Hearing Loss in the Older Adult

Abstract

Hearing loss has a profound impact on an individual. A hidden disability, hearing loss disrupts the way we communicate and ultimately limits our ability to socialize and engage with others. Hearing loss is the most common communication disorder in the older adult population. Our aim is to update readers about types of hearing loss, and to provide specific information on intervention options for conductive hearing loss. This article will address implantable hearing devices used to correct conductive loss and recent technological advances in these devices.

Key words: hearing loss, hearing aids, bone-conduction device, hearing implant, osseointegration

Sensorineural hearing loss in the older adult

Sensorineural hearing loss is the most common hearing disorder amongst older adults. It presents when there is pathology in the cochlea or the auditory neural pathways. All patients complaining of hearing loss require a full audiological assessment which includes an evaluation of air- and bone-conduction hearing levels. Once sensorineural hearing loss has been diagnosed, the search for a cause often does not alter treatment course for auditory rehabilitation, typically with conventional air-conduction hearing aids. The primary care physician should assess the external ear canal for pathology and also evaluate the tympanic membrane. In the presence of otitis externa, a tympanic membrane perforation, or active chronic otitis media, a referral to otolaryngology is recommended as conventional air-conduction hearing aids may not be appropriate first-line treatment. If the patient does have otitis externa or a tympanic membrane perforation, a conventional air-conduction

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hearing aid may worsen the patient's condition by causing otorrhea secondary to infection which would lead to mandatory cessation of the use of hearing aids. This often leads to a frustrated patient who has already invested their time and financial resources into acquiring hearing aids. If there is an asymmetrical sensorineural hearing loss, the primary care physician should seek the opinion of an otolaryngologist to further treat the underlying pathology. An MRI of the internal auditory canal is performed in order to rule out a vestibular schwannoma.

Conductive Hearing Loss in the Older Adult

Conductive hearing loss is caused by various pathologies involving the external auditory canal and the middle ear. External ear abnormalities include: external auditory canal atresia, otitis externa, and a large mastoid cavity which communicates directly with the external ear canal. Common middle ear conditions include: tympanic membrane perforations and chronic infections of the middle ear and mastoid, cholesteatoma, and chronic infections of the middle ear and mastoid. Mixed hearing loss is a combination of a sensorineural hearing loss and a conductive hearing loss. Any patient with conductive hearing loss or mixed hearing loss should be referred to an otolaryngologist. With the help of an audiologist, the otolaryngologist will diagnose the cause of the conductive hearing loss so that appropriate treatment options can be discussed with the patient.

Bone-conduction implants are often the only way to adequately and safely amplify a patient's conductive hearing.[1] Bone-anchored hearing aid implants, also known as bone-conduction hearing devices, utilize the patient's preserved inner ear function to restore hearing. Bone-conduction hearing devices rely on the transmission of sound vibrations that travel through the skull directly to the cochlea to enhance hearing by bypassing the external or middle ear entirely. Implanted hearing systems are composed of two main components: a sound processor, often with similar components to a hearing aid, and a surgical implant which relies on osseointegration with the bone of the skull. Osseointegration is crucial to the operation of these devices. Osseointegration connects the implant surface to the osteocytes to ensure that the implant works optimally and safeguards against extrusion from the bone.

Classification of Bone-Conduction Hearing Devices (BCD)

Current bone-conduction devices are classified as percutaneous or transcutaneous. Percutaneous devices utilize a screw abutment which is anchored to the skull and protrudes through the skin. The hearing aid processor attaches to the abutment and transforms sound into sound waves sending them directly into the bone through the osseointegrated titanium implant. The Bone Anchored Hearing Aid (BAHA™)

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system by Cochlear Americas and the Ponto™ system by Oticon Medical are both percutaneous bone conduction devices, which consist of the largest part of the bone conduction market.[2]

Transcutaneous devices are implants concealed completely under the skin; the hearing aid processor connects to the implant with a magnet-based system. These devices are further subdivided into active and passive systems. Active systems provide direct-to-bone stimulation where the implant is the source of the sound vibrations. Passive systems drive sound from the sound processor, through the soft tissue, then to the bone. MedEl's Bonebridge™ and Oticon Medical's Bone Conduction Implant (BCI)** are examples of active transcutaneous systems. Medtronic Xomed Inc.'s Otomag Alpha (M) Bone Conduction Hearing System implant (see Figure 1) and Cochlear's America's BAHA™ Attract** are passive transcutaneous systems**.[3-5]

Transcutaneous systems utilize an osseointegrated implant with internal magnets and an external component consisting of an external magnet and sound processor. Transcutaneous devices are becoming an increasingly popular choice over percutaneous devices due to the possibility of infection and cosmetic concerns that arise with the abutment. The complications of soft tissue reactions, infection around the abutment, and loss of the implant with percutaneous systems make transcutaneous implants very attractive.[6] Transcutaneous systems combine the benefits of a reduction of infective complications with a reduced cost to the patient or the taxpayer, making it an appealing option. As transcutaneous technology advances, we are beginning to see an increasing preference for transcutaneous systems like the Medtronic Xomed Inc.'s Otomag Alpha (M) Bone Conduction Hearing System implant.

