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Short Communication

An approach to bilateral bone-anchored hearing aid surgery in children: contralateral placement of sleeper fixture

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Abstract

Objective: Bone-anchored hearing aid surgery in younger children is a two-stage procedure, with a titanium fixture being allowed to osseointegrate for several months before an abutment is fitted through a skin graft. In the first procedure, it has been usual to place a reserve or sleeper fixture approximately 5 mm from the primary fixture as a backup in case the primary fixture fails to osseointegrate. This ipsilateral sleeper fixture is expensive, is often not used, and is placed in thinner calvarial bone where it is less likely to osseointegrate successfully. The authors have implanted the sleeper fixture on the contralateral side, with the additional objective of reducing the number of procedures for bilateral bone-anchored hearing aid implantation, providing a cost-effective use for the sleeper.

Methods: The authors implanted the bone-anchored hearing aid sleeper fixture in the contralateral temporal bone instead of on the ipsilateral side in seven successive paediatric cases with bilateral conductive hearing loss requiring two-stage bone-anchored hearing aids, treated at the Royal Manchester Children's Hospital, UK.

Results: The seven patients ranged in age from five to 15 years, with a mean age of 10 years; in addition, a 20-year-old with learning disability was also treated. In each case, the contralateral sleeper fixture was not needed as a backup fixture, but was used in four patients (57 per cent) as the basis for a second-side bone-anchored hearing aid.

Conclusions: In children with bilateral conductive hearing loss, in whom a bilateral bone-anchored hearing aid is being considered and the second side is to be operated upon at a later date, we recommend placing the sleeper fixture on the contralateral side at the time of primary first-side surgery. Our technique provides a sleeper fixture located in an optimal position, where it also offers the option of use for a second-side bone-anchored hearing aid and reduces the number of procedures needed.

Key words: Implants and Prostheses; Hearing Aids; Conductive Deafness; Child; Bone Anchored Hearing Aids

Introduction

Bone-anchored hearing aids (BAHAs) are an accepted method of rehabilitating conductive hearing loss in conditions in which conventional hearing aids cannot be used. The BAHA system uses an osseointegrated titanium implant to conduct sound from a microphone-transducer unit through the temporal bone to the inner ear. Unlike conventional bone conduction hearing aids, the BAHA contacts bone without intervening soft tissue, which improves sound propagation to the cochlea.

In younger children, BAHA surgery is usually carried out as a two-stage procedure, with the fixture being allowed to osseointegrate for several months before an abutment is fitted through a skin graft. During the first procedure, it has been usual to place a reserve or sleeper fixture approximately 5 mm from the primary fixture as a backup in case the primary fixture fails to osseointegrate. The ipsilateral sleeper fixture is expensive ($1000 in the US, £298 in the UK; 2008 prices for self-tapping, flanged, 4 mm, Cochlear™ fixture), is often not used, and is placed near the primary fixture in thinner calvarial bone.

For cases in which bilateral BAHAs are being considered and in which the second side is to be operated upon at a later date, we recommend placing the sleeper fixture on the contralateral side at the time of primary first-side surgery. In our series of seven cases, we found that contralateral placement of the sleeper fixture provided a reserve fixture in an optimal position, and also reduced the number of procedures for placement of a second-side BAHA.

Methods

Seven successive cases identified for bilateral bone-anchored hearing aid implantation, in which the second side was to be operated upon at a later date, were selected for the contralateral sleeper fixture technique, between 2004 and 2007. We placed a sleeper fixture on the

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contralateral side, using a 1.5 cm incision located at the optimal site for fixture placement.

With the patient under general anaesthesia, both sites were measured and marked through the skin with methylene blue dye on a needle. Symmetrical positioning of the primary fixture and the sleeper fixture was judged easily at the time of surgery. The child's head was turned to one side, prepared and re-draped, and a 1.5 cm, post-auricular incision was made over the intended fixture site. The fixture was placed in the standard fashion described by the manufacturer (Cochlear™, Weybridge, UK). Usually, a 4 mm-long sleeper fixture was implanted. A cover screw was attached to prevent tissue growth into the inner thread, and subcuticular 4-0 Vicryl was used for closure. The child's head was then turned to the other side, and the procedure repeated.

In older children, the primary site may be operated upon as a single stage procedure, with placement of a self-tapping fixture with abutment. The contralateral fixture is placed as described above.

Relevant literature was identified by searching Medline and Embase, using the keywords 'BAHA', 'bone-anchored hearing aids', 'bilateral fitting', 'contralateral', 'hearing loss' and 'sleeper fixture'.

Results

Our paediatric cases ranged in age from five to 15 years, with a mean age of 10 years; in addition, a 20-year-old with learning disability was also treated (see Table I). Of the seven cases, three had bilateral discharging mastoid cavities, two had Down syndrome, one had Treacher–Collins syndrome, and one had a left unilateral discharging mastoid cavity and chronic suppurative otitis media in the right ear. In each case, the contralateral sleeper fixture was not needed as a backup fixture, but was used in four patients (57 per cent) as the basis for a second-side BAHA.

