T1 Mapping Detects Myocardial Oedema in a Rat Model of Myocardial Ischaemia

Other Conference Item

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Methods: CMR imaging was performed using a 1.5T GE Scanner with adenosine stress. Study endpoints included re-hospitalisation for chest pain, obstructive coronary artery disease on angiography, non-fatal myocardial infarction (MI) and cardiac death.
Results: Three hundred and seventeen patients (131 female, mean age 47 ± 6.8 years) were enrolled. All patients had suspected CAD and were deemed to be low-risk. All enrolled patients had a normal AP-CMR with no stress hypoperfusion, and no delayed enhancement demonstrated. Indications for CMR included exertional angina, equivocal exercise stress tests and syncope. On 12-month follow up, no patients achieved the measured endpoints. Notably, there was no MI or cardiac death. Additionally, AP-CMR had an excellent safety profile, with only three patients developing complications, all of which were minor and did not require specific treatment.
Conclusion: Our data support the utility of AP-CMR as a non-invasive tool in the investigation of CAD in low-risk patients. A normal AP-CMR predicts a very low adverse event rate and an excellent 12-month prognosis in patients with suspected CAD. AP-CMR may have a role in reducing the number of inappropriate coronary angiographies.

4. Hypertrophic Cardiomyopathy: Clinical and Imaging Characteristics of an Irish HCM Registry

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Background: Hypertrophic cardiomyopathy (HCM) is the most common inherited cardiac disorder and is the leading cause of sudden cardiac death (SCD) in the young. HCM is associated with significant heterogeneity in terms of phenotypic expression and clinical course, and clinical characteristics may differ among HCM populations internationally. It is important, therefore, to establish a registry to characterise the HCM population in Ireland.
We have previously presented data from a registry comprising 99 HCM patients (O'Connor, 2011). Here we present a comprehensive analysis of an expanded registry of 162 patients, describing patient demographics, risk factors for SCD, ICD discharge events, echocardiographic and cardiac MRI (CMR) characteristics.
Methods: Patients with HCM were identified in St Vincent's University and Private Hospitals, and Blackrock Clinic by review of patient records, CMR, echocardiogram, holter and ICD reports. Clinical details, symptom status, imaging indices and ICD data were recorded.
Results: 162 patients with HCM were identified. The majority (63.6 %) were male. Median age at registration was 59 years (range 17–90 years). Risk factors for SCD were prevalent: 39 patients (24.1 %) had documented non-sustained ventricular tachycardia (NSVT), 15 had history of syncope (9.3 %), 48 had family history of HCM (29.6 %), 33 had family history of SCD (20.4 %), 1 had an aborted SCD (0.6 %), 2 patients (1.2 %) had LV wall thickness of >30 mm, and 4 of 59 patients (6.8 %) who underwent exercise stress test had a hypotensive response to exercise.
Atrial fibrillation (AF) was documented in 56 patients (34.6 %). The prevalence of CVA and TIA was 6.8 and 4.9 %, respectively.
Symptom status was known for 126 patients. The majority (75.4 %) were NYHA Class I, 21.4 % were NYHA Class II and 3.2 % NYHA Class III. Chest pain, palpitations and pre-syncope were present in 25.4, 14, and 6.2 %, respectively.
47 patients (29 %) had ICDs in situ. Shocks were documented in 13 patients (27.7 %). 11 (84.6 %) had experienced an inappropriate shock, the main trigger for which was AF (63.6 %).
Echocardiogram reports were available for 127 patients. The average ejection fraction (EF) was 65.7 ± 0.91 %. Systolic anterior motion (SAM) of the mitral valve was documented in 28.3 % of cases. 29 patients (17.9 %) had LVOT outflow obstruction >30 mmHg. Average dimensions were as follows: left atrial diameter 44.1 ± 1.03 mm, LVEDD 47.34 ± 0.66 mm, LVESD 29.5 ± 0.64 mm, IVSD 18.48 ± 0.55 mm, posterior wall thickness 12.65 ± 0.45 mm.
93 patients underwent CMR. The presence and extent of myocardial fibrosis, as demonstrated by late gadolinium enhancement (LGE) had been shown to have prognostic significance in HCM (O'Hanlon et al.). Fibrosis was demonstrated in 63 patients (67.7 %), SAM in 25 cases (26.9 %) and right ventricular involvement in 7 cases (7.5 %). Average EF was 68.73 ± 1.22 %. Cardiac dimensions were as follows: Maximal wall thickness was 19.56 ± 0.66 mm, Anterior septal wall thickness 18.39 ± 0.86 mm, Posterior septal wall thickness 9.98 ± 1.06 mm, End diastolic 49.61 ± 1.02 mm, End systolic dimension 28.86 ± 1.05 mm, Left atrial diameter 38.9 ± 1.2 mm.
Asymmetric septal HCM was the most common morphological variant. Apical-variant HCM was present in 19 patients (20 %), a higher proportion than reported in other Western cohorts.
Conclusion: These data expand significantly on the initial report from this registry, providing comprehensive baseline characteristics for the Irish HCM cohort. Important findings include the high prevalence of AF and CVA, and the high proportions of patients with myocardial fibrosis, SAM and apical-variant HCM. To our knowledge this is the largest cohort of patients with HCM in Ireland, and the continued expansion of this registry with regular reporting of data will provide a valuable means by which to document, analyse, and prospectively evaluate the characteristics and outcomes of the HCM population in Ireland.

