Bone Conduction Solutions for Children with Hearing Loss

Lisa Vaughan Christensen, AuD

American Academy of Audiology, President
Cook Children's Medical Center, Audiology Program Manager

Agenda

- Conductive and Mixed Hearing Loss in Children
- Single-Sided Deafness in Children
- Advantages of Bone Conduction Solutions
- Fitting Bone Conduction Solutions for Children

Learning Outcomes

After this course learners will be able to…

- Describe the common etiologies for conductive and mixed hearing loss in children and list common treatment options.
- List the considerations for treating single-sided deafness in children.
- Explain how treatment with bone conduction is uniquely suited to conductive and mixed hearing loss in children as well as single-sided deafness.
- Describe the fitting and validation of Baha bone conduction solutions in children.

Conductive and Mixed Hearing Loss in Children

Conductive and Mixed Hearing Loss (CMHL) in Children

- Prevalence of conductive hearing loss in children may be up to 3.5% of the general population[1]
- Conductive hearing loss in children may be permanent or temporary
- Causes may include otitis media, microtia/atresia, genetic causes or syndromes

1 - Feder KP, Michaud D, McNamee J, Fitzpatrick E, Ramage-Morin P, Beauregard Y. (2017) Prevalence of hearing loss among a representative sample of Canadian children and adolescents, 3 to 19 years of age. Ear & Hearing, 38(1):7-20.

Microtia and Atresia

Microtia

- Spectrum of deformities of the outer ear
- Grades:
  - I – ear is smaller than normal, minor alterations in form
  - II – conchal type microtia; much of the lower 2/3 of the ear is present
  - III – lobular type microtia; "peanut" shape
  - IV – anotia; no ear present
- Treatments can include prosthetics or surgical reconstruction

Atresia

- Absence or closure of the external auditory canal
- Can be classified by likelihood of repair (1-10)[1]
  - Based on findings of high resolution CT scan
  - 8 out of 10 equals 80% chance of hearing restoration (SRT between 15-25 dB)
  - Scores less than or equal to 5 are generally not considered candidates for surgical repair
- Surgical repair (canalplasty) usually not attempted until age 3-6

1 Jahrsdoerfer, RA, Yeakley, JW, Aguilar, EA, Cole, RR, Gray, LC (1992). Grading system for the selection of patients with congenital aural atresia. American Journal of Otology, (1) 13:6-12.

Chronic Otitis Media

- Persistent inflammation of the middle ear or mastoid
- Chronic suppurative otitis media can occur with tympanic membrane perforation
- 60% of those with chronic suppurative otitis media will have hearing impairment[1]
- Rate of chronic otitis media is estimated at 3% in North America with 22.5% occurring in children under 5[2]

1 World Health Organization (2004) Chronic suppurative otitis media: Burden of illness and management options.
2 Monasta et al (2012) Burden of disease caused by Otitis Media: Systematic review and global estimates. PLoS One, 7(4), e36226

Fluctuating Hearing Loss in Childhood

- Otitis media can cause fluctuating hearing loss in childhood
- Hearing loss due to otitis media in childhood can be more common in some indigenous populations or in developing countries[1]
- 29% of children with Down Syndrome have permanent mixed or conductive hearing loss; another 32% have fluctuating losses[2]
- Children with cleft palate are more likely to have chronic otitis media and hearing aid use among this population is reported at around 10%[3]

1 Monasta et al (2012) Burden of disease caused by Otitis Media: Systematic review and global estimates. PLoS One, 7(4), e36226
2 - Nightengale E, Yoon P, Wolter-Warmerdam K, Daniels D, Hickey F (2017) Understanding hearing and hearing loss in children with Down Syndrome. American Journal of Audiology, 26:301-308
3 - Gani B, Kinshuck AJ, Sharma R. (2012) A review of hearing loss in cleft palate patients. Int J Otolaryngol, 2012 (Online Article ID 548698)

Genetic Syndromes

Several genetic syndromes may be associated with conductive or mixed hearing loss, for example:

- CHARGE Syndrome
- Treacher-Collins Syndrome
- Branchio-oto-renal Syndrome
- Stickler Syndrome

Single Sided Deafness in Children

Single-Sided Deafness (SSD)

- Onset of universal newborn hearing screening has led to early identification of SSD, but clear recommendations for management have lagged[1]
- Prevalence estimates for SSD are about 1 per 1000 at birth rising to 14% of adolescents[1]
- Untreated, SSD in childhood can lead to delayed speech and language development[2], behavioral concerns[3] and academic concerns[4]

1 – Lieu J (2018) Permanent unilateral hearing loss and childhood development. Curr Otorhinolaryngol Rep, 6(1): 74-81.
2 – Vohr et al (2012) Language outcomes and service provision of preschool children with congenital hearing loss. Early Hum Dev. Jul; 88(7):493-8.
3 – Lieu J (2012) Longitudinal study of children with unilateral hearing loss. Laryngoscope, 122(9)
4 – Lieu J (2013) Unilateral hearing loss in children: Speech-language and school performance. B-ENTSuppl 21

Treatment for SSD in Children

- AAA's Pediatric Amplification Guidelines (2013):
  - "Children with aidable unilateral hearing loss should be considered candidates for amplification due to evidence for potential developmental and academic delays."
- Treatment options
  - Monitoring with no treatment
  - Classroom accommodations (ie, preferential seating, remote microphone technology)
  - Hearing aids (ie, traditional, CROS)
  - Bone conduction technology

Bone Conduction Solutions

Using Bone Conduction to Treat Hearing Loss

Conductive and Mixed Hearing Loss

Single-Sided Deafness

Technology Foundations

- Invented and developed in the 1970's by Professor Brånemark and Dr. Tjellström
- Cleared by the FDA in 1995 for mixed and conductive hearing loss and in 2002 for single-sided deafness
- About 40,000 people in the United States now hear with a Baha solution[1]

Dr Tjellström and the first Baha recipient, Mona Andersson (in 2012)

1 – Cochlear Internal Recipient Data, December 2017

Osseointegration

- The process by which living bone tissue bonds with titanium
- Makes direct bone conduction possible
- Provides the basis of long-term predictability and success of the Baha System

Why Bone Conduction?

