ACKNOWLEDGEMENTS

I am grateful to my guide Dr. Aparna Irodi, Professor, Department of Radiology, Christian Medical College and Hospital, Vellore for all her hard work and expert guidance throughout the work on my dissertation.

I express my gratitude to Dr. Elizabeth Joseph, Professor in the Department of Radiology, Christian Medical College and Hospital, Vellore for her moral support and encouragement.

I am very thankful to Dr. Binita Riya Chacko, Professor, Department of Radiology, Christian Medical College and Hospital, Vellore for her valuable inputs and support.

I thank Dr. Soumya Regi, Assistant Professor, Department of Radiology, Christian Medical College and Hospital, Vellore for her support.

I also thank Dr. Bernice for all her help.

I specially thank Mr. Victor, for accommodating and performing high quality MRIs and Mr. Bijesh and Mr. Madan for their help with statistics and data analysis. Special thanks to Akanksha and Neha for their help in data analysis.

I thank CMC Vellore and all my teachers, for making this study and this course a reality. I am grateful most importantly to all the patients without whom this study would not have been possible.

I am very thankful for the help and support from my loving husband and daughters, in completing the thesis.

I thank the Lord Jesus who is my creator, redeemer, my rock and my strength.

TABLE OF CONTENTS

INTRODUCTION

Myocardial infarction is defined as myocardial necrosis due ischemia caused by coronary artery disease because of atherosclerotic plaque or due to spasm to the coronary arteries (1). Prognosis of myocardial infarction depends on patient's age, co-morbidities (diabetes and hypertension), and extent of ischemic myocardium and severity of left ventricular dysfunction. (2). Left ventricular dysfunction after infarction can be improved by intervention, depending on the amount of residual viable tissue (3).

Myocardial viability

Hibernating and stunned myocardium represent viable myocardium, with contractile dysfunction.

Hibernating myocardium: Chronic impaired coronary blood flow at rest causes decreased myocardial contraction, which can potentially recover with revascularization (4).

Stunned myocardium: Myocardium that shows depressed cardiac contraction due to repeated episodes of ischemia with stress but, has normal blood flow at rest. Myocardial contractile dysfunction is reversible with time in stunned myocardium (4).

Revascularization results in significant improvement in contraction in the viable myocardial segments of the heart. However, careful patient selection is needed due to the high mortality and morbidity associated with revascularization procedures (4). If there is significant residual viable myocardium in an arterial territory, then it is amenable for revascularization. However, if most of the arterial territory is infracted, then there is less chance of functional recovery and revascularization procedures are not advised.

ECG, ECHO, stress SPECT, cardiac MRI, CT Coronary angiography and conventional coronary angiography are some of the investigations used in assessment of viability of myocardium.

ECG

Electrocardiogram (ECG) is a primary diagnostic test for myocardial infarction. ST – segment, T wave and QRS complex show changes in myocardial infarction. ST segment elevation or depression, pathological Q waves will generally indicate myocardial infarction and the leads in which these changes are seen would indicate the segments that are involved. Exercise induced ST elevation and reciprocal ST depression indicates residual tissue viability.

Echocardiography

In myocardial infarction, ECHO is used to look at regional wall motion abnormalities, assessment of the left ventricular function and complications. Dysfunctional but viable myocardium has preserved contractile reserve which can be evoked by appropriate stimulus like low dose Dobutamine infusion where viable myocardium shows improvement in LV ejection fraction depending on the number of segments of involvement.

Cardiac MRI

Cardiac MR imaging has now surpassed most other modalities in cardiac morphological, functional assessment and tissue characterization. Viable myocardium usually shows normal contractility and does not show any late gadolinium enhancement. Viability is assessed by systolic wall thickening and end diastolic wall thickness by cine MRI. End diastolic left ventricular wall thickness > 5.5 mm generally indicates viable myocardium. On late gadolinium

enhancement (LGE) images, infarcted tissues show enhancement whereas normal tissues show washout of the Gadolinium. Good recovery of LV function after revascularization is seen if the LGE in a myocardial segment is <25% of its thickness. Segments with 26 -50 % transmural LGE show intermediate recovery and segments with > 50% transmural enhancement generally do not show significant functional improvement with revascularization.

Late gadolinium enhancement helps in better tissue characterization and the pattern of enhancement can also be used to differentiate ischemic and non-ischemic cardiomyopathies. In infarction, the enhancement starts in the sub-endocardial region and proceeds towards the epicardium with increasing degree of infarction. In contrast, in non-ischemic cardiomyopathies, the enhancement is usually mid-myocardial or epicardial in location. These cardiac MR imaging sequences are qualitative (visual) and comparisons of relative signals (semi quantitative in evaluation). So, there could be errors in disease assessment, especially if there is diffuse involvement.

Adenosine stress cardiac MRI can be done to look for inducible ischemia. Dobutamine infusion Cine MRI assesses the contractile reserve, which can predict response to coronary revascularization. This is superior to Dobutamine echocardiography.

Cardiac single photon emission computed tomography (SPET)

Technetium 99m sestamibi and Technitium 99m tetrofosmin are the common radiotracers used. Myocardial perfusion imaging is done at rest and after stress and by noting regional differences in the radiotracer uptake at rest and stress, viable or infarcted myocardium can be identified.

Fixed perfusion defects in rest and stress indicate infarcted myocardium, while normalization on the rest imaged suggest inducible ischemia with viable myocardium.

PET:

To assess myocardial viability 18F-FDG is the tracer is used. Cardiac glucose uptake and distribution is used to assess the myocardial perfusion. Normal perfusion and 18F FDG uptake indicates normal healthy myocardium. Mismatch pattern with reduced perfusion and preserved 18F FDG uptake is seen in hibernation. Matched reduction in the perfusion and 18F –FDG uptake denotes scarred or infarcted myocardium. Sub endocardial / transmural scar can be assessed depending on percentage of tracer uptake(4).

Parametric Myocardial T1 and T2 Mapping:

Parametric myocardial mapping are noninvasive techniques, enabling direct quantitative analysis of tissue alterations of myocardium in cardiac diseases using cardiac MRI. Changes in the myocardial tissue can be quantified with spatial visualization depending on the changes in the extracellular volume (ECV), T2*(star), T1and T2 relaxation times. These changes may be intracellular in the cardiomyocytes as seen in iron overload and glycosphingolipids deposition in Fabrys disease. Extracellular changes in the cardiac interstitium are seen in myocardial fibrosis and amyloidosis. Myocardial edema shows both intracellular and extracellular changes(5). T1 mapping consists of quantifying the T1 relaxation time of a tissue by using analytical expressions of image-based signal intensities.

T1 is longitudinal (spin lattice) relaxation time of tissue. Basic T1 mapping principle is acquiring many images with different T1 weighting and signal intensity of images is fitted into

the equation for T1 relaxation. Equilibrium magnetization is nulled or inverted by RF pulses. Summary of temporal and spatial changes of inversion recovery are T1 maps. T1 maps are displayed using color / threshold scales and Grey scale to enable visual interpretation. Myocardial mapping produces images that have standardized, reproducible scales. Myocardial tissue at particular field strength exhibits a range of normal relaxation times, deviation from which indicates cardiac disease.

T2 mapping is more sensitive to detection of myocardial tissue edema than T2-weighted Cardiovascular Magnetic Resonance (CMR).

Normal values: Due to variability of T1 and T2 values in regard to age and inhomogeneities in tissue properties and also variation from machine to machine, there is a need to standardize normal values in regard to local population and each machine.

Applications of T1, T2 mapping in patients with Myocardial infarction:

T1 values of infarcted tissue prolongs as compared to normal myocardium. Therefore T1 mapping may be helpful to detect infarcted myocardium without the use of Gadolinium. This could be useful in patient in whom Gadolinium is contraindicated (like in renal failure). As LGE tends to assess only relative enhancement, hibernating or ischemic myocardium does not show any abnormality on the LGE images. Similarly diffuse myocardial involvement could also be potentially missed on LGE imaging as it relies on differential enhancement.

We sought to establish normal values for our population and investigate the potential use of T1 and T2 mapping in assessing myocardial viability and also to assess the values in in ischemic and hibernating myocardium.

AIMS AND OBJECTIVES

Aim of the study: To carry out T1and T2 mapping of the myocardium in normal subjects and in patients with myocardial infarction and study the differences between them.

Objectives:

1. To study the native (pre contrast) T1 and T2 and post contrast T1 relaxation times of myocardium in normal subjects and establish a baseline reference value for our institution.
2. To study the native T1, T2 relaxation and post contrast T1 times of myocardium in myocardial infarction.
3. To see if native T1, T2, post contrast T1relaxation times in infracted myocardium differ significantly from the normal values.
4. To assess if T1 and T2 relaxation times help to differentiate normal from abnormal and viable from non-viable myocardium.

REVIEW OF LITERATURE

Rising incidence of cardiovascular disease in India

Heart diseases are becoming an epidemic in India. Cardiovascular disease (CVD) is a leading cause of mortality in India including poorer states and rural India. CVD affects Indians a decade earlier in the most productive midlife in comparison to the western population. India has ~ 30 million heart patients and on average 2 lakh heart surgeries are performed every year based on the latest statistics. Death rate due to heart disease in India is ~ 275per lakh greater than global average of ~ 235per lakh. High case fatality and younger age of onset of heart disease are features of concern in our sub-continent (6). So there is a need to improve the imaging techniques in the detection, follow up and treatment of myocardial infarction.

Rationale for viability imaging

Revascularization procedures, medical therapy and cardiac transplant are treatment options for cardio vascular diseases. The left ventricular dysfunction after infarction can be improved by interventional procedures depending on the amount of residual viable myocardial tissue(3). Coronary artery bypass graft (CABG graft) and endovascular stenting are the revascularization procedures in treatment of heart disease(7). Newer imaging techniques are being developed to identify the viable myocardial tissue and thus help in planning for revascularization procedures.

Pathology of viable myocardium

Imbalance between oxygen supply and demand leads to myocardial ischemia. Regional myocardial perfusion and rate of force of myocardial contraction determine the extent of ischemia (7). The different possible outcomes of coronary artery occlusion are myocardial

infarction, myocardial ischemia, stunned myocardium, hibernating myocardium and normal structure and function. If there is good collateral blood flow, infarction is prevented and myocardium remains normal. Myocardial infarction is due to gross reduction of blood flow resulting in low ATP levels causing cellular necrosis and cell death. Pre ischemic state of the myocardium, collateral vessels and diameter of the occluded vessel determine the extent of myocardial infarction. Myocardial infarction spreads from endocardium to the epicardium. Epicardium is mostly viable in transmural infarcts.

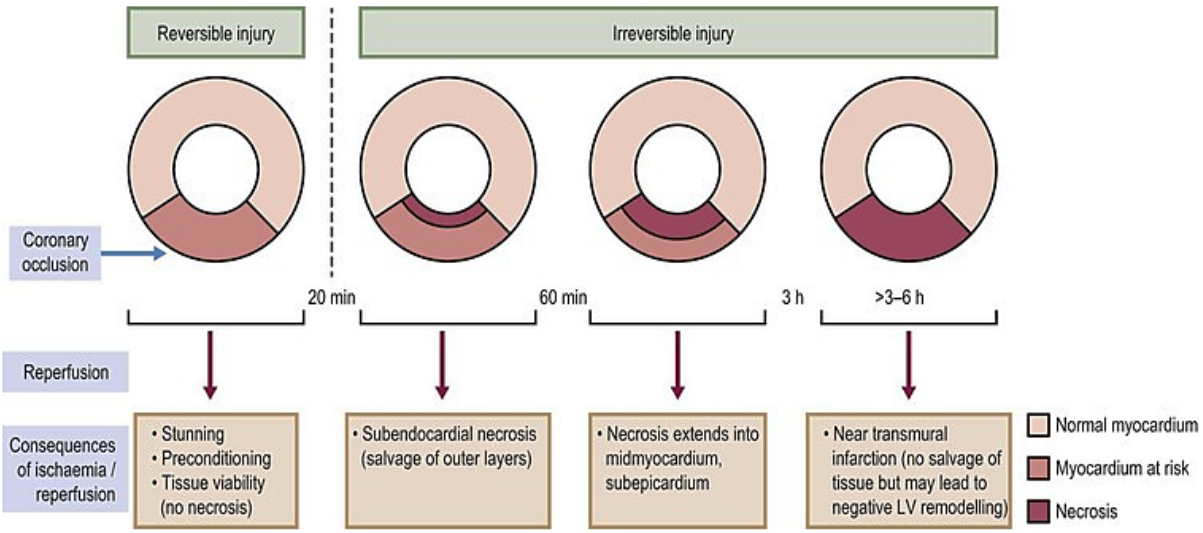


Figure-1: Effects of Ischemia and reperfusion on myocardial tissue viability and necrosis

In the early 1980's it was assumed that LV dysfunction at rest was an irreversible process. Regional and global improvement in LV functions following coronary artery revascularization led to the concept of assessing myocardial viability. Viable, but dysfunctional myocardium is hibernating and stunned myocardium. Mechanical dysfunction that develops even after the establishment of normal / near normal coronary blood flow in the absence of irreversible damage to the myocardium is stunned myocardium. Dysfunction may last for days to hours but

there is improvement in LV function with time(7). In hibernating myocardium, chronically reduced resting coronary blood flow leads to hypokinesia, even in the absence of infarction, which is the adaptive response of the myocardium.

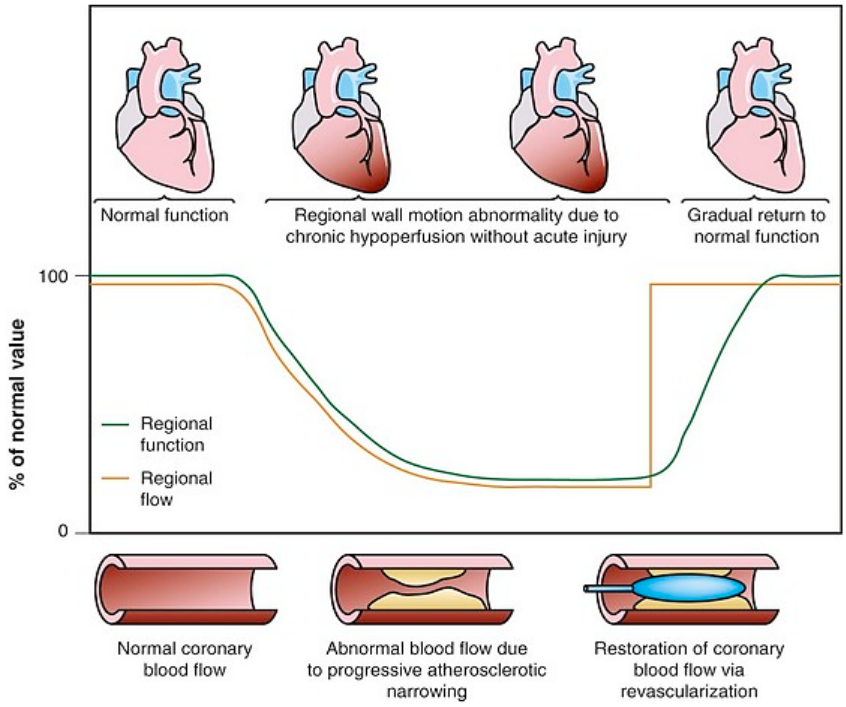


Fig.2: Hibernating Myocardium

Image courtesy: Nuclear Medicine Imaging of Myocardial Viability [Internet]. Radiology

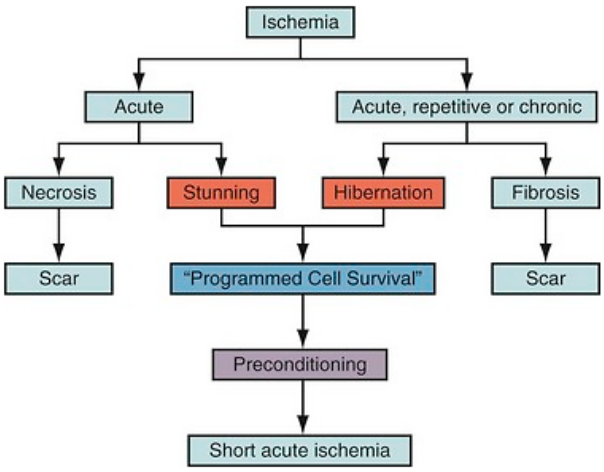


Fig.3: Outcome of Coronary artery occlusion

Image courtesy: Nuclear Medicine Imaging of Myocardial Viability [Internet]. Radiology

Metabolism of the myocardium

Metabolism of the myocardium is aerobic under physiological conditions(8). Normal myocardium is considered metabolically omnivorous. By oxidative metabolism of fatty acids and glucose, heart meets its energy demands. Non-esterified fatty acids are energy source even in fasting conditions. There is switch to glucose in post – prandial state.

Metabolic changes in stunned and hibernating myocardium

The process of oxidation of fatty acids is very sensitive to hypoxia. Ischemic myocytes prefer glucose as energy substrate. Under ischemic conditions there is impairment of oxidation of fatty acids which is taken over by aerobic and anaerobic oxidation of glucose to keep the myocardium viable(3,9). Metabolic stunning, with delay in the utilization of free fatty acids with restoration of blood flow is seen in animal models of repetitive stunning(10). Due to reactivation of fetal gene programme there is metabolic switch from fat to glucose metabolism in hibernating myocardium (11).

The goal of myocardial viability assessment is to identify patients with reversible LV dysfunction. Stunned myocardium (due to transient myocardial ischemia), hibernating myocardium (chronic hypoperfusion) are conditions with reversible LV dysfunction. After revascularization, different imaging studies can be used to assess the improvement in global and regional LV function, LV ejection fraction and LV volumes. Revascularization prevents sudden cardiac death due to ventricular arrhythmias with improvement in exercise capacity and long term survival. However revasculazation (CABG and percutaneous plasty and stenting) procedures are associated with significant procedure related mortality and morbidity. Due to the

high risk of therapautic intervention procedures, there is need for careful patient selection, by assessing the viability of myocardium.

Myocardial viability assesement – multi modality imaging

There is increase in the incidence of coronary artery disease (CAD) leading to chroinc heart failure despite significant improvement in the prevention and treatment of heart disease(12). Five year survival for ischemic cardiomyopathy is ~ 59%,which is worse than non ischemic cardiomyopathy(13). Various imaging modalities can differentiate viable myocardium from necrosis or scar depending on properties of viable myocardium. Non – invasive viability testing for assesment of viable myocardium by using various indirect parameters are:

1) *Stress echocardiography (ECHO)*

ECHO can assess myocardial viability by measuring left ventricular wall thickness or myocardial contractile reserve. A marker of viability in resting ECHO is left ventricular end diastolic wall thickness (EDWT) more than 6 mm and is used as marker of functional recovery following revascularization(14). LV EDWT < 6mm has less likelyhood to recover LV function(14).

Assesment of contractile reserve is another criteria to assess viable myocardium. Stress ECHO with dobutamine stress, adenosine or dipyridamole is used to assess the contractile reserve(11). ECHO imaging is obtained at baseline, low dose dobutamine and high dose dobutamine.

With low dose dobutamineinfusion of 5-10mg/kg/min, viable myocardium shows increased contractile function, while non viable myocardium shows no response.

Biphasic response: Viable myocardium can also be detected by biphasic response. Low dose dobutamine shows increased acitivity in the hibernating segment. With high dose dobutamine, there is reduced function (due to ischemia; worsening at peak stress). In patients with biphasic response the initial inotrophic response to low dose dobutamine is due to hibernating myocardium and worsening LV funtion at high dose is due to ischemia(15).

Sustained contractile response: Here, there is improvement in contractile response with low dose Dobutamine with no further deterioration of contractile respone at peak stress. In sustained contractile response, there is sufficient coronary flow even at peak stress and patients are less likely to benefit from revascularization procedures(15).

Worsening contractile response: There is no improvement at any stage with worsening contractile function even with low dose Dobutamine. Patients with worsening function are likely to have significant scar, do not have contractile reverse and will not benefit from revasculazition.

75% of segments with biphasic response have been shown to recove LV function at 14 months follow up, while only only 22 % of segments with sustained response showed recovery. Patients with worsening of function rarely recovered(16). High dose dobutamine in comparison to low dose dobutamine protocol has higher sensitivity and specificity in predicting functional recovery following revascularization(17).

Limitations of stress echo are operator dependency in both data acquisition and interpretation. Adequate acoustic window is also a limitation. Main advantages of stress echocardiography are wide availablity, relatively low cost, no radiation burden and ease of use in patients with implanted devices(18).

2) *Nuclear imaging techniques to identify myocardial viability*

Scintigraphic techniques for evaluating viable myocardium are Positron emission tomography (PET) and Single photon emission tomography (SPET). Radiotracers that can be used in cardiac imaging are Tc 99m/ Thallium 201for perfusion, thallium 201 for cell membrane integrity, Tc 99m MIBI for intact mitochondria, ^{18}FDG for preserved glucose metabolism, iodine 123-labelled fatty acids for free fatty acid metabolism (betamethyliodophenylpentadecanoic acid(BMIPP))(7).

Single photon emission tomography (SPET): Single photon emmitting radio isotopes are used to detect viable myocardium in SPET. Cell membrane integrity and myocardial perfusion determine the uptake of radiotracer. Viable myocardial segments have preserved radiotracer uptake. Imaging myocardial contractile reserve/ substrate metabolism myocardial viability can be assessed (15).

Technetium99m: Tc99m emit high energy photons with a narrow peak energy width. Half life is shorter as compared to thallium and so a higher dose of radiotracer can be given and a better image quality can be obtained. Tc 99m may under evaluate viability compared to thallium as it undergoes less redistribution(19).

^{123}I- labelled 15 –(p-iodophenyl)3-R,S- methylpentadecanoic acid(BMIPP) is a radio labelled fatty acid tracer to demonstrate fatty acid metabolism . Following revascularization for acute MI, decreased BMIPP uptake compared to myocardial perfusion in myocardial segments, suggest metabolically dysfunctional myocardium indicating low likelyhood of functional recovery(20).

The sensitivity and specificity of Technetium 99m SPET to predict functional recovery following revascularization is estimated to be 83% and 65%(17). Although SPET is easy to perform and highly reproducible, its limitations include higher cost, radiation risk, limited spatial resolution and difficultly to visualise small transmural infarcts. Interpreting images in patients with 3 vessel ischemia is also difficult (balanced ischemia). Attenuation artifacts from diaphram /breast is also a limitation(15). It has lower cost and good sensitivity compared to PET(17).

Positron emission tomography(PET)

Positron emiting radotracers that can be used in cardiac PET are, Rubidium-82, Ammonia -13, Oxygen -15 and Fluorine -18 fluorodeoxyglucose (18 FDG). Most validated radiotracer in cardiac PET metabolism is 18 FDG, a glucose analogue. For the assesement of ischemia and hypoxic myocardium, glucose is a prefered metabolite(18,21). Viability assessement includes myocardial perfusion and metabolism. Myocardial perfusion can be assessed at rest and pharmocological stress (for stress induced ischemia) by using Rubidium -82 /N-13 ammonia. 18 FDG glucose (glucose metabolism), C-11 acetate (oxidative metabolism), C-11 palmitate (fatty acid metabolism) assess the myocardial metabolism(15). Most commonly, FDG is used to assess myocardial metabolism in clinical practice. Since FDG is metabolised to F-18 FDG 6 phosphate, which cannot be further metabolised , itis trapped in the myocytes(11). Glucose load and intravenously admistered insulin improves FDG image quality(22). Uptake and metabolism of 18 FDG, depends on viable glucose transporters and viable myocytes. Normal FDG uptake and normal perfusion is seen in viable myocytes. Preserved FDG uptake and reduced perfusion is seen in hibernating myocardium. Scarred myocardium has absent FDG uptake and no

perfusion (21,23). In viable, but, jeopardised myocardium, FDG uptake increases due to preference for glucose than fatty acid metabolism (shift to anaerobic metabolism). By analysis of segmental myocardial perfusion and metabolism, amount of normal, hibernating and necrotic myocardium can be assessed.

Viable, but jeopardised myocardial segments show reduced perfusion and normal / increased glucose metabolism – i.e there is a mis-match between perfusion and glucose uptake. In transmural myocardial infarction, there is < 50% uptake with matched perfusion and metabolic defect. Non transmural infarct without viability has >50% uptake with less severe matched perfusion and metabolic defect. In stunned myocardium, myocardial perfusion is normal / nearly normal and FDG uptake is normal / reduced. Stress perfusion is typically reduced and myocardial contractility is reduced.

PET and CT imaging combined together are excellent for imaging of microvascular no reflow phenomena, myocardial scar and detailed assessment of myocardial metabolism(24). Stress testing is not required in cardiac PET for myocardial viability. Extensive studies done on diagnostic performance of FDG PET and value in clinical management, have shown sensitivity of 92 % and specificty of 63% (17). High cost, limited availability and use of radiotracer are main limitations of PET. Wide spread use is limited because most of the radiotracers are cyclotron produced. Radiation exposure from PET is high as compared to SPET.

3) *Multidectector computer tomography(MDCT)*

CT coronary angiography is a widely used technique. Delayed contrast enhanced CT can assess myocardial viability, but, is currently a research application. Principle is same as late gadolinium

enhancement (LGE) of cardiac MRI in evaluation of myocardial scar. Like gadolinium, iodinated CT contrast agents have extracellular distribution and similar kinetics. Arterial phase hypo enhancing myocardium suggests macro/ micro vascular obstruction. Hyper enhancement at 5 minutes suggests infarct due to extra cellular accumulation of contrast.

5 minutes post contrast CT scan has been shown to differentiate infarcted from normal myocardium in animal models(21). To the standard coronary CT protocol, myocardial viability protocol can be added. Extra contrast is not needed and there is only 5 minutes extra scan time with mild increase in radiation dose, in comparison to coronary CT angiography. Studies on cardiac CT were mostly done on animal models. There is no data available to predict functional recovery following revascularization using cardiac CT.

4) *Cardiac MRI*

Cardiac MRI is currently the gold standard in the evaluation of cardiac anatomy and function. Cardiac MRI is a noninvasive diagnostic tool and has unique ability to characterize the myocardium. CMR has the ability to overcome limitations of nuclear medicine(18). Late gadolinium enhancement (LGE) is the fundamental CMR technique which helps in the detection of replacement fibrosis like scar and regional abnormalities by qualitative methods. However, it fails to detect diffuse disease that involves whole of the myocardium(25). MRI gives high contrast and high resolution images, making it an excellent technique for measuring ventricular volumes, ejection fraction, myocardial mass and regional wall motion. Up to 1-2 mm of spatial resolution and temporal acquisition of 20-50 ms can be achieved. By accurately defining the extent of necrosis, CMR is able to distinguish transmural variations in viability. Thus, excellent

spatial resolution is one of the strongest points of cardiac MRI which is relatively poor in PET and scintigraphy.

Cardiac MRI follows the same principles as other MRI techniques with additional ECG gating. The main techniques used in cardiac MRI are:

Spin echo imaging: In this technique heart tissue is visualized as bright and blood appears black, so, it is called “black blood technique”. This technique is used to study the anatomy of the heart.

Gradient echo imaging: In this technique myocardium appears dark and blood appears bright, so, it is called “bright blood technique. Ventricular mass, left and right ventricular sizes and function, intracardiac shunts, and intracardiac masses are evaluated by this technique. SSFP (steady state free precession) is the main sequence used here, which can generate high spatial (~2 mm in-plane) and temporal (<30 ms) resolution cine images within an 8 to 12 seconds breath hold.

Flow velocity encoding: It is also called phase contrast technique and it directly quantifies the blood flow. It helps in quantifying the severity of valve regurgitation and stenosis, size of intra cardiac shunts and severity of arterial stenosis.

Gating: Two types of gating are used in cardiac MRI, ECG gating to monitor the cardiac cycle and respiratory gating by monitor respiration. Real time CMR methods acquire the entire image in < 100 ms, but, are limited by low temporal and spatial resolution. So ECG gating is used and data is acquired over multiple cardiac cycles. Good ECG gating methods give excellent image quality in sinus rhythm, even in atrial fibrillation, atrial or ventricular premature beats. By breath holding most of the images can be acquired. However images which require long acquisition time can be done by using respiratory gating in addition to cardiac ECG gating. This technique

is useful to get high resolution imaging of coronary arteries. Respiratory gating is done using navigator to track the movement of the diaphragm or using elastic band around the chest which can monitor respiratory motion.

Basic Cardiac axis imaging planes in CMR

SSFP scout view is used for planning to acquire imaging planes in the direction of cardiac axis. On true transverse slices, by a plane transecting mitral valve and apex, left ventricular vertical long-axis (VLA) is obtained. Acquiring a plane transecting the VLA through apex and mitral valve, horizontal long axis (HLA) is obtained. Stack of short axis images are obtained perpendicular to HLA from base to apex. By a plane transecting both LV and RV, four chamber of left ventricle is obtained. Perpendicular to 4 chamber, two chamber is obtained. By a plane transecting the LV through LV out flow tract, three chamber LV is obtained.

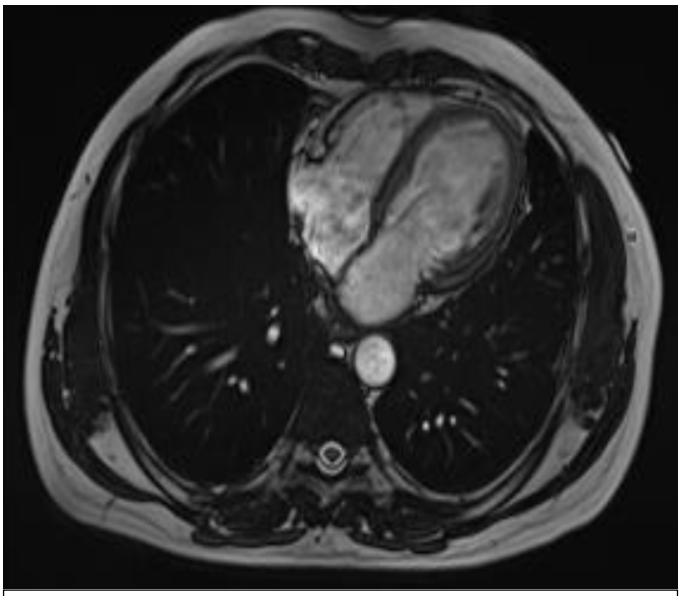


Fig.4: True axial SSFP image of the chest showing four cardiac chambers

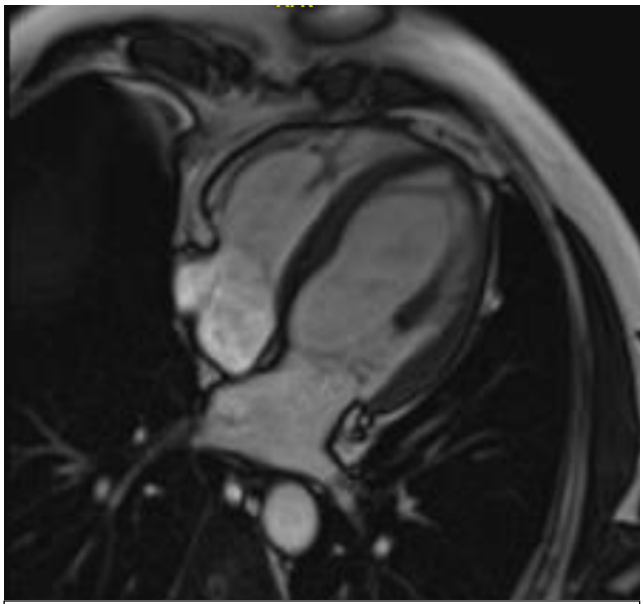


Fig.5: Four chamber view SSFP image in end-diastole

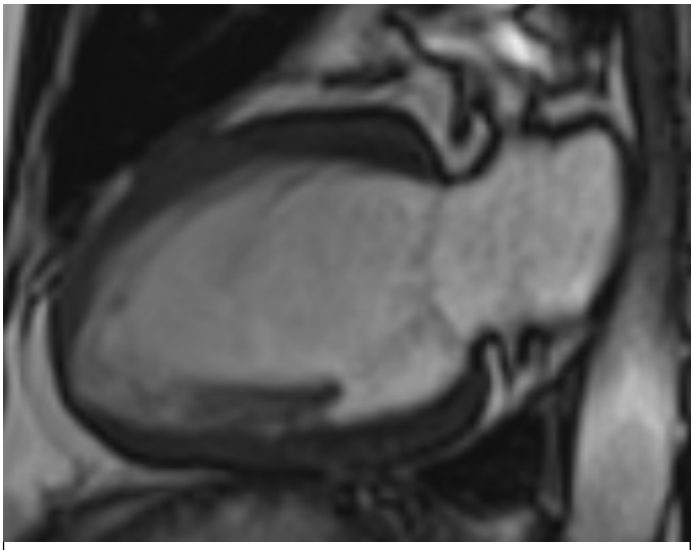


Fig.6: Two chamber view SSFP image in end-diastole

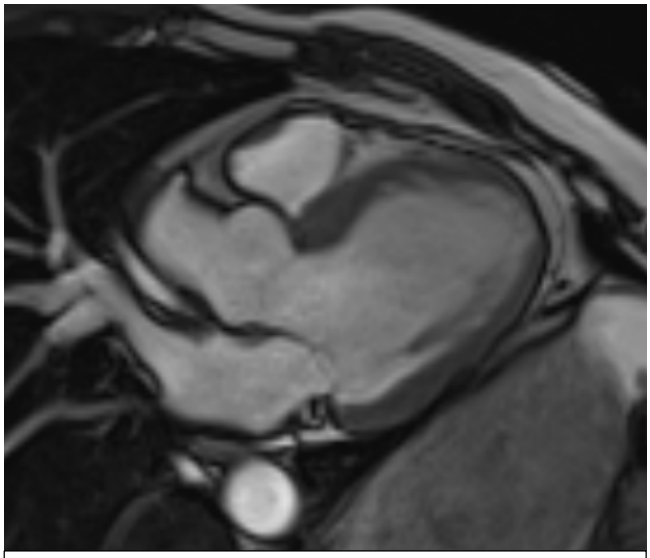


Fig.7: Three chamber left ventricular outflow tract

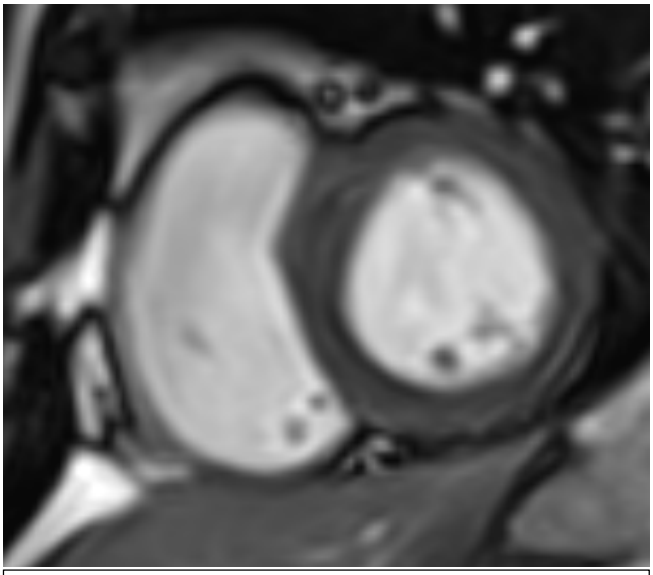


Fig.8: Short axis mid cavity view of heart

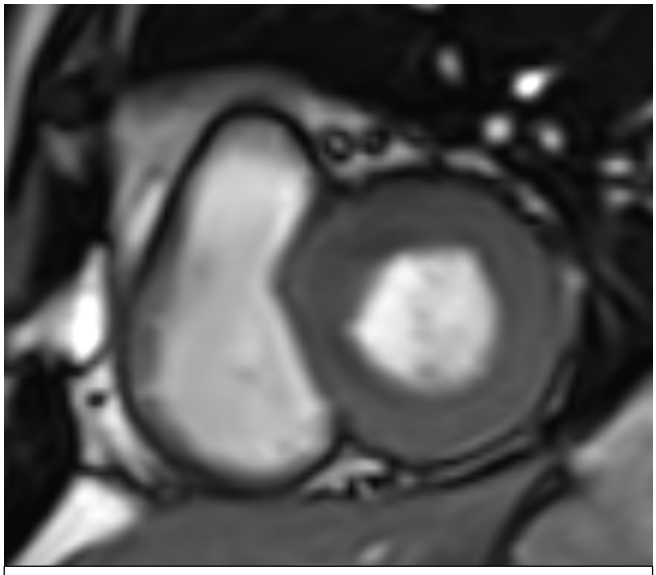


Fig.9: Short axis apical view of heart

In CMR, the three principal techniques used to assess viability are, late gadoliniumlinum delayed enhancement (LGE), end diastolic wall thickness(EDWT) and dobutamine/ adenosine stress(25). Viability is predicted by assesement of EDWT. To predict functional recovery following revascularization, EDWT > 5.5 cm is taken as cut off(26). On dobutamine stress

CMR, viable myocardium shows increased contractility of dysfunctional myocardium, while non viable myocardium remains dysfunctional. Wall motion changing from akinetic to hypokinetic or hypokinetic to normal with Dobutamine infusion, predicts improvement with vascularization.

