Fluid-dynamics and biological features of unstable plaques: different shear stress for different plaques

Fluid-dynamics and biological features of unstable plaques: different shear stress for different plaques

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Background: The use of Optical Coherence Tomography (OCT) in acute coronary syndromes (ACS) allows recognizing ruptured fibrous cap (RFC) and intact fibrous cap (IFC) culprit lesions. The biological differences between them, as recently pointed out in translation studies, highlight different mechanisms for a similar clinical manifestation that might deserve different therapeutic approaches. The relationship between endothelial wall shear stress (WSS) and ACS has been demonstrated, however the differences in WSS features between RFC and IFC have not been elucidated.

Purpose: The aim of this study is to provide a fluid-dynamic and biological description of unstable and stable (SA) plaques, according to OCT analysis.

Methods: We enrolled 10 SA and 20 Non-ST Elevation Myocardial Infarction (NSTEMI)-ACS patients, with IFC (n=10) and RFC (n=10) culprit lesions according to OCT analysis. We performed Real-time PCR primer array on pooled Peripheral Blood Mononuclear Cell (PBMC) for 30 different molecules whose expression is strictly dependent on WSS. High-fidelity 3D-coronary artery models were created for 3 patients per group, applying previously validated methodologies.

Results: Among the groups we found a broad difference in molecular expression (Fig. 1A), with RFC displaying higher levels of molecules involved in vasoconstriction/dilatation (EDN1, NOS3), cellular adhesion (ICAM1), and peptidase inhibition (PI16). A significantly higher WSS was observed in RFC group ($p<0.001$, Fig 1B and C), with larger variability and larger areas exposed to both low and high WSS (Fig. 1D). Interestingly, the molecules overexpressed in RFC are known to be upregulated by high WSS.

Conclusions: Our data demonstrated that IFC and RFC unstable plaques are associated with different WSS conditions, alongside with the expression of different molecular patterns specifically related to altered WSS. In the era of precision medicine these findings may have relevant therapeutical implications.