ELECTRICAL NETWORK PROPERTIES AND DISTRIBUTION OF POTENTIALS IN THE CAT COCHLEA

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The patterns of electrical resistance and capacitance in the cochlea formed by the anatomical organisation of the tissue structures and fluids are important in determining the distribution of electrical potentials which arise during normal acoustic stimulation (von Békésy, 1951). Cochlear potential distributions have in the past been measured by recording from the scalar fluids both the spread of cochlear microphonics and also potentials due to electrical stimulation. However, similar distributions in the hair cell-nerve ending region of the organ of Corti may not necessarily occur because of current shunting effects due to the electrical network patterns. To examine these current shunting effects, a three dimensional mathematical model of the electrical properties of the cat cochlea was constructed. This was formed from a two dimensional cochlear cross-section model similar to that proposed by Johnstone *et al.*, (1966) for the guinea pig. Sixteen such sections were resistively coupled to form the three dimensional model. Results derived from this model predict that during electrical stimulation of the cochlea, the current in the organ of Corti region attenuates quite differently to the scalar voltage by a degree which depends on the stimulus electrode configuration.

The accuracy of these model results has been validated in experiments in which the cat scala tympani was electrically stimulated. The resulting current distribution in the organ of Corti region has been measured by examining the excitability characteristics of units in the auditory nerve and inferior colliculus. In monopolar stimulation in which the reference electrode was placed in the neck muscles, gross excitation of the auditory nerve occurred and an attenuation of less than 1dB/mm cochlear length was measured. With a reference electrode in the scala vestibuli, the attenuation was approximately 1.8dB/mm. Bipolar stimulation of the scala tympani produced an attenuation of approximately 3-4dB/mm. These results, although smaller than expected on the basis of attenuation measurements in the guinea pig scalae (von Békésy, 1951), are nevertheless in close agreement with the model predictions. The model predicts that the spiral ligament produces current shunting along the cochlea in the region of the cochlear nerve fibres producing the small attenuation figures. However, it also predicts that this shunting will have little effect on the scala tympani voltage attenuation so that scalar voltage measurements should in general yield higher attenuations.

These results are significant in regard to the design of a multi-channel cochlear prosthesis in which the excitation current is required to be restricted close to the stimulus site.

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Title:
Electrical network properties and distribution of potentials in the cat cochlea [Abstract]

Date:
1978

Citation:
Black, R. C., & Clark, G. M. (1978). Electrical network properties and distribution of potentials in the cat cochlea [Abstract]. In Proceedings of the Australian Physiological and Pharmacological Society, Canberra, ACT.

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