S11

Trends in Clinical Cardiovascular Magnetic Resonance (CMR) Utilization

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Background: Cardiovascular magnetic resonance (CMR) imaging has emerged in the past decade as a non-invasive imaging modality capable of providing high resolution cardiac images. New techniques including routine use of Gadolinium administration along with delayed enhancement provide unique information for accurate tissue characterization especially for ischemic and non-ischemic cardiomyopathies.

Purpose: To record CMR use over a period of 8 years and characterize trends in CMR utilization.

Subjects and methods: Retrospective analysis of a prospectively maintained database was performed. Data regarding patients scanned between January 2003 and October 2011 was queried for patient demographics and scan indications.

Results: A total of 3557 patients (61% males) were scanned. Scans performed increased significantly over the 8 year period in the following manner: 11 scans (2003), 177 scans (2004), 309 scans (2005), 428 scans (2006) 435 scans (2007) 455 scans (2008), 611 scans (2009), 646 scans (2010), 552 scans (Jan-Oct 2011). The main indications and their percent change from 2004 and 2011 were as follows: tumor evaluation (from 9% in 2004 to 6% in 2011), RVD (from 1% to 10%), myocarditis (from 2% to 11%), cardiomyopathy (from 3% to 20%), STEMI (from 0% to 7%), Stress CMR (from 0% to1.4%), T2*for cardiac iron overload (from 0% to 7%), MR angiography (from 70% to 27%).

Conclusions: A substantial increase in CMR scans performed for all indications occurred during the 8 year period. Analyzing the trends in CMR utilization demonstrates a significant increase in the percent of CMR studies performed for cardiomyopathy, myocarditis and STEMI evaluation. This trend affirms the increasing acceptability of CMR as an imaging modality in the cardiology arsenal.

Three Dimensional Fly-Through Characterizes Coronary Ostia in Patients with Coronary Anomalies

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Introduction: Anomalous origin of the right or left coronary artery (AORCA or AOLCA) from the contralateral sinus of Valsalva is a congenital heart defect associated with exercise-induced ischemia and sudden death. This has been thought to be due to aortic enlargement in patients with an elliptical ostium. Hypothesis Fly-Through (FT) analysis in Cardiac Magnetic Resonance (CMR) characterizes abnormal coronary ostial morphology in patients with AORCA and AOLCA from the contralateral sinus of Valsalva.
Methods: We retrospectively analyzed 56 consecutive CMR coronary studies (mean age 11.6 ± 4.6 years) from January 2006 to January 2010 with the diagnosis of AORCA (n=20), AOLCA (n=7), or normal coronary origins (n=28). One postmortem heart specimen with AOLCA was imaged and analyzed with FT to validate our technique. FT analysis was used for visualization and measurement of the coronary ostia, and localization relative to the intercoronary commisure (ICC).
Results: Distinct aortic origins of the RCA and LCA were seen in all 56 studies. An elliptical orifice with a longer superior-inferior dimension was seen in all AORCA and AOLCA ostia, in contrast to the circular origin in all normal coronary origins. This was quantified in AORCA and AOLCA ostia with a long to short axis ratio of 2.5 ±0.4 compared to 1.06 ± 0.26 in controls ($p<0.001$). The locations of the ostia in AORCA and AOLCA were also significantly closer to the ICC, with the ratio of the ostial-ICC angle to the ICC-neighboring non-coronary commissural angle of 0.09 ± 0.07, compared to 0.54 ± 0.10 in controls ($p<0.001$) (A ratio of 0.5 indicates that the ostium is in the center of the sinus). Ostial morphology was confirmed in all nine patients who underwent operative repair and one patient at autopsy (Figure).
Conclusions: FT in coronary CMR identified abnormal ostial morphology and location in AORCA and AOLCA. This may be important in stratifying a patient’s risk for sudden death.

<IMAGE03>

Can CT Coronary Angiography (CTCA) be Used as a Non-Invasive Estimate of SYNTAX Score?