Choosing the right candidate for a bone-conduction device involves a multidisciplinary approach. Otolaryngologists and audiologists must work together to evaluate patients who will be the best surgical and audiological candidates for these devices.

Overall, transcutaneous systems take longer to implant compared with percutaneous systems.[7] Most percutaneous implants are implanted under local anesthetic. Transcutaneous implants require more drilling, hence the need for general anesthetic in most patients. The Medtronic Xomed Inc.'s Otomag Alpha (M) Magnetic implant is smaller than the Bonebridge™, hence it takes less time to implant. With the size of the Bonebridge™, preoperative CT planning is recommended by most surgeons, but is not required for the Medtronic Xomed Inc.'s Otomag Alpha (M) Magnetic implant given its smaller size.[8] The BCI is not available on the market at the time of publication.

Candidacy Considerations for BCDs

Surgical candidacy considerations

The following conditions must satisfy the audiological criteria in order for patients to be classified good candidates for BCDs:[9]

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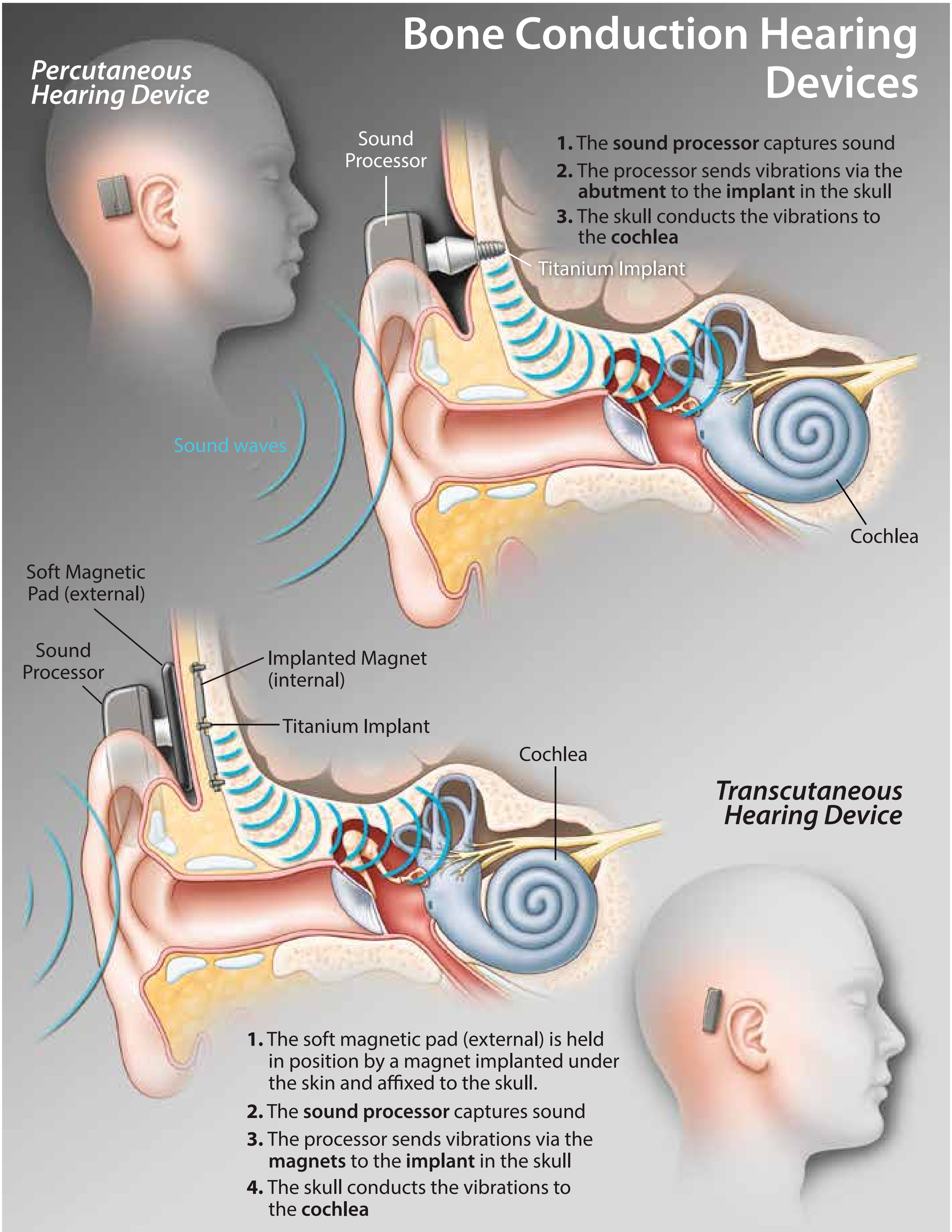
Bone Conduction Hearing Devices
Percutaneous Hearing Device
Sound Processor
1. The sound processor captures sound
2. The processor sends vibrations via the abutment to the implant in the skull
3. The skull conducts the vibrations to the cochlea
Titanium Implant
Sound waves
Cochlea
Soft Magnetic Pad (external)
Sound Processor
Implanted Magnet (internal)
Titanium Implant
Cochlea
Transcutaneous Hearing Device
1. The soft magnetic pad (external) is held in position by a magnet implanted under the skin and affixed to the skull.
2. The sound processor captures sound
3. The processor sends vibrations via the magnets to the implant in the skull
4. The skull conducts the vibrations to the cochlea

