RSNA 2017 Explore. Invent. Transform.
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Explore Invent Transform

SSQ03

Cardiac (MRI)

Thursday, Nov. 30 10:30AM - 12:00PM Room: S504AB

CA MR

AMA PRA Category 1 Credits ™: 1.50
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

Participants

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Pamela K. Woodard, MD, Saint Louis, MO (*Moderator*) Research agreement, Siemens AG; Research, Eli Lilly and Company; Research, F. Hoffmann-La Roche Ltd; ; ; ; ;
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Sub-Events

SSQ03-01 Multicenter Study Comparing PSIR Motion Correction Late Gadolinium Enhancement Sequence with TurboFLASH and TrueFISP Late Gadolinium Enhancement Sequences

Thursday, Nov. 30 10:30AM - 10:40AM Room: S504AB

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PURPOSE

The Phase-Sensitive Inversion Recovery with Motion Correction (PSIRMoCo) is an improved single-shot rapid LGE sequence, which has higher spatial resolution compared to the traditional TrueFISP sequence and shorten acquisition time compared to the TurboFLASH sequence. This study aims to investigate a PSIRMoCo prototype against TurboFLASH and TrueFISP in terms of acquisition time and image quality.

METHOD AND MATERIALS

Inclusion criteria was patients/volunteers undergoing LGE CMR. Exclusion criteria was patients who did not have late gadolinium enhancement images. A total of 70 subjects (70% male, 17% had arrhythmia, 2% were poor breath-holders) were recruited in two hospitals. Patients were recruited consecutively for a 6-month period. Data was all acquired on 1.5T MAGNETOM Avanto scanner (Siemens Healthcare, Erlangen, Germany). MRI TurboFLASH images were acquired first at 8 minutes post contrast injection followed by the PSIRMoCo sequence and the TrueFISP PSIR sequence. Images with poor contrast differentiation between the myocardium and blood pool were excluded from the analysis. Acquisition time was measured based on the timings from the MRI times stated on the images. Image quality was assessed by 2 doctors separately without access to the image information, using a 4-point Likert scale (4 for the best, 1 for the worst). A P-value<0.05 was regarded as statistically significant. ANOVA, Kruskal-Wallis H test and Mann-Whitney U test were used for comparing the three groups.

RESULTS

The total scan times for PSIRMoCo, TurboFLASH and TrueFISP were 187±43 sec, 636±144 sec, and 164±37sec, respectively (p<0.001). There was no statistically significant difference in scan time between PSIR MoCo and TrueFISP. Image quality scores of the three groups were 3.8±0.26, 3.3±0.47, and 3.5±0.31, respectively (p=0.0001). Separately, PSIRMoCo showed a statistically higher image quality score compared to TurboFLASH (p<0.0001) and TrueFISP (p=0.008).

CONCLUSION

PSIR MoCo shows statistically significant time saving compared to TurboFLASH and better image quality compared to TurboFLASH and TrueFISP.

CLINICAL RELEVANCE/APPLICATION

PSIR MoCo should be considered for routine use instead of TurboFLASH as it saves approximately just under 8 minutes in scan time with improved image quality.

SSQ03-02 Detection of Patients with High-Risk Coronary Artery Disease Using Coronary Flow Velocity Reserve:

3T-MRI Fast Velocity-Encoded Cine Study

Thursday, Nov. 30 10:40AM - 10:50AM Room: S504AB

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PURPOSE

We previously developed a method to measure coronary flow velocity reserve (CFVR) in the left main trunk (LM) during stress (ATP (0.16mg/kg/min)) and at rest non-invasively mainly using healthy volunteers. The purpose of this current study is to evaluate the method's diagnostic value in detecting patients with high-risk coronary artery disease (CAD).

