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Computational Study to Investigate Effect of Tonometer Geometry and Patient-Specific Variability on Radial Artery Tonometry

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Abstract— Tonometry-based devices are valuable method for vascular function assessment and for measurement of blood pressure. However current design and calibration methods rely on simple models, neglecting key geometrical features, and anthropometric and property variability among patients. Understanding impact of these influences on tonometer measurement is thus essential for improving outcomes of current devices, and for proposing improved design. Towards this goal, we present a realistic computational model for tissue-device interaction using complete wrist section with hyperelastic material and frictional contact. Three different tonometry geometries were considered including a new design, and patient-specific influences incorporated via anthropometric and age-dependent tissue stiffness variations. The results indicated that the new design showed stable surface contact stress with minimum influence of the parameters analyzed. The computational predictions were validated with experimental data from a prototype based on the new design. Finally, we showed that the underlying mechanics of vascular unloading in tonometry to be fundamentally different from that of oscillatory method. Due to directional loading in tonometry, pulse amplitude maxima was observed to occur at a significantly lower compression level (around 31%) than previously reported, which can impact blood pressure calibration approaches based on maximum pulse pressure recordings.

Keywords— radial tonometry; pulse pressure amplitude, blood pressure calibration, oscillometric method, hyperelastic FEA