Direct Bone Conduction:

- Works independently of ear canal and middle ear
- Direct transmission gives the power needed to hear what's missing
- Pre-operative testing is possible
- High wearing comfort
- Typically a routine outpatient procedure
- Predictable outcome

Baha® Systems

Non-Surgical

Baha Connect

Baha Attract

Baha System Candidacy

Conductive & Mixed Hearing Loss (CMHL)

Candidacy is based on bone conduction thresholds

Bone Conduction PTA equal to or better than 65 dB at 0.5, 1, 2 & 3 kHz

Bilateral fitting requires symmetric bone conduction thresholds

Less than 10 dB on average (0.5, 1, 2 & 3) or less than 15 dB at individual frequencies

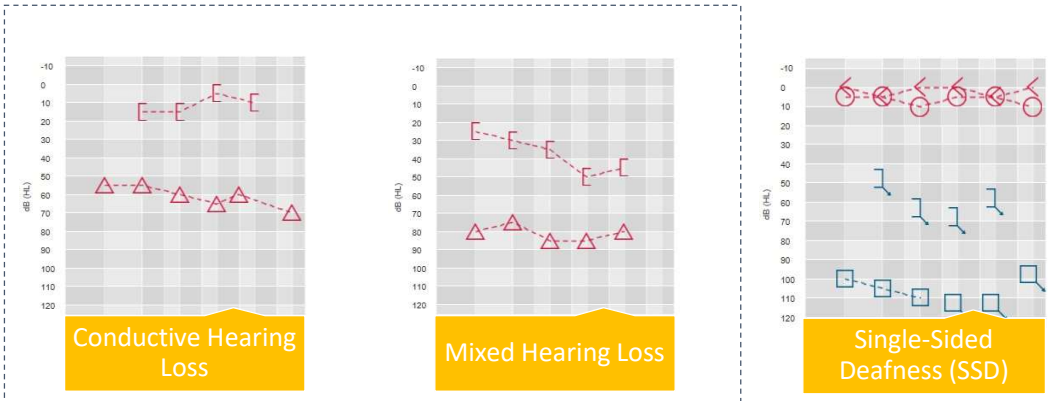
Single-Sided Deafness (SSD)

Profound SNHL in one ear and Normal hearing in the good ear

Defined as Air Conduction PTA equal to or better than 20 dB at 0.5, 1, 2 & 3 kHz

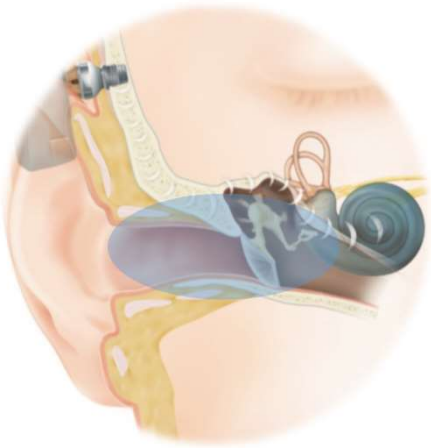
Surgery can be considered for children 5 years of age or older

Baha System Candidacy

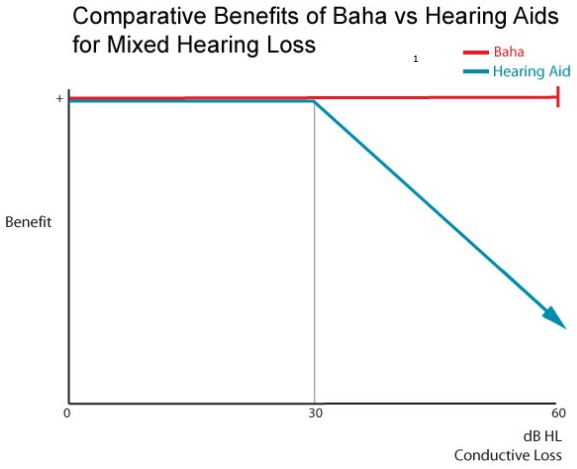


Baha System Candidacy: CMHL

- Direct bone conduction bypasses the outer and middle ear
- Baha solutions treat conductive & mixed hearing loss
  - Atresia
  - Chronic middle ear disease
  - Cholesteatoma
  - Congenital abnormalities
- Baha devices do not have to overcome conductive component, only amplify for any sensorineural component



Baha System vs Hearing Aids for CMHL



- The greater the air-bone gap, the more a Baha system will outperform hearing aids[2]
- Hearing aid prescriptions for conductive and mixed hearing loss require more gain and receive less clinical research than for sensorineural hearing loss[3]
- Hearing aid fitting can be difficult if there is drainage from the ear, ear pain or a mastoid cavity present after mastoidectomy[4]

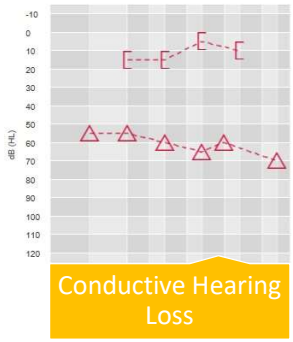
1 - Snik AF et al. (2005) Consensus Statements on the BAHA System: Where Do We Stand at Present? Annals of ORL 114(125), 195:1-12
2 – Mylanus EAM, van der Pouq K, Snik M (1998) Intraindividual comparison of the bone-anchored hearing aid and air-conduction hearing aids. Arch Otolaryngol Head Neck Surg, 124(3):271-276
3 - Johnson EE. (2013) Prescriptive amplification recommendations for hearing losses with a conductive component and their impact on the required maximum power output: An update with accompanying clinical explanation. J Am Acad Audiol, 24(6):452-60.
4 - Gluth MB, Friedman AB, Atcherson SR, Dornhoffer JL. (2013) Hearing aid tolerance after revision and obliteration of canal wall down mastoidectomy cavities. Otology & Neurotology, 34(4):711-4.

Baha System Advantages for CMHL

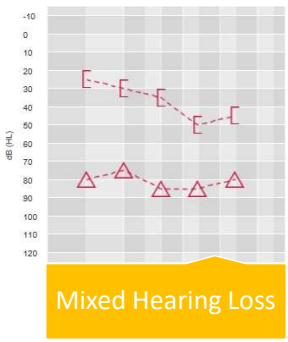
- Nothing worn on the external ear, which is helpful in cases where ear drainage is present[1] or if pinnas are misshapen
- Baha does not need to be re-adjusted if the air conduction thresholds fluctuate because gain is only required for the bone conduction thresholds
- Pre-operative testing can be used to predict post-operative benefit[2]
- Use of Baha is associated with high user satisfaction and good long-term benefit[3,4]

1 - Bouhabel S, Arcand P, Saliba I. (2012) Congenital aural atresia: bone-anchored hearing aid vs. external auditory canal reconstruction. Int J Pediat Otorhinolaryngol. 76(2):272-7.
2 - Monini S, Filippi C, Atturo F, Biagini M, Lazzarino AI, Barbara M. (2015) Individualised headband simulation test for predicting outcome after percutaneous bone conduction implantation. Acta Otorhinolaryngol Ital. 35(4):258-64
3 - Gardell ISK, Andresen K, Faber CE, Wanscher JH. (2015) Bone-anchored hearing aids are effective and associated with a high degree of satisfaction. Danish Medical Journal, 62(7):A5108
4 - Rasmussen J, Olsen S, Nielsen LH. (2012) Evaluation of long-term patient satisfaction and experience with the Baha bone conduction implant. Int J Audiol. 51(3):194-9.

