Coronary computed tomography angiography based endothelial wall shear stress in normal coronary arteries


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Background: Endothelial wall shear stress (ESS) is a biomechanical force which plays a key role in the formation and evolution of atherosclerotic lesions.

Purpose: This study aims to evaluate ESS in coronary arteries without atherosclerosis, and to assess various factors affecting ESS values.

Methods: Coronary computed tomography angiography (CCTA) images from patients with suspected coronary artery disease were analyzed to identify coronary arteries without atherosclerosis. Minimal and maximal ESS values were calculated for 3-mm segments with dedicated software. Segments were categorized according to lumen diameter tertiles into small (<2.6 mm), intermediate (2.6–3.2 mm) or large (≥3.2 mm) size classes. Normal ranges of minimal and maximal ESS values were calculated per vessel and vessel size.

Results: A total of 349 normal vessels from 168 patients (mean age 59.4±9.2 years, 39% men) were included. ESS was highest in the left anterior descending artery compared to the left circumflex and the right coronary arteries (2.3 Pa vs. 1.9 Pa vs. 1.6 Pa for minimal ESS, p < 0.001 and 3.7 Pa vs. 3.0 Pa vs. 2.5 Pa for maximal ESS, p < 0.001). ESS values were highest in small vessel segments compared to intermediate or large segments (3.8 Pa vs. 1.7 Pa vs. 1.2 Pa for minimal ESS, p < 0.001 and 6.0 Pa vs. 2.6 Pa vs. 2.0 Pa for maximal ESS, p < 0.001). Weak to moderate correlation was found between ESS and the distance from the ostium (ρ values ranging from 0.22 to 0.62 for different vessels).

Conclusion: We derived ESS values from the CCTA images for visually normal coronary arteries. ESS values depend strongly on the lumen diameter of the coronary vessel. The normal ranges of minimal and maximal ESS can be used in future studies, where ESS values in stenotic lesions are compared to the normal values derived in the present analysis.