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QUANTITATIVE EVALUATION OF SCANNING ELECTRON MICROSCOPY-EXAMINED CILIARY MORPHOLOGICAL CHANGES IN CONTROL AND NOISE EXPOSED GUINEA PIG COCHLEAS

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Abstract

Many investigations of noise-induced hearing loss have demonstrated a poor correlation between hearing threshold and hair cell loss. One reason for this is that more subtle changes in the hair cell, such as detailed morphological changes of stereocilia, have not been evaluated. However, examining such changes increases the problem of distinguishing experimental pathological changes from artefacts. Preparation of the specimen for scanning electron microscopy (SEM) may result in too many artefacts for an adequate quantification of defects due to noise exposure.

One problem with some earlier studies seems to be lack of controls and/or statistical analysis for the purpose of eliminating the influence of artefacts and spontaneous degeneration.

The aim of this study was to compare unexposed and noise-exposed cochleas examined with SEM in order to determine if subtle changes due to noise could be distinguished from preparation artefacts and from spontaneous deterioration.

Ten different types of hair cell changes were found in exposed and control animals. By means of using controls for statistical comparison with noise-exposed animals two cell damage categories -- hair cell loss and missing stereocilia -- were found to be produced by exposure to noise.

KEY WORDS: Noise Exposure, Stereocilia, Cochlea, Guinea Pig, Scanning Electron Microscope, Morphology, Statistical Analysis, Preparation artefacts, Hair Cell, Glutaraldehyde.

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Introduction

Investigations of noise-induced hearing loss have demonstrated a poor correlation between hearing threshold and hair cell loss (Engström et al., 1966; Robertson, 1981; Slepecky et al., 1982). It is generally accepted that a better understanding of the ear's ability to process information will come from noting more subtle changes in hair cell morphology rather than simply cataloguing the total loss of hair cells. The use of light microscopy (LM), transmission electron microscopy (TEM), and scanning electron microscopy (SEM) to evaluate the effects of acoustic exposure on hair cells has resulted in the identification of many changes in hair cell morphology. However, as one examines more subtle morphological alterations, the ever-present problem of distinguishing pathological changes from artefacts increases. A variety of hair cell damage conditions have been described (Nielsen and Slepecky, 1986). Some authors are of the opinion that these represent only temporary changes, while others interpret them as direct or indirect signs of functional defects (Soudijn, 1976; Hunter Duvar, 1977a; Engström and Engström, 1978; Liberman and Beil, 1979; Erlandsson et al., 1980).

Liberman and Beil (1979) have suggested that the cochlear dissection necessary for SEM evaluation of the stereocilia may result in changes in ciliary morphology which would be attributed to noise-induced changes. To ensure the preservation of the stereocilia they embedded their specimens in plastic prior to dissection and used the light microscope to evaluate the condition of the embedded stereocilia. They showed that it was also possible to evaluate minor changes in ciliary morphology with LM.

Pathological changes can be found in unexposed cochleas examined by SEM, but no one has hitherto investigated Liberman and Beil's suggestion that the preparation of a specimen for SEM causes subtle changes in ciliary morphology which could