SHEAR STRESS

Abstract nos: 451 - 455

TCT-451

Shear stress analysis in multimodality imaging a sub-analysis of IBIS 4 study

Christos Bourantas,[1] Lorenz Raber,[2] Antonis Sakellarios,[3] Alexios Karagiannis,[4] Kyohei Yamaji,[5] Taniwaki Masanori,[6] Maria Radu,[7] Aris Moschovitis,[8] Michael Papafaklis,[9] Dik Heg,[10] Fanis Kalatzis,[11] Katerina Naka,[12] Dimitrios Fotiadis,[11] Lampros Michalis,[13] Patrick Serruys,[14] Hector Garcia-Garcia,[15] Stephan Windecker[2]
[1]Barts Health NHS Trust; Institute of Cardiovascular Sciences, UCL, London, United Kingdom; [2]University Hospital Bern, Bern, Switzerland; [3]Department of Materials Science and Engineering, University of Ioannina, Ioannina, Greece; [4]CTU Bern, and Institute of Social and Preventive Medicine (ISPM), University of Bern, Bern, Switzerland; [5]Department of Interventional Cardiology, Bern University Hospital, Bern, Switzerland; [6]Bern University Hospital, Bern, Switzerland; [7]The Heart Centre, Rigshospitalet, Copenhagen, Denmark; [8]Inselspital, Bern, Switzerland; [9]Barts Heart Centre, London, United Kingdom; [10]Clinical Trials Unit, Department of Clinical Research, Institute of Social and, Bern, Switzerland; [11]Department of Materials Science and Engineering, Ioannina, Greece; [12]Department of Cardiology, Medical School, Ioannina, Greece; [13]University of Ioannina, Ioannina, Greece; [14]Imperial College, London, United Kingdom; [15]Medstar Washington Medical Center, Bethesda, Maryland, United States

BACKGROUND Several studies have shown that intravascular ultrasound (IVUS)-derived plaque morphology and endothelial shear stress (ESS) distribution can predict atherosclerotic evolution. However it is unclear whether multimodality imaging combined with ESS will enable more detailed prediction of atherosclerotic disease progression.

METHODS 44 patients (73 vessels), recruited in the IBIS 4 study, admitted with a STEMI that had serial IVUS and optical coherence tomography (OCT) in the culprit and non-culprit vessel at baseline and 13 months follow-up were included in the analysis. The IVUS and OCT data were co-registered and at every 3mm segments the plaque burden, composition and plaque micro-characteristics were estimated. The coronary artery anatomy was reconstructed by fusing IVUS and X-ray imaging data, blood flow simulation was performed in the baseline models and the predominant ESS were calculated at every 3mm interval.

RESULTS Baseline ESS and plaque burden and composition estimated by IVUS but not the OCT-derived plaque micro-characteristics were associated with the changes in the lumen dimensions and plaque burden (Table). The addition of the OCT-derived plaque micro-features did not improve the accuracy of the model that included the baseline ESS and IVUS-derived plaque features (area under the curve: 0.774 vs 0.773) in predicting 3mm segments that will exhibit disease progression at follow-up (defined as a reduction in lumen area and increase in plaque burden).

	Delta lumen		Delta plaque burden	
	β	P	β	P
Baseline ESS	0.238	<0.001	-0.014	<0.001
Lumen area	-0.127	<0.001	0.007	<0.001
Plaque burden	2.266	<0.001	-0.207	<0.001
Excessive expansive remodelling	-0.337	0.021	0.013	0.096
Necrotic core burden	0.017	0.015	-0.001	<0.001
Macrophages	0.031	0.801	-0.010	0.124
Neo-vessels	-0.009	0.967	-0.007	0.525
Min cap thickness	-0.006	0.112	0.001	0.153

CONCLUSION OCT-derived plaque micro-features did not improve the accuracy of the model that included IVUS-derived plaque characteristcs and ESS in predicting segments that will exhibit disease progression. Further research is required in order to examine whether multimodality imaging can identify more accurately than standalone imaging vulnerable lesions that are likely to cause cardiovascular events.

CATEGORIES IMAGING: Vulnerable Plaque

TCT-452

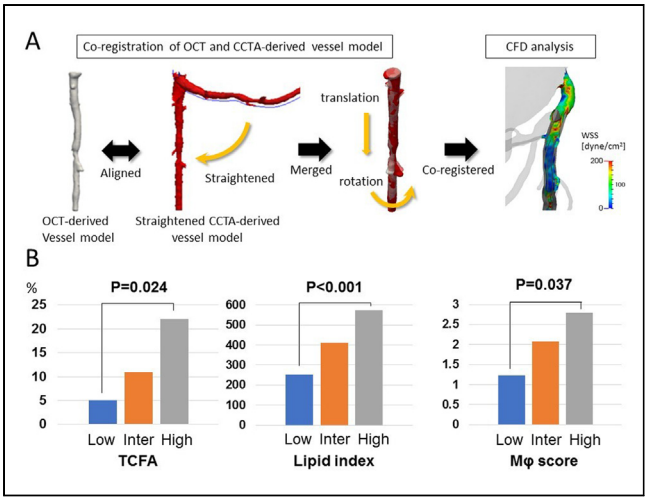
High Wall Shear Stress was Strongly Associated with Plaque Vulnerability in Computational Fluid Dynamics with Combined Optical Coherence Tomography and Heartflow FFRCT Simulation

Takayoshi Toba,[1] Gilwoo Choi,[2] Yuichiro Nagano,[3] Hiroyuki Kawamori,[1] Toshiro Shinke,[1] Charles Taylor,[4] Hiromasa Otake[3]
[1]Kobe University Graduate School of Medicine, Kobe, Japan; [2]HeartFlow, Inc., Redwood City, California, United States; [3]Kobe University Graduate School of Medicine, Kobe-shi, Japan; [4]HeartFlow, Inc, Redwood City, California, United States

BACKGROUND Wall shear stress (WSS) has recently been proposed as an important factor affecting the development of vulnerable plaques. However, clinical relevance of the association between WSS and high-risk plaque is not fully established. The objective of this study is to assess the association between WSS acting on atherosclerotic plaques and lesion characteristics by using computational fluid dynamics (CFD) with combined optical coherence tomography (OCT) and coronary CT angiography (CCTA) vessel model.

METHODS Twenty-nine vessels in 24 patients who underwent CCTA and OCT were analyzed. Each vessel was divided into 3-mm segments based upon MLA location. All the segments were classified into fibroatheroma, calcified and fibrous plaque according to the major plaque component. The prevalence of thin-cap fibroatheroma (TCFA), lipid index (summation of lipid arc at every 1 mm interval) and macrophage score were also assessed at each segment. After co-registration of OCT and CCTA images, CFD analysis was performed to calculate WSS in estimated maximum hyperemic condition with Heartflow FFRCT simulation (Figure A).

RESULTS A total of 256 segments were analyzed. WSS was significantly higher in segments with fibroatheroma than those with the others (Fibroatheroma;181.0 dyne/cm2 vs Calcified plaque; 83.8 dyne/cm2 and Fibrous plaque; 56.9 dyne/cm2, p=0.003 and p< 0.001 respectively). Compared with the segments exposed to lowest tertile WSS, the prevalence of TCFA, lipid index and macrophage score were significantly higher in those exposed to the highest tertile WSS (Figure B).



CONCLUSION High WSS was significantly associated with the burden of plaque vulnerability. This study might lead to more detailed identification of high-risk plaques.

CATEGORIES IMAGING: Vulnerable Plaque