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Note on Cochlear Implant: Develop Speech in Deaf and Mute People



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ABSTRACT

Cochlear implant is electromagnetic device which surgically placed in temporal bone of skull bone behind ear. Sometime it's called as "Bionic ear" because it was first time invented by America Bionic Corporation. Cochlear implant offers the hope of regaining or restoring the ability to sense sound for some people who have experienced significant hearing loss. Although it is not miracle device. Cochlear implant helps in some children and adults who are born deaf or hearing loss occurs late in life.



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INTRODUCTION

This is an artificial hearing system which uses electromagnetic device i.e. cochlear implant which provides sense of sound to people who are deaf and hard of hearing. Through this device deaf person can learn and understand speech solely without requiring any visual clue such as lip reading and sign language. This artificial ear called as bionic ear.

How normal hearing and hearing loss is occurs?

Human ear is made up of three parts:

1. Outer part: contains ear canal.
2. Middle part: contains ear drum and three tiny bones malleus, incus, stapes.
3. Inner part: contains cochlea which connect to brain via auditory nerve.

When person is exposed to a sound, sound is picked up by ear canal. Then it comes to middle part of ear where it is filtered by ear drum. When it comes across ear drum three tiny bones get vibrates, then this sound vibration enters into cochlea which is fluid filled snail shape curled tube, in that fluid thousands of hair cells are present. Due to entered sound vibration fluid inside cochlea also get vibrates and hair cells move back and forth while they apply electrostatic charges to sound energy and convert it into electrical signal, which is sent to brain via auditory nerve and interpretation and hearing occurs.

When person is exposed to loud sound consistently, sound vibration causes fast vibration of tiny bones present in middle ear so that fluid inside cochlea also vibrates fast and hair cells get bent, broken down and get damage. Its re-growth can not occur and sound energy can not convert into electrical signal so hearing loss occurs.

Types, causes and treatment of hearing loss

There are three types of hearing loss

1. Conductive hearing loss

These causes due to problem occur in outer part i.e. in ear canal and middle part i.e. ear drum and its three tiny bones

Causes

- Malformation of outer and middle ear structure

- Fluid retention in middle ear from cold
- Ear infection
- Allergies
- Perforated ear drum
- Benign tumor
- Impacted earwax
- Foreign body in ear
- Otosclerosis

Treatment

Antifungal and antibiotics are used when ear infection occurs and perforated ear drum can be repaired by myringoplasty. Hearing loss can be detected by an instrument i.e. Otoloscope.

2. Sensorineural hearing loss

These causes due to problem occur in inner part of ear i.e. in cochlea and in auditory nerve.

Causes

- Exposure to loud noise
- Head trauma
- Malformation of inner ear
- Genetically
- Aging
- Otosclerosis: A hereditary disorder in which a bony growth forms around a small bone in middle ear and prevent it from vibration when stimulated by sound.

Treatment

Corticosteroids are prescribed when swelling or inflammation in cochlear hair cells occurs, and if benign tumor occurs in inner ear it is surgically removed.

3. Mixed hearing loss

These causes due to problem occur in outer part, middle ear and inner part of ear i.e. in cochlea and in auditory nerve.

Cochlear Implant

Cochlear implant is surgically implanted device that helps to overcome problem in cochlea in which hair cells get damaged. This implant artificially stimulates inner area of ear and send electrical signal to auditory nerve and then to brain for interpretation.

Cochlear implant device consists of two parts outer part and inner part, in which outer part remains outside of the body and inner part remains inside the body.

Cochlear implant device consists of following components:

Outer part:

1. Microphone
2. Sound and speech processor
3. Head piece in which transmitter is present.

Inner part (Implant package):

1. Receiver
2. Electrodes



Photo courtesy of Cochlear, Ltd.

Figure: 1



Figure: 2

Figure 1: Cochlear implant with head piece, receiver, and electrode [inner part]

Figure 2: Cochlear implant with speech processor, microphone and head piece [outer part]

Working of Cochlear implant

Microphone picks up sound from environment, which transmits through cable to speech processor, where it gets filter, analyzes, and converts sound energy to digital code, which is stored into chip in speech processor by audiologist. This digital sound transmits through cable to head piece where transmitter is present and transmits this digital sound to receiver under skin and then to electrodes which are spirally wound around cochlea in inner part of ear. This digital sound then converts into electrical signal due to electrostatic charges applied by tiny electrodes and finally this electrical signal is transmitted by auditory nerve to brain where it gets interpreted and hearing occurs.

