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MULTI-PARAMETER COMPUTATIONAL MODEL OF FLOW MEDIATED DILATION WITH FLUID-STRUCTURE INTERACTION COUPLED WITH LUMPED PARAMETER APPROACHES

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Flow-mediated dilation (FMD) is a valuable non-invasive clinical assessment of endothelial dysfunction, a key indicator of atherosclerosis. The progression of atherosclerosis from paediatric ages can lead to the manifestation of cardiovascular diseases (CVDs) in later life. Hence, early lesion detection in younger years using FMD will heavily support timely disease assessment and treatment. In FMD, the diameter of the brachial artery is measured ultrasonically before, during, and after the inflation of a cuff applied to the lower arm of a subject. The cuff is placed distal to the ultrasound probe to capture predominantly endothelium-dependent vasodilation [1]. The process induces a period of reactive hyperaemia, causing the brachial artery to vasodilate, due to an increase in shear stress that results in release of nitric oxide. The brachial artery's peak dilation is used for calculating the percentage difference between peak and baseline diameter (FMD percentage). Modelling FMD computationally offers a non-invasive assessment of vascular health and haemodynamic parameters.

The haemodynamics associated with FMD are strongly influenced by fluid-structure interactions (FSI) between the arterial wall and blood flow. The model therefore utilised a co-simulation approach between STAR-CCM+ and Simcenter Amesim. STAR-CCM+ was used for modelling the fluid and structure domains and Amesim for modelling the transient boundary conditions (BCs) required for modelling FMD. The model was used for exploring FMD calculations in addition to exploring parameters such as pulse wave velocity (PWV), oscillatory shear index (OSI) and wall shear stress (WSS), which are valuable for the assessment of atherosclerosis development. The study includes idealised geometries of the bifurcation from the brachial artery to the radial and ulnar arteries [2]. A parametric analysis is currently being undertaken for various boundary conditions and bifurcation angles.

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