BAHS Introduction

Barinder Samra BSc, MSc, CS (Aud)

2017

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
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.
Components of BAHS Devices and Implant

- Sound processor
- Coupling
- Screw
- Abutment
- Tri-Implant
Osseointegration and Direct Bone Conduction

Osseointegration

Abutment (6, 9, 12, or 14 mm long)
Implant (3 or 4 mm long)

Because sound matters

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

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

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

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

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

![Graph showing average BC threshold](image1)

Average BC is less than 65 dB HL

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

![Graph showing average air-to-bone gap](image2)

Av. ABG is larger than 30 dB
Conductive and Mixed Hearing Losses

Advantages of a BAHS device

Bone Anchored Sound Processor

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

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\(^3\)

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
- Patients can still need amplification post surgery

- Fewer follow up visits and fewer complications with BAHS when compared to surgery


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

Candidacy Categories

- Conductive & mixed hearing losses
- Single-sided deafness (SSD)
- Other
Single-Sided Deafness (SSD) (Profound Unilateral Sensorineural HL)

- Deaf cochlea
- Functioning cochlea

BAHS Works as a CROS Device

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
Candidates for SSD

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

CROS Versus Bone Anchored HA

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

Bone anchored HA
- Ear canal is open
- Only one device
- Normal battery drain

Advantages of Treating SSD

- High scores in subjective patient tests
- Better or equal speech understanding in noise compared to Cros aid


Candidacy Categories

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

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

Case Study
### Candidacy - In Summary

<table>
<thead>
<tr>
<th>Conductive/Mixed</th>
<th>Single Sided Deafness</th>
<th>Medical Indications</th>
</tr>
</thead>
</table>

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).
Materials

- Candidacy Guide

- Candidacy Quick Guide

Agenda

- BAHS Principles

- BAHS Candidates
  - Advantages of BAHS device
  - Contraindications for surgery

- Bilateral Conductive and Mixed Hearing Losses
  - Bilateral or Unilateral Fitting - Making a Decision

- Ponto 3 Super Power
  - The Importance of Increased MFO

- Methods of Sound Transmission
  - Skin Drive and Direct Drive
Bilateral Conductive and Mixed Hearing Losses

Bilateral or Unilateral Fitting - Making a Decision

Bilateral Fitting - Making a Decision

Symmetrical BC

Bilateral Conductive/Mixed HL

Look at Masked BC

Less than 10 dB HL on average

And less than 15 dB HL at individual frequencies

Fit Bilaterally = True Binaural Effect
**Bilateral Fitting**

Skull provides enough attenuation to acoustically isolate BAHS output

**Bilateral Fitting - Benefits**

- Binaural Loudness Summation
- Improvement in Speech Recognition in Noise
- Utilise Binaural Squelch
- Improved sound localisation
Unilateral Fitting—Making a Decision

Asymmetrical BC
Bilateral Conductive/Mixed HL
Look at masked BC
If BAHS is fitted on poor BC side, then it will work like a CROS device
Fit BAHS to the side with best BC

Unilateral Fitting—Making a Decision?
If BAHS is fitted on poor BC side, then it will work like a CROS device.

Unilateral Fitting - Making a Decision?

- **Bilateral Conductive/Mixed HL**
  - Look at Masked BC
    - Symmetrical BC
      - Fit 2 BAHS = Bilateral Effect
    - Asymmetrical BC
      - Fit BAHS to the Side With Best BC
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

because sound matters

Ponto 3 SuperPower
-The Importance of Increased MFO
Ponto 3 – The Definition of Power

The most powerful family of abutment-level sound processors

Ponto 3 45 dB HL
Ponto 3 Power 55 dB HL
Ponto 3 SuperPower 65 dB HL

Ponto 3 – BrainHearing at the Core

Better hearing begins here

Power your Brain
Power to participate
Powerful sound quality
Empowering children
The Recipe for Ponto Sound Quality

Output – more loud and soft sounds
Bandwidth - greater range of high and low tones
Clarity - without distortion

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

Challenge in BAHS
Maximum Output is Low

<table>
<thead>
<tr>
<th>Device</th>
<th>Measured MPO</th>
<th>Reference</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sophono Alpha 1</td>
<td>50-80 dB HL</td>
<td>Hol et al., 2013</td>
<td>Sophono, Boulder, US</td>
</tr>
<tr>
<td>Bonebridge</td>
<td>65-88 dB HL</td>
<td>Martens et al, 2014</td>
<td>Med El, Ingolstadt, Austria</td>
</tr>
<tr>
<td>Standard Baha Divino BP 200</td>
<td>67-80 dB HL</td>
<td>Carlsson &amp; Hakansson, 1997; Zwartenburg et al, 2014</td>
<td>Cochlear All, Goteborg, Sweden</td>
</tr>
<tr>
<td>Standard Ponto</td>
<td>67-80 dB HL</td>
<td>Zwartenburg et al, 2014</td>
<td>Oticon Medical, Aalborg, Denmark</td>
</tr>
<tr>
<td>Baha Ciqilla, Baha 5 SuperPower*, Ponto 3 SuperPower*</td>
<td>80-85 dB HL</td>
<td>More</td>
<td>Cochlear All, Goteborg, Sweden/Oticon Medical, Aalborg, Sweden</td>
</tr>
</tbody>
</table>

Objective measurement of the MPO of several hearing devices¹
¹Updated spring 2017

https://www.youtube.com/watch?v=k7MYdxdjpw
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.

Ponto 3 – SuperPower made beautiful

The world’s first single-unit SuperPower

- Ponto 3 SuperPower combines a discreet-, 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
Ponto 3 SuperPower
Committed to Providing a Higher MFO

Maximum Force Output level at 90 dB SPL input

14 dB higher max output

The highest output ever from an abutment-level sound processor

Because sound matters

Sound Environments are Dynamic

Wagner et al. (2008)

Because sound matters
Bone anchored users benefit from higher max. output

Input

Output

Max. output

Because sound matters

Bone anchored users benefit from higher max. output

Input

Output

Max. output

Amplification

Because sound matters
Bone anchored users benefit from higher max. output

Input

Output

Saturation @ this input level

Distortion

Max. output

Dynamics in the sound environments and speech are reproduced
Bone anchored users benefit from higher max. output

Saturation @ this input level

Max. output
Devices with 45 dB HL fitting range

35190-00

Bone anchored users benefit from higher max. output

Saturation @ this input level

10 dB
Max. output
Devices with 45 dB HL fitting range

35190-00
Bone anchored users benefit from higher max. output

A larger proportion of the dynamics are reproduced without being limited

Saturation @ this input level

Input

Output

Ponto 3 SuperPower

Max. output

10 dB

Max. output Devices with 45 dB HL fitting range

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 address skin attenuation

- **SSD patients**
  - Better ability to loudness match sounds from the device to the normal hearing ear

Because sound matters
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
Methods of Sound Transmission

- Direct Drive
- Skin Drive
- Bone Conduction Devices
  - Vibrator in Processor
  - Vibrator held by Headband or Softband
  - Vibrator held by Implanted magnet

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

---


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

---

Skin Drive vs Direct Drive

Any Questions?