MP4-6

Revealing cardiac microstructure in a human fetal heart of 8 weeks of gestation with synchrotron-based X-ray phase contrast tomographic imaging

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Introduction: Understanding the complexity of heart morphogenesis and the associated functional consequences of congenital heart disease is essential for providing appropriate treatment strategies. Since our knowledge on the microstructure of the whole fetal & paediatric heart is limited, novel imaging approaches offered by synchrotron facilities can provide structural detail currently not available otherwise. Our aim is to visualise and quantify cardiac microstructure in fetal hearts at different stages of development using synchrotron-based X-ray Phase-Contrast tomography Imaging (X-PCI).

Methods: A normal fetal heart of 8 weeks and 6 days of gestation was selected from the from the Ospedale Maggiore Policlinico (Milan, Italy). While the specimen was fixed in formalin, it was placed in water as supporting medium for acquisition. X-PCI was performed at 1.625µm resolution at the TOMCAT Beamline (Swiss Light Source, Paul Scherer Institut, Villigen, Switzerland) using an energy of 20 keV. Several acquisitions were necessary to cover the whole heart along its long axis. The image series were reconstructed using Gridrec algorithm. Orientation of myocytes aggregates was computed using an in-house structure tensor algorithm.

Results: Fig.1(a) Two images of the gross specimen with scale - base to apex 2mm. Fig.1(b)-(c) show longitudinal (4-chamber) and short axis maximum intensity projection slices, respectively, from the X-PCI image dataset showing detail of myocardial structure. The ventricular myocardium is composed mainly of trabeculations while the compact myocardium is thin and under-developed. Taking both trabecular and compact myocardium together there is organisation even at this early gestation (see Fig.1(d)) with a clear change in helical angle (from 60º to -60º) from endo to epicardium, especially the septal wall.

Conclusions: We managed for the first time to image a normal fetal heart with high-resolution and in 3D at an early stage of development, resolving detail of myocyte aggregates and providing information on cardiac microstructure without the need for sample processing or sectioning.

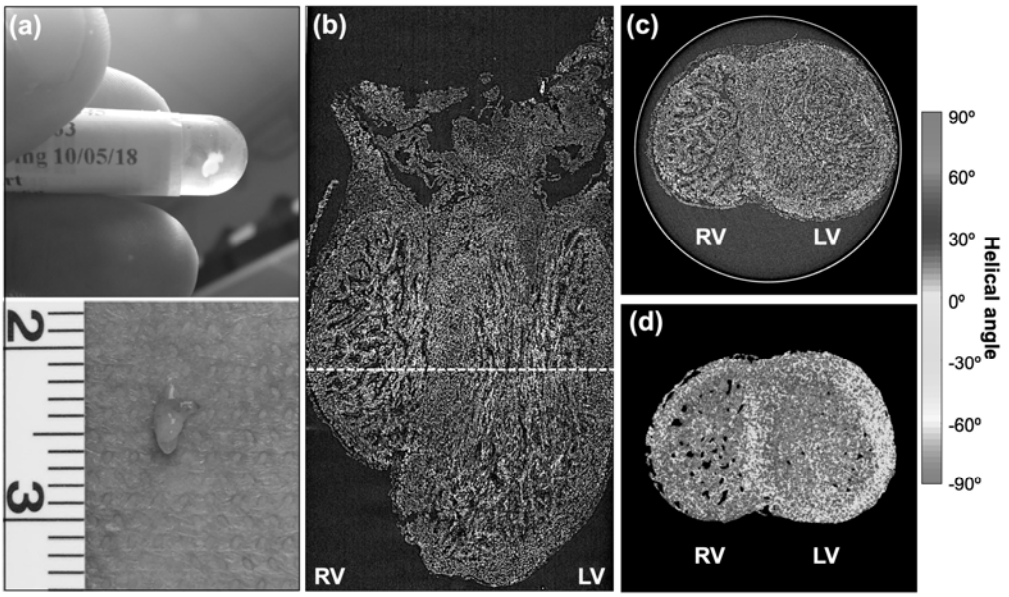

Figure 1