World Academy of Science, Engineering and Technology
International Journal of Biomedical and Biological Engineering
Vol:10, No:02, 2016

Polyurethane Membrane Mechanical Property Study for a Novel Carotid Covered Stent

Authors : Keping Zuo, Jia Yin Chia, Gideon Praveen Kumar Vijayakumar, Foad Kabinejadian, Fangsen Cui, Pei Ho, Hwa Liang Leo

Abstract : Carotid artery is the major vessel supplying blood to the brain. Carotid artery stenosis is one of the three major causes of stroke and the stroke is the fourth leading cause of death and the first leading cause of disability in most developed countries. Although there is an increasing interest in carotid artery stenting for treatment of cervical carotid artery bifurcation therosclerotic disease, currently available bare metal stents cannot provide an adequate protection against the detachment of the plaque fragments over diseased carotid artery, which could result in the formation of micro-emboli and subsequent stroke. Our research group has recently developed a novel preferential covered-stent for carotid artery aims to prevent friable fragments of atherosclerotic plaques from flowing into the cerebral circulation, and yet retaining the ability to preserve the flow of the external carotid artery. The preliminary animal studies have demonstrated the potential of this novel covered-stent design for the treatment of carotid therosclerotic stenosis. The purpose of this study is to evaluate the biomechanical property of PU membrane of different concentration configurations in order to refine the stent coating technique and enhance the clinical performance of our novel carotid covered stent. Results from this study also provide necessary material property information crucial for accurate simulation analysis for our stents. Method: Medical grade Polyurethane (ChronoFlex AR) was used to prepare PU membrane specimens. Different PU membrane configurations were subjected to uniaxial test: 22%, 16%, and 11% PU solution were made by mixing the original solution with proper amount of the Dimethylacetamide (DMAC). The specimens were then immersed in physiological saline solution for 24 hours before test. All specimens were moistened with saline solution before mounting and subsequent uniaxial testing. The specimens were preconditioned by loading the PU membrane sample to a peak stress of 5.5 Mpa for 10 consecutive cycles at a rate of 50 mm/min. The specimens were then stretched to failure at the same loading rate. Result: The results showed that the stress-strain response curves of all PU membrane samples exhibited nonlinear characteristic. For the ultimate failure stress, 22% PU membrane was significantly higher than 16% ($p<0.05$). In general, our preliminary results showed that lower concentration PU membrane is stiffer than the higher concentration one. From the perspective of mechanical properties, 22% PU membrane is a better choice for the covered stent. Interestingly, the hyperelastic Ogden model is able to accurately capture the nonlinear, isotropic stress-strain behavior of PU membrane with R2 of 0.9977 ± 0.00172. This result will be useful for future biomechanical analysis of our stent designs and will play an important role for computational modeling of our covered stent fatigue study.

Keywords : carotid artery, covered stent, nonlinear, hyperelastic, stress, strain
Conference Title : ICBET 2016 : International Conference on Biomedical Engineering and Technology
Conference Location : Melbourne, Australia
Conference Dates : February 04-05, 2016

Open Science Index, Biomedical and Biological Engineering Vol:10, No:02, 2016 publications.waset.org/abstracts/41343.pdf