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Equivalent noise levels generated by the rotating burr on the ossicular chain as measured by Laser Doppler Vibrometry: A temporal bone study

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Background: Inadvertent drilling on the ossicular chain, usually in the region of the short process of the incus, has been regarded as one of the causes of a sensorineural hearing loss that may follow tympanomastoid surgery. Post-operative high frequency hearing loss is more often observed than low frequency hearing loss. It is therefore speculated that the hearing loss is caused by vibration of the ossicular chain that resembles acoustic noise trauma. It is generally considered that using a large cutting burr is more likely to cause damage than a small diamond one; although the mechanism of drill induced hearing loss is poorly understood. Laser Doppler Vibromatory allows a no mass analysis so necessary for the measurement of ossicular chain micromovement.

Aim: The aim was to investigate the equivalent noise level, and its frequency characteristics generated by drilling onto the short process of the incus.

Methods and Materials: Five fresh cadaver temporal bones were used. The stapes displacement was measured using Laser Doppler Vibrometry during drilling episodes. The vibratatory stimulus for each episode was achieved by engaging the burr on the postero-lateral surface of the short process of the incus. Diamond and cutting burrs with different diameters (1 mm, 2.3 mm and 3.1 mm) were used for the study. The effect of drilling was compared with the acoustic signal generated stapes displacement and the equivalent noise level calculated. Results: The equivalent noise levels generated by drilling on the incus ranged from 93 – 124 dB SPL. For a 1 mm cutting burr, the maximum noise level was 107 dB SPL, whilst a 2.3 mm cutting burr produced a maximum noise level of 124 dB SPL. Diamond burrs generally generated less equivalent noise level than their cutting counterparts, with a 2.3 mm diamond burr generating a maximum equivalent noise level of 102 dB SPL. With a cutting burr, the energy of equivalent noise increased at the higher end of its frequency spectrum, a 2.3 mm cutting burr producing an equivalent noise level of 104 dB SPL at 1 kHz, but 124 dB SPL at 8 kHz. In contrast, the same sized diamond burr produced 95 dB at 1 kHz and 99 dB at 8 KHz respectively.

Conclusion: This study suggests that inadvertent burring on the ossicular chain can produce vibratory force that would be analogous with noise levels known to produce hearing loss. For the same type of burr, the larger the diameter the greater the vibratory force, and for the same size of burr, the cutting more than the diamond burr. The cutting burr produces more high frequency than lower frequency vibratory energy.