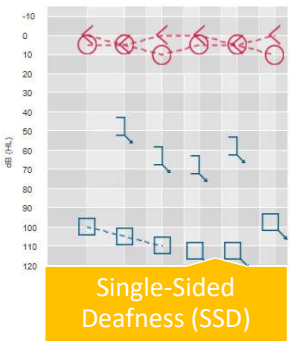
Baha System Candidacy



Conductive Hearing Loss



Mixed Hearing Loss

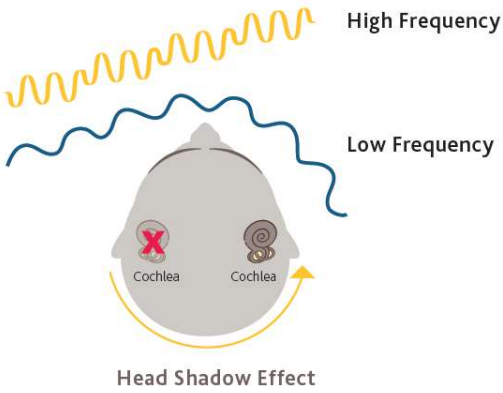


Single-Sided Deafness (SSD)

Baha System Candidacy: SSD

Two ears:

1. Help overcome the head shadow effect
2. Help understanding of speech in background noise
3. Help in the location of sound

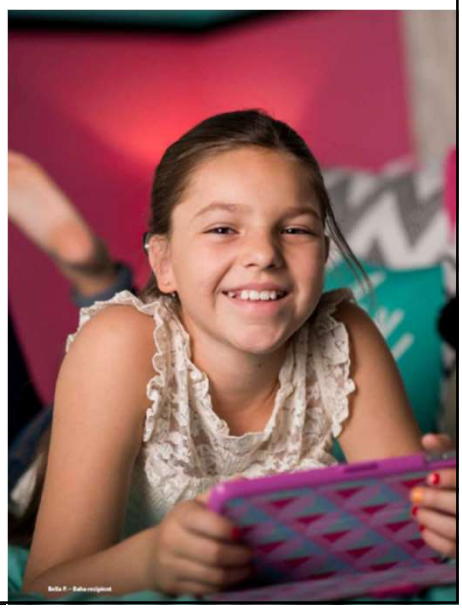


Treatment Options for SSD

Treatment options: SSD

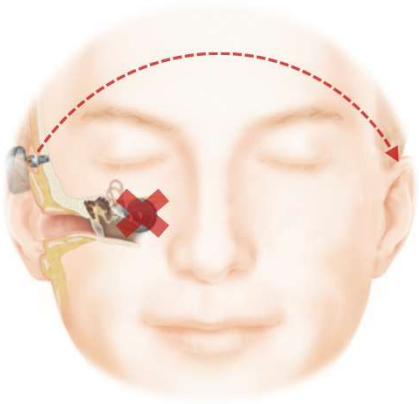
- Child remains untreated*
- CROS hearing aids
- Bone conduction devices (e.g., Baha)

**Parent or physician choice*



Advantages of Bone Conduction for SSD

- Improved speech understanding in noisy environments[1]
- Helps to lift the head shadow effect[1-4]
- Reduces the psychosocial consequences associated with hearing impairment[1,5-6]
- Long-term patient satisfaction and hearing benefits[7-8]



1. Hol MKS, Bosman AJ, Snik AFM, Mylanus EAM, Cremers CWRJ. "Bone anchored hearing aids in unilateral inner ear deafness: an evaluation of audiometric and patient outcome measurements." Otol Neurotol (2005:26): 999-1006.
2. Lin LM, Bowditch S, Anderson MJ, May B, Cox KM, Niparko K. Amplification in the rehabilitation of unilateral deafness: speech in noise and directional hearing effects with bone-anchored hearing and contralateral routing of signal amplification. Otology and Neurology 2006;27(2):172-82.
3. Pai I, Kelleher C, Nunn T, Pathak N, Jindal M, Fitzgerald O'Connor A, Jiang D. Outcome of bone-anchored hearing aids for single-sided deafness: A prospective study. Acta Oto-Laryngologica, Early Online 1-5.
4. Wazen JJ, Spitzer JB, Ghossaini SN, et al. Transcranial contralateral cochlear stimulation in unilateral deafness. Otolaryngology Head Neck Surg 2003;129(3):248-54.
5. Newman CW, Sandridge DA, Wodzisz LM. "Longitudinal benefit from and satisfaction with the Baha System for patients with acquired unilateral sensorineural hearing loss. Otol Neurotol 2008; 29: 1123-1131.
6. Schroder SA, Ravn T, Bonding P. BAHA in single sided deafness: patient compliance and subjective benefit. Otol Neurotol. 2010; 31: 404-408.
7. Kompis M, Wilhem W, Caversaccio. Long term benefit of bone anchored hearing systems in single sided deafness. Acta Oto-Laryngologica. 2017; 13:398-402.
8. Maurizio B, Biagini M, Lazzarino AI, Monini S, Hearing and quality of life in a south European BAHA population. Acta Oto-Laryngologica. 2010 130: 1040-1047.

Bone Conduction vs CROS

- The Baha system is a discreet solution worn on one side, while CROS hearing aids require users to wear devices on both ears
- Baha allows wireless streaming to be mixed with environmental mic from the bad side while CROS aids may require turning off the bad side in order to stream[1]
- The Baha System bypasses outer and middle ear and sends clearer, more crisp sound directly to the inner ear[2]
- Studies show that the Baha System provides better speech understanding in noise than CROS hearing aids[3-4]

1 – Phonak CROS II wireless compatibility, downloaded from: https://www.phonakpro.com/us/en/support/product-support/hearing-aids/cros-ii/compatibility-cros-ii.html December, 2017
2 - Gustafsson J. BCDrive performance vs. conventional bone conduction transducer. Cochlear Bone Anchored Solutions AB, 629908, 2015
3 - Niparko JK, Cox KM, Lustig LR. Comparison of the bone-anchored hearing aid implantable hearing device with contralateral routing of offside signal amplification in the rehabilitation of unilateral deafness. Otology & Neurotology, 2003 Jan;24(1):73-78
4 - Hol MKS, Bosman AJ, Snik AFM, Mylanus EAM, Cremers CWRJ. "Bone anchored hearing aids in unilateral inner ear deafness: an evaluation of audiometric and patient outcome measurements." Otol Neurotol (2005:26): 999-1006.

Non-Surgical Bone Conduction Solutions

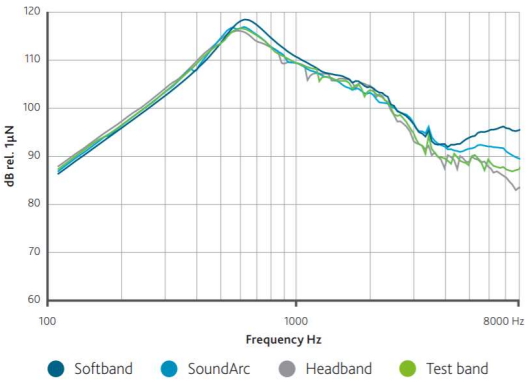
Baha Systems for Children: Non-surgical

- Prior to age 5, only non-surgical alternatives are available for children
- Softband is ideal for babies and toddlers
- Baha SoundArc is an effective and stylish alternative for young children
- Natural progression from non-surgical option to surgical option for consistent and reliable access to hearing[1]

1 – Flynn MC. Design concept and technological considerations for the Cochlear Baha 4 Attract System. Cochlear Bone Anchored Solutions AB, E82744, Nov 2013.

