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Finite Element Analysis of Shape Memory Alloy Stents in Coronary Arteries

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Abstract : The coronary artery stent is a promising technology that can treat various coronary diseases. Materials used for manufacturing medical stents should have high biocompatible properties. Stent alloys, in particular, are remarkably promising good clinical outcomes, however, there is threaten of restenosis (reoccurring of artery narrowing due to fatty plaque), stent recoiling, or in long-term the occurrence of stent fracture. However, stents that are made of Nickel-titanium (Nitinol) can bare extensive plastic deformation and resist restenosis. This shape memory alloy has outstanding mechanical properties. Nitinol is a unique shape memory alloy as it has unique mechanical properties such as; biocompatibility, super-elasticity, and recovery to original shape under certain loads. Stent failure may cause complications in vascular diseases and possibly blockage of blood flow. Thus, studying the behaviors of the stent under different medical conditions will help the doctors and cardiologists to predict when it is necessary to change the stent in order to prevent any severe morbidity outcomes. To the best of our knowledge, there are limited published papers that analyze the stent behavior with regards to the contact surfaces of plaque layer and blood vessel. Thus, stent material properties will be discussed in this investigation to highlight the mechanical and clinical differences between various stents. This research analyzes the performance of Nitinol stent in well-known stent design to determine its bearing with stress and its dislocation in blood vessels, in comparison to stents made of different biocompatible materials. In addition, a study of its performance will be represented in the system. Finite Element Analysis is the core of this study. Thus, a physical representative model will be discussed to show the distribution of stress and strain along the interaction surface between the stent and the artery. The reaction of vascular tissue to the stent will be evaluated to predict the possibility of restenosis within the treated area.

Keywords : shape memory alloy, stent, coronary artery, finite element analysis
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