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The Role of Bone Anchored Hearing Aids in The Management of Hearing Loss

Essay

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جامعة عين شمس
قسم الأنف والأذن والحنجرة

دور السمـاعات المثبتة عظميـاً فى عـلاج حـالات فقـد السمـع

توطئة للحصول على درجة الماجستير
فى الأنف والأذن والحنجرة
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Aim of the Work

This essay aims to evaluate the role of bone anchored hearing aid (BAHA) system in rehabilitation of patients with hearing loss.

This study includes a review for types, mechanism of action, patient selection, advantages and disadvantages of BAHA system and surgical procedure of implantation with possible perioperative complications.

Content

List of Abbreviations

LF	**:**	Low frequency.
MF	**:**	Middle frequency.
HF	**:**	High frequency.
DBC	**:**	Direct bone conduction.
BAHA	**:**	Bone anchored hearing aid.
C°	**:**	Centigrade
FDA	**:**	American food and drug administration
HL	**:**	Hearing loss.
SNHL	**:**	Sensorineural hearing loss.
BC	**:**	Bone conduction.
AC	**:**	Air conduction.
SSD	**:**	Single sided deafness.
CROS	**:**	Contralateral routing of signals
dB	**:**	deci Bell.
PTA	**:**	Pure tone average.
KHZ	**:**	Kilo hertz.
PB	**:**	Phenotric balanced.
US	**:**	United states.
HZ	**:**	Hertz.
mm	**:**	Millimeter
mg/ml	**:**	Milligram per mill.
µg/ml	**:**	Microgram per mill.
Iv	**:**	Intravenous.
NDSC	**:**	National deaf children society.
BMLD	**:**	Binaural masking level differences.
APHAB	**:**	Abbreviated profile of hearing aid benefit.
BEST	**:**	Balanced electromagnetic separation transducer.
BASS	**:**	Bone anchored sound stimulator.

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Introduction

The number of cases with hearing loss in adults and children has doubled during the last 30 years. This makes hearing loss one of the commonest causes of communication disorders which greatly affect education, employment and patients well-being ***(Benson and Marano, 1998)***.

The mode of treatment depends on the cause, the type, and the severity of hearing loss. Common treatments include drugs, surgery and hearing aids ***(Steven, 1983)***.

The bone anchored hearing aid (BAHA) system is a surgically implantable system for the treatment of conductive and mixed types of hearing loss. It works through natural skull bone transmission as a pathway for sound to travel to the inner ear, bypassing the external auditory canal and the middle ear. By this principle we can overcome some hearing problems as congenital malformations in the middle or external ear and therapy resistant middle ear infections with patent external auditory canal ***(Snik et al., 2005)***.

There are many advantages of this system over conventional hearing aids. Reduction of incidence of ear infections is considered the most important advantage. A dryer ear is a constant finding and implies that patients will require fewer visits to otolaryngology department with better communication performance ***(Mylanus et al., 1998)***.

The bone anchored hearing aid (BAHA) system consists of three parts: a titanium implant, an abutment and a sound processor. The titanium implant is placed during a short surgical procedure and over time naturally integrates with the skull bone. With high degree of safety and limited numbers of serious complications ***(Tjellstrom et al., 2001)***.

Rare complications after (BAHA) implantation include loss of skin graft, skin growth over the abutment and implant extrusion. Most of complication are successfully treated in an office setting ***(Shirazi et al., 2006)***.

Introduction to BAHA System

Physiology of bone conduction:

Because the inner ear (the cochlea) is embedded in a bony cavity (bony labyrinth) in the temporal bone, vibrations of the entire skull can cause fluid vibrations in the cochlea it self. Therefore, under appropriate conditions, tuning fork or an electronic vibrator placed on any bony protuberance of the skull (specially on the mastoid process), causes the person to hear the sound, unfortunately, the energy available even in very loud sound in the air, is not sufficient to cause hearing through. The bone except when a special electromechanical sound transmitting device is applied directly to the bone ***(Stevens, 1983)***.

