduction threshold < 20 dB HL



- Or the patient chooses not to use an air conduction CROS system

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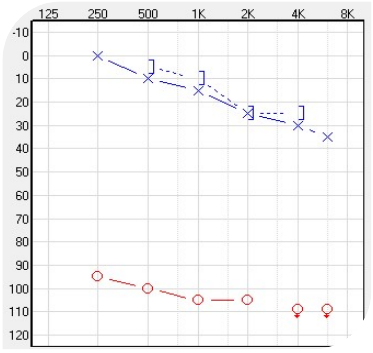
Candidates for SSD

- Single-sided deafness caused by:
  - Acoustic neuroma
  - Sudden deafness
  - Congenital causes
  - Cholesteatoma
  - Ototoxic drugs
  - Meniere's disease



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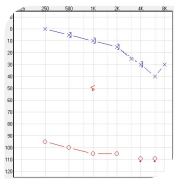
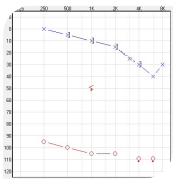
CROS Versus Bone Anchored HA



CROS

- Ear canal in good ear partially occluded by device
- Must wear two devices
- Poor acceptance[8]
- Can have high battery drain



Bone anchored HA

- Ear canal is open
- Only one device
- Normal battery drain

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8. Niparko, J. K., et al. (2003). "Comparison of the bone anchored hearing aid implantable hearing device with contralateral routing of offside signal amplification in the rehabilitation of unilateral deafness." Otol Neurotol **24**(1): 73-78.

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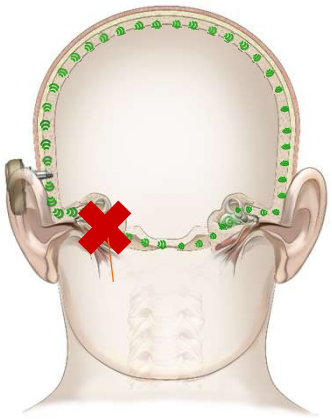
Advantages of Treating SSD

High scores in subjective patient tests[9]



Better or equal speech understanding in noise compared to Cros aid [8,9]

8) Niparko, J. K., et al. (2003). "Comparison of the bone anchored hearing aid implantable hearing device with contralateral routing of offside signal amplification in the rehabilitation of unilateral deafness." Otol Neurotol **24**(1): 73-78.
9) Kim, G., et al. (2017). "Efficacy of Bone-Anchored Hearing Aids in Single-Sided Deafness: A Systematic Review." Otol Neurotol **38**(4): 473-483.

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Candidacy Categories

- Conductive & mixed hearing losses
- Single-sided deafness (SSD)
- Other

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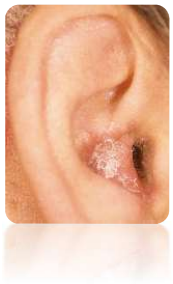
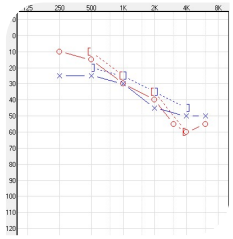
Other Medical Indications

- Maybe not a direct candidate, audiologically
- Physical constraints for fitting
  - Underlying skin condition
  - Inflammation
  - Reaction to earmoulds
  - Stenosis





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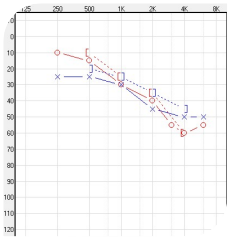
Case Study



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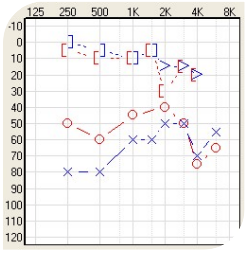
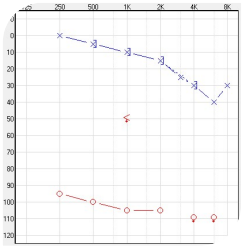
Candidacy - In Summary

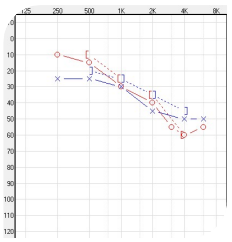
Conductive/Mixed



Single Sided Deafness



Medical Indications



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A Patient May Not be a Candidate for an BAHS Implant if:

- They have poor hygiene and are unable to care for their abutment site
- Their bone quality will not support the implant, for example, it is too thin, or it is brittle due to radiation.
- They have a skin condition that will reduce their ability to heal following surgery.
- They are under 5 years of age (US, Canada and Singapore).