Non-Surgical Options

Transfer Efficiency for Non-Surgical Options[1]



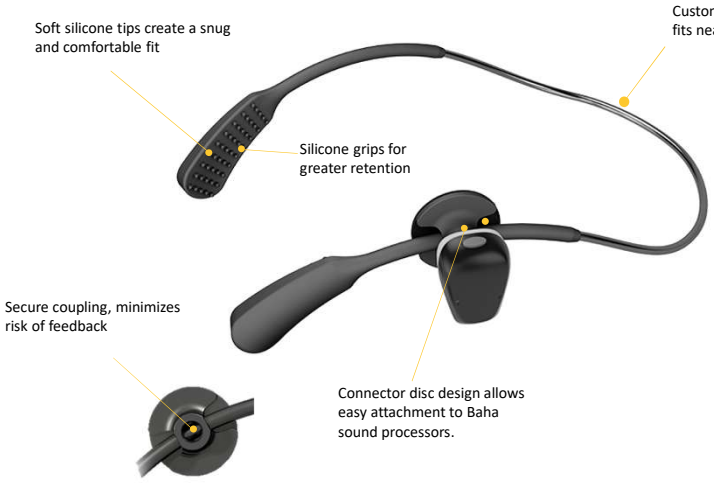
Transfer efficiency of the Baha SoundArc compared to the Baha Softband. Both were mounted on an artificial mastoid.

Baha SoundArc *Baha Softband*

Cochlear's non-surgical options are designed to provide a comfortable, high-quality experience for children not yet old enough for a surgical option or to allow patients to try a bone conduction solution prior to surgery

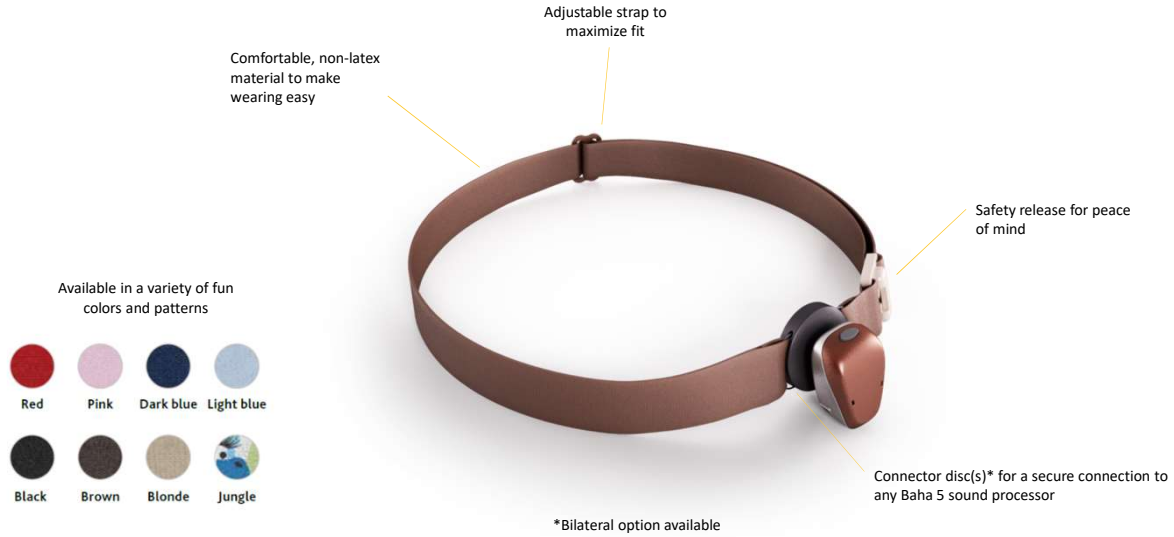
1 – Cochlear (2018) Design concept, technical verification and patient testing of the new Cochlear Baha SoundArc. (BUN655)

Baha SoundArc



Variety of soft colored tips to match hair, mood and clothes

The Baha Softband

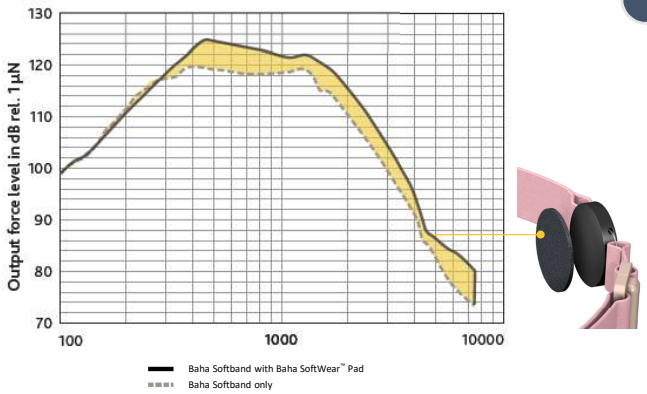


*Bilateral option available

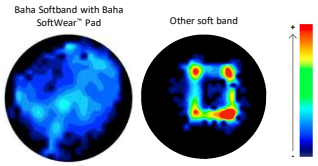
Baha SoftWear Pad

With a SoftWear pad, Softband users can demonstrate up to

3.8 dB BETTER SOUND TRANSMISSION[1]



Designed to reduce pressure and improve comfort by adapting to the contours of the head, maximizing the contact surface area and evenly distributing pressure



50% LESS PRESSURE COMPARED TO OTHER SOFTBANDS[1]

1. Flynn MC, Fyrlund H. Design concept and technological considerations for the new Baha Softband. Cochlear Bone Anchored Solutions AB, 631194, 2015.

Non-Surgical Options

Surgical Bone Conduction Solutions

Surgical Options

Baha Attract

Baha Connect

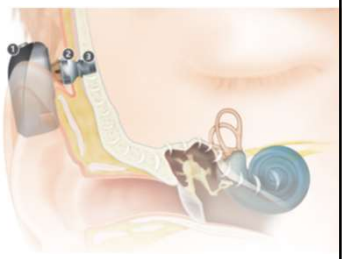
- The Baha Attract provides clinically proven performance with nothing through the skin[1]
- The Baha Connect's direct connection with the implant provides the maximum possible gain[2]
- Two systems with one strong foundation[3]

1 – Briggs R, Van Hasselt A, Luntz M, Goycoolea M, Wigren S, Weber P, Smeds H, Flynn M, Cowan R. Clinical performance of a new magnetic bone conduction hearing implant system: results from a prospective, multicenter, clinical investigation. Otol Neurotol. 2015;36(5):834-41.
2 - Clinicaltrials.gov ID NCT01796236. Clinical and Health Economic Evaluation With a New Baha® Abutment Combined With a Minimally Invasive Surgical Technique
3 - Nelissen RC, Stalfors J, de Wolf MJ, Flynn MC, Wigren S, Eeg-Olofsson M, Green K, Rothera MP, Mylanus EA, & Hol MK. Long-term stability, survival, and tolerability of a novel osseointegrated implant for bone conduction hearing: 3-year data from a multicenter, randomized, controlled, clinical investigation. Otol Neurotol. 2014, 35(8): 1486-91.

