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An investigation of correlation between left coronary bifurcation angle and hemodynamic changes in coronary stenosis by coronary computed tomography angiography-derived computational fluid dynamics

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Abstract

The purpose of this study was to investigate the correlation between left coronary bifurcation angle and coronary stenosis with use of coronary CT angiography (CCTA)-generated computational fluid dynamics (CFD) analysis when compared to the CCTA analysis of coronary lumen stenosis with invasive coronary angiography (ICA) as the reference method. Thirty patients with calcified plaques at the left coronary artery were included in the study with all patients undergoing CCTA and ICA examinations. CFD simulation of left coronary models was performed to analyze hemodynamic changes including wall shear stress, wall pressure and flow velocity, with findings correlated to the coronary stenosis and degree of bifurcation angle. The mean bifurcation angle was measured 83.7 ± 12.7º and 82.3 ± 11.8º on CCTA and ICA, respectively, with no significant difference (p=0.65). Of 25 significant stenosis at left anterior descending (LAD) and 13 at left circumflex (LCx) on CCTA, only 15 and 6 of them were confirmed to be >50% stenosis at LAD and LCx respectively on ICA. Wall shear stress was noted to increase in the LAD and LCx models with significant stenosis and wider angulation (>80º), but demonstrated little or no change in most of the other coronary models with no significant stenosis and narrower angulation. Wall pressured was decreased at the coronary arteries with significant stenosis, while flow velocity was increased with turbulence observed at the post-stenotic sites. This study further clarifies the relationship between left coronary bifurcation angle and significant stenosis, with angulation measurement serving as a more accurate approach than lumen assessment for determining significant coronary stenosis. Left coronary bifurcation angle is suggested to be incorporated into coronary lumen assessment when diagnosing coronary artery disease.

Keywords: Angulation, coronary artery disease, calcified plaque, computational fluid dynamics, correlation, coronary computed tomography angiography