METHOD AND MATERIALS

Fifty-nine patients with suspected CAD (age; 67 ± 11 yr, male; n = 36) who underwent 3.0-tesla (T) magnetic resonance imaging (MRI) and angiography were studied. Coronary flow velocity in LM was measured with breath-hold velocity-encoded cine using 3.0-T MRI during ATP stress and at rest. CFVR was calculated by dividing peak-velocity during stress by that at rest. The extent and severity of angiographic disease of LM, left anterior descending artery (LAD), and left circumflex artery (LCx) were estimated with the use of the Leaman score (LS) which is able to stratify the risk of coronary artery using angiography.

RESULTS

Among the patients evaluated, 24 had 1-vessel disease (LAD (n = 17), LCx (n = 7)) and 18 patients had 2-vessel disease. Four patients had => 50% stenosis in LM. Fifty-one out of 59 patients showed low LS (0-10) and 8 had high LS (=>10.5 (equivalent to proximal LAD = 90-99%)). CFVR of CAD patients with high LS which means high-risk CAD was significantly lower than that of patients with low LS (1.57 ± 0.31 vs. 2.18 ± 0.73, $p < 0.05$) (Figure). In receiver operating characteristic (ROC) analysis of CFVR for detection of high-risk CAD patients, the area under the ROC curve was 0.79 ($p = 0.0296$). Sensitivity was 100% and specificity was 62.8% using a cutoff of 1.98 for detection of high-risk CAD patients.

CONCLUSION

Low CFVR in LM derived by velocity-encoded cine using 3.0-T MRI can predict downstream coronary atherosclerotic burden. This method is a simple and reliable index to detect patients with high-risk CAD without radiation exposure.

CLINICAL RELEVANCE/APPLICATION

Coronary flow velocity reserve measured using 3.0-T MRI is able to evaluate severity of coronary artery disease with high sensitivity.

SSQ03-03 Gadolinium-enhanced Cardiac MR Exams of Human Subjects are Associated with Significant Increases in the DNA Repair Marker 53BP1 but Not the Damage Marker γH2AX

Thursday, Nov. 30 10:50AM - 11:00AM Room: S504AB

Participants
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PURPOSE

To examine whether MR exams cause double-strand (ds) DNA damage by analyzing changes in the DNA damage and repair markers γH2AX and 53BP1 in patients who underwent a cardiac magnetic resonance (MR) exam.

METHOD AND MATERIALS

Our prospective study of outpatients scheduled for a 1.5 T gadolinium-enhanced cardiac MR exam was subject to Institutional Review Board approval. Patients with history of malignancy or who were receiving chemotherapy, radiation therapy, or steroids were excluded. MR sequence data were recorded for each patient. Blood samples were obtained from immediately before and after MR exposure. An automated immunofluorescence assay quantified γH2AX or 53BP1 foci number in isolated peripheral blood mononuclear cells. Changes in foci number were analyzed within patients using the Wilcoxon signed-rank test. Clinical and MR procedural characteristics were compared between patients who had a >10% increase in γH2AX or 53BP1 foci numbers and patients who did not.

RESULTS

Sixty patients (median age: 55 years, 39 males) were enrolled in our study. The number of γH2AX foci did not significantly change following cardiac MR (median foci per cell pre-MR=0.11, post-MR=0.11, p=.90), but the number of 53BP1 foci significantly increased following MR (median foci per cell pre-MR=0.46, post-MR=0.54, p=0.0140). Clinical and MR characteristics did not differ significantly between patients who had at least a 10% increase in foci per cell and those who did not.

CONCLUSION

MR exposure leads to a small (median 17%) increase in 53BP1 foci, suggesting increased DNA repair. Accordingly, a lack of increase in number of foci of the ds DNA damage marker γH2AX does not necessarily indicate an absence of DNA damage.

CLINICAL RELEVANCE/APPLICATION

1. Elevated DS DNA repair marker levels suggest that cardiac MR may cause DS DNA damage, and further study using both γH2AX and 53BP1 is necessary.

SSQ03-04 Detection of Myocardial Scar by Late Gadolinium Enhancement Cardiac MR using Gadoterate Meglumine

Thursday, Nov. 30 11:00AM - 11:10AM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

To compare the efficacy of late gadolinium enhancement cardiac MR (LGE-CMR) for myocardial scar detection between 2 macrocyclic GBCAs (gadoterate meglumine vs. gadobutrol).

