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Designing and fabrication of anisotropic stent for the treatment of coronary heart disease

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Statement of the Problem: Coronary Heart Diseases lead towards the stenosis where the plaques are accumulated under coronary artery endothelium layer. This deposition blocks the coronary artery and does not allow smooth flow of blood to the walls of the heart. The design of stent has great influence on late lumen loss along with neointimal proliferation which affects the rate of restenosis. It is revealed that design of stent also affect the platelet activation and thrombogenesis. The purpose of this study is to design and fabricate a new coronary stent design with Auxetic geometry which will complement the body's vascular system anisotropic properties. Based on previous studies, we can hypothesize that the new Auxetic design of stent will allow good anchorage with arterial walls. When expanded through an inflated balloon, the special feature of this design allows maintaining vascular patency by expanding in two directions simultaneously.

Findings: During longitudinal expansion there is no foreshortening in the Auxetic stent. This is an advantage over existing coronary stents where foreshortening cause the problem of stent migration. The 3.3 % elastic recoil shows that the luminal patency will effectively be maintained by the coronary artery. Having no foreshortening and minimal recoiling in the present stent will might avert the stent from migration problem while being expanded in the coronary artery which will reduce the chances of thrombogenesis and restenosis.

Conclusion & Significance: Auxetic design the stent has anisotropic properties that make it a great match for coronary vessel anisotropic structural properties. When expanded radially through balloon catheter the auxetic stent size increases in both radial and longitudinal directions exhibiting no foreshortening. It is believed that auxetic stent will prevent stent migration and will effectively maintain the luminal patency of the coronary artery due to the auxetic property of the stent design.

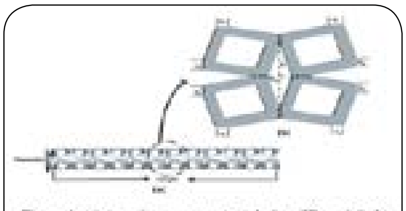

Figure 1. (a) Auxetic coronary stent design (2D model) (b) Single unit cell.

Recent Publications

1. Skousen, D. J., Jones, K. N., Kowalski, T., Bowden, A. E., & Jensen, B. D. (2017). Exploration of Carbon-Filled Carbon Nanotube Vascular Stents. In Microactuators and Micromechanisms (pp. 103-114). Springer, Cham.
2. Wu, W., Song, X., Liang, J., Xia, R., Qian, G., & Fang, D. (2017). Mechanical properties of anti-tetrachiral auxetic stents. Composite Structures.
3. Bukhari, F., Ansari, U., Najabat Ali, M., Akhtar, H., Asif, S., Mohammad, U., & Mir, M. (2017). A biaxial strain–based expansion mechanism for auxetic stent deployment. Journal of applied biomaterials & functional materials, 15(3), 196-205.
4. Bhullar, S. K., Ko, J., Cho, Y., & Jun, M. B. (2015). Fabrication and Characterization of Nonwoven Auxetic Polymer Stent. Polymer-Plastics Technology and Engineering, 54(15), 1553-1559.

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Biography

Hafsa Inam is a PhD student of Biomedical Engineering and Sciences at School of Mechanical and Manufacturing Engineering, NUST, H-12 Islamabad, Pakistan. She completed her Masters in Biomedical Sciences in 2017 from School of Mechanical and Manufacturing Engineering SMME, NUST, H-12 Islamabad Pakistan. As a part of her MS research program, she completed her research project entitled 'Magnetically Targeted Drug Delivery Approach using Imaging Technology and PID Feedback Loop System'. After completing her MS, she is working as a research associate on a project funded by Ignite. Pakistan.

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