Baha Attract

- Internal and external magnets connect to provide an invisible link between the sound processor and implant
- Comfortable, easy to use and care for
- Designed with MRI safety in mind (approved for 1.5T)

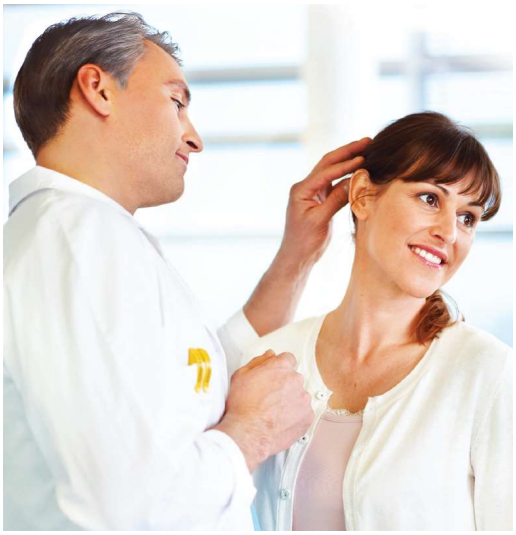
Baha Connect



- Utilizes a small abutment to provide a direct connection between the sound processor and implant
- Requires some daily cleaning and care
- Safe for MRI (at 1.5T and 3.0T)

Surgical Details

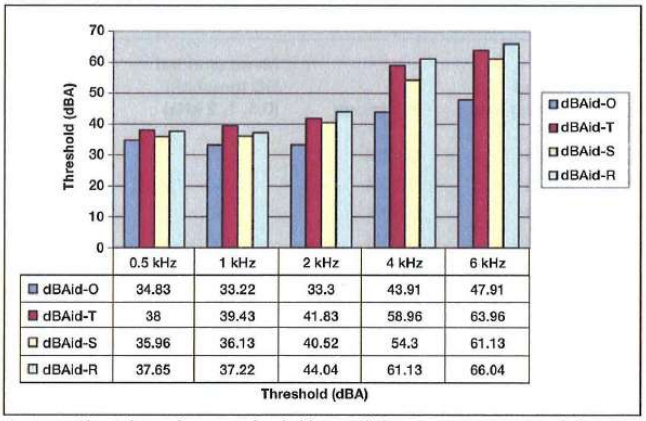
- Surgical procedure is straight-forward, usually lasting less than an hour
- Baha Connect is designed and FDA-cleared for preservation of soft tissue
- One or two stage surgery depending on age and bone integrity
- Outpatient procedure
- Adult surgeries can be done under local anesthesia
- Sound processor is fit:
  - 12 weeks for Baha Connect
  - 4 weeks for Baha Attract



Non-surgical vs. Surgical

Why consider a surgical option?

- Significant difference in thresholds with surgical option better than non-surgical options[1]
- Better sound transmission with a surgical option when compared to non-surgical option[2]
- Consistent access to sound
- More discretion with surgical option



	0.5 kHz	1 kHz	2 kHz	4 kHz	6 kHz
dBAid-O	34.83	33.22	33.3	43.91	47.91
dBAid-T	38	39.43	41.83	58.96	63.96
dBAid-S	35.96	36.13	40.52	54.3	61.13
dBAid-R	37.65	37.22	44.04	61.13	66.04

Figure 1. Chart shows the mean threshold in each listening situation at each frequency (dBAid-O = Baha osseointegrated implant; dBAid-T = Baha Testband; dBAid-S = Baha Softband; dBAid-R = Baha test rod).

Graph from Kara et al (2016)[2]

1. Heywood et al., (2011) Comparison of hearing thresholds obtained with Baha preoperative assessment tools and those obtained with the osseointegrated implant. Ear, Nose & Throat Journal, 90(5), E21-E27,
2. Kara, A., Iseri, M., Durgut, M., Topdag, M., & Ozturk, M. (2016). Comparing audiological test results obtained from a sound processor attached to a Softband with direct and magnetic passive bone conduction hearing implant systems. European Archives of Oto-Rhino-Laryngology, 273(12), 4193-4198.

Baha 5 Sound Processors

Small. Smart. Powerful.

Baha® 5 Sound Processors share the same unique technology building blocks to deliver a smart and seamless hearing experience to all patients.

The Cochlear Nucleus 7 Sound Processor is compatible with iPhone, iPad and iPod touch. For compatibility information visit www.cochlear.com/compatibility

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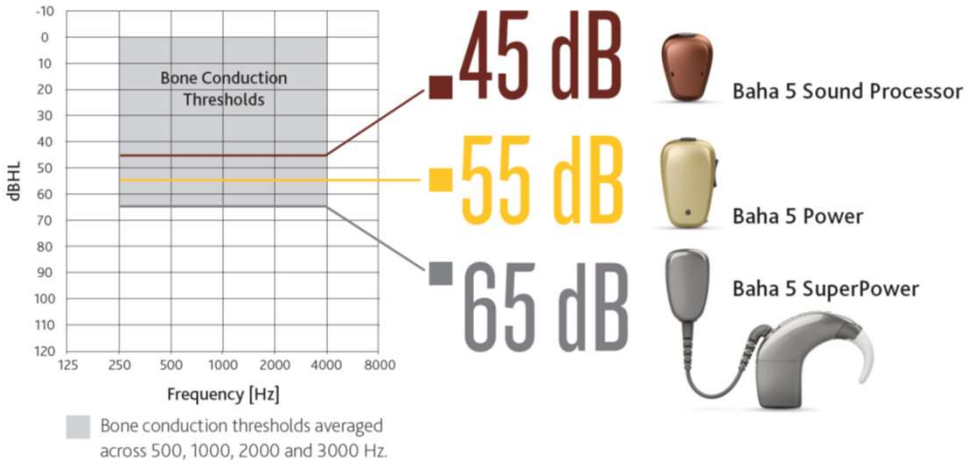
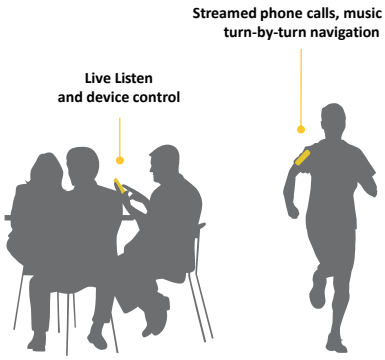
Baha 5 Portfolio



Course presented in partnership with

Connectivity for Communication

With innovative Bluetooth low energy technology, Baha 5 sound processors are the hearing implant industry's first Made for iPhone hearing devices.