METHOD AND MATERIALS

40 subjects (61±11 years, 67.5% men) who were referred for evaluation of cardiomyopathy with LGE-CMR performed using standard of care 0.2mmol/kg gadobutrol were recruited prospectively within an 8-week period for a research CMR scan using 0.2mmol/kg gadoterate meglumine. Both clinical and research CMR scans were performed at 1.5T. All subjects underwent a standard CMR protocol consisting of multiplanar cine steady state free precession (SSFP) and post contrast delayed enhanced PSIR SSFP and PSIR TurboFlash sequences. Myocardial scar quantification was performed on short-axis PSIR-TurboFlash images using commercially available software (Circle 5.3, Calgary, Canada) and myocardial scar percentage mass was calculated. Qualitative scar analysis was performed by 2 observers using the 16-segment AHA model and the area of scar per segment (0=none, 1=1-25%, 2=26-50%, 3=51-75%, 4=76-100% of the segment area) was scored. Segmental ratings were summed across all 16 segments to derive a global scar score for each scan. Reader confidence in visualizing the scar tissue for each agent was recorded on a 5-point scale (1=poor, 2=fair, 3=good, 4=very good, 5=excellent).

RESULTS

With PSIR SSFP technique, percentage myocardial scar mass averaged 5.9±9.8% and 5.2±7.2% for gadobutrol and gadoterate meglumine, respectively (p>0.05, ICC=0.89, 95% CI:0.78-0.94). With PSIR TurboFlash technique, percentage myocardial scar mass was 7.19±11 and 6.03±8.51 for gadobutrol and gadoterate meglumine, respectively (p>0.05, ICC=0.96, 95% CI:0.93-0.98). Global qualitative segmental LGE scores showed comparable scar detection using gadobutrol vs. gadoterate meglumine (5.3±7.5 vs. 5.4±7.2, p>0.05). Reader confidence for scar visualization was similar between gadobutrol and gadoterate meglumine (4.35±0.7 vs. 4.22±0.6, p>0.05).

CONCLUSION

Gadoterate meglumine is comparable to gadobutrol for identifying myocardial scar on LGE-CMR both qualitatively and quantitatively and can detect scar with a similar degree of diagnostic confidence as Gadobutrol.

CLINICAL RELEVANCE/APPLICATION

Gadoterate Meglumine, an alternative macrocyclic GBCA to the more routinely used Gadobutrol, has recently become available in the U.S. and may have comparable efficacy for detecting myocardial scar on routine LGE-CMR

SSQ03-05 Diffuse Myocardial Fibrosis in Diabetes Mellitus: Findings From t1 Mapping Imaging and Cardiac MRI Strain

Thursday, Nov. 30 11:10AM - 11:20AM Room: S504AB

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PURPOSE

To investigate diffuse myocardial fibrosis and the relationship between cardiac MRI strain in diabetes mellitus (DM) using T1 mapping and cardiac tissue tracking.

METHOD AND MATERIALS

Thirty-one patients with DM without impairment of renal function (Group1), 21 cases of DM with impairment of renal function (Group2) and 23 normal control individuals were enrolled. All patients underwent cardiovascular magnetic resonance (CMR), including cardiac cine sequence and T1 mapping MOLLI sequence. Cardiac function indexes, tissue tracking and T1 mapping were all measured by cvi42 and compared statistical. Pearson's correlation between the T1 mapping parameters and the left cardiac strain parameters were also investigated.

RESULTS

All the patients recruited finished CMR and the baseline characteristics were recorded. Group2 presented with higher pre-contrast T1 value than Group1 and control group (Group2: 1314.80±43.72ms; Group1: 1259.12±42.48ms; control group: 1264.25±47.45ms, both $P<0.05$). Regarding the post-contrast T1 value, lower post-contrast T1 value were observed in Group2 but the differences were not statistically significant (Group2: 490.25±58.59ms; Group1: 521.61±70.50ms; control group: 508.20±35.82ms, both $P>0.05$). Compared with control group, Group1 and Group2 had significantly higher ECV (Group1: 31.02±2.97ms; Group2: 34.09±4.23; control group: 27.39±2.40ms, both $P<0.05$). Negative correlation was showed between the circumferential peak diastolic strain rate and ECV in Group1 and Group2 ($r=-0.459$, $r=-0.459$, $P<0.05$).

