

Endobronchial and Coronary Stent Design and Analysis using the Finite Element Method

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Abstract

Stents are small tubular mesh devices used in the treatment of a wide range of diseases. They are implanted in sites of blockage to restore normal fluid flow by scaffolding the affected area. Stents have revolutionised the treatment of both coronary artery disease (CAD) and lung cancer. Existing commercial stents on the market have key problems due to rapid re-occlusion of the vessel due to factors including vessel injury or tumour ingrowth. Massive mucous retention is also a significant problem of endobronchial stenting due to the airways interrupted natural mucociliary function. There is currently a strong clinical need to design and develop new enhanced coronary and endobronchial stent devices that help maintain the natural vessel function and prevent re-occlusion. The development of stenting technology is rapid and is pushing towards covered devices that can deliver drugs/cells as well as introducing novel biodegradable materials. Gaining an understanding of the mechanisms of tissue remodelling that leads to vessel re-occlusion is also very important in stent development.

Computational finite element (FE) modelling is an important tool in the design and development of novel stents. Currently, FE modelling is a requirement for the FDA approval of a commercial stent device. In the current work, the commercial FE code Abaqus (Dassault Systemes USA) is used for advanced stent design, development and optimisation of novel endobronchial and coronary stent technologies. Novel FE models that can capture tissue response and healing following an associated injury, such as stent implantation, will also be explored. The current work involves a multifactorial approach with investigations focusing on: self-expanding laser-cut & braided stents; polymer covered stents; biodegradable stent technology; *in-vivo* stent-vessel loading; and tissue remodelling due to stent implantation. Experimental validation of the FE analyses will inform the development of the next generation of stent designs.