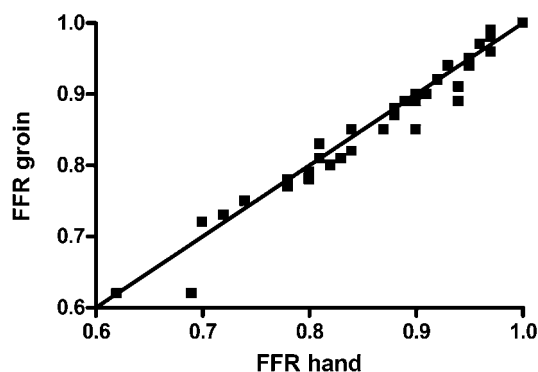
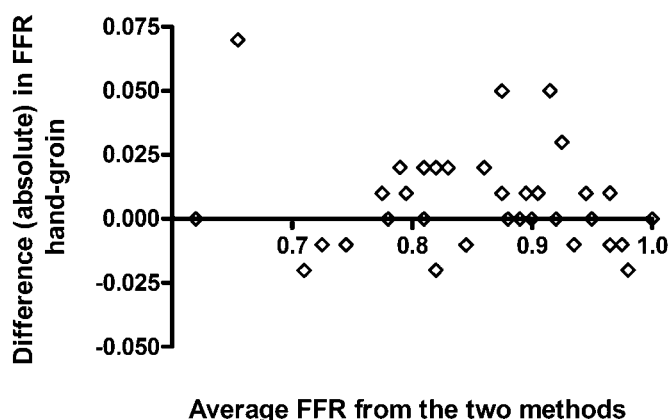


figures 1 and 2 below. Abstract 020 figure 1 shows FFR using hand vein for adenosine vs FFR using femoral (groin) vein for adenosine—paired data are shown as (x, y) points. The line of unity is shown for a theoretical perfect agreement between the measures. Abstract 020 figure 2 shows a Bland Altman plot of FFR derived from hand vs groin adenosine infusions.



Abstract 020 Figure 1



Abstract 020 Figure 2

The mean difference between the two measures of FFR was 0.007 with a SD of 0.020. The 95% limit of agreement extended from  $-0.031$  to  $+0.046$ . Using a threshold for ischaemia of  $\text{FFR} \leq 0.75$ , there were no cases in which use of hand vein adenosine would have misclassified a lesion compared to the “gold standard” central vein adenosine. Using a threshold for ischaemia of  $\text{FFR} \leq 0.80$ , there was one case which would have been classified differently. Time to maximal hyperaemia was significantly greater with hand vein adenosine infusion. ( $75.7 \pm 32.8$  s vs  $40.5 \pm 10.3$  s,  $p < 0.001$  on t test). **Conclusion** The use of hand vein adenosine infusion produced very similar values of minimum FFR to those using femoral vein adenosine. These data have important practical implications for patients undergoing transradial procedures who require FFR assessment.

## 021 COMPUTER MODELLED CORONARY PHYSIOLOGY AND “VIRTUAL” FRACTIONAL FLOW RESERVE FROM ROTATIONAL ANGIOGRAPHY

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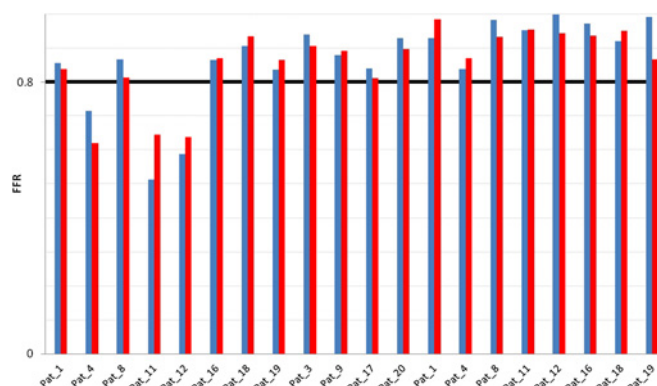
**Background** Percutaneous coronary intervention (PCI) guided by fractional flow reserve (FFR) measurement is superior to visual angiographic assessment alone. We have developed a workflow that

takes a single rotational angiogram (RoCA), reconstructs the 3-dimensional arterial tree and applies computational fluid dynamics (CFD) to calculate the FFR without the need to induce hyperaemia or perform invasive pressure measurements.

**Methods** 20 patients, scheduled for elective PCI underwent RoCA. The FFR was measured with a Combewire (Volcano), under resting and hyperaemic conditions. Physiologically significant lesions were stented and the measurements repeated. The arterial anatomy was reconstructed on a Philips 3DCA workstation. Generic boundary conditions for CFD were derived from the measured data. The calculated (“virtual”) and measured FFR values were then compared.