CONCLUSION

T1 mapping is an alternative sequence for the evaluation of diffuse myocardial fibrosis in DM patients. Myocardial fibrosis is correlated with circumferential peak diastolic strain rate in DM patients.

CLINICAL RELEVANCE/APPLICATION

(dealing with T1 mapping imaging and cardiac MRI strain) ' T1 mapping is an alternative sequence for the evaluation of diffuse myocardial fibrosis in DM patients.'

SSQ03-06 Subclinical Left Ventricle Dysfunction in Diabetes Mellitus Patient: Assessed by Cardiac MRI Strain Analysis

Thursday, Nov. 30 11:20AM - 11:30AM Room: S504AB

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PURPOSE

Cardiovascular disease is the key cause of mortality of diabetes mellitus (DM), for which in-time detection of dysfunction and early intervention can significantly improve the prognosis. The aim of this study is to evaluate the subclinical left ventricle (LV) dysfunction in DM patient and whether the patient with good glycemic control have decreased cardiac function with time using cardiac magnetic resonance (CMR) strain analysis.

METHOD AND MATERIALS

In total, 23 DM patients with normal LVEF, including 13 patients diagnosed not more than 10 years and 10 patients diagnosed more than 10 years, and 25 healthy subjects, underwent CMR examination. LV global myocardial strain parameters including peak strain, peak systolic strain rate and peak diastolic strain rate, as well as global radial, circumferential and longitudinal analysis were calculated and compared among the three patient groups.

RESULTS

DM group had a significantly lower longitudinal peak strain (-15.32 ± 5.18 vs. -19.53 ± 2.76, $p=0.007$) and peak diastolic strain rate (1.22 ± 0.29 vs.1.50± 0.28, $p=0.000$), circumferential peak diastolic strain rate (1.20 ± 0.39 vs. 1.50 ± 0.26, $p=0.000$), and higher radial peak systolic strain (2.59 ± 0.81 vs. 2.0 ± 0.61, $p=0.033$) compared with the normal subjects. The DM patient diagnosed more than 10 years have lower peak systolic strain rate [radial (2.03 ± 0.52 vs. 2.61 ± 0.77, $p < 0.000$), circumferential (-0.89 ± 0.19 vs. -1.02 ± 0.20, $p < 0.000$) and longitudinal (-0.79 ± 0.11 vs. -0.97 ± 0.13, $p < 0.000$), respectively], lower radial peak strain (38.18 ± 9.89 vs. 43.47 ± 10.88, $p < 0.000$) and lower circumferential peak diastolic strain rate(1.01 ± 0.26 vs. 1.24 ± 0.21, $p = 0.004$) compared with diagnosed not more than 10 years.

CONCLUSION

Cardiac MRI strain is sensitive to early dysfunctional of heart, which might help with better management for the DM patients with

normal LVEF. Moreover, the cardiac function is gradually reduced with time, even though the blood glucose controlled well, especially the systolic function.

CLINICAL RELEVANCE/APPLICATION

Cardiac MRI strain is sensitive to early dysfunctional change of DM patients than traditional heart function evaluation parameters, which might help with better management for the DM patients with normal LVEF

SSQ03-07 Aortic Stiffness, Myocardial Fibrosis, Left Ventricular Strain and Epicardial Fat in Hypertension and Diabetes Mellitus

Thursday, Nov. 30 11:30AM - 11:40AM Room: S504AB

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PURPOSE

A combined assessment of aortic stiffness, left ventricular (LV) fibrosis, LV strain and epicardial fat volume (EFV) may decrease risk in patients with cardiovascular risk factors such as hypertension (HTN) or diabetes mellitus (DM). Using a MRI approach these parameters were assessed in 63 patients and related to the presence of HTN and DM.

