RELATION BETWEEN PLAQUE TYPE, PLAQUE THICKNESS, BLOOD SHEAR STRESS, AND PLAQUE STRESS IN CORONARY ARTERIES ASSESSED BY X-RAY ANGIOGRAPHY AND INTRAVASCULAR ULTRASOUND

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Abstract

Atheromatic plaque progression is affected, among others phenomena, by biomechanical, biochemical, and physiological factors. In this paper, the authors introduce a novel framework able to provide both morphological (vessel radius, plaque thickness, and type) and biomechanical (wall shear stress and Von Mises stress) indices of coronary arteries.

First, the approach reconstructs the three-dimensional morphology of the vessel from intravascular ultrasound (IVUS) and Angiographic sequences, requiring minimal user interaction. Then, a computational pipeline allows to automatically assess fluid-dynamic and mechanical indices. Ten coronary arteries are analyzed illustrating the capabilities of the tool and confirming previous technical and clinical observations.

The relations between the arterial indices obtained by IVUS measurement and simulations have been quantitatively analyzed along the whole surface of the artery, extending the analysis of the coronary arteries shown in previous state of the art studies. Additionally, for the first time in the literature, the framework allows the computation of the membrane stresses using a simplified mechanical model of the arterial wall.

Circumferentially (within a given frame), statistical analysis shows an inverse relation between the wall shear stress and the plaque thickness. At the global level (comparing a frame within the entire vessel), it is observed that heavy plaque accumulations are in general calcified and are located in the areas of the vessel having high wall shear stress. Finally, in their experiments the inverse proportionality between fluid and structural stresses is observed. [**Med Phys. 2012;39:7430-45]** PMID: 23231293

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