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Materials

- Candidacy Guide
- Candidacy Quick Guide

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Bilateral Conductive and Mixed Hearing Losses

Bilateral or Unilateral Fitting -Making a Decision

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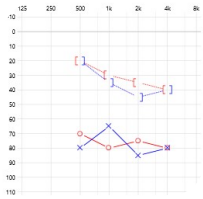
Bilateral Fitting- Making a Decision



Bilateral Conductive/Mixed HL

↓

Look at Masked BC

↓

Symmetrical BC

Less than 10 dB HL on average

And less than 15 dB HL at individual frequencies

↓

Fit Bilaterally= True Binaural Effect

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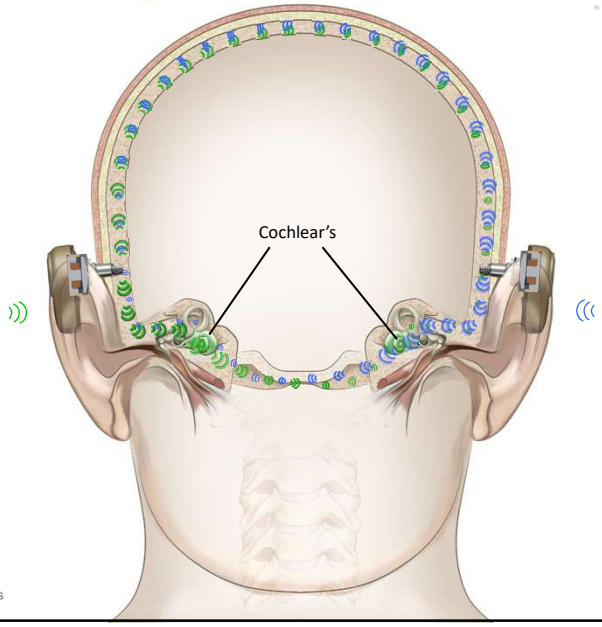
Bilateral Fitting



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Bilateral Fitting- Benefits

Skull provides enough attenuation to acoustically isolate BAHS output

Binaural Loudness Summation

Improvement in Speech Recognition in Noise

Utilise Binaural Squelch

Improved sound localisation

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Unilateral Fitting-*Making a Decision*

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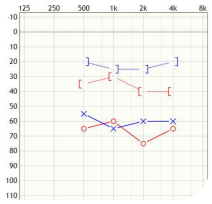
Unilateral Fitting-*Making a Decision?*

Bilateral Conductive/Mixed HL

?



Asymmetrical BC

Fit BAHS to the side with best BC

If BAHS is fitted on poor BC side, then it will work like a CROS device

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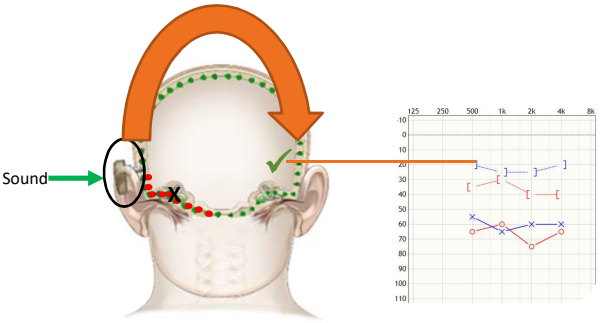
Unilateral Fitting-*Making a Decision?*

If BAHS is fitted on poor BC side, then it will work like a CROS device



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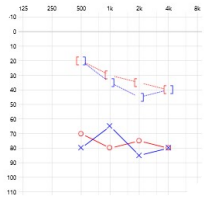
Unilateral Fitting-Making a Decision



Bilateral Conductive/Mixed HL

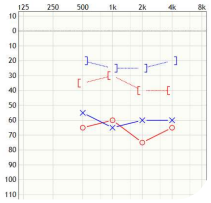
Look at Masked BC

Symmetrical BC

Asymmetrical BC

Fit 2 BAHS = Bilateral Effect

Fit BAHS to the Side With Best BC



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Ponto 3 – The Definition of Power

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Ponto 3 – BrainHearing at the Core

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The Recipe for Ponto Sound Quality

Output – more loud and soft sounds

Output

Bandwidth - greater range of high and low tones

Bandwidth

Clarity - without distortion

Clarity

These are all at core of our development and the fundamentals for delivering Ponto Sound Quality.

