THE MANCHESTER AUDITORY BRAINSTEM IMPLANT PROGRAMME

INFORMATION
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THE AUDITORY BRAINSTEM IMPLANT

An auditory brainstem implant (ABI) is an electronic device that attempts to replace the function of the damaged auditory (hearing) nerve by electrically stimulating the cochlear nucleus in the brainstem to produce a sensation of sound.

The internal implant device

The ABI device used in Manchester is made by the Cochlear Company. The internal device has 21 electrodes on the implant. The electrodes of the ABI are connected to a small control circuit called the receiver stimulator. The receiver stimulator fits behind the ear. The ABI received the CE mark in August 1998.

The internal ABI consists of an electrode array and a receiver stimulator that are implanted during the operation. The electrode array of the ABI is placed onto the cochlear nucleus (which forms part of the hearing area of the brainstem).

Figure 1: The internal implant and electrode array (not to scale)
The external implant device

The external part of the equipment (figure 2) consists of a battery driven speech processor that fits behind the ear rather like a hearing aid. The processor is connected to a transmitting coil by a cable. There is a magnet in the middle of the coil that holds the external device onto the implant that is underneath the skin at the back of the ear. In some situations it may be necessary to fit a body worn speech processor (figure 3). The external parts of the implant are fitted about six weeks after surgery.

Figure 2: The behind the ear speech processor (not to scale)

Figure 3: The body worn speech processor (not to scale)
How the auditory brainstem implant works

1. The microphone on the speech processor picks up sound signals from the environment, which are then sent to the speech processor.

2. The speech processor processes the sound signals which are then sent to the transmitting coil.

3. The transmitting coil transmits signals across the skin to the internal receiver and electrode array on the cochlear nucleus.

4. The electrodes are stimulated and then they send electrical impulses along the cochlear nucleus.

5. The cochlear nucleus passes the signals to the brain where they are interpreted as sound. This whole process happens very quickly.

What can you expect to hear with an ABI?

An ABI can help a totally deafened person to become more aware of everyday sounds and improve speech understanding with lipreading. One or two people are able to understand a few words without lipreading when listening with the ABI. The ABI may help to monitor the pitch and loudness of the voice.

At first, the new sensation of sound produced by the ABI will be very different from any previous experiences of sound. It can take many months to retrain the ear to make sense of the sounds. People describe the sounds they first hear with the implant as bleeps and buzzes or bonging noises.

As more people are receiving ABI systems it has become clear that there are a wide range of possible benefits. Improved speech understanding with lipreading and the ability to distinguish different pitches would be considered a good outcome. A more moderate outcome would consist of hearing noises that will help with lipreading. There is a possibility that the device, once implanted, may not produce a hearing sensation, or that circumstances encountered during surgery may prevent implantation.
ASSESSMENTS FOR AN AUDITORY BRAINSTEM IMPLANTATION

In order to determine whether an ABI may benefit you, various assessments must be carried out. These include:

1. **Initial Assessment**
   The medical history and details of hearing loss will be determined at this session. This will include questions about the length of time of deafness. An assessment of other factors is also determined. These factors include communication skills; use of hearing aids; tinnitus; employment status and general health. A hearing test will be performed at this session to assess the amount of residual hearing. If candidates are already using hearing aids it is necessary to perform speech discrimination tests.

2. **MRI Scan**
   MRI is an abbreviation for Magnetic Resonance Imaging. This is similar to an x-ray but provides more detailed information about the structures involved in hearing especially the inner ear and the brainstem. You may already have MRI scans on a regular basis to monitor the presence of any tumours on the auditory nerve.

3. **Promontory Stimulation Test**
   It may be necessary to undertake this test if you have had surgery to remove an acoustic neuroma. This test provides information about the function of the auditory or hearing nerve. It involves making a small incision in the eardrum under local anaesthetic. An electrode is introduced into the ear and rests just at the opening to the cochlea. A small electrical current is passed along the electrode to stimulate the auditory nerve and a sensation of sound may be heard. If a sound is detected it will indicate whether the auditory nerve is functioning in response to electrical stimulation and so a cochlear implant may be more appropriate than an ABI.

4. **Psychological Assessment**
   A number of psychological tests may be carried out. These will provide information about learning style, motivation and expectations of an auditory brainstem implant.

5. **Information Session**
   Suitable candidates for an ABI will be given information about the surgical procedure and will be asked to sign an informed patient consent form prior to surgery. You will also be shown the external equipment that needs to be worn for the ABI to function. There will be a discussion about what to expect to hear with an ABI as well as an opportunity to meet an implant user. This helps to develop realistic expectations as well as providing information about the commitment required from someone considering an ABI.