In CMR, wall motion abnormality can be scored qualitatively by visual assessment as:

0 – normal, 1 - Mild or moderate hypokinesia, 2 - Severe hypokinesia, 3 - Akinesia, and

4 – Dyskinesia.

Late gadolinium enhancement MRI imaging: In this technique 0.1-0.2 m mol/kg bolus of Gadolinium based contrast is injected. After 10-20 minutes, T1 scout images are obtained and from the T1 scout images, the adequate inversion time (TI) to null the normal myocardium is chosen. Correct inversion time should be chosen to get good quality images. Optimal inversion time varies from person to person and by factors like cardiac output and dosage of contrast. "Optimal TI time" is which results in complete suppression of signal from normal myocardium with bright signal from myocardial cavity and even brighter signal from the infarcted tissue.

Gadolinium is restricted to the interstitial and extravascular spaces. So when there is a loss of membrane integrity in the form of sarcolemmal breakdown in the infarcted tissue, Gadolinium accumulates in the extravascular and interstitial spaces with delayed wash out due to poor vascularity and fibrosis. Thus on delayed imaging, infarcted tissue shows enhancement or increased signal due to the T1 times as a result of the gadolinium. Inversion recovery sequence where the normal myocardium is nulled is the ideal method to demonstrate this enhancement.

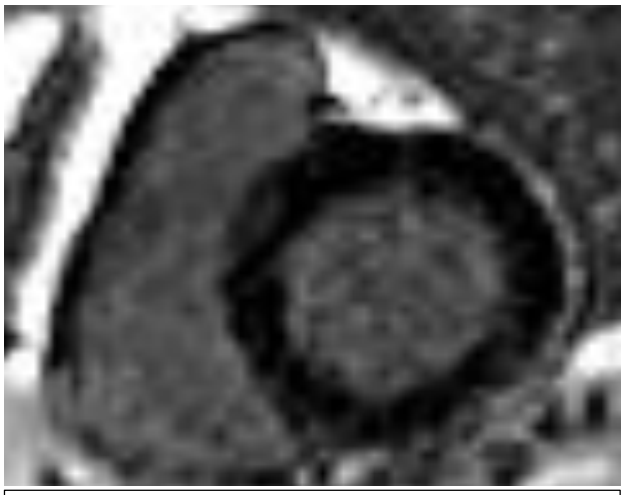


Fig10: PSIRimage–short axis view at the basal level

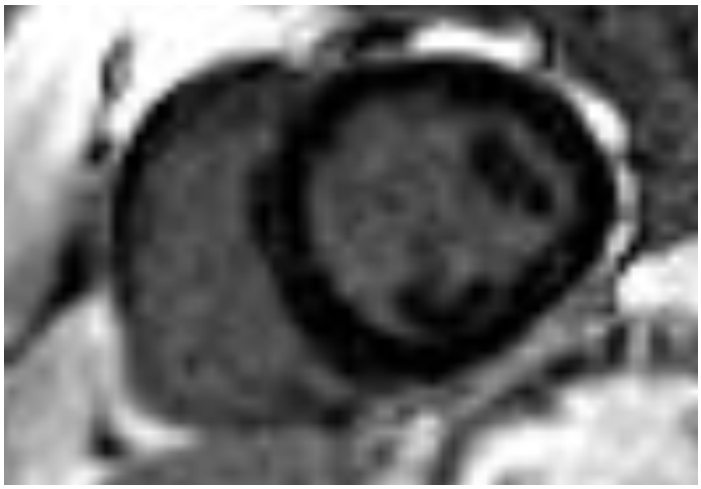


Fig11: PSIR image – short axis view at mid cavity level

By selecting the correct inversion time, sub endocardial, mid myocardial and transmural late gadolinium enhancement can be accurately quantified and intramural thrombus can also be visualized. In myocardial infarction, LGE is seen in a coronary arterial territory and the enhancement starts from subendocardial region and progresses toward the epicardium with varying degrees of thickness of myocardium being involved, based on the degree of ischemia Based on the thickness of myocardium that is involved, the delayed enhancement in myocardial infarction can be scored as follows:

0 – No hyper enhancement with regional wall motion abnormality (RWMA)

1 - Sub endocardial hyper enhancement of 1 to 25% thickness of wall thickness with RWMA

2 – Sub endocardial hyper enhancement of 25 to 50% thickness of wall thickness with RWMA

3 – Sub endocardial hyper enhancement of 51 to 75% thickness of wall thickness with RWMA

4 – Hyper enhancement of 76 to 100% thickness of the myocardial wall with RWMA

LGE is very sensitive in picking up even small sub endocardial infarction. In detecting sub endocardial infarction in patients with coronary artery disease and LV dysfunction, CMR has been shown to have greater sensitivity than PET (27).

Microvascular obstruction: Myocardial segments that are hypo enhanced in the first pass perfusion are due to microvascular obstruction even though the epicardial vessels are patent(26). Regions with severe microvascular obstruction show no LGE with poor LV function, suggesting non-viable myocardium and generally a poorer prognosis.

T2 weighted STIR imaging: Myocardial segments can be hyper intense on T2 STIR images due to edema which can be seen in acute infarcts. Myocardial edema usually extends beyond the area of infarction.

Delayed enhancement and T2 differentiates acute and chronic infarcts: Both acute and chronic infarcts show delayed enhancement (DE).Myocardial edema is a marker of acute MI and is depicted on T2W STIR imaging. So combination of DE and T2W STIR imaging is a clinically reliable tool to differentiate acute from chronic MI.

A study by Kim et al(29) showed that CMR is an excellent tool to predict chances of myocardial recovery following revascularization. In this study, myocardial segments with no LGE showed 100% recovery in function, segments with 26 -50 % transmural scar had 45 % recovery in function, 51 – 75% transmural scar had 7% recovery in function and segments with 76 – 100% transmural scar had no recovery(15).

CMR is the best current diagnostic modality in detection of myocardial infarct and assessing the transmural extent of the infarction. Some internal cardiac defibrillators (ICD) and pace makers are presently a contraindication to CMR. However, more recently manufactured pacemakers are MRI compatible with modified MRI pulse sequence protocols. Due to risk of nephrogenic systemic fibrosis in renal failure patients with (GFR<30 ml/min) gadolinium is contraindicated in patients with poor renal function. In 5-10% of patients, claustrophobia limits the use of CMR.

This could be overcome by using large bore magnets and sedation. In unstable patients it is difficult to treat dobutamine related arrhythmias and ischemia inside the magnet.

In LGE images, myocardial infarctions are displayed as high signal intensity, on arbitrary scale. Signals cannot be quantified or compared between different subjects. Visualization of disease depends on contrast between normal and abnormal myocardium(30).

Myocardial parametric mapping

Myocardial parametric mapping quantifies the T1 relaxation time, T2 relaxation time and extracellular volume (ECV) of myocardial tissues by using analytical expression of images based on signal intensities(31). Relaxation of hydrogen nuclei (or protons) determines the signal intensity of the pixel. Different tissues such as fibrosis, fatty tissue and edema have different relaxation times. Quantitative T1 and T2 gives more diagnostic information than conventional MRI(32). These quantitative T1 and T2 techniques provide voxel by voxel map of the entire myocardium and are simple in imaging and analysis, with less subjectivity and high reproducibility(30). These are now integrated into routine CMR protocol(33) as an additional quantitative study(34). Changes from visualization to quantification is true “revolution” in CMR(35). Parametric maps are not only useful as a biomarker for diagnosis of non-ischemic and ischemic cardiomyopathies, but also helpful in the planning of treatment and monitoring progression of disease process. Quantification and visualization of the myocardial diseases is possible by myocardial mapping, irrespective of the disease being diffuse or focal(5). Late gadolinium enhancement assesses focal fibrosis as against T1 mapping which assesses focal as well as diffuse fibrosis.

Mapping techniques: T1 mapping is acquired in a single breath hold. There are three standard sequences which can be used - Shortened MOLLI (ShMOLLI) sequence, Standard Look-Locker (LL) sequence and Modified LL inversion-recovery (MOLLI) sequence.

Look locker (LL sequences): These sequences are obtained prospectively and continuously throughout cardiac cycle without cardiac gating, without any reference to specific phase. Images are obtained at multiple TIs after application of single 180 degree pulse. This sequence is called LL sequence or "TI scout".

MOLLI (Modified Look –Locker inversion recovery): MR sequence is applied for acquiring native T1 values(33). Equilibrium magnetization is inverted or nulled by RF pulse for measuring T1. After inversion or saturation, pulse images are acquired at different times. The curve fitting of all images in a sequence generates a pixel map of the T1 values which is represented in a single image which is the T1 map(34).

Selective data acquisitions are performed at end diastole of successive heart beats and hence the limitations of LL sequence are overcome by this way. With each heartbeat, single image is obtained and multiple images are obtained at each IR. With set of 3 consecutive IRs with increasing TIs with one breath hold, 11 images are obtained over 17 heart beats. By using narrow acquisition window and parallel imaging techniques, cardiac motion is minimized.

Many studies have shown MOLLI sequences to be accurate for myocardial mapping (30),(36). MOLLI has lower T1 value than LL sequences(37). Merging of image sets from different IR acquisitions with different TIs into single dataset are possible by MOLLI. T1 values in each voxel are represented by signal intensity and are displayed as parametric color maps. T1 values are obtained directly using region of interest (ROI) with specialized T1 mapping software(38).

SHMOLLI: Piechnik et al investigated the SHMOLLI sequence in order to decrease the long breath hold of ~ 18 sec of MOLLI sequence(39). Normal subjects at end expiration can hold their breath ~ for 20.9 sec (range 13 to 74 sec)(40). Patients with pulmonary compromise have average breath hold of ~ 9 sec (range 2- 16 sec)(40). Patients with low heart rate cannot hold their breath for long time. Average breath hold in SHMOLLI sequence is 9 sec (± 1.1 sec) and number of heart beats required for acquisition of the sequence is 9.

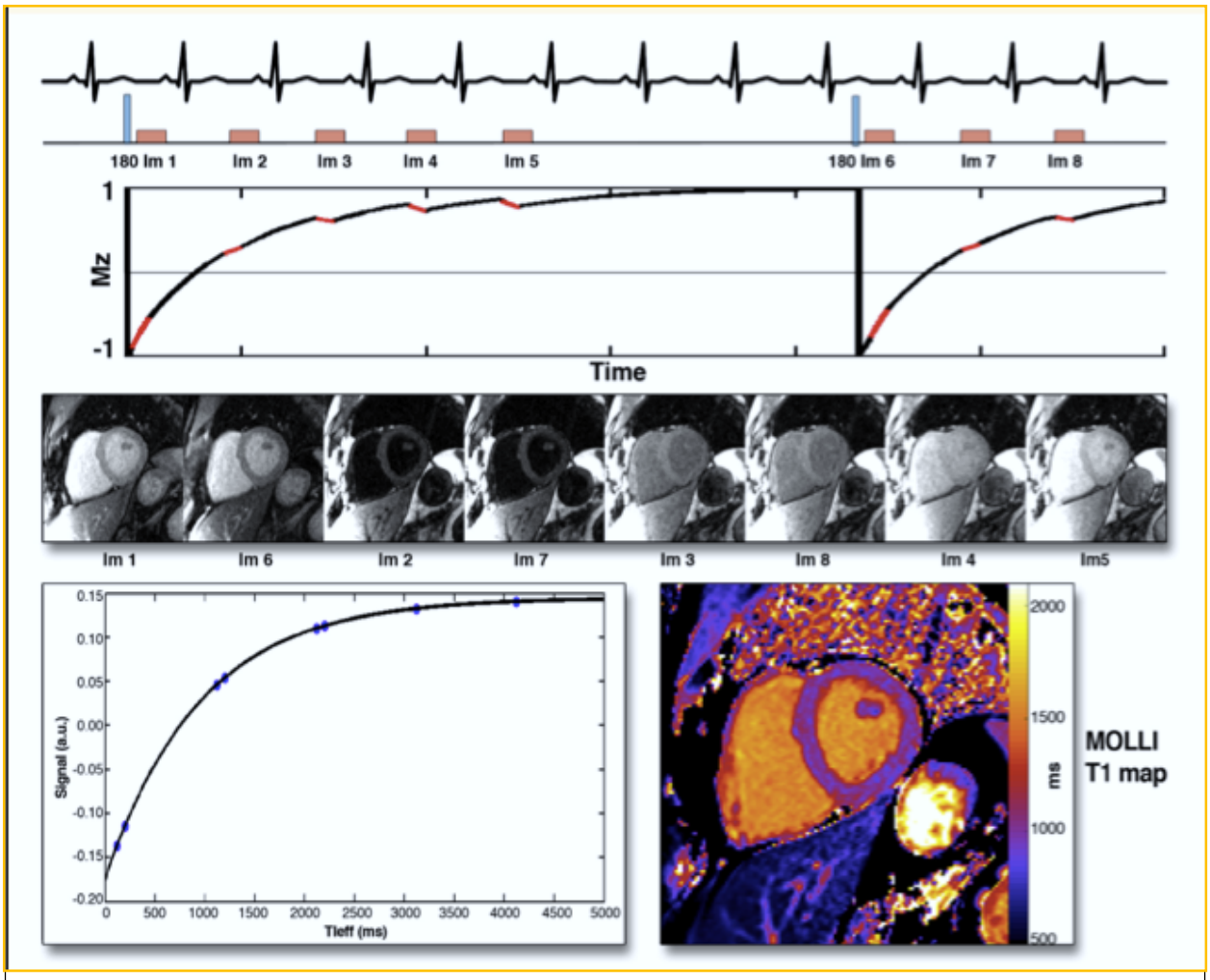


Fig.12: MOLLI SEQUENCE

Image courtesy: T1 Mapping: Basic Techniques and Clinical Applications

Techniques	Method	Advantage	Disadvantage
LL	T1- measured by a periodic and continuous train of RF pulses followed by the inversion pulse	T1 relaxation measured at multiple time points of cardiac cycle	Partial volume effect due to physiological motion and misregistration, variability with heart rate
MOLLI	IR-weighted images at different inversion times are acquired following which the images are sorted into a single data set according to consecutive inversion times	Single breath hold, within a cardiac cycle, single slice and single readout	Single breath hold with 17 heartbeat, heart rate dependent
shMOLLI	modification of MOLLI	Faster acquisition time, short breath-hold duration of only nine heartbeats	Reduced precision
SASHA	The SR pulse non-selectively saturates the longitudinal magnetization to zero, independent of previous acquisitions. Recovery periods are not required between successive saturation pulses because recovery always begins from a saturated state. The best-known T1 method is SASHA	The best-known T1 method is SASHA	T2-dependence, magnetization transfer effect and dependence on inversion efficiency

T1 mapping: Spin-lattice or longitudinal relaxation time commonly called “native T1” or T1 relaxation time is used to characterize different tissues and is a tissue specific constant time. Depending upon rate of energy transfer from an excited proton to its surroundings, T1 relaxation time varies. It varies depending upon magnetic field strength, temperature, molecular shape, size and viscosity. Native T1 value varies according to the field strength and is directly proportional to the field strength. T1 values vary with sex and age of the patient. Higher T1 values are seen in older patients and men(33). Fat, water, iron etc have unique constitutional T1 relaxation time depending upon the interstitial and cellular composition. Change in the constituents in myocardial diseases alter the T1 and T2 values(34). 940 to 1000 m sec is the normal T1 relaxation time of the myocardium using 1.5 T MRI. Diseases causing fibrosis, edema or amyloid deposition cause prolongation of T1 values. Siderosis, fat deposition and Anderson – Fabry disease cause shortening of T1 values. Increase in interstitial space due to fibrosis (infarction, scar and cardiomyopathy) and edema (recent infarction/inflammation) are also increase the native T1 (41).

Depending upon the severity and nature of cardiac disease, there are two possible types of collagen deposition within cardiac tissue, focal scarring and diffuse or interstitial fibrosis.

Focal scarring: Focal scarring is seen on LGE with visual difference in the signal intensity between the area of focal scarring and normal myocardium.

Interstitial fibrosis or diffuse fibrosis: This is not seen on LGE as it lacks the difference in signal intensity to be visually appreciated. An inversion pulse with LGE uniformly suppresses the entire myocardium despite retention of contrast. By measuring the intrinsic T1 time ms, T1 mapping overcomes this limitation.

Post gadolinium T1: Gadolinium chelates are admistered at dose of 0.15 mmol/kg. Since gadolinium is continuously excreted by the kidneys, T1 values vary with wash out phase. T1 values are typically obtained at 12 and 25 minutes after administration of contrast(31). *Native T1 versus post gadolinium T1:* Native T1 values are longer than post gadolinium T1 values in normal myocardium due to relaxing effect of residual gadolinium. In diffuse fibrosis due to increased volume of retained contrast relaxing effect is greatly amplified than regional scarring. Fibrotic myocardium has shortened T1 on post gadolinium T1 sequences with good correlation with endomyocardial biopsy(31). Even without use of gadolinium, native T1 is a promising sequence to detect myocardial abnormalities (33).

Myocardial T2 mapping: Spin- spin or transverse relaxation time or "T2 relaxation time" is also tissue specific. Bright blood T2-preparation pulse based sequences or dark blood turbo spin echo are used in myocardial T2 mapping. Applying a T2 preparation pulse based sequence followed by read out using SSFP (steady state free precession) sequence and T2 decay curve is calculated by which T2 parametric maps are obtained(33). T2 CMR can differentiate acute and chronic infarct by noting presence / absence of edema. T2 relaxation time is sensitive to myocardial edema after cardiac ischemia and reperfusion(42). It detects edema even beyond the limits of T2 weighted CMR(43). Normal myocardial T2 relaxation time is 52.18msec at 1.5 Tesla and 45.1 at 3T(tesla)(33).

A study by Florian Bonner on myocardial T2 mapping showed that T2 decreased towards the heart bases. Significant higher T2 values were obtained in female volunteers in all myocardial regions. T2 time correlated significantly to age. Results showed that T2 maps are highly reproducible. Presence of diabetes, hypertension, female sex and aging showed increased

myocardial T2 values. Mid ventricular long and short axis are used to measure native T1, T2 and post Gadolinium T1 values used for small samples. Short axis at base, mid cavity and apex are preferred for larger sample volume.

Native T1 values from normal population are used as base line reference. Reference values are obtained in healthy control population acquired under same scanning condition like scanner type, scan time and contrast agent. Determination of T1 times is done by manual ROIs or by applying automatic threshold.

A study by Tiago in 2014 (44) compared the three T1 mapping sequences (Sh MOLLI, MOLLI, SASHA). They used mid ventricular slice for mapping. Results showed no association of T1 with cardiovascular risk group. Depending on the sequence used T1 differed significantly. In their study, T1 values using MOLLI was 1199 ± 28 (m sec), ShMOLLI was 1174 ± 37 (m sec) and SASHA was1487 ± 36(m sec)(44).

Application of parametric maps in non-ischemic cardiomyopathies:

Dilated cardiomyopathy: Important cause of cardiac dysfunction is “diffuse myocardial fibrosis” and has prognostic significance. Late gadolinium enhancement (LGE) can detect fibrosis only in the presence of normal myocardium elsewhere, showing a contrast between normal and scarred myocardium. *LGE* fails to detect fibrosis in diffuse myocardial fibrosis due to absence of normal myocardium. Parametric maps are useful in diffuse myocardial fibrosis and show high T1 and T2 values and lower post Gadolinium T1 values compared to the control healthy population. High native T1 value in dilated cardiomyopathy predicts adverse out come with high diagnostic accuracy.

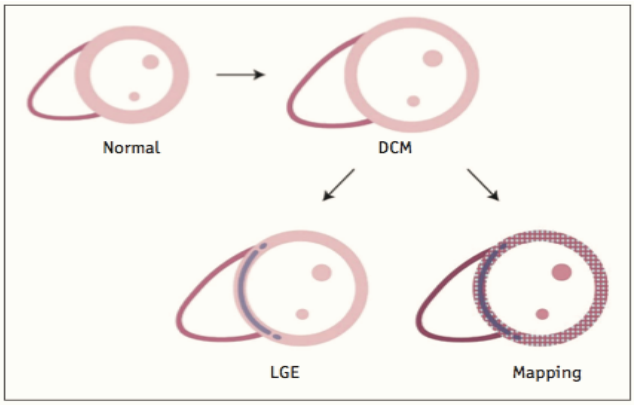


Fig13: Dilated cardiomyopathy

Image source: Myocardial T1 and T2 Mapping: Techniques and Clinical Applications. Korean J Radiol 2017;18 (1):113-131

Hypertrophic cardiomyopathy: One of the most common hereditary myocardial diseases is hypertrophic cardiomyopathy. Morphological type of HCM and the extent of fibrosis can be evaluated by cardiac MRI. Extent of fibrosis in the myocardial muscle can be evaluated by T1 maps. Diffuse interstitial fibrosis in HCM shows significant increase in native T1 and low post contrast T1values. Diffuse myocardial fibrosis in HCM, not detected by LGE can be detected by T1 mapping. Elevated T1 values correlated with increase in the myocardial muscle hypertrophy and disease severity. ECV is considered a potential biomarker to distinguish between hereditary and acquired HCM(33).

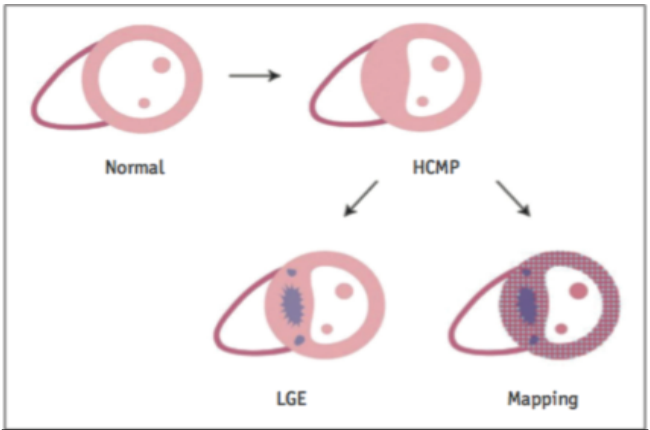


Fig.14: Hypertrophic cardiomyopathy

Image source:- Myocardial T1 and T2 Mapping: Techniques and Clinical Applications. Korean J Radiol 2017;18 (1):113-131

Amyloidosis: Cardiac involvement in amyloidosis is seen with immunoglobulin light chain or transthyretin types of amyloidosis. Being a depositional disease, infiltration and expansion of the interstitial space by amyloid is seen histologically. Endomyocardial biopsy is the mainstay of diagnosis. Global and circumferential sub endocardial enhancement being hall mark of the disease is seen late in the disease course or may not be seen. However in amyloidosis there is significant increase in the native T1 and ECV values, considered reflective of the disease process(33).

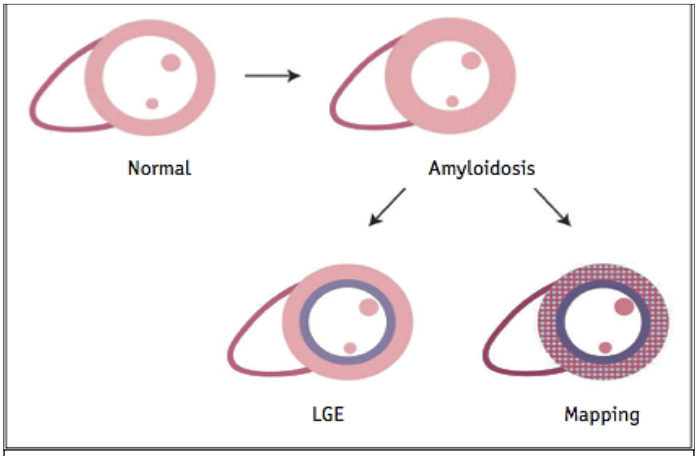


Fig.15: Amyloidosis

Image source: Myocardial T1 and T2 Mapping: Techniques and Clinical Applications. Korean J Radiol 2017;18 (1):113-131

Myocarditis: Inflammation of the myocardium by various agents causes myocarditis. Sub epicardial and mid myocardial LGE localized to the inferior and lateral walls is typically seen in myocarditis. This type of LGE is either subtle or often not seen. Underlying edema and inflammation cause significant elevation of native T1values. Distinguishing between acute and recovering phase of myocarditis is possible by T1 mapping. Myocardial edema is better detected by T2 mapping.

Fabry disease: It is a X linked storage disorder. Mutation in the gene of alpha galactosidase causes the disease. Left ventricular hypertrophy of Fabry disease has to be differentiated from other causes of LVH. LGE is seen in the inferior lateral wall in Fabry disease. Deposition of glycophosphingolipids in the myocytes in the left ventricular septum is distinctive feature of Fabry disease and cause decrease in the native T1 values(33).

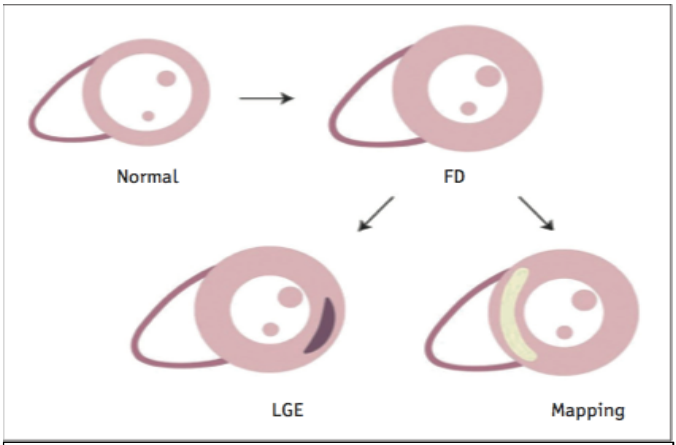


Fig.16: Fabry disease

Image source- Myocardial T1 and T2 Mapping: Techniques and Clinical Applications. Korean J Radiol 2017;18(1):113-131

Application of parametric maps in ischemic cardiomyopathies:

Acute myocardial infarction (AMI): Evaluation of acute myocardial infarction is based on the location, size, transmural extension of the infarction, micro vascular obstruction (MVO), area at risk (AAR) and hemorrhage. Both diagnosis and risk stratification can be achieved by cardiac MRI. Parametric mapping is an evolving tool in the evaluation of AMI. Acute myocardial edema due to the content of free water, increases both T1 and T2 values. So native T1 detects myocardial edema in acute myocardial infarction.

Native T1-mapping in comparison to T2-weighted CMR for detection of acute myocardial edema: For detecting acute myocardial edema T2 weighted CMR is a standard technique (45).

It is used to differentiate chronic MI and acute MI (46) and estimating of areas at risk(47). A study by Ferreira showed nativeT1-mapping with ShMOLLI is the best method for detecting myocardial edema(48). T1 mapping shows great sensitivity in the detection of free water content. For assessing myocardial edema, compared to T2-weighted imaging, T1-mapping is a complementary technique. Significantly larger area was seen in T1-mapping compared to T2-weighted methods(48). Acute myocardial infarction can be diagnosed by native T1 with correct cut off value(33).For evaluation of area at risk (AAR) after acute myocardial infarction (AMI) both T1 and T2 values showed same qualitative results(49). Areas with microvascular obstruction (MVO) have shown higher native T1 values than remote myocardium and lower native T1 values than infarcted myocardium(50).

Messroghli et al, studied the utility of T1 mapping of myocardium in acute MI(51) at 1.5 tesla MRI. Look lockers sequence (LL sequence) was used in this study. Native T1 obtained in their study, in acute myocardial infarction was 849 ± 60 ms compared to 721 ± 37 ms in controls. Post Gadolinium T1 in acute myocardial infarction was 262 ± 19 (m sec) compared to 362 ± 27 ms in controls. This study established T1 prolongation in area of infarct seen in all patients. T1 prolongation was larger in spatial extent of area of than hyper enhanced areas on LGE images. Compared to non-infarcted areas, T1 values were increased by 18± 7 % (SE $p< 0.05$) in infarcted areas. Significant reduction was seen in post contrast myocardial T1 values as compared to remote myocardium in acute myocardial infarction and the areas showing T1 reduction were same as hyper-enhanced regions on conventional T1-weighted images. Compared to non-infarcted tissue, reduction in post gadolinium T1 values by 27 ± 4% (p, 0.05) was seen in infarcted tissue. Without the use of contrast media T1 mapping can detect

myocardial necrosis. Using a combination of pre and post contrast T1 maps, much more information can be obtained that exceeds conventional contrast studies(51).

In another study by Messroghli et al evaluated acute or chronic myocardial infarction(36) by T1 mapping with modified look locker inversion recovery sequence (MOLLI). In this study, native T1 of 1011 ± 66 (acute infarction), Post Gadolinium T1 of was 494 ± 23(acute infarction), Native of 987 ± 34(chronic infarction) was reported. This study concluded that in acute and chronic infarction, pre contrast T1 values were higher than T1 values in remote myocardium(36). T1 values were different in acute and chronic MI. Precontrast threshold *T1* maps showed 96% sensitivity with 91% specificity in segmental abnormalities caused by acute MI. Study done by Dall 'Armellina et al. correlated native T1 values to the degree of myocardial damage. They compared T1, LGE and T2 values. They concluded that functional recovery after AMI could be predicted based on the T1 values(50). Intramyocardial hemorrhage can show T1 shortening effect and native T1 can detect it(52).

Chronic myocardial infarction: Cardiac MRI plays an important role in chronic MI by assessing the infarct size, edema, LV remodeling and complications. Native T1 values can help to differentiate acute and chronic MI, based on myocardial edema(36), which usually resolved 6 months after acute MI.

In a study done by Klein et al on ischemic cardiomyopathy(53) using (MOLLI) Modified look locker inversion recovery sequence, native T1 values of 720 ± 18 ms and Post gadolinium T1 values of 250 ± 30 ms were obtained in patients in contrast to native T1 values of 720 ± 11 and Post gadolinium T1 values of 340 ± 40ms in controls. This study concluded that in ischemic

cardiomyopathy, post contrast T1 values were significantly decreased compared with normal myocardium(53).

Kali et al used 3T CMRI to detect chronic MI in canine models. Transmurality and infarct size were overestimated in acute MI, on T1 mapping as compared to LGE images which was not seen in chronic MI. Chronic MI territories showed extensive replacement fibrosis on histology. Results showed high diagnostic accuracy of native T1 maps to determine the size, location and transmurality of chronic MI at 3 T. Clinical translation requires studies in patients (54).

Bauner et al studied chronic myocardial infarction(31) using MOLLI sequence. In their study native T1 was 1160 ± 80 ms and Post gadolinium T1 was 239 ± 74 ms in chronic infarction in contrast to a native T1 of 1001 ± 47 ms and Post contrast T1 of 380 ± 59 ms in controls. This study showed post gadolinium T1 values in chronically infarcted myocardium are significantly different from those in healthy normal myocardium.

Reza Nezafat et al(55) concluded that 3T native T1 mapping has great potential for replacing LGE (56).

Dastidar et al (57) tried to show that native T1 and T2 mapping can assess myocardial viability without use of gadolinium. Patients and controls underwent 1.5T to assess LV function and presence and extent of myocardial infarction (scar transmurality). MOLLI sequence with motion corrected was used. Grading of the scar was done using scale of 0-4 for 16 AHA segments. Grade 0 was no scar, Grade 1 was 1-24%, Grade2 was 25-49%, Grade3 was 50-74% and Grade 4 was >75% scar thickness. Segments < 50% LGE were considered viable. LGE viability was compared with corresponding native segmental T1and T2 values obtained from T1 maps and T2 maps. Total of 800 segments were analyzed (320 healthy controls and 480 MI patients).

(57)Mean segmental T1 and T2 values for scar transmurality grade 0-4 were, 1031 ± 31 ms, 1070±33 ms, 1103± 32 ms, 1164± 58ms and 1206± 118 ms ($p< 0.001$) respectively; For T2: Grade 0: 52± 4 ms, Grade1: 55± 4 ms, Grade2: 58± 5 ms, Grade3: 59± 8 ms, Grade 4: 66± 9 ms ($p<0.001$) in chronic MI. ROC analysis of 480 segments of chronic MI, demonstrated that native T1 mapping had an excellent diagnostic performance for myocardial viability assessment, as compared to LGE as gold standard.

Native T1 had high diagnostic accuracy for viability compared to T2 mapping, LV wall thickness and regional wall motion abnormality. In their study, T1 threshold of 1090 ms best differentiated viable and non-viable segments with sensitivity of 90% and specificity of 91%.

MATERIALS AND METHODOLOGY

Study period

Study was conducted in the department of Radiology between December 2016 and September 2017 after obtaining approval from the Institutional Review Board (IRB Min No: 10171 (OBSERVE) DATED 06.07.2016)

Study design: Prospective cross sectional descriptive study

Recruitment of subjects

Inclusion criteria:

Normal subjects: Patients who were referred for MRI of other body parts who were normotensive, non-diabetic and who did not have any cardiac risk factors and who gave consent for performing the study were included as normal subjects.

The status "normal subject" was based on:

i) No cardiac related medical history

ii) Absence of any symptoms indicating cardiovascular dysfunction

iii) Normal cardiac dimensions and function proven by cine CMR

A detailed questionnaire and assessment of available lab parameters was used to ensure that the normal subjects were free of cardiac risk factors (enclosed). The study for normal subjects was done using the fluid research grant fund, an institutional grant for the research project.

Cases: All patients referred for cardiac MRI between December 2016 and September 2017 for myocardial viability assessment and who had given their consent for the study were included in the study.

In addition to routine cardiac MRI sequences, native T1, post contrast T1 and T2 mapping were done. Contrast injection (gadolinium) was part of all routine cardiac MR studies.

Informed consent: Informed consent (enclosed) was taken by the principal investigator.

Exclusion criteria: Patients who were not able to co-operate were excluded from the study. Patients with contraindications for gadolinium injection (like reduced GFR less than 30ml/min) were also excluded. No vulnerable groups (e.g., pregnant women, children) were enrolled in the study.

Sampling strategy: Consecutive patients referred for cardiac MRI and who gave consent for the research project voluntarily, were recruited for the study.

Sample size calculation: Required sample size to show the difference in T1 of 17.5 units (17 cardiac segments per patient) with 80% power and 5% level of significance with variability of 126 units (RadioGraphics 2014; 34:1594–1611) was found to be 814*2 = 1628 segments (50 healthy controls and 50 patients)

Data collection

*Demographic details:*_Relevant data like history of risk factors (age, sex, family history, smoking, hypertension, dyslipidemia, diabetes mellitus, and obesity), number of years of hypertension and diabetes were collected using a questionnaire which was part of the clinical research form (enclosed). Indication for referral was noted. Weight and height, systolic and diastolic blood pressure along with lipid profile values were also documented. Patients were asked questions about his/her medical history and the medication(s) he/she was taking.

Demographic data were also collected from the patient records and direct patient interview before the cardiac MRI.

MRI Machine: All examinations were performed in 1.5T clinical MRI system (Siemens Magnetom Avanto fit, Erlangen, Germany).

Technical details of the MRI machine: System length: 160 cm, Bore size: 60cm, system weight 5.3 tons, RF Tim:204x48, Gradient strength: SQ Gradients (45mT/m@200T/m/s), Helium composition: zero helium boil-off technology. Total imaging matrix (TIM) – integrated coil technology, provides up to 204 coil elements and 48 channels. Dot Go- an MRI exam software helps in streamlining the protocols. It is powered by new syngo MR E11 software – platform.

Details of the MRI procedure

The procedure was explained to the patients and normal subjects in detail and the 'patient information sheet' was given, following which an informed consent was obtained.

Normal subjects: After completing their regular MRI, ECG leads were placed and T1 and T2 mapping was performed followed by post contrast T1 mapping. In addition, short axis cine images of heart and LV function calculation were done to ensure that ejection fraction was normal. It took an additional of 3-5 minutes for T1andT2 mapping of the myocardium in controls.

