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Listen To What The Teeth Say: Soundbite Hearing System. A Technological Advancement.

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ABSTRACT:

In this world of technology, we as medical and dental specialists are interdependent on each other when it comes to the treatment of number of diseases affecting humans. One of such condition often affecting the human population is hearing loss or much specifically the single sided deafness. Single Sided Deafness (SSD) is the term given to significant or total hearing loss in only one ear. SSD is usually a permanent condition which impairs one's ability to tell the direction a sound is coming from. It can also be responsible for difficulty understanding speech or conversations on the deaf ear side, particularly in a noisy environment. The SoundBite hearing system allows people with single-sided deafness to wear an intraoral device and a small microphone in the deaf ear to regain lost hearing. Unlike implantable bone conduction hearing aids, SoundBite requires no surgery. Rather, it is the world's first removable and non-surgical hearing solution to use the well-established principle of bone conduction to imperceptibly transmit sound via the teeth. Custom made for each patient, SoundBite is simple, removable, and totally non-invasive. Further, no dental alterations to the teeth are necessary, and the device is virtually invisible. SoundBite has been clinically proven to improve one's ability to hear and understand speech, even in noisy environments. The goal of this article is to introduce and highlight the importance of this non invasive system to the dental surgeons, orthodontists and audiologist, and help them in making use of this appliance for treatment of patients with single sided deafness

Keywords: SoundBite, Single Sided Deafness, Bone-anchored hearing aid, Sensorineural.

[I] INTRODUCTION

Hearing loss is a significant and common disability that affects approximately 9% of the Canadian population.[1]Overall it is estimated that 16% of UK adults and 50% of those over 75 are affected by some level of hearing loss.[2] This disability is more prevalent in older populations and if uncorrected can lead to social isolation and communication difficulties.[3,4]

Hearing loss can be broadly classified as sensorineural (inner ear), conductive (external and middle ear), or mixed hearing loss. In sensorineural hearing loss, the auditory cranial nerve or part of the bone of the inner ear is defective due to aging, heredity, viral or bacterial infection, and other conditions. Single sided deafness is another term used for unilateral sensorineural deafness.[5]

It is a condition where the inner ear on one side has difficulty sending signals to the brain, but the outer and middle parts of this ear function normally.[2] It is estimated that at least 70% of those with single-sided sensorineural hearing loss will experience difficulty localising the source of a sound and picking out sound in background noise.[6] This may cause feelings of isolation, difficulties with employment, and problems as a pedestrian or driver.[7]

In conductive hearing loss the sound waves' path through the ear canal, past the ear drum, and into the inner ear is impeded by a physical or mechanical blockage, e.g., a totally blocked ear canal at birth (atresia), tumors in the ear canal, long-term infections of the ear canal (otitis externa) or ear drum (otitis media, tympanic cavity infection), or severe skin problems in the ear canal, such as dermatitis,[5]glue ear, wax build up, a burst ear drum and abnormal growth of bones in the middle ear.[2]

Mixed hearing loss is a combination of both conditions. The degree of hearing loss is defined as mild (26 to 40 decibels (dB) hearing loss), moderate (41 to 55 dB hearing loss), moderately severe (56 to 70), severe (71 to 90 dB hearing loss), and profound (91 dB or more hearing loss).[5]

Air-conduction hearing aids (ACHAs) are the standard treatment for hearing loss that cannot be medically or surgically corrected. This technology assessment focuses on the use of semi-implantable electromagnetic hearing aids and bone-anchored hearing aids as an alternative to ACHAs for the treatment of hearing loss.[8]