- Patients with severe otitis externa which flare up every time they use air-conduction hearing aids.
- Patients with acquired or congenital external auditory canal atresia, including patients whose external auditory canal has been closed surgically.
- Patients with chronic otitis media with either a large tympanic membrane perforation or a cholesteatoma.
- Patients with mastoid cavities after a mastoidectomy.
- Patients where ossicular chain reconstruction has failed to improve the conductive hearing loss.

Percutaneous technology is recommended for patients who will recover more optimally after a quick procedure using local anesthetic. Patients with significant comorbidities who are high-risk general anesthetic candidates should be offered a percutaneous implant as an option.

Patient Factors that Influence Choice of Implants

Patients who are at increased risk of skin and soft tissue reactions, including poor wound healing in diabetics, tend to make poorer candidates for percutaneous implant systems. Patients who work in dirty environments and situations where there is an increased risk of skin infection should be counselled carefully about the increased infective risks associated with a percutaneous implant and the augmented cost of maintenance. These patients should be given the option of a transcutaneous system.[10]

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Otolaryngology and audiology must work together to evaluate the best surgical and audiological candidates for these devices.

Patients who have an increased risk of trauma and the potential to damage a percutaneous abutment should be given the option of a transcutaneous device. Patients with limited finger dexterity should be given the choice of transcutaneous devices because sound processors tend to be easier to attach directly to the skin rather than to an abutment.[11] In addition to ergonomics of use, some patients reject the appearance of the abutment for cosmetic reasons. Some patients do not like the look of certain sound processors. These considerations help guide patient choice. Maintenance costs (cost of batteries for the sound processor) and reliability of sound processors are also factors that need to be discussed with patients.

Audiological criteria for BCDs

Patients must undergo a full audiological assessment of their air- and bone-conduction thresholds. Bone-anchored devices are most appropriate for patients who have significant conductive hearing loss and who will not benefit from a conventional hearing aid. Size of the air-bone gap should be more than 30 dB PTA (average of 0.5, 1, 2, 4kHz) to have the most optimal benefits compared to that of an air-conduction hearing aid.[10,12,13] Patients with mixed hearing losses can still benefit from bone-conduction devices, so long

Key Points

Any patient with a conductive hearing loss or mixed hearing loss should be referred to an otolaryngologist.

Choosing the right candidate for a bone-anchored hearing system involves a multidisciplinary approach.

Otolaryngology and audiology must work together to evaluate the best surgical and audiological candidates for these devices.

The Medtronic Xomed Inc.'s Otomag Alpha (M) Bone Conduction Hearing System is a passive soft-tissue driven transcutaneous system that is safe, easy to implant, and reliable.[16]

Bone conduction hearing devices are a viable option for some patients with conductive and mixed hearing losses where a conventional hearing aid is not a good choice.

as their bone-conduction thresholds are within the fitting range of the sound processor. Percutaneous devices (Ponto™ and BAHA™) and active transcutaneous implants (Bonebridge™) have fitting ranges of 45 dB HL for optimal benefit. Patients with more severe sensorineural components can benefit from the most powerful Ponto™/BAHA™ devices with fitting ranges up to 65 dB HL. Passive transcutaneous devices such as the Medtronic Xomed Inc.'s Otomag Alpha (M) Bone Conduction Hearing System have a fitting range better than 45 dB HL. The BAHA™* Attract requires a 30 dB HL air-bone gap, but could compensate for sensorineural components up to 45 dB HL.[14] Criteria for candidacy varies on the available maximum output of the devices. Percutaneous and active transcutaneous devices have the largest fitting range, whereas passive transcutaneous devices are best suited for patients with bone-conduction results above 30 dB HL caused by attenuation of sound as it passes through soft tissue.[8]

Patients with single-sided deafness may also benefit from bone-conduction devices, but must have normal hearing in their other ear. The bone-conduction device acts as a contralateral routing of signal (CROS) device to send sound from the deaf side to the cochlea of the opposite ear. Bone-conduction systems can be a viable option for this type of hearing loss.[15] It is recommended that patients pursue a trial of an air-conduction CROS hearing aid first before making the decision to implant a BCD.