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https://www.youtube.com/watch?v=kTMEydoxdpw

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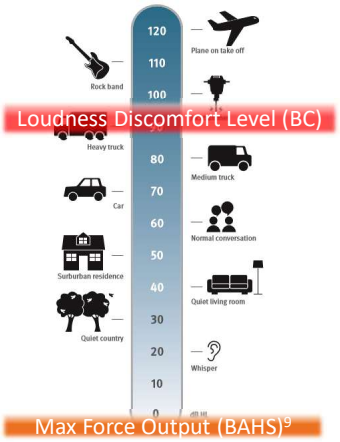
Challenge in BAHS
Maximum Output is Low



Device	Measured MPO	Reference	Manufacturer
Sophono Alpha 1	56 dB HL	Hol et al., 2013	Sophono, Boulder, US
Bonebridge	65 dB HL	Mertens et al, 2014	Med-El, Innsbruck, Austria
Standard Baha Divino/BP100	67-69 dB HL	Carlsson & Hakansson, 1997 Zwartenkot et al. 2014	Cochlear BAS, Goteborg, Sweden
Standard Ponto	67-69 dB HL	Zwartenkot et al. 2014	Oticon Medical, Askim, Sweden
Baha Cordelle, Baha 5 SuperPower*; Ponto 3 SuperPower*.	80-85 dB HL	Idem	Cochlear BAS, Goteborg, SwedenOticon Medical, Askim, Sweden

Objective measurement of the MPO of several hearing devices[1]
*(*updated spring 2017)*

35190-00

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10) http://www.snikimplants.nl

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Challenge in BAHS
Maximum Output is Low

- Transmitting sound via vibrations through the skull bone is not as efficient as transmitting sound via the ear canal.
- As such the maximum force output (MFO) of BAHS devices is much lower than the maximum power output (MPO) of hearing aids.
- The MFO of a BAHS device is much lower than uncomfortable loudness levels.

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Ponto 3 – SuperPower made beautiful
The world's first single-unit SuperPower

- Ponto 3 SuperPower combines a descreet-, small design and a battery that lasts.
- Abutment-level processor - no strings or need for any bulky ear- or body-worn devices

- Combine discretion with usability
- Follows the contours of the ear
- Left and right versions
- Available in six colours

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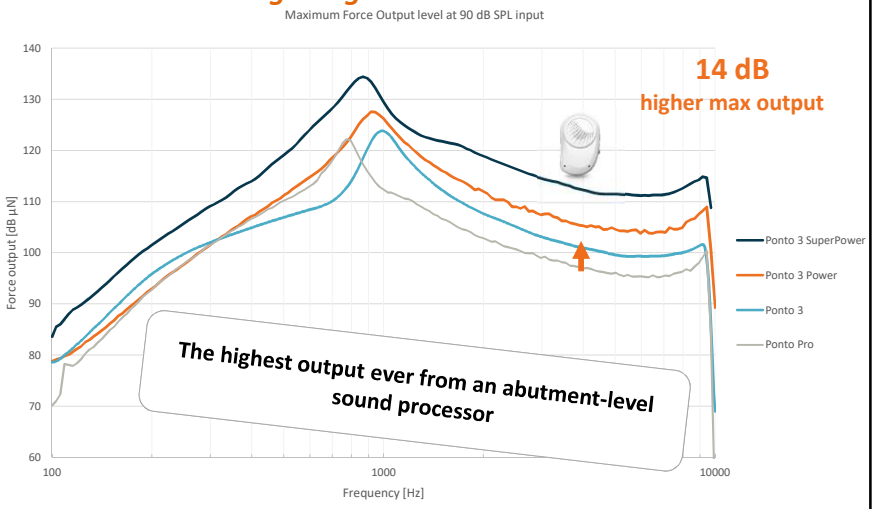
Ponto 3 SuperPower

