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Research Article

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Comparison of Cardio Vascular Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) for Detection of Myocardial Viability

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Abstract

Coronary artery disease (CAD) remains the most common cause of death. However, the number of deaths from myocardial infarction has decreased. Mortality from congestive heart failure has more than doubled. It is important to note that CAD accounts for the majority (almost 70%) of congestive heart failure cases.

In the clinical management of patients with congestive heart failure by CAD, the accurate assessment of myocardial viability is crucial to guide treatment. This is because revascularization of dysfunctional but viable myocardium can improve ventricular function and long term survival.

Generally nuclear imaging, stress echocardiography and stress electrocardiography have been the clinical main step for assessing myocardial viability as well as to detect myocardial Ischemia.

Recently cardiovascular MR (CMR) is a rapidly emerging non-invasive imaging technique, providing high resolution images of the heart in any desired plane and without radiation. CMR has the unique ability to evaluate several markers of myocardial viability that are of proven value [2]. The focus of the present study is on the rapidly emerging clinical role of cardiovascular MRI in the detection of viable myocardium.

Objective: To assess the role of cardiovascular MRI for detection of Myocardial viability.

Keywords: Magnetic resonance imaging; Positron emission tomography; Myocardial infarction; Coronary artery disease; Myocardium; Ventricular dysfunction

Background and Rationale

Ischemic coronary illness related mortality has been on the decline stage, in spite of the fact that its pervasiveness has been on the ascent since the late 1970s. One of the contributing elements to this decay has been improved determination and restorative administration. Each clinician looks to respond to two key inquiries while assessing patients with suspected or known IHD: What is the worldwide ventricular function? Is the myocardium viable? A PET is the pillar of finding of myocardial viability. In the previous decade cardiovascular attractive reverberation (CMR) imaging has risen as a critical clinical strategy with the capability of responding to all the appropriate inquiries in a solitary report [3,4]. Direct imaging of myocardial fibrosis is currently conceivable with the utilization of a reversal recuperation arranged T1, weighted slope reverberation grouping after the intravenous administration of a gadolinium-Chelate (Gad). The CMR technique has been named delayed-enhancement (DE-MRI) and demonstrate nonviable tissue as "hyper enhanced" or bright [5,6].

The DE-MRI technique is rapidly assuming a prominent role in the assessment of viability, as it has the advantages of being performed under resting condition and with no exposure to radiation.

Klein et al discovered that the territory complexity improvement is estimated by CECMR correlated closely with myocardial infarcts defined by PET in patients with Ischemic cardiomyopathy [7].

Kuhl et al compared F-18 fluorodeoxyglucose (FDG) PET and CECMR in 26 Patients. The study showed that segmental glucose uptake by PET is inversely correlated with the segmental extent of contrast enhancement and that using a cut off value of 37% segmented enhancement, optimally differentiated viable from non-viable segment defined by PET, using PET as the gold standard, this resulted in a sensitivity and specificity of CECMR for detection of viable myocardium of 96% and 84% respectively [8].

Because of its superior spatial resolution, CMR has the unique ability to assess small infarcts and to measure the trans mural extent of myocardial infarction [9,10]. This advantage has been used to detect micro-infarcts associated with successful coronary angioplasty, as well as the detection of sub endocardial infarcts which are missed by SPECT.

Methods

It was a prospective observational study. Patients who had undergone cardiac PET underwent cine MRI for ventricular motion abnormality. Then rest perfusion study was performed with 5ml IV contrast *Omniscan where perfusion defect was detected to rule out ischemia. It was followed by late gadolinium enhancement where contrast media omniscan was given with dose of 0.1 mmole/kg body weight and a wait of 10 minutes is required to acquire delayed imaging for detection of scar The study was conducted at Max Super Specialty hospital (a unit of Max Healthcare institute limited) in the department of Radiology. The duration of the study was approx. 14 months. Around 27 subjects recruited for the study were undergone MRI. The procedure for MRI was around 1 hr.

*Currently, gadolinium enhanced MRI of the heart is off-label use for all approved GBCAs

Image Analysis

Image analysis was done on GE MRI work station by experienced radiologist blinded to PET finding. 17 myocardial segments of heart (Figure 1a) were assessed and analysis of three parameters for these particular segments were selected and done with the following

protocol (Figure 1b). All Cardiac PET & MRI finding were compared and retrospective analyses were done to correlate both modalities.

