Visualization of Coronary Artery Bypass Grafts and Coronary Artery Stents in Re-Animated and Perfusion Fixed Human Hearts

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Using Visible Heart® methodologies we imaged coronary artery bypass grafts (CABGs) and coronary stents in isolated beating human hearts and perfusion fixed human hearts. Due to the varying cardiac health of the donor hearts it has been possible to see progressive levels of stent endothelialization and vascular calcification. The isolated heart model uses a clear Krebs–Henseleit buffer in place of blood, allowing for the unique opportunity to image the coronary vessels. In the isolated human heart a fiberscope was inserted into either the native coronary artery or the CABG with the heart in sinus rhythm. In order to verify cardiac function during the imaging process the following measurements were read at a sampling rate of 5 kHz: ECG, aortic flow, and ventricular pressures. Perfusion fixed hearts were fixed in an end diastolic state achieved by applying pressures comparable to physiological conditions. This process causes the coronary arteries to fix in a dilated state. CABGs of human hearts were then imaged using fluoroscopy (angiograms) and fiberscopic techniques. The stented native coronary arteries of human hearts were imaged via fluoroscopy and by dissection. Through a variety of imaging techniques and using Visible Heart® methodologies we have obtained a unique visualization of a CABG and a coronary artery stent in a beating human heart during sinus rhythm. Investigative studies in perfusion fixed human hearts have provided a more complete anatomical imaging study of stent endothelialization in the native coronary arteries and vascular calcification in bypass grafts.

A Laser-Based Device for Tissue Fusion

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A prototype device (patent pending) has been created, and successfully used, to fuse tissue membranes as an alternative to sutures or staples. The joining, or coaptation, is accomplished through the controlled application of laser heating and pressure to induce protein denaturation and subsequent tissue fusion, through renaturation and intertwining, across the interface. Lasers have been used by a number of researchers to close wounds in controlled laboratory tests over the last 15 years. Many encouraging results have been obtained; however, no commercial delivery systems are currently available. This is due primarily to two factors: requiring an inordinate amount of experience on the part of the operator to detect changes in tissue appearance, and attempting to achieve general applicability for multiple tissue systems, i.e., a one-size-fits-all approach. Different combinations of system performance parameters may be required for different types of tissues. The present device overcomes these barriers as it is tailored for the particular application of septal laser fusion, namely for the coaptation of mucoperichondrial membranes. The optimal laser performance characteristics are pre-set for nasal tissue and packaged in an easy to use device. The important parameters involved in fusing biological tissues using radiation from laser sources are identified. The development of the device followed from computational modeling of the fusion process based on engineering first-principles from heat transfer, fluid dynamics and optics, and from experimental results on a particular tissue system. The experiments were designed and analyzed using orthogonal arrays, employing a subset of the relevant parameters, i.e., laser irradiance, dwell time and spot size, for a range of wavelengths. The in vitro fusion experiments employed 1 cm by 1 cm sections of equine nasal mucosa having a nominal thickness of 1 mm.

