Factors Affecting Neural Response Telemetry Recordings in the Chronically Stimulated Cat

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There is now overwhelming evidence that for the best outcomes in congenitally deaf patients they should receive effective auditory stimulation, via a cochlear implant, as early as possible. However, ensuring effective stimulation in very young patients requires the objective determination of the threshold and maximum comfortable levels of stimulation. To this end, systems to record the electrically evoked compound action potential (ECAP) have been developed, including Neural Response Telemetry (NRT) by Cochlear Ltd. Many factors affect the ability of these systems to record ECAPs, including electrode impedance, electrode location, and evoked auditory brainstem response (EABR) threshold. Two months after neonatal deafening, profoundly deaf cats were implanted with banded multi-channel scalar tympani electrode arrays and received unilateral ES to a restricted section of the basal turn from a Nucleus® CI24 cochlear implant and Nucleus® ESPrit 3G speech processor. Daily monitoring of the electrode voltage waveforms in response to 100 μA stimuli allowed for detailed assessment of electrode impedances. Additionally, Custom Sound EP® clinical software and Nucleus® Freedom™ implants and speech processors were used to monitor electrode impedance and record NRT every two weeks. Finally, EABRs were recorded every month. A total of 56 electrodes were implanted in 8 animals, from which it was possible to record EABRs from 49 electrodes (87%) and NRTs from 28 electrodes (50%). When both an EABR and NRT could be recorded from the same electrode there was no significant difference between the threshold for EABR and NRT (Student T-test; $p = 0.342$). For some electrodes ($n = 21$; 37%) it was possible to record an EABR but not an NRT. When compared to electrodes for which it was possible to record both EABRs and NRTs, these electrodes did not have significantly different electrode impedances (Student T-test; Access Resistance: $p = 0.403$; Total Impedance: $p = 0.705$), EABR thresholds (Student T-test; $p = 0.130$) nor were they located within different regions of the cochlear (Chi-square; $p = 0.720$). In no case was it possible to record an NRT but not an EABR. These results indicate that it is possible to record NRTs in only 57% of cases where there is known to be a response, but that electrode impedance, electrode location, and threshold are not contributing factors. Improvements in the ability to objectively determine threshold and maximum comfortable levels of stimulation are still required as they may contribute to an improved clinical performance among subjects implanted at a very young age. Work funded by NIDCD (NO1-DC-3-1005), Garnett Passe and Rodney Williams Memorial Foundation, The Bionic Ear Institute & the Victorian State Government.