

## Editorial

# Bone anchored hearing aids and prostheses

Osseointegration is defined as direct contact between living bone and a loaded implant surface. It was discovered by Per-Ingvar Branemark in 1969.

This useful property was soon used in the mouth for the fixation and retention of missing teeth. It was not long before its Swedish inventor used the same technique for the extra oral retention of prostheses and the direct contact with bone was quickly recognized as a useful method of gaining direct bone conduction of sound.

For the last five years this system has been commercially available and is marketed by the Nobelpharma company of Sweden. Professor Anders Tjellstrom of Goteborg, Sweden, has played a major part in this development and has acquired a huge experience. In the last three years this technique has been introduced into the United Kingdom and is stimulating considerable interest.

Its main use in otolaryngology is for the retention of auricular prostheses for patients with congenital ear abnormalities or who have lost their external ear through trauma or malignant disease. A potentially larger group of patients with conductive hearing loss who cannot be fitted with, or who are unable to wear, conventional aids can now be helped by using the Bone Anchored Hearing Aid (BAHA).

The incidence of malformation of the external ear was found to be 2.41 per 10,000 births in a study by Stevenson *et al.* (1950). Malformations of the auricle frequently appear in combination with those of the external auditory canal and the middle ear. Unilateral microtia may be associated with various ipsilateral facial malformations involving the first and second branchial arch. Unilateral or bilateral microtia can be part of a bilateral malformation such as mandibular facial disostosis (the Treacher Collin's syndrome).

Any child born with a congenital defect evokes great feelings of guilt and anxiety in the parents. Congenital ear deformities which cannot be easily hidden from the world lead parents to urgently seek an effective treatment. Unfortunately, as most ENT Surgeons know, the results of surgery for the congenital ear, no matter how honestly and competently performed, rarely, if ever, pleases the patient. There are numerous instances of children undergoing many operations involving much time in hospital to produce results that are little better than the original congenital ear. Further surgery to improve hearing or to enable the fitting of a hearing aid has been equally disappointing.

It is not surprising, therefore, that this new and exciting technique has provoked considerable interest in ENT departments throughout the United Kingdom. In the last three years several teams have been developed and in 1992 a national user group called the British Facial and Audio-logical Implant Group was formed. Success in this field

can only be achieved by teamwork in the planned management with a whole programme of organized surgery and rehabilitation for patients with congenital ear problems. An ideal team should be composed of audiologists, maxillofacial technologists, speech therapists and surgeons, with the latter usually drawn from the disciplines of otolaryngology, maxillo-facial and oral surgery and plastic surgery.

In Birmingham there is a once-monthly specialized clinic which all members of the team attend and where a treatment plan for each patient is formulated encompassing prosthetic rehabilitation, audiology, speech therapy and surgery. The patient or the patient's family are important in the decision-making process and the team insists that patients should meet others who have already undergone the treatment and rehabilitation, and that they spend time alone with them to ensure that they fully understand the process and feel no pressure from surgical enthusiasm.

The surgery itself is relatively straightforward. However, if the patient has a craniofacial disorder then anaesthesia may be complex and challenging and this does require the full co-operation of an anaesthetist who is comfortable with these potentially difficult patients. The surgery is usually staged, the small titanium screws being fixed at pre-designed points to the mastoid bone at a preliminary operation which can be undertaken under local anaesthetic.

Three months are allowed for the titanium fixtures to become firmly osseointegrated and then at the second procedure, the fixtures are once again located and the overlying tissue greatly reduced to produce skin immobility around the penetrating abutments, which are affixed at this second stage. Some few weeks after the second stage operation the patient is ready to be fitted with the auricular prosthesis, the hearing aid or both. The manufacture of the auricular prosthesis is extremely skilled and requires not only the use of modern silicones to give a natural appearance and feel but considerable artistic skill to carve a life-like ear and to tint it to conform with the patient's natural skin colour. The prostheses are retained on small gold bars which are soldered to the abutments. It is intended that the patient should not sleep with their prosthesis, but affix it on awaking, when it will remain comfortable and secure all day. All normal activities can be undertaken wearing the prosthesis including swimming. The only attention the patient need make is to cleaning around the skin penetrating abutment daily, to prevent the accumulation of skin debris.

The essence of success is the thinning of the skin so there is no movement between the abutment and the skin. All the auricular prostheses that have been fitted in the Birmingham series have been successfully worn by the patients with few and only minor complications.