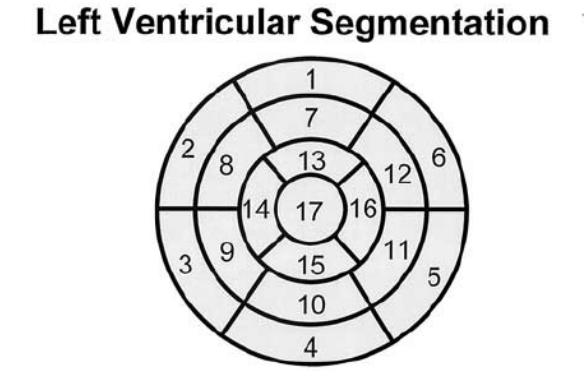

Figure 1a: Diagram showing numbering and names of myocardial segments.

Wall motion abnormality	Rest MR Perfusion	Delayed Enhancement
Normal wall motion.-1	Normal Perfusion----0	No Myocardial delayed enhancement-----0
Hypokinesia – Decreased wall motion. -2	Mild Hypo perfusion-----1b	Enhancement involvement up to 25% wall thickness of myocardium-1
Akinesia – Absent wall motion - 3	Moderate Hypo perfusion-----2b	25-50% wall thickness involvement-2
Dyskinesia – Abnormal irregular wall motion. (During systole wall move outward and during diastole wall motion is inwardly)-4	Severe Hypo perfusion------3b	50-75% wall thickness involvement-3
		75% wall thickness involvement-4

Figure 1b: Parameters selected for analysis and their scoring

Selection and Enrollment of Participants

The patients were recruited based upon the inclusion and exclusion criteria. The subject were enrolled after voluntary consent was taken. A total of 27 subjects were recruited

Inclusion Criteria:

- Age > 45 years, male or female
- Indication - Patients who have undergone cardiac PET and showed positive result
- Renal function Test clearance. E.g. Creatinine, Urea, GFR

Ejection fraction

Patient who have ejection fraction <45%

Exclusion criteria

Reason for ineligibility:

- Claustrophobic patients (Patient who can't lie down in MRI Scanner)
- High Creatinine/low GFR patients.
- Abnormal value of creatinine - > 1.4
- Abnormal eGFR-< 50

Contra-indication:

- Acute Myocardial infarction within few days
- Asthma
- Second or third degree Atrio-ventricular block.
- Sick sinus syndrome.
- Symptomatic bradycardia

Study Enrollment Procedure:

Patient who fulfilled all the inclusion and none of exclusion criteria and were willing to give voluntary informed consent to participate were enrolled in the study. Prior to first recruitment of subject into the study Institutional Ethics Committee approval were taken of the Site.

Ethical Consideration

This project was carried out according to ethical guidelines for biomedical research on human participants, Indian council of medical research, Indian good clinical practice guidelines and Declaration of Helsinki 2013. This statement had been developed to protect the interests of people who agree to participate in human research studies.

Informed Consent Forms

The consent forms were prepared by the research team after explanation of the purpose, risks and benefits of the study. For subjects who cannot read and write English, a consent form is prepared in Hindi.

Participant Confidentiality

Any data, forms, reports, video recordings and other records that leave the site were identified only by a participant identification number (Participant ID) to maintain confidentiality. All records were kept in a locked file cabinet. All computer entry and networking programs were done using PIDs only. Information was not released without written permission of the participant, except as necessary for monitoring by Institutional ethics committee (IEC) of the site and any regulatory authority.

Statistical Analysis

Agreement between PET and MR findings was evaluated separately for each segment for perfusion, viability and motion. Agreement in terms of percentage and cohen kappa were calculated for statistical significance. SPSS (Statistical Package for the Social Sciences) was used for calculations.

Result

CMR and PET data of all 27 patients were done for the evaluation and 459 segments were compared in total. In our study we got significant agreement between PET and MRI for perfusion and viability (Figure 2a and 2b) for most of the segments (-75-80%) (Figure 3a and 3b). CMR found more scar/fibrosis than PET in subjects with

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EF < 35%. CMR revealed less scars than PET in subjects with EF >40%. There was no significant agreement noted between PET and MRI for myocardial motion.

