An Examination of Wall Shear Stresses in Curved Arterial Vessels Using Bioresorbable Stents

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Abstract

Bioresorbable stents are providing temporary mechanical support to keep a narrowed or blocked coronary artery open and restore the blood flow and will be gradually degraded and resorbed after the healing and remodeling of arterial wall. This new generation of stents has lower rates of restenosis and in-stent thrombosis in comparison with permanently bare-metal stents. Since this new generation is still in the early stages of development, more study is needed on their mechanical properties, material, design and performance. Applying metal stents in very tortuous coronary sections can produce high shear stresses at the edges while also impacting the geometry of the vessel. Since bioresorbable stents are conformable, the stresses should be less on the arterial walls. In this study, an analysis on the mechanical characteristics of bare-metal stents (e.g., Co-Cr (L 605) and Stainless steel) and bioresorbable stents (PLLA) during expansion in curved segments is investigated using COMSOL. The purpose of this study was to examine the stresses on stents after expansion in the deployment process of the stent (see Fig. 1). COMSOL Multiphysics, utilizing the structural mechanics module, was used to examine the pressure applied on the inner surface of the stent during expansion. The file containing information related to plastic deformation during the expansion of a biomedical stent was also examined from the COMSOL library and modified for the current study. A metal stent without conformability was analyzed for comparison.
Wall shear stresses were found to be higher in the bare metal stents than in the bioresorbable stents, resulting in a straightening within the arterial wall. Studies show that deployment of conventional stents in curved segments lead to higher rates of plaque prolapse. Also, the metal stent can affect the blood flow in curved segments due to its sharp edges and can cause back flow and turbulent wakes. The bioresorbable stent has more flexibility and ability to conform to the vessel shape without overstressing the arterial wall and assisting in reducing flow instabilities.

Figures used in the abstract

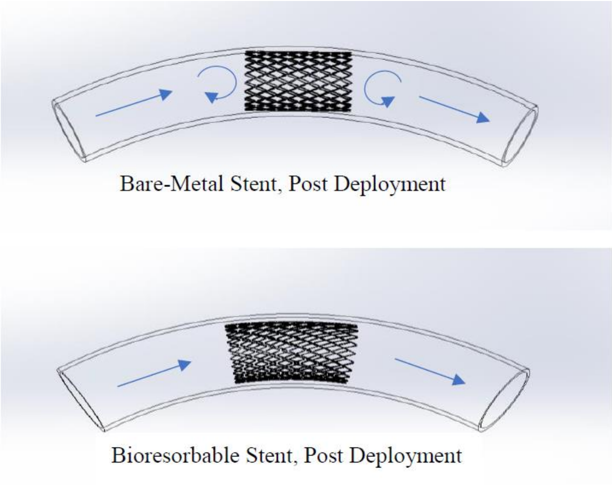

Figure 1: Schematic view of bare-metal and bioresorbable stents - post development