THE EFFECT OF POSITION OF THE SCALA TYMPANI ELECTRODE ARRAY ON AUDITORY NERVE EXCITATION
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Multiple-channel auditory prostheses provide both temporal and formant information to profoundly-totally deaf patients. This is achieved via direct electrical stimulation of selective regions of the residual auditory nerve using an electrode array located in the scala tympani. Histological evidence has shown that these electrode arrays lie along the outer wall of the scala tympani, some distance from the residual nerve elements. In the present study we systematically varied the position of the electrode array within the cat scala tympani in order to investigate the influence of electrode position on neural excitation. Such knowledge may contribute to the development of improved electrode arrays for auditory prostheses.

Seven totally deaf, two partially deaf and two normal hearing adult cats were used in this study. Each animal was anaesthetized with pentobarbitone sodium (35 mg kg\(^{-1}\) i.p.). Using a micromanipulator, a bipolar electrode array was inserted, via the round window, 6 mm into the scala tympani of the left cochlea. Electrically-evoked auditory brainstem responses (EABRs) were recorded as the stimulating electrode was systematically moved from the outer wall of the scala to the modiolus. All manipulation of the electrode array was done under visual control. At the conclusion of the experiment each animal was killed with an overdose of pentobarbitone sodium (i.m.) and tissue samples were removed for histological examination.

We consistently observed a significant reduction in threshold and an increase in the dynamic range of the EABR as the electrode array was moved from the outer wall towards the modiolus. A representative example is illustrated in the Figure, where the amplitude of wave IV of the EABR is plotted as a function of stimulus current for the electrode array in four specific locations: (i) the outer wall of the scala tympani (outer wall), (ii) the middle of the scala (middle), (iii) adjacent to the modiolus (modiolus), and (iv) below the peripheral processes in the region of the habenula perforata (habenula). In all cochleas, the lowest threshold and widest dynamic range was observed with the electrode in the 'habenula' position despite histological data showing that a number of deafened cochleas had no remaining peripheral processes. Low thresholds and wide dynamic ranges were also consistently observed when the array was positioned adjacent to the modiolus.

The present results indicate that the optimum placement of a scala tympani electrode array is adjacent to the peripheral processes. However, such a placement would be difficult to achieve in practice while minimizing electrode insertion trauma. An electrode array lying adjacent to the modiolus would be a safe alternative while ensuring a significant reduction in thresholds compared with the present location of the array (outer wall). Such an array would presumably result in more localized sites of excitation leading to further improvements in speech recognition among patients.

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