Computational Modeling and Simulations

Computational Modeling of Blast Wave Transmission Through Human Ear

Understanding how blast waves propagate through the human ear is a necessary step in the development of effective hearing protection devices. Researchers from the University of Oklahoma (Norman, OK) have constructed the first 3D finite element (FE) model to simulate blast wave transmission through the ear and validated it with measurements from cadaver studies (*Leckness, Nakmali, and Gan, 2018*).

Pressures measured at the ear canal of cadaver temporal bone specimens exposed to blast overpressure from vertical, horizontal, and frontal directions were applied at the entrance of the ear canal in the model and ranged from 50 to 80 kPa. The pressure waveforms near the tympanic membrane (TM) in the canal (P1) and behind the TM in the middle ear cavity (P2) were calculated. The model-predicted results were then compared with measured P1 and P2 waveforms recorded in human cadaver ears during blast tests. For the P1 location, the error in the model-predicted peak pressure level was 3.0, 25, and 20 percent, for the vertical, horizontal, and front blast directions, respectively. Error for A-duration was 9.1, 17, and 13 percent for the vertical, horizontal, and front blast directions, respectively. Finally, the error in the model-predicted 1ms kurtosis was 15, one, and 9.8 percent for the vertical, horizontal, and front blast directions, respectively. Qualitative assessment of P2 wave forms indicated good agreement between model and cadaver results. The FE model will be used to improve auditory hazard assessment models and better understand blast wave transmission through the human ear. Ultimately, these efforts will contribute to the development of advanced hearing protection devices.

This effort was managed by CDMRP with support from PH/TBIRP and MOMRP/JPC-5.

REFERENCES:

Leckness, K., Nakmali, D., & Gan, R. Z. (2018). Computational Modeling of Blast Wave Transmission Through Human Ear. Mil Med, 183(suppl_1), 262-268. doi:10.1093/milmed/usx226