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The SYNTAX score is used for evaluation of patients with complex coronary artery disease undergoing revascularisation. It is usually calculated off-line, meaning that in suitable patients, PCI is performed at a later date. The ability to non-invasively estimate SYNTAX score would allow the heart team to recommend optimal treatment prior to invasive coronary angiography (ICA), thus enabling the diagnostic and therapeutic procedure to be performed at the same session. We aimed to test the agreement between CTCA and ICA in patients who had undergone both procedures within a 2 month period and had at least one significant stenosis by ICA.
Methods: CT scans were performed on a 64S scanner. SYNTAX score was independently and blindly calculated by 2 experienced readers of CCTA and 2 invasive cardiologists in 104 patients, age 57±10, with significant (>50%) stenoses in 1.7±0.7 vessels. Calcium score averaged 597±727 Agatston units.
Results: Agreement between ICA and CCTA for conventional vessel based analysis (presence of >50% stenosis per vessel) was good with kappa 0.66 and accuracy 83%. The mean SYNTAX score was 14.1±10.0 by ICA and 10.2±6.8 by CTCA, with a significant underestimation of 3.9 by CCTA ($p<0.001$). Weighted kappa was 0.33, indicating only fair agreement. If only good quality CCTA's were used, kappa improved to 0.56. Analysis of the cause of the bias showed ICA to identify more lesions per patient (2.2±1.3 vs. 1.7±1.0, $p<0.001$), while the mean score per lesion was not different (6.4 vs. 5.9, p=ns). Regarding various components of the SYNTAX score, CCTA identified 12/24 occlusions (kappa 0.6); agreement for calcified lesions was fair (kappa 0.36), while agreement regarding bifurcation lesions and long lesions was poor.
In summary, CCTA, despite having a good agreement in conventional vessel based analysis, showed only a fair agreement for the calculation of SYNTAX score, and cannot be currently used as a substitute for diagnostic ICA for this purpose.

Automatic Detection of Myocardial Perfusion Defects in Patients Undergoing 256-Row Coronary CTA

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Background: 256-row coronary CT angiography (CCTA) has the potential to assess both coronary anatomy and myocardial perfusion. We studied the ability of a fully automatic tool to detect CCTA myocardial perfusion defects (MPD) compared to a reference standard of Tc99m SPECT perfusion imaging.

Methods: 68 pts with suspected or known CAD (age: 63±11 yrs, 24% female) were evaluated by both CCTA and SPECT. MPD on CCTA was automatically computed and presented as a defect probability map (CTDP)(Philips). CTDP is based on probabilistic tissue modeling, where each pixel is classified according to its maximum a-posteriori probability to belong to a normal or abnormal myocardium. SPECT uptake was graded from 0 (normal) to 4 (no uptake) on the resting images. Performance of CTDP to detect moderate-severe SPECT-MPD (grade ≥2) at rest was analyzed on a pt and vessel territory based analysis.

Results: Amongst 35 SPECT positive vessel territories CTDP correctly identified 31 (89%), and amongst 169 SPECT negative territories CTDP correctly identified 144 (85%). Amongst 28 positive SPECT pts CTDP correctly identified 25 (89%), and amongst 40 SPECT negative pts CTDP correctly identified 24 (60%) (Table).

Conclusions: In this preliminary study of automatic analysis of MPD: 1.CTDP showed high sensitivity and NPV but moderate specificity and PPV to detect SPECT-MPD at rest. 2. CTDP may forewarn the examiner of a possible MPD and due to its high NPV may indicate a low probability of significant rest MPD's in pts undergoing 256-row CCTA.

