Cochlear Implant… The only hope for severely Deaf

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For centuries, people believed that only a miracle could restore hearing to the deaf. It was not until forty years ago that scientists first attempted to restore normal hearing to the deaf by electrical stimulation of the auditory nerve. The first experiments were discouraging as the patients reported that speech was unintelligible. However, as researchers kept investigating different techniques for delivering electrical stimuli to the auditory nerve, the auditory sensations elicited by electrical stimulation gradually came closer to sounding more like normal speech. Today, a prosthetic device, called cochlear implant, can be implanted in the inner ear and can restore partial hearing to profoundly deaf people. Some individuals with implants can now communicate without lip-reading or signing, and some can communicate over the telephone.

What Is Normal Hearing?

Ear consists of three parts that play a vital role in hearing—the external ear, middle ear, and inner ear.

- **Conductive hearing**: Sound travels along the ear canal of the **external ear** causing the ear drum to vibrate. Three small bones of the **middle ear** conduct this vibration from the ear drum to the cochlea (auditory chamber) of the **inner ear**.

- **Sensorineural hearing**: When the three small bones move, they start waves of fluid in the cochlea, and these waves stimulate more than 16,000 delicate hearing cells (**hair cells**). As these hair cells move, they generate an electrical current in the auditory nerve. It travels through inter-connections to the brain area that recognizes it as sound.

How Is Hearing Impaired?

When there is a disease or obstruction in the **external** or **middle ear**, conductive hearing may be impaired. Medical or surgical treatment can probably correct this.

An **inner ear** problem, however, can result in a sensorineural impairment or **nerve deafness**. In most cases, the hair cells are damaged and do not function. Although many auditory nerve fibers may be intact and can transmit electrical impulses to the brain, these nerve fibers are unresponsive because of hair cell damage. Since severe sensorineural hearing loss cannot be corrected with medicine, it can be treated only with a cochlear implant.

What is a cochlear implant?

A cochlear implant is an electronic device designed to help severe to profoundly deaf individuals who gain little or no benefit from hearing aids.

Cochlear implant systems convert everyday sounds into coded electrical impulses. These electrical pulses stimulate the hearing nerve, and the brain interprets them as sound.
A cochlear implant system consists of two main parts:

- an internal *implanted* part called the implant,
- and an external part known as the *speech processor*.

**How a cochlear implant works**

1. Sounds are picked up by a microphone and turned into electrical signals.
2. These signals go to the speech processor where they are *“coded”* (turned into a special pattern of electrical pulses).
3. These pulses are sent to the coil and are then transmitted across the intact skin (by radio waves) to the implant.
4. The implant sends a pattern of electrical pulses to the electrodes in the cochlea.
5. The auditory nerve picks up these electrical pulses and sends them to the brain. The brain recognizes these signals as sound.

**Who can benefit from a cochlear implant?**

Both children and adults can use cochlear implants effectively, whether they are born deaf or whether hearing loss occurs later in life.

It is not possible to predict how much benefit any individual will attain from a cochlear implant, but the following points are widely recognized.

- Children born deaf will have the greatest benefit if they have an implant before the age of 5 and preferably by the age of 3.
• If a person has memory of speech and language, they may receive more benefit from a cochlear implant.

• The longer the period of profound deafness, the more limited the benefits are likely to be.

Cochlear implants are only appropriate for hearing losses primarily caused by a problem in the inner ear (the cochlea). They are intended for people who are unable to gain sufficient speech information through conventional hearing aids.

**What are the benefits of cochlear implants?**

*Hearing everyday sounds:*
Virtually all users benefit by being able to hear more environmental sounds. This helps people to keep in touch with their environment. It is also an important safety consideration as it enables people to hear traffic, sirens, alarms, etc.

*Hearing and understanding speech:*
Virtually all users will hear speech sounds through the cochlear implant. It usually takes some time before they begin to understand these sounds, especially for children. Being able to hear speech can be of great help to those who lip-read, and it makes everyday communication much easier for the vast majority of users.

