

AUDITORY BRAINSTEM IMPLANTS

Morgann Robitaille

Biomedical Engineering Seminar III

University of Rhode Island, Kingston, Rhode Island 02881

Acoustic neuromas are lesions that form on the cochleovestibular nerve (auditory nerve) and bilateral acoustic neuromas are formed in a rare disease called neurofibromatosis type 2. In both cases, the removal of these benign tumors results in a complete transection of the auditory nerve and total deafness. If these tumors are not removed, they can cause compression of the brainstem and are ultimately fatal.

Cochlear implants are of no help to this patients group because the damage is beyond the cochlea. In such cases, the current technology is auditory brainstem implantation (ABI). As its name suggests, the ABI is placed and acts directly on the brainstem, thereby bypassing all structures that lie peripheral to that point. This effectively avoids most of the problems associated with cochlear implantation. The structure works by stimulating the cochlear nuclear complex, which consists of the dorsal and ventral cochlear nuclei. The axons of the auditory nerve terminate at the ventral cochlear nucleus. Instead of placing the device directly on this structure, it is placed on the lateral recess of the fourth ventricle, which is adjacent to both cochlear nuclei. The auditory brainstem implant works very similar to that of the cochlear implant. The surgery to implant the device is actually done at the same time as the lesions or tumors are being removed. An external microphone picks up sound waves and sends them to the signal processor where it selects particular characteristics of the sound and electrically encodes them. The

coded signal is sent back to the transmitter and then forwarded to the receiver stimulator. The signal is sent straight to the microelectrode array just below the cochlear nucleus. Most patients implanted (~200) have regained limited hearing ability even though the sounds are most often jumbled and understanding speech is difficult. Because of the tonotopic organization of the ventral nucleus, stimulation of the electrode array lying straight on top does not produce the desired effects. A penetrating array of electrodes has been under development and implanted into cats. This device can actually penetrate this area of the brainstem and can evoke tonotopically localized neural activation in the inferior colliculus. This improved selectivity will hopefully result in improved speech understanding in human patients. Another factor contributing to the lack of resolution in surface ABI's is the high current need for stimulation.

One distinct reason for the limited success of current ABI's is that direct stimulation of the cochlear nucleus can bypass important neural processing. If the penetrating electrodes do not help in improved speech recognition, it could be assumed that specific processing in the CN are critical for speech understanding and cannot be recreated.

- www.mjm.mcgill.ca/issues/v03n02/v03p115/v03p115fs.htm
- www.irc.cordis.lu/success/complete_success.cfm?SUCCESS_ID=64