The general anatomy of the cardiac conduction system (CCS) has been known for 100 years, but its complex irregular 3D geometry is not well understood largely because the specialised tissue cannot be easily distinguished from working myocardium. The best anatomical descriptions come from serial sectioning of preparations taken from appropriate areas of the heart. Low X-ray attenuation has formerly ruled out micro-computed tomography (micro-CT) to resolve topology of soft tissue, but incorporation of high molecular weight molecules enhances differential attenuation and allows visualisation of fine detail. Using an iodine based contrast agent, we obtained exquisite high resolution contrast enhanced micro-CT images of cardiac tissue from rat and rabbit in which the three major subdivisions of the CCS can be differentiated from the surrounding contractile myocardium, and visualised in 3D. The sinoatrial node and the associated ring bundle, the atrioventricular conduction axis (including inferior nodal extension and penetrating bundle), His bundle, bundle branches and Purkinje network can be objectively identified by differential attenuation. Purkinje fibres within the ventricles appear both as structures running on the endocardial surface and free running in the luminal cavity. Controversially, analogous structures are present in the atria, mainly on or near to the endocardial surface. Although the current findings are consistent with existing anatomical representations, the new images offer superior resolution and are the first 3D representations of the CCS within intact mammalian hearts. The method promises to improve the anatomical fidelity of computational models designed to understand complex normal and pathological conduction within the heart.

The jeopardised ischaemic area-at-risk (AAR) is a key prognostic determinant in acute myocardial infarction. Myocardial oedema imaging with T2-weighted cardiac magnetic resonance CMR is validated for imaging the AAR and T2 ‘mapping’ is a new method for AAR imaging with clinical and research potential. We aimed to develop an automated post-processing method that would enable straightforward volumetric quantification of AAR with T2 maps. Our approach retains user input (i.e. clinical judgement) to confirm the presence of oedema on an image which is then subjected to an automated analysis. The new method was tested on 12 acute MI patients who had a CMR within 48 hours of hospital admission. Manual segmentation of the left ventricular wall and oedema were available for comparison. Left ventricular wall boundaries were delineated automatically by variational level set methods followed by automated detection of myocardial oedema by fitting a Gaussian-Gaussian mixture statistical model. The mean perpendicular distances between automatically detected left ventricular boundaries and corresponding manual delineated boundaries were 1.8±0.2 mm for endocardial boundaries and 2.3±0.3 mm for endocardial boundaries. Dice similarity coefficients for agreement (0=no agreement, 1=perfect agreement) between manual delineation and automated segmentation of the left ventricular wall boundaries and oedema regions were 0.85±0.02 and 0.74±0.05, respectively. Compared to standard manual approaches, the new semi-automated method for estimating myocardial oedema is straightforward and accurate.