

# BILATERAL IMPLANTS

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As an introduction to the benefits of bilateral implantation it is worth restating the advantages of hearing with two ears (see Figure 1). By using both ears you can localise sound and hear speech in background noise more easily.

## The advantages of binaural hearing

Binaural hearing uses

- Head diffraction
- Binaural squelch
- Binaural redundancy

Benefits of binaural hearing

- Horizontal localisation
- Stimulation of both acoustic pathways
- Capturing the better ear

*Figure 1*

The three main components of bilateral hearing which provide these advantages are diffraction, the binaural squelch effect and binaural summation. The first, diffraction, or the head shadow effect, occurs if there is an object, such as your head, in the path of the sound. You will hear better on the side which the sound is coming from, and hear less well on the side nearest the noise source. This is because the high frequency sounds do not pass as well around the head to reach the ear nearest the noise source. The second component, binaural squelch occurs because there are differences in the timing and the intensity of the sounds reaching the ears when the noise and the sound are from two different places. The ear nearest the sound will hear the sound before the opposite ear and will also hear a more intense version of the sound than the opposite ear. As a result the brain is able to tune into the ear where the sound is clearer. This is how, with normal hearing, you are able to tune into a speaker and ignore any background noise. The third component, binaural

## Possible benefits of bilateral CI

- Improved speech intelligibility and sound quality
  - Head diffraction
  - Binaural squelch
  - Binaural redundancy
- Localisation
- Ensures better ear is implanted
- Avoiding further auditory deprivation
- Gives another option if 1 implant/processor fails
- Suppression of tinnitus

*Figure 2*



redundancy, is used when the sound and the noise come from the same place. For people with normal hearing it is easier to hear the sound when using two ears in this situation rather than one.

The advantages gained from bilateral implantation are that you have two sets of acoustic signals going into your brain where potentially the attributes of binaural hearing could occur. Evidence suggests that with bilateral implants people are able to benefit from the head shadow effect. The potential advantages are listed in figure 2.

## Possible disadvantages of bilateral CI

- Increased cost
- Further surgery session (sequential) and associated risks
- Self image
- Managing two systems
- Possible increased tinnitus
- Possible increased balance problems
- Residual hearing lost in both ears

*Figure 3*

There are however many factors that must be taken into account when considering bilateral cochlear implantation, see Figure 3. One of these factors is cost which impacts on the limited funding that already exists for the conventional single implant. These new costs vary depending on whether a patient has two implants in the same operation session (simultaneous surgery) or when the second implant is done at a later date (sequential surgery). The cost is currently cheaper in the case of simultaneous surgery. With sequential surgery all of the risks associated with having the first cochlear implant surgery apply. These risks include increased risk from anaesthetic, possible increase in tinnitus and balance disturbance, increased chance of

infection and possible problems with the facial nerve. Finally, with bilateral implantation any residual hearing is lost in both ears so a candidate can never return to using conventional hearing aids therefore patients must carefully consider the impact of losing their residual hearing.

The Manchester Implant Programme (MCIP) began in 1988 and we now have 22 bilateral cochlear implant users. Patients with the Manchester team are currently advised that bilateral implantation is not a routine clinical event. We assess candidates on an individual basis taking into account type and level of hearing loss, duration of deafness and cause of hearing loss. Typical candidates where bilateral implantation may be recommended are those who have had meningitis as their cochleae may be ossifying (filled with bone) unless an implant is inserted quickly. We also have patients with additional sensory disabilities for whom bilateral implantation may be considered a good option. A further group of patients who may be offered a second device are those who are not performing as well with their first device as was expected.

### Subjective Reports

- “Can follow group conversations better”
- “Better localisation of sounds”
- “Better understanding of speech in noise”
- “Overall, more confident”
- “Two implants are the difference between a 2D and 3D world”
- “Second implant is initially distracting”

*Figure 4*

A survey of some of our bilateral patients, gave a series of subjective comments (see Figure 4). In addition to the comments made, some patients felt that the second implant sounded different to the first one and this was sometimes disliked; however with time and use the two sounds slowly converged and the benefits of listening with two processors began to appear.

Across the world, a number of studies have been conducted with adult bilateral cochlear implant patients. One of which was a Nucleus multicentre trial in the UK, involving a total of 29 sequentially implanted subjects. The speech discrimination findings of this trial were that there is a significant advantage in having the second implant where speech and noise were presented in front of the user i.e. redundancy, or where noise was presented on the first implanted side i.e. the head shadow effect. It was noted that for some people the second implant alone scored worse in noisy environments especially if there were long delays between initial and second surgery.

Through patient questionnaires, the trial found that bilateral implantation improved spatial hearing, quality of hearing and for some people speech hearing. In this trial tinnitus had worsened in some people who took part although it was felt that these changes may have arisen by chance. It was concluded that bilateral implantation would be more cost effective if binaural processors were used where stimulation from one speech processor reached both cochleae and if the negative effects of tinnitus were removed.

The cost effectiveness branch of this study found that the difference in quality of life for profoundly deaf adults following unilateral cochlear implantation surgery is significant whereas the improvement in quality of life between a bilateral user and the unilateral user is only small.

Research is ongoing and currently MCIP is involved in clinical trials with the Med-EL and Advanced Bionics devices to find out more information about the possible benefits and limitations of bilateral cochlear implantation in adults and children.

There is no current NICE (National Institute for Clinical Excellence) guidance on cochlear implants although a NICE appraisal is ongoing and their recommendations will be published in the spring of 2008. It is expected that the evidence about bilateral implantation will be reviewed and a recommendation made. It is worth noting that when NICE reported on the use of hearing aids it recommended that they should be used on both ears where appropriate.

Finally, I would like to mention bimodal stimulation (see Figure 5). We encourage our implant users to use a hearing aid in their unimplanted ear whenever possible. Users experience a much more natural sound when using both devices. Stimulation of the auditory pathway in the non implanted ear is beneficial not just for the present but also for the future where new technology may be able to take advantage of the residual hearing situation. Some patients may benefit from bimodal compared with bilateral cochlear implantation.

### Bimodal stimulation

- HA use encouraged & supported
- Appropriate amplification for residual hearing in non-CI ear
- More natural sound when listening with HA and CI
- Used if some useful hearing at low frequencies in non-CI ear.
- Preservation of auditory pathway
- HA ear may be used for future technology

*Figure 5*