Committed to Providing a Higher MFO



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Sound Environments are Dynamic

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Wagener et al. (2008)

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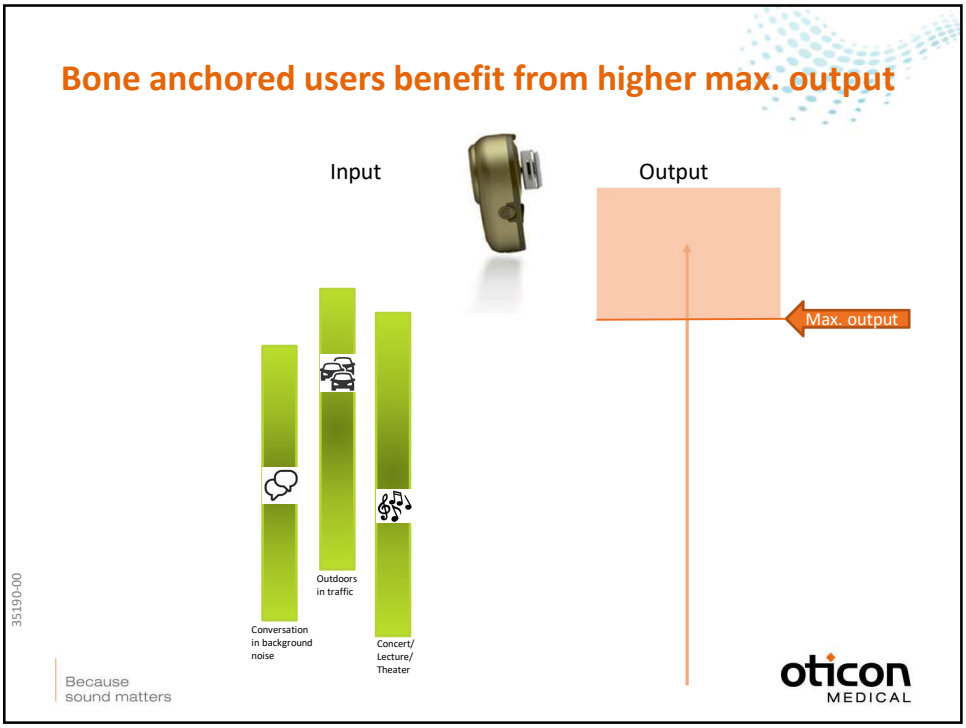
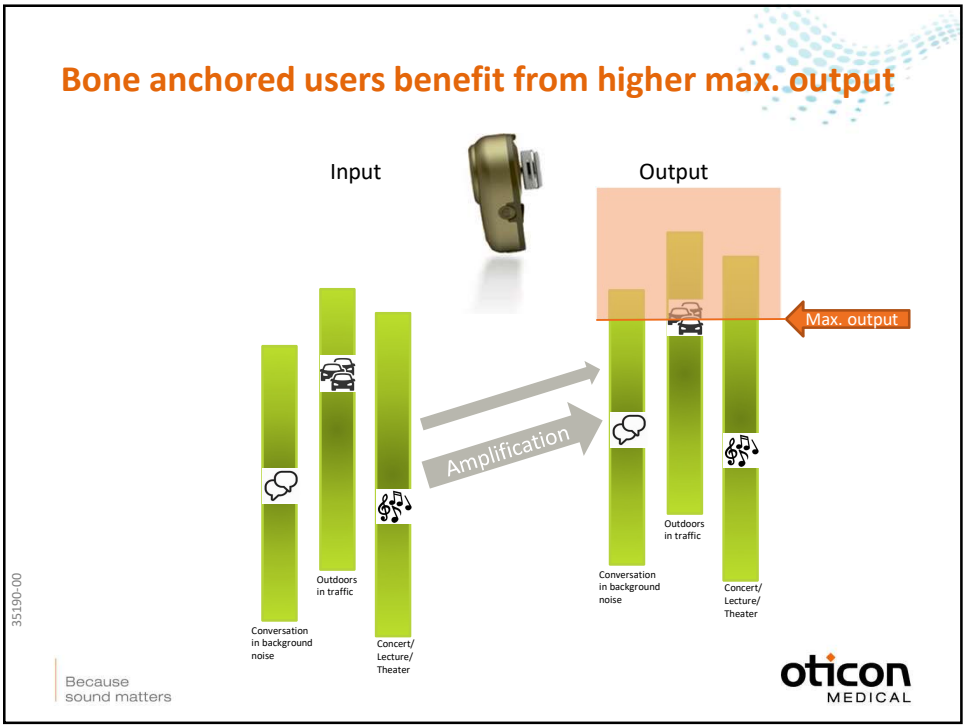
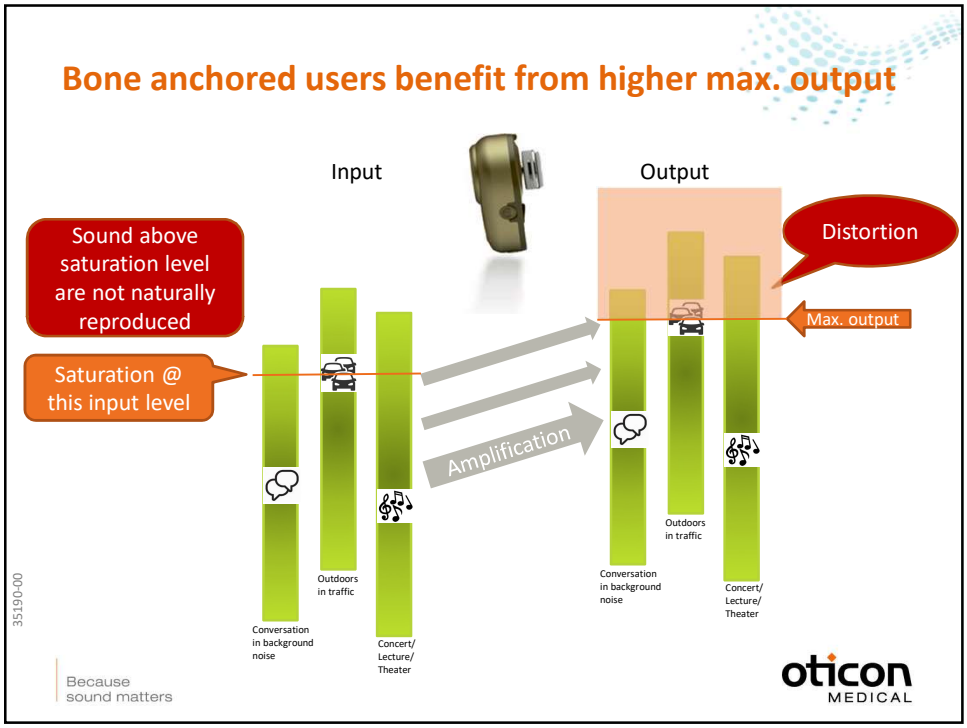
Bone anchored users benefit from higher max. output



