Paper ID: 54810
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IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Human Physiology in Space (2)

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COMPUTATIONAL FLUID DYNAMICS APPLIED TO THE STUDY OF RELATIVE MOTION BETWEEN CALCIUM CRYSTALS AND ENDOLYMPH.

Abstract

There are two main theories that attempt to explain the mechanisms of space motion sickness. Sensory conflict theory states that on Earth, human orientation is computed by four sensory inputs: otolithic information of the gravity vector and linear accelerations; angular acceleration measured by the semicircular canals; visual information regarding body position; proprioceptive inputs about spatial localization of the body. And second, the fluid shift hypothesis which states that changes in cranial pressure (fluid shift) in microgravity may cause restriction to the flow of endolymph from the cochlea to the endolymphatic sac.

In most fluid dynamics models, gravity is taken into account as a constant. In fact, in the literature of numerical models for fluid dynamics, gravity acceleration is considered not to be significant. However, gravity is not an absolute value and it is dependent on mass distribution, mass density, altitude and even topography. Gravity acceleration will vary along the way for any space exploration. For human physiology study in space, higher level of accuracy could mean healthier astronauts and more predictable effects

To simulate the relative motion between a fluid and a single particle is necessary to consider the relative motion between a particle and a volume of fluid. For measuring the relative motion the two following situations were considered: a) one particle and a fluid moving in opposite directions; b) a particle and a fluid both moving in the same direction although at different rates.

This work intents to apply computational modelling to study the fluid resistance between the crystals of calcium and endolymph in order to demonstrate how different values in gravity should be included in mathematical models to simulate the behavior of labyrinth system in the space exploration. Fluid flow is typically chaotic which means that tiny changes in structure and surface can result in very distinct flows. Hence, the accuracy of these models can have direct influence on determination of physiological parameters for future manned space missions.