

Mathematical Model for the Vestibular System

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The diagnosis of the Vestibular System pathologies is always performed following a specific procedure independently on the anatomical individualities for a given patient. This might result in an impairing diagnostic ability. Considering the personalized medicine in the development of rotational tests, there are certain optimized angular directions that maximize stimulation in a certain semicircular canal, almost completely inhibiting the other two. It is expected that this plane of rotation, known as prime direction, can provide a better response on clinical test [Furman, 2016].

Based on mathematical models of the membranous labyrinth and their simulation by means of Computational Fluid Dynamics techniques, we evaluate how different planes of rotation affect the vestibular diagnosis. Based on our results [Arán-Tapia et al., 2022], a different plane of rotation, selected following the angular relationships between the planes of the semicircular canals, helps to distinguish each cupular stimulus contribution on the nystagmus, resulting in an optimization of the rotational testing of the vestibular function.

The study of the individualities of the membranous labyrinths through numerical simulations can serve as a tool to increase the vestibular diagnosis success. In future, this technique can help to achieve personalized treatment procedures, improve knowledge about vestibular pathophysiology and implement a database for the application of data science.

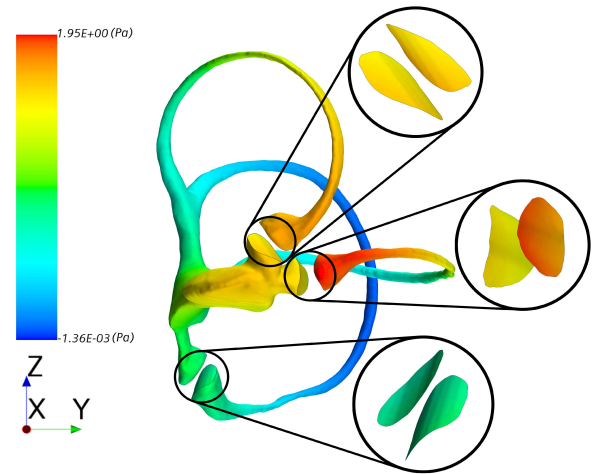


Fig. 1. The total pressure distribution for the real model of the left membranous labyrinth, under Htest angular direction for rotating reference frame. With amplified vision of cupula walls, where horizontal ones show the biggest pressure differences. The data was obtained at the end of stimulation when the head returns to the initial position (clockwise rotation).

Furman, J.M., 2016. Rotational testing. *Handb Clin Neurol* 137, 177186. <https://doi.org/10.1016/B978-0-444-63437-5.00012-1>

Arán-Tapia et al, 2022. Personalized Design for Optimal Rotational Testing of the Vestibular Function (submitted)