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INTRACOCHLEAR FACTORS CONTRIBUTING TO PSYCHOPHYSICAL PERCEPTS FOLLOWING COCHLEAR IMPLANTATION

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Variations of performance of cochlear implant patients may be related to several factors. In this anatomical study we focus on determining how intracochlear factors affect postoperative psychophysical percepts of the 22-channel cochlear implant system. We have used 3-dimensional (3D) computer reconstruction of cochleas of former Nucleus 22-channel implant patients to quantitatively map intracochlear pathology relative to electrode positions, and relate the type and quantity of pathology to the T and C levels and dynamic ranges of individual electrodes. Preliminary results of this study were presented at the International Symposium on Cochlear Implants, Speech and Hearing Research in Melbourne, October, 1994 (1).
Using the system described by Seldon (2), temporal bone sections were reviewed and analysed on a computer monitor via a Data Translation DT2851 frame-grabber card. We made 3D computer reconstructions from five temporal bones of cochlear implant patients and measured the following factors: distance between electrode ring's center and Rosenthals canals center ('dis'), the cross-sectional areas of fibrous tissue ('ft') and new bone ('nb') as intracochlear histopathological changes, and the density of residual spiral ganglion cells ('sgc') at each electrode ring position. The interrelationship between the postoperative psychophysical parameters (T and C levels, DR) and these factors were analyzed. To correlate the psychophysical percepts with the anatomical factors, Pearson's correlation coefficients were calculated. Multiple regression analysis was also performed to find the combination of factors that contribute to the performance. In the multiple regression analysis, T and C levels and DR were used as dependent variables, and the anatomical factors as independent variables.
Values for 'dis' were 1.1-2.2 mm and tended to be shorter toward the apex of the cochlea. All cochleas had several histological changes ('ft' and 'nb') along the electrode array, and there was considerable individual variation. Four had notable changes (more than 10 mm3), and two of those had much new bone formation. The histological changes tended to be greater in the lower basal turn, and there was a high correlation between histological changes and 'dis'. The total number of residual spiral ganglion cells was 5591-11001, with one exception (21158).
The results showed several significant correlations and regressions, allowing us to draw some overall conclusions. For the T level, three cochleas showed a significant relation with 'dis', i.e., a longer distance contributes to a higher T level. For the DR, a higher 'sgc' contributed to a higher DR in three cases, and a longer distance contributed to a higher DR in two cases. A lower T level with a wider DR was considered to be related to sensitivity and function of the inner ear and speech recognition ability (3). So a shorter 'dis' and a higher residual 'sgc' (or, in the other cases, lower intracochlear changes) contribute to good speech recognition ability.
1) Kawano A, Seldon HL, Pyman BJ, Clark GM: Intracochlear factors contributing to psychophysical percepts following cochlear implantation: A case study. Intl Cochlear Implant, Speech and Hearing Symposium, Melbourne (1994), p 150
2) Seldon HL: Three-dimensional reconstruction of temporal bone from CT scans on a personal computer. Arch Otolaryngol Head Neck Surgery 1991; 117:1158-1161

3) Shiroma M, Honda K, Kawano A, et. al. Factors contributing to phoneme recognition ability of users of the 22-channel cochlear implant system. Ann Otol Laryngol 1992;101: 32-37