COCHLEAR IMPLANTS IN CHILDREN

It is well-established that profound deafness in childhood affects the development of auditory speech perception, speech production, and English language skills. Some children with profound deafness develop viable oral communication skills with conventional hearing aids but most do not. Failure to develop adequate oral communication skills can have a significant negative effect on educational and employment opportunities in these individuals. The American Academy of Audiology recognizes multichannel cochlear implants as sensory aid options for children with profound hearing impairments who demonstrate limited or no functional benefit from conventional hearing aid amplification. Multichannel cochlear implants are appropriate for children with prelingual or postlingual deafness. The Academy further recognizes that parents (or legal guardians) have the right to choose a cochlear implant if they decide that it is the most appropriate option for their child.

Background

A cochlear implant is an electronic prosthetic device that is surgically placed in the inner ear and under the skin behind the ear for the purpose of providing useful sound perception via electrical stimulation of the auditory nerve. Cochlear implants are intended to provide prelingually or postlingually deafened children, who obtain limited functional benefit from conventional amplification, improved sound and speech detection and improved auditory perception of speech. Because research in adults and children has shown significantly greater benefit with multichannel than single-channel cochlear implants,[1,2] only multichannel devices should be used in the pediatric population. Multichannel cochlear implants attempt to mimic the place representation of frequencies along the cochlea by tonotopic arrangement and stimulation of electrodes.

The law requires that the safety and efficacy of a cochlear implant be demonstrated through clinical investigations before the device can be commercially marketed as accepted clinical practice. Following years of extensive testing, the U.S. Food and Drug Administration approved the first multichannel cochlear implant as medically safe for use in adults (1984) and children (1990). Cochlear implants also have been found to be medically safe by the American Academy of Otolaryngology-Head and Neck Surgery, the American Medical Association, and virtually all health insurance companies.

Cochlear Implant Benefits

Studies on the efficacy of multichannel cochlear implants in the pediatric population have reported postoperative speech perception and speech production results in postlingually deafened children and in children with congenital or acquired prelingual deafness. All children, especially those implanted at a young age, demonstrated improvement in sound detection and in their auditory perception skills following implantation.[3-8] In addition, research has shown that children with multichannel cochlear implants achieved performance levels that exceeded those of their non-implanted peers who used other sensory aids, including conventional hearing aids and vibrotactile aids.[9-11] Studies also have shown improvement in speech production skills and overall speech intelligibility in children with multichannel implants, including children with prelingual deafness.[12-14] Improvements in auditory speech recognition and speech production occur over a long time-course in prelingually deafened children who receive multichannel cochlear implants. There are large individual differences in the benefit that children derive from multichannel cochlear implants due to factors such as age at onset of deafness, age at implantation, amount of cochlear implant experience, and educational training. Reliable predictors of cochlear implant performance, however, have not been identified.

Guidelines for Determining Candidacy for Cochlear Implants

Accurate assessment of hearing impairment by an audiologist is a critical factor in the determination of implant candidacy. The audiologist should use an age-appropriate combination of behavioral and physiological measures to determine hearing status. A pure tone audiogram demonstrating severe-to-profound, bilateral sensorineural hearing loss should be confirmed by acoustic reflex data and, when appropriate, auditory brainstem responses to both clicks and tonal stimuli. Behavioral audiological tests should be repeated following the provision of appropriate electroacoustic amplification and training. A cochlear implant is indicated only after the child has had a sufficient trial with hearing aid amplification.

The audiological criteria for implantation are a congenital or acquired profound, bilateral sensorineural hearing loss and limited or no functional benefit from electroacoustic hearing aid amplification. Generally, a pure tone average (500, 1000, 2000 Hz) of 90 dB HL or greater in both ears is indicated. The criteria for limited functional hearing aid benefit continue to evolve and are influenced by the performance results reported for pediatric multichannel cochlear implant users. Hearing aid benefit is examined in terms of: (1) aided thresholds with conventional hearing aids relative to aided results reported for multichannel cochlear implant users, including aided results in the high frequencies where important consonant cues occur, and (2) performance on word recognition tasks, administered with auditory cues only in a closed- or open-response set. Transtympanic promontory stimulation immediately prior to surgery may aid in the selection of the ear to be implanted.[15]

Candidates for cochlear implantation require medical evaluation by an otolaryngologist, including history, physical examination and imaging studies of the temporal bone. The patient should be free of active ear disease, have an intact tympanic membrane, and be an acceptable candidate for general anesthesia. High resolution computerized tomography (CT) scan, magnetic resonance imaging (MRI), or both, are necessary to identify the implantable cochlea and patent internal auditory canal.

Electrical promontory stimulation is indicated when auditory nerve integrity is in doubt.

The implant components and function, the risks, limitations, and potential benefits of implantation, the surgical procedure, and the postoperative follow-up schedule should be discussed with parents (or guardians), and the child, if age appropriate. Ideally, children should be enrolled in educational programs that support the use of auditory prostheses and the development of auditory and speech skills, regardless of the particular communication method employed. It is further recommended that parents (or guardians), and the child, if age appropriate, be fully informed about alternatives to implantation, horizontal acculturation, and Deaf culture.

Guidelines for Management of Children with Cochlear Implants

Children who receive cochlear implants require ongoing audiological management and otolaryngological follow-up. Ongoing management by an audiologist includes programming the implant parameters and monitoring device performance from electrical threshold and dynamic range data. Electrically evoked auditory brainstem responses (EABR), middle latency responses (MLR), or acoustic reflexes (EART) may be used intraoperatively with stimuli delivered to the cochlear implant prior to leaving the operating room or postoperatively on an outpatient basis to facilitate the fitting process.[16] These objective measures can be particularly useful in children who are either difficult to condition or otherwise unable to respond consistently through the electrical stimuli used to program the speech processor. Follow-up audiological evaluations are required to assess improvement in sound and speech detection and auditory reception of speech following implantation. Medical evaluation by an otolaryngologist should be performed as needed to monitor the postoperative course and medical status of the child.

Pediatric cochlear implant users require training to maximize the benefits that they receive from their devices. Rehabilitation should focus on the development of a wide range of listening behaviors within meaningful communicative contexts. Ideally, there should be close interaction between the audiologist at the implant center, the clinician who provides rehabilitative services, and educators working on a day-to-day basis with the child. For a child to realize optimal benefit from a multichannel cochlear implant, educators should have an understanding of device function and maintenance, as well as an appropriate level of expectation regarding the child's progress with the implant.

Future Needs

The field of cochlear implants is still in its infancy. Technological advances will lead to the development of more sophisticated and improved devices. It appears inevitable that as technology for cochlear prostheses advances, candidacy criteria for implantation will continue to expand to include a wider range of the population with severe and profound hearing impairments. Audiological training programs must provide course work and clinical experience with cochlear prostheses. Audiologists with expertise in the diagnosis (including the use of electrophysiological techniques), management, and habilitation of children with hearing impairments are necessary to ensure competent provision of professional services by pediatric cochlear implant programs.

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