Pattern of Gentamicin-induced Cochlear Degeneration in the Guinea Pig
A Morphological and Electrophysiological Study

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Durch Gentamyzin verursachte Degeneration in der Schnecke des Meerschweinchens
Eine morphologische und elektrophysiologische Studie


Schlüsselwörter: Gentamyzin-induzierte Kochleadegeneration – Degenerationspunkt – Vakuolisierung der Reissnerschen Membran – Elektrokochleographie

Summary. Gentamicin-induced cochlear degeneration in the guinea pig was studied by complete hair-cell counting (cytocochleograms) and phase-contrast and interference microscopical examination of the stria vascularis and Reissner’s membrane. Gentamicin (100 mg/kg/day) was administered over a period of 7–17 days. The first loss of hair cells (OHC) occurred in a region 6–8 mm from the round window. From this ‘degeneration point’, the loss of hair cells progressed towards the round window (fast) and the apex (slowly). The stria vascularis showed no signs of degeneration. Reissner’s membrane,

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on the other hand, showed intracellular vacuolization of the endolymphatic cells over the complete length of the cochlea after 12 or more days' intoxication. Hearing loss was measured by electrocochleography with skin electrodes. The histologic findings were compared with the objective audiograms.

Key words: Gentamicin-induced cochlear degeneration – Degeneration point – Reissner’s membrane vacuolization – Skin-electrode-evoked response audiometry

Introduction

The ototoxic effect of the aminoglycoside antibiotic gentamicin has been extensively studied by various workers. Many of these investigations were concerned with the damage caused by gentamicin to the hair cells of the organ of Corti. Lundquist and Wersäll [15] were the first to demonstrate the toxic effect of gentamicin on the hair cells by means of electron microscopy. Hawkins et al. [9], Wright [24], and Federspil [6] studied the effect with the aid of phase-contrast microscopy, while Ylikoski [27] and Darrouzet and Guilhaume [5] made use of interference-contrast light microscopy and transmission electron microscopy. In a scanning-electron-microscopy study, Theopold [20] demonstrated abnormalities in the hair cells after gentamicin intoxication. Harpur and Bridges [8] evaluated the normal organ of Corti and the same organ after damage by gentamicin in the guinea pig by means of scanning and transmission electron microscopy.

These studies showed that gentamicin initially damages the first row of outer hair cells (OHC I) in the basal turn of the cochlea. The damage progresses in the apical direction, and to the second and third outer hair cells (OHC II and OHC III). The inner hair cells (IHC) remain intact for a long time. The degeneration of the IHC, when it does occur, also seems to proceed from base to apex. In the above-mentioned studies, the hearing loss caused by gentamicin was measured by the disappearance of the Preyer reflex [6, 8, 24] by operant conditioning [25, 26], and by cochlear microphonic response changes and action potential changes of the cochlear nerve [9].

In the present study, both the degenerative changes in the organ of Corti and the hearing loss are studied as a function of the duration of administration of gentamicin. The hearing loss is compared with the degenerative pattern. Special attention is given to the starting point of the degeneration process. The stria vascularis and the Reissner membrane are also investigated.

Material and Methods

Dosage

Fifteen healthy adult guinea pigs (strain: CGP-GP, A165-mean: 889 g and average 835.8 g) were used for the experiment. Each animal was given 100 mg/kg of gentamicin once a day for a period