Cochlear Implants

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I. INTRODUCION

Cochlear Implants are small electrical devices that are worn both internally and externally in order to enhance or correct hearing in patients with profound deafness. Research started in the 1950s and in the 1980s the first commercial device was approved. These implants are used to directly stimulate the auditory nerve and improve hearing. The Cochlear Implant works specifically for problems with the inner ear and the cochlea when there is sensorineural hearing loss.

II. HEARING

A. How Normal Hearing Works

During normal hearing, the outer ear captures sound vibrations which are first sent to the ear cannel and then the middle ear. While in the middle ear the vibrations cause the Malleus, Incus, and Stapes bones to move. These tinny bones create motion in the cochlear fluid which causes the hair cells, located in the cochlea, to move back and forth. This movement of the hair cells sends electrical signals to the auditory nerve that is carried to the brain.

B. How Cochlear Implants Work

With the Cochlear Implant, sound is picked up by the external microphone and through the antenna is sent to the sound and speech processor. The sound and speech processor selects and arranges sound in order to differentia background noise from speech. This processor is made up of a minicomputer that processes sound into digital information and is worn externally. From here the sound is converted into electrical signals that the transmitter is able to send to the implant package. The implant package determines how much current is to pass to the electors and sends the signals. By controlling the amount of current and the position of the electrodes in the cochlea, the implant package is able to determine loudness and pitch. The signals that are sent to the stimulator are converted into electrical pulses and sent to the electrode array. Electrode arrays act like the hair cells that are present in normal hearing and stimulate the nerve endings in the cochlea so that the message is able to be sent to the brain. In order for this all to work, the internal receiver or stimulator and the transmitter must be aligned using the magnets.

III. THEORIES

A. Place Theory

The Place Theory depends on the idea that the inner ear responds to sound based on the location. The cochlea has a better response to a single tone at one place. It is believed that lower pitches are sent to areas of the cochlea that are more responsive to lower frequency. Therefore higher pitches are sent to different areas. This is achieved in implants by using multiple channels with the electrodes dispersed about the cochlea.

B. Time Theory

The Time Theory follows the idea that the inner ear responds to the timing of sound. It is believed that the cochlea is more responsive to different kinds of pulses. In these implants, the sound signals are converted into pulses.

IV. APPLICATION

A. Surgery

Surgery for Cochlear Implants is a short outpatient procedure that last about two to three hours. While under general anesthesia, doctors make a three to four millimeter “bed” in the temporal bone. An opening in the mastoid bone is created allowing access to the middle ear. A

small whole is made into the cochlea and the electrode arrays are threaded into the cochlea. The receiver is implanted into the skull and the implant package is secured.

B. Activation

Two to four weeks after the incision is healed activation of the Cochlear Implant occurs. An audiologist attaches the headset and aligns the external magnet with the implanted. Using a computer system information is transferred between the implant and sound and speech processor in order to check the components. The audiologist then programs the sound and speech processor by individually turning on the electrodes to test for the threshold and comfortable listening levels. This is done by increasing the electrical current that passes through the auditory nerve until the patient is able to hear a soft beep. This process is continued for an array of levels therefore creating a hearing map. By matching the use of the different electrodes when they respond to sound with volumes, the map is able dictate how each electrode stimulates the nerve endings.

C. Rehabilitation

After the Cochlear Implant has been activated it takes time for the patient to be able to understand the sounds. Multiple factors including age when hearing was lost, ability to speak prior to hearing loss and age will impact the ability to interpret and identify sounds. The first day after activation speech is garbled or high pitched, but over time hearing becomes more natural and clearer. In order to optimize performance patients are recommended to continue programming sessions in increments up to one year. Listening exercises help the patients to recognize sounds while Speech and Language Therapy is used to help patients with their speech when they have been years without speaking and may have forgotten how it sounds.

V. CONCLUSION

Cochlear Implants improve patient's ability to hear although some may still require speech reading to understand speech. With a Cochlear Implant, patients have improved voice monitoring and speech reading. Patients are able to hear and recognize environmental sounds as well as soft sounds. Though there may still be trouble with background noise people with Cochlear Implants are able to talk on the phone, which was not as possible with normal hearing aids. The success rates for the Cochlear Implant are dependent on the patient's ability to speak and hear prior to hearing loss as well as the number of functioning auditory nerves.

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