Discussion

The BAHA is indicated for treatment of conductive hearing loss cases in which conventional hearing aids cannot be used. Indications include microtia in Treacher–Collins syndrome, isolated microtia, Goldenhar syndrome, chronic suppurative otitis media and discharging mastoid cavities. In Down syndrome patients, who suffer a high incidence of glue ear, acute otitis media and stenotic external auditory meatus, BAHA can be a successful method of amplification.[1]

Bone conduction of sound from one source stimulates both cochleae, but attenuation by the skull can occur.[2] Bilateral BAHA implantation provides better sound localisation than monaural hearing and better speech recognition in both quiet conditions (diotic summation) and noisy conditions (when the speech and noise come from opposite directions).[3–6] Bosman *et al.* demonstrated that sound localisation and speech recognition in noisy situations improved with bilateral amplification.[4] In the UK, it is common practice for children with bilateral conductive hearing loss to be fitted with bilateral behind-ear hearing aids. In those who require bilateral BAHA implantation, for reasons including acceptance of the device and cost, it is still more usual to fit a BAHA on one side and to plan to fit a contralateral BAHA at a later date.

In younger children, who have thinner and softer cortical bone, two-stage surgery allows time for osseointegration before the BAHA abutment is fitted. The two-stage technique described by Tjellstrom is generally used for children under 12 years of age, or in older children with cognitive difficulties.[7,8] The weight of the BAHA abutment and the potential for knocking the protruding abutment are avoided during the osseointegration period in two-stage surgery. Two-stage surgery is also considered in adults with an increased risk of failure of osseointegration, such as after radiotherapy or in cases of fibrous dysplasia.

Sleeper or reserve fixtures are used in two-stage surgery to optimise the outcome. Zeitoun *et al.* reviewed the benefits of placing a sleeper fixture in children undergoing two-stage surgery, and noted that there may be incomplete insertion of the fixture in thin calvarial bone, or the fixture may be knocked out by injury.[9] Loss of the fixture is a significant issue. One study found traumatic fixture loss in two out of 20 children under the age of five years after two-stage surgery, and in four out of 20 older children after single-stage surgery.[10]

In cases of trauma or failure of osseointegration, the sleeper fixture obviates the need for a repeat first-stage procedure and consequent four- to six-month delay while osseointegration is awaited. In order to avoid this delay, it is current practice during two-stage surgery to fit an ipsilateral sleeper fixture in reserve; however, in our experience this ipsilateral sleeper fixture is not often used. At the time of writing, in our seven reported cases (see Table I), the contralateral fixture has not been needed as a reserve or backup, but it has found use in four of our patients as the basis of bilateral BAHA

TABLE I

SEVEN CASES WITH CONTRALATERAL BAHA SLEEPER FIXTURE

Case no	Diagnosis	Age at bilat 1st stage (yr)	Bilat BAHA fitted?	Complications
1	Bilateral discharging mastoid cavities	5	Yes	Nil
2	Treacher–Collins syndrome	14	Yes	Nil
3	Down syndrome	15	Yes	Nil
4	Bilateral discharging mastoid cavities	6	No	Nil
5	Bilateral discharging mastoid cavities	15	No	Nil
6	Left discharging mastoid cavity, bilateral CSOM	7	Currently using behind-ear hearing aid for Right ear	Nil
7	Down syndrome (adult with special needs)	20	Yes	Nil

No = number; bilat = bilateral; yr = years; BAHA = bone-anchored hearing aid; CSOM = chronic suppurative otitis media;

implantation, reducing the number of procedures these patients have needed.

References

1 Sheehan PZ, Hans PS. UK and Ireland experience of bone anchored hearing aids (BAHA) in individuals with Down syndrome. *Int J Pediatr Otorhinolaryngol* 2006;**70**:981–6
2 Stenfelt S, Hakansson B, Tjellstrom A. Vibration characteristics of bone conducted sound *in vitro*. *J Acoust Soc Am* 2000;**107**:422–31
3 Snik AFM, van der Pouw CTM, Beynon AJ, Mylanus EAM, Cremers CWRJ. Binaural application of the bone-anchored hearing aid. *Ann Otol Rhinol Laryngol* 1998;**107**:187–93
4 Bosman AJ, Snik AFM, van der Pouw CTM, Mylanus EAM, Cremers CW. Audiometric evaluation of bilaterally fitted bone-anchored hearing aids. *Audiology* 2001;**40**:158–67
5 van der Pouw CTM, Snik AFM, Cremers CWRJ. Audiometric results of bilateral bone-anchored hearing aid application in patients with bilateral congenital aural atresia. *Laryngoscope* 1998;**108**:548–53
6 Dutt SN, McDermott A, Burrell SP, Reid AP, Proops DW. Speech intelligibility with bilateral bone-anchored hearing aids: the Birmingham experience. *J Laryngol Otol* 2002;**116**:47–51
7 Tjellstrom A. Osseointegrated systems and their applications in the head and neck. *Adv Otolaryngol Head Neck Surg* 1989;**3**:39–70
8 Proops DW. The Birmingham bone anchored hearing aid programme: surgical methods and complications. *J Laryngol Otol* 1996;**110**(suppl):7–12
9 Zeitoun H, De R, Thompson SD, Proops DW. Osseointegrated implants in the management of childhood ear abnormalities: with particular emphasis on complications. *J Laryngol Otol* 2002;**116**:87–91
10 Davids T, Gordon KA, Clutton D, Papsin BC. Bone-anchored hearing aids in infants and children younger than 5 years. *Arch Otolaryngol Head Neck Surg* 2007;**133**:51–5

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