Cases

Sequences performed in cases were:

* Routine SSFP axial sections of the thorax covering the heart, from apex to base

* SSFP cine sequences in 4 chamber, 2 chamber and short axis views from base to apex

* Native T1 and T2 mapping was done in short axis view at three levels, including basal segment, mid cavity and apical segment, 2 chamber and 4 chamber view

* Gadolinium was admistered IV, at a dose of 0.1 m mol/kg. Late Gadolinium scans were acquired 10 minutes after IV injection of contrast agent Gadolinium, after nulling the myocardium in the short axis, 2 chamber and 4 chamber view with magnitude and PSIR (phase sensitive inversion recovery) images.

Inversion Recovery (IR) pulses were used to null the signal from normal myocardium during delayed enhanced imaging, so that enhancement of the abnormal myocardium is well appreciated. TI scout images or look locker images were performed where each image in the series has a progressively larger TI and the appropriate TI time at which the normal myocardium is dark or nulled was chosen for the late gadolinium enhancement images. Inversion time is usually 330 msec after the RF pulse, but varies from person to person.

***** Post contrast T1 mapping images done.

17 cardiac segment model as described by the American Heart Association was used to describe the T1 and T2 mapping.

Personnel: Cardiac MRI was done by trained radiographers from department of Radiology, who were well versed with cardiac imaging. No additional training was required to perform T1 and T2 mapping.

Details of T1 and T2 mapping sequences: The native T1, post contrast T1 mapping cardiac MRI scans were performed using the MOLLI sequence on 1.5-T MRI scanner (1.5T Siemens Magne-tom Avanto fit). Modified Look-Locker inversion recovery sequence (MOLLI) T1 mapping were done with FOV 320 × 320; TR/TE/flip-angle: 3.3 ms/1.57 ms/50°, interpolated voxel size

0.9 × 0.9 × 8 mm, phase encoding steps n = 166, HR adapted trigger delay, with 11 (3-3-5) phase sampling arrangements.

T1 mapping: T1 mapping with Myomaps was performed using an inversion recovery based pulse sequence. The software provides a flexibe interface to enable evaluation of myocardial tissue T1 relaxation time.Native T1 values of the myocardial tissue were evaluated using long T1 protocols.

FOV of 360 x 360; slice thickness 8 mm; TR 279.84 ms; TE 1.13 ms was used. 8 images with varying inversion times (TI values), with wide range from 120 to 3800 were used from which computer generated color coded maps of the T1 relaxation times were obtained, after motion correction.

In addition, another Seimens sequence of short T1 was also acquired, where images with 9 different inversion times with shorter range from 120 to 1800. T1 short sequence had FOV 360 x 360; slice thickness 8 mm; TR 359.84 ms; TE 1.13 ms.

T2 mapping used FOV 360 x360; slice thickness 8 mm; TR 193.27 ms; TE 1.07 ms.

T2 had different prep times of 0, 25, 55 msec.

T1 (T1 short and T1 long) T2 and T1 post gadolinium mapping were displayed using standard color maps.

Measuring T1 and T2 Values: T1 and T2 values in all the segments in normal subjects as well as patients (including normal myocardium, hibernating segments and infarcted segments) were recorded by the primary investigator from the above sequences and was checked by guide / co-guide.

Manually drawn ROIs were used to measure the T1 and T2 values. Small ROI <20 pixel were avoided. Large drawing ROIs covering complete area of each segment was used. ROIs were placed accurately in the central myocardium on the color maps, avoiding partial volume artifacts of adjacent blood pool and extra cardiac tissue.

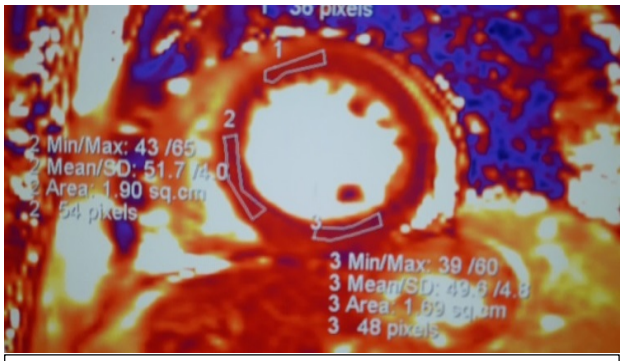


Fig.17: Manually drawn large segmental ROIs

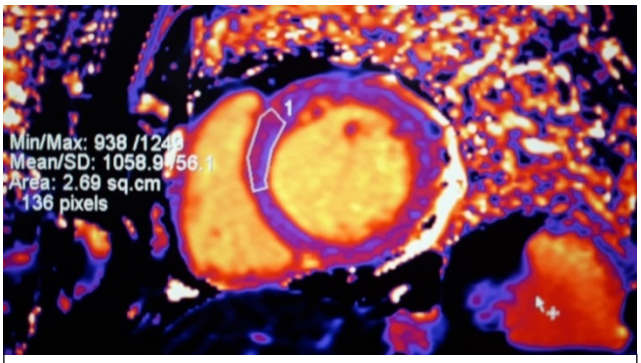


Fig.18: Manually drawn large segmental ROIs

T1 and T2 relaxation times of the LV myocardium were recorded for the 17 cardiac segments on short axis views as well as the 4 chamber and 2 chamber views, in patients and normal subjects. At the time of recording the T1 and T2 values, the investigator was blinded to the findings on the rest of the images including the findings on LGE images. Following this, MRI scans were reported in a standardized format and checked by Guide / co-guides. Other findings including segments of wall motiona abnormality. late Gadolinium enhancement and final diagnosis based on clinical and routine cardiac MRI sequences were also documented.

Recording MRI Findings

We followed the 17 segment model of the heart, described by the American Heart association for T1 and T2 mapping of the myocardium.

17-Segment Model (AHA):

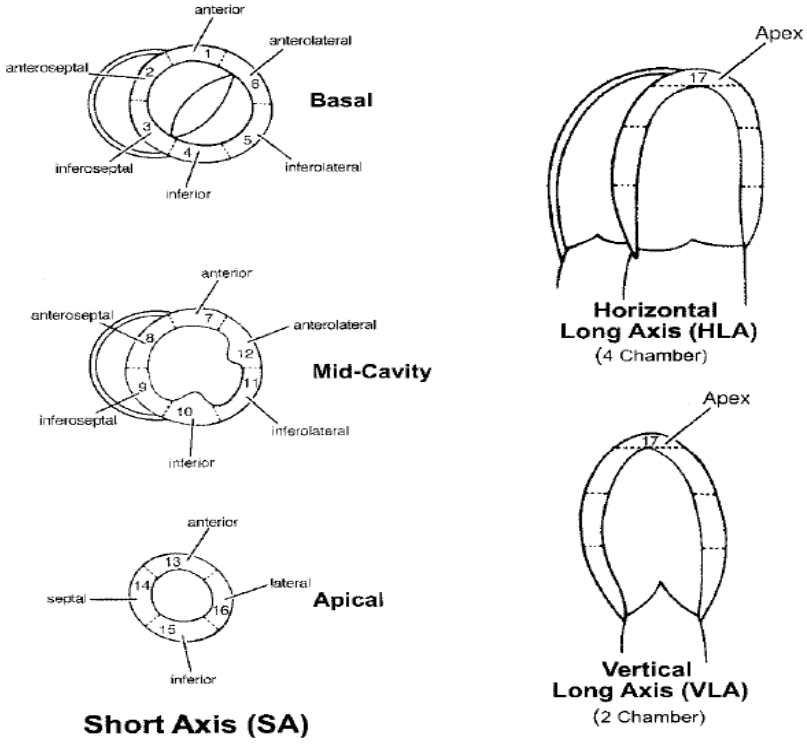


Fig.19: Seventeen segment model of the heart

T1 Mapping – Native T1 relaxation times in all segments were documented by manually drawn region of interest on the computer generated color maps for complete area of each segment.

T2 Mapping – T2 relaxation times in all segments was documented by manually drawn region of interest on the computer generated color maps for complete area of each segment.

T1 Post Gadolinium Mapping – Post contrast T1 relaxation times in all segments was documented by manually drawn region of interest on the computer generated color maps for complete area of each segment.

Wall motion abnormality was scored qualitatively by visual assessment as follows:

0 – normal; 1 - Mild or moderate hypokinesia; 2 - Severe hypokinesia; 3 - Akinesia, and

4 – Dyskinesia

Late gadolinium enhancement (LGE) was scored as follows: 0 – No late gadoliniumlium enhancement; 1 - LGE of 1 to 25% thickness of the myocardium; 2 - LGE of 26 to 50% thickness of the myocardium; 3 - LGE of 51 to 75% thickness of the myocardium.

4 - LGE of 76 to 100% thickness of the myocardium; <50% LGE was taken as viable myocardium.

Based on the final diagnosis on the routine cardiac MRI images including the late gadoliniumlium enhancement images, all subjects included in the study were categorized as follows, for further statistical analysis -

Category 0: healthy normal control.

Category 1: normal segments in MI patients (no LGE or wall motion abnormality).

Category 2: hibernating myocardium (wall motion abnormality with no LGE).

Category 3: Infarct with residual viable myocardium (wall motion abnormality with LGE in 1 - 24%thickness of myocardium).

Category 4: Infarct with residual viable myocardium (wall motion abnormality with LGE in 26-49% thickness of myocardium).

Category 5: Infarct with no significant residual viable myocardium (wall motion abnormality with LGE in 50-74% thickness of myocardium).

Category 6: Infarct with no residual viable myocardium (wall motion abnormality with LGE in >75% thickness of myocardium or transmural infarct).

These categories were assigned at a later stage and at the time of recording the T1 and T2 values, the principal investigator was blinded to the categories.

RESULTS AND ANALYSIS

Data was entered using EPIDATA software and screened for outliers and extreme values using Box-Cox plot and histogram (for shape of the distribution). All the statistical analysis was performed using SPSS 18.0 and Dx test software.

A total number of 71 people underwent cardiac MRI for T1 and T2 mapping of the myocardium. Out of these, 31 were healthy normal controls and 40 were patients with myocardial infarction who were referred for viability CMRI.

Demography:

A. Age distribution: The mean age of the subjects included in the study was 42 years in controls and 56years in patients.

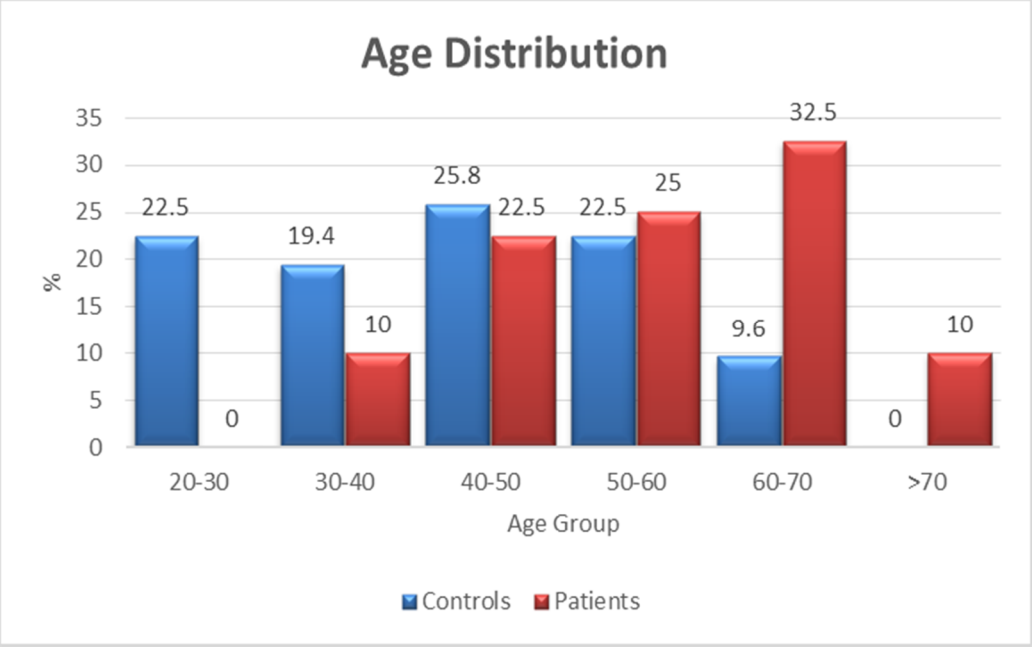


Fig 20: Age distribution

B. Gender: 68% (No.: 20) were males and 32 % (No.:10) were females in controls. 85% were males (No.:34) and 15% were females (No.:6) in the patient group

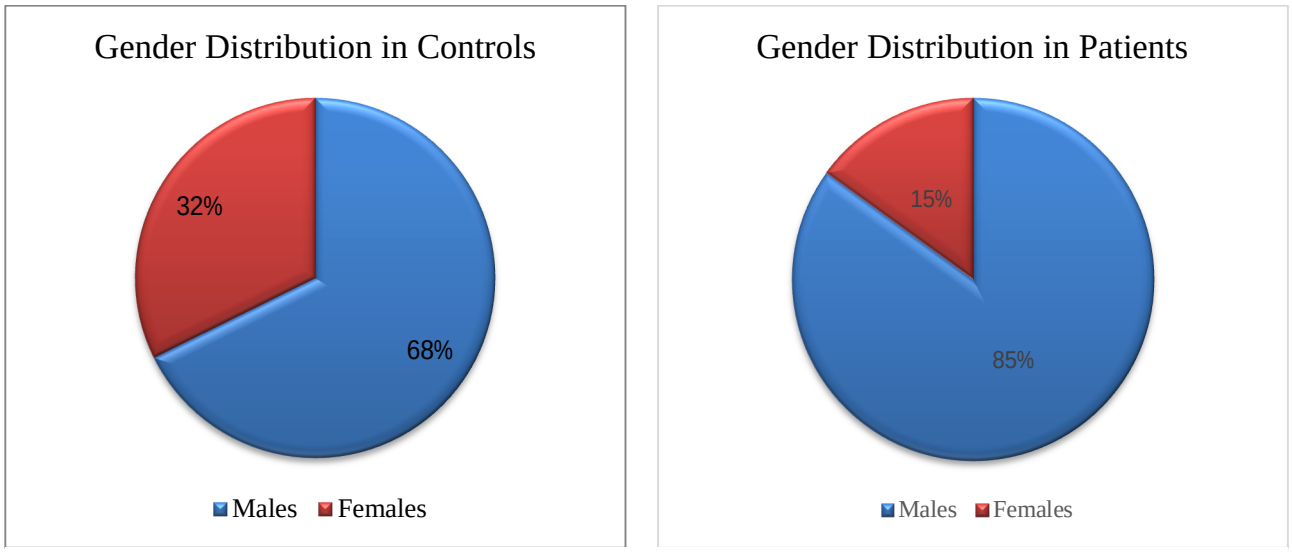


Fig.21: Gender distribution in Control group and Patients

C. Risk profile: Most prevalent risk factor in the study patients was diabetes (35%) and hypertension (21%). Family history and smoking were other risk factors.

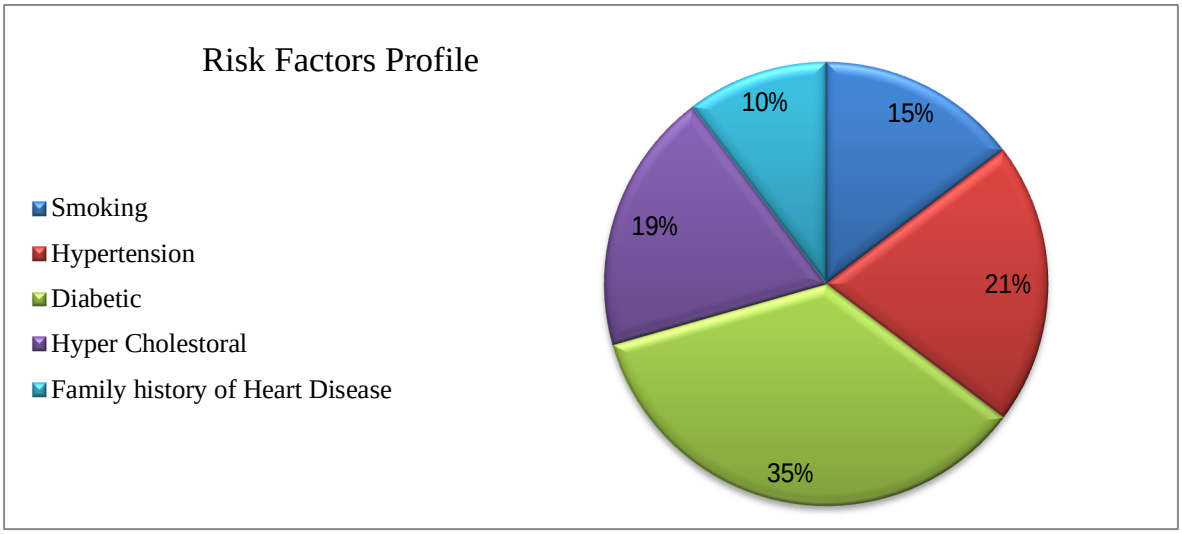


Fig.22: Risk profile

Number of myocardial segments analyzed

Total number of myocardial segments in 71 subjects, including normal controls and myocardial infarction patients, including all the segments that could be assessed on short axis, 4 and 2 chamber images were 1775. Out of these 98% (No: 1731) segments were analyzed and 2 % (No: 44) of the segments could not be assessed due to artifacts and other reasons.

Of the segments that could be analyzed, 58% (1000 segments) were from patients and 42% (731 segments) were from controls.

Based on the final diagnosis on the routine cardiac MRI images including the late gadoliniumlium enhancement images, all subjects included in the study were categorized as follows, for further statistical analysis -

Category 0: healthy normal control.

Category 1: normal segments in MI patients (no LGE or wall motion abnormality).

Category 2: hibernating myocardium (wall motion abnormality with no LGE).

Category 3: Infarct with residual viable myocardium (wall motion abnormality with LGE in 1 - 24%thickness of myocardium).

Category 4: Infarct with residual viable myocardium (wall motion abnormality with LGE in 26-49% thickness of myocardium).

Category 5: Infarct with no significant residual viable myocardium (wall motion abnormality with LGE in 50-74% thickness of myocardium).

Category 6: Infarct with no residual viable myocardium (wall motion abnormality with LGE in >75% thickness of myocardium or transmural infarct).

Of the total number of segments analyzed in patients, 37% of segments were considered to be normal (category 1) on conventional CMRI as they did not show any wall motion abnormality or abnormal enhancement. 33 % of analyzed segments were in category 6 (i.e. these segments showed hypo or akinesia and >75% to transmural late gadolinium enhancement).

Segments with infarcts, but, significant residual viable myocardium were 23%.

No of hibernating segments (Group 2): 15%.

No of segments with < 25 % infarction (Group 3): 2%.

No of segments with <50% infraction (Group 4):6%.

Thus 23 % of segments could potentially show improvement after revascularization procedures.

Total non-viable segments was 40%

No of segments with 50-75% infarction were7%

No of segments with >75% infarction were 33%

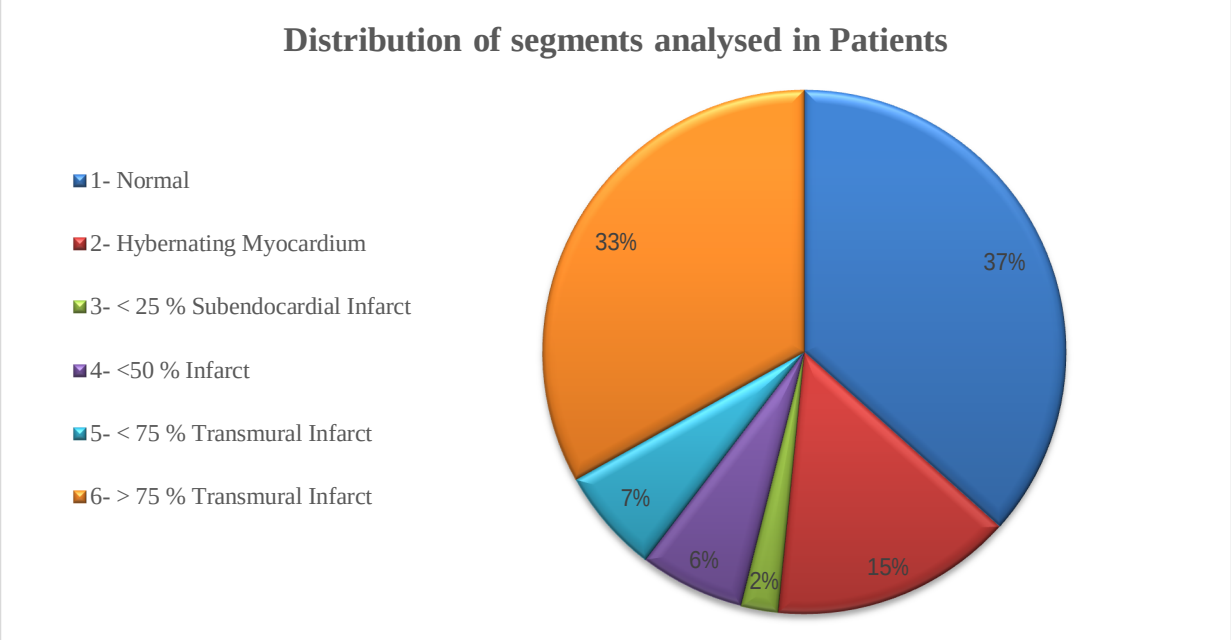


Fig.23: Distribution of different categories in the segments analyzed in patients

Groups in Patients	Frequency	Percent
1-Normal	366	36.6
2-Hibernating	150	15.0
3-< 25% Subendocardial	23	2.3
4 < 50% of myocardial	65	6.5
5 < 75% of transmural	65	6.5
6 - > 75% transmural	331	33.1
Total	1000	100.0

Table.1: No. of segments in each group

T1 and T2 Mapping

ANOVA was used to compare T1 Short, T1 Long, T2 and Post-gadolinium T1 values in the different categories, with the normal values obtained from healthy normal subjects. A receiver-operating characteristic analysis was performed to calculate areas under the curves and the Youeden Index was used to depict optimal cutoff values from the receiver-operating characteristic curves

A. Mean segmental T1 and T2 values in the controls:

T1 short: 956.57 ± 65.6 ms,

T1 long: 1040.47±74 ms,

T2: 51.3±16 ms

post gadolinium T1: 561.65 ±70 ms

B. Group 1(Normal appearing segments in patients):

1-Normal in patients	T1short	T1long	T2	post_gadolinium
Mean	**993.70**	**1077.09**	**53.21**	**516.05**
Median	**987.00**	**1069.00**	**52.00**	**505.00**
Std. Deviation	**62.975**	**75.580**	**5.631**	**89.054**
Range	**534**	**475**	**41**	**870**
Minimum	**777**	**912**	**39**	**289**
Maximum	**1311**	**1387**	**80**	**1159**

Table.2: T1, T2 values of group 1-Normal segments in patients

Mean segmental T1 and T2 values group 1(Normal appearing segments in patiensts):

Native T1 (long T1): 1077.90 ±75.5 ms

T1 short: 993.70± 62.9 ms

T2 : 53.21±5.6 ms

T1 post Gadolinium: 516.05± 89 ms

T1, T2 values in the normal appearing segments (with no LGE or RWMA) in myocardial infarction patients were higher in comparison with healthy controls. Post gadolinium T1 values of normal segments (no LGE and RWMA) in myocardial infarction patients were lower in comparison with healthy controls. This suggests that even the seemingly normal segments in patients with myocardial infarction in other areas, are actually abnormal. LV remodeling and adverse cardiac event possibly causes increase in the native T1 in remote areas of the heart.

Group-1-Normal		Mean	Std. Deviation
T1 short	Normal	956.57	65.641
	Abnorm	993.70	62.975
T1 long	Normal	1040.47	74.391
	Abnorm	1077.09	75.580
T2	Normal	51.32	16.791
	Abnorm	53.21	5.631
T1 – post gadolinium	Normal	561.65	70.639
	Abnorm	516.05	89.054

t-test for Equality of Means			
	P- Value	Mean Difference	Std. Error Difference
T1 short	.000	-37.128	4.338
	.000	-37.128	4.277
T1 long	.000	-36.614	4.861
	.000	-36.614	4.885
T2	.041	-1.893	.924
	.008	-1.893	.717
T1 – post gadolinium	.000	45.600	5.676
	.000	45.600	6.130

Table.3: Comparison between Controls and group 1-Normal in patients and t-test

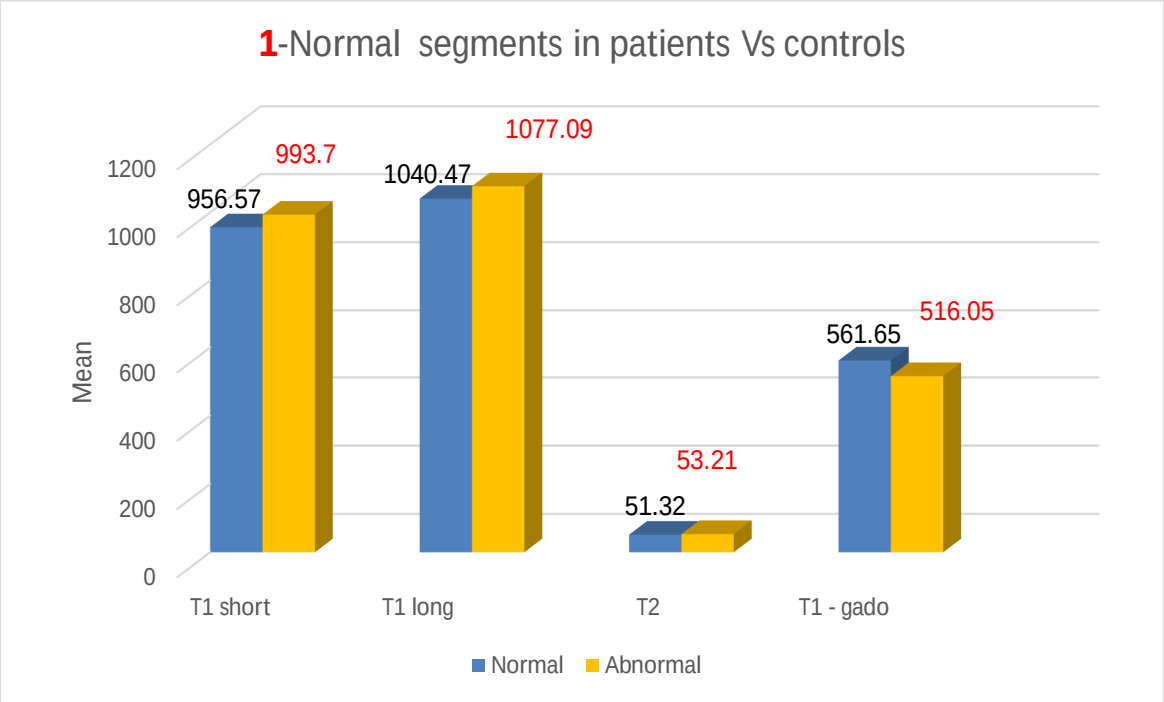


Fig. 24: Comparison of T1, T2 and post gadoliniumlinium T1 values between Controls and group 1- (Normal appearing segments on conventional MRI, in patients)

C. Group 2: hibernating myocardium:

2-Hibernating	T1short	T1long	T2	post_gad
Mean	**1066.56**	**1101.56**	**53.20**	**513.86**
Median	**1009.00**	**1100.00**	**52.00**	**513.00**
Std. Deviation	**600.035**	**74.569**	**5.100**	**86.112**
Range	**340**	**577**	**33**	**360**
Minimum	**861**	**917**	**43**	**318**
Maximum	**1201**	**1494**	**76**	**678**

Table.4: T1, T2 values of group 2-Hibernating Myocardium

Mean Segmental T1 and T2 values in group 2: hibernating myocardium:

T1 short: 1066.56± 600ms

T1 long: 1101.56±74.5ms

T2: 53.2± 5.1ms

T1 post gadolinium: 513.86±86 ms

Segments with regional wall motion abnormality, but, no LGE, suggesting hibernating myocardium (Group: 2) also showed difference in the T1 and T2 values as compared to normal subjects which was statistically significant with $p<0.05$ and with 95% confidence intervals.

Group-2-Hibernating		Mean	Std. Deviation
T1 short	Normal	956.57	65.641
	Abnormal	1066.56	600.035
T1 long	Normal	1040.47	74.391
	Abnormal	1101.56	74.569
T2	Normal	51.32	16.791
	Abnormal	53.20	5.100
T1 - Gadolinium	Normal	561.65	70.639
	Abnormal	513.86	86.112

t-test for Equality of Means			
	P-Value	Mean Difference	Std. Error Difference
T1 Short	.000	-109.991	23.688
	.030	-109.991	50.241
T1 Long	.000	-61.092	6.759
	.000	-61.092	6.769
T2	.182	-1.881	1.409
	.016	-1.881	.777
T1 - Gadolinium	.000	47.789	6.855
	.000	47.789	7.684

Table. 5: Comparison between Controls and group 2-Hibernating Myocardium and t-test

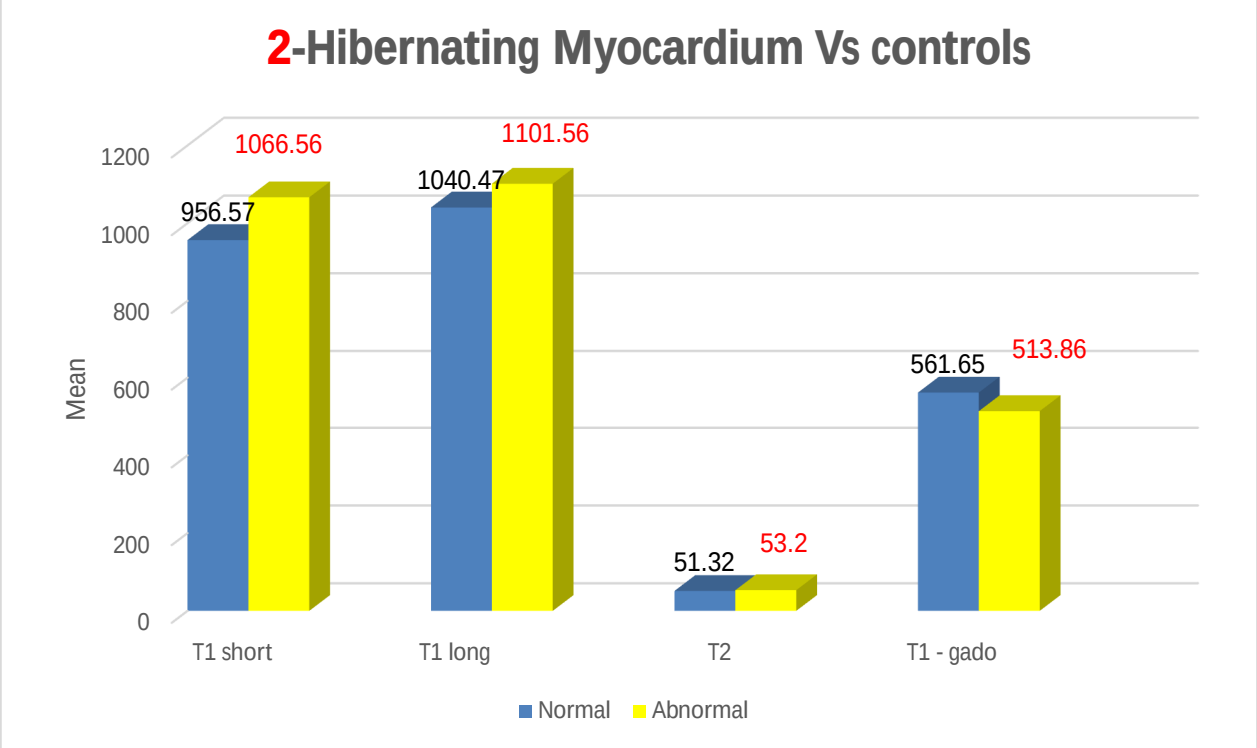


Fig. 25: T1,T2 values of group 2-Hibernating Myocardium

D: Group 3 < 25% sub endocardial infarction:

3-< 25% Sub-endocardial Infarct	T1short	T1long	T2	post_gadolinium
Mean	**1042.94**	**1149.09**	**56.05**	**570.83**
Median	**1030.50**	**1149.50**	**54.00**	**606.00**
Std. Deviation	**66.719**	**97.564**	**6.344**	**72.352**
Range	**275**	**439**	**23**	**215**
Minimum	**943**	**964**	**49**	**437**
Maximum	**1218**	**1403**	**72**	**652**

Table.6: T1, T2 values of group 3- < 25 % sub endocardial Infarction

Mean segmental T1 and T2 values in group 3 < 25% sub endocardial infarction:

In Group 3, mean

T1 short was 1042.94±66.7 ms,

T1 long: 1149.09±97.5 ms,

T2:56±6.3 ms and

T1post Gadolinium was 570.83±72 ms

which was again significantly different from normal controls with p value of <0.05.

Group-3-< 25% Sub-endocardial Infarct		Mean	Std. Deviation
T1 short	Normal	956.57	65.641
	Abnormal	1042.94	66.719
T1 long	Normal	1040.47	74.391
	Abnormal	1149.09	97.564
T2	Normal	51.32	16.791
	Abnormal	56.05	6.344
T1 - Gadolinium	Normal	561.65	70.639
	Abnormal	570.83	72.352

t-test for Equality of Means			
	P-Value	Mean Difference	Std. Error Difference
T1 Short	.000	-86.376	15.683
	.000	-86.376	15.928
T1 Long	.000	-108.618	16.281
	.000	-108.618	20.992
T2	.199	-4.729	3.675
	.004	-4.729	1.530
T1 - Gadolinium	.588	-9.186	16.928
	.602	-9.186	17.314

Table.7: Comparison between Controls and group 3- < 25 % Sub endocardial Infarct and t-test

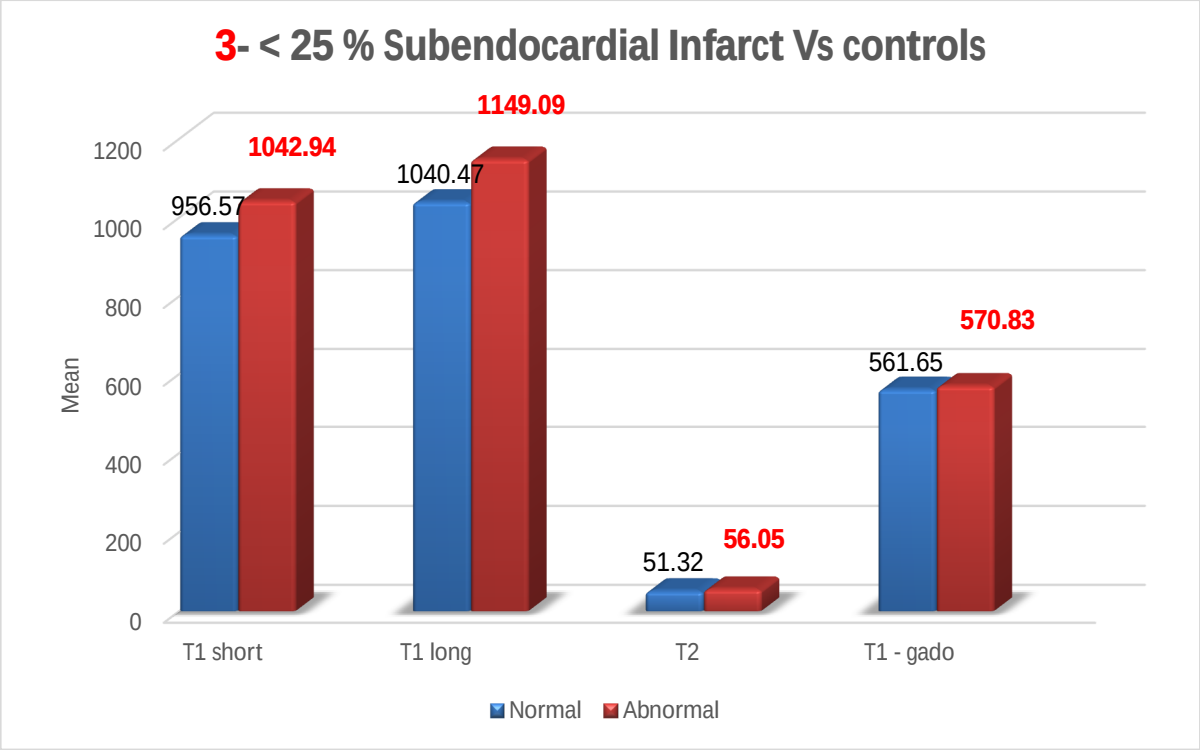


Fig.26: Comparison between Controls and group 3- < 25 % Sub endocardial Infarct

E: Group 4 < 50% of myocardial infarction:

4 - < 50% of myocardial infarction	T1short	T1long	T2	post_gadolinium
Mean	**983.78**	**1082.05**	**52.68**	**488.73**
Median	**988.00**	**1078.00**	**52.00**	**484.00**
Std. Deviation	**137.751**	**73.069**	**5.038**	**65.401**
Range	**406**	**346**	**26**	**289**
Minimum	**820**	**958**	**43**	**347**
Maximum	**1226**	**1304**	**69**	**636**

Table8: T1, T2 values of group 4- <50 % Infarct

Mean segmental T1 and T2 values in group 4 < 50% of myocardial infarction:

Group 4: T1 short: 983.7 ±137 ms,

T1 long: 1082±73 ms,

T2:52.6±5 ms,

T1 post gadolinium: 488.7±65 ms, $p<0.05\%$.

