THE INFLUENCE OF ELECTRODE GEOMETRY ON THE ELECTRICALLY EVOKED AUDITORY BRAINSTEM RESPONSE. R. K. Shepherd, S. Hatsushika, & G.M. Clark. Department of Otolaryngology, University of Melbourne, Parkville 3052, Victoria, Australia.

The electrically-evoked auditory brainstem response (EABR) consists of a series of far-field potentials that reflect synchronous neural activity within the auditory brainstem in response to a transient electrical stimulus. The EABR appears relatively simply organized in terms of its amplitude and latency behaviour. The growth in amplitude of wave IV of the EABR, for example, reflects changes in the amplitude of the electrically-evoked VIII nerve compound action potential as a function of stimulus intensity. In addition, single unit population studies have shown a monotonic relationship between the growth in EABR amplitude and the number of nerve fibres being stimulated (Merzenich and White, 1977). The EABR can therefore, provide an insight into the response of the auditory nerve to electrical stimulation. We have used this technique to investigate the efficacy of electrical stimulation of the auditory nerve using a variety of stimulating electrode geometries.

Normal hearing and chronically deafened cats were used in this study. The normal hearing animals consistently demonstrated lower thresholds and larger response amplitudes at suprathreshold stimulus levels. However, the response of the two populations to the various electrode geometries was similar. EABRs were readily evoked using the Cochlear (Nucleus) banded electrode array. Increasing the inter-electrode spacing resulted in lower thresholds while the gradient of the input-output function (EABR amplitude Vs log current) remained basically unchanged. The EABR was also dependent on the location of the electrode array within the scala tympani. A systematic reduction in threshold and a slight increase in dynamic range was observed as the electrode was moved from the outer wall of the scala towards the modiolus. EABRs were also readily elicited from a monopolar electrode placed on the round window. Thresholds were usually lower, and the gradient of the input-output function higher than EABRs evoked via bipolar scala tympani electrodes. EABR thresholds were elevated when the monopolar electrode was placed on the promontory. In contrast with bipolar scala tympani electrodes, monopolar electrodes readily evoked facial nerve activity which completely masked the EABR. Finally, bipolar extracochlear electrodes could also evoke EABR activity providing the electrodes were placed close to the endosteum. EABR thresholds were dependent on inter-electrode distance, with greater inter-electrode spacing resulting in both lower EABR and facial nerve thresholds.

These results suggest that the optimum placement of a scala tympani electrode array is close to the modiolus. They also highlight the need to place extracochlear electrodes next to the endosteum in closely spaced bipolar pairs. The ease of evoking facial nerve activity with both monopolar and bipolar extracochlear electrodes illustrates serious limitations with these designs.

Merzenich M. M. & White M. W. 1977. Cochlear implant. The interface problem. In: Functional Electrical Stimulation: Applications in Neural Prostheses. Hambrecht F.T. & Reswick J. B. (Eds), Marcel Dekker Inc., New York.

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