Abstract: **P3109**

**Coronary vulnerable plaque development is promoted by multidirectional wall shear stress**

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**Topic(s):**
Atherosclerosis, Cerebrovascular Diseases, Aneurysm, Restenosis

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Aim – Wall shear stress (WSS) has been widely associated with plaque development and destabilization. However, the multidirectionality of WSS, induced by the pulsatile nature of blood flow in combination with the arterial geometry, is rarely taken into account. The purpose of this study was to investigate the influence and predictive value of five (multidirectional) WSS parameters for coronary plaque progression and composition.

Methods – Familial hypercholesterolemic pigs (n=10, castrated male, 3 years old) were put on a high-fat diet and underwent imaging (near infrared spectroscopy-intravascular ultrasound (NIRS-IVUS), optical coherence tomography (OCT) and CT) of the three main coronary arteries at baseline and 10/12 months follow-up. IVUS-based lumen contours were combined with the centerline of artery as extracted from CT to obtain a 3D reconstruction of the coronary artery. Local flow velocity measurements were combined with the 3D-geometry of the coronary arterial lumen to calculate five multidirectional WSS parameters including: time average wall shear stress (TAWSS), oscillatory shear index (OSI), relative residence time (RRT), trans wall shear stress (TransWSS), cross flow index (CFI). For the analysis, arteries were divided into 3mm/45° sectors (n=3627). Per vessel each segment was classified as low, mid or high for each WSS metric based on the average value in the sector. Changes in wall thickness (WT) and plaque composition were assessed with NIRS-IVUS and OCT, and histology and related to the local (multidirectional) WSS.

Results – Half of the pigs developed lumen intruding, complex, lipid-rich plaques. In these pigs, coronary segments exposed to low baseline levels of TAWSS exhibited a significantly larger plaque growth per month compared to regions with either mid or high TAWSS (p<0.05, see figure). Furthermore, plaque growth correlated positively with the multidirectional WSS metrics OSI, RRT and CFI, with high multidirectionality resulting in the largest plaque growth (see figure). The positive predictive values (PPV) of the WSS metrics for plaque presence (WT>0.5mm) at follow up were 50% (low TAWSS), 48% (high OSI), 49% (high RRT), 47% (high CFI) and 43% (high transWSS). The PPVs for the presence of a fibroatheroma observed with histology were 61% (low TAWSS), 58% (high OSI), 61% (high RRT), 59% (high CFI) and 49% (high transWSS).

Conclusions – This study shows that both low and multidirectional WSS promote the development of large and complex coronary atherosclerotic plaques with vulnerable characteristics. The high predictive values for fibrous cap atheroma development demonstrate the potential of multidirectional WSS metrics as a predictive clinical marker for vulnerable disease.
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