**Results** There were 11 right coronary artery (RCA) cases (6 stented) and 12 left coronary artery (LCA) cases (8 stented). The anatomy was reconstructed, and the FFR computed in each case (pre- and post-stenting). The CFD model accurately predicted which lesions were physiologically significant ( $\text{FFR} < 0.8$ ) and which were not ( $\text{FFR} > 0.8$ ) in all cases. The virtual FFR values deviated from the measured by  $\pm 6\%$  ( $\text{SD} = 6\%$ ) for both RCA and LCA cases.

**Conclusion** We have developed a novel, user-friendly workflow, which has the potential to predict FFR without the need for invasive measurements or inducing hyperaemic conditions. Our model identified lesions requiring intervention in all cases. Further work will optimise and refine the model by better characterising the downstream generic boundary conditions. We aim to improve the accuracy of the optimised model with more complex patients and lesions.



Abstract 021 Figure 1 Graph demonstrates measured FFR (blue) vs calculated FFR (red) for LCA cases (8 pre- and post-stent cases and 4 non-stented cases).

## 022 DYNAMIC THREE-DIMENSIONAL WHOLE HEART MAGNETIC RESONANCE MYOCARDIAL PERFUSION IMAGING: VALIDATION AGAINST PRESSURE WIRE DERIVED FRACTIONAL FLOW RESERVE FOR THE DETECTION OF FLOW-LIMITING CORONARY HEART DISEASE

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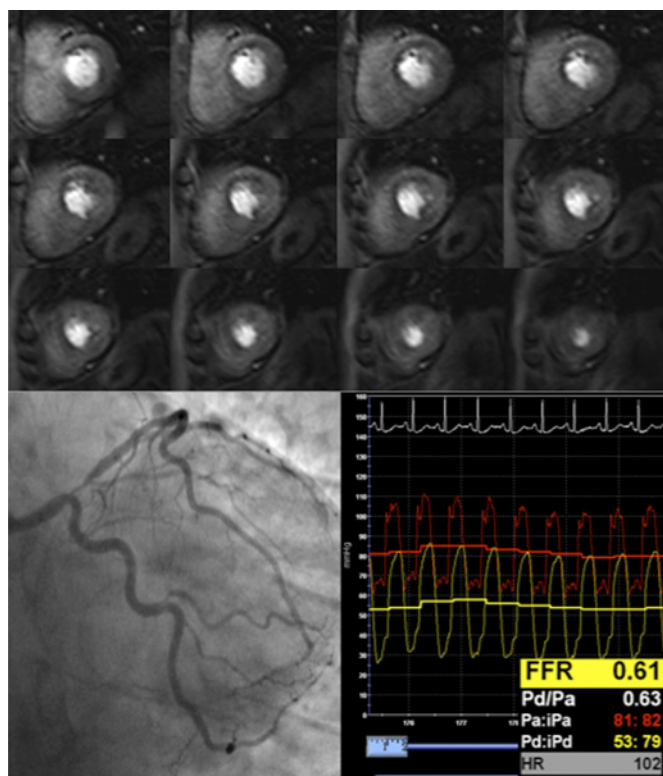
**Background** Three-dimensional (3D) myocardial perfusion cardiovascular magnetic resonance (CMR) has recently been proposed to overcome the limited spatial coverage of conventional perfusion CMR methods. The method has shown good diagnostic accuracy for the detection of coronary artery disease determined by quantitative coronary angiography. However the relationship between the severity of a coronary stenosis on quantitative coronary angiography and its functional significance is variable. Pressure wire-derived fractional flow reserve (FFR)  $< 0.75$  correlates closely with objective evidence of reversible ischaemia and it has been demonstrated that ischaemia-guided PCI confers a prognostic benefit.

**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  $2.3 \times 2.3 \text{ mm}^2$ , 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.

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

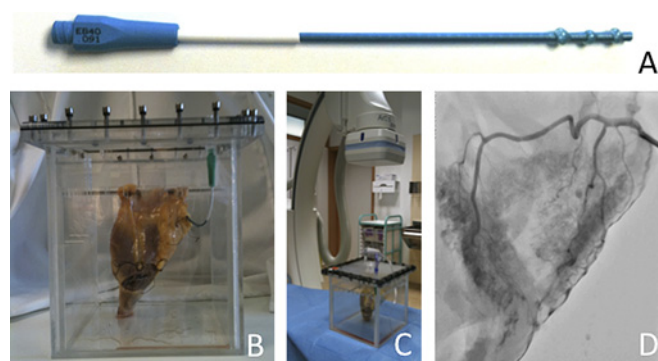
doi:10.1136/heartjnl-2012-301877b.23

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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,  $I(z) = I_0 \exp(-\mu_t z)$ , where  $\mu_t(z)$  is the local optical attenuation, the parameter of interest. The local signal intensity,  $I_0$ , is also a free parameter in the fit, but is currently not analysed. The data are fitted in windows of 200  $\mu\text{m}$  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.