6. **The Final Decision**
   Following completion of all the assessments the team will meet to discuss cases and make a final decision regarding suitability.
**SURGERY FOR AN AUDITORY BRAINSTEM IMPLANT**

The surgery consists of a craniotomy (an operation on the skull, necessary for the removal of the acoustic neuroma), placement of the electrode array onto the cochlear nucleus, and placement of the receiver stimulator into the skull bone behind the ear. To assist with placement of the device the implant is stimulated during surgery and brain responses will be recorded via electrodes attached to the scalp. The risks of surgery are those generally associated with the removal of the acoustic neuroma, plus those associated with implantation of the electrode and its associated receiver. Your surgeon will discuss the specific risks with you. Removal of the tumour in most cases will lead to a total loss of hearing in the operated ear. The long-term effect of electrical stimulation of the central nervous system is not clearly known.

During surgery, the receiver stimulator and electrode array are implanted, following removal of the acoustic neuroma. The operation lasts several hours.

On returning from theatre you will find your head is tightly bandaged and will remain like this for at least the first few days of your stay in hospital. This does make it difficult to wear spectacles and some people take the arm off one side of their spectacles before they come into hospital.

A couple of days after the operation you will have an x-ray to check the position of the implant. Some preliminary tests may be performed to test the function of the implant. Stitches will be removed before you go home. You will be able to feel a bump behind your ear where the receiver package is.

You will be given the contact address and phone number of the medical staff when you are discharged in the unlikely event that you have problems at home. Normally you should consult your own GP if you have any problems after your discharge. Your GP should contact the hospital if necessary.

**PLEASE NOTE:** The implant operation involves fitting the internal equipment only. You will NOT be able to hear with the device until the external speech processing equipment is fitted, usually about six weeks after the operation.
FITTING THE SPEECH PROCESSOR

The external equipment (speech processor, microphone and transmitting coil) is fitted about six weeks after the implant operation. This is what we call the "switch on". The external equipment is connected to a computer and programmed to measure the quietest and most comfortably loud levels of sound. The initial programming sessions are in the ENT Department at Manchester Royal Infirmary because it is necessary to monitor the heart rate during the first programming session.

Measurements are made during the switch on to determine the levels of current required to produce hearing sensations. As the cochlear nucleus is in the brainstem area, it is likely that electrical currents may spread and stimulate other nerves. The current spread may produce some side effects such as a facial twitch or a tickle in the throat or sensations in the limbs. The design of the implant is such that these side effects may be eliminated through reprogramming.

The hearing sensations will be perceived as bleeping sounds coming from the computer. The first programming session may take up to two hours as each electrode is measured individually. These measurements are created into a programme in the computer and are stored in your speech processor. The speech processor is then switched on and you may be aware of sound around you. At first the sound may not be very meaningful and certainly nothing like sound as you may remember.

It is important to be aware that there is a possibility that you may not hear sound at all with the ABI.

After the initial programming session at the Manchester Royal Infirmary, your appointments will take place in the Implant Centre at the University of Manchester, across the road from the hospital.
ADJUSTING TO THE NEW SENSATION OF SOUND

Following the switch on there is an intensive course of rehabilitation. This includes adjustments to the programme in your speech processor and auditory training sessions to help you to understand the sound from the ABI.

During the switch on week you will normally be required to attend the hospital for two days. Accommodation may be arranged at the hospital free of charge for you. Partners or friends may be accommodated at the nurse’s home in the hospital for a small charge.

After the first week you must attend the University one session a week for the first month. Following these appointments we will assess how often we need to see you. Usually appointments are on a monthly basis for the following three months but it does depend on individual progress. You will be encouraged to practise some listening exercises at home with partners or friends which will help you to get used to the sound.

We have no way of accurately predicting what the sound sensation will be like with the ABI. We do know that everybody has a different experience and it is important for us to monitor your progress very carefully over the first few months of implant use to ensure you are getting the best from your ABI.

ASSESSMENTS WITH THE AUDITORY BRAINSTEM IMPLANT

Prior to receiving an ABI you may have done some lipreading tests and we will have made a recording of your voice. This gives us a baseline for measuring progress with the implant.

To help us to monitor your progress with the ABI we need to do a series of assessments with you. These assessments are performed at 3 days, one month, nine months and eighteen months after the switch on. The assessments include tests to determine your ability to hear everyday sounds and speech.

If you have any questions relating to this information, please contact a member of the
team (contacts listed on page 2).