Bone anchored users benefit from higher max. output




Bone anchored users benefit from higher max. output
Input
Output
Sound above saturation level are not naturally reproduced
Saturation @ this input level
Distortion
Max. output
Amplification
Conversation in background noise
Outdoors in traffic
Concert/ Lecture/ Theater
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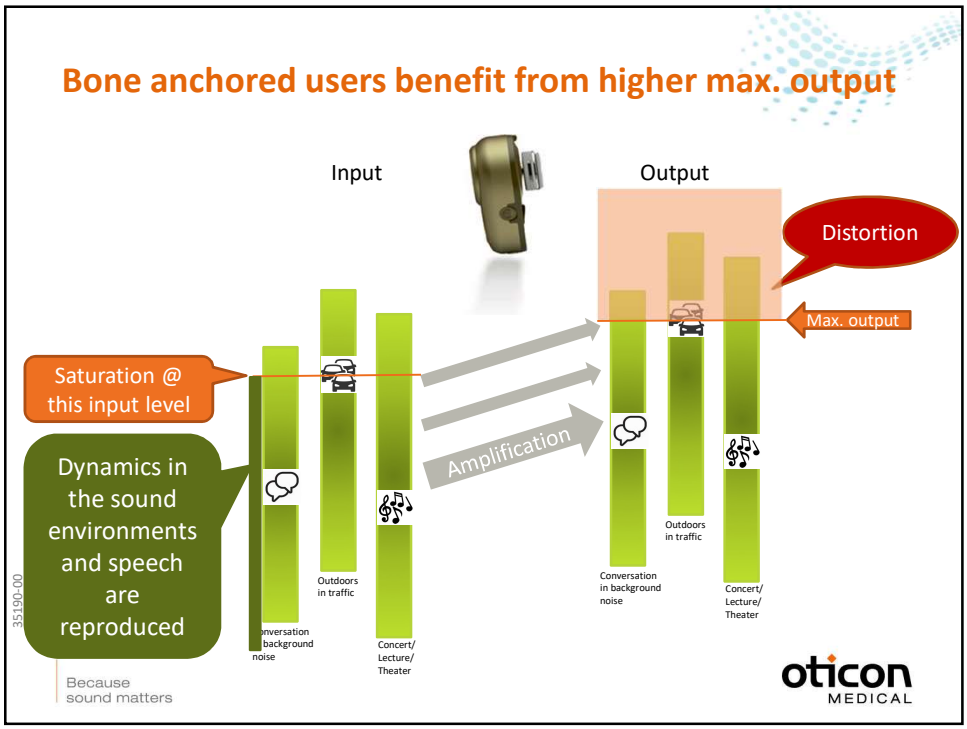
Bone anchored users benefit from higher max. output
Input
Output
Saturation @ this input level
Dynamics in the sound environments and speech are reproduced
Distortion
Max. output
Amplification
Conversation in background noise
Outdoors in traffic
Concert/ Lecture/ Theater
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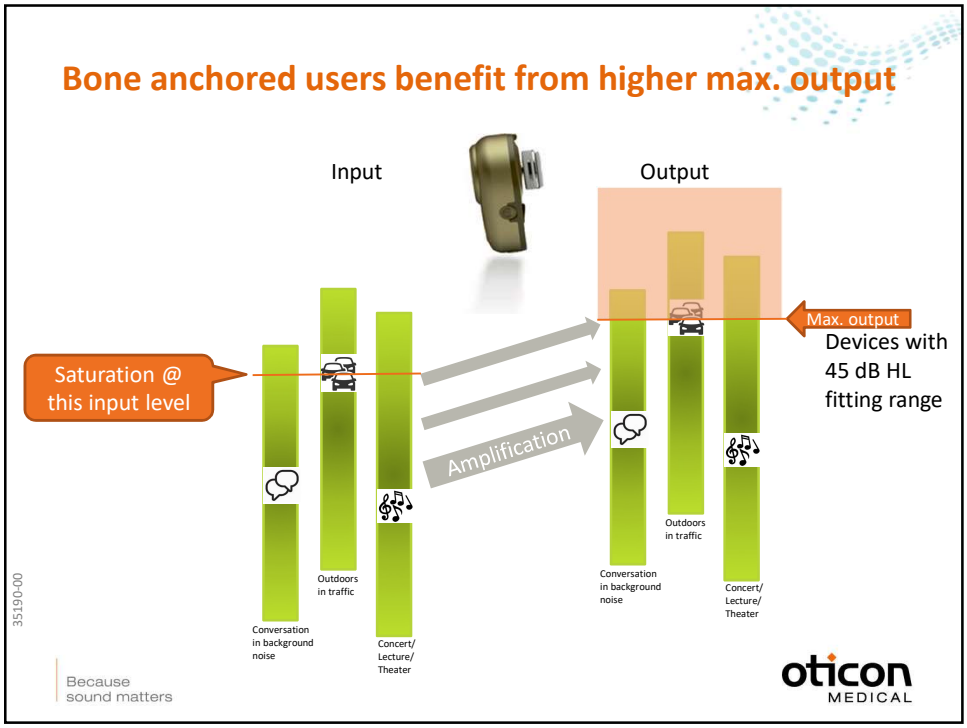