METHOD AND MATERIALS

20 healthy controls (57.2±8.2years[y]; 26.2±3.9kg/m²), 31 hypertensive patients without DM (HTN-Pts; 59.6±6.7y; 28.4±4.7kg/m²) and 12 with DM (DM-Pts; 58.8±9.9y; 30.7±6.3kg/m²) were examined at 1.5Tesla. No patients had coronary artery disease; all patients had a normal LV ejection fraction. Aortic stiffness was evaluated by velocity encoded MRI to determine pulse wave velocity (PWV) of the aortic arch (Fig. A), EFV by a 3D-Dixon sequence with acquisition of fat-only images and fat-fraction maps (Fig. B&C), LV T1 relaxation times (T1) to detect fibrosis using a MOLLI scheme, and, longitudinal & circumferential systolic strain (LS; CS) by feature tracking software.

RESULTS

Age and gender did not differ significantly; BMI was higher in DM-PTs compared to controls. Results were adjusted for BMI. EFV was highest in DM-PTs followed by HTN-PTs and controls (EFV = 78.4±28.0 vs. 64.2±27.3 vs. 50.3±22.7ml/m²; $P<0.05$). T1 was higher in DM-PTs and HTN-PTs than in controls (T1 = 994.0±43.2 resp. 991.6±35.5 vs. 964.6±40.3ms; $P<0.05$). PWV was significantly higher in DM-PTs and LV strain lower compared to HTN-PTs and controls (PWV = 9.8±3.3 vs. 8.6±1.7 resp. 8.1±1.9m/s; LS = -20.9±5.1 vs. -24.7±4.6 resp. -25.5±3.8%; CS = -24.4±5.7 vs. -27.1±5.0 resp. -28.3±4.1%). Fig. D illustrates a healthy male with a lower T1 compared to a HTN-Pt (Fig. E) and Fig. F with a higher LS compared to a DM-PT.

CONCLUSION

Hypertension and diabetes mellitus are associated with LV fibrosis; cardiac remodeling as well as metabolic and inflammatory mechanisms of an increased EFV may play a role. EFV and aortic stiffness are further increased and LV strain reduced in DM-PTs possibly due to an increased metabolic and inflammatory burden associated with DM. A multi-parameteric assessment of these parameters can easily be integrated into a routine MRI exam and may be supportive for a more accurate cardiovascular risk evaluation.

CLINICAL RELEVANCE/APPLICATION

MRI is an accurate tool for evaluation of cardiovascular risk and prognostic parameters in patients with risk factors, such as hypertension or diabetes mellitus.

SSQ03-08 Strain of Ascending Aorta on Cardiac Magnetic Resonance in 1,027 Patients: Relation with Age, Gender, and Cardiovascular Disease

Thursday, Nov. 30 11:40AM - 11:50AM Room: S504AB

Participants
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PURPOSE

To evaluate aortic strain (AS) with cardiac magnetic resonance (CMR) in a large series of consecutive patients with different cardiovascular diseases (CVDs).

METHOD AND MATERIALS

Two-dimensional phase-contrast gradient-echo sequences of the ascending aorta were retrospectively selected in 1,027 patients (726 males, 301 females). In all images, aortic lumen area was segmented using a semi-automatic approach to calculate AS values. Subgroup analysis was performed for patient with normal CMR, Tetralogy of Fallot (ToF), and ischemic heart disease (IHD). Multivariate and post-hoc analyses were performed to evaluate the effect of age, gender and CVDs on AS values. In order to consider also the age factor, the subjects were grouped into 7 age bins of 10 years (0-9, 10-19, 20-29, 30-39, 40-49, 50-59 and >= 60 years).