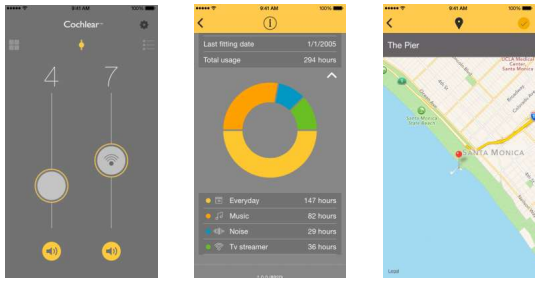


Bluetooth®

Made for iPhone | iPad | iPod

The First Smart App for Bone Conduction

Advanced control of sound processor and wireless accessories, personalisation and support – directly from iPhone®, iPad®, iPod touch® and Android™ smartphones.



Available on the App Store

GET IT ON Google Play

Course presented in partnership with

True Wireless Accessories

2.4 GHz Wireless Technology

Mini Microphone 2/2+

- Range up to 82 feet†
- Up to 10 hours of battery life
- Drop detection mute feature
- Directional microphone
- Table mic mode*
- FM compatibility*
- Built-in telecoil*
- Line-in connector*

Phone Clip

- Hands-free connection to any Bluetooth enabled mobile phone
- Answer and end calls with one button
- Use as a basic remote control
- Up to 6 hours of talk time (80 hours of standby time)

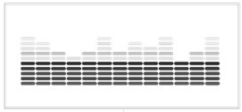
TV Streamer

- Easy to connect to virtually any analog or digital device
- Range of up to 23 feet†
- Install and forget – just a click of a button on the processor to watch TV

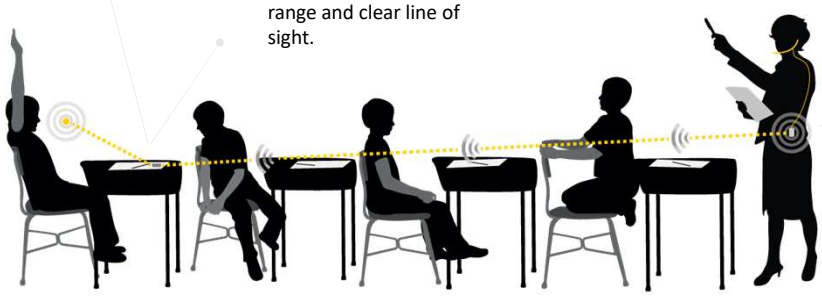
*Mini Mic 2+ only
†Clear line of sight

FM Capabilities with the Mini Mic 2+

Maintains dynamic FM signal across wireless connection.



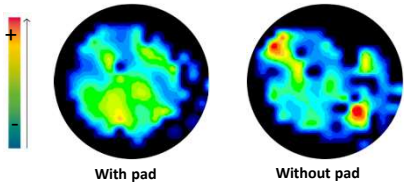
Mini Microphone can be placed anywhere within range and clear line of sight.



Tips for Fitting Baha in Children

Using the SoftWear Pad

The SoftWear pad for SoundArc and Softband



i-Scan pressure measurements on SoundArc, with and without Baha SoftWear Pad

Designed to reduce pressure and improve comfort by adapting to the contours of the head, maximizing the contact surface area and evenly distributing pressure

Attach by removing adhesive and sticking to the connector disc; replace when worn or soiled

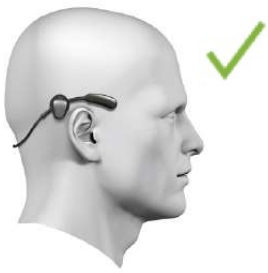
Adjusting the Softband

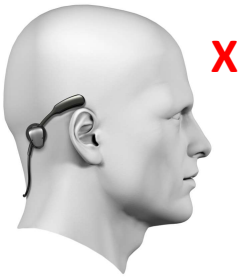
Tighten the Softband until it is close-fitting enough to be able to fit one finger between the head and connector disc. This will ensure effective sound transmission while ensuring it is loose enough so as not to cause discomfort.

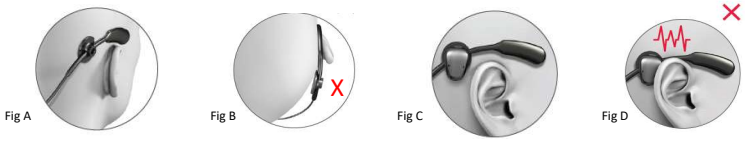
It is acceptable to have variable placement of the sound processor (ie, on the forehead for infants); position compensation is disabled by default in the software for a child/softband fitting to account for this, but may be also enabled if the sound processor will be consistently placed

Adjusting the SoundArc

- ✓ Place just **above the ears and follow the contours of the head. It should not rest on the pinna.** The bow should rest against the back of the head (fig A).
- ✓ Ensure that the entire area of **the Connector disc sits flush against the skin** on the head above and behind the ear; **it should not wobble** (fig B)**.**
- ✓ Ensure the Connector disc is in **direct contact with the skin** under the hair. It may be necessary to move or part the hair.
- ✓ The soft tips should rest comfortably and slightly **in front of the ear** (fig C).
- ✓ Interference with glasses or the pinna may cause feedback (fig D)







Attaching the Sound Processor

Any sound processor in the Baha Portfolio can be used with SoundArc and Softband

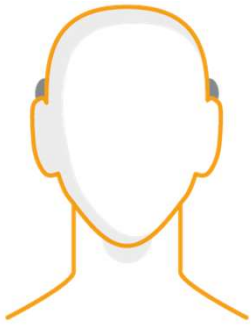
Attach the Baha sound processor to the connector disc

Importance of Bilateral Fitting

Audiological indications[1]

- Bilateral mixed or conductive hearing loss
- <10 dB difference on average (.5, 1, 2 & 3 kHz) or
- <15 dB difference at individual frequencies

To achieve binaural hearing, bone conduction thresholds should be symmetrical.[2]



Note: In the United States and Canada, the placement of a bone anchored implant is contraindicated in children below the age of 5.

Common otological causes (pediatrics)

- Bilateral microtia/atresia
- Ear canal stenosis
- Treacher-Collins syndrome

1. Janssen RM, Hong P, Chadha NK. Bilateral Bone-Anchored Hearing Aids for Bilateral Permanent Conductive Hearing Loss: A Systematic review. Otolaryngol Head Neck Surg. 2012;147(3):412-22.
2. Bosman et al; Audiometric Evaluation of Bilaterally fitted Bahas (2001) Audiology 40, 158-167

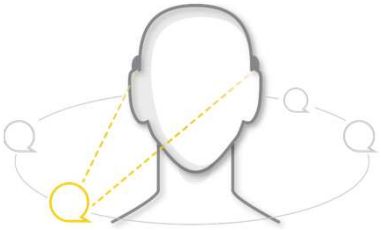
Bilateral: Improved ability to localize sounds

Several studies demonstrate clear localization benefits when comparing a unilateral bone conduction fitting to a bilateral fitting.[1-3]