5. T1 Mapping Detects Myocardial Oedema in a Rat Model of Myocardial Ischaemia

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Purpose: Ischemic cell death is characterized by cellular oedema. Cardiovascular magnetic resonance (CMR) can be used to detect oedema using T2 weighted imaging, but this technique has a number of technical limitations. T1 mapping is a quantitative measurement which car directly reflects the amount water in a tissue. Changes in T1 reflect changes in tissue composition. Our aim was to study the development of oedema in a small animal model of myocardial Ischemia.
Methods: Rats (n = 8) underwent coronary occlusion for 30 min followed by 60 min of reperfusion to delineate the time course of development of changes in non-contrast T1 abnormalities. T1 was quantified by 3.0 T CMR (Phillips) using a Small Animal Look-Locker Inversion Recovery (SALLI) sequence. T1 was quantified over time starting from baseline prior to occlusion in the remote zone and in the area at risk.
Following the experiment the hearts were removed. The coronary artery was reoccluded to allow delineation of the area at risk with evans blue, then stained using triphenyltetrazolium chloride (TTC). This defined 1-Area at Risk, 2-Infarction [white], 3-Salvaged myocardium [stained red from TTC], and 4-Remote [Stained blue].
Results: On coronary occlusion all rats developed myocardial ischemia initially confirmed by ECG changes and ventricular arrhythmia. Fatal arrhythmia occurred in 2 Rats.
During occlusion T1 increased in the area at risk ($p < 0.001$). This increase was noted within the first 10 min of coronary occlusion and

remained unchanged during the 30 min period of ischemia ($p = 0.74$) and following reperfusion at 30 ($p = 0.83$) and 60 min ($p = 0.81$).
Conclusions: During coronary occlusion, T1 increases in the area at risk consistent with the formation of ischemia. This change is noticeable with 10 min of coronary occlusion. T1 mapping is a robust quantitative method to detect the effects of myocardial ischemia.

6. Clinical Outcomes of Patients with Low-Flow, Low Gradient Severe Aortic Stenosis and Either Preserved or Reduced Ejection Fraction Undergoing TAVR

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Objectives: We aimed to assess the safety and efficacy of transcatheter aortic valve implantation (TAVI) among patients presenting with paradoxical low-flow, low-gradient, severe aortic stenosis (AS) (PLFAS) and classical low-flow, low-gradient severe AS (LFLG).
Background: The clinical outcomes of patients presenting with low-gradient severe AS undergoing TAVI are unclear.
Methods: Of 533 symptomatic patients undergoing TAVI, 385 had a full pre-procedural right and left heart catheterization. 208 patients had high-gradient AS (HGAS; mean gradient [MG] ≥40 mmHg), 85 had PLFAS (MG ≤40 mmHg, indexed aortic valve area [iAVA] ≤0.6 cm^2 m^{-2}, stroke volume index ≤35 ml/m^2, ejection fraction (EF) ≥50 %) and 61 had LFLG (MG ≤40 mmHg, iAVA ≤0.6 cm^2 m^{-2}, EF ≤40 %).
Results: Compared with HGAS, PLFAS and LFLG had higher systemic vascular resistances (HGAS: 1912 ± 654 vs PLFAS: 2006 ± 586 vs LFLG: 2216 ± 765 dyne s cm^{-5}, $p = 0.007$) but lower valvulo-arterial impedances (HGAS: 7.8 ± 2.7 vs PLFAS: 6.9 ± 1.9 vs LFLG: 7.7 ± 2.5 mmHg mL^{-1} m^{-2}, $p = 0.027$). At 30-days, no differences in cardiac death (6.5 vs 4.9 vs 6.6 %, $p = 0.90$) or death (8.4 vs 6.1 vs 6.6 %, $p = 0.88$) were observed among HGAS, PLFAS and LFLG groups, respectively. At 1-year, New York Heart Association functional improvement occurred in most surviving patients (HGAS: 69.2 % vs PLFAS: 71.7 % vs LFLG: 89.3 %, $p = 0.09$) and no significant differences in overall mortality were observed (17.6 %, vs 20.5 %, vs 24.5 %, $p = 0.67$). Compared with HGAS, LFLG had a higher 1-year cardiac mortality (adj hazard ratio 2.45, 95 % confidence interval 1.04–5.75, $p = 0.04$).
Conclusions: TAVI in PLFAS or LFLG patients is associated with clinical outcomes comparable with HGAS patients and all groups profit symptomatically to a similar extent.

