Joint Department of Biomedical Engineering
Marquette University / Medical College of Wisconsin

Announcement of Public Dissertation Defense

Thursday, April 2nd, 2020 @ 9:00 am
Join Microsoft Teams Meeting

Ph.D. Candidate: Atefeh Razavi, M.S.

Advisor: John LaDisa, Jr., Ph.D.

ABSTRACT

"PATIENT-SPECIFIC MODELING OF ALTERED CORONARY ARTERY HEMODYNAMICS TO PREDICT MORBIDITY IN PATIENTS WITH ANOMALOUS ORIGIN OF A CORONARY ARTERY"

Anomalous aortic origin of a coronary artery (AAOCA) is a condition where a coronary artery arises from the opposite aortic sinus, often with an acute angle of origin (AO). AAOCA is associated with ischemia. This is especially concerning when the anomalous coronary artery takes an intramural course within the aortic wall, creating the potential for distortion or compression. Unroofing surgery replaces a restrictive ostium and intramural segment with a large ostium from the appropriate sinus and aims to create a less acute AO. Although these anatomical features may alter the coronary blood flow patterns, hemodynamic indices such as time averaged wall shear stress (TAWSS), oscillatory shear index (OSI) and fractional flow reserve (FFR) that can change the patient's future risk for ischemia and morbidity remain largely unexplored. We hypothesized that morphology of the anomalous coronary artery has a significant impact on local hemodynamics of AAOCA and aimed to 1) characterize hemodynamic alterations in AAOCA by patient-specific simulation of 6 patients pre-operative and post-unroofing using advanced coronary artery boundary conditions, 2) assess the impact of AO on the severity of hemodynamics alterations, and 3) characterize the hemodynamic effect of proximal narrowing of the anomalous artery and hyperemic resistance of the downstream vasculature (HMR). Our findings from Aim 1 suggested that different flow patterns exist natively between right and left coronary arteries, a reduction in TAWSS is observed post-unroofing, and that unroofing may normalize TAWSS but with variance related to the AO. Data from Aim 2 indicated that AO alters TAWSS and OSI in simulations run from a patient-specific model with virtually rotated AOs. Proximal to the ostium, arterial wall experienced lower TAWSS for more acute AO. Distal to the ostium, arterial wall experienced higher TAWSS for more acute AO. Findings from Aim 3 showed that for a fixed narrowing, higher HMR resulted in higher FFR indicating the interaction of the upstream and downstream micro-vasculature resistance regulate FFR. Virtual manipulation of the anomalous artery provided a direct comparison for the effect of the anatomic high-risk features. Collectively, the results from this study serve as the foundation for larger scale studies of AAOCA, that could correlate hemodynamics with outcomes for risk stratification and surgical evaluation.

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