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The pulsating brain: an interface-coupled fluid-poroelastic model of the cranial cavity

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Driven by cardiac and respiratory pulsations, our brain and the cerebrospinal (CSF) fluid surrounding it exhibit complex fluid flow and displacement patterns. Despite being essential to normal brain function, our understanding of intracranial dynamics is still limited, and various diseases are associated with impaired CSF flow and elevated intracranial pressure [1]. Computational models offer further insights into pulsatile intracranial dynamics, but are complicated by the close interplay of arterial inflow, venous outflow, CSF motion and brain tissue movement inside the rigid cranial cavity.

In this talk, I will present a new computational model of cardiac-induced pulsatile motion inside the human cranial cavity. The CSF flow in the subarachnoid space and ventricular system is modelled using the time-dependent Stokes equations, and coupled with Biot's poroelasticity equations in the brain tissue, thus integrating all major intracranial constituents into the modelling approach. Employing the pulsatile inflow of blood into brain tissue as a driver of motion, the model enables us to study the dynamics of the entire intracranial system.

Following [2], the model is discretized using a coupled/monolithic approach with a mixed Taylor-Hood type finite element scheme and implemented with the finite element framework *FEniCS*. Numerical results obtained with a detailed 3D human head model and physiological material parameters are presented and compared with experimental data. The new model faithfully replicates the main aspects of intracranial pulsatile motion.

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