Bone anchored users benefit from higher max. output
Input
Output
Saturation @ this input level
Amplification
Max. output
Devices with 45 dB HL fitting range
Conversation in background noise
Outdoors in traffic
Concert/ Lecture/ Theater
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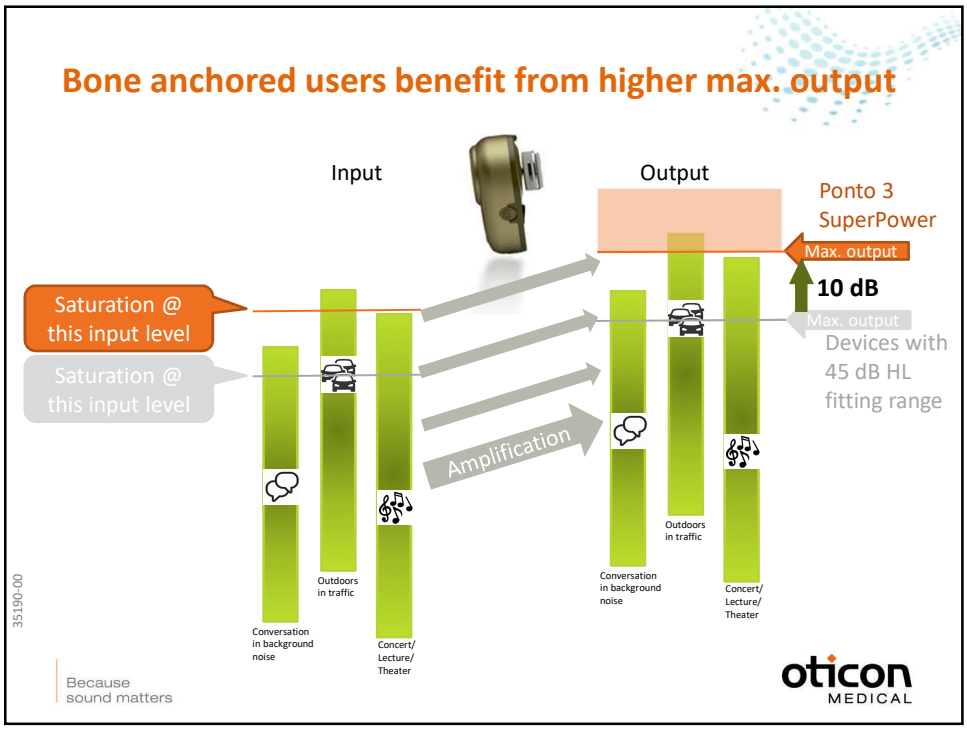
Bone anchored users benefit from higher max. output
Input
Output
Ponto 3 SuperPower
Max. output
10 dB
Max. output
Saturation @ this input level
Saturation @ this input level
Amplification
Devices with 45 dB HL fitting range
Conversation in background noise
Outdoors in traffic
Concert/ Lecture/ Theater
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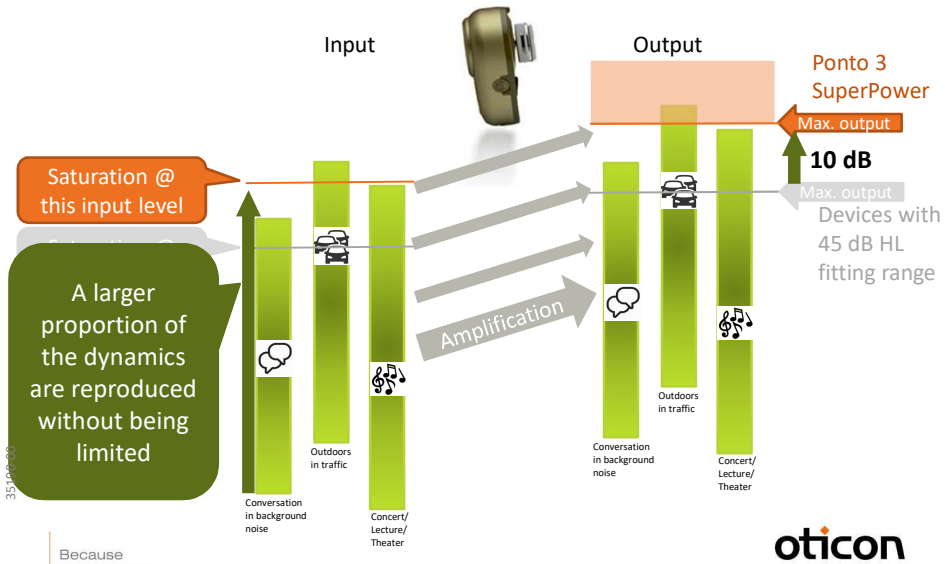
Bone anchored users benefit from higher max. output



