


CARDIOVASCULAR FLASHLIGHT

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Three-dimensional reconstruction imaging of the human foetal heart in the first trimester

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High-resolution episcopic microscopy (HREM) is a novel method producing high-quality, three-dimensional (3D) images of tissue from a variety of species. We report, for the first time, the use of HREM to create high-resolution 3D reconstructions of the human foetal heart in the first trimester. These models are suitable for a detailed morphological investigation to produce ‘virtual’ images of any section plane and 3D models that can be examined using ‘virtual’ dissection.

Following ethical approval by our institutional review committee and written consents, we collected normal foetal hearts from surgical termination of singleton pregnancies followed by HREM processing, including automatic image capturing of the surface of sectioned sample blocks. Each captured image data set was used to generate 3D models by volume rendering.

The detailed structures can be seen more clearly in the HREM reconstruction (Panel B) than in the original photograph (Panel A). In this normal 11-week heart (modelled with an isotropic resolution of 3 μm), we can clearly observe several specific features of the human foetal heart, including large atrial appendages, prominent coronary arteries, and the relatively small size of the atrial chambers (Panels B and F). Volume rendering, which allows internal morphology of the heart to be examined at high resolution, shows thickened great arterial walls (Panels C–E) and details of valve and septal architecture (Panels C and D). Multi-planar reconstructed images demonstrate detailed structures of the inside of cardiac chambers (Panels E and F).

The HREM is a useful tool to investigate the morphology of the human foetal heart in early gestation when manual manipulation is difficult and has the potential to act as a gold-standard of normal and abnormal foetal cardiac morphology to inform 3D foetal echocardiographical studies.

Abbreviations used in the figures are: Ao, aorta; AV, aortic valve; EV, Eustachian valve; FF, foramen flap; LA, left atrium; Lapp, left atrial appendage; LV, left ventricle; MV, mitral valve; PT, pulmonary trunk; PV, pulmonary valve; RA, right atrium; Rapp, right atrial appendage.

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