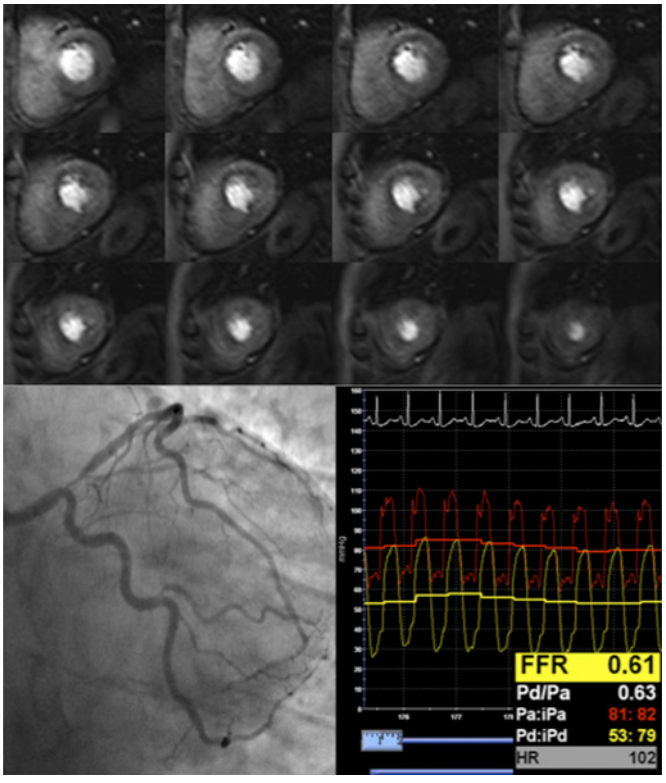
Objectives To determine the diagnostic accuracy of whole heart 3D myocardial perfusion CMR against invasively determined FFR.
Methods 55 patients referred for angiography underwent rest and adenosine stress 3D myocardial perfusion CMR at 3Tesla (3D turbo gradient echo, flip angle 15, TR 2.0 ms/TE 1.0 ms, 12 slices of 5 mm thickness, in-plane resolution 2.3×2.3 mm^2, 10-fold k-space and time k-t broad linear speed up technique acceleration with k-t principal component analysis). Perfusion was scored visually as on a coronary territory basis on a score from 0 to 3. Ischaemic burden was calculated by quantitative segmentation of the volume of hypoenhancement. The FFR was measured in vessels with >50% severity stenosis. Fractional flow reserve <0.75 was considered haemodynamically significant.
Results Two patients were excluded (one due to claustrophobia, the other had poor image quality). From the remaining 53 patients and 159 coronary vessels, 64 underwent pressure wire assessment and 39 had an FFR<0.75. Sensitivity, specificity and diagnostic accuracy of CMR analysis per patient was 90%, 91% and 91%, respectively for the detection of significant coronary artery disease. By coronary territory the values were 79%, 92% and 88%.
Conclusion 3D CMR stress perfusion can detect functionally significant coronary artery disease with excellent sensitivity, specificity and predictive values when compared with FFR. 3D CMR perfusion imaging may offer an alternative method of detecting ischaemia for the purpose of guiding revascularisation and risk stratification.



Abstract 022 Figure 1 3D CMR perfusion of a patient with a proximal LAD lesion with positive fractional flow reserve (FFR=0.61). Note the subendocardial perfusion defect from the base towards the apex.

