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Four-chamber Cochlea box model: Establishing acoustic comfort, illustrating injury and towards therapy

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ABSTRACT

The unrolled cochlea is modeled using the finite-element software ANSYS13, with four inner chambers representing the Scala Vestibuli contiguous with the Scala Tympani thru a rounded helicotrema, the Scala Media, the inner and the outer hair cells. The tectorial membrane is represented as a plate in contact with the hair cells. An improvement to previously presented results is the inclusion of a tapered helicotrema. Various geometries are compared, i.e. with straight sides and with tapered sides, and see the differences in the frequency response of the models.

Applying real values for material properties and the human hearing range and using characteristic frequency at certain nodes inside the Scala Media, the tapered model is calibrated to establish the reference comfort. Hearing injury is regarded by subjecting nodes to increasing sound pressure levels until the frequency response disappears. This is done at the same time monitoring the change in electrical potential in the inner and outer hair cell regions. The potential change between the normal and the injured conditions is inputted to the Gibbs energy equation for the ATP-ADPase glycolysis to identify a possible route to remedy.