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Bone Anchored Hearing Prosthesis: An Update

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Keywords

Bone anchored hearing prosthesis; Hearing implants; Hearing aids

Introduction

Conventional hearing aids use the airway to amplify sound. Many people have difficulty using hearing aids due to changes in the external ear that impair the adaptation of the hearing aid in the canal, such as patients who were born with malformations (external ear canal atresia, microtia, or anotia), chronic infections (chronic otitis with leakage of secretion from the ear), tumors or post-surgical anatomical alterations of the ear in which it is necessary to increase the size of the canal, as in surgeries for cholesteatoma (tympanomastoidectomy, for example). In these cases, bone-anchored hearing aids can be indicated, as they will send the sound stimulus directly from the prosthesis (speech processor) to the cochlea via bone conduction, "skipping" the damaged outer and middle ears. The aim of this review article is to discuss about the updates in bone anchored hearing prosthesis.

Discussion

There are two ways that sound can stimulate our inner ear, the airway and the bone way. Air conduction is the main one and, in patients with normal ears, the sound enters the ear pavilion and external auditory meatus, vibrates the tympanic membrane and the ear ossicles (hammer, incus and stapes), stimulating the cochlea that transforms mechanical energy into electrical energy, which is transmitted to the cochlear nerve or auditory nerve, which is then carried to the brain [1].

Sound conduction essentially through the bone occurs when there is any obstruction or interruption in the passage of sound through the external ear, in the ear canal, or through the middle ear, in the eardrum, or in the ossicles, in which case the stimulus goes through the bones of the skull to the cochlea, evidently with a loss of sound intensity, as the sound amplification mechanism that the eardrum and ossicles provide is lost [2,3]. Bone Anchored Hearing Prosthesis, or Osteo Anchored Hearing Prosthesis, are devices that provide bone conduction of sound to the cochlea.

The concept of bone conduction has been around for a long time. One of the first to adopt it was composer Ludwig van Beethoven. Beethoven began to lose his hearing when he was in his early twenties and needed a way to hear his music so he could keep writing. He then realized that by placing the end of a stick on the piano and the other end between his teeth, he would be able to perceive the sound. The vibrations of the piano sound traveled down the shaft, past his teeth and skull to his cochlea. This allowed Beethoven to hear enough to continue composing, with some of his greatest works being created when he already had severe hearing loss [4].

Conventional hearing aids use the airway to amplify sound. Many people have difficulty using hearing aids due to changes in the external ear that impair the adaptation of the hearing aid in the canal, such as patients who were born with malformations (external ear canal atresia, microtia, or anotia), chronic infections (chronic otitis with leakage of secretion from the ear), tumors or post-surgical anatomical alterations of the ear in which it is necessary to increase the size of the canal, as in surgeries for cholesteatoma (tympanomastoidectomy, for example). In these cases, bone-anchored hearing aids can be indicated, as they will send the sound stimulus directly from the prosthesis (speech processor) to the cochlea via bone conduction, "skipping" the damaged outer and middle ears [5,6].

Another group of patients who can benefit from bone conduction prostheses is those who have unilateral deafness. These patients do not necessarily have external ear canal or middle ear problems

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but are unable to adapt or have satisfactory results with hearing aids due to the degree of hearing loss (severe or profound). This is called Single-Sided Deafness (SSD). In this situation, the patient has difficulty in locating the sound source and in understanding sounds in noisy environments or where several people are talking at the same time [7].

Stimulation via bone conduction is possible thanks to the implantation of a titanium pin that transmits the vibration of the prosthesis directly to the skull bone in the retroauricular area. This vibration travels through the skull bone to the cochlea [8].

In the case of unilateral deafness, the patient will not hear on the operated side but the opposite one. Sound goes through bone conduction to stimulate the other ear, improving the ability to locate the sound source [9,10].

There are two bone conduction systems, transcutaneous and percutaneous. In the percutaneous system, a titanium pin is surgically inserted through the skin. In the transcutaneous system, the skin remains intact and the internal and external devices are connected by magnets [11].

Baha and Ponto

In both, there is a pin of titanium that goes through the skin, so-called percutaneous systems [8].

Baha Attract, Bonebridge and Osia System

In these, there is no pin going through the skin. The connection is made by an internal and external magnet system, which is why they are called transcutaneous.

Osia System

In these, there is also no pin going through the skin, the connection is made by an internal and external magnet system, which is why they are called transcutaneous.

Among both systems, the transcutaneous ones (BAHA attract, BoneBridge and, Osia) have lesser complications of skin infection [12].

The percutaneous (BAHA Connect and PONTO) have the aesthetic disadvantage of the pin crossing the skin, in addition to complications related to the external pin and skin infections, but they have superior amplification capacity, as they connect the speech processor directly to the bone, without the skin attenuation [13].

The type of osteo anchored prosthesis indicated, percutaneous or transcutaneous, depends on clinical, anatomical, audiological criteria, expected results, etiology of deafness, among other criteria assessed by the surgeon and the speech therapist [11].

Percutaneous Prosthesis Surgery

Before surgery, a test with a bow or soft band is performed; simulating the result of the surgery, and this is a great advantage when compared to cochlear implants where there is no possibility of prior testing.

The surgery consists of installing a titanium pin in the region behind and above the ear, usually about 5 cm away from the external auditory meatus, depending on the bone thickness and skin conditions. This position can be variable. The incision is usually small, 2 cm to 3 cm. In adults, surgery can be performed under local anesthesia, and the speech processor is placed by the speech therapist after the osseointegration, which occurs 2 to 3 months after surgery, on average [15].

In cases where surgery is not possible because there is not enough bone thickness, usually in children under 5 years of age, the prosthesis can be used with an elastic band (softband) until the child and their skull bone grows and has sufficient thickness to adapt the pin [16].

Conclusion

The bone-anchored hearing devices are important hearing rehabilitation tools that are constantly being improved. Significant advances were reached in the past few years, which have improved the stability of the implant, quality of the sound and safety of implantation. New techniques and devices which deploy bone conduction have been introduced which will make surgical rehabilitation of conductive and mixed hearing loss progress, aiming for better patient outcomes.

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