STRESSES IN STENTED CORONARY ARTERY: EFFECT OF FIBROUS CAP THICKNESS

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Introduction

The deployment of stent reopens the blocked regions of arteries and restores the blood flow. Despite their success, post-stenting often associates with the restenosis process. Stresses that are generated within or on the stenosed arteries have impact on the progress of restenosis. Besides stenting procedures, the plaque structure, especially the thickness of fibrous cap (FC) is vital in inducing the level of stresses. This computational study investigates the importance of fibrous cap thickness (FCT) on wall stresses following the post-stented blood flow locally around a single stent strut.

Methods

A 2D axisymmetric idealized geometry of human coronary artery representing 60% stenosis is modelled in a cylindrical unit. Plaque is composed of FC, necrotic core (NC) and fibrosis (F) layers. FCT is varied in thin, medium and thick values. A single unit of stent is modelled as a ring with rectangular section [Jimenez, 2006]. The models are simulated using the finite element based package of COMSOL Multiphysics 3.5a. Initially, the stent strut element is not present. The plaque layers and arterial wall (AW) are expanded by applying a pressure value of 100 mmHg. In the second step, the strut is placed fixed under the lumen pressure of 100 mmHg. The deformation of plaque and AW is in static condition. The Newtonian blood flow is simulated around deformed structure at steady condition.

Results

Figure 1a shows the wall shear stress (WSS) distribution along the z- direction of stented artery. WSS magnitude differs considerably between the two sides of the strut which creates asymmetric hemodynamic condition around the strut. However, there is no significant difference on WSS distribution for different thicknesses of FC. Figure 1b demonstrates the effect of FCT on von Mises stress (VMS) in FC layer. The graph reveals that higher stresses are generated with the thinner FC. Among the different layers, FC experiences the highest value of VMS. AW experiences the minimum stresses, and F experiences higher stresses than NC.

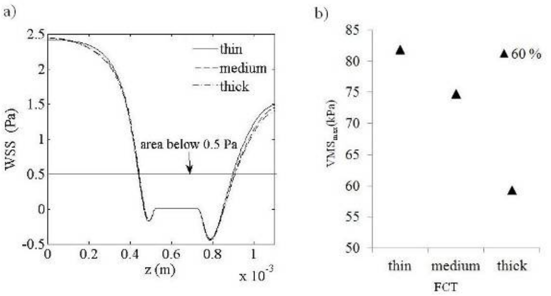

Figure 1: a) WSS distribution along z-direction of stented artery for different FCT b) Maximum value of VMS through FC layer for different FCT

Discussion

The present study focused on the influence of FCT on the stresses acting on or within the stenosed AW after stenting. The result reveals that thinner FCs leads to higher value of stresses within the wall layers as already presented by Tang *et al.* 2005. However, WSS remains independent of the variation in FCT. On the other hand, the profile of strut with circular cross-section alters the WSS distribution. The area of recirculation zone significantly reduces that are created behind the strut due to deformation of the wall. This study limits to the angioplasty pressure applied to expand the stenosed artery and to the simplified assumptions of geometries. Further studies with anatomically realistic models will provide more valuable information.

References

Jimenez *et al*, Ann Biomed Eng. 37 (8):1483-1494, 2009.

Tang *et al*, J Biomech Eng. 127(7): 1185-1194, 2005.