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Assessing Arterial Blockages Using Animal Model and Computational Fluid Dynamics

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Abstract : This paper investigates the effect of developing arterial blockage at the abdominal aorta on the blood pressure waveform at an externally accessible location suitable for invasive measurements such as the brachial and the femoral arteries. Arterial blockages are created surgically within the abdominal aorta of healthy Wistar rats to create narrowing resemblance conditions. Blood pressure waveforms are measured using a catheter inserted into the right femoral artery. Measurements are taken at the baseline healthy condition as well as at four different severities (20%, 50%, 80% and 100%) of arterial blockage. In vivo and in vitro measurements of the lumen diameter and wall thickness are taken using Magnetic Resonance Imaging (MRI) and microscopic techniques, respectively. These data are used to validate a 3D computational fluid dynamics model (CFD) which is developed to generalize the outcomes of this work and to determine the arterial stress and strain under the blockage conditions. This work indicates that an arterial blockage in excess of 20% of the lumen diameter significantly influences the pulse wave and reduces the systolic blood pressure at the right femoral artery. High wall shear stress and low circumferential strain are also generated at the blockage site.

Keywords : arterial blockage, pulse wave, atherosclerosis, CFD
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