Semi-implantable electromagnetic hearing aids use the periodic attraction and repulsion of two magnetic fields, one electromagnetic and the other static magnetic, to cause vibration of the ossicles and transmission of sound to the inner ear. When the external sound processor receives sound, it is transformed into electrical signals, which are then amplified and transmitted to a magnetic device that is surgically implanted into the middle ear. The implant's vibrations directly drive the ossicles' movement, producing amplified sound perception. By mimicking the natural vibrations of the ossicular chain, an enhanced signal is sent to the cochlea, resulting in a clearer sound that can be increased without the volume amplification required by ACHAs. In addition, since the air pressure on each side of the sound processor is the same, the wearer does not experience the feeling of occlusion that is common with standard hearing aids.[8]

While conductive hearing loss can often be treated with ACHAs, in some cases (e.g., those resulting from the congenital malformation of the external ear canal, pinna and middle ear structures) the use of ACHAs is precluded. In these cases, a standard bone conducting hearing aid (BCHA) is required. A bone-anchored hearing aid (BAHA) is an alternative to a standard BCHA.[8]

BAHA devices take advantage of the physical property of bone to conduct sound. The device plays a vital role in treatment of conductive hearing loss and unilateral sensorineural hearing loss.[9] The BAHA system consists of three components: a titanium post implant, an external abutment and an electronic sound processor. It is important to note that the BAHA system requires surgical implantation of the titanium post followed by the integration of the implant into the bony architecture. The device works by transmitting sound through bone to the inner ear thus, skipping both the external auditory canal and the middle ear.[3,9] In the case of unilateral sensorineural hearing loss the sound is

transmitted transcranially and stimulates the cochlear fluid of the unaffected inner ear. The titanium screw is implanted directly into the mastoid bone in order to overcome the loss of energy during the transcutaneous transmission of sound. The electronic sound processor is responsible for the transmission of sound vibrations via the external abutment to the titanium implant.[10] There are a number of complications associated with the BAHA device. The most common complication is skin irritation at the site of the implant. A more serious complication is the failure of the titanium post to osseointegrate. This complication can lead to poor function or failure of the implant. In addition, several less common but potentially dangerous complications such as skin flap necrosis, wound dehiscence; bleeding and pain have been reported.[10,11]

Bone conduction hearing aids are used in very young children who are not candidates for air conduction hearing aids. Bone conduction hearing aids may be uncomfortable to wear because they are comprised of a bone conduction transducer held in place by a steel springband over the head. A potential alternative to conventional bone conduction hearing aids are bone-anchored hearing aids held in place by a headband. Use of a headband allows the bone-anchored hearing aid to be held against the skin behind the ear. In this application there is no implantation surgery; rather, the sound processor is attached firmly to the head using either a hard or soft headband, and the amplified vibrational sound is transmitted transcutaneously to the bones of the skull for transmission to the cochlea. Children may use a headband until their temporal bone is mature enough for implantation of a bone anchored hearing aid. For adults, a headband is often used to determine whether they might benefit from bone conduction hearing technology.[8]

Semi-implantable electromagnetic hearing aids and bone-anchored hearing aids are classified by the U.S. Food and Drug Administration (FDA) as hearing aids.[8]

Totally implantable hearing systems are also being evaluated in patients with hearing loss. This form of device is totally implanted behind the outer ear and in the middle ear. Unlike hearing aids, this device does not use a microphone or a speaker. Three implanted components comprise the system: a sound processor, a sensor and a driver that converts electrical signals transmitted by the sound processor to the inner ear, where they are perceived as sound. The device is powered with a maintenance-free battery that may last up to nine years and requires no recharging. Another totally implantable active middle ear device uses a microphone implanted beneath the skin. Sound is picked up by the microphone and transmitted to a transducer in the middle ear. The transducer vibrates the bones of the middle ear allowing vibrations to enter the cochlea.[8]

The sound conduction property of bone exploited in the BAHA technology has also been applied in the most recent technological advancement for the treatment of unilateral sensorineural hearing loss; the SoundBite Hearing Aid.[12]

The SoundBite Hearing System:

A unique technological approach for the treatment of unilateral sensorineural hearing loss is the use of a removable oral device called the SoundBite hearing system developed by Sonitus Medical.[4]