Furthermore, users may go on to understand speech without lip-reading. Many, although not all, cochlear implant users are able to achieve this with time.

*Improving the user’s own speech:*
Hearing their own speech and the speech of others often helps cochlear implant users fine-tune their speech.

*Listening in background noise:*
When there is background noise, it is more difficult for all of us to hear speech, but especially for hearing aid and cochlear implant users. All cochlear implants have special features to help in such situations, including fast stimulation rate and advanced speech processing strategy, providing outstanding speech understanding in background noise.

*Using the phone can become a reality!*
Many users are eventually able to understand speech without lip-reading. Some users also go on to be able to have conversations over the telephone.

**Assessments**

**Audiological:**
- Hearing levels with and without hearing aids, for tones and for speech
- Test of auditory nerve function
- Establishing existence of any significant additional conditions or needs
- Establishing appropriate expectations
Medical:
- Evaluation of cause of hearing loss
- General health
- Condition of the ears
- Establishing existence of any significant additional conditions or needs
- Establishing appropriate expectations

Radiological:
- CT and/or MRI scan of the ears
- Psychological ability to cope with operation
- Ability to cope with follow-up program
- Establishing existence of any significant additional conditions or needs
- Establishing appropriate expectations

Speech & Language:
- Assessing educational needs
- Establishing existence of any significant additional conditions or needs
- Establishing appropriate expectations

Educational:
- Assessing stage of speech and language development
- Establishing existence of any significant additional conditions or needs
- Establishing appropriate expectations

Surgery
The operation usually takes between 2 and 4 hours. The risks involved in cochlear implant surgery are small and compare well with other ear surgeries.

1. A general anesthetic is normally given.
2. The skin is shaved in the area where the incision is to be made.
3. A bed is drilled out in the bone behind the ear for the implant.
4. A hole is made into the cochlea.
5. The electrode array is inserted into the cochlea.
6. The electrode array and the implant are secured in place.
7. Electrode function is tested before the wound is closed.
8. There is usually little discomfort when the patient wakes up.
9. Pain medication can normally be given if required.
10. Patients are usually up and about the next day. The length of stay in the hospital can be as short as 1-2 days.

First Sounds
The speech processor is fitted 3 to 6 weeks after surgery. The speech processor is set up individually for each user.

To program the processor for the user:
- the user wears the processor,
- the processor is also attached to the clinic computer,
- the clinic computer generates signals at carefully controlled levels,
• the user indicates:
  o the quietest signal heard (\textit{Threshold} level)
  o the loudest comfortable signal heard (\textit{Most Comfortable} level)

• these two levels are measured for all the electrodes in the cochlea,

• using this information, a speech processor program is created which allocates sounds between these two levels, i.e., loud enough to hear but not so loud as to be uncomfortable. The program is fine-tuned during following clinic sessions.

\textbf{Follow-up program}

The cochlear implant user needs to be fully committed to the follow-up program designed by the Cochlear Implant Team in order to attain the greatest benefit from the implant system. The follow-up program includes:

\textit{Help, advice and support:}
Assistant should be available not only for technical matters which may arise, but also for general questions. The team can also give you information on support groups for cochlear implant users and their families.

\textit{Regular medical check-ups:}
The implant site should be checked regularly by a physician.

\textit{Regular re-programming of the speech processor:}
Cochlear implant users should visit their clinic regularly for re-programming of the speech processor. This allows the audiologist to check that the implant is continuing to function well. He or she can also make any small modifications or improvements to the program so that the user will continue to have the greatest benefit from the implant system.

\textit{Speech and language therapy and advice:}
Regular speech and language therapy is usually available, especially for children.

\textit{Educational advice and support (for children):}
Children using cochlear implants usually have regular contact with an educational specialist qualified to work with the hearing impaired. He or she can offer advice and support and monitor the child’s progress with the cochlear implant system.

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