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Characterization of harmonic response of Human Middle Ear using Finite Element Approach

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HIGHLIGHTS

- A study was carried out on the human middle ear with special attention to its three dimensional modeling.
- Extensive literature survey was performed to obtain the modeling techniques to develop a compatible 3D model of human middle ear.
- Pathological conditions affecting the hearing capacity of human were investigated to determine gain and loss in hearing capacity.

Abstract

Human middle ear (ME) is an important organ of the auditory system. Sound energy stimulates the cochlear fluids present in the inner ear. Ossicular chain, a part of human middle ear consists of Tympanic membrane (TM), ossicles, ligaments and muscles. Hearing loss is reported when the ossicles in the chain gets degraded. Surgical intervention is one of the approaches to overcome the situation. The possibility of replacement of damaged ossicles with normal biocompatible biomaterials is explored in the current study. To study the sound transfer function, a FE model is developed using μCT (Computed Tomography) scan data imported in MIMICS Research 19.0 (Materialise Interactive Medical Image Control System) modeling software. The harmonic response at the stapes footplate and umbo is examined with the assumption that sound pressure is incident from lateral side of eardrum. Pathological conditions are analysed to determine the gain or loss in hearing capacity for Cholesteatoma, Partial mallear fixation and variations of material properties in Tympanic membrane (TM). The human audible sound pressure levels (SPLs) of 60, 80, 100 and 120 dB are applied on eardrum within frequency range of 100 Hz to 10000 Hz. The results are compared with healthy ear to investigate gain or loss in hearing capacity for these pathologies.

Keywords – Humam middle ear, Computer Tomography, Pathologies, Harmonic response.