1549716

3D Characterization of Coronary Arteries for Assessing Risk of Plaque Rupture by Using Patient-Specific Computational Models Based on IVUS-VH Images.

Lavi, I[1]; Tzang, O[1]; Avrahami, I[2]; Kornowski, R[3]; Einav, S[1]
[1]Tel-Aviv University, Department of Biomedical Engineering, Tel-Aviv, Israel; [2]AFEKA – Tel Aviv Academic College of Engineering, Department of Biomedical Engineering, Tel Aviv, Israel; [3]Rabin Medical Center and the Sackler School of Medicine, Petach Tikva, Israel

Background: The disruption of vulnerable plaques is considered as the major cause of cardiovascular events. The probability of a specific plaque to rupture strongly depends on mechanical and biomechanical factors; however, the explicit processes that lead to an acute ischemic event are, to large extent, still unknown.

Objectives: To develop a 3D model which characterizes the morphology of the plaque based on IVUS-VH images.

Method: Our technique allows to select any desired segment of the artery, by collecting the IVUS-VH cross-section images, and to create a 3D model of the artery wall and its plaque components (Fig 1). A finite element analysis system takes this 3D-model as its input to evaluate the flow and stress distributions in the diseased artery with atherosclerotic plaque and to identify the sites prone to rupture.

Results: The reconstruction of the complex plaque in the segment enables to identify high risk areas and to examine the effect of calcium and necrotic core pools on the cap stability. Based on the 3D geometrical model of the lumen, the flow patterns throughout the atherosclerotic lesion and the shear stresses are calculated and a biomechanical analysis is used to estimate the mechanical forces at the lesion site. Our results indicate that minute calcium deposits, especially when adjacent to the lumen and nearby necrotic cores, are associated with high stress distribution which act on the thin-cap fibro-atheroma (TCFA) and may impair its stability.

Conclusions: This IVUS-based 3D computational model provides better insights into plaque vulnerability and may improve the understanding of the biomechanisms leading to plaque rupture.

Figure 1. A 3D reconstruction of the culprit lesion, including multi-component plaque structure based on IVUS-VH slices.