Native T1 shows significant relation to the degree of myocardial damage assessed by late gadolinium enhancement. Myocardial segments with <50% infarction are considered viable.T1 values predict the functional recovery after MI. Mean T1 long 1082±73 ms of group 4 can potentially be taken as cut- off to differentiate viable and non-viable myocardium.

Group-4 < 50% of myocardial infarction		Mean	Std. Deviation
T1 short	Normal	956.57	65.641
	Abnormal	983.78	137.751
T1 long	Normal	1040.47	74.391
	Abnormal	1082.05	73.069
T2	Normal	51.32	16.791
	Abnormal	52.68	5.038
T1 - Gadolinium	Normal	561.65	70.639
	Abnormal	488.73	65.401

t-test for Equality of Means			
	P-Value	Mean Difference	Std. Error Difference
T1 Short	.005	-27.212	9.755
	.123	-27.212	17.403
T1 Long	.000	-41.574	9.636
	.000	-41.574	9.494
T2	.521	-1.364	2.126
	.135	-1.364	.909
T1 - Gadolinium	.000	72.915	9.838
	.000	72.915	9.237

Table.9: Comparison between Controls and group 4- <50 % Infarct and t-test

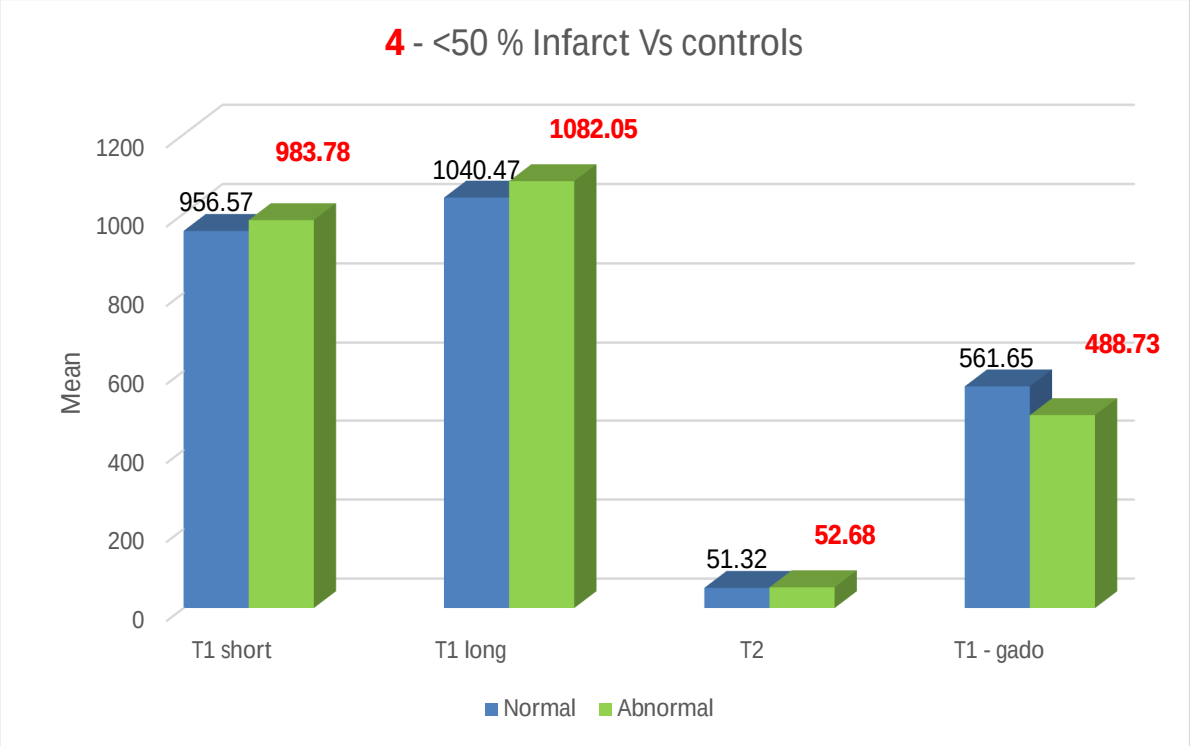


Fig.27: Comparison between Controls and group 4- <50 % Infarct

F: Group 5 (50- 75% of transmural infarction):

5 - < 75% of transmural infarction	T1short	T1long	T2	post_gadolinium
Mean	**1018.32**	**1115.78**	**55.40**	**427.62**
Median	**1022.00**	**1107.00**	**55.00**	**427.00**
Std. Deviation	**106.340**	**104.333**	**7.161**	**114.284**
Range	**620**	**777**	**45**	**390**
Minimum	**671**	**816**	**45**	**231**
Maximum	**1291**	**1593**	**90**	**621**

Table10: T1, T2 values of group 5- < 75 % Transmural Infarct

Mean segmental T1 and T2 values in group 5 (50- 75% of transmural infarction):

Group 5: T1 short: 1018.32±106 ms,

T1 long: 1115.78±104 ms,

T2:55.4± 7ms,

T1 post gadolinium: 427.6±114 ms, $p<0.05\%$

Myocardial segments with 50-75% thickness of LGE are non-viable segments and there is low chance of improvement after revascularization procedures. In this group, native T1 was less accurate while, post contract T1 values were more accurate in the detection non-viable infarction.

Group 5 < 75% of transmural infarction		Mean	Std. Deviation
T1 short	Normal	956.57	65.641
	Abnormal	1018.32	106.340
T1 long	Normal	1040.47	74.391
	Abnormal	1115.78	104.333
T2	Normal	51.32	16.791
	Abnormal	55.40	7.161
T1 - Gadolinium	Normal	561.65	70.639
	Abnormal	427.62	114.284

t-test for Equality of Means			
	P-Value	Mean Difference	Std. Error Difference
T1 Short	.000	-61.747	9.602
	.000	-61.747	14.310
T1 Long	.000	-75.309	10.104
	.000	-75.309	13.345
T2	.053	-4.081	2.102
	.000	-4.081	1.101
T1 - Gadolinium	.000	134.025	11.577
	.000	134.025	17.297

Table11: Comparison between Controls and group 5- < 75 % Transmural Infarct

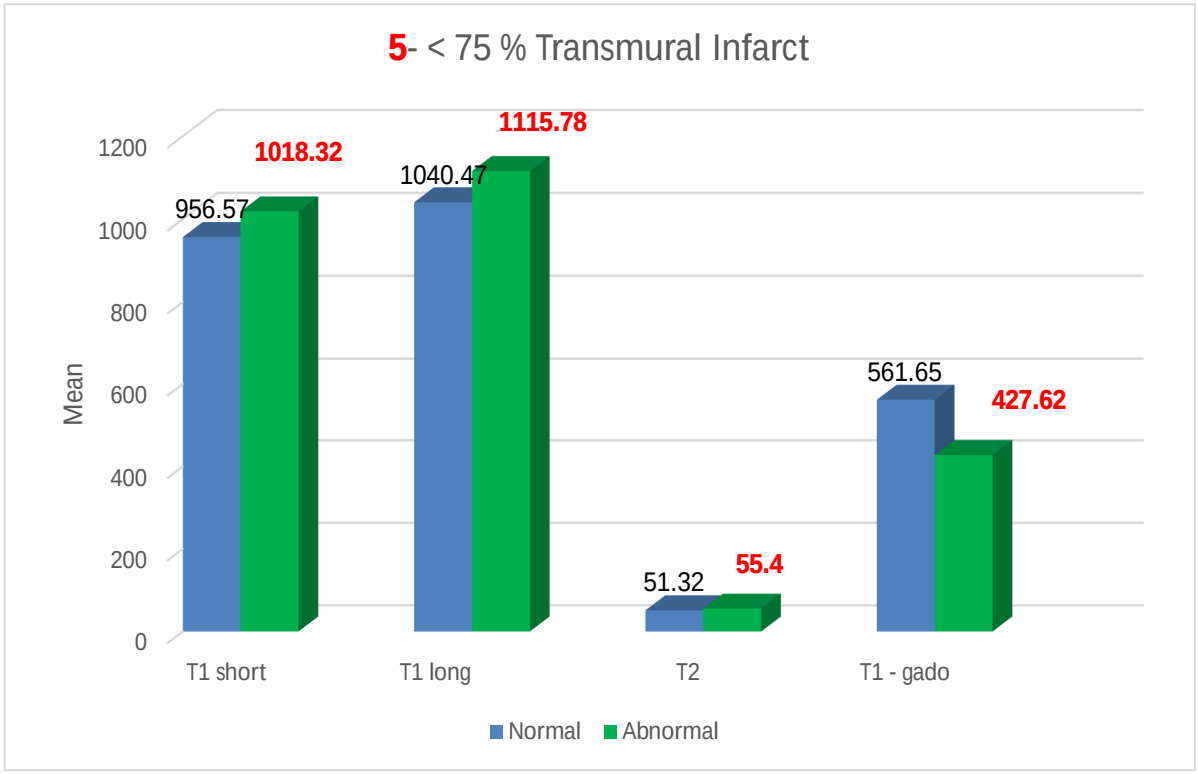


Fig.28: Comparison between Controls and group 5- < 75 % Transmural Infarct

G: Group 6 > 75% transmural infarction:

6 - > 75% transmural infarction	T1short	T1long	T2	post_gadolinium
Mean	**1037.46**	**1125.17**	**58.11**	**420.93**
Median	**1030.00**	**1116.00**	**56.00**	**410.00**
Std. Deviation	**112.689**	**111.933**	**8.992**	**113.989**
Range	**916**	**895**	**53**	**944**
Minimum	**574**	**646**	**39**	**230**
Maximum	**1490**	**1541**	**92**	**1174**

Table12: T1, T2 values of group 6- > 75 % Transmural Infarct

Mean segmental T1 and T2 values in group 6 > 75% transmural infarction:

Group 6: T1 short: 1037.46±112 ms,

T1 long: 1125±17 ms,

T2:58.11±8ms,

T1 post gadolinium: 420.9±113 ms, $p<0.05\%$.

Group 6 > 75% transmural infarction		Mean	Std. Deviation
T1 short	Normal	956.57	65.641
	Abnormal	1037.46	112.689
T1 long	Normal	1040.47	74.391
	Abnormal	1125.17	111.933
T2	Normal	51.32	16.791
	Abnormal	58.11	8.992
T1 - Gadolinium	Normal	561.65	70.639
	Abnormal	420.93	113.989

	t-test for Equality of Means		
	P-Value	Mean Difference	Std. Error Difference
T1 Short	.000	-80.891	5.699
	.000	-80.891	6.834
T1 Long	.000	-84.695	5.940
	.000	-84.695	6.849
T2	.000	-6.793	1.013
	.000	-6.793	.827
T1 - Gadolinium	.000	140.716	6.357
	.000	140.716	7.321

Table13: Comparison between Controls and group 6- > 75 % Transmural Infarct

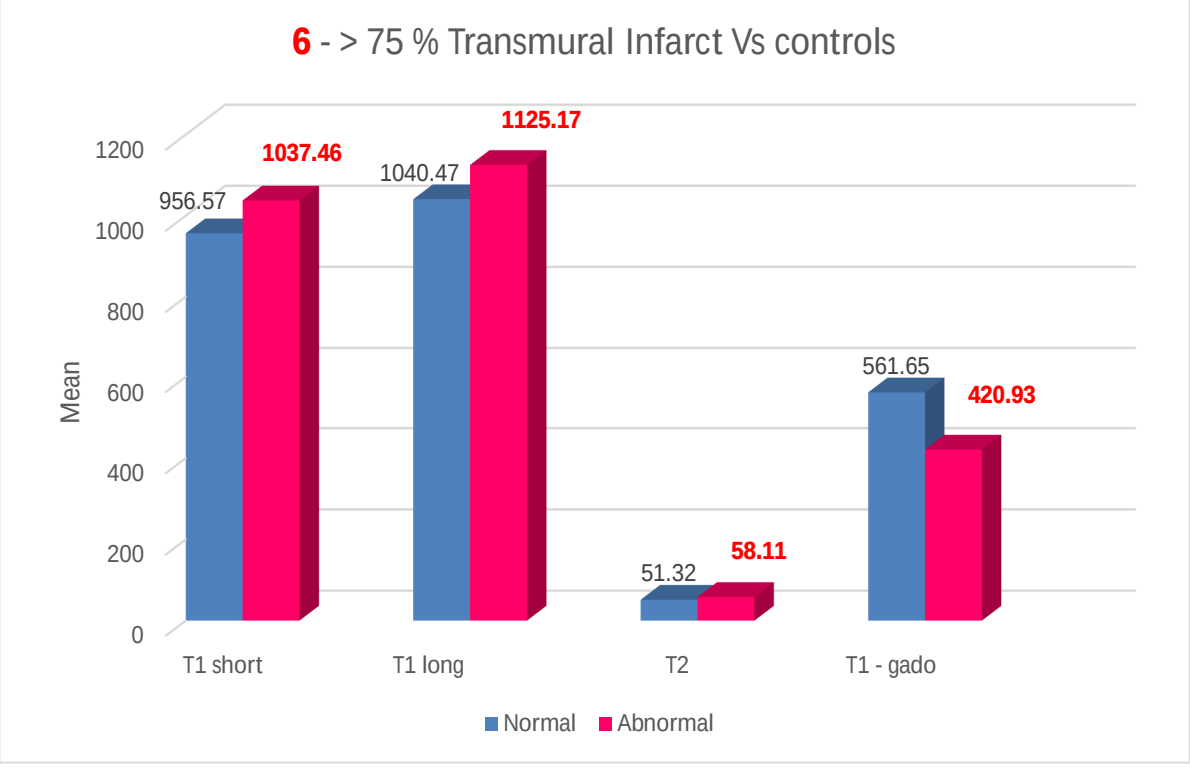


Fig.29: Comparison between Controls and group 6- > 75 % Transmural Infarct

Diagnostic accuracy of native T1 values was better than T2 values in the assessment of different groups of myocardial infarctions.

Ranges of T1 values (short and long), T2 values and post gadolinium T1 values in the different categories are shown below.

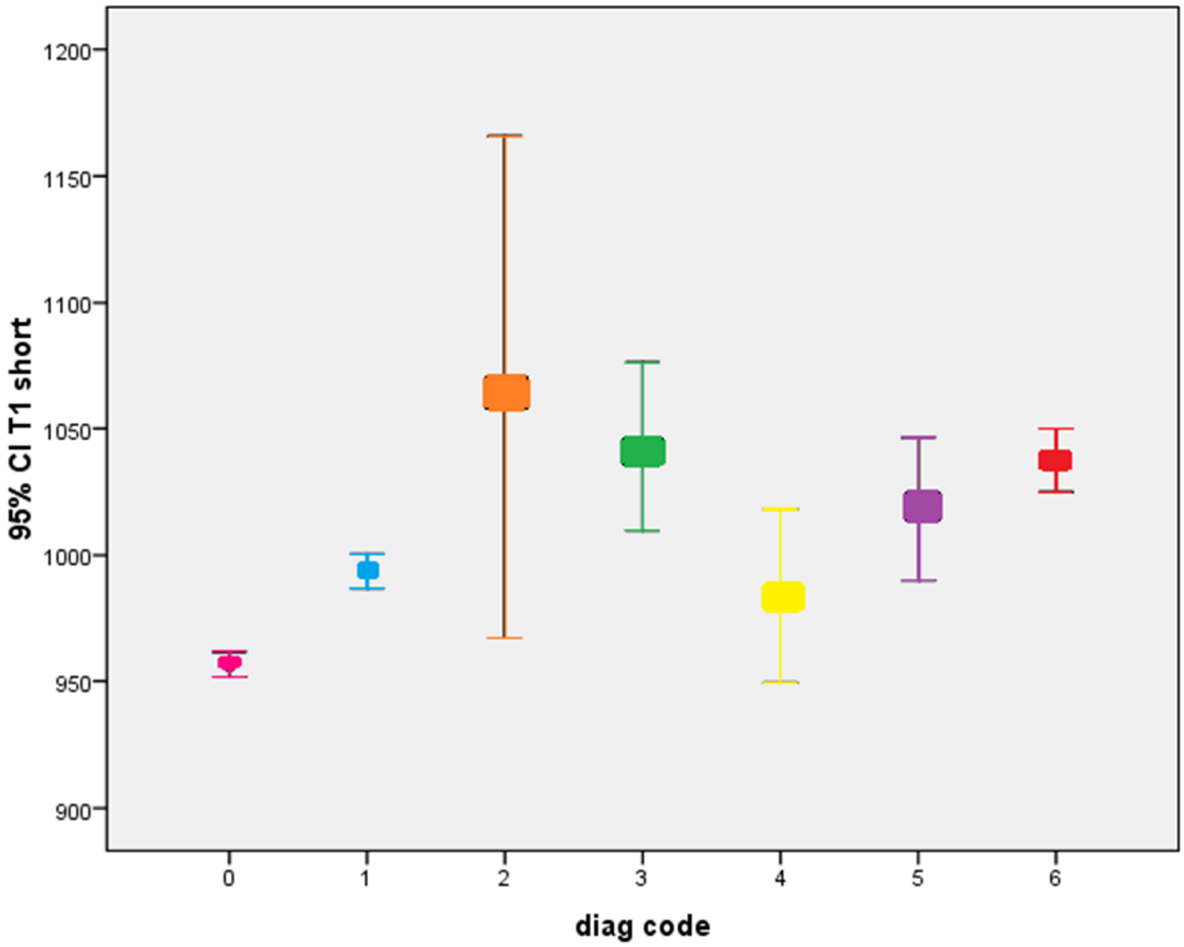


Fig.: 30

For T1 values assessed by short T1 method, controls and normal segments in patients showed very narrow range of values, which significantly differed from each other. Similarly, the range of values in segments with different degrees of infarcts was different from controls except in group 4, which showed

overlap with normal values. Overlap in the ranges of viable (groups 3 and 4) and non-viable infarcts (groups 5 ad 6) is also evident.

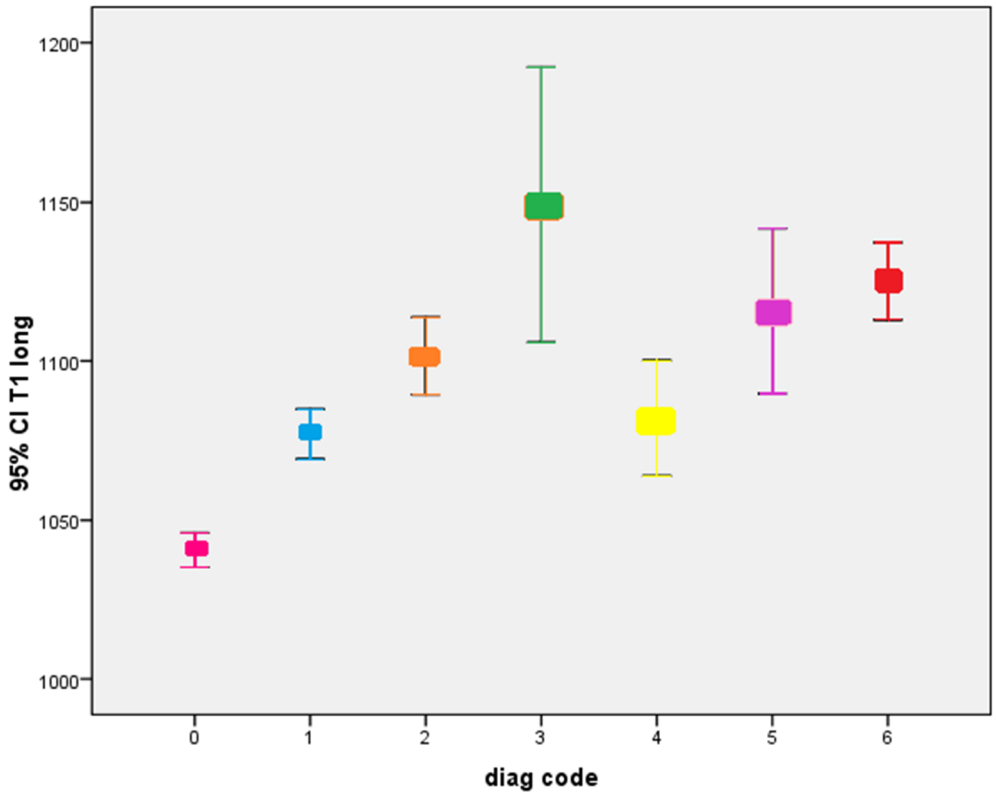


Fig. 31

For T1 values assessed by long T1 method, Controls and normal segments in patients showed a narrow range of values, which significantly differed from each other. Similarly, all types of segments in patients differed from controls. Again, overlap in the ranges of viable (groups 3 and 4) and non-viable infarcts (groups 5 ad 6) was present, but, to a lesser degree than short T1 method.

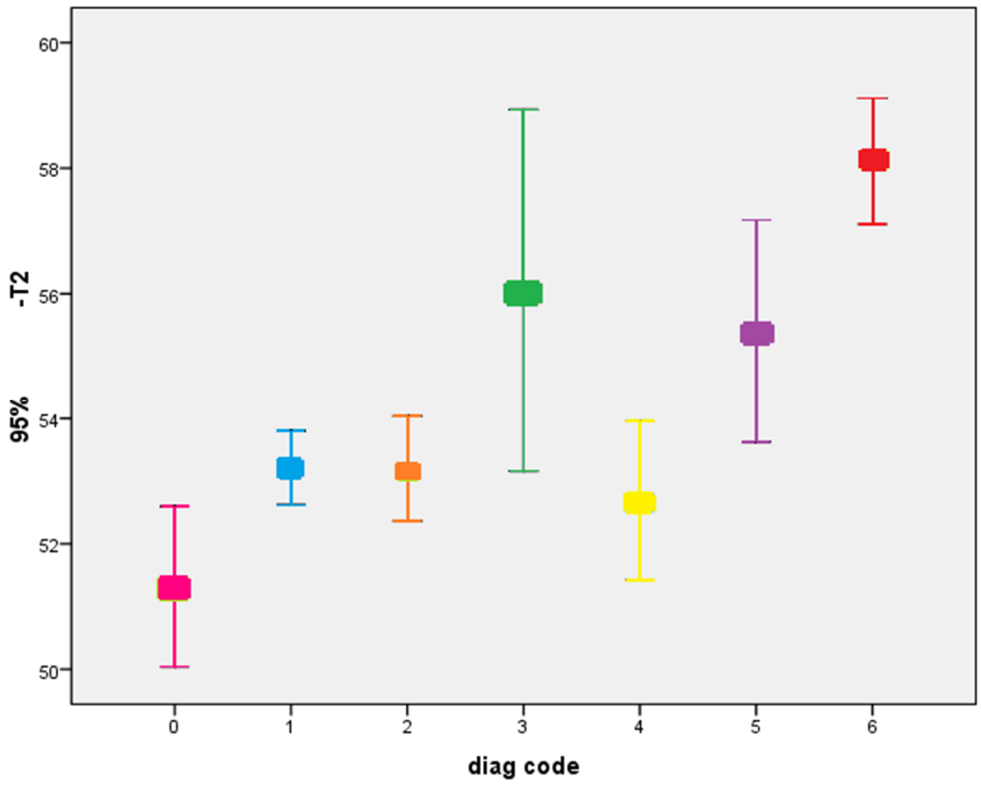


Fig. 32

There was considerable overlap in the ranges of T2 values across different categories. T2 maps mainly depict edema in acute MI and, can differentiate acute and chronic infarction based on the presence and absence of edema. Myocardial edema usually resolves six months after acute insult. As almost all of our patients had chronic MI, T2 mapping was not very helpful to differentiate the groups.

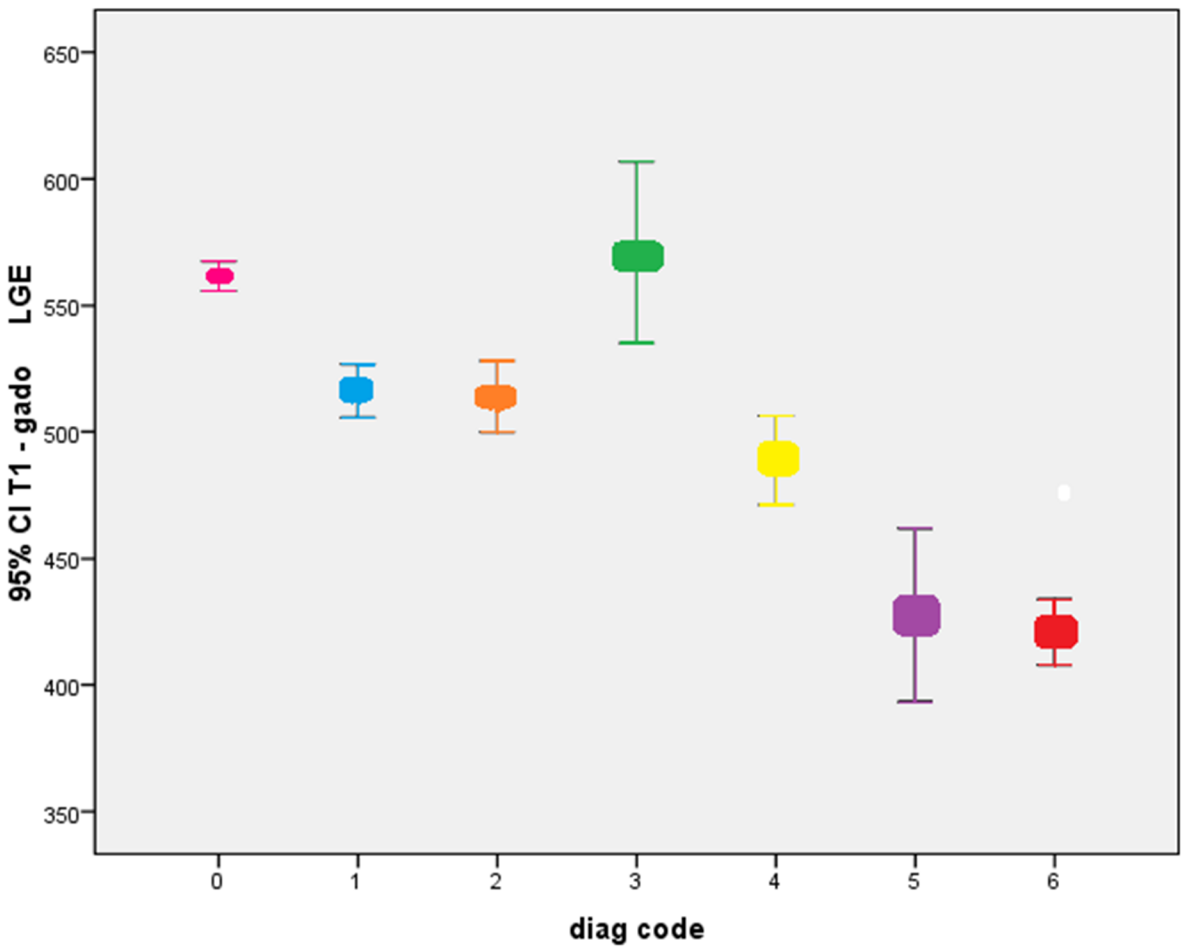


Fig. 33

Post gadolinium T1 values show significant reduction in non-viable infarction (> 50% infarction) as compared to normals and also as compared to < 50% infarct with no significant overlap in the ranges. Post contract T1 values are more accurate in the detection non-viable infarction.

There was some overlap between 1-25% infarct and normal subjects. As the number of segments in the 1-25% infarct category is small, these results could be spurious.

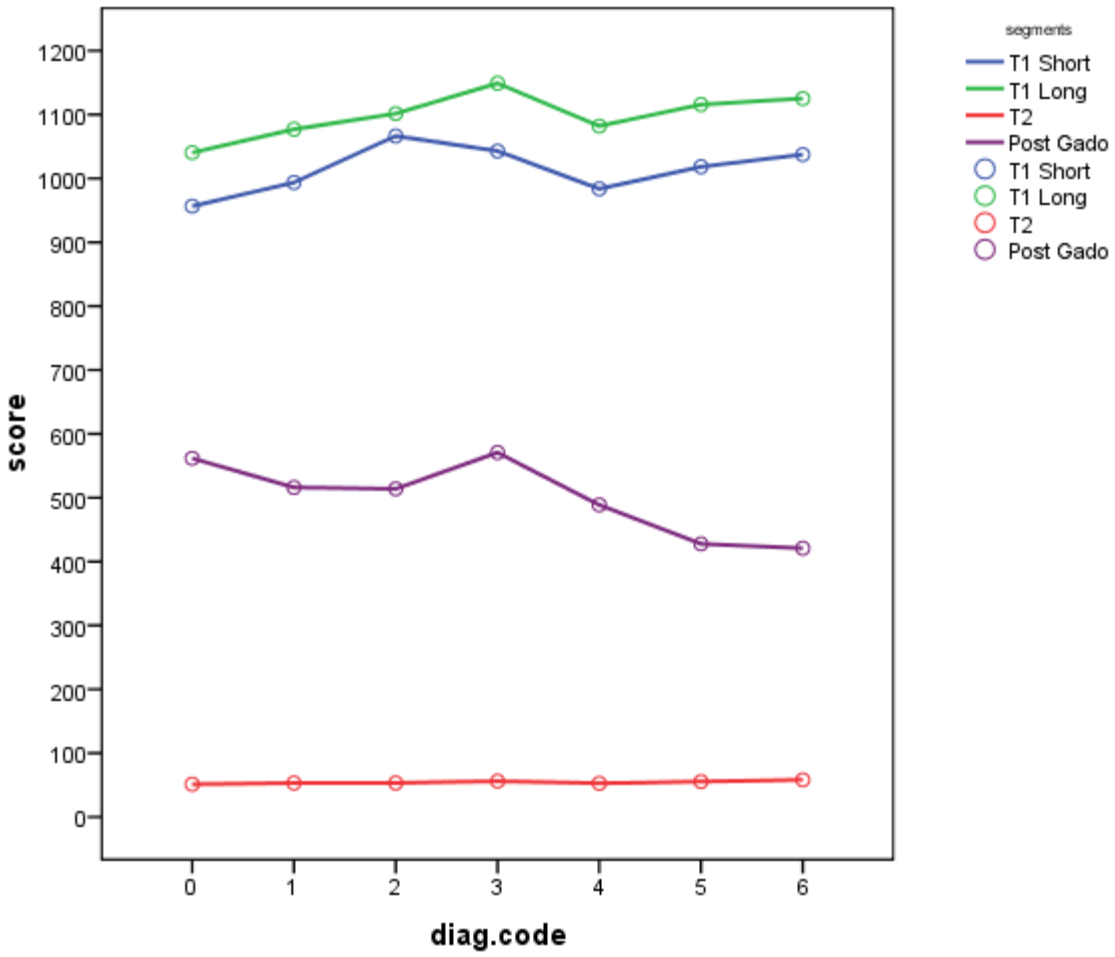


Fig. 34

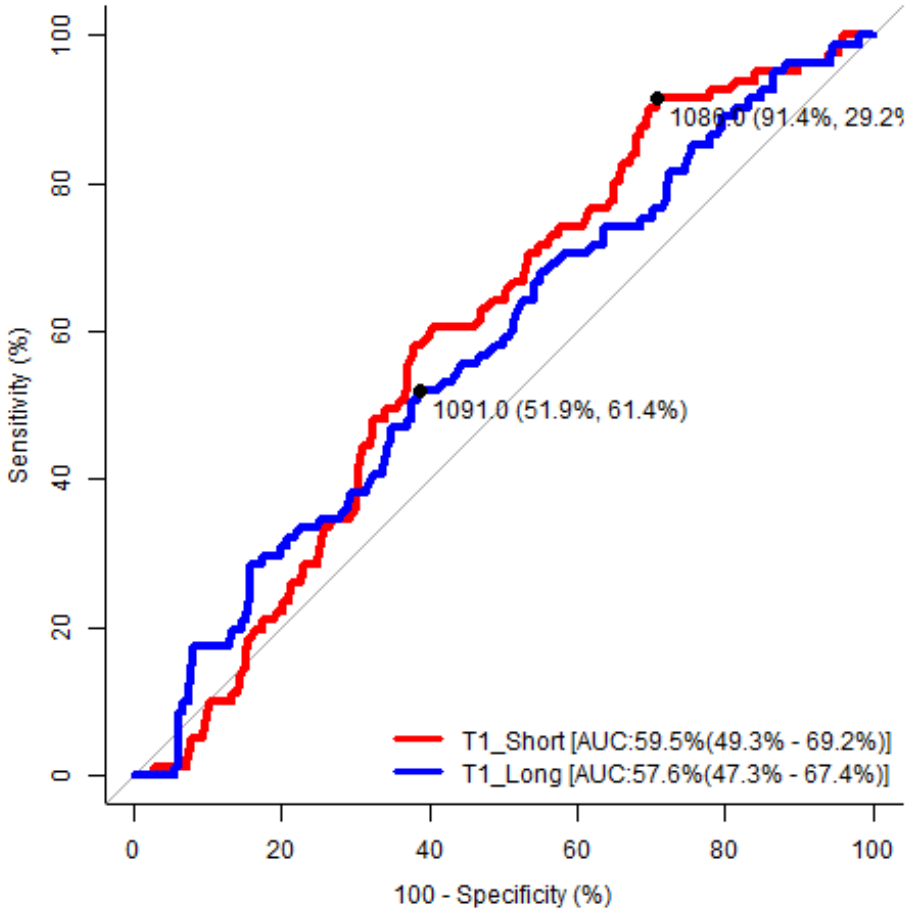
Combined graph of all the maps shows a trend of increasing native T1 (long and short) with increasing degree of infarct, and decreasing post gadolinium T1 values, with higher grades of infarcts. T2 values were not significantly different as most of our patients had chronic MI and the edema would have resolved at the time of imaging.

ROC Curve:

Viable Vs Non-viable infarction

(<25% and <50% Vs <75% and>75% infarction)

Using ROC curves, a threshold of 1086 ms on T1 short imaging, best differentiated viable and non-viable myocardium with sensitivity of 91.3% and specificity of 29.2%. A T1 long threshold of 1091ms best differentiated viable and non-viable myocardium with sensitivity of 51.8% and specificity of 61.4 %.