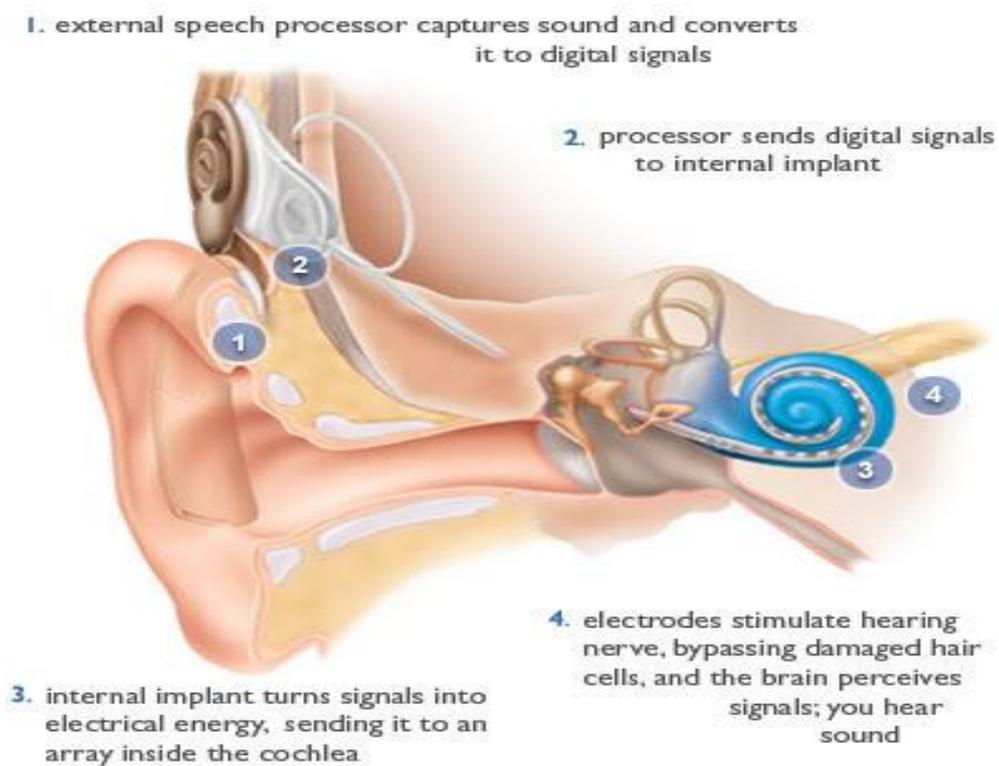


Figure 3: Working of each component of implant

Cochlear Implant Surgery

This surgical operation takes 2 to 4 hrs. First general anesthesia is given to patient. This surgery involves securing implant package under the skin and inside the skull, and threading of the wire containing electrode spirally around the cochlea. To secure implant package, surgeon first drill 3 to 4 millimeter bead in skull bone, then open up mastoid bone behind ear

to allow access to middle ear, drill small hole and inserts wire containing electrode spirally around cochlea and then incision is closed.

Advantages of Cochlear Implants

- One can enable to hear conversation and thus learn spoken language with relatively easy, particularly for those with severe-profound hearing loss.
- May enable one to use a regular telephone, otherwise it wasn't possible.
- Avoids problems of acoustic feedback & ear mold issues.
- Greater ease in high frequency consonant perception, e.g., /sh/, /s/, /f/, /t/, /k/, /p/, /h/
- Distance hearing is likely better than with hearing aids, although FM systems are still needed in classrooms due to noise factor.
- May be greater potential for incidental learning.
- Greater opportunity for natural sounding voice.
- Understanding women on the telephone may be easier as compared to understand them with a cochlear implant for a severe-profound loss.
- Provides impetus for enabling TC children to transition from signing to hearing'n'speaking.
- Bypasses the cochlea which is likely the source of deafness.
- Is "lifesaving" technology for those who otherwise might not hear or those who would have to struggle in order to hear, or for those who cannot do well with hearing aids even with a severe hearing loss, such as those with auditory neuropathy

Disadvantages of Cochlear Implants

- Environmental & practical living issues
 - static: radar detector, playgrounds, trampolines, computers, carpeting
 - pressure: some recommended restrictions such as scuba diving
 - magnetic: suggested MRI restriction
 - trauma: some restrictions from rough sports such as football
- Surgical issues
 - staph infection (low risk)
 - vertigo (low risk)
 - tinnitus, may be worsened or improved (low risk).
 - partial facial nerve paralysis (low risk and if occurs, is typically temporary).

- competency of surgeon
- If complications occur, then travel time/cost enter the equation for follow-up care.
- Insurance and cost issues
 - If inadequate insurance, medical costs and device are expensive.
 - Processor and accessories are expensive.
 - Securing approval from health policy may be time-consuming and aggravating.
- Less control over prosthetic device, i.e. once a manufacturer's device is implanted, the implantee has no option but to remain with that device for life, unless the device fails or the implantee elects to pay for another surgery/device.
- Loud buzzing sound when implant user is within close proximity to neon lights; interferes with speech signal.
- Programming issues: dependent on mapper/audiologist
 - Travel and time costs if mapper is not in child's area.
 - Mapping session is time-consuming, boring, and can be expensive.
 - It should be re-programmed annually (more often for young children).
 - Programming is not always easy, especially for establishing the comfort levels.
 - Changing from one program to another oftentimes involves a temporary setback in one's discrimination.
 - Adapting to change in strategies is difficult for many people
- Wearing a body processor is more problematic than a BTE processor/hearing aid.
 - It interferes in the romance department.
 - It may be difficult for women when using the bathroom.
 - It gets in the way of clothing for many women and may require a different wardrobe.
 - Cable wire (cord) sometimes falls off.
- Processor battery gives no warning that it will "go dead" and may place the implantee in the uncomfortable position of suddenly not being able to hear while engaged in conversation (although the option of having a warning that is audible to everyone within earshot is available, this is not a viable choice for most teens and adults).
- Batteries have a dramatically shorter life span than do hearing aid batteries; this can be very inconvenient and more expensive.
- If and when the device fails, the implantee may go through a prolonged period of emotional anguish due to not hearing/understanding, at least until the insurance

company approves another surgery. Then, after surgical re-implantation, the implantee must go through another month of silence between time of surgery and initial stimulation.

- Because residual hearing is typically destroyed upon implantation, the difference between hearing and not hearing (due to device not being used) becomes dramatic; this is "a black'n'white issue" unless implantee has either another implant or hearing aid in the other ear.
- If and when the stimulator (the internal part of device) fails or is damaged, then another surgery may be mandated; each successive surgery carries the additional risk of the electrodes not working as well as before.
- Low frequency consonant discrimination for placement cues may be more difficult.
- We still don't know the long-term effects of implants, i.e., 30-50 years, and implants may cause bone growth and scarring inside the cochlea.

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