FEA TECHNIQUES FOR SIMULATION OF STENT INSTALLATION IN DISEASED ARTERIES

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Atherosclerosis is a leading cause of death in the western world. The plaque build up in atherosclerotic patients may occlude the arterial lumen reducing the blood flow. The plaques may also rupture leading to thrombosis. This could lead to heart attack or a stroke. Balloon angioplasty is commonly used to treat the disease as an alternative to complex surgery. During this process, a catheter mounted balloon is inserted the diseased artery and is inflated to widen the arterial lumen. In order to maintain a minimum lumen size, a catheter mounted stent is then inserted and expanded through pressurization.

Most metal stents are complex structures manufactured from thin wall steel tubes by precision laser cutting techniques. Biocompatible stainless steel alloys are generally used for stents, but shape memory materials have entered the market in recent years. Since metals exhibit elastic-plastic behavior, it is important to understand the following design parameters: angioplasty balloon pressure required for stent deployment, stent elastic recovery or spring back, and stent radial compression due to arterial wall pressure. Finite element analysis (FEA) provides an efficient alternative to testing in providing a good estimate of these parameters. FEA techniques also provide deployed stent geometry, plastic strain distributions in the stents, and contact stress distributions in the arterial wall. These analysis results are crucial to the stent design verification process, and also allow physicians choose the best type of stent for the arterial lumen size and type of plaque deposit observed in a patient.

The present work details the FEA technique applied to the process of mounting (crimping) a stent onto a balloon catheter, and the deployment of the stent in a diseased artery. The stress distribution in the artery and plastic strain history in the stent are monitored for failure limits. Sensitivity analysis is also beneficial in choosing an optimum pressure history and the right type of stent geometry.