Cochlear Implants

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Sareh Rajaee
Biomedical Engineering, University of Rhode Island
Kingston, RI 02881

The ear consists of three sections: the outer ear, the middle ear and the inner ear. The outer ear consists of the pinna and the ear canal. It picks up sounds and transmits them as waves, to the eardrum. The middle ear consists of the eardrum and the ossicles. The sound waves cause the eardrum to vibrate and set the ossicles into motion. The inner ear consists of the cochlea, which contains intricate hair cells (or sensory cells); and the vestibular system, which controls balance. The motion of the middle ear causes the hair cells of the inner ear to move. The hair cells change the movement to electrical impulses that are transferred to the auditory nerve fibers, which transfers them to the brain, where they are interpreted as sound.

There are three types of hearing loss: conductive, sensorineural, and mixed hearing loss. Conductive hearing loss occurs when the eardrum and middle ear bones do not properly transmit sound to the cochlea. This may result in mild to moderate hearing impairment. Sensorineural hearing loss is caused by the deterioration of the cochlea, with some or all of the hair cells damaged or motionless. This may result in mild to profound hearing impairment. Mixed hearing loss involves a combination of conductive and sensorineural hearing loss. This may result in mild to profound hearing impairment.

Hearing Aids and Cochlear implants are both biomedical devices used to help people who suffer from some form of hearing loss. A hearing aid might be beneficial to a person with a conductive hearing loss, as the hearing aid captures sound from the environment and amplifies it, although, it does not result in clearer sound. A cochlear implant may benefit individuals with sensorineural hearing loss, as it sends the electronic sound stimulation directly to the remaining auditory nerve fibers.

Cochlear implants undergo a complicated series of steps, but in the end they are successful. First, the ear-level microphone of the speech processor picks up sounds from the environment. The sound processor dictates the range (Input Dynamic Range) of sound levels from the environment that will be converted into high-resolution digital signals. The internal chip in the speech processor analyzes the sounds and digitizes it into coded signals. The coded signals are then sent from the speech processor to the transmitting coil, which sends the coded signals as FM signals to the cochlear implant receiver/stimulator under the skin.

The cochlea is described as Tonal Topic, meaning the nerve fibers located at the base of the cochlea are responsible for high frequency sound, while those located at the end are responsible for low frequency sound. The implant breaks the speech spectrum into its different frequency representations and releases those electrical signals at the appropriate place in the cochlea. The implant receiver/stimulator delivers the appropriate amount of electrical energy to the array of electrodes inside the cochlea. The electrodes then stimulate the remaining auditory nerve fibers in the cochlea.

Sources

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