Cochlear Implants

ELE482 Biomedical Engineering Seminar

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Hearing loss for the most part can occur in a variety of forms. Defects in the outer or middle ear, where sound vibrations are too slow to create full sound can be amplified with the help of the common hearing aide. What most people do not know is that some hearing loss can go beyond the middle ear and into the inner ear where the hair cells lining the cochlea are damaged, this is called sensorineural loss or nerve deafness.

There have been miraculous developments over the past 30 years in which doctors and researchers have developed ways to help patients this type of profound deafness. Implantation is a remarkable procedure even to those who are aware of the mechanics behind it. The cochlear implant is a microelectrode array that is implanted into the cochlea and directly stimulates the auditory nerve. The electrodes are embedded in a silicon matrix and situated are along the cochlea's basilar membrane. The sound is received by an external microphone placed behind the ear and analyzed by a microprocessor. Once analyzed, the electrical signal is sent through the skin to the internal implant and to the appropriate electrode on the membrane. The membrane is tonotopically organized, meaning that high frequency sounds are activated at the base of the membrane and low frequencies at the apex of the basilar membrane. Because of this specific quality, the CI can access most of the frequencies of the original cochlea.

The procedure requires a short surgery where the transmitter/receiver is placed on the skull behind the ear and the tiny electrode wires are inserted into the cochlea. The recovery time is about 1-2 days and the fitting of the headset and processor is done for about 4-6 weeks after the surgery. Over this period of time, the doctor creates a MAP or program of comfortable hearing for each individual patient.

Since the first implant in 1957, experiments and research across the globe are being conducted to improve these devices. It has been shown that patients with implants are able to hear a wide range of sounds and speech. Although the first sounds heard after surgery is rather choppy, with time they become more natural.

Unfortunately there is a part of the membrane that electrodes are not able to reach; it is the thinnest narrowest winding part of the cochlea. It has been proven though, that these frequencies are not necessary for understanding speech transmission. The auditory cortex of the brain is able to process sounds with enough harmonics to fill in the missing frequencies.

It is also important to understand that some people may not benefit from this type of solution because of a defect further up the hearing chain. If the auditory nerve has been transected as with neruofibromatosis type 2, auditory brainstem implanting is a better hope for these patients. Researchers are still working on ways to improve ABI as they are not completely perfected but do assist in helping patients with to hear some tones.

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