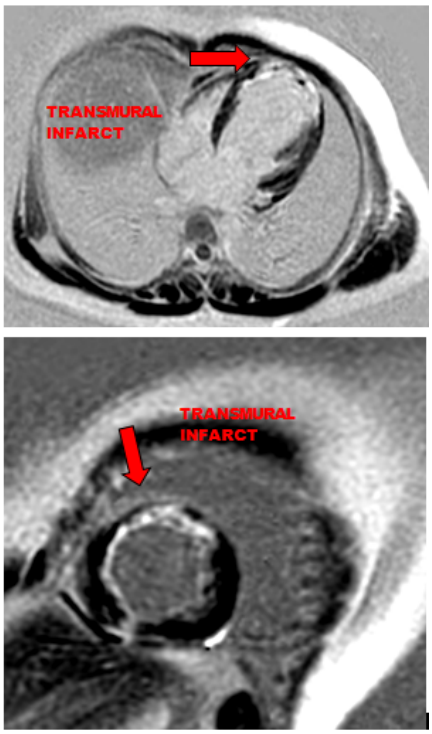

Figure 2a: Cardiac MRI short and horizontal axis showing trans mural infarct (arrows) involving the apical, apical anterior, antero-septal segments.

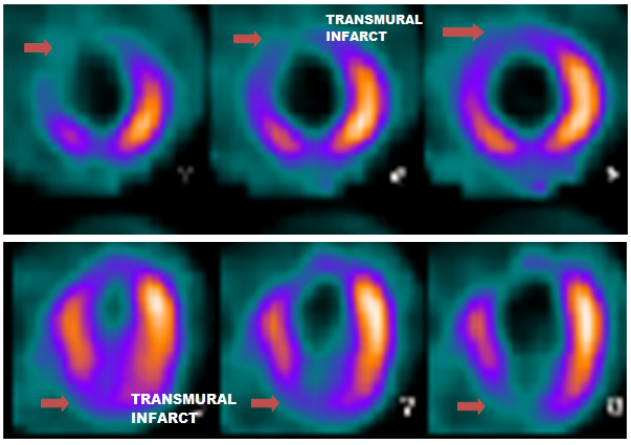

Figure 2b: PET short and horizontal axis showing transmural infarct (arrows) involving the apical, apical anterior, antero-septal segments.

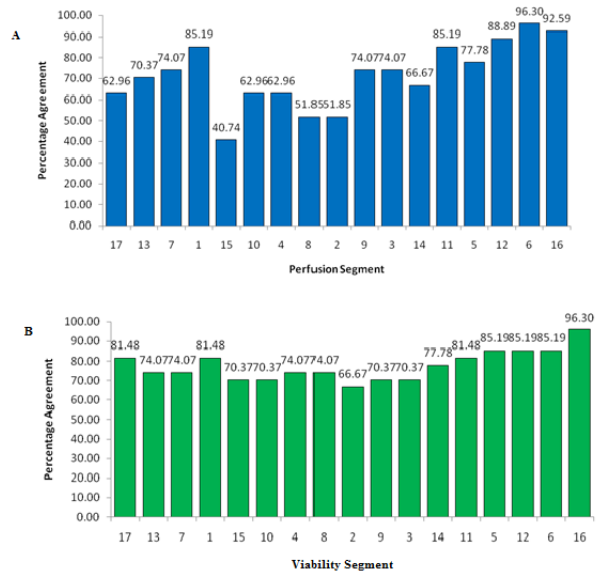

Figure 3: A and B showing significant agreement between PET and MRI for perfusion and viability for most of the segments.

Discussion

It has been shown that patients with chronic ventricular dysfunction and CAD have poor long term survival. Identification of such patients who may benefit from revascularization procedures is the major goal to improve outcomes. Several viability studies have estimated the long term prognosis as a final endpoint and concluded that viable myocardium was related to the improvement in myocardium function. Magnetic resonance is able to assess myocardial viability through a number of different techniques and methods. These techniques can assess metabolic, functional and morphological changes and tissue properties as well as cellular viability. The most widely used and with the greatest clinical application potential is delayed myocardial amplification. This technique is able to easily and objectively identify areas of the hyperintensive signal in the myocardium after administration of the contrast agent, with excellent histological correlation to characterize areas with myocardial infarction/fibrosis.

Conclusion

Magnetic resonance is able to assess myocardial viability through a number of different techniques and procedures and methods. These techniques can assess metabolic, functional, and morphological alterations and tissue characteristics, in addition to evaluating cellular viability. Moreover MRI costs less and has easy availability as compared to PET CT.

Limitation

As our sample size was small further studies including larger patient cohorts undergoing viability imaging are required for further evaluation.

Grants

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