10.30–11.00 **Poster Presentation Coffee/Exhibition**

7. In-Vivo Study of Myocardial Metabolic Changes in a Rat Model

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Background: Hyperpolarized 13C-labeled tracers offer the first method to measure cardiac substrate metabolism in real time and in vivo (1). Understanding the metabolic changes that occur in myocardial ischemia could help in diagnosis and treatment. Our aim was to study if the regional metabolic changes that occur following coronary occlusion were detectable in a small-animal model.
Methods: Myocardial metabolism was studied with MRS using Rats ($n = 6$) who were injected with 2 ml of 90 mM hyperpolarized [1-13C] pyruvate over 7 s via a tail vein before and after coronary occlusion. The left coronary artery was occluded for 30 min for create myocardial ischemia followed by reperfusion using a closed chest method (2). Scanning was performed using a horizontal bore 9.4T Bruker Biospec system with a 13C/1H radiofrequency (RF) volume coil and a 13C receive surface coil placed over the heart. ECG, respiration rate, and body temperature were monitored throughout the experiment. Anatomical images were acquired prior to 13C-imaging for spatial localization of the heart and correct coil positioning. To investigate the metabolic changes in ischemia, hyperpolarized (13) C-labelled pyruvate was injected prior to coronary occlusion, following reopening of the coronary artery. The dynamic time series were acquired by collecting 13C spectra prior to each injection of hyperpolarized [1-13C] pyruvate. The MRS-images with hyperpolarised [1-13C] pyruvate were acquired in a short-axis view of the heart using a cardiac- and respiratory-gated CSI pulse sequence. [1-13C] pyruvate was hyperpolarized using a custom built DNP system. Following the experiment the hearts were removed. The coronary artery was re-occluded to allow delineation of the area at risk and staining for myocardial infarction. This was then correlated with the metabolic maps.
Results: Before infarction, a uniform and myocardium specific distribution of the lactate and alanine signal was detected in the metabolite maps over the anterior wall of the left ventricle. After ischemia the signal from alanine, and bicarbonate was reduced, with an increase in lactate, whereas, in the region not affected by infarction, the signal levels were comparable to the levels before coronary occlusion.
Conclusion: This study demonstrates that hyperpolarized 13C MRS can be used to visualize regional changes in cardiac metabolism in rats after myocardial infarction. This method holds promise for the investigation of ischemic heart disease, and may provide a role in guiding future therapies.

8. Significant Radiation Dose Reductions in Advanced Cardiac CT Imaging—Are We Keeping Up with the Guidelines. Our Experience with Ireland's Only 320 Slice

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Introduction: We report our experience with Irelands first and only 320 Slice Multi Detector Row scanner in Advanced CT Coronary Angiography (CTCA).
CTCA is increasingly used in the non-invasive assessment of patients with suspected coronary artery disease and low to intermediate Framingham risk of CAD. It is possible to achieve significant dose reductions with careful adjustment of several scanning parameters. We report our experience of significant dose reductions with currently available CT technology and discuss possible future areas of study and quality improvement in Cardiac CT Angiography.
Methods: Prospective unselected enrolment of 100 patients attending for routine scanning for first assessment of significant coronary stenosis for Calcium scoring & CTCA. Small FOV, 85 kV, Dynamically triggered volume acquisition, prospectively gated CT data acquisition protocol in one single heart beat.
Results: (N = 100) Average(±)SD:
Age 56 yr(±)9, HR 56 bpm, KV:85(±)9 Average total body dose (1.71 mSv(±) 0.26, min 0.7, max 2.7. (mA)69(±)30.