WALL SHEAR STRESS AS A DETERMINATE FOR CORONARY ATHEROSCLEROTIC PLAQUE DISTRIBUTION, COMPOSITION AND REMODELING AS ASSESSED BY INTRAVASCULAR ULTRASOUND AND RADIOFREQUENCY TISSUE CHARACTERIZATION IN HUMANS IN VIVO

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Background: Wall shear stress is an important local factor for the pathogenesis of atherosclerosis. Computational fluid dynamics (CFD) facilitate the calculation of local WSS patterns. Intravascular ultrasound (IVUS) allows the assessment of coronary plaque distribution and measurement of wall thickness and remodeling indices. IVUS derived radio frequency data analysis (RFA) has been shown to distinguish different plaque types. The aim of this study was to assess a possible correlation between different levels of WSS and plaque distribution, composition remodeling in human coronary arteries in vivo.

Methods: We examined 10 patients with computed tomography coronary angiography (CTA). Subsequently patients underwent invasive coronary angiography and IVUS imaging. The CTA data of the vessels were extracted, meshed and used for CFD calculations. According to the level of WSS, the vessel surface was divided into quartiles. IVUS measurements and RFA were performed using a commercially available software tool.

Results: Calculation of WSS was performed in 21/30 vessels. IVUS analysis could be performed in 15/30 arteries. In areas of low WSS (quartile 1) plaque prevalence (49.6%) and wall thickness (0.43mm) were significantly higher than in the other quartiles (32.1% and 0.34mm on average) (p<0.01). The average relative content of the different plaque components was 69.2% for fibrous, 20.0% for fibro-fatty, 9.0% for necrotic and 1.8% for calcified tissue. There was a higher content of fibro-fatty plaque tissue in the areas exposed to low WSS. Conversely, a significantly higher amount of fibrous and calcified tissue was observed in areas exposed to a high level of WSS (quartile 4) (p<0.05). A positive remodeling was predominantly found in areas of low WSS, whereas high WSS more often was associated with negative remodeling (p<0.05).

Conclusions: This study shows for the first time in vivo a direct correlation between local WSS and the distribution, composition and remodeling of coronary atherosclerotic plaques in humans. Serial assessments of plaque lesions are needed to confirm these initial findings and to investigate the impact of WSS over time.