Investigation of Isolated Human Heart by Micro-Computed Tomography

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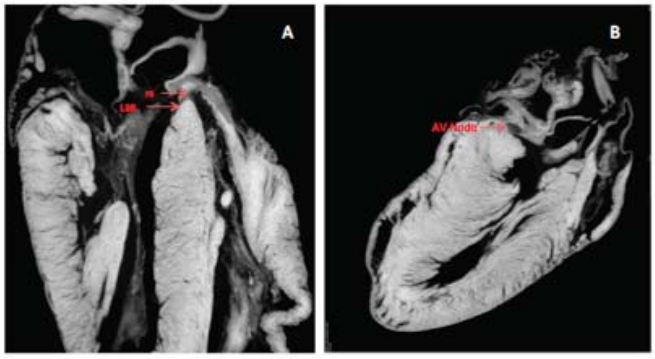
Abstract

Background: While much is known about gross anatomy of complex congenital heart disease (CHD), the microanatomy including cardiac conduction system (CCS), microvasculature, and muscular orientation require further investigation to aid surgical repair and to model prospective 3D presentation of Complex CHD.
Methods: MicroCT scanning analysis and reconstruction of ex-vivo animal heart (rat and chicken), normal and complex CHD fetal heart (Atrioventricular Septal Defect, Isomerism) were provided by Great Osmond Street Hospital, London, UK. Tissue preparation was optimized in a series of preliminary experiments, including iodine dilution for tissue penetration and fixation. Images were obtained using Nikon XTH225 ST microfocus-CT scanner (Nikon Metrology, UK). X-ray energies, target material (Tungsten, Molybdenum, Copper) and flux were optimized for each specimen. Raw images were post-processed using VG Studio MAX (Volume Graphics GmbH, Germany) and Fiji ImageJ before virtually dissect to trace CCS, microvasculature and myocardium. Histology examination using Masson's Trichrome was used to verify tissue identity from microCT image.
Result: We presented contrast-enhanced microCT image of cardiac tissue from animal and human heart in which cardiac tissue could be distinguished from surrounding myocardium. There was a distinctive X-ray attenuation between myocardium, vasculature (high attenuation) and CCS (low attenuation). Rat heart was the only specimen in which Atrioventricular node, His Bundle and Bundle Branch can be determined and visualized in 3D model.
Conclusion: Contrast-enhanced microCT offers non-invasive technique to create an accurate microanatomical model of the heart particularly CCS, that can be constructed into 3D model.



A. Micro-CT image of Rabbit Heart with the visualization of Bundle of His (PB) and Left Bundle Branches (LBB). B. AV Node appear as an ellipsoid low attenuation structure.