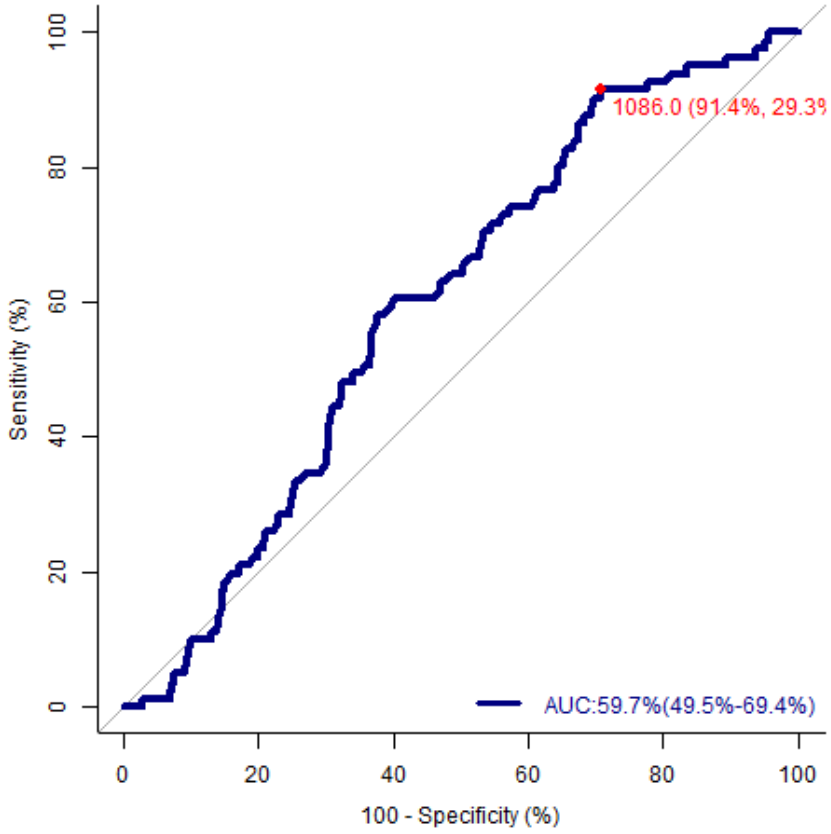
Graph.1: combined T1 short and long for viable Vs non-viable infarction

Area under the ROC curve (AUC)		
Variable	AUC	95% CI
T1_Short	0.595	0.493, 0.692
T1_Long	0.576	0.473, 0.674

Summary			
Variable	Cutoff	Sensitivity (%)	Specificity (%)
T1_Short	1086	91.358	29.201
T1_Long	1091	51.852	61.433

Comparison		
Comparison	AUC Diff.	P – Value
T1_Short and T1_Long	0.019	0.553

ROC Curve: (T1 Short)

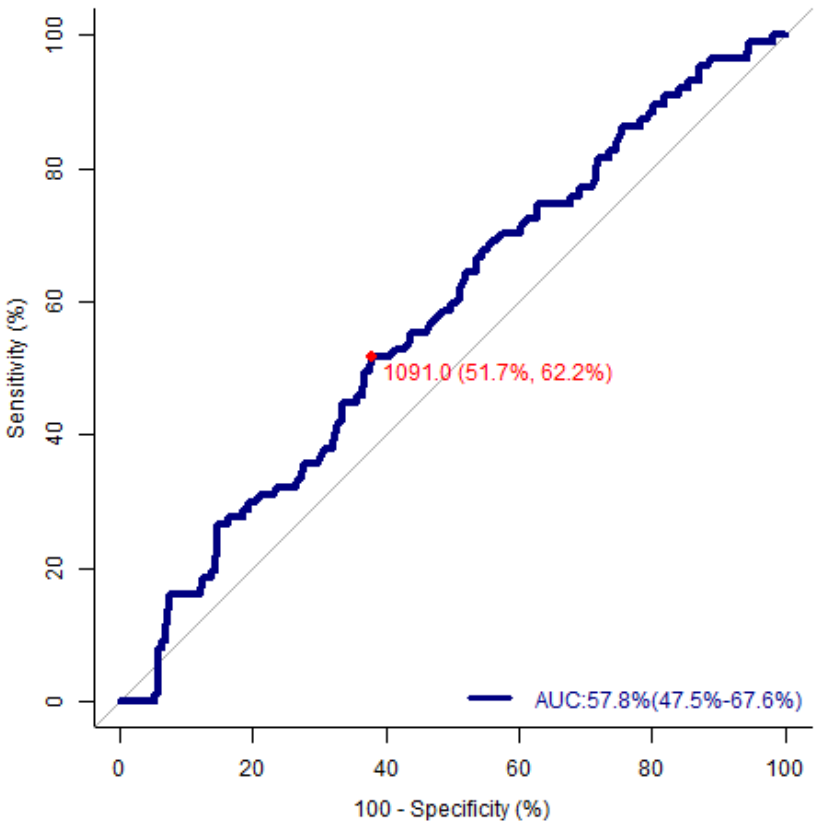


Graph. 2: T1 short for viable Vs non-viable infarction

Area under the ROC curve (AUC)	
Area under the ROC curve (AUC) :	0.597 (0.495, 0.694)
Standard Error :	0.032
Prob > Z (P - Value) :	0.001

Summary	
Cutoff :	1086
Sensitivity (%) :	91.358
Specificity (%) :	29.301

ROC Curve: (T1 Long)



Graph. 3: T1 long for viable Vs non-viable infarction

Area under the ROC curve (AUC)	
Area under the ROC curve (AUC) :	0.578 (0.475, 0.676)
Standard Error :	0.033
Prob > Z (P - Value) :	0.009

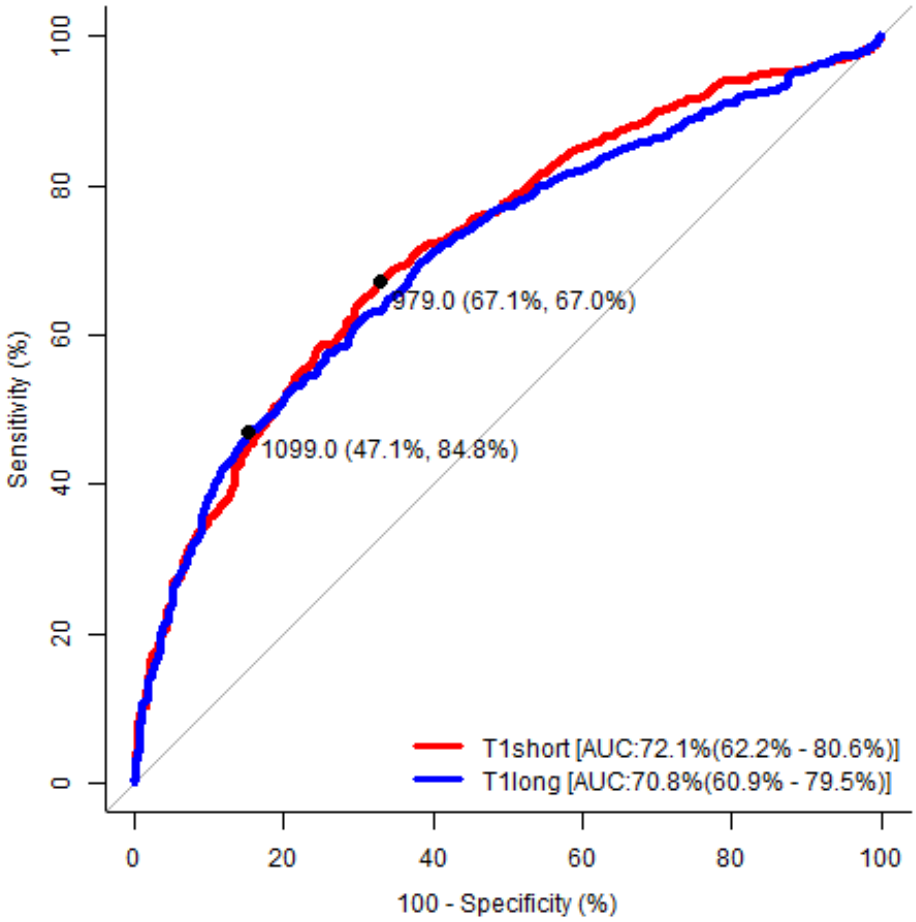
Summary	
Cutoff :	1091
Sensitivity (%) :	51.724
Specificity (%) :	62.176

ROC Curve:

Normal (controls) Vs. Infarcted myocardial segments

(<25%, <50 %,< 75%, >75% infarction)

A T1 short threshold of 979 ms best differentiated normal and infarcted myocardium with sensitivity of 67% and specificity of 67%. A T1 long threshold of 1099ms best differentiated normal and infarcted myocardium with sensitivity of 47% and specificity of 84%.



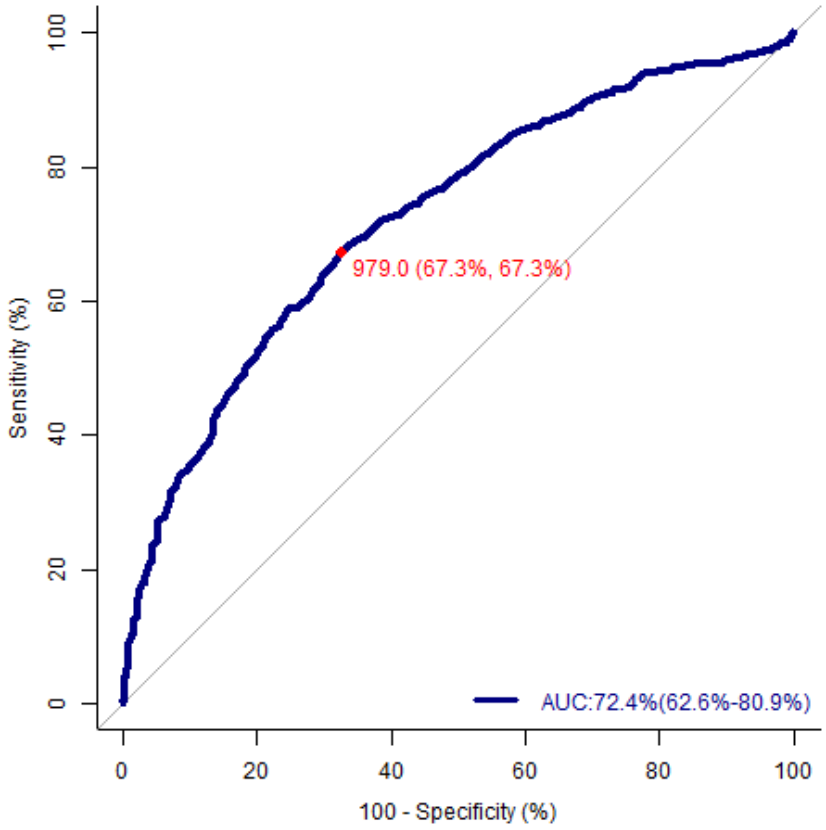
Graph. 4: Normal (controls) Vs. Infarcted myocardial segments (Combined)

Area under the ROC curve (AUC)		
Variable	AUC	95% CI
T1short	0.721	0.622, 0.806
T1long	0.708	0.609, 0.795

Summary			
Variable	Cutoff	Sensitivity (%)	Specificity (%)
T1short	979	67.14	67.025
T1long	1099	47.052	84.816

Comparison		
Comparison	AUC Diff.	P – Value
T1short and T1long	0.012	0.324

ROC Curve: (T1 Short)

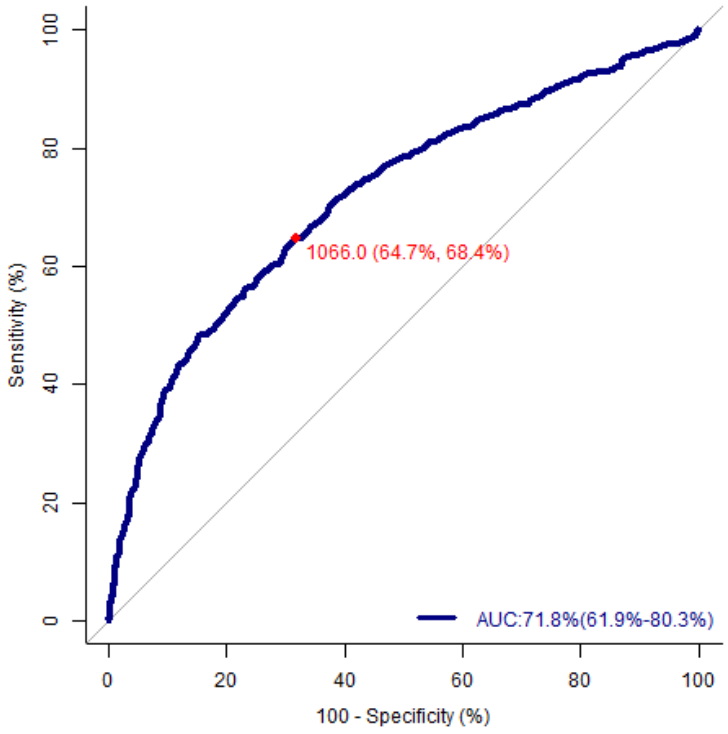


Graph. 6: T1 short of normal (controls) Vs. infarcted myocardial segments

Area under the ROC curve (AUC)	
Area under the ROC curve (AUC) :	0.724 (0.626, 0.809)
Standard Error :	0.013
Prob > Z (P - Value) :	<0.001

Summary	
Cutoff :	979
Sensitivity (%) :	67.277
Specificity (%) :	67.259

ROC Curve (T1 Long)



Graph. 7: T1 long of normal (controls) Vs. infarcted myocardial segments

Area under the ROC curve (AUC)	
Area under the ROC curve (AUC) :	0.718 (0.619, 0.803)
Standard Error :	0.012
Prob > Z (P - Value) :	<0.001

Summary	
Cutoff :	1066
Sensitivity (%) :	64.694
Specificity (%) :	68.353

T1, T2 mapping of the myocardium with non- viable infarct with >75% of transmural enhancement

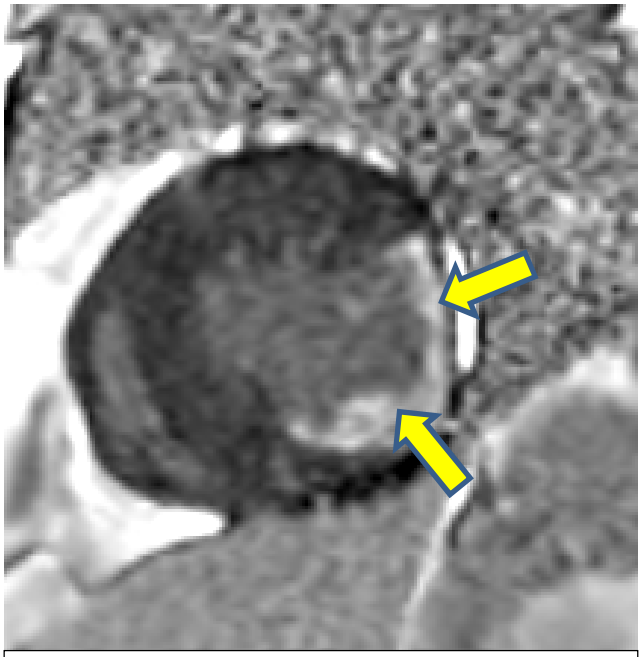


Fig.35: >75% transmural infarction - LGE

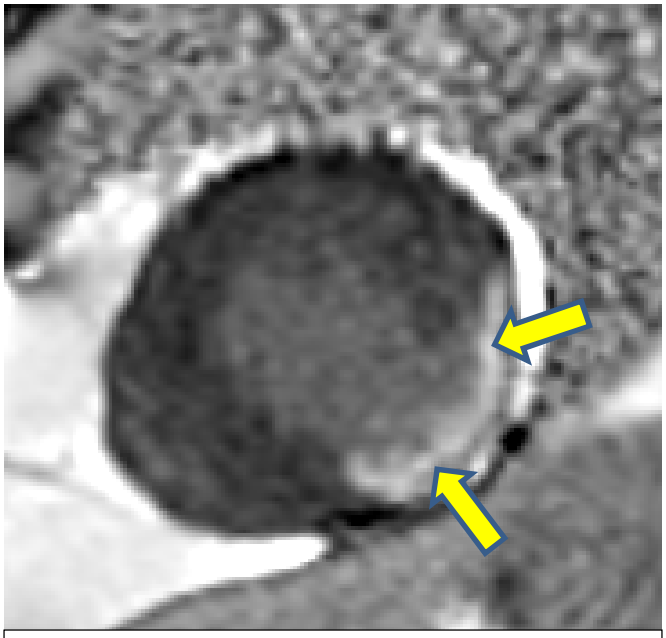


Fig.36: >75% transmural infarction -LGE

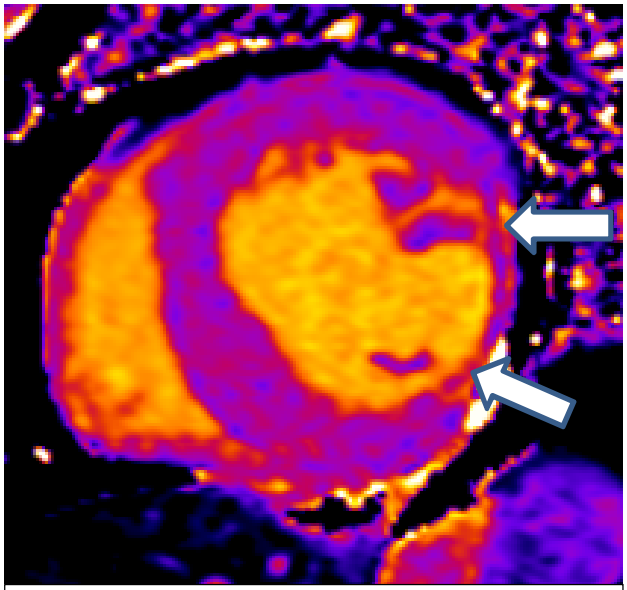


Fig.37: T1 Long - >75% transmural infarction

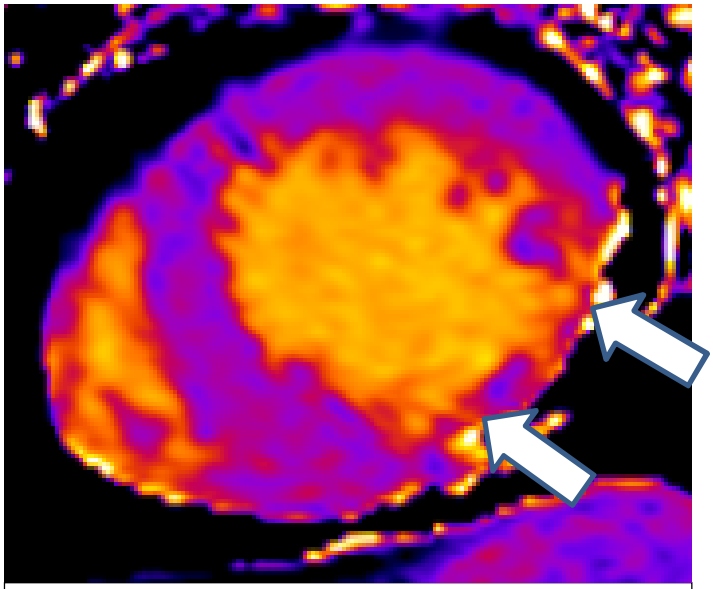


Fig.38: T1 Long->75% transmural infarction

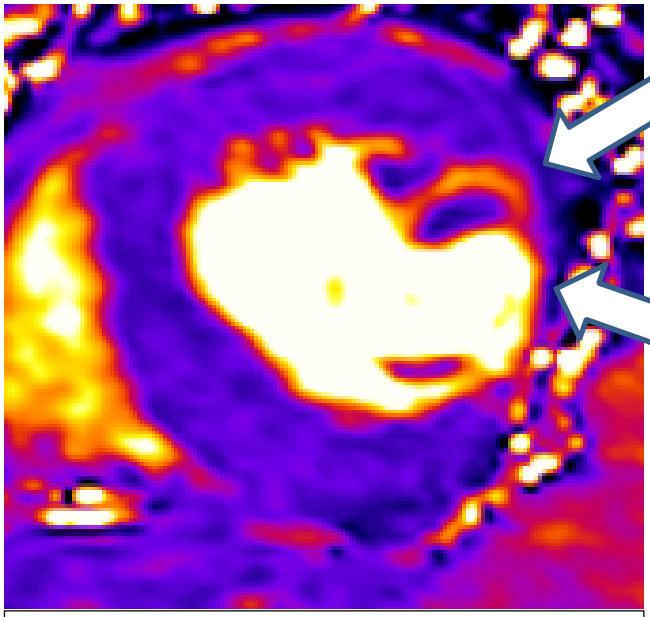


Fig.39: T2 - >75% transmural infarction

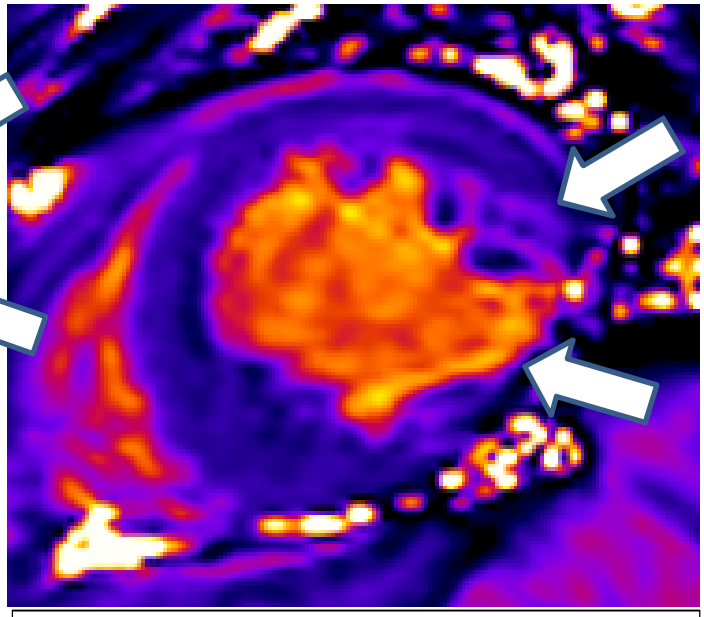


Fig.40T2 - >75% transmural infarction

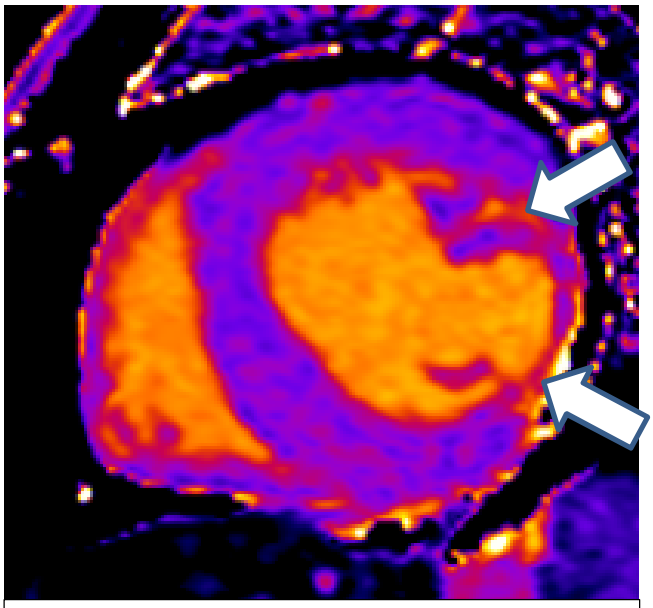


Fig.41: T1 short- >75% transmural infarction

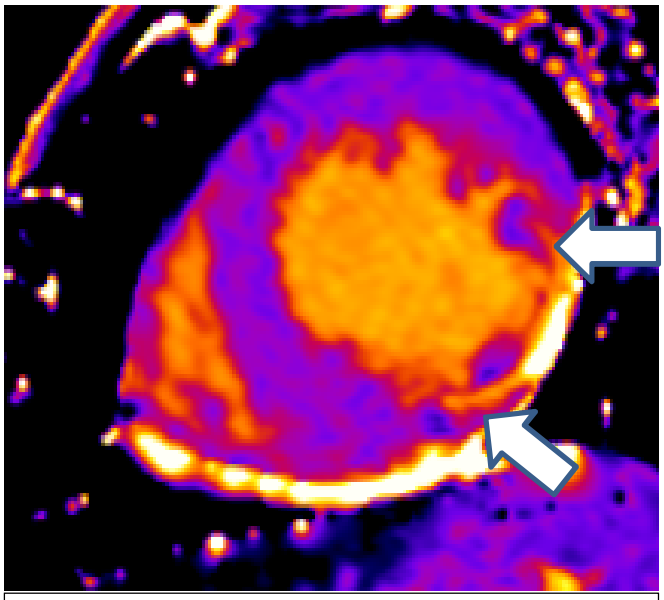


Fig.42: T1 short- >75% transmural infarction

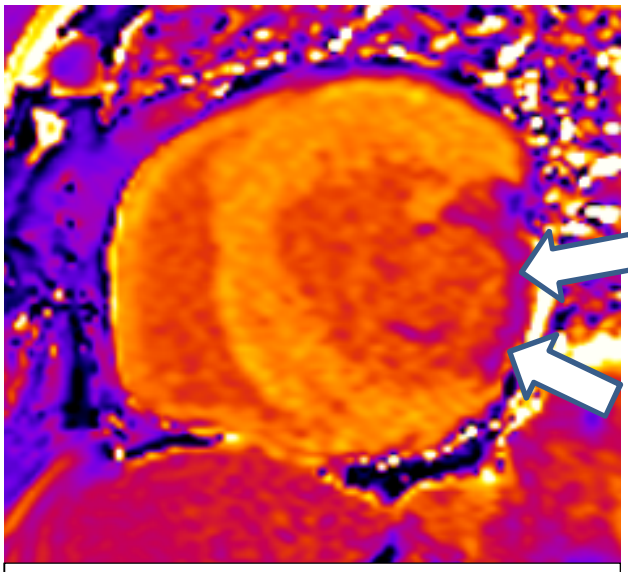


Fig.43: T1 post gadoliniumlinium- >75% transmural infarction

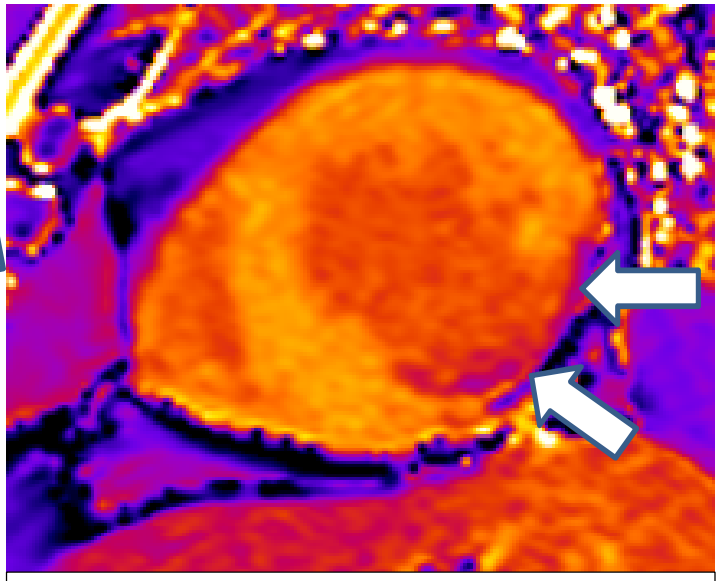


Fig.44: T1 post gadoliniumlinium- >75% transmural infarction

T1, T2 mapping of the myocardium with non- viable infarct with >75% of transmural enhancement

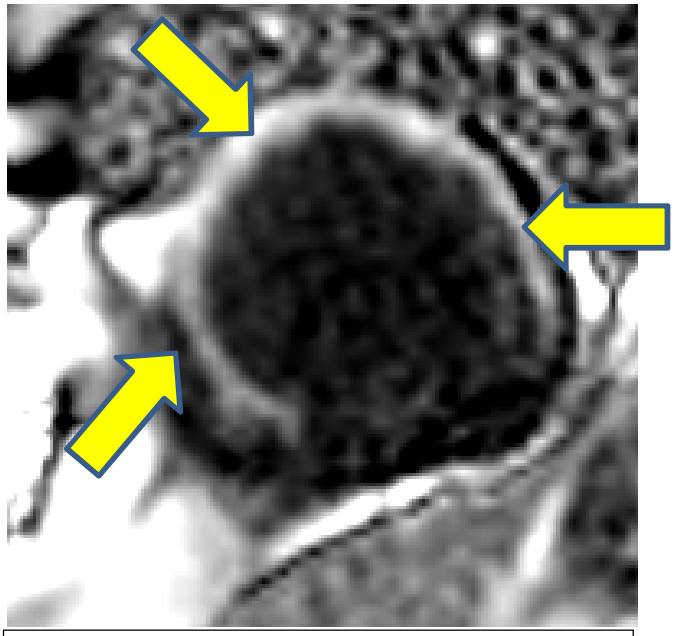


Fig.45: >75% transmural infarction - LGE

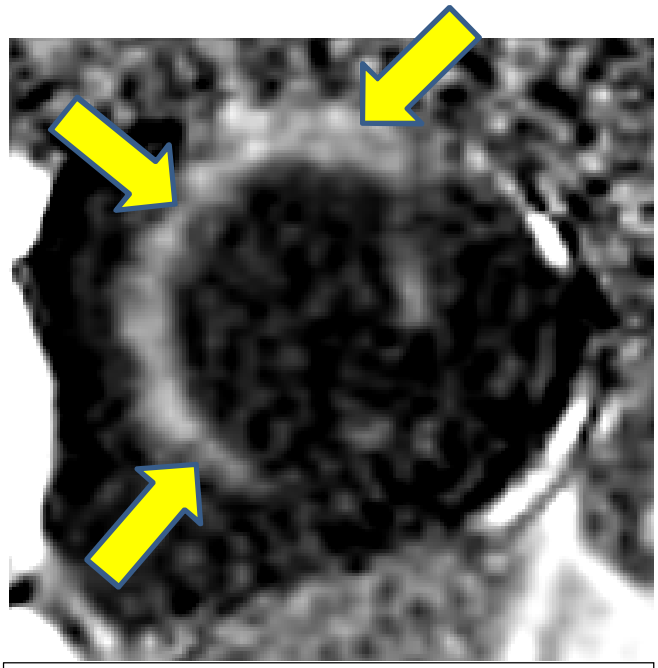


Fig.46: >75% transmural infarction - LGE

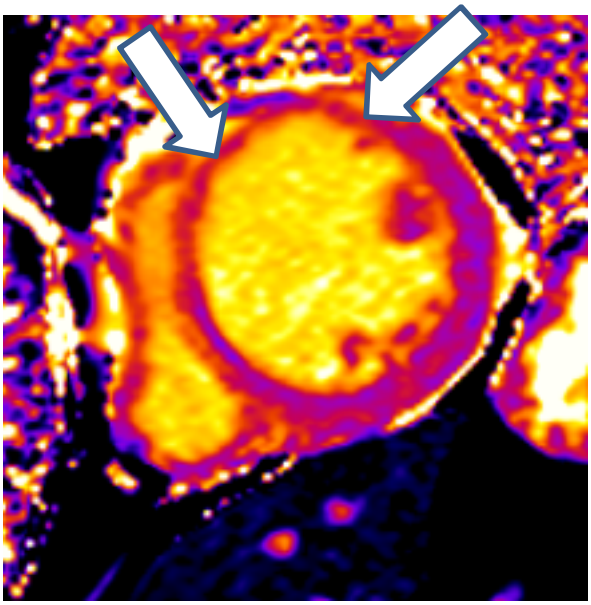


Fig.47: T1 long: >75% transmural infarction

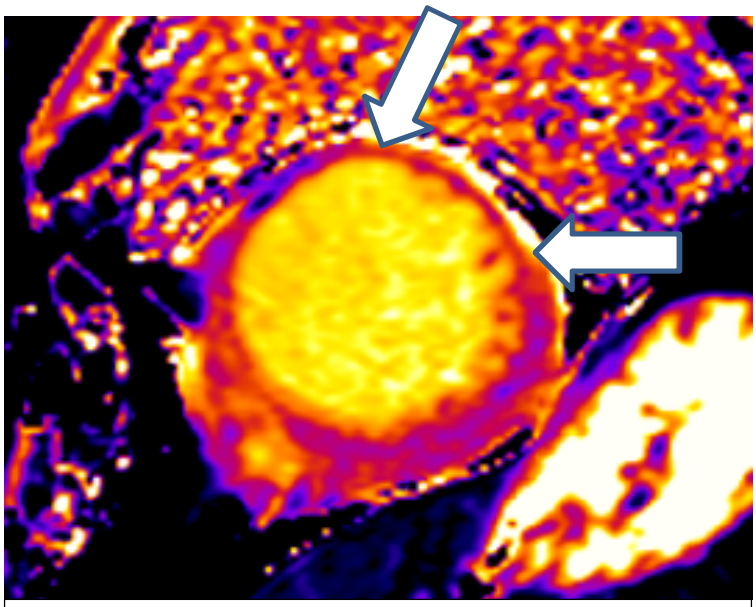


Fig.48: T1 long: >75% transmural infarction

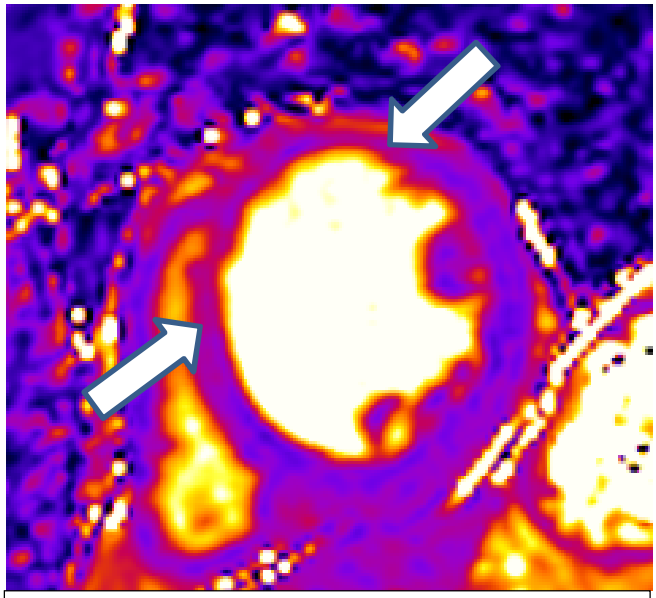


Fig.49: T2: >75% transmural infarction

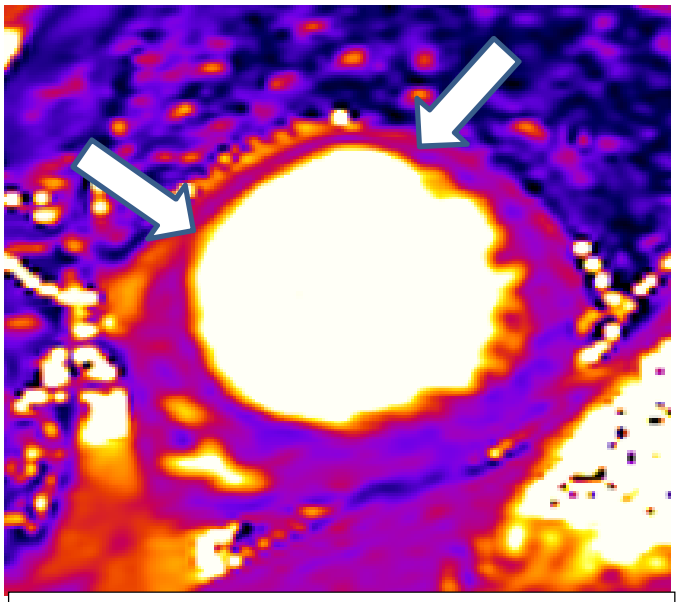


Fig.50: T2: >75% transmural infarction

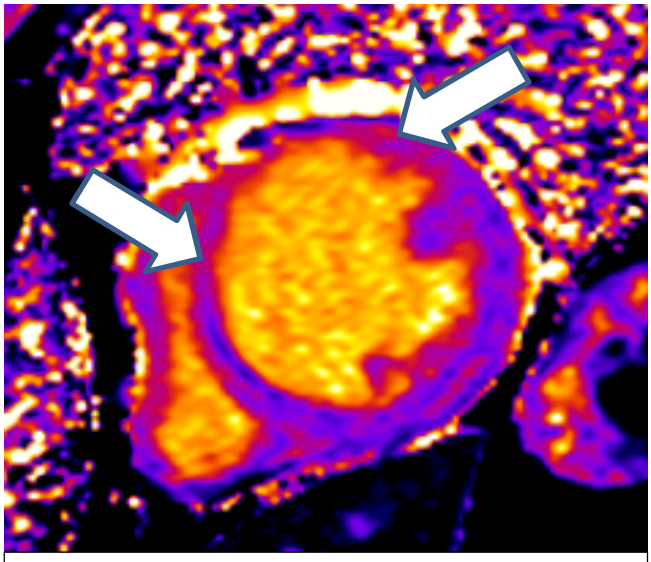


Fig.51: T1 Short: >75% transmural infarction

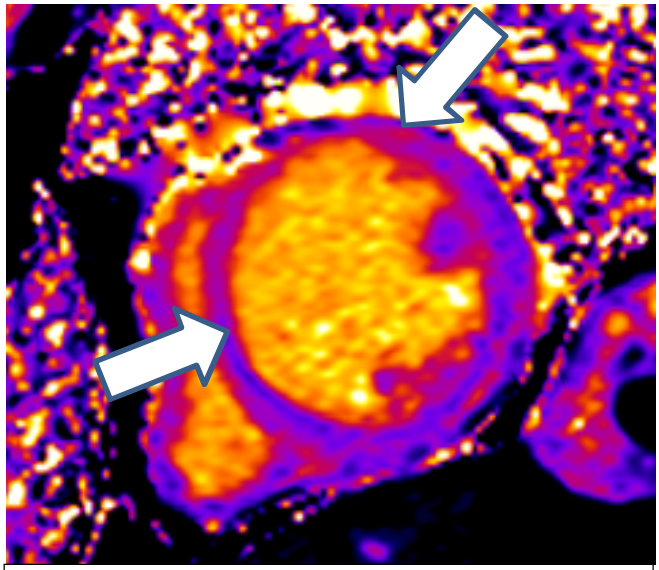


Fig.52: T1 Short: >75% transmural infarction

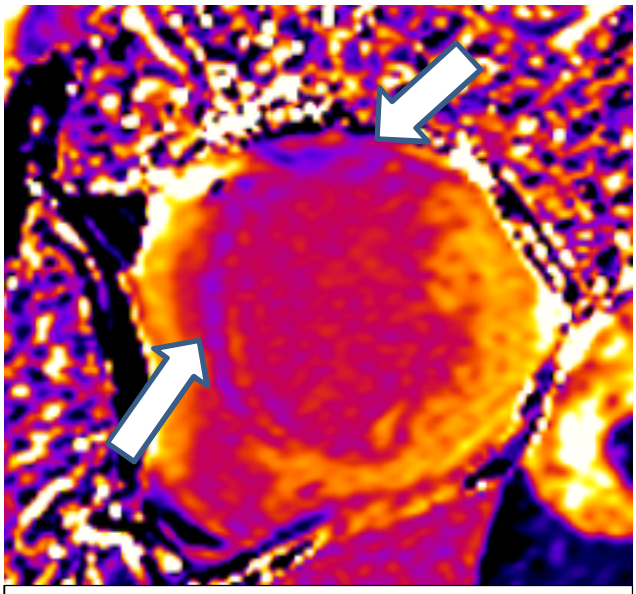


Fig.53: T1 post gadolinium: >75% transmural infarction

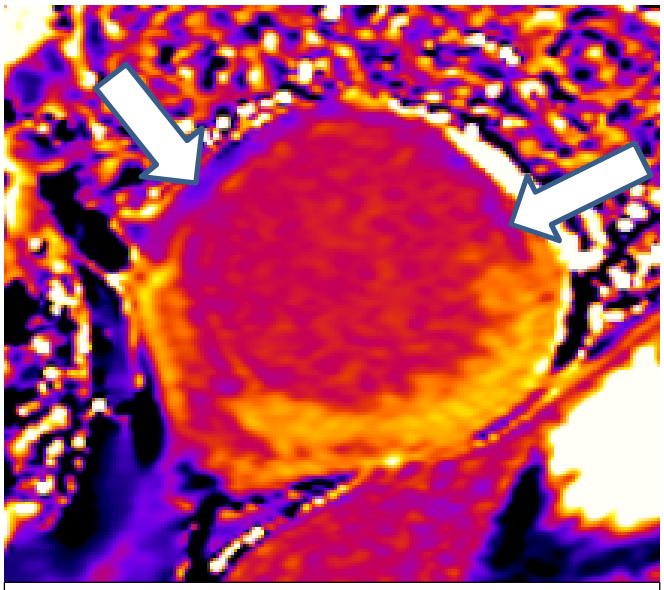


Fig.54: T1 post gadolinium: >75% transmural infarction

DISCUSSION

Parametric T1 and T2 mapping of the myocardium is a novel technique for quantitative measurements of T1 and T2 relaxation times of myocardium, which can reflect disease process. These values can be depicted on colour coded maps and the values can be calculated by drawing ROIs on the colour maps. Routine acquisition of T1 and T2 maps are now possible in all patients referred for cardiac MRI, due to improvement in technology and T1 mapping is a clinical tool now.