023 AN EX-VIVO "WHOLE HUMAN HEART MODEL" FOR THE DEVELOPMENT OF INTRAVASCULAR IMAGING

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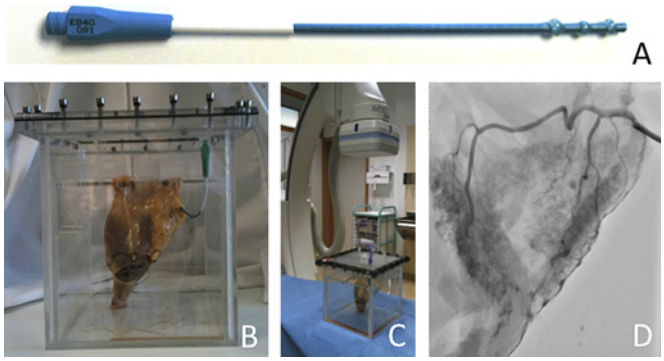
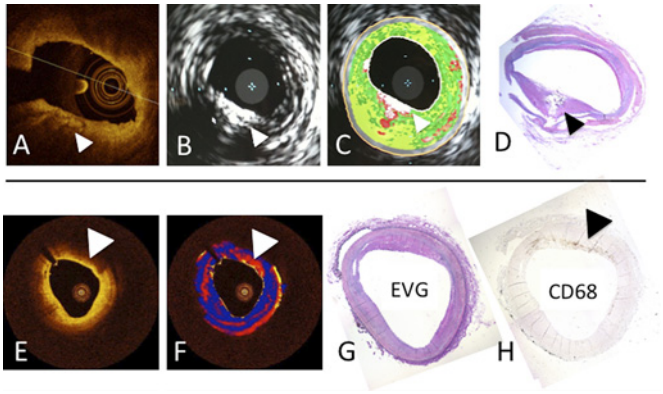
Background Intravascular imaging modalities are used clinically to investigate ambiguous angiographic coronary lesions, guide and optimise stent deployment, and assess stent-related complications. Both intravascular ultrasound (IVUS) and optical coherence tomography (OCT) facilitate characterisation of plaque components, although a lack of adequate spatial resolution and depth of penetration, respectively, limit their clinical application. Adaptation of the existing technologies and novel techniques are in development but require further validation. We have developed an ex-vivo whole heart cadaveric model that facilitates multi-modality imaging and accurate comparison with histology.
Methods We have developed a model for fluoroscopic and invasive assessment of coronary arteries within "whole heart" cadaveric specimens. Hearts are provided by the West of England heart valve bio-bank, following harvesting of valves for homograft production. The coronary ostium is dissected and mobilised to allow cannulation with a modified 6F coronary guiding catheter (Abstract 023 figure 1A), secured with sutures. The cadaveric specimen is held within a purpose-built perspex container, with adaptors on both sides of the container's lid allowing connection of the guide catheter internally, and a Y-connector and pressure/injector manifold externally, see Abstract 023 figure 1 panel B. Cadaveric specimens undergo angiography (see Abstract 023 figure 1C,D), placement of a 0.014″ guide wire and imaging catheter manipulation with the artery held at physiological temperature and pressure. In collaboration with the Department of Bioengineering, Erasmus MC, Rotterdam, we are using this model for assessment and validation of optical attenuation analysis as a tool to accurately delineate areas of macrophage infiltration, a major marker of plaque vulnerability. Optical attenuation governs the signal drop-off associated with tissue penetration. It is derived by fitting the following functional relation to the OCT data, $I(z) = I_o \exp(-\mu_t z)$, where $\mu_t(z)$ is the local optical attenuation, the parameter of interest. The local signal intensity, I_o, is also a free parameter in the fit, but is currently not analysed. The data are fitted in windows of 200 μm length, after appropriate processing to reduce speckle noise.



Abstract 023 Figure 1

Results Comparison of OCT, IVUS, and VH-IVUS against histology confirm the challenges in characterising plaque (Abstract 023 figure 2A–D: arrows indicate calcium). Analysis of optical attenuation appears to correlate with areas of macrophage infiltration (arrows in Abstract 023 figure 2E–H).
Conclusions Our ex-vivo whole heart cadaveric model facilitates accurate comparison of imaging modalities against histology. Developments in the imaging technologies are necessary to facilitate plaque characterisation as a clinical application. Optical attenuation may offer additional information regarding the macrophage content and "vulnerability" of plaque, validation work using our cadaveric model is ongoing.



Abstract 023 Figure 2

024 VALIDATION OF TISSUE CHARACTERISATION AND VULNERABLE PLAQUE CLASSIFICATION USING VIRTUAL HISTOLOGY IVUS (VH-IVUS) AGAINST HUMAN POST-MORTEM HISTOLOGY