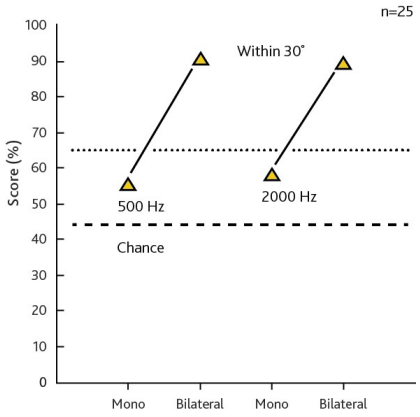
Bilateral patients are able to localize sound within 30°

9 TIMES OUT OF 10

Unilateral patients are close to chance level.[1]



Localization of sound, bilateral vs unilateral[1]



Mono = unilateral fitting
Bilateral = bilateral fitting

1. Bosman AJ, Snik AF, van der Pouw CT, Mylanus EA, Cremers CW. Audiometric evaluation of bilaterally fitted bone-anchored hearing aids. Audiology. 2001;40:158-167.
2. Agterberg MJ, Hol MK, Cremers CW, Mylanus EA, van Opstal J, Snik AF. Conductive hearing loss and bone conduction devices: restored binaural hearing? Adv Otorhinolaryngol. 2011;71:84-91.
3. Dun CA, Agterberg MJ, Cremers CW, Hol MK, Snik AF. Bilateral Bone Conduction Devices: Improved Hearing Ability in Children With Bilateral Conductive Hearing Loss. Ear Hear. 2013;34(6):806-8.

Bilateral: Improved hearing in noise

Available clinical evidence suggests that a two ear approach leads to improved hearing in noise.[1-3]

Up to

3.1 dB

improved SNR

when going from a unilateral to bilateral fitting[1]

Difference in Speech Reception Threshold in Noise between bilateral and unilateral bone conduction implant condition

Study	N	Mean improvement in SNR with bilateral vs unilateral BCI
Bosman et al.[2]	25	2.5 dB (sound and noise separated) P < .001
Priwin et al.[3]	12	3.1 dB (sound and noise separated) 2.8 dB (surround sound)

1. Jansen RM, Hong P, Chadha NK. Bilateral bone anchored hearing aids for bilateral permanent conductive hearing loss: a systematic review. Otolaryngol Head Neck Surg. 2012;147(3):412-22.
2. Bosman AJ, Snik AF, van der Pouw CT, Mylanus EA, Cremers CW. Audiometric evaluation of bilaterally fitted bone-anchored hearing aids. *Audiology*. 2001;40:158-167.
3. Priwin C, Stenfelt S, Granstrom G, Tjellstrom A, Hakansson B. Bilateral bone-anchored hearing aids (BAHAs): an audiometric evaluation. *Laryngoscope*. 2004;114:77-84.

Bilateral: Improved audibility

A bilateral fitting of a bone conduction solution provides a summation effect. This will improve the dynamic range and speech perception in quiet.[1]

Up to

5.4 dB

summation effect

when going from a unilateral to bilateral fitting[1]

Difference in Speech Reception Threshold in Quiet between bilateral and unilateral bone conduction implant Condition

Study	N	Mean improvement in SRT with bilateral vs unilateral BCI
Bosman et al.[2]	25	4.0 dB (P < .001)
Hamann et al.[3]	23	4.0 dB
Priwin et al.[4]	12	5.4 dB (P = .001)

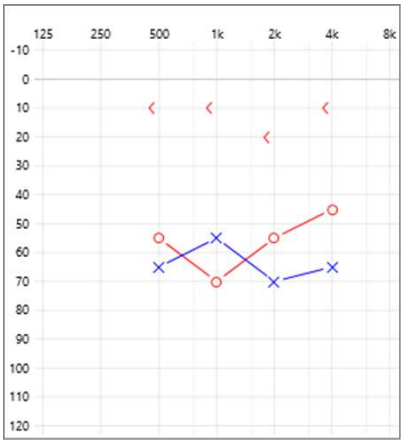
1. Jansen RM, Hong P, Chadha NK. Bilateral bone anchored hearing aids for bilateral permanent conductive hearing loss: a systematic review. Otolaryngol Head Neck Surg. 2012;147(3):412-22.
2. Bosman AJ, Snik AF, van der Pouw CT, Mylanus EA, Cremers CW. Audiometric evaluation of bilaterally fitted bone-anchored hearing aids. *Audiology*. 2001;40:158-167.
3. Hamann C, Manach Y, Rouilleau P. Bone anchored hearing aid. Results of bilateral applications [in French]. *Rev Laryngol Otol Rhinol (Bord)*. 1991;112:297-300.
4. Priwin C, Stenfelt S, Granstrom G, Tjellstrom A, Hakansson B. Bilateral bone-anchored hearing aids (BAHAs): an audiometric evaluation. *Laryngoscope*. 2004;114:77-84.

Case Studies

Manny: Introduction

- Born with bilateral microtia and atresia
- Diagnosed with moderate to severe hearing loss in both ears at 3 months of age
- Combined microtia and atresia surgery with several follow up surgeries throughout the first 5 years of life

Manny: Audiogram (12 mos of age)



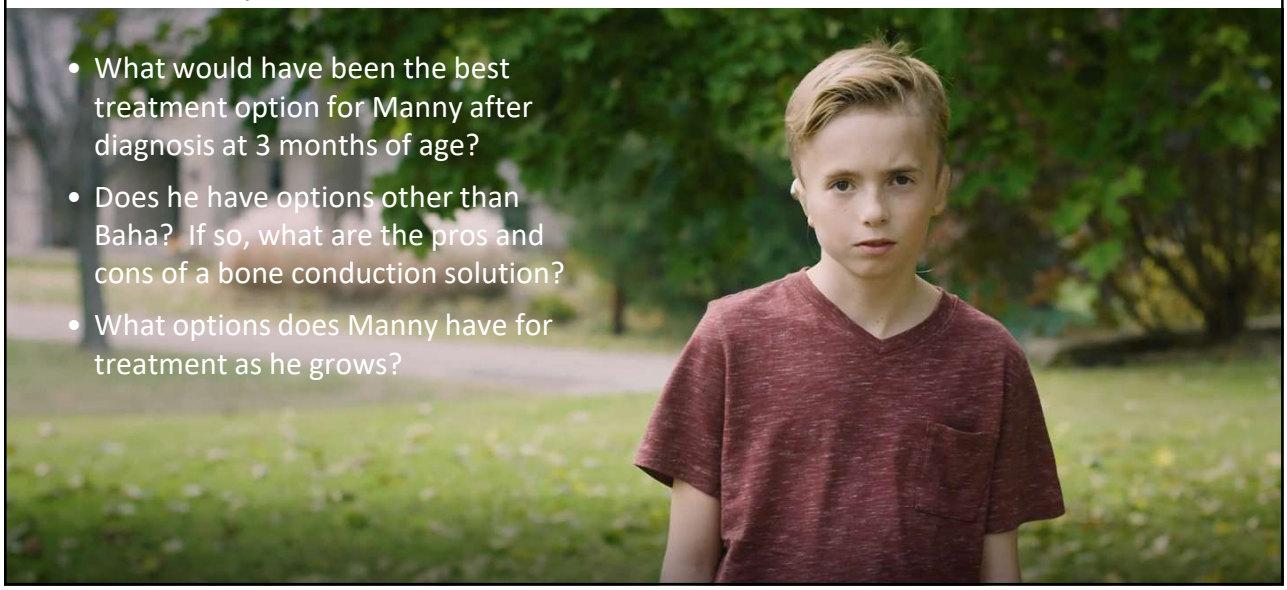
Test Method:

