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On the way to differentially diagnosing middle-ear and inner-ear disorders

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Laser Doppler vibrometry has proved to be very useful in diagnosing ossicular chain disorders by measuring the umbo velocity. Although it has been supposed that these measurements contain information about both the middle ear and the inner ear, it has not been possible to separate the information, to differentially diagnose middle- and inner-ear disorders. Here we propose a method to separate information about middle-ear and inner-ear components in records of vibration measurements on the human umbo. For this purpose, distortion product otoacoustic emissions (DPOAEs) were measured on the human eardrum using a very sensitive laser Doppler vibrometer. They proved to have a very stable phase behaviour but a highly fluctuating amplitude feature that was used to develop a parameter called the fluctuation ratio (FR). The FR is postulated to be an attribute of the cochlear amplifier and to have a specific input/output characteristic which is affected differentially by middle- and inner-ear disorders. It correlates with hearing threshold and predicts threshold with a standard deviation of only 8 dB. The predictability is improved when the eardrum transfer characteristic is taken into account. We believe that vibration measurements of DPOAE on the human eardrum can become a new tool for separating middle-ear from inner-ear disorders and for objective assessment of hearing threshold. Supported by the German Research Council, DFG GU 194/6-1 and partially by the European Commission, Marie Curie Training Site, HEARING (QLG3-CT-2001-60009).