Terminology:

Technical terms used in T1 and T2 mapping of the myocardium	
Terminology	Meaning of the term
Native T1	T1 that is acquired without contrast media
T1ms	Time constant for T1 recovery (spin-lattice relaxation or longitudinal magnetization)
T2ms	Time constant for T2 recovery or spin-spin relaxation(transverse magnetization)
Parametric mapping	Additional images obtained from each pixel (T1 and T2 magnetic tissue properties)
T1 post Gadolinium	T1 values acquired after contrast is given

Table. 14 Technical terms used in T1 and T2 mapping of the myocardium

Normal values: The composition of the myocardial tissue is uniform and has a regular magnetic property. When acquired under the same conditions, T1 and T2 relaxation values have a narrow range. T1 and T2 values are different at 1.5T and 3T CMRI. In this study, the native T1, post contrast T1 and T2 mapping of myocardium was performed using the MOLLI sequence, on 1.5-T MRI scanner (1.5T Siemens Magnetom Avanto fit).

Number of healthy individuals required for reference ranges for low precision, which is sufficient for large magnitude biological changes (like acute myocardial injury, amyloid, iron deposition) are 20 normal subjects. High precision is necessary for small magnitude biological changes (like diffuse myocardial fibrosis), and for a high precision, sample size of 50 healthy individuals was calculated.

In our study, control group had 31 healthy individuals, which was sufficient to take it as a reference range for myocardial infarction (with low precision). Mean and lower and upper range of normal was obtained by mean ± 2 SD of the normal data in our study.

Color coded maps were generated and the T1 and T2 relaxation values in different segments were calculated by manually drawing ROIs in the 17 segment model as described by the American Heart Association was used to describe the T1 and T2 mapping. Large drawing ROIs covering complete area of each segment was used. ROIs were placed accurately in the central myocardium on the color maps, avoiding partial volume artifacts of adjacent blood pool and extra cardiac tissue.

Mean segmental T1 and T2 values in the controls:

Values	In our study ms	Standard Reference values quoted in literature (which may vary in different machines) ms
Native T1 (long T1 method)	**1040.47±74**	**982±46** (58)
T1 short	**956.57 ± 65.6**	**No data available**
T2	**51.3±16**	**52.18** (33)
T1 post gadolinium	**561.65 ±70**	**523±72**

Table. 15 Mean segmental T1 and T2 values in the controls

We established native T1, T1 (post Gadolinium) and T2 relaxation times of myocardium in normal subjects and these can be used as baseline reference values in our institution, for low precision studies.

Application of parametric CMRI in myocardial infarction:

Management of myocardial infarction and ischemic heart disease depends upon viability assessment. If more than 50% of the thickness of the myocardium is infarcted, it is less likely to benefit or recover functionality after re-vascularization. Conventionally, this is determined by assessing the degree of transmurality on the late Gadolinium enhancement images.

We included 40 patients with myocardial infarction in the study. Based on the final diagnosis on the routine cardiac MRI images including assessment of regional wall motion abnormality and

the transmurality of the late gadoliniumlium enhancement images, all subjects included in the study were categorized as follows, for further statistical analysis -

Category 0: healthy normal control.

Category 1: normal segments in MI patients (no LGE or wall motion abnormality).

Category 2: hibernating myocardium (wall motion abnormality with no LGE).

Category 3: Infarct with residual viable myocardium (wall motion abnormality with LGE in 1 - 24%thickness of myocardium).

Category 4: Infarct with residual viable myocardium (wall motion abnormality with LGE in 26-49% thickness of myocardium).

Category 5: Infarct with no significant residual viable myocardium (wall motion abnormality with LGE in 50-74% thickness of myocardium).

Category 6: Infarct with no residual viable myocardium (wall motion abnormality with LGE in >75% thickness of myocardium or transmural infarct).

These categories were assigned at a later stage and at the time of recording the T1 and T2 values, the principal investigator was blinded to the categories. Segments with LGE <50% were considered viable and more than 50% were considered as non-viable. Total number of myocardial segments analyzed was 1731. Number of segments analyzed in patients was 58% (1000) and controls were 42% (731).

T1, T2 and T1 post Gadolinium values obtained from Myomaps were compared with LGE viability. Native T1 has high diagnostic potential in the differentiation of normal, non-viable and viable myocardium.

Mean segmental T1 and T2 values in the category 0 to 6 in our study were as follows:

Mean	**0-Healthy Controls ms**	**1-Normal ms**	**2-Hibernating ms**	**3-< 25% Subendocardial Ms**	**4 < 50% of myocardial ms**	**5 < 75% of transmural ms**	**6 - > 75% transmural ms**
T1 short	**956.57 ± 65.6**	**993.70± 62.9**	**1066.56± 600**	**1042.94±66.7**	**983.7 ±137**	**1018.32±106**	**1037.46±112**
T1 long	**1040.47±74**	**1077.90 ±75.5**	**1101.56±74.5**	**1149.09±97.5**	**1082±73**	**1115.78±104**	**1125±17**
T2	**51.3±16**	**53.21±5.6**	**53.2± 5.1**	**56±6.3**	**52.6±5**	**55.4± 7**	**58.11±8**
T1 post gadolinium	**561.65 ±70**	**516.05± 89**	**513.86±86**	**570.83±72**	**488.7±65**	**427.6±114**	**420.9±113**

Table. 16. Mean segmental T1 and T2 values in the category 0 to 6

The values obtained in our study were in correlation with the mean segmental T1 values for different grades of myocardial infarction in comparison to study done by Dastidar et al (57) in viability assessment of chronic MI.

In their study, they used a scale of 0-4 (0=no scar, 1=1to24%, 2=25to49%, 3=50to74%, 4>75% scar thickness) and mean segmental T1 values for transmural scar grade were

Mean	**0-Healthy Controls** ms	**1-Normal** ms	**2-Hibernating** ms	**3-< 25% Subendocardial** ms	**4 < 50% of myocardial** Ms	**5 < 75% of transmural** ms	**6 - > 75% transmural** Ms
T1	NIL	1031±31	NIL	1070±33	1103±32	1164±58	1206±118
T2	NIL	52±4	NIL	55±4	58±5	59±8	66±9

Table. 17 Values obtained in a study by Dastidar et al (57)

The threshold values in our study were as follows:

Threshold native T1 value of 1091ms, calculated by T1 long method differentiated viable and non-viable myocardium with sensitivity of 51.7% and specificity of 62.2%, in comparison to threshold T1 of 1090 ms which best differentiated viable from non-viable segments with sensitivity of 90% in the study by Dastidar et al(57).

Similarly, threshold value of 1086 ms on T1 short method best differentiated viable and non–viable myocardium with sensitivity of 91.4% and specificity of 29.3%.

T1 short threshold of 979 ms best differentiated normal and infarcted myocardium with sensitivity of 67.14% and specificity of 67.025%. A T1 long threshold of 1099 ms differentiated normal and infarcted myocardium with sensitivity of 47.05% and specificity of 84.8%.

Native T1, T2 values were more in all categories of patients as compared to the controls and this was statistically significant with $p<0.05$ and with 95% confidence intervals. This suggests that parametric T1 and T2 mapping of the myocardium has high diagnostic potential in the differentiation of normal, non-viable and viable myocardium. Even the seemingly normal segments in patients with myocardial infarction, are actually abnormal, which may be related to remodeling of LV and adverse cardiac event possibly causes increase in the native T1 in remote areas of the heart.

Native T1 shows significant relation of the degree of myocardial damage assessed by late gadolinium enhancement. Myocardial segments with <50% infarction are considered viable.T1 values can potentially be used to predict the functional recovery after MI. Mean T1 long 1082±73 ms of group 4 can be taken as cut-off to differentiate viable and non-viable myocardium.

Combined graphs of show that native T1 (long and short) has better diagnostic accuracy to detect different groups of myocardial infarction as compared to T2 values.

T2 maps can differentiate acute and chronic infarction based on the presence or absence of myocardial edema which usually resolves six months after acute insult. Since most of our patients had chronic infarct, T2 mapping was not particularly helpful.

Post gadolinium T1 values show significant reduction in non-viable infarction (> 50% thickness of LGE). Post contrast T1 values were more accurate in the detection of non-viable infarction.

Factors that influence post contrast T1 values are contrast dose, time and type of contrast. Significance of post contrast T1 is reduced due to the above factors. So native T1 mapping (without contrast) is preferred to quantify myocardial infarction.

Nephrogenic systemic fibrosis, a systemic fatal scleroderma like illness with gadolinium develops in patients with moderate /severe kidney failure. So non-contrast T1 mapping can potentially replace gadolinium in patients with renal failure, to assess the myocardial infarction and viability.

Focal scarring is seen on LGE due to visual difference in the signal intensity between the area of focal scarring and normal myocardium. Interstitial fibrosis or diffuse fibrosis is not seen on LGE as it lacks the difference in signal intensity to be visually appreciated. An inversion pulse with LGE uniformly suppresses the entire myocardium despite retention of contrast. By measuring the intrinsic T1 time, T1 mapping overcomes this limitation. So T1 mapping is the imaging technique in the identification of diffuse myocardial fibrosis.

CONCLUSION

Cardiac MRI with its excellent spatial resolution is a gold standard in the evaluation of cardiac anatomy and function.

We set up the practice of performing T1 and T2 mapping in our institution and established native T1, T2 relaxation times and post contrast T1 values of myocardium in normal subjects which can be used as baseline reference values in our institution. Normal T1 values in our institution are 1040.47±74 ms (native) and 561.65 ±70 ms (post contrast). Normal T2 value is 51.3±16 ms.

T1 values were higher in all categories of segments in patients with myocardial infarcts as compared to the controls which was statistically significant with p value of <0.05 and 95% confidence interval. The native T1 values showed an increasing trend with increasing degree of infarct, while the post contrast T1 values showed a decreasing trend. T2 values were not significantly different across categories. This is probably because all the patients in our study had chronic myocardial infarction.

Apparently normal segments in patients with myocardial infarction are probably actually abnormal, as even these segments showed higher native T1 values than controls which may be related to remodeling of left ventricle. This could not be detected by conventional late gadolinium enhancement imaging.

T1 mapping has great potential in differentiating normal from infarcted myocardium and also viable (infarct involving <50% thickness of myocardium) from non-viable (infarct involving >50% thickness of myocardium) segments. Threshold native T1 value of 1091 ms differentiated viable from non-viable myocardium with sensitivity of 51.7% and specificity of 62.2%.

Native T1 mapping can thus, potentially replace post gadolinium studies in the evaluation of myocardial infarction, especially in patients where gadolinium is contraindicated.

LIMITATIONS

1. Manually drawn ROIs are subject to partial volume from extra cardiac tissue and adjacent blood. Software package for analysis with automatically generated ROIs will standardize the analysis and reduce manual effort.

2. In a segment with partial involvement, the ROIs were not restricted to the region of involvement. Instead, the entire segment was included.

3. Baseline reference values of high precision (small magnitude biological changes) studies required recruitment of 50 healthy normal controls. 20 more studies need to be included in the control group for high precision data.

Bibliography

References:

1. Mendis S, Thygesen K, Kuulasmaa K, Giampaoli S, Mähönen M, Ngu Blackett K, et al. World Health Organization definition of myocardial infarction: 2008–09 revision. Int J Epidemiol. 2011 Feb 1;40(1):139–46.

2. Alderman EL, Fisher LD, Litwin P, Kaiser GC, Myers WO, Maynard C, et al. Results of coronary artery surgery in patients with poor left ventricular function (CASS). Circulation. 1983 Oct;68(4):785–95.

3. Gropler RJ, Bergmann SR. Myocardial viability—what is the definition? [Internet]. Soc Nuclear Med; 1991 [cited 2017 Jul 29]. Available from: http://jnm.snmjournals.org/content/32/1/10.full.pdf

4. Schinkel AFL, Poldermans D, Elhendy A, Bax JJ. Assessment of Myocardial Viability in Patients with Heart Failure. J Nucl Med. 2007 Jul 1;48(7):1135–46.

5. Messroghli DR, Moon JC, Ferreira VM, Grosse-Wortmann L, He T, Kellman P, et al. Clinical recommendations for cardiovascular magnetic resonance mapping of T1, T2, T2* and extracellular volume: A consensus statement by the Society for Cardiovascular Magnetic Resonance (SCMR) endorsed by the European Association for Cardiovascular Imaging (EACVI). J Cardiovasc Magn Reson. 2017 Oct 9;19:75.

6. Chauhan S, Aeri BT. The rising incidence of cardiovascular diseases in India: Assessing its economic impact. J Prev Cardiol. 2015;4(4):735–40.

7. Themes UFO. Nuclear Medicine Imaging of Myocardial Viability [Internet]. Radiology Key. 2015 [cited 2017 Aug 1]. Available from: https://radiologykey.com/nuclear-medicine-imaging-of-myocardial-viability/

8. Camici P, Ferrannini E, Opie LH. Myocardial metabolism in ischemic heart disease: basic principles and application to imaging by positron emission tomography. Prog Cardiovasc Dis. 1989 Dec;32(3):217–38.

9. Kobayashi K, Neely JR. Control of maximum rates of glycolysis in rat cardiac muscle. Circ Res. 1979 Feb;44(2):166–75.

10. Di Carli MF, Prcevski P, Singh TP, Janisse J, Ager J, Muzik O, et al. Myocardial blood flow, function, and metabolism in repetitive stunning. J Nucl Med Off Publ Soc Nucl Med. 2000 Jul;41(7):1227–34.

11. Taegtmeyer H. Tracing cardiac metabolism in vivo: one substrate at a time. J Nucl Med Off Publ Soc Nucl Med. 2010 May 1;51 Suppl 1:80S–87S.

12. Gheorghiade M, Bonow RO. Chronic Heart Failure in the United States. Circulation. 1998 Jan 27;97(3):282–9.

13. Bart BA, Shaw LK, McCants CB, Fortin DF, Lee KL, Califf RM, et al. Clinical determinants of mortality in patients with angiographically diagnosed ischemic or nonischemic cardiomyopathy. J Am Coll Cardiol. 1997 Oct;30(4):1002–8.

14. Cwajg JM, Cwajg E, Nagueh SF, He ZX, Qureshi U, Olmos LI, et al. End-diastolic wall thickness as a predictor of recovery of function in myocardial hibernation: relation to rest-redistribution T1-201 tomography and dobutamine stress echocardiography. J Am Coll Cardiol. 2000 Apr;35(5):1152–61.

15. Partington SL, Kwong RY, Dorbala S. Multimodality imaging in the assessment of myocardial viability. Heart Fail Rev. 2011 Jul;16(4):381–95.

16. Cornel JH, Bax JJ, Elhendy A, Maat AP, Kimman GJ, Geleijnse ML, et al. Biphasic response to dobutamine predicts improvement of global left ventricular function after surgical revascularization in patients with stable coronary artery disease: implications of time course of recovery on diagnostic accuracy. J Am Coll Cardiol. 1998 Apr;31(5):1002–10.

17. Schinkel AFL, Bax JJ, Poldermans D, Elhendy A, Ferrari R, Rahimtoola SH. Hibernating myocardium: diagnosis and patient outcomes. Curr Probl Cardiol. 2007 Jul;32(7):375–410.

18. Talib A. Assessment of myocardial viability: a review of current non invasive imaging techniques. In: International Cardiovascular Forum Journal [Internet]. 2014 [cited 2017 Jul 29]. p. 113–117. Available from: http://icfjournal.org/index.php/icfj/article/viewFile/34/61

19. Medrano R, Lowry RW, Young JB, Weilbaecher DG, Michael LH, Afridi I, et al. Assessment of myocardial viability with 99mTc sestamibi in patients undergoing cardiac transplantation. A scintigraphic/pathological study. Circulation. 1996 Sep 1;94(5):1010–7.

20. zotero://attachment/782/ [Internet]. [cited 2017 Sep 18]. Available from: zotero://attachment/782/

21. Lardo AC, Cordeiro MAS, Silva C, Amado LC, George RT, Saliaris AP, et al. Contrast-Enhanced Multidetector Computed Tomography Viability Imaging After Myocardial Infarction. Circulation. 2006 Jan 24;113(3):394–404.

22. Dilsizian V, Bacharach SL, Beanlands RS, Bergmann SR, Delbeke D, Gropler RJ, et al. PET myocardial perfusion and metabolism clinical imaging. J Nucl Cardiol. 2009 Aug;16(4):651–651.

23. Tillisch J, Brunken R, Marshall R, Schwaiger M, Mandelkern M, Phelps M, et al. Reversibility of cardiac wall-motion abnormalities predicted by positron tomography. N Engl J Med. 1986 Apr 3;314(14):884–8.

24. Elfigih IA, Henein MY. Non-invasive imaging in detecting myocardial viability: Myocardial function versus perfusion. IJC Heart Vasc. 2014 Dec;5:51–6.

25. Shabana A, El-Menyar A. Myocardial Viability: What We Knew and What Is New [Internet]. Cardiology Research and Practice. 2012 [cited 2017 Jul 7]. Available from: https://www.hindawi.com/journals/crp/2012/607486/

26. Götte MJ, van Rossum AC, Twisk JWR null, Kuijer JPA null, Marcus JT, Visser CA. Quantification of regional contractile function after infarction: strain analysis superior to wall thickening analysis in discriminating infarct from remote myocardium. J Am Coll Cardiol. 2001 Mar 1;37(3):808–17.

27. Klein C, Nekolla SG, Bengel FM, Momose M, Sammer A, Haas F, et al. Assessment of Myocardial Viability With Contrast-Enhanced Magnetic Resonance Imaging: Comparison With Positron Emission Tomography. Circulation. 2002 Jan 15;105(2):162–7.

28. Manning WJ, Pennell DJ. Cardiovascular Magnetic Resonance. Elsevier Health Sciences; 2010. 668 p.

29. Kim RJ, Wu E, Rafael A, Chen EL, Parker MA, Simonetti O, et al. The use of contrast-enhanced magnetic resonance imaging to identify reversible myocardial dysfunction. N Engl J Med. 2000 Nov 16;343(20):1445–53.

30. Messroghli DR, Radjenovic A, Kozerke S, Higgins DM, Sivananthan MU, Ridgway JP. Modified Look-Locker inversion recovery (MOLLI) for high-resolution T1 mapping of the heart. Magn Reson Med. 2004 Jul 1;52(1):141–6.

31. Burt JR, Zimmerman SL, Kamel IR, Halushka M, Bluemke DA. Myocardial T1 Mapping: Techniques and Potential Applications. Radiographics. 2014 Mar;34(2):377–95.

32. Akçakaya M, Weingärtner S, Roujol S, Nezafat R. On the Selection of Sampling Points for Myocardial T1 Mapping. Magn Reson Med Off J Soc Magn Reson Med Soc Magn Reson Med. 2015 May;73(5):1741–53.

33. Kim PK, Hong YJ, Im DJ, Suh YJ, Park CH, Kim JY, et al. Myocardial T1 and T2 Mapping: Techniques and Clinical Applications. Korean J Radiol. 2017;18(1):113–31.

34. Hamlin SA, Henry TS, Little BP, Lerakis S, Stillman AE. Mapping the Future of Cardiac MR Imaging: Case-based Review of T1 and T2 Mapping Techniques. RadioGraphics. 2014 Oct 1;34(6):1594–611.

35. Nagel E, Narula J. Evolution and Revolution in CMR Imaging. JACC Cardiovasc Imaging. 2013 Jul 1;6(7):837–8.

36. Messroghli DR, Walters K, Plein S, Sparrow P, Friedrich MG, Ridgway JP, et al. Myocardial T1 mapping: application to patients with acute and chronic myocardial infarction. Magn Reson Med. 2007 Jul;58(1):34–40.

37. Nacif MS, Turkbey EB, Gai N, Nazarian S, van der Geest RJ, Noureldin RA, et al. Myocardial T1 mapping with MRI: comparison of look-locker and MOLLI sequences. J Magn Reson Imaging JMRI. 2011 Dec;34(6):1367–73.

38. Xue H, Shah S, Greiser A, Guetter C, Littmann A, Jolly M-P, et al. Motion correction for myocardial T1 mapping using image registration with synthetic image estimation. Magn Reson Med. 2012 Jun;67(6):1644–55.

39. Piechnik SK, Ferreira VM, Dall'Armellina E, Cochlin LE, Greiser A, Neubauer S, et al. Shortened Modified Look-Locker Inversion recovery (ShMOLLI) for clinical myocardial T1-mapping at 1.5 and 3 T within a 9 heartbeat breathhold. J Cardiovasc Magn Reson. 2010 Nov 19;12(1):69.

40. Marks B, Mitchell DG, Simelaro JP. Breath-holding in healthy and pulmonary-compromised populations: effects of hyperventilation and oxygen inspiration. J Magn Reson Imaging JMRI. 1997 Jun;7(3):595–7.

41. Germain P, El Ghannudi S, Jeung M-Y, Ohlmann P, Epailly E, Roy C, et al. Native T1 Mapping of the Heart – A Pictorial Review. Clin Med Insights Cardiol. 2014 Dec 1;8(Suppl 4):1–11.

42. Bönner F, Jacoby C, Temme S, Borg N, Ding Z, Schrader J, et al. Multifunctional MR monitoring of the healing process after myocardial infarction. Basic Res Cardiol. 2014;109(5):430.

43. Bönner F, Janzarik N, Jacoby C, Spieker M, Schnackenburg B, Range F, et al. Myocardial T2 mapping reveals age- and sex-related differences in volunteers. J Cardiovasc Magn Reson [Internet]. 2015 Feb 6 [cited 2017 Jul 19];17(1). Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4318191/

44. Teixeira T, Hafyane T, Stikov N, Akdeniz C, Greiser A, Friedrich MG. Comparison of different cardiovascular magnetic resonance sequences for native myocardial T1 mapping at 3T. J Cardiovasc Magn Reson [Internet]. 2016 Oct 4 [cited 2017 Jul 19];18. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC5050636/

45. Myocardial Edema—a New Clinical Entity | Magnetic Resonance Imaging | Cardiac Muscle [Internet]. [cited 2017 Jul 21]. Available from: https://www.scribd.com/document/259277585/Myocardial-Edema-a-New-Clinical-Entity

46. Abdel-Aty H, Zagrosek A, Schulz-Menger J, Taylor AJ, Messroghli D, Kumar A, et al. Delayed enhancement and T2-weighted cardiovascular magnetic resonance imaging differentiate acute from chronic myocardial infarction. Circulation. 2004 May 25;109(20):2411–6.

47. Payne AR, Casey M, McClure J, McGeoch R, Murphy A, Woodward R, et al. Bright-Blood T2-Weighted MRI Has Higher Diagnostic Accuracy Than Dark-Blood Short Tau Inversion Recovery MRI for Detection of Acute Myocardial Infarction and for Assessment of the Ischemic Area at Risk and Myocardial Salvage. Circ Cardiovasc Imaging. 2011;4(3):210–9.

48. Ferreira VM, Piechnik SK, Dall'Armellina E, Karamitsos TD, Francis JM, Choudhury RP, et al. Non-contrast T1-mapping detects acute myocardial edema with high diagnostic accuracy: a comparison to T2-weighted cardiovascular magnetic resonance. J Cardiovasc Magn Reson. 2012 Jun 21;14(1):42.

49. Ugander M, Bagi PS, Oki AJ, Chen B, Hsu L-Y, Aletras AH, et al. Myocardial edema as detected by pre-contrast T1 and T2 MRI delineates area at risk associated with acute myocardial infarction. JACC Cardiovasc Imaging. 2012 Jun;5(6):596–603.

50. Dall'Armellina E, Piechnik SK, Ferreira VM, Si QL, Robson MD, Francis JM, et al. Cardiovascular magnetic resonance by non contrast T1-mapping allows assessment of severity of injury in acute myocardial infarction. J Cardiovasc Magn Reson. 2012 Feb 6;14(1):15.

51. Messroghli DR, Niendorf T, Schulz-Menger J, Dietz R, Friedrich MG. T1 mapping in patients with acute myocardial infarction. J Cardiovasc Magn Reson Off J Soc Cardiovasc Magn Reson. 2003;5(2):353–9.

52. Pedersen SF, Thrysøe SA, Robich MP, Paaske WP, Ringgaard S, Bøtker HE, et al. Assessment of intramyocardial hemorrhage by T1-weighted cardiovascular magnetic resonance in reperfused acute myocardial infarction. J Cardiovasc Magn Reson. 2012 Aug 30;14:59.

53. Klein C, Nekolla SG, Balbach T, Schnackenburg B, Nagel E, Fleck E, et al. The influence of myocardial blood flow and volume of distribution on late Gd-DTPA kinetics in ischemic heart failure. J Magn Reson Imaging. 2004 Oct 1;20(4):588–94.

54. Kali A, Choi E-Y, Sharif B, Kim YJ, Bi X, Spottiswoode B, et al. Native T1 Mapping by 3-T CMR Imaging for Characterization of Chronic Myocardial Infarctions. JACC Cardiovasc Imaging. 2015 Sep;8(9):1019–30.

55. Nezafat R. Native T1 Mapping for Myocardial Infarction: Time to Throw Out the Gadolinium? JACC Cardiovasc Imaging. 2015 Sep;8(9):1031–3.

56. Kali A, Cokic I, Tang RLQ, Yang H-J, Sharif B, Marbán E, et al. Determination of Location, Size and Transmurality of Chronic Myocardial Infarction Without Exogenous Contrast Media Using Cardiac Magnetic Resonance Imaging at 3T. Circ Cardiovasc Imaging. 2014 May;7(3):471–81.

57. Dastidar AG, Pontecorboli G, Harries I, Moret C, Morgan G, Garate ED, et al. 4 Non-contrast assessment of myocardial viability in chronic myocardial infarction by native T1 and T2 mapping at 1.5T CMR: comparison with late gadolinium enhancement technique. Heart. 2017 May 1;103(Suppl 4):A2–A2.

58. Messroghli DR, Plein S, Higgins DM, Walters K, Jones TR, Ridgway JP, et al. Human Myocardium: Single-Breath-hold MR T1 Mapping with High Spatial Resolution—Reproducibility Study. Radiology. 2006 Mar 1;238(3):1004–12.

WRITTEN INFORMED CONSENT FORM

For normal population **Date:**

Study title: T1 and T2 mapping of the myocardium

It has been explained to me by the investigator in the language that I understand that this study is being carried out as extra imaging in addition to the regular MRI that I will be undergoing. By this technique, they are trying to study two properties of heart muscle called T1 and T2 relaxation times, and finding the normal range of values in Indian population in this MRI machine.

It has been explained to me that no extra drugs / extra charges and there is no risk involved in this study It has also been explained that I am free to withdraw from the study any time I want and this will not in any way compromise my treatment. I understand that my identity and participation will not be revealed in any information released to third parties.

No Extra Charges

Subjects' Name :

Date of Birth/ Age:

- I confirm that I have read and understood the information sheet for the above study and have had the opportunity to ask questions
- I understand my participation is purely voluntary and that I can withdraw from the study anytime, without any reason, without my medical care being affected.
- I understand that my identity will not be revealed in any information.

I agree to take part in the above study.

Signature of subject **Date**

Name of the subject Thumb Impression

Signature of the investigator **Date**

Name of the investigator

Signature of the witness **Date**

Name of the witness Thumb Impression

Contract address:

Dr. Grace Rebecca, PG Registrar, Department of Radiology, Christian Medical College and Hospital, Vellore – 632 004, Tamil Nadu, Mobile No :9442249535

लिखा सूचित सहमति फॉर्म

आम जनता के लिए तारीख:

अध्ययन का शीर्षक : T1 और T 2 मायोकार्डि यमके मानचित्रण

अन्वेषक द्वारा मुझे समझाया गया है कि मैं समझता हूँ कि इस अध्ययन नियमित एमआरआई कि दौर से गुजर रहा होगा के अलावा अतिरिक्त इमेजिंग के रूप में किया जा रहा है | इस तकनीक के द्वारा, वे T2 छूट बार T1 बुलाया हृदय की मांसपेशी के दो गुण और अध्ययन करने के लिए कोशिश कर रहे हैं, और इस एमआरआई मशीन में भारतीय आबादी में मूल्यों के सामान्य श्रेणी खोजने कोशिश कर रहे हैं |

यह मुझे समझाया गया है कि बिना किसी अतिरिक्त दवाओं का इस्तेमाल कर रहे हैं और इस अध्ययन में कोई खतरा शामिल नहीं है | यह भी बताया गया है कि मैं किसी भी समय अध्ययन से वापस लेने के लिए स्वतंत्र हूँ और मैं चाहता हूँ यह किसी भी तरह से मेरे इलाज समझौता नहीं करेंगे | मैं समझता हूँ कि मेरी पहचान और भागीदारी तीसरे पक्ष के लिए जारी किया गया कोई भी जानकारी में खुलासा नहीं किया जाएगा |

No Extra Charges

व्यक्ति का नाम:

जन्म / आयु दिनांक :

• मैं इस बात की पुष्टि है कि मैंने पढ़ा है और ऊपर के अध्ययन के लिए जानकारी शीट को समझा और सवाल पूछने का मौका मिला है |

• मैं समझता हूँ कि मेरी भागीदारी पूरी तरह स्वैच्छिक है और मैं किसी भी कारण के बिना, मेरे चिकित्सा, देखभाल प्रभावित किया बिना अध्ययन किसी भी समय वापस ले सकता हूँ|

• मैं समझता हूँ कि मेरी पहचान कोई भी जानकारी में पता नहीं किया जाएगा। मैं ऊपर अध्ययन में भाग लेने के लिए सहमत हूँ।

व्यक्ति के हस्ताक्षर दिनांक

व्यक्ति का नाम

व्यक्ति के हस्ताक्षर दिनांक

व्यक्ति का नाम

व्यक्ति के हस्ताक्षर दिनांक

व्यक्ति का नाम

For any queries, kindly contact- Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535

লিখিত অবহিত সম্মতি ফর্ম তারিখ:

গবেষণার শিরোনাম: myocardium এর T1 এবং T2 ম্যাপিং

এটা ভাষা যে আমি বুঝতে পারি যে এই গবেষণায় অতিরিক্ত পরীক্ষা সম্পন্ন হচ্ছে তদন্তকারী দ্বারা আমাকে ব্যাখ্যা করা হয়েছে | T1 এর ম্যাপিং, তাড়াতাড়ি রোগ শনাক্ত, রোগের তীব্রতা নির্ণয় এবং নির্দিষ্ট অবস্থার মধ্যে রোগেরগতিনির্দেশক অর্ন্তদৃষ্টি প্রদান করার প্রতিশ্রুতি এটা | আমার কাছে ব্যাখ্যা করা হয়েছে যে কোন অতিরিক্ত ওষুধ ব্যবহার করা হয় না এবং কোন ঝুঁকি তার নেই এই গবেষণায় | এটি ব্যাখ্যা করা হয়েছে যে আমি গবেষণা থেকে যে কোন সময় আমি নাম প্রত্যাহার করার বিষয় মুক্ত এবং এই ছবিটি কোনভাবেই আমার চিকিত্সা নিয়ে সমঝোতা করবে না | আমি বুঝেছি যে আমার পরিচয় এবং অংশগ্রহণ তৃতীয় পক্ষের কাছে কোনো তথ্য প্রকাশ করা হবে না.

No Extra Charges

প্রজা 'নাম

জন্ম / বয়স তারিখ:

i) আমি নিশ্চিত করছি যে আমি পড়েছি এবং উপরে অধ্যয়নের জন্য তথ্য শীট বুঝেছি এবং প্রশ্ন জিজ্ঞাসা করার সুযোগ ছিল

ii) আমি বুঝেছি আমার অংশগ্রহণ বিশুদ্ধরূপে স্বেচ্ছাসেবামূলক এবং আমি কোন কারণ ছাড়াই, অধ্যয়ন যে কোনো সময় থেকে নাম প্রত্যাহার করতে পারি, আমার চিকিৎসা ক্ষতিগ্রস্ত না করে |

iii) আমি বুঝেছি যে আমার পরিচয় কোন তথ্য প্রকাশ করা হবে না.

iv) আমি উপরে গবেষণায় অংশ নিতে সম্মত হন.

বিষয় এর স্বাক্ষর তারিখ

বিষয় এর নাম Thumb Impression

তদন্তকারীর স্বাক্ষর তারিখ

তদন্তকারী র নাম

সাক্ষীর স্বাক্ষর তারিখ

সাক্ষীর নাম Thumb Impression

For any queries, kindly contact- Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535

WRITTEN INFORMED CONSENT FORM

Date:

Study title: T1 and T2 mapping of the myocardium

It has been explained to me by the investigator in the language that I understand that this study is being carried out as extra test. T1 mapping promises to detect early disease, quantify disease severity and provide prognostic insights into certain conditions. It has been explained to me that no extra drugs/ extra charge and there is no risk involved in this study It has also been explained that I am free to withdraw from the study any time I want and this will not in any way compromise my treatment. I understand that my identity and participation will not be revealed in any information released to third parties.