In conclusion, bone-conduction devices provide an excellent option for hearing restoration. There are many advantages over air-conduction devices for patients with conductive and mixed hearing loss. We recommend that patients undergo audiological evaluation and be referred to otolaryngology to further discuss candidacy for these implants.

References

1. Dybala, P. Bone-Anchored Hearing Devices. Healthy Hearing website. https://www.healthyhearing.com/help/hearing-aids/bone-anchored. Updated May 16, 2017. Accessed January 9, 2018.

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Clinical Pearls

Assessment and patient selection for bone-conduction hearing implants require a multidisciplinary approach with otolaryngologists and audiologists. Best candidates meet criteria both surgically and audiologically.

Softband bone-conduction trials with an audiologist can be used to demo and counsel patients on the device and technology. It is non-invasive, only requiring the external processor and a specialized headband to demonstrate its function.

Key Point

Bone conduction hearing devices are a viable option for some patients with conductive and mixed hearing losses where a conventional hearing aid is not a good choice.

2. Reinfeldt S, Håkansson B, Taghavi H, Eeg-Olofsson M. New developments in bone-conduction hearing implants: a review. Medical Devices (Auckland, NZ). 2015;8:79-93. doi:10.2147/MDER.S39691.
3. Sprinzl G, Lenarz T, Ernst A, et al. First European multicenter results with a new transcutaneous bone conduction hearing implant system: short-term safety and efficacy. Otol Neurotol. 2013;34:1076–83.
4. Siegert R, Kanderske J. A new semi-implantable transcutaneous bone conduction device: clinical, surgical, and audiologic outcomes in patients with congenital ear canal atresia. Otol Neurotol. 2013;34:927–34.
5. Reinfeldt S, Hakansson B, Taghavi H, et al. New developments in bone-conduction hearing implants: a review. Med Devices (Auckl) 2015;8:79–93.
6. den Besten C, Nelissen R, Peer P, et al. A retrospective cohort study on the influence of comorbidity on soft tissue reactions, revision surgery, and implant loss in bone-anchored hearing implants. Otol Neurotol. Jun 2015;36(5):812-818.
7. Iseri et al. Transcutaneous bone-anchored hearing aids versus percutaneous ones: multicentre comparative clinical study. Otology & Neurotology. 2015;36(5):849-53.
8. Kozlowski K, Friedland D. Implantable hearing devices. Current Surgery Reports. 2014;2:1–10.
9. Hagr A. BAHA: Bone-Anchored Hearing Aid. International Journal of Health Sciences. 2007;1(2):265-276.
10. De Wolf M, Hendrix S, Creamers C, et al. Better performance with bone anchored hearing aid than acoustic devices in patients with severe air-bone gap. The Laryngoscope 2011;121:613-16.
11. Gawęcki W, Stieler OM, Balcerowiak A, et al. Surgical, functional and audiological evaluation of new Baha® Attract system implantations. European Archives of Oto-Rhino-Laryngology. 2016;273(10):3123-3130.
12. Bosman A, Snik A, Hol M, et al. Evaluation of a new powerful bone-anchored hearing system: A comparison study. Journal of the American Academy of Audiology 2013; 24(6)505-13.
13. Mylanus E, van der Pouw K, Snik A, et al. Intraindividual comparison of the bone-anchored hearing aid and air-conduction hearing aids. Archives of Otolaryngoloy-Head & Neck Surgery 1998;124(3):271-6.
14. Dimitriadis PA, Farr MR, Allam A, Ray J. Three year experience with the cochlear BAHA attract implant: a systematic review of the literature. BMC Ear, Nose, and Throat Disorders. 2016;16:12.
15. Hol M, Kunst S, Snik A, et al. Pilot study on the effectiveness of the conventional CROS, the transcranial CROS and the BAHA™ transcranial CROS in adults with unilateral inner ear deafness. European Archives of Otorhinolaryngol. 2010 Jun;267(6):889-96.
16. Siegert R and Kanderske J. A New Semi-Implantable Transcutaneous Bone Conduction Device: Clinical, Surgical, and Audiologic Outcomes in Patients with Congenital Ear Canal Atresia. Otology & Neurotology. 2013;34:927-934.