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Transient pressure changes in the vertebral canal during whiplash motion – a hydrodynamic modeling approach

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Abstract

In vehicle collisions, the occupant's torso is accelerated in a given direction while the unsupported head tends to lag behind. This mechanism results in whiplash motion to the neck. In whiplash experiments conducted for animals, pressure transients have been recorded in the spinal canal. It was hypothesized that the transients caused dorsal root ganglion dysfunction. Neck motion introduces volume changes inside the vertebral canal. The changes require an adaptation which is likely achieved by redistribution of blood volume in the internal vertebral venous plexus (IVVP). Pressure transients then arise from the rapid redistribution. The present study aimed to explore the hypothesis theoretically and analytically. Further, the objectives were to quantify the effect of the neck motion on the pressure generation and to identify the physical factors involved. We developed a hydrodynamic system of tubes that represent the IVVP and its lateral intervertebral vein connections. An analytical model was developed for an anatomical geometrical relation that the venous blood volume changes with respect to the vertebral angular displacement. This model was adopted in the hydrodynamic tube system so that the system can predict the pressure transients on the basis of

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