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Microstructural Volumetric Imaging of a Human Gastroesophageal Junction

AIM: To combine the micro-anatomy (muscle distribution and fiber orientation) and physiology of the GEJ into a 3D computational model to better understand the relationship between the anatomy and physiology of the GEJ. **BACKGROUND**: A realistic 3D anatomically-based computer model of the GEJ has been constructed using cross-sectional images from the Visible Human Project. The boundaries of the esophagus were manually traced on each slice (260 slices, 2 mm apart) and used to construct the 3D computer model with accurate geometric information. We seek to augment the geometrical model with microstructural details on the fiber orientation and distribution using a large volume imaging system. **METHODS AND RESULTS**: An *en-bloc* harvest of the GEJ from a cadaver has been imaged to obtain detailed microstructural information such as muscle fiber size and orientation. The tissue was excised 10 hrs after death and suspended in a specially designed jig to maintain anatomical relations. The sample was fixed in 3% formalin for 1 week before wax embedding resulting in 75x75x55 mm^3 sample block. A custom built extended-volume imaging system comprising a digital camera (Canon1D MarkII) and Ultramill (Leica SP2600) mounted over a precision (0.1µm step) XYZ stage (Aerotech) was used to obtain detailed microstructural information using Surface Imaging Microscopy. The surface of the block is milled flat, etched, stained with May-Grunwald and a 6x6 overlapping matrix of images captured to cover the entire surface at 8.22 µm pixel resolution. This cycle is then repeated at 50 µm Z steps. The stained tissue is segmented out from the image which is effectively a 3 µm optical section with resolution comparable to conventional histological thin sections. The fiber information will be extracted and used to augment the 3D model. The model will be used to simulate a normal swallow by solving the laws of mechanics that govern finite deformation elasticity and results will be compared to experimental recordings. **CONCLUSIONS**: The model is a framework which can be used to examine the roles of micro-anatomy in the functionality of the GEJ. The model will provide opportunities to examine the relationship between anatomy and physiology in health and disease and allow the determination of the contributions of different elements of anti-reflux surgery.