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OAE latency and tuning: implications for cochlear models and diagnostic perspectives

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BACKGROUND: The experimental relation between the OAE latency and frequency is due to the tonotopic nature of the cochlear geometry and to the bandwidth of the cochlear filter. Indeed, transmission line cochlear models predict that the OAE latency is dependent on the slowing down of each traveling wave frequency component near its tonotopic place, which is more pronounced for high-Q resonances. Model-dependent methods have been proposed to get objective estimates of the tuning curve from OAE latency measurements. As the cochlear filter is associated with the active and nonlinear feedback mechanism mediated by the OHCs, its quality factor is a function of the stimulus level and of the OHC functionality. Therefore, a study of the OAE latency as a function of frequency and stimulus level is important to study the nonlinear behavior of the cochlear amplifier.
METHODS: 280 TEOAE waveforms from 10 young subjects were recorded for different levels of the click stimulus, from 60 to 90 dB, using both linear and nonlinear acquisition paradigms. TEOAEs were time-frequency analyzed using a wavelet technique, getting a measure of the TEOAE latency as a function of frequency. The TEOAE phase-gradient delay was also evaluated and compared with the wavelet latency estimate. A simple 1-d transmission line cochlear model was used to provide the theoretical relation between cochlear delay and tuning.
RESULTS AND CONCLUSIONS: The experimental latency-frequency relation is well represented by a power law, with longer latency and steeper slope at lower stimulus levels. The tuning curve estimates confirm that the quality factor of the cochlear filter increases with frequency and decreases with increasing stimulus level. The quantitative analysis of these results is model-dependent, thus more experimental data are needed to help developing reliable models, which are necessary to open new perspectives for the objective diagnostics of the cochlear filter.