The bone conducted sound is transmitted to the inner ear basically by three modes of excitation, as follows:

Low frequency **(LF)**, inertial movement of the middle ear ossicles and the inner ear fluids excited by acceleration of the temporal bone.

Middle frequency and high frequency **(MF+HF)**, compressional excitation of the inner ear spaces caused by dimensional changes of the cochlear shell.

High frequency **(HF)**, sound energy radiated into the external ear canal and middle ear cavity transmitted via the middle ear ossicles to the cochlea ***(Tonndrof, 1966)***.

The three modes of excitation have different significant in different frequency ranges. The three modes are also valid for direct bone conduction (d.b.c), because the acoustic pathways to the cochlea are the same for conventional and direct bone conduction ***(Anthony and Maniglia, 1995)***.

Hearing by bone conduction:

The general idea of a conventional bone conduction hearing device is that the bone-conduction sound by passes an impaired or diseased external or middle ear. With the introduction of the BAHA, on new type of excitation was introduced, called direct bone conduction (dbc). In which the sound transmission without the skin and soft tissue being part of the vibration transmission, path between the transducer and the skull bone. ***(Hakansson et al., 1984)***.

Problems:

Although conventional bone-conduction hearing aids have been used successfully for many years, they are associated with a number of practical problems that may result in limited use or patient rejection. The bone conduction transducers have to be pressed firmly against the skull to achieve sufficient sound transmission. This is accomplished by wearing a headband or special spectacles with a rigid frame. The pressure needed to apply the device effectively often causes skin irritation, itching headaches and sometimes skin ulcers. In addition, the head band or special spectacles are often clumsy and unattractive. Another problem is a technical shortcoming of transcutanous bone conduction. This implies that relatively powerful amplifiers are needed. Therefore problems with gain and the maximum output of the device may limit the patient's performance ***(Snik et al., 2004)***.

These problems has been overcomed by the introduction of the bone anchored hearing aid "BAHA" system. BAHA system is a surgically implantable percutanous temporal bone stimulator in which

percutanous device penetrates the skin. This system depends on direct bone conduction (d.b.c) and osseointigration which works by enhancing natural bone transmission as a pathway for sound to travel to the inner ear bypassing the external auditory canal and middle ear ***(Jaclyn et al., 2002)***.

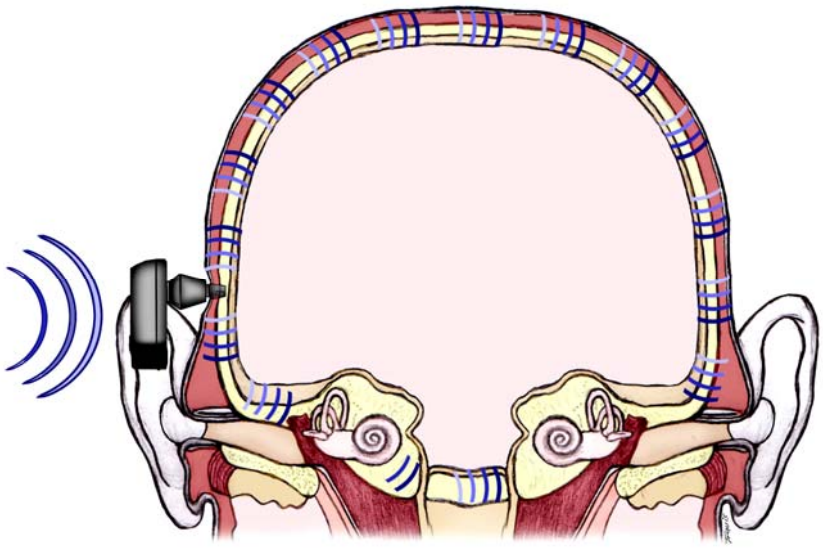

Fig. (1-1): Direct bone conduction ***(Jaclyn et al., 2002)***.

To understand principle of BAHA system we should highlight on osseointegration process and its parameters of fixation.