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3D Modelling and Numerical Analysis of Human Inner Ear by Means of Finite Elements Method

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Abstract : This paper presents a method to generate a finite element model of the human auditory inner ear system. The geometric model has been realized using 2D images from a virtual model of temporal bones. A point cloud has been gotten manually from those images to construct a whole mesh with hexahedral elements. The main difference with the predecessor models is the spiral shape of the cochlea with its three scales completely defined: scala tympani, scala media and scala vestibuli; which are separate by basilar membrane and Reissner membrane. To validate this model, numerical simulations have been realised with two models: an isolated inner ear and a whole model of human auditory system. Ideal conditions of displacement are applied over the oval window in the isolated Inner Ear model. The whole model is made up of the outer auditory channel, the tympani, the ossicular chain, and the inner ear. The boundary condition for the whole model is 1Pa over the auditory channel entrance. The numerical simulations by FEM have been done using a harmonic analysis with a frequency range between 100-10.000 Hz with an interval of 100Hz. The following results have been carried out: basilar membrane displacement; the scala media pressure according to the cochlea length and the transfer function of the middle ear normalized with the pressure in the tympanic membrane. The basilar membrane displacements and the pressure in the scala media make it possible to validate the response in frequency of the basilar membrane.

Keywords : finite elements method, human auditory system model, numerical analysis, 3D modelling cochlea
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