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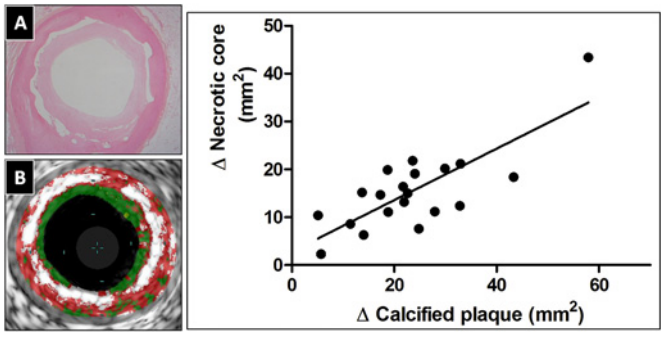
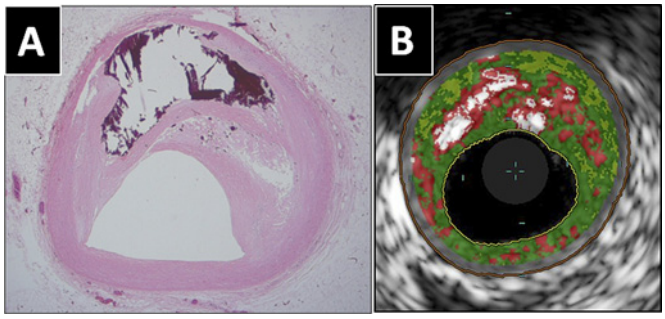
Introduction VH-IVUS is increasingly used in clinical trials to classify vulnerable thin-capped fibroatheroma (TCFA). However, VH-IVUS has not been validated for classifying coronary plaque against the gold standard of human post-mortem histology.

Methods Ten human coronary arteries were obtained at post-mortem. VH-IVUS examination was performed in a pressure-perfused system. The arteries were then fixed, stained and sectioned giving 72 co-registered 400 μm segments. Slides from each segment were examined by a histopathologist to determine the presence of calcification, necrotic core and to classify any plaque present. A fibroatheroma was considered a TCFA if fibrous cap thickness was <65 μm. VH-IVUS analysis was performed on each segment to compare tissue characterisation and plaque classification by an operator blinded to the histology. To explore a possible link between VH-IVUS detection of calcification and necrotic core artefact we also performed VH-IVUS of coronary segments in 20 patients pre- and immediately post-stenting to determine if there was a relationship between increasing calcium (simulated by stent struts) and necrotic core.

Results VH-IVUS was excellent at determining the presence of atherosclerotic plaque (sensitivity-100%, specificity-93%) and calcification (sensitivity-96%, specificity-90%) (Abstract 024 figure 1). Necrotic core was detected with a sensitivity of 100% but a specificity of 40%. For classification of a fibroatheroma by VH-IVUS (confluent NC >10% of plaque area for three consecutive frames) sensitivity was 87% and specificity-74%. Of the 24 segments wrongly attributed to contain necrotic core by VH-IVUS, 92% also contained calcium (67% contained >10% calcium). Stent struts are mistaken by VH-IVUS as calcification, surrounded by necrotic core not present on histology (Abstract 024 figure 2). Analysis of arterial segments pre- and post-stenting showed a linear correlation between increasing calcium (stent struts) with increases in necrotic core (r^2=0.61) suggesting some necrotic core surrounding calcium maybe artefact. VH-IVUS distinguished TCFA (fibroatheroma with core in contact with lumen) with sensitivity-71% and specificity-74%. As 65 μm is beyond the spatial resolution of VH-IVUS we repeated the analysis with caps <200 μm considered thin and the sensitivity of VH-IVUS to detect TCFA rose to 80%, specificity-76% (Abstract 024 table 1).



Abstract 024 Figure 1 (A) Post-mortem histology demonstrating presence of calcification and necrotic core with co-registered VH-IVUS (B) (necrotic core = red, calcium = white).



Abstract 024 Figure 2 Left : (A) Post-mortem histology demonstrated coronary segment with stent struts but no significant necrotic core. (B) Co-registered VH-IVUS image showing stent struts mistaken for calcium with necrotic core artefact. Right: Linear correlation between increase in calcified plaque and increase in necrotic core in coronary segments pre- and post-stenting.

Abstract 024 Table 1

Histology defined plaque	Correctly classified by VH-IVUS
All Fibroatheroma	26/30 (87%)
Calcified Fibroatheroma	18/26 (69%)
Fibrocalcific	9/24 (38%)
All TCFA (cap <65 μm)	5/7 (71%)
Calcified TCFA (cap <65 μm)	3/6 (50%)
All TCFA (cap <200 μm)	8/10 (80%)

Conclusion In comparison with histology, VH-IVUS reliably discriminated calcified plaque and detected necrotic core (classifying fibroatheromas) with good sensitivity. However, the specificity to detect necrotic core dropped in the presence of dense calcification due to necrotic core artefact. The sensitivity and specificity to detect TCFA was also limited by VH-IVUS spatial resolution.

025 FEASIBILITY OF COMBINED CARDIOVASCULAR MRI AND PERCUTANEOUS CORONARY INTERVENTION IN A HYBRID LABORATORY

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Background The relationship between anatomy and associated pathophysiology in coronary artery disease (CAD) is complex and