No Extra Charges

Subjects' Name

Date of Birth/ Age:

- I confirm that I have read and understood the information sheet for the above study and have had the opportunity to ask questions
- I understand my participation is purely voluntary and that I can withdraw from the study anytime, without any reason, without my medical care being affected.
- I understand that my identity will not be revealed in any information.
- I agree to take part in the above study.

Signature of subject **Date**

Name of the subject Thumb impression

Signature of the investigator **Date**

Name of the investigator

Signature of the witness **Date**

Name of the witness Thumb impression

For any queries, kindly contact- Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535; Tamil Nadu

लिखा सूचित सहमति फॉर्म

अध्ययन का शीर्षक : T1 और T 2 मायोकार्डि यमके मानचित्रण तारीख:

यह अन्वेषक ने मुझे समझाया है मैं समझता हूँ कि इस अध्ययन अतिरिक्त परीक्षण के रूप में किया जा रहा है । T1 मानचित्रण जल्दी बीमारी का पता लगाने का वादा किया, रोग की गंभीरता यों और कुछ शर्तों में शकुन अंतर्दृष्टि प्रदान |

यह मुझे समझाया गया है कि बिना किसी अतिरिक्त दवाओं का इस्तेमाल कर रहे हैं और वहाँ कोई खतरा नहीं इस अध्ययन में शामिल है | यह भी बताया गया है कि मैं अध्ययन से किसी भी समय मैं वापस लेने के लिए स्वतंत्र हूँ और यह किसी भी तरह से मेरे इलाज में समझौता नहीं करेंगे | मैं समझता हूँ कि मेरी पहचान और भागीदारी तीसरे पक्ष के लिए जारी किया गया कोई भी जानकारी में खुलासा नहीं किया जाएगा |

No Extra Charges

व्यक्ति का नाम:
जन्म / आयु दिनांक :

1) मैं इस बात की पुष्टि है कि मैंने पढ़ा है और ऊपर के अध्ययन के लिए जानकारी शीट को समझा और सवाल पूछने का मौका मिला है |
2) मुझे समझ में मेरी भागीदारी पूरी तरह स्वैच्छिक है और मैं किसी भी कारण के बिना , अध्ययन किसी भी समय मेरे चिकित्सा देखभाल प्रभावित किए बिना वापस ले सकता हूँ।
3) मैं समझता हूँ कि मेरी पहचान कोई भी जानकारी में पता नहीं किया जाएगा।
4) मैं उपरोक्त अध्ययन में भाग लेने के लिए सहमत हैं।

व्यक्ति के हस्ताक्षर दिनांक
व्यक्ति का नाम

Thumb Impression

अन्वेषक के हस्ताक्षर दिनांक
अन्वेषक के हस्ताक्षर दिनांक
गवाह के हस्ताक्षर दिनांक

गवाह का नाम Thumb Impression

For any queries, kindly contact- Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535

ஆராய்ச்சியில் பங்கேற்பதற்கு இணக்கம்

ஆய்வுத்

தலைப்பு :

மேலே சொல்லப்பட்டு இருக்கும் ஆராய்ச்சி ஆய்வில் பங்கேற்பதற்கு நீங்கள் அழைக்கப்படுகிறீர்கள்.

பங்கேற்க நீங்கள் சம்மதிக்கும் முன், பின்வருவன பற்றி உங்களுக்கு ஆய்வாளர் தெரிவிக்க் வேண்டும்:

i. நோக்கம், செய்முறைகள், மற்றும் ஆராய்ச்சியின் கால அளவு;
ii. சோதனைகளில் பயன்படுத்தப்படுபவையாக இருக்கும் செய்முறைகள்;
iii. ஏதேனும் நியாயமாக எதிர்பார்க்கக் கூடிய அபாயங்கள் அல்லது அசௌகரியங்கள்;
iv. ஆராய்ச்சின் ஏதேனும் உள்ளார்ந்த பலன்கள்;
v. ஏதேனும் மாற்று செய்முறைகள் அல்லது சிகிச்சைகள்; மற்றும்
vi. இரகசியத்தன்மை எவ்வாறு பாதுகாக்கப்படும்.

பொருந்தும் இடங்களில், பின்வருவன பற்றியும் ஆய்வாளர் உங்களுக்குத் தெரிவிக்க வேண்டும்:

i. காயம் ஏற்பட்டால் இருக்கின்ற ஏதேனும் இழப்பீடு அல்லது மருத்துவ சிகிச்சை;
ii. எதிர்பாராத அபாயங்களுக்கான சாத்தியம்;
iii. ஆய்வாளர் உங்கள் பங்கேற்பை நிறுத்தக் கூடிய சூழ்நிலைகள்;
iv. உங்களுக்கு ஆகும் ஏதேனும் கூடுதல் செலவுகள்;
v. பங்கேற்பதை நிறுத்த நீங்கள் முடிவு செய்தால் என்ன நடக்கும்;
vi. பங்கேற்கும் உங்கள் விருப்பத்தை பாதிக்கக் கூடிய புதிய கண்டுபிடிப்புகள் பற்றி உங்களுக்கு எப்போது சொல்லப்படும்; மற்றும்
vii. ஆய்வில் எத்தனை பேர் பங்கேற்பார்கள்.

No Extra Charges

பங்கேற்க நீங்கள் சம்மதித்தால், இந்த ஆவணத்தில் கையெழுத்திடப்பட்ட நகல் ஒன்றும், ஆராய்ச்சி பற்றிய எழுத்தபூர்வமான தொகுப்புரை ஒன்றும் உங்களுக்கு கொடுக்கப்பட வேண்டும்.

ஆராய்ச்சி பற்றி உங்களுக்கு கேள்விகள் இருந்தால் எந்த சமயத்திலும் __(Name of Principal Investigator)__ அவர்களை ___(Contact Details)___ -ல் நீங்கள் தொடர்பு கொள்ளலாம்.

ஆராய்ச்சியின் போது நீங்கள் காயம்பட்டால் உங்களது ஆய்வாளர், __(Name of Principal Investigator)__ அவர்களை ___(Contact Details)___ -ல் நீங்கள் தொடர்பு கொள்ளலாம்.

குறிப்பு: அனைத்து ஆய்வுகளுக்கும், தயவு செய்து குறைந்தபட்சம் உங்கள் மருத்துவமனையின் தொலைபேசி எண்ணை குறிப்பிடவும். மேலும் அதிக பட்ச ஆபத்தான ஆய்வுகளுக்கு, மருத்துவமனையின் தொலைபேசி எண் மற்றுமின்றி உங்களது
ஆய்வாளர் அல்லது ஆய்வு வழிநடத்துனர் தொலைபேசி எண்ணை குறிப்பிடவும். [தயவு செய்து படித்த பின்னர் இந்த குறிப்பை நீக்கவும்.]

நீங்கள் ஒரு ஆராய்ச்சி பங்கேற்பாளராக, உங்கள் உரிமைகளை பற்றி ஒரு சுதந்திரமான கருத்து வேண்டும் என்று விரும்பினால், நீங்கள் NHG Domain Specific Review Board-டுடைய செயலகத்துக்கு 6471-3266-ல் தொடர்பு கொள்ளலாம்.

இந்த ஆராய்ச்சியில் உங்கள் பங்கேற்பு சுயவிருப்பமாகும். நீங்கள பங்கேற்க மறுத்தால் அல்லது நிறுத்த முடிவு செய்தால், நீங்கள் தண்டிக்கப்பட மாட்டீர்கள் அல்லது பலன்களை இழக்க மாட்டீர்கள்.

மேலுள்ள தகவல்கள் உள்ளிட்டு ஆராய்ச்சி ஆய்வானது உங்களுக்கு வாய்வழியாக விளக்கப்பட்டிருக்கிறது மற்றும் பங்கேற்பதற்கு நீங்கள்

சுயவிருப்பத்தில் இணங்குகிறீர்கள் என்பது இந்த ஆவணத்தில் கையெழுத்திடுவதன் அர்த்தமாகும்.

பங்கேற்பாளர் பெயர்	பங்கேற்பாளர் கையெழுத்து	தேதி
		Thumb Impression
சாட்சி பெயர்	சாட்சி கையெழுத்து	தேதி
ஆய்வாளர் பெயர்	ஆய்வாளர் கையெழுத்து	தேதி
		Thumb Impression

For any queries, kindly contact- **Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535**

PATIENT INFORMATION SHEET

Study title: T1 and T2 mapping of the myocardium

The following information is provided to inform you about this study and your participation in it. Please read the information carefully and you are free to ask any questions regarding the study and the information given. The participation in this study is purely voluntary and you are free to withdraw from the study anytime.

Purpose of the study:

A cardiac MRI T1 and T2 myocardial mapping technique is a non –invasive study, enabling direct visualisation of properties and healthiness of heart muscle. By this technique, we are trying to study two properties of heart muscle called T1 and T2 relaxation times, by doing some extra imaging, in addition to the regular MRI that you will be undergoing.

T1 mapping promises to detect early disease, quantify disease severity and provide prognostic insights into certain conditions.

No Extra charge

Method to be followed:

Patient is to arrive at MRI Room 8, one hour prior to the scheduled test time.

Patient will be asked to change into a hospital gown and remove all jewellery, dentures and hearing aids.

Intravenous (IV) cannula (usually 20G) will be placed.

Baseline blood pressure will be checked.

During the test:

Standard MRI sequences including post Gadolinium studies will be obtained as requested by your treating doctor.

In addition, extra sequences will be done including native T1 andT2 mapping and post contrast T1 mapping of myocardium is done which takes additional 1 minute

Confidentiality:

The participation in the study will remain confidential and shall be known only to the investigators.

Withdrawal from the study:

Participation in this study is purely voluntary and you can withdraw from the study anytime without any reason. It will not compromise your treatment in any way. There are no potential risks involved in this study and you need not pay any extra money for the test.

For any queries, kindly contact- Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535

Detailed information about the Procedure

What is cardiac MRI T1 and T2 mapping technique?

The magnetic resonance imaging (MRI) machine is a tube with a centre opening that is about three feet wide.

A table slides into the central opening and the patient lies on the table. Pictures of the heart are created using a magnetic field, radio waves and computers.

No X-rays are used to create the images.

The images made by the MRI will allow your doctor to look at the anatomy and functioning of your heart.

In addition, by using doing T1 and T2 mapping of the heart, we will try to see the abnormality of the heart muscle from another perspective.

What are the benefits and risks of the stress test?

There is absolute no risk involved in the study. You will just have to be within the scanner for an additional minute or so.

This test can potentially help us to detect the disease earlier.

It can also helps us to know amount of disease in the heart.

Before the test:

• You cannot have anything to eat or drink for 4 hours before your test.

• Take your medications as instructed by your doctor

On day of the test

Patient is to arrive at MRI Room 8, one hour prior to the scheduled test time.

Patient will be asked to change into a hospital gown and remove all jewellery, dentures and hearing aids.

A needle {Intravenous (IV) cannula (usually 20G)} will be placed in your hand or elbow region.

Baseline blood pressure will be checked.

• Before the test starts, you will be asked questions about your medical history and the medication(s) you are taking and also to make sure it is safe for you to have an MRI scan.

During the test:

Standard MRI sequences including post Gadolinium studies are obtained.

Native T1 andT2 mapping and post contrast T1 mapping of myocardium is done which takes additional 1 minute

• During the test, you will hear knocking sounds as the machine takes the pictures. We will also prompt you with instructions. For example, we may ask you to hold your breath for 8 to 10 seconds

• It is important for you to stay as still as possible because movements can create glitches in the pictures.

• At the end of the procedure, your IV canula (needle) will be removed.

After the test

• You may resume your normal activity unless your doctor tells you differently.

• Take your regular medications as directed unless your doctor tells you differently.

• By the following day, the test results will be sent to the doctor who ordered the test. You will need to contact your doctor to discuss the results of your test.

• Keep any scheduled follow-up appointments with your primary doctor

For any queries, kindly contact- **Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535**

రోగి సమాచార పత్రము

అధ్యయనం పేరు: T1 and T2 మ్యాపింగ్ ఆఫ్ ది మయోకార్డియమ్

ఈ అధ్యయనంలో పాల్గొ నడంగురించి ఈ క్రింది సమాచారం మీకు తెలియచేయడమైనది. దీనిని జాగ్రత్తగా చదివి ఈ సమాచారంలో మీకు ఏవైనా సందేహాలు ఉన్నయెడల స్వేచ్చగా అడగగలరు. ఈ పరిశోధనలో పాల్గొ నడంపూర్తిగా నా నిర్ణయమని, ఏ కారణం లేకుండా ఈ అధ్యయనం నుండి విరమించుకొనవచ్చని నాకు తెలియచేయడమైనది.

అధ్యయనం ఉద్దేశం

కార్డియాక్ MRI T1 and T2 మయోకార్డియల్ మ్యాపింగ్ అనునది సురక్షితమైన, గుండె కండరాల పనితనం గురించి అధ్యయనం చేయు ఒక పద్ధతి. ఈ పద్ధతి ద్వారా మీ గుండె కండరాలకు సంబంధించిన రెండు విషయాల (T1 and T2) సడలింపు సమయాలను సాధారణ MRI స్కానింగ్ తో పాటు ఎక్స్ట్రా ఇమేజింగ్ ద్వారా చేయబడును. ఈ పరిశీలన ద్వార మీ గుండె కండరాలకు సంబంధించిన రెండు విషయాల (T1 and T2) సడలింపు సమయాలతో ఇండియా దేశ వాసుల సడలింపు సమయాలతో సరిచూచెదరు.

No Extra Charges

అధ్యయనం చేయు పద్ధతి:

రోగి తనకు నిర్ణయించిన సమయానికన్నా ఒక గంట ముందుగా MRI స్కానింగ్ రూము 8 కి రావలెను.

హాస్పిటల్ వారు ఇచ్చే దుస్తు లనుపేషెంట్ ధరించి బంగారు ఆభరణాలు, పెట్టు డుపళ్ళు మరియు వినికిడికి సంబంచిన ఇతరమైనవాటిని తీసివేయవలెను.

డయబెటిస్ లేదా గుండెకు సంబంధించిన ఇతర సమస్యలకు పూర్వం గురయినారాఅని తెలుసుకొని ప్రస్తు తబ్లడ్ ప్రెషర్ చెక్ చేసెదరు.

అధ్యయన సమయంలో: మీకు చికిత్స చేసే డాక్టరుగారు అడిగిన విధంగా స్టాండర్డ్ MRI చేయబడును.

ECG లెడ్లు మీ శరీరానికి అమర్చి మీ గుండె యొక్క పనివిధానాన్ని, కొన్ని cine ఇమేజ్ లను మరియు నేటివ్ T1 and T2 మ్యాపింగ్ చేసెదరు.

T1 and T2 మ్యాపింగ్ చేయుటకు ఒక నిమిషం అలాగే cine ఇమేజ్ లను తీయుటకు 3-4 నిమిషములు అవును.

కాన్ఫిడెన్షియల్: మీరు ఈ అధ్యయనంలో పాల్గొ నేవిషయం పరిశోధకునికి కాకుండా ఇతరులకు తెలియకుండా గోప్యంగా ఉంచెదరు.

అధ్యయనం నుండి ఉపసంహారణ :

ఈ అధ్యయనంలో పార్టిసిపేషన్ పూర్తిగా స్వచ్ఛంద మరియు మీరు ఏ కారణం లేకుండా ఎప్పుడైనా అధ్యయనం నుండి వెనక్కి తీసుకోవచ్చు. ఇది ఏ విధంగా మీ చికిత్స రాజీ ఉండదు. ఈ అధ్యయనంలో ప్రమేయం ఏ సంభావ్య ప్రమాదాల ఉన్నాయి మరియు మీరు పరీక్ష కోసం ఏ అదనపు డబ్బు చెల్లిస్తా రుపనిలేదు.

ఏ ప్రశ్నలు కోసం , దయచేసి డాక్టర్ గ్రేస్ రెబెక్కా పీజీ రిజిస్ట్రార్ శాఖ రేడియాలజీ , సిఎంసి వెల్లూ రుcontact- . మొబైల్ + 9442249535

విధానము గురించి వివరమైన సమాచారం

కార్డియాక్ **MRI T**1 మరియు **T**2 మ్యాపింగ్ టెక్నిక్ ఏమిటి **?**

అయస్కాంత ప్రతిధ్వని ఇమేజింగ్ (MRI) యంత్రం గురించి మూడు అడుగుల వెడల్పు ఉంది ఓపెనింగ్ కేంద్రం గొట్టం. ఒక పట్టిక కేంద్ర ప్రారంభ లోకి మునిగి మరియు రోగి పట్టిక ఉంది. గుండె యొక్క చిత్రాలు రూపొందించి ఒక ఐస్కాంత , రేడియో తరంగాలు మరియు కంప్యూటర్లు సృష్టించబడతాయి

తోటుట్టువుల ఎక్స్రేలను చిత్రాలు సృష్టించడానికిఉపయోగిస్తా రు

MRI చేసిన చిత్రాలు మీ గుండె యొక్క నిర్మాణం మరియు పనితీరును చూడండి అనుమతిస్తు ంది

చేయడం T1 మరియు గుండె యొక్క T2 మ్యాపింగ్ ఉపయోగించి , మేము ఈ MRI మెషీన్ కోసం మన జనాభాలో గుండె కండరాల సాధారణ విలువలు ఏర్పాటు ప్రయత్నిస్తు ంది

ఒత్తిడి పరీక్ష యొక్క ప్రయోజనాలు మరియు నష్టాలు ఏమిటి **?**

అధ్యయనంలో పాల్గొ న్న సంపూర్ణ ఏ ప్రమాదం ఉంది. మీరు కేవలం ఒక అదనపు 4-5minutes లేదా కోసం స్కానర్ లోపల ఉంటుంది .

ఈ పరీక్ష సమర్థవంతంగా మునుపటి వ్యాధి గుర్తించడం మాకు సహాయపడుతుంది.

ఇది కూడా మాకు హృదయ వ్యాధి మొత్తం తెలుసు సహాయపడుతుంది చేయవచ్చు .

పరీక్ష ముందు:

• మీ వైద్యుడు సూచించిన విధంగా మీ మందులు తీసుకోండి

పరీక్ష రోజున:

రోగి MRI రూమ్ 8, ఒక గంట షెడ్యూల్ పరీక్ష సమయం ముందు వద్దకు ఉంది.

రోగి ఆసుపత్రిలో గౌను లోకి మార్చడానికి మరియు అన్ని ఆభరణాలు , దంతాలు మరియు వినికిడి తొలగించడానికి అడగబడతారు.

బేస్లైన్రక్తపోటు తనిఖీ చేయబడుతుంది .

• పరీక్ష మొదలవుతుంది ముందు, మీరు మీ వైద్య చరిత్ర మరియు మందుల (లు) మీరు ఒక MRI స్కాన్ కలిగి ఖచ్చితంగా సురక్షితమని చేయడానికి కూడా తీసుకొని మరియు గురించి ప్రశ్నలు అడుగుతారు .

పరీక్ష సమయంలో:

కోరడం జరిగింది రెగ్యులర్ MRI పూర్తి అవుతుంది.

కాయిల్స్ మార్పులు ఉండవచ్చు మరియు ECG లీడ్స్ పరిష్కరించబడుతుంది. మయోకార్డియంకు స్థా నికT1 and T2 మ్యాపింగ్ అదనపు 1 నిమిషం పడుతుంది ఇది జరుగుతుంది. సినీ కార్డియాక్ MRI సన్నివేశాలు మరింత 3-4min పట్టవచ్చు పూర్తి చేసారు.

• పరీక్ష సందర్భంగా , మీరు యంత్రం చిత్రాలు పడుతుంది తలక్రిందులు శబ్దా లువినవచ్చు. మేము కూడా సూచనలతో మీరు అడుగుతుంది. ఉదాహరణకు , మేము 8 నుంచి 10 సెకన్ల మీ శ్వాసను నొక్కి మీరు అడగవచ్చు

• ఇది ఉద్యమాలు చిత్రాలు అవాంతరాలు సృష్టించవచ్చు ఎందుకంటే మీరు ఇప్పటికీ సాధ్యమైనంత ఉండడానికి ముఖ్యం.

పరీక్ష తర్వాత

• మీ డాక్టర్ భిన్నంగా మీరు చెబుతుంది తప్ప మీరు మీ సాధారణ కార్యకలాపాలు రెస్యూమ్ ఉండవచ్చు.

• మీ డాక్టర్ భిన్నంగా మీరు చెబుతుంది తప్ప దర్శకత్వం మీ సాధారణ మందులు తీసుకోండి.

• తరువాతి రోజు ద్వారా, పరీక్షా ఫలితాలు పరీక్ష ఆదేశించాడు డాక్టర్ పంపబడును . మీరు మీ పరీక్ష ఫలితాలు చర్చించడానికి మీ వైద్యుడు సంప్రదించడానికి అవసరం.

• మీ ప్రాధమిక వైద్యుడు ఏ షెడ్యూల్, నియామకాలు అనుసరించండి.

For any queries, kindly contact- **Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535**

रोगी सूचना शीट

अध्ययन शीर्षक: मायोकार्डियमके T1 और T 2 मानचित्रण
निम्न जानकारी इस अध्ययन और उस में अपनी भागीदारी के बारे में सूचित करने के लिए प्रदान की जाती है ।
कृपया जानकारी ध्यान से पढ़ें और आप अध्ययन और दी गई जानकारी के बारे में किसी भी सवाल पूछने के लिए स्वतंत्र हैं ।
इस अध्ययन में भागीदारी पूरी तरह स्वैच्छिक है और आप कभी भी अध्ययन से वापस लेने के लिए स्वतंत्र हैं।

अध्ययन का उद्देश्य:
एक हृदय एमआरआई T1 और T2 दौरे मानचित्रण तकनीक एक गैर इनवेसिव अध्ययन है, हृदय की मांसपेशी के गुणों के प्रत्यक्ष दृश्य सक्षम है। इस तकनीक के द्वारा, हम हृदय की मांसपेशी के दो गुणों का अध्ययन करने के लिए कोशिश कर रहे हैं
कहा जाता है T1 और T 2 relaxation time, कुछ अतिरिक्त इमेजिंग कर रही है, नियमित रूप से एमआरआई कि दौर से गुजर जाएगा।
ऐसा करके , हम इस एमआरआई मशीन में भारतीय आबादी में मूल्यों के सामान्य श्रेणी स्थापित करना चाहते हैं ।

No Extra Charges

विधि का पालन किया जाना है:
रोगी एमआरआई कमरे 8, एक घंटे के लिए निर्धारित परीक्षा का समय से पहले आ रहा है ।
मरीज को एक अस्पताल का गाउन में बदलने के लिए और सभी के आभूषण, डेन्चर और सुनने के सामान को दूर करने के लिए कहा जाएगा।
आधारभूत रक्तचाप की जाँच की जाएगी और यह सुनिश्चित किया जाएगा मधुमेह या दिल की बीमारी के किसी भी अन्य सुविधाओं का कोई इतिहास नहीं है।

जांच के दौरान:
स्टैंडर्ड एमआरआई के रूप में अपने इलाज चिकित्सक द्वारा अनुरोध प्राप्त किया जाएगा।
इसके अलावा, ईसीजी सुराग अपने शरीर पर तय किया जाएगा और अतिरिक्त दृश्यों कुछ सिने छवियों और देशी T1 और T 2 मानचित्रण सहित दिल के लिए किया जाएगा।
यह T1 और T 2 मानचित्रण और सिने छवियों के लिए 3-4 min के लिए अतिरिक्त 1 मिनट लगते हैं ।

गोपनीयता:
अध्ययन में भाग लेने के गोपनीय रहेगा और केवल जांचकर्ताओं के लिए जाना जाएगा ।

अध्ययन से निकासी:
इस अध्ययन में भागीदारी पूरी तरह स्वैच्छिक है और आप किसी भी कारण के बिना कभी भी अध्ययन से वापस ले सकते हैं । यह किसी भी तरह से अपने इलाज समझौता नहीं करेंगे। कोई संभावित इस अध्ययन में शामिल जोखिम भी हैं और आप परीक्षण के लिए किसी भी अतिरिक्त पैसे का भुगतान नहीं की जरूरत है । किसी भी प्रश्न के लिए, कृपया contact- डॉ. Grace Rebecca, पीजी रजिस्ट्रार, रेडियोलॉजी विभाग, सीएमसी वेल्लोर। मोबाइल- +9442249535.

प्रक्रिया के बारे में विस्तृ तजानकारी
हृदय एमआरआई T1 और T 2 मानचित्रण तकनीक क्या है?

चुंबकीय अनुनाद इमेजिंग (एमआरआई) मशीन एक केंद्र खोलने की है कि लगभग तीन फीट चौड़ा है के साथ एक ट्यूब है।
एक मेज केंद्रीय उद्घाटन में स्लाइड और रोगी की मेज पर स्थित है। दिल का चित्र एक चुंबकीय क्षेत्र , रेडियो तरंगों और कंप्यूटर का उपयोग कर बनाई गई हैं ।
कोई एक्स रे चित्र बनाने के लिए इस्तेमाल नहीं कर रहे हैं ।
एमआरआई द्वारा बनाई गई छवियों हमें शारीरिक रचना और अपने दिल के कामकाज को देखने के लिए अनुमति देगा।
इसका उपयोग कर T1 और दिल की T2 मानचित्रण करने से, हम इस एमआरआई मशीन के लिए हमारी आबादी में हृदय की मांसपेशियों के लिए सामान्य मूल्यों की स्थापना करने की कोशिश करेंगे |

लाभ और तनाव परीक्षण के जोखिम क्या हैं?
वहाँ कोई खतरा अध्ययन में शामिल नहीं है। आपको बस एक अतिरिक्त 4-5minutes या ऐसा करने के लिए स्कैनर के भीतर करना होगा |
इस परीक्षा में संभावित रोग पहले पता लगाने के लिए हमारी मदद कर सकते हैं।
यह हमें दिल में रोग की राशि पता करने के लिए मदद कर सकते है।

परीक्षण से पहले:

•अपने चिकित्सक द्वारा निर्देश दिए अपनी दवा ले|

परीक्षा के दिन:

रोगी एमआरआई कमरे 8, एक घंटे के लिए निर्धारित परीक्षा का समय से पहले आ रहा है । मरीज को एक अस्पताल का गाउन में बदलने के लिए और सभी के आभूषण , डेन्चर और सुनने के सामान को दूर करने के लिए कहा जाएगा। आधारभूत रक्तचाप की जाँच की जाएगी । इससे पहले परीक्षण शुरू होता है, आप को अपनी चिकित्सा के इतिहास और दवाओं के बारे में सवाल पूछा जाएगा, आप यह भी सुनिश्चित रहे एमआरआई स्कैन सुरक्षित है।

जांच के दौरान:
नियमित रूप से अनुरोध किया गया एमआरआई किया जाएगा।
Coils परिवर्तन हो सकता है और ईसीजी सुराग तय हो जाएगा। मायोकार्डि यमके मूल निवासी T1 और T 2 मैपिं ग हो जो अतिरिक्त 1 मिनट लगते है। सिने हृदय एमआरआई दृश्यों किया जाता है जो 3-4min अधिक समय लग सकता है ।
परीक्षण के दौरान, आप दस्तक ध्वनियों के रूप में मशीन तस्वीरें लेता सुना होगा। यह भी निर्देश के साथ संकेत होगा। उदाहरण के लिए, हम 8 से 10 सेकंड के लिए अपनी सांस रोक के लिए आप पूछ सकते हैं |
• यह आप के रूप में अभी भी संभव के रूप में रहने के लिए है क्योंकि आंदोलनों चित्रों में glitches बना सकते हैं महत्वपूर्ण है।

परीक्षण के बाद
जब तक आप अपने डॉक्टर से अलग ढंग से बताता है कि आप अपने सामान्य गतिविधि फिर से शुरू हो सकती है।
• निर्देशन के रूप में जब तक आप अपने डॉक्टर से अलग ढंग से बताता है कि अपने नियमित रूप से दवा लेने ।

• अगले दिन तक, परीक्षण के परिणाम डॉक्टर जो परीक्षण का आदेश दिया करने के लिए भेजा जाएगा। आप अपने परीक्षण के परिणामों पर चर्चा करने के लिए अपने डॉक्टर से संपर्क करने की आवश्यकता होगी ।
• अपनी प्राथमिक चिकित्सक के साथ किसी भी अनुसूचित अनुवर्ती नियुक्तियों रखें

For any queries, kindly contact- **Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535**

PATIENT INFORMATION SHEET

Study title: T1 and T2 mapping of the myocardium

The following information is provided to inform you about this study and your participation in it. Please read the information carefully and you are free to ask any questions regarding the study and the information given. The participation in this study is purely voluntary and you are free to withdraw from the study anytime.

Purpose of the study:

A cardiac MRI T1 and T2 myocardial mapping technique is a non –invasive study, enabling direct visualisation of properties of heart muscle. By this technique, we are trying to study two properties of heart muscle called T1 and T2 relaxation times, by doing some extra imaging, in addition to the regular MRI that you will be undergoing.

By doing this, we wish to establish the normal range of values in Indian population in this MRI machine.

No extra money will be charged for the patient for T1 and T2 mapping

Method to be followed:

Patient is to arrive at MRI Room 8, one hour prior to the scheduled test time.

Patient will be asked to change into a hospital gown and remove all jewellery, dentures and hearing aids.

Baseline blood pressure will be checked and it will be ensured that there is no history of diabetes or any other features of heart disease.

During the test:

Standard MRI will be obtained as requested by your treating doctor.

In addition, ECG leads will be fixed on your body and extra sequences will be done for the heart including some cine images and native T1 andT2 mapping.

It takes additional 1 minute for the T1 and T2 mapping and 3-4min for the cine images.

Confidentiality:

The participation in the study will remain confidential and shall be known only to the investigators.

Withdrawal from the study:

Participation in this study is purely voluntary and you can withdraw from the study anytime without any reason. It will not compromise your treatment in any way. There are no potential risks involved in this study and you need not pay any extra money for the test.

Detailed information about the Procedure

What is cardiac MRI T1 and T2 mapping technique?

The magnetic resonance imaging (MRI) machine is a tube with a centre opening that is about three feet wide.

A table slides into the central opening and the patient lies on the table. Pictures of the heart are created using a magnetic field, radio waves and computers.

No X-rays are used to create the images.

The images made by the MRI will allow us to look at the anatomy and functioning of your heart.

By using doing T1 and T2 mapping of the heart, we will try to establish normal values for heart muscle in our population for this MRI machine.

What are the benefits and risks of the stress test?

There is absolute no risk involved in the study. You will just have to be within the scanner for an additional 4-5minutes or so.

This test can potentially help us to detect the disease earlier.

It can also helps us to know amount of disease in the heart.

Before the test:

• Take your medications as instructed by your doctor

On day of the test

Patient is to arrive at MRI Room 8, one hour prior to the scheduled test time.

Patient will be asked to change into a hospital gown and remove all jewellery, dentures and hearing aids.

Baseline blood pressure will be checked.

• Before the test starts, you will be asked questions about your medical history and the medication(s) you are taking and also to make sure it is safe for you to have an MRI scan.

During the test:

Regular MRI that has been requested will be done.

Coils may be changes and ECG leads will be fixed. Native T1 andT2 mapping of myocardium is done which takes additional 1 minute. Cine cardiac MRI sequences are done which may take 3-4min more.

• During the test, you will hear knocking sounds as the machine takes the pictures. We will also prompt you with instructions. For example, we may ask you to hold your breath for 8 to 10 seconds

• It is important for you to stay as still as possible because movements can create glitches in the pictures.

After the test

• You may resume your normal activity unless your doctor tells you differently.

• Take your regular medications as directed unless your doctor tells you differently.

• By the following day, the test results will be sent to the doctor who ordered the test. You will need to contact your doctor to discuss the results of your test.

• Keep any scheduled follow-up appointments with your primary doctor

For any queries, kindly contact- **Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535**

நோயாளி தகவல் தாள்

ஆய்வு தலைப்பு: மையோகார்டியம் என்ற முதல் T1 மற்றும் டி 2 மேப்பிங்

பின்வரும் தகவல்களை இந்த ஆய்வு மற்றும் அது உங்கள் பங்கு பற்றி தெரிவிக்க வழங்கப்படுகிறது. தகவல் கவனமாகப் படிக்கவும் மற்றும் நீங்கள் ஆய்வு மற்றும் கொடுக்கப்பட்ட தகவல் தொடர்பாக எந்த கேள்விகள் கேட்க இலவச உள்ளன. இந்த ஆய்வில் பங்கு முற்றிலும் தன்னார்வ மற்றும் நீங்கள் ஆய்வு எப்போது இருந்து திரும்ப இலவச இருக்கிறீர்கள் .

ஆய்வின் நோக்கம் :

ஒரு இதய எம்ஆர்ஐ T1 மற்றும் T2 இதய மேப்பிங் நுட்பம் இதய தசை பண்புகள் நேரடிப் பார்வைக்கு செயல்படுத்த , ஒரு அல்லாத -invasive கல்வியாகும். இந்த தொழில் நுட்பம் மூலம், நீங்கள் அனுபவித்து என்று வழக்கமான எம்ஆர்ஐ கூடுதலாக , சில கூடுதல் இமேஜிங் செய்து , இதய தசை இரண்டு பண்புகள் T1 மற்றும் T2 தளர்வு முறை என்று படிக்க முயற்சி .
இதை செய்வதன் மூலம், நாம் இந்த எம்ஆர்ஐ இயந்திரம் இந்திய மக்கள் தொகையில் மதிப்புகள் சாதாரண வரம்பில் அமைக்க விரும்புகிறது.

No Extra Charges

முறை பின்பற்றப்பட வேண்டும் :

நோயாளி ஒரு மணி நேரம் திட்டமிடப்பட்டுள்ளது சோதனை நேரம் முன் எம்ஆர்ஐ அறை 8 மணிக்கு வந்து உள்ளது .
நோயாளி ஒரு மருத்துவமனையில் கவுன் மாற்ற மற்றும் அனைத்து நகைகள் , பொய்ப்பற்கள் மற்றும் விசாரணை எய்ட்ஸ் நீக்க கேட்கப்படும்.
பேஸ்லைன் இரத்த அழுத்தம் சோதிக்கப்பட வேண்டும் மற்றும் அது நீரிழிவு அல்லது இதய நோய் வேறு எந்த அம்சங்கள் பற்றிய வரலாறு எதுவும் என்று உறுதி செய்யப்படும்.

சோதனையின் போது :

உங்கள் சிகிச்சை மருத்துவர் மூலம் கேட்டு ஸ்டாண்டர்ட் எம்ஆர்ஐ பெறவுள்ளது.
கூடுதலாக, ஈசிஜி தடங்கள் உங்கள் உடலில் செய்யப்படும் மற்றும் சில சினி படங்கள் மற்றும் சொந்த முதல் T1 மற்றும் டி 2 மேப்பிங் உட்பட இதய கூடுதல் காட்சிகளை செய்யப்படும்.
அது சினிமா படங்களை T1 மற்றும் T2 மேப்பிங் மற்றும் 3-4min கூடுதல் 1 நிமிடம் எடுக்கும்

ரகசியக்காப்பு :

ஆய்வில் பங்கு ரகசியமாக இருக்கும் மற்றும் மட்டுமே விசாரணை தெரியவரும் என்றார்கள்.

ஆய்வில் இருந்து பின்வாங்கும் :

இந்த ஆய்வில் பங்கேற்பு முற்றிலும் தன்னார்வ மற்றும் நீங்கள் எந்த காரணமும் இல்லாமல் எப்போது ஆய்வு இருந்து திரும்ப முடியும் . அது எந்த வழியில் உங்கள் சிகிச்சை விட்டுக்கொடுக்கமாட்டோம். இந்த ஆய்வில் ஈடுபட்டுள்ள எந்த அபாயங்கள் உள்ளன நீங்கள் சோதனை எந்த கூடுதல் பணம் செலுத்தத் தேவையில்லை.
எந்த கேள்விகளுக்கு, தயவுசெய்து டாக்டர் கிரேஸ் ரெபேக்கா , தங்கும் பதிவாளர் , கதிரியக்கவியல் துறை , சி.எம்.சி. வேலூர் contact- . Mobile- + 9442249535

நடைமுறை பற்றி விரிவான தகவல்களை

இதய எம்ஆர்ஐ T1 மற்றும் T2 மேப்பிங் நுட்பம் என்ன?