The SoundBite hearing system also makes use of the sound conduction properties of bone; yet, unlike the BAHA system, does not require the use of surgery.[4,13] This system uses a microphone unit housing a receiver and wireless transmitter to receive sound (Figure1). The microphone portion of the unit sits in the affected ear canal to take advantage of the ability of the ear's pinna and external ear canal to capture and direct sound into the microphone, while the receiver and the transmitter sit in a unit behind the affected ear.[4,13] The unit then transmits the captured sound

wirelessly to a removable oral device similar to a retainer that sits over the maxillary molars in the mouth(Figure2). The oral device touches several structures in the mouth including the gingiva, teeth and the inner cheek (Figure3). The electrical signal from the behind the ear transmitter is captured by the oral device and is transduced into vibrational energy using a piezoelectric transducer.[13] The vibrations are conducted by way of the teeth to the bone and transcranially to the cochlea of the ear. One of the advantages of the piezoelectric transducer is that it allows a much wider frequency range to be conducted through the teeth than the traditional electrodynamic transducers used in the BAHA systems.[13]

The SoundBite intraoral device is similar to a retainer or partial denture worn in the maxillary arch. Parts of the SoundBite touch the gingiva, teeth, and inner cheek. An actuator on the buccal side of the device has a round post that fits typically between the 2 most distal teeth; this is the part that creates the sound. The battery and electronic components are on the lingual surface and connect to the actuator via a wire from the buccal to the lingual aspects along the distal surface of the most distal tooth.

A proper intraoral examination should be done by the dentist before fitting a SoundBite appliance; this includes visual as well as radiographic examination and probing to make sure that the teeth are healthy. The SoundBite is a removable device, and the abutment teeth are usually the last three in maxillary arch. There can be no active caries or periodontal or endodontic conditions affecting the abutment teeth. SoundBite has been successfully used on teeth with fillings, crowns, or implants or those have had endodontic treatment. Anatomy and orthodontic placement must be considered. If a tooth is worn or a crown poorly contoured, the SoundBite might not have enough retention, if the position of the teeth is poor, then the patient might not derive the full benefit from the device. Orthodontic treatment might be needed to align the teeth before using the device.[4]

Since the device vibrates the maxillary molars to transmit vibrations to the bone, this force of the oral device is four orders of magnitude lower than the forces exerted on the teeth by normal mastication and is within the force range of normal orthodontic devices and does not damage the surface of the maxillary molars.[13] Moreover, the oral device is comfortable, well tolerated in most patients, does not affect the speech and can even be worn while eating.[4,13]

Some of the disadvantages of the Soundbite system are: the patient cannot drink alcohol while wearing the oral device, risk of aspiration/swallowing of the oral device if the patients physical responses are impaired, and the most important is that healthy teeth are needed to fit the device properly and good oral anatomy for full benefit; the last three teeth in the maxillary arch are usually the abutment teeth and must be free of active caries, periodontal and endodontic conditions.[12]

There are several advantages of the SoundBite hearing system compared to bone anchored hearing aids (BAHA)which include: avoidance of surgery and surgical complications, no need to wait 3 months before use since osseointegration is not required, discreet oral device and discreet behind the ear unit with optimized microphone location does not cause discomfort, the device helps in delivering high fidelity sound with a wide frequency range and lastly the removable nature of the device is patient friendly.[12]

Conclusion:

We live in an exciting time in the world of medicine and dentistry in which we can truly be part of the health of the total patient.The SoundBite is a new hearing prosthesis that delivers bone conduction energy. It is a nonsurgical, noninvasive treatment for SSD. It requires the expertise of at least 3 health care specialists: a physician, an audiologist, and a dentist. The patient must have healthy teeth with

acceptable alignment and good undercuts for the appliance to have the right amount of retention. The SoundBite has significantly provided an improvement in ease of communication, hearing in background noise, sound reverberation, and an overall global hearing benefit.

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