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Electrophysiological Study of Inaudible Ultrasonic Hearing Achieved by Cochlear K^+-Circulation Current.

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Summary

Although the hearing range of humans is under 20 kHz, we hear inaudible-ultrasound via bone conduction. However, details of its physiological mechanism are unknown. In this study, to investigate the possibility of ultrasound reception in the cochlea, we measured the local field potentials (LFP) evoked by sound and ultrasound stimulations. Under general anesthesia, we recorded the potentials from the temporal bone in guinea pigs. The stimulus waveform was 103 kHz 85 dB tone burst with a duration of 200 msec. 103 kHz is above the guinea pig's hearing range. We performed frequency analysis by fast Fourier transform on LFP. In the analysis, we observed three signal peaks: 103 kHz, 206 kHz, 245.84 kHz. Examining the relationship between these signals and stimuli in waveforms, only 103 kHz was synchronized with the stimulus. This synchronized LFP is likely the cochlear microphonics (CM), which reflects the excitation of the primary auditory receptor cells. Furthermore, as we increased the strength of the stimulus at 103 kHz, CM amplitude gradually increased. Its stimulus-potential relationship was 'nonlinear'; cochlear amplifies smaller sound more, and bigger sound less. Additionally, in comparison with the potential recorded under anoxia, CM was actively amplified. We finally measured CM at frequencies within the range from 80 to 201 kHz. At a frequency of 127 kHz or lower, CM exhibited significant nonlinearity and amplification. To the contrary, these features were lessened in more than 127 kHz, and disappeared at frequencies over 201 kHz.