The Bone Anchored Hearing Aid, because of the direct connection between the aid and the bone, offers a quality of sound not experienced by other bone conducting hearing aids. The indications for the bone conducting hearing aid are:

1. any person who benefits from a conventional bone conduction aid;
2. patients using an air conduction aid in spite of discharging ears;
3. patients with atresia;
4. patients with ears that start to discharge when an ear mould is used;
5. patients with intractable external otitis;
6. patients with bilateral radical cavities who experience acoustic feedback;
7. as an alternative strategy in the management of otosclerosis.

Patients who are referred for consideration for a Bone Anchored Hearing Aid are now seen in a separate clinic where only the otologists and audiologists are present. The indications for use are of a conductive hearing loss which can be accompanied by sensori-neural hearing loss up to 45 dB for the ear level aid. Those with a sensori-neural hearing loss up to 60 dB can still be aided but need to wear a body worn Bone Anchored Hearing Aid. The 52 patients wearing Bone Anchored Hearing Aids in the Birmingham series so far are fairly evenly split between those with congenital aural atresia and those with bilateral cavities who were unable to wear a conventional insert hearing aid because of discharge. Most of the latter group had been previously fitted with a conventional bone conducting hearing aid but had found them to be both uncomfortable, unsightly and inefficient. Latterly, a small group of bilateral otosclerotics who could not or would not wear a conventional insert hearing aid and who did not wish for stapedectomy, have been fitted with a Bone Anchored Hearing Aid. This group have found the Bone Anchored Hearing Aid very acceptable and it is proposed that it now be considered an alternative treatment strategy for the otosclerotic patient.

Of the 52 patients fitted in the Birmingham series, all are wearing their hearing aids for at least eight hours a day and all report improved comfort and efficiency and many make the point that they are unaware that they are wearing the aid. It is set back on the mastoid process and tends to be hidden by the hair and is, therefore, cosmetically acceptable.

Complications from the Bone Anchored Hearing Aid programme have been few. Two fixtures were spontaneously lost for no good reason and the patients' required re-implantation. Great distress was caused to these two patients when they returned to their previously unsatisfactory hearing aids. This led to a policy change so that Bone Anchored Hearing Aid patients are fitted with two fixtures, one acting as a sleeper should there be a problem with the first.

The audiometric evaluation of the Bone Anchored Hearing Aid showed the greatest benefit to be gained by the aural atresia group. The audiological benefit in the group who suffer from chronic suppurative otitis media was not so great but, nevertheless, all the patients so fitted are day-long wearers and none of them, when questioned, would wish to return to their former hearing aids. The

overwhelming benefit that they gain is increased comfort, binaural hearing, better quality sound and a reduction in the discharge from their ears.

The timing of the surgery for osseointegration is important. By seeing recently born children with congenital ear abnormalities, early appropriate audiological rehabilitation can be started and the children spared unnecessary operations. The policy in Birmingham is that the Bone Anchored Hearing Aid would be fitted as early as possible to aid speech and language development and, to date, the youngest child to be fitted is two-and-a-half years old. The fitting of the auricular prosthesis should be delayed until later to allow for skull growth. The ideal time to affix an auricular prosthesis for a child would seem to be sometime around the 10th birthday so that the treatment is completed before the child enters secondary school. Parents of babies with congenital ears are encouraged to come to the clinic early to discover what is available and perhaps to allay their natural anxiety and guilt.

The future of osseointegrated services is the subject of debate. There is no doubt that this procedure is best not undertaken on an occasional basis, and as with all surgery, the complications are fewest if procedures are regularly undertaken. It is imperative that there should be an overall team involved in the management of the patient and it would make sense that these teams should be as busy as possible. It is therefore advocated that there should be a few tertiary referral centres around the country for the treatment of congenital ear abnormalities.

The provision of Bone Anchored Hearing Aids for the non-congenital ear can obviously be undertaken on a much wider basis and it is anticipated that this will be the growth area in the next decade. The provision of Bone Anchored Hearing Aids for adults is not difficult and the technique can be undertaken under a local anaesthetic as a Day Case.

The difficulty that may well limit the application of this technology is the cost. The hearing aid itself costs in excess of £1,000 and once implanted these patients require lifelong supervision and maintenance. Osseointegration offers an exciting new means to the otologist in the constant battle to rehabilitate the hard of hearing.

#### References

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