Acoustic Trauma Effects with Varying Exposure Times*

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Summary. Guinea pigs have been exposed to 20 kHz for 2 h, 1 h, 30 min, 15 min, or 7.5 min, and the resultant damage was observed 3, 6, and 12 weeks post exposure. The areas of outer hair cell damage were statistically compared. Significant differences were obtained after a 3-week survival time with the shorter exposure times, but this difference was no longer apparent after 12 weeks. Myelinated nerve fibre and inner hair cell damage occurred only with total outer hair cell loss.

Key words: Guinea pig — Acoustic trauma — 20 kHz — Short exposure times

In previous experiments guinea pigs have been exposed to 20 kHz at 120 dB SPL for a period of 1 h and examined 3 weeks post exposure (Pye 1973, 1978). Doubling the exposure time did not increase the area of outer hair cell damage and some cases showed even less damage (Pye 1979). At the time various suggestions were put forward: these findings could have resulted from the fact that the groups were exposed over a period of time or that the initial damage could have occurred at the beginning of the exposure and then the cells became fatigued and thus were protected from further damage. This phenomenon has now been further investigated.

Methods

Firstly, the previous experiments for the 1- and 2-h exposures have now been repeated, using different litter mates in each series and doing the exposures at random. In all the experiments reported here 5 to 6-week old, randomly bred albino guinea pigs were used, with six animals in each series. Only the left ear was exposed and the right ear was used as a control. The intensity remained at 120 dB SPL and the exposure frequency was 20 kHz. Secondly, the exposure times were

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Results

Outer Hair Cell Degeneration

Figure 1 shows the areas of damage obtained after new exposures to 1 or 2 h, and examined at 3, 6, or 12 weeks post exposure. No damage was seen in two of a total of 36 exposed ears, whereas for the others the damage reached from around

successively halved to 30, 15, and 7.5 min. Thirdly, for most exposure series, the survival time was increased to 6 and 12 weeks in addition to 3 weeks.

The surface specimen technique was used throughout and the whole cochlea was examined under phase contrast and Nomarski differential interference contrast microscopy. As in previous findings, only one main area of outer hair cell damage results from these exposures and this was measured by fractions of the basal turn, rather than by counting every hair cell. There is usually a small area of partial damage apically from the main area. If more than one outer hair cell of three adjacent cells in any row was found to be damaged when observing from apex to base, this was counted as the beginning of the actual area of damage. For assessing whether a sensory hair cell was damaged, the cellular membrane, cytoplasm, nucleus and hairs were examined. Statistical analysis was carried out comparing the areas of outer hair cell damage by the Mann-Whitney U-test and the Kruskall Wallis analysis of variance by ranks. P values of 0.05 were taken as the threshold of significance. Inner hair cell and myelinated nerve fibre damage were also noted for the first time, but were not quantified.