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# Numerical modeling of fluid-porous structure interaction in arteries

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# Numerical modeling of fluid-porous structure interaction in arteries

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**Abstract:**

Considering arterial wall as an elastic structure is a common assumption in Fluid-Structure Interaction simulations. However; it neglects realistic arterial wall model. In reality, arterial wall like other soft tissues is viscoelastic and it shows poroelastic behavior as well. The present study attempts to investigate the effect of both poroelasticity and tissue viscoelasticity on fluid-structure interaction in arteries and analyze the role of extracellular fluid flow in the apparent viscoelastic behavior of the arterial wall.

We discuss a computational framework for modeling multiphysics systems of coupled flow and mechanics problems via finite element method. Physically meaningful interface conditions are imposed on the discrete level via mortar finite elements or Nitsche's coupling. We present applications of the framework to model flow in arterial flows based on Navier Stokes/Stokes flows coupled with the Biot system of poroelasticity. We discuss stability and accuracy of the spatial discretization and loosely coupled non-iterative time-split formulations. We further investigate the interaction of an incompressible fluid with a structure featuring possibly large deformations. In small deformation we can assume that reference and current configurations are the same. But this is not the case in large displacement and mesh movement is necessary in fluid-structure computations in order to define clearly the deformed configuration.

We also study the energy exchange in the interaction between the blood flow and the arterial wall to investigate the distribution and dissipation of the energy delivered to the artery during one heart cycle. Our result suggests that poroelasticity is an important mechanism at longer time scales. However it cannot represent hysteresis since hysteresis is an indicator of mechanical energy dissipation while poroelasticity transforms part of the total energy input into the intramural flow. Conversely, viscoelasticity is a true dissipation mechanism and it is responsible to hysteresis.