Title of Contribution:
Extension of liver biomechanics framework for whole-body applications

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Abstract:

Liver transplantation is the only curative treatment for end-stage liver disease, but changing demographics and Western lifestyles are leading to an increase in elderly, multi-morbid donors and recipients. When faced with a marginal graft, surgeons must weigh the risks: accept a suboptimal organ with potential postoperative complications or reject it, increasing the recipient's chances of dying on the waiting list. Simulation-based risk assessment via a digital liver twin has enormous potential to evaluate and, if necessary, optimise or cancel the planned transplantation process in everyday clinical practice, e.g. modelling patient-specific impairment of liver grafts [1]. During the transplant procedure, the organ changes bodies from donor to recipient, but may also be linked to a perfusion machine as a conservatory measure. An important research question is how the different milieus affect liver function during and after the procedure. To investigate this, the existing tissue-scale model is coupled with an external third scale model (e.g., representing body or perfusion machine) to incorporate the influence of the surrounding environment. This is of particular interest as it enables the use of physiologically more realistic boundary conditions and allows the simulation of reperfusion scenarios compared to the standalone tissue-cell boundary value problem. In this work, the framework for coupling tissue-scale and cellular-scale processes based on FEniCSx [2], libRoadRunner [3], and preCICE [4] will be extended by an additional ODE-based physiologically based pharmacokinetic (PBPK) model [5]. We look into the theory, implementation, validation and challenges behind this ODE-PDE-ODE approach during simulation scenarios with clinical relevance.

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