Parameter	Vessel territory based analysis (95% CI) (N=204)	Patient based analysis (95% CI) (N=68)
Sensitivity	89% (78-99)	89% (78-100)
Specificity	85% (80-91)	60% (45-75)
Negative predictive value	97% (96-100)	89% (77-100)
Positive predictive value	55% (42-68)	61% (46-76)
Predictive accuracy	86% (81-91)	72% (61-83)

Half-Dose Tc99 Sestamibi Stress Myocardial Perfusion Is as Accurate as Full Dose Scan

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Background: Recently, iterative image reconstruction software (evolution for cardiac, GE) has allowed to obtain equivalent image quality with half dose (HD) TC99 Sestamibi while performing stress myocardial perfusion imaging (MPI) as compared to full dose (FD) myocardial perfusion imaging (MPI). However angiographic correlation has not been explored so far.
Objective: To compare sensitivity and specificity between patients undergoing stress HD MPI as compared to FD MPI and invasive angiography within 60 days.
Methods: 37 patients (Age 64.4±4 years, 59.5% men, BMI 28.1±6.6 kg/m2, known CAD 46%) underwent stress-rest HDMPI and 20 patients (Age 63.3±4 years 85% men, BMI 26.9±4.7, known CAD 50%) FD MPI during the same period. All patients underwent invasive coronary angiography within 60 days.
Results: Mean administered and effective radiation dose were 20. 6±10.8 mCi and 6.2±3.2 mSv for the HD MPI as compared to 38.7±13.1 mCi and 11.6±3.9 mSv for the FD MPI group ($p<0.0001$). Sensitivity, specificity, positive and negative predictive value were 89%, 63%, 89%, 63% for the HD MPI and 81% 75% 92% 50% for the FD MPI group (p= NS , respectively).
Conclusion: Preliminary results suggest HD MPI is equally sensitive and specific as compared to FD MPI to predict obstructive coronary disease. Larger patient population is still warranted to perform HD MPI as a routine protocol.

MRI TAG Line Can Help Demonstrate Pericardial Adhesion in Constrictive Pericarditis

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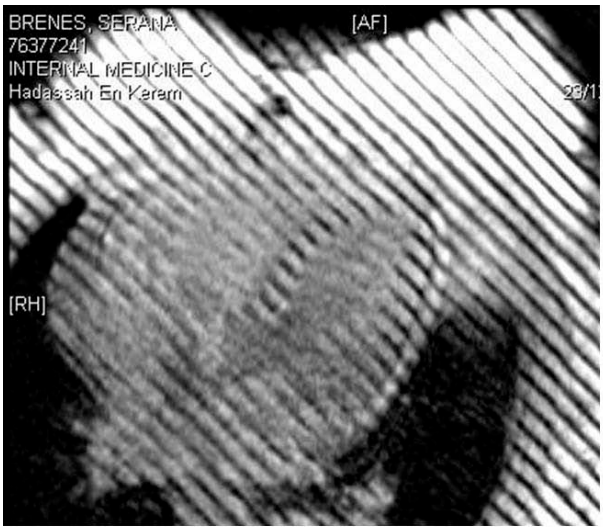

The diagnosis of constrictive pericarditis is often very challenging, raising the need for new novel methods to diagnose this entity. Clinical evaluation combined with cardiac imaging and hemodynamic studies are used to help making final diagnosis. MRI is an excellent tool to demonstrate pericardial thickening the imaging equivalents of constrition. Tissue tagging is an MRI technique in which parallel lines of reduced signal are generated. These can be followed up during cardiac cycle. MR tagging has been suggested as a tool for demonstrating fibrotic adhesions between the visceral and parietal pericardial layers. Persistence of the pericardial TAG lines throughout the cardiac cycle can only occur if there is fusion of the pericardial layers.
In our institution we are using tagging as in all suspected contrition cases referred for cardiac MRI. In this work we present our first experience with tagging for the diagnosis of contrition. The existence of adhesions by tagging is in correlation with pericardial width, mitral valve restrictive inflow velocities, septal motion abnormality and dilatation of the inferior vena cava. Of the 3 patients with positive tagging who underwent surgical procedure, all were found to have constriction during operation.
These preliminary findings indicate that TAG may serve as another tool to demonstrate constrictive physiology using cardiac MRI. Further studies are needed to test the sensitivity and specificity of TAGing for constrictive pericarditis.