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Opinion Article

Neuroprosthetics: Auditory Brainstem Implants for Specialized Hearing Restoration Innovations

Philip Jade*

Department of Audiology, University of Oslo, Oslo, Norway

DESCRIPTION

Auditory Brainstem Implant (ABI) is a remarkable neuroprosthetic device designed to restore hearing sensations in individuals with specific types of hearing loss or deafness. Unlike cochlear implants that bypass damaged hair cells in the inner ear, ABIs target the auditory brainstem, specifically the cochlear nucleus or the superior olivary complex, to stimulate the auditory pathway.

This sophisticated technology provides a hearing sensation by directly stimulating the brainstem, offering potential benefits for individuals who are not candidates for cochlear implants.

Understanding auditory brainstem implant

Candidates and indications: ABI candidates often include individuals with Neuro Fibromatosis type 2 (NF2), which leads to bilateral vestibular schwannomas (vestibular tumors). These tumors may affect the auditory nerve, making cochlear implantation challenging or impossible, hence making ABI a potential option.

Surgical procedure: Implantation of an ABI involves a complex neurosurgical procedure where electrodes are placed directly onto the surface of the brainstem. The surgery requires precision and expertise due to the proximity of the implantation site to vital brain structures.

Mechanism and functionality

Neural stimulation: The ABI works by converting sound signals into electrical impulses delivered to the brainstem. These electrical signals bypass the damaged auditory nerve and stimulate the brainstem directly, aiming to elicit auditory sensations.

Signal processing and perception: The electrical stimulation from the ABI does not replicate natural hearing but provides the brain with auditory cues. The brain adapts to interpret these electrical signals, allowing the individual to perceive sound patterns and speech signals.

Efficacy and outcomes

Auditory sensation and speech perception: ABI recipients may experience varying levels of auditory sensation and speech perception. While the technology does not provide normal hearing, some individuals report improved sound awareness, environmental awareness, and speech understanding.

Rehabilitation and adaptation: Post-implantation rehabilitation and auditory training are crucial for ABI recipients to adapt to the new auditory input. Auditory therapy assists individuals in making sense of the electrical signals and improving their ability to interpret sound.

Challenges and considerations

Limited population: The use of ABIs is relatively rare and is primarily reserved for individuals with NF2 or other specific conditions affecting the auditory nerve or brainstem, limiting the number of potential candidates.

Surgical risks and complications: ABI surgery involves inherent risks associated with neurosurgery, including the potential for injury to surrounding brain structures, infections, and post-operative complications.

Future directions and research

Technological advancements: Ongoing research focuses on improving ABI technology, including electrode designs, signal processing strategies, and miniaturization of devices to enhance outcomes and reduce surgical complexities.

Expanded candidate criteria: Exploring the possibility of widening the candidate pool for ABIs beyond NF2 patients by considering other neurological conditions or auditory nerve-related pathologies.

Auditory brainstem implants represent a pioneering advancement in auditory neuroprosthetics, offering a potential hearing solution for individuals with specific types of hearing loss or deafness. While the technology holds promise, it remains a specialized intervention with unique considerations regarding

Correspondence to: Philip Jade, Department of Audiology, University of Oslo, Oslo, Norway, E-mail: jade@gmail.com

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candidacy, surgical intricacies, and post-implantation rehabilitation. Continued research and advancements in ABI technology are essential for improving outcomes, expanding candidacy criteria, and providing an alternative auditory rehabilitation option for individuals who previously had limited hearing restoration possibilities.