RESULTS

Taking into account the whole sample, the AS resulted inversely correlated with age ($\rho = -0.51$, $P<.001$). Multivariate analysis showed significant differences in AS among decades of age ($P<.001$), genders ($P=.007$) and CVD subgroups ($P<.001$) without interaction among these factors. Post-hoc analysis showed significantly lower AS in ToF and IHD patients compared to subjects with normal CMR (P<.001). Gender-related differences were significant in ToF subjects ($P=.008$), in particular men with ToF showed a lower AS when compared with men with normal CMR ($P=.005$). In IHD patient, AS was lower compared to normal CMR subjects (men: $P<.001$, women: $P=.016$), without significant difference between genders ($P=.732$). Aortic strain reduction during aging was observed in all CVD groups.

CONCLUSION

Differences in age, gender, and CVD independently affect AS. The lower AS observed in ToF fosters its assessment during follow-up in adulthood. The gender-related difference gives the basis for future studies focused on its possible causes and clinical implications. Nevertheless, further investigations on elderly patients and, in particular, in adults with congenital heart disease are advised.

CLINICAL RELEVANCE/APPLICATION

Our results showed that age, gender, and CVDs independently affect the ascending AS, highlighting the importance of its follow-up assessment, especially in patients with congenital cardiac diseases.

SSQ03-09 Effectiveness of Multiparametric Structure-Function Cardiac MRI in Detection of Acute Cardiac Allograft Rejection

Thursday, Nov. 30 11:50AM - 12:00PM Room: S504AB

Awards
Student Travel Stipend Award

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PURPOSE

Acute cardiac allograft rejection (ACAR) is a leading cause of morbidity and mortality in heart transplant (Tx) recipients. Non-invasive screening with cardiac magnetic resonance imaging (CMR) is promising given its ability for comprehensive characterization of acute myocardial injury and subtle left ventricular (LV) structural and functional changes. We hypothesized that CMR-derived T2, T1, extracellular volume fraction (ECV), and LV velocities will differ between 1) healthy controls and Tx recipients without history of ACAR and 2) Tx recipients with and without current evidence of ACAR.

METHOD AND MATERIALS

CMR at 1.5T (Magnetom Aera/Avanto, Siemens, Erlangen, Germany) was performed prospectively on 76 Tx recipients (49.9±15.9 yrs, 45% female) and 14 controls (47.7±16.7 yrs, 36% female) for 131 total studies. Analyses were stratified based on myocardial biopsy grade: Controls (N=14), No ACAR (no history of ACAR, N=68), Past ACAR (history of ACAR, N=34), ACAR+ (active grade>=1R ACAR, N=15). CMR included T2-mapping, pre- and post- contrast T1-mapping (to calculate ECV), and tissue phase mapping (TPM; to generate myocardial velocities).

RESULTS

T2 was significantly higher in No ACAR patients compared to controls (49.4±3.4 ms vs. 45.2±2.3 ms, P<0.01). Compared to No ACAR patients, patients with Past ACAR (51.7±4.1 ms vs. 49.4±3.4 ms, P<0.01) or current ACAR+ (53.8±4.9 ms vs. 49.4±3.4 ms,

P<0.01) had greater T2 values. ECV was significantly elevated in ACAR+ patients compared to recipients without ACAR (31.6±3.6% vs. 26.7±3.2%, P<0.01) regardless of history of ACAR (No ACAR and Past ACAR). ROC analysis for the detection of ACAR+ revealed AUC of 0.80 and 0.85 for T2 and ECV respectively. TPM identified lower peak systolic longitudinal velocities and higher peak diastolic radial velocities in No ACAR patients compared to controls (2.8±1.0 cm/s vs. 4.9±1.1 cm/s, P<0.01; -3.7±0.8 cm/s vs. -2.9±0.7 cm/s, P<0.01).

CONCLUSION

CMR parameters are sensitive to structural and functional change in Tx recipients. T2 and ECV are effective at detecting ACAR, supporting further development of CMR for ongoing surveillance post Tx.

CLINICAL RELEVANCE/APPLICATION

CMR-derived T2 and ECV are effective in detecting acute cardiac allograft rejection (ACAR) following heart transplant, promoting use of multiparametric CMR as an alternative ACAR screening tool.