- Visual Reinforcement Audiometry (VRA)
- Headphones (supra-aural) for air conduction
- Good reliability

Speech Audiometry:

- Right SDT: 55
- Left SDT: 60
- Bone Conduction SDT: 5

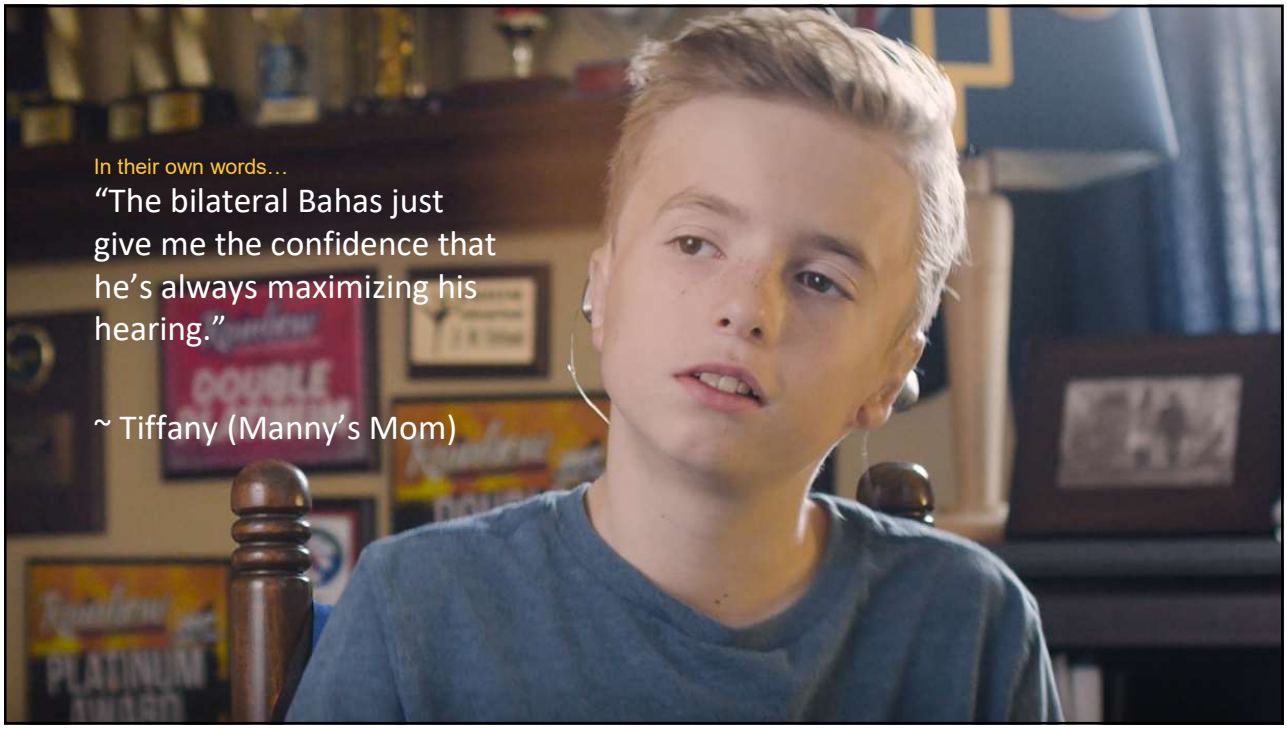
Manny: Discussion



- What would have been the best treatment option for Manny after diagnosis at 3 months of age?
- Does he have options other than Baha? If so, what are the pros and cons of a bone conduction solution?
- What options does Manny have for treatment as he grows?

Manny: Outcome

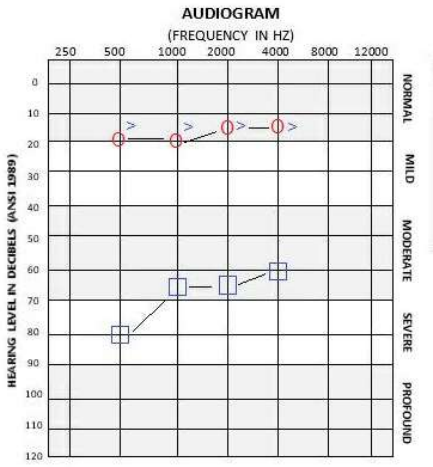
- Manny received a softband at 3 months of age; he was fit bilaterally at 12 months of age
- Thresholds were in the normal range with his Baha sound processors on the softband
- After a surgery which significantly worsened the hearing in his left ear at age 5, his family pursued a surgical Baha solution on that side and then a Baha on the other side shortly after
- Manny's family is thrilled with his progress – his speech and language is age-appropriate and he attends mainstream school



Brynlee: Introduction

- Born with unilateral microtia and atresia
- Diagnosed with moderate conductive loss in the right ear at 3 months of age
- Fit with Softband just prior to her first birthday.

Brynlee: Audiogram (18 mos of age)



Test Method:

- Visual Reinforcement Audiometry (VRA)
- Headphones (supra-aural) for air conduction
- Good reliability

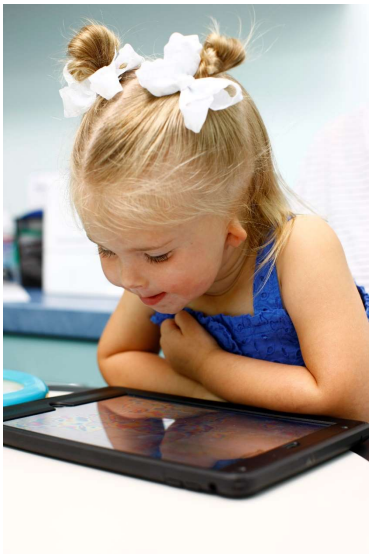
Speech Audiometry:

- Right SDT: 10
- Left SDT: 65

Brynlee: Discussion

- What would have been the best treatment option for Brynlee after diagnosis at 3 months of age?
- Does she have options other than Baha? If so, what are the pros and cons of a bone conduction solution?
- What options does Brynlee have for treatment as she grows?

Brynlee: Outcome



- Brynlee received a softband at 12 months of age
- Thresholds were in the normal range with her Baha sound processor on the softband
- Brynlee only qualifies for Deaf Education services – not other therapies at this time. Parents decided not to pursue any goals relating to that due to Brynlee doing well with listening/speech.
- Family is excited to meet with their surgeon to discuss implantation soon.

Conclusions

- Bone conduction is a unique treatment solution for children, especially those with conductive, mixed or unilateral hearing loss
- Cochlear offers solutions for children from Softband to SoundArc through to Baha Connect and Attract when children are ready for surgery
- Baha 5 sound processors offer wireless connectivity for FM use in the schools