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Ponto 3 SuperPower optimal solution for all patient groups

- **Patients with conductive loss**
  - Higher MFO means better utilization of patients dynamic range
  - More natural sound in louder listening environments
- **Patients with mixed hearing losses**
  - Higher MFO gives larger dynamic range / headroom in the device, so more sounds are reproduced naturally without being limited
  - Higher gain needs excellent feedback management
- **Softband and head band users**
  - Higher MFO to adress skin attenuation
- **SSD patients**
  - Better ability to loudness match sounds from the device to the normal hearing ear

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Agenda

- BAHS Principles
- BAHS Candidates
  - *Advantages of BAHS device*
  - *Contraindications for surgery*
- Bilateral Conductive and Mixed Hearing Losses
  - *Which Side to Fit?*
- *Ponto 3 Super Power*
  - *The Importance of Increased MFO*
- Methods of Sound Transmission
  - *Skin Drive and Direct Drive*

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Methods of Sound Transmission
-Skin Drive and Direct Drive

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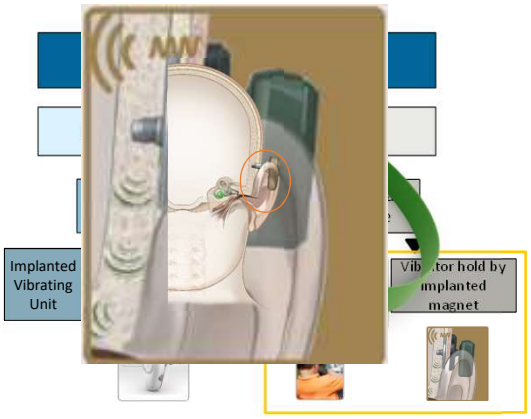
Methods of Sound Transmission



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11) Briggs (2015) Clinical Performance of a New Magnetic Bone Conduction Hearing Implant System: Results from a Prospective, Multicenter, Clinical Investigation. Otol Neurotol. 2015 Jun;36(5):834-41.

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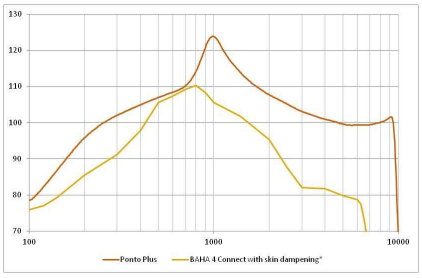
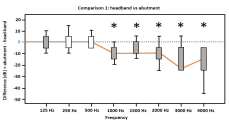
Sounds are Attenuated in Skin Drive Solutions

- Physical facts with Skin Drive solutions:
  - There is 10-20 dB sound attenuation in mid to high frequency region[2]
  - These devices have lower perceived output in the mid to high frequencies



Difference in hearing threshold obtain with headband vs abutment



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Magnetic/Softband

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12) Verstraeten et al (2008) Comparison of the audiologic results obtained with the bone-anchored hearing aid attached to the headband, the testband and to the 'snap' abutment. Otology & Neurotology 30: 70-75

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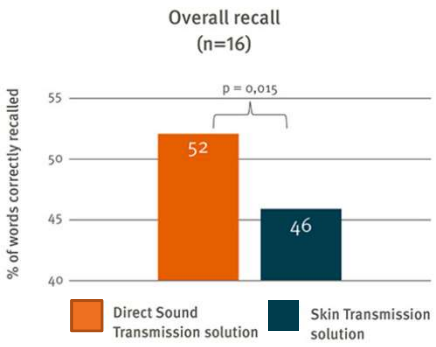
Skin Drive vs Direct Drive

13% improvement of words correctly recalled



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13) Lunner (2016) Using speech recall in hearing aid fitting and outcome evaluation under ecological test conditions. Ear & Haring, vol 37, supplement 1, 145S-154S

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Any Questions?

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