காந்த ஒத்ததிர்வு படமெடுத்தல் (MRI) இயந்திரத்தை என்று சுமார் மூன்று அடி அகலம் திறந்து ஒரு மையத்தில் ஒரு குழாய் ஆகும்.
ஒரு அட்டவணை மத்திய திறப்பு ஸ்லைடுகள் மற்றும் நோயாளி அட்டவணை அமைந்துள்ளது. இதய படங்கள் ஒரு காந்த, ரேடியோ அலைகள் மற்றும் கணினிகள் பயன்படுத்தி உருவாக்கப்படுகின்றன.
இல்லை எக்ஸ் கதிர்கள் படங்களை உருவாக்க பயன்படுத்தப்படுகின்றன.

எம்ஆர்ஐ மூலம் படங்களை எங்களுக்கு உங்கள் இதயம் உடற்கூறியல் மற்றும் செயல்பாட்டை பார்க்க அனுமதிக்கும்.
செய்து T1 மற்றும் இதயம் டி 2 மேப்பிங் பயன்படுத்தி, நாம் இந்த எம்ஆர்ஐ இயந்திரம் இதய தசை சாதாரண மதிப்புகள் எங்கள் மக்கள் தொகையில் நிறுவ முயற்சி.
காந்த ஒத்ததிர்வு படமெடுத்தல் (MRI) இயந்திரத்தை என்று சுமார் மூன்று அடி அகலம் திறந்து ஒரு மையத்தில் ஒரு குழாய் ஆகும்.
ஒரு அட்டவணை மத்திய திறப்பு ஸ்லைடுகள் மற்றும் நோயாளி அட்டவணை அமைந்துள்ளது. இதய படங்கள் ஒரு காந்த, ரேடியோ அலைகள் மற்றும் கணினிகள் பயன்படுத்தி உருவாக்கப்படுகின்றன.
இல்லை எக்ஸ் கதிர்கள் படங்களை உருவாக்க பயன்படுத்தப்படுகின்றன.
எம்ஆர்ஐ மூலம் படங்களை எங்களுக்கு உங்கள் இதயம் உடற்கூறியல் மற்றும் செயல்பாட்டை பார்க்க அனுமதிக்கும்.
செய்து T1 மற்றும் இதயம் டி 2 மேப்பிங் பயன்படுத்தி, நாம் இந்த எம்ஆர்ஐ இயந்திரம் இதய தசை சாதாரண மதிப்புகள் எங்கள் மக்கள் தொகையில் நிறுவ முயற்சி.

அழுத்த சோதனை உள்ள நன்மைகள் மற்றும் ஆபத்துகள் என்ன?

ஈடுபட்டு ஒரு கூடுதல் 4-5minutes அல்லது ஐந்து ஸ்கேனர் க்குள் இருக்க வேண்டும் முழுமையான எந்த ஆபத்து உள்ளது . இந்த சோதனை சாத்தியமுள்ள முந்தைய நோய் கண்டறிய எங்களுக்கு உதவ முடியும். இது எங்களுக்கு இதய நோய் அளவு தெரியும் உதவுகிறது முடியும் .

சோதனை முன் :

உங்கள் மருத்துவர் குறிப்பிட்டுள்ளது உங்கள் மருந்துகளை எடுத்து
சோதனை நாளில்
நோயாளி ஒரு மணி நேரம் திட்டமிடப்பட்டுள்ளது சோதனை நேரம் முன் எம்ஆர்ஐ அறை 8 மணிக்கு வந்து உள்ளது . நோயாளி ஒரு மருத்துவமனையில் கவுன் மாற்ற மற்றும் அனைத்து நகைகள் , பொய்ப்பற்கள் மற்றும் விசாரணை எய்ட்ஸ் நீக்க கேட்கப்படும். பேஸ்லைன் இரத்த அழுத்தம் சோதனை

செய்யப்படும். சோதனை துவக்குவதற்கு முன், உங்கள் மருத்துவ வரலாறு மற்றும் மருந்து (கள்) நீங்கள் எம்ஆர்ஐ ஸ்கேன் வேண்டும் உறுதி அது பாதுகாப்பானது செய்ய கூட எடுத்து ஏன் பற்றிய கேள்விகள் கேட்கப்படும்.

சோதனையின் போது :

கேட்கப்பட்டுள்ளது என்று வழக்கமான எம்ஆர்ஐ செய்யப்படும்.
சுருள்கள் மாற்றங்கள் இருக்கலாம் மற்றும் ஈசிஜி தடங்கள் சரி செய்யப்படும்.
மையோகார்டியம் பூர்வீ கமுதல் T1 மற்றும் டி 2 மேப்பிங் கூடுதல் 1 நிமிடம் எடுக்கும் எந்த செய்யப்படுகிறது. சினி இதய எம்ஆர்ஐ காட்சிகளை எந்த மேலும் 3-4min ஆகலாம் செய்யப்படுகின்றன. சோதனை போது, நீங்கள் இயந்திரம் படங்கள் எடுக்கும் என தட்டி சத்தம் கேட்க வேண்டும். நாங்கள் வழிமுறைகளை நீங்கள் கேட்கும். உதாரணமாக, நாம் 8 முதல் 10 விநாடிகள் மூச்சை நீங்கள் கேட்கலாம். இது இயக்கங்கள் படங்களை குறைபாடுகள் உருவாக்க முடியும் என்பதால், நீங்கள் இன்னும் முடிந்தவரை தங்க முக்கியமான உள்ளது.

சோதனைக்கு பிறகு

• உங்கள் மருத்துவர் வித்தியாசமாக நீங்கள் சொல்கிறது தவிர நீங்கள் உங்கள் சாதாரண செயல்பாடு மீண்டும் கூடும் .
உங்கள் மருத்துவர் வித்தியாசமாக நீங்கள் சொல்கிறது வரை இயக்கிய • உங்கள் வழக்கமான மருந்துகளை எடுத்து.
• அடுத்த நாள் மூலம், சோதனை முடிவு சோதனை உத்தரவிட்டார் மருத்துவரிடம் அனுப்பி வைக்கப்படும். நீங்கள் உங்கள் சோதனை முடிவுகளை விவாதிக்க உங்கள் மருத்துவர் தொடர்பு கொள்ள வேண்டும் .
• உங்கள் முதன்மை மருத்துவர் எந்த திட்டமிடப்பட்டுள்ளது பின்தொடர் நியமனங்கள் வைத்து

For any queries, kindly contact- **Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535**

రోగి సమాచార పత్రము

అధ్యయనం పేరు: T1 and T2 మ్యాపింగ్ ఆఫ్ ది మయోకార్డియమ్

ఈ అధ్యయనంలో పాల్గొ నడంగురించి ఈ క్రింది సమాచారం మీకు తెలియచేయడమైనది. దీనిని జాగ్రత్తగా చదివి ఈ సమాచారంలో మీకు ఏవైనా సందేహాలు ఉన్నయెడల స్వేచ్చగా అడగగలరు. ఈ పరిశోధనలో పాల్గొ నడంపూర్తిగా నా నిర్ణయమని, ఏ కారణం లేకుండా ఈ అధ్యయనం నుండి విరమించుకొనవచ్చని నాకు తెలియచేయడమైనది.

అధ్యయనం ఉద్దేశం

కార్డియాక్ MRI T1 and T2 మయోకార్డియల్ మ్యాపింగ్ అనునది సురక్షితమైన, గుండె కండరాల పనితనం గురించి అధ్యయనం చేయు ఒక పద్ధతి. ఈ పద్ధతి ద్వారా మీ గుండె కండరాలకు సంబంధించిన రెండు విషయాల (T1 and T2) సడలింపు సమయాలను మీకు చేసే సాధారణ MRI స్కానింగ్ తో పాటు ఎక్స్ట్రా ఇమేజింగ్ ద్వారా చేయబడును.

T1 మ్యాపింగ్ చేయుట వలన గుండె వ్యాధి ప్రారంభ లక్షణాలను, వ్యాధి యొక్క తీవ్రతను మరియు ఇతర లోగుట్టు విషయాలను తెలుసుకొనుటకు సాధ్యపడును.

No Extra Charges

అధ్యయనం చేయు పద్ధతి:

రోగి తనకు నిర్ణయించిన సమయానికన్నా ఒక గంట ముందుగా MRI స్కానింగ్ రూము 8 కి రావలెను.

హాస్పిటల్ వారు ఇచ్చే దుస్తు లనుపేషెంట్ ధరించి బంగారు ఆభరణాలు, పెట్టు డుపళ్ళు మరియు వినికిడికి సంబంచిన ఇతరమైనవాటిని తీసివేయవలెను.

ఇంట్రవీనస్ (IV) కాన్యులా (సాధరణంగా 20 గ్రాములు) ఉంచెదరు.

ప్రస్తు తబ్లడ్ ప్రెషర్ చెక్ చేసెదరు.

అధ్యయన సమయంలో:

మీకు చికిత్స చేసే డాక్టరుగారు అడిగిన విధంగా స్టాండర్డ్ MRI తోపాటు పోస్ట్ గడోలినియం అధ్యాయనాలు చేయబడును.

నేటివ్ T1 and T2 మ్యాపింగ్ అలాగే పోస్ట్ కాంట్రాస్ట్ T1 మ్యాపింగ్ ఆఫ్ మయోకార్డియమ్ చేసెదరు. దీనికి అదనంగా ఒక నిమిషం ఎక్కువ అవును.

కాన్ఫిడెన్షియల్: మీరు ఈ అధ్యయనంలో పాల్గొ నేవిషయం పరిశోధకునికి కాకుండా ఇతరులకు తెలియకుండా గోప్యంగా ఉంచెదరు.

అధ్యయనం నుండి ఉపసంహరణ :

ఈ అధ్యయనంలో పార్టిసిపేషన్ పూర్తిగా స్వచ్ఛంద మరియు మీరు ఏ కారణం లేకుండా ఎప్పుడైనా అధ్యయనం నుండి వెనక్కి తీసుకోవచ్చు. ఇది ఏ విధంగా మీ చికిత్స రాజీ ఉండదు. ఈ అధ్యయనంలో ప్రమేయం ఏ సంభావ్య ప్రమాదాల ఉన్నాయి మరియు మీరు పరీక్ష కోసం ఏ అదనపు డబ్బు చెల్లిస్తా రుపనిలేదు.

ఏ ప్రశ్నలు కోసం , దయచేసి డాక్టర్ గ్రేస్ రెబెక్కా పీజీ రిజిస్ట్రార్ శాఖ రేడియాలజీ , సిఎంసి వెల్లూ రుcontact- . మొబైల్ + 9442249535

విధానము గురించి వివరమైన సమాచారం
కార్డియాక్ MRI T1 మరియు T2 మ్యాపింగ్ టెక్నిక్ ఏమిటి ?

అయస్కాంత ప్రతిధ్వని ఇమేజింగ్ (MRI) యంత్రం గురించి మూడు అడుగుల వెడల్పు ఉంది ఓపెనింగ్ కేంద్రం గొట్టం. ఒక పట్టికకేంద్ర ప్రారంభ లోకి మునిగి మరియు రోగి పట్టికఉంది. గుండె యొక్క చిత్రాలు రూపొందించి ఒక ఐస్కాంత , రేడియో తరంగాలు మరియు కంప్యూటర్లు సృష్టించబడతాయి
తోటుట్టు వులఎక్స్రేలను చిత్రాలు సృష్టించడానికిఉపయోగిస్తా రు
MRI చేసిన చిత్రాలు మీ డాక్టర్ మీ గుండె యొక్క నిర్మాణం మరియు పనితీరును చూడండి అనుమతిస్తు ంది అదనంగా , చేయడం T1 మరియు గుండె యొక్క T2 మ్యాపింగ్ ఉపయోగించి , మేము మరొక కోణం నుండి గుండె కండరాలు అసాధారణత చూడటానికి ప్రయత్నించండి.
మీరు తినడానికి లేదా మీ పరీక్ష ముందు 4 గంటల త్రాగడానికి ఏదైనా ఉండకూడదు.
• మీ వైద్యుడు సూచించిన విధంగా మీ మందులు తీసుకోండి
పరీక్ష రోజున:
రోగి MRI రూమ్ 8, ఒక గంట షెడ్యూల్ పరీక్ష సమయం ముందు వద్దకు ఉంది.

రోగి ఆసుపత్రిలో గౌను లోకి మార్చడానికి మరియు అన్ని ఆభరణాలు, దంతాలు మరియు వినికిడి తొలగించడానికి అడగబడతారు.

ఒక సూది {ఇంట్రావీనస్ (IV) కాన్యులా (సాధారణంగా 20G)} మీ చేతి లేదా మోచేయి ప్రాంతంలో పెట్టబడుతుంది. బేస్లైన్రక్తపోటు తనిఖీ చేయబడుతుంది.

• పరీక్ష మొదలవుతుంది ముందు, మీరు మీ వైద్య చరిత్ర మరియు మందుల (లు) మీరు ఒక MRI స్కాన్ కలిగి ఖచ్చితంగా సురక్షితమని చేయడానికి కూడా తీసుకొని మరియు గురించి ప్రశ్నలు అడుగుతారు.

పరీక్ష సమయంలో:

పోస్ట్ డోలీనియమ్ అధ్యయనాలు సహా ప్రామాణిక MRI సన్నివేశాలు తీస్తా రు

స్థా నికT1 and T2 మ్యాపింగ్ మరియు పోస్ట్ విరుద్ధంగా మయోకార్డియంకు యొక్క T1 మ్యాపింగ్ అదనపు 1 నిమిషం పడుతుంది ఇది జరుగుతుంది

• పరీక్ష సందర్భంగా, మీరు యంత్రం చిత్రాలు పడుతుంది తలక్రిందులు శబ్దా లువినవచ్చు. మేము కూడా సూచనలతో మీరు అడుగుతుంది. ఉదాహరణకు, మేము 8 నుంచి 10 సెకన్ల మీ శ్వాసను నొక్కి మీరు అడగవచ్చు

• ఇది ఉద్యమాలు చిత్రాలు అవాంతరాలు సృష్టించవచ్చుఎందుకంటే మీరు ఇప్పటికీ సాధ్యమైనంత ఉండడానికి ముఖ్యం.

• ప్రక్రియ యొక్క ముగింపులో, మీ IV దానిమీద తొడుగు (సూది) తొలగించబడుతుంది.

పరీక్ష తర్వాత

• మీ డాక్టర్ భిన్నంగా మీరు చెబుతుంది తప్ప మీరు మీ సాధారణ కార్యకలాపాలు రెస్యూమ్ ఉండవచ్చు.

• మీ డాక్టర్ భిన్నంగా మీరు చెబుతుంది తప్ప దర్శకత్వం మీ సాధారణ మందులు తీసుకోండి.

• తరువాతి రోజు ద్వారా, పరీక్షా ఫలితాలు పరీక్ష ఆదేశించాడు డాక్టర్ పంపబడును. మీరు మీ పరీక్ష ఫలితాలు చర్చించడానికి మీ వైద్యుడు సంప్రదించడానికి అవసరం.

• మీ ప్రాధమిక వైద్యుడు షెడ్యూల్, నియామకాలు అనుసరించండి.

For any queries, kindly contact- **Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535**

रोगी सूचना शीट

अध्ययन शीर्षक: मायोकार्डियमके T1 और T2 मानचित्रण

निम्न जानकारी इस अध्ययन और उस में अपनी भागीदारी के बारे में सूचित करने के लिए प्रदान की जाती है । कृपया जानकारी ध्यान से पढ़ें और आप अध्ययन और दी गई जानकारी के बारे में किसी भी सवाल पूछने के लिए स्वतंत्र हैं| इस अध्ययन में भागीदारी पूरी तरह स्वैच्छिक है और आप कभी भी अध्ययन से वापस लेने के लिए स्वतंत्र हैं।

अध्ययन का उद्देश्य:

एक हृदय एमआरआई T1 और T2 दौरे मानचित्रण तकनीक एक गैर इनवेसिव अध्ययन है, हृदय की मांसपेशी के गुणों के प्रत्यक्ष दृश्य सक्षम है। इस तकनीक के द्वारा, हम हृदय की मांसपेशी के दो गुणों का अध्ययन करने के लिए कोशिश कर रहे हैं| कहा जाता है T1 और T 2 relaxation time, कुछ अतिरिक्त इमेजिंग कर रही है, नियमित रूप से एमआरआई कि दौर से गुजर जाएगा।

T1 मानचित्रण जल्दी बीमारी का पता लगाने का वादा करता है, रोग की गंभीरता यों और कुछ शर्तों में शकुन अंतर्दृष्टि प्रदान करते हैं।

विधि का पालन किया जाना है:

रोगी एमआरआई कमरे 8, एक घंटे के लिए निर्धारित परीक्षा का समय से पहले आ रहा है ।

मरीज को एक अस्पताल का गाउन में बदलने के लिए और सभी के आभूषण, डेन्चर और सुनने के सामान को दूर करने के लिए कहा जाएगा।

अंतःशिरा (चतुर्थ) प्रवेशनी (आमतौर पर 20 ग्राम) रखा जाएगा।

आधारभूत रक्तचाप की जाँच की जाएगी|

जांच के दौरान:

पोस्ट gadolinium अध्ययन सहित स्टैंडर्ड एमआरआई दृश्यों के रूप में अपने इलाज चिकित्सक द्वारा अनुरोध प्राप्त किया जाएगा।

इसके अलावा, अतिरिक्त दृश्यों मूल निवासी टी 1 और मायोकार्डियमकिया जाता है जो अतिरिक्त 1 मिनट लगते हैं की टी 2 मानचित्रण और पोस्ट विपरीत T1 मानचित्रण सहित किया जाएगा।

गोपनीयता:

अध्ययन में भाग लेने के गोपनीय रहेगा और केवल जांचकर्ताओं के लिए जाना जाएगा ।

अध्ययन से निकासी:

इस अध्ययन में भागीदारी पूरी तरह स्वैच्छिक है और आप किसी भी कारण के बिना कभी भी अध्ययन से वापस ले सकते हैं । यह किसी भी तरह से अपने इलाज समझौता नहीं करेंगे। कोई संभावित इस अध्ययन में शामिल जोखिम भी हैं और आप परीक्षण के लिए किसी भी अतिरिक्त पैसे का भुगतान नहीं की जरूरत है । किसी भी प्रश्न

के लिए, कृपया contact- डॉ. Grace Rebecca, पीजी रजिस्ट्रार, रेडियोलॉजी विभाग, सीएमसी वेल्लोर। मोबाइल- +9442249535.

प्रक्रिया के बारे में विस्तृत जानकारी

हृदय एमआरआई T1 और T 2 मानचित्रण तकनीक क्या है?

चुंबकीय अनुनाद इमेजिंग (एमआरआई) मशीन एक केंद्र खोलने की है कि लगभग तीन फीट चौड़ा है के साथ एक ट्यूब है।

एक मेज केंद्रीय उद्घाटन में स्लाइड और रोगी की मेज पर स्थित है। दिल का चित्र एक चुंबकीय क्षेत्र , रेडियो तरंगों और कंप्यूटर का उपयोग कर बनाई गई हैं ।

कोई एक्स रे चित्र बनाने के लिए इस्तेमाल नहीं कर रहे हैं ।

एमआरआई द्वारा बनाई गई छवियों हमें शारीरिक रचना और अपने दिल के कामकाज को देखने के लिए अनुमति देगा।

इसका उपयोग कर T1 और दिल की T2 मानचित्रण करने से, हम इस एमआरआई मशीन के लिए हमारी आबादी में हृदय की मांसपेशियों के लिए सामान्य मूल्यों की स्थापना करने की कोशिश करेंगे |

लाभ और तनाव परीक्षण के जोखिम क्या हैं?

अध्ययन में कोई खतरा शामिल नहीं है । तुम बस एक अतिरिक्त मिनट या ऐसा करने के लिए स्कैनर के भीतर करना होगा। इस परीक्षा में संभावित रोग पहले पता लगाने के लिए हमारी मदद कर सकते हैं।

यह हमें दिल में रोग की राशि पता करने के लिए मदद कर सकते है।

No Extra Charges

परीक्षण से पहले:

• आप खाने के लिए या अपने परीक्षण से पहले 4 घंटे के लिए पीने के लिए कुछ भी नहीं कर सकते।

• अपने चिकित्सक द्वारा दिए निर्देश के रूप में अपनी दवा ले|

परीक्षा के दिन

रोगी एमआरआई कमरे 8, एक घंटे के लिए निर्धारित परीक्षा का समय से पहले आ रहा है ।

मरीज को एक अस्पताल का गाउन में बदलने के लिए और सभी के आभूषण , डेन्चर और सुनने के सामान को दूर करने के लिए कहा जाएगा।

एक सुई { अंतःशिरा (चतुर्थ) प्रवेशनी (आमतौर पर 20 ग्राम) } अपने हाथ या कोहनी क्षेत्र में रखा जाएगा।

आधारभूत रक्तचाप की जाँच की जाएगी ।
इससे पहले परीक्षण शुरू होता है, आप को अपनी चिकित्सा के इतिहास और दवाओं के बारे में सवाल पूछा जाएगा, आप यह भी सुनिश्चित रहे एमआरआई स्कैन सुरक्षित है।
जांच के दौरान:

पोस्ट gadolinium अध्ययन सहित स्टैंडर्ड एमआरआई दृश्यों के रूप में अपने इलाज चिकित्सक द्वारा अनुरोध प्राप्त किया जाएगा।
इसके अलावा, अतिरिक्त दृश्यों मूल निवासी टी 1 और मायोकार्डि यमकिया जाता है जो अतिरिक्त 1 मिनट लगते हैं की टी 2 मानचित्रण और पोस्ट विपरीत T1 मानचित्रण सहित किया जाएगा।
• परीक्षण के दौरान, आप के रूप में मशीन तस्वीरें लेता दस्तक आवाज़ सुन जाएगा । हम यह भी निर्देश के साथ संकेत होगा। उदाहरण के लिए, हम 8 से 10 सेकंड के लिए अपनी सांस रोक के लिए आप पूछ सकते हैं|

• यह आप के रूप में अभी भी संभव के रूप में रहने के लिए है क्योंकि आंदोलनों चित्रों में glitches बना सकते हैं महत्वपूर्ण है।

• प्रक्रिया के अंत में, अपने चतुर्थ canula (सुई) को हटा दिया जाएगा ।

परीक्षण के बाद:

• जब तक अपने डॉक्टर अलग ढंग से बताता नहीं तब तक अपने सामान्य गतिविधि फिर से शुरू कर सकते है।

जब तक अपने डॉक्टर अलग ढंग से बताता नहीं तब तक अपने नियमित रूप से दवा ले ।

• अगले दिन तक, परीक्षण के परिणाम डॉक्टर जो परीक्षण का आदेश दिया करने के लिए भेजा जाएगा। आप अपने परीक्षण के परिणामों पर चर्चा करने के लिए अपने डॉक्टर से संपर्क करने की आवश्यकता होगी ।
• अपनी प्राथमिक चिकित्सक के साथ किसी भी अनुसूचित अनुवर्ती नियुक्तियों रखें।

For any queries, kindly contact- **Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535**

PATIENT INFORMATION SHEET

Study title: T1 and T2 mapping of the myocardium

The following information is provided to inform you about this study and your participation in it. Please read the information carefully and you are free to ask any questions regarding the study and the information given. The participation in this study is purely voluntary and you are free to withdraw from the study anytime.

Purpose of the study:

A cardiac MRI T1 and T2 myocardial mapping technique is a non –invasive study, enabling direct visualisation of properties and healthiness of heart muscle. By this technique, we are trying to study two properties of heart muscle called T1 and T2 relaxation times, by doing some extra imaging, in addition to the regular MRI that you will be undergoing.

T1 mapping promises to detect early disease and to know the amount of disease in the heart

No extra money will be charged for T1 Na T2 mapping of the myocardium

Method to be followed:

Patient is to arrive at MRI Room 8, one hour prior to the scheduled test time.

Patient will be asked to change into a hospital gown and remove all jewellery, dentures and hearing aids.

Intravenous (IV) cannula (usually 20G) will be placed.

Baseline blood pressure will be checked.

During the test:

Standard MRI sequences including post Gadolinium studies will be obtained as requested by your treating doctor.

In addition, extra sequences will be done including native T1 andT2 mapping and post contrast T1 mapping of myocardium is done which takes additional 1 minute

Confidentiality:

The participation in the study will remain confidential and shall be known only to the investigators.

Withdrawal from the study:

Participation in this study is purely voluntary and you can withdraw from the study anytime without any reason. It will not compromise your treatment in any way. There are no potential risks involved in this study and you need not pay any extra money for the test.

Detailed information about the Procedure

What is cardiac MRI T1 and T2 mapping technique?

The magnetic resonance imaging (MRI) machine is a tube with a centre opening that is about three feet wide.

A table slides into the central opening and the patient lies on the table. Pictures of the heart are created using a magnetic field, radio waves and computers.

No X-rays are used to create the images.

The images made by the MRI will allow your doctor to look at the anatomy and functioning of your heart.

In addition, by using doing T1 and T2 mapping of the heart, we will try to see the abnormality of the heart muscle from another perspective.

What are the benefits and risks of the test?

There is absolute no risk involved in the study. You will just have to be within the scanner for an additional minute or so.

This test can potentially help us to detect the disease earlier.

It can also helps us to know amount of disease in the heart.

Before the test:

- You cannot have anything to eat or drink for 4 hours before your test.
- Take your medications as instructed by your doctor

On day of the test

Patient is to arrive at MRI Room 8, one hour prior to the scheduled test time.

Patient will be asked to change into a hospital gown and remove all jewellery, dentures and hearing aids.

A needle {Intravenous (IV) cannula (usually 20G)} will be placed in your hand or elbow region.

Baseline blood pressure will be checked.

• Before the test starts, you will be asked questions about your medical history and the medication(s) you are taking and also to make sure it is safe for you to have an MRI scan.

During the test:

Standard MRI sequences including post Gadolinium studies are obtained.

Native T1 andT2 mapping and post contrast T1 mapping of myocardium is done which takes additional 1 minute

• During the test, you will hear knocking sounds as the machine takes the pictures. We will also prompt you with instructions. For example, we may ask you to hold your breath for 8 to 10 seconds

• It is important for you to stay as still as possible because movements can create glitches in the pictures.

• At the end of the procedure, your IV canula (needle) will be removed.

After the test

• You may resume your normal activity unless your doctor tells you differently.

• Take your regular medications as directed unless your doctor tells you differently.

• By the following day, the test results will be sent to the doctor who ordered the test. You will need to contact your doctor to discuss the results of your test.

• Keep any scheduled follow-up appointments with your primary doctor

For any queries, kindly contact- **Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535**

நோயாளி தகவல் தாள்

ஆய்வு தலைப்பு: மையோகார்டியம் என்ற முதல் T1 மற்றும் T2 மேப்பிங்.
பின்வரும் தகவல்களை இந்த ஆய்வு மற்றும் அது உங்கள் பங்கு பற்றி தெரிவிக்க வழங்கப்படுகிறது. தகவல் கவனமாகப் படிக்கவும் மற்றும் நீங்கள் ஆய்வு மற்றும் கொடுக்கப்பட்ட தகவல் தொடர்பாக எந்த கேள்விகள் கேட்க இலவச உள்ளன. இந்த ஆய்வில் பங்கு முற்றிலும் தன்னார்வ மற்றும் நீங்கள் ஆய்வு எப்போது இருந்து திரும்ப இலவச இருக்கிறீர்கள் .

ஆய்வின் நோக்கம்:
ஒரு இதய எம்ஆர்ஐ T1 மற்றும் T2 இதய மேப்பிங் நுட்பம் பண்புகள் மற்றும் இதய தசை healthiness நேரடிப் பார்வைக்கு செயல்படுத்த , ஒரு அல்லாத -invasive கல்வியாகும். இந்த தொழில் நுட்பம் மூலம், நீங்கள் அனுபவித்து என்று வழக்கமான எம்ஆர்ஐ கூடுதலாக , சில கூடுதல் இமேஜிங் செய்து , இதய தசை இரண்டு பண்புகள் T1 மற்றும் T2 தளர்வு முறை என்று படிக்க முயற்சி .
முதல் T1 மேப்பிங் ஆரம்ப நோய் கண்டறிய நோயின் தீவிரத்தன்மை கணக்கிட மற்றும் சில நிபந்தனைகளை ஒரு முன்கணிப்பு நுண்ணறிவு வழங்க உறுதி .

No Extra Charges

முறை பின்பற்றப்பட வேண்டும் :
நோயாளி ஒரு மணி நேரம் திட்டமிடப்பட்டுள்ளது சோதனை நேரம் முன் எம்ஆர்ஐ அறை 8 மணிக்கு வந்து உள்ளது .
நோயாளி ஒரு மருத்துவமனையில் கவுன் மாற்ற மற்றும் அனைத்து நகைகள் , பொய்ப்பற்கள் மற்றும் விசாரணை எய்ட்ஸ் நீக்க கேட்கப்படும்.
நாளங்கள் (IV) வடிகுழாய் (வழக்கமாக 20g) வைக்கப்படும் .
பேஸ்லைன் இரத்த அழுத்தம் சோதனை செய்யப்படும்.

சோதனையின் போது :
உங்கள் சிகிச்சை மருத்துவர் மூலம் கேட்டு பதவியை கடோலினியம் ஆய்வுகள் உள்ளிட்ட தரநிலை எம்ஆர்ஐ காட்சிகளை பெறவுள்ளது.
கூடுதலாக, கூடுதல் காட்சிகளை சொந்த முதல் T1 மற்றும் டி 2 மேப்பிங் மற்றும் கூடுதல் 1 நிமிடம் எடுக்கும் எந்த மையோகார்டியம் செய்யப்படுகிறது பதவிக்கு மாறாக முதல் T1 மேப்பிங் உட்பட செய்யப்படும்.

ரகசியக்காப்பு :
ஆய்வில் பங்கு ரகசியமாக இருக்கும் மற்றும் மட்டுமே விசாரணை தெரியவரும் என்றார்கள்.

ஆய்வில் இருந்து பின்வாங்கும் :
இந்த ஆய்வில் பங்கேற்பு முற்றிலும் தன்னார்வ மற்றும் நீங்கள் எந்த காரணமும் இல்லாமல் எப்போது ஆய்வு இருந்து திரும்ப முடியும் . அது எந்த வழியில் உங்கள் சிகிச்சை விட்டுக்கொடுக்கமாட்டோம். இந்த ஆய்வில் ஈடுபட்டுள்ள எந்த அபாயங்கள் உள்ளன நீங்கள் சோதனை எந்த கூடுதல் பணம் செலுத்தத் தேவையில்லை.
எந்த கேள்விகளுக்கு, தயவுசெய்து டாக்டர் கிரேஸ் ரெபேக்கா , தங்கும் பதிவாளர் , கதிரியக்கவியல் துறை , சி.எம்.சி. வேலூர் contact- . Mobile- + 9442249535.

நடைமுறை பற்றி விரிவான தகவல்களை

இதய எம்ஆர்ஐ T1 மற்றும் T2 மேப்பிங் நுட்பம் என்ன?

காந்த ஒத்ததிர்வு படமெடுத்தல் (MRI) இயந்திரத்தை என்று சுமார் மூன்று அடி அகலம் திறந்து ஒரு மையத்தில் ஒரு குழாய் ஆகும்.
ஒரு அட்டவணை மத்திய திறப்பு ஸ்லைடுகள் மற்றும் நோயாளி அட்டவணை அமைந்துள்ளது. இதய படங்கள் ஒரு காந்த , ரேடியோ அலைகள் மற்றும் கணினிகள் பயன்படுத்தி உருவாக்கப்படுகின்றன.
இல்லை எக்ஸ் கதிர்கள் படங்களை உருவாக்க பயன்படுத்தப்படுகின்றன.
எம்ஆர்ஐ மூலம் படங்களை உங்கள் மருத்துவர் உங்கள் இதயம் உடற்கூறியல் மற்றும் செயல்பாட்டை பார்க்க அனுமதிக்கும்.
கூடுதலாக, செய்து T1 மற்றும் இதயம் டி 2 மேப்பிங் பயன்படுத்தி , நாம் மற்றொரு கண்ணோட்டத்தில் இதய தசை பிறழ்தல் பார்க்க முயற்சி .

அழுத்த சோதனை உள்ள நன்மைகள் மற்றும் ஆபத்துகள் என்ன?

ஆய்வில் ஈடுபட்டுள்ள முழுமையான எந்த ஆபத்து உள்ளது . நீங்கள் ஒரு கூடுதல் நிமிடம் அல்லது ஐந்து ஸ்கேனர் க்குள் இருக்க வேண்டும்.

இந்த சோதனை சாத்தியமுள்ள முந்தைய நோய் கண்டறிய எங்களுக்கு உதவ முடியும்.
இது எங்களுக்கு இதய நோய் அளவு தெரியும் உதவ முடியும்.

சோதனை முன் :

• நீங்கள் சாப்பிட அல்லது உங்கள் சோதனை முன் 4 மணி குடிக்க எதுவும் இல்லை முடியும்.
• உங்கள் மருத்துவர் குறிப்பிட்டுள்ளது உங்கள் மருந்துகளை எடுத்து

சோதனை நாளில்:

நோயாளி ஒரு மணி நேரம் திட்டமிடப்பட்டுள்ளது சோதனை நேரம் முன் எம்ஆர்ஐ அறை 8 மணிக்கு வந்து உள்ளது .
நோயாளி ஒரு மருத்துவமனையில் கவுன் மாற்ற மற்றும் அனைத்து நகைகள் , பொய்ப்பற்கள் மற்றும் விசாரணை எய்ட்ஸ் நீக்க கேட்கப்படும்.
ஒரு ஊசி { நாளங்கள் (IV) வடிகுழாய் (வழக்கமாக 20g) } உங்கள் கை அல்லது முழங்கை பகுதியில் வைக்கப்படும்.
பேஸ்லைன் இரத்த அழுத்தம் சோதனை செய்யப்படும்.
• சோதனை துவக்குவதற்கு முன், உங்கள் மருத்துவ வரலாறு மற்றும் மருந்து (கள்) நீங்கள் எம்ஆர்ஐ ஸ்கேன் வேண்டும் உறுதி அது பாதுகாப்பானது செய்ய கூட எடுத்து ஏன் பற்றிய கேள்விகள் கேட்கப்படும்.

சோதனையின் போது :

பதவியை கடோலினியம் ஆய்வுகள் உள்ளிட்ட தரநிலை எம்ஆர்ஐ காட்சிகளை பெற்று வருகின்றனர்.
மையோகார்டியம் பூர்வீ கமுதல் T1 மற்றும் டி 2 மேப்பிங் மற்றும் பிந்தைய மாறாக முதல் T1 மேப்பிங் கூடுதல் 1 நிமிடம் எடுக்கும் எந்த செய்யப்படுகிறது
• சோதனை போது, நீங்கள் இயந்திரம் படங்கள் எடுக்கும் என தட்டி சத்தம் கேட்க வேண்டும். நாங்கள் வழிமுறைகளை நீங்கள் கேட்கும். உதாரணமாக, நாம் 8 முதல் 10 விநாடிகள் மூச்சை நீங்கள் கேட்கலாம்
• இது இயக்கங்கள் படங்களை குறைபாடுகள் உருவாக்க முடியும் என்பதால், நீங்கள் இன்னும் முடிந்தவரை தங்க முக்கியமான உள்ளது.
• நடைமுறை முடிவில், உங்கள் நான்காம் வடிகுழாய் (ஊசி) அகற்றப்படும்.

சோதனைக்கு பிறகு:

• உங்கள் மருத்துவர் வித்தியாசமாக நீங்கள் சொல்கிறது தவிர நீங்கள் உங்கள் சாதாரண செயல்பாடு மீண்டும் கூடும் .

உங்கள் மருத்துவர் வித்தியாசமாக நீங்கள் சொல்கிறது வரை இயக்கிய • உங்கள் வழக்கமான மருந்துகளை எடுத்து.

• அடுத்த நாள் மூலம், சோதனை முடிவு சோதனை உத்தரவிட்டார் மருத்துவரிடம் அனுப்பி வைக்கப்படும். நீங்கள் உங்கள் சோதனை முடிவுகளை விவாதிக்க உங்கள் மருத்துவர் தொடர்பு கொள்ள வேண்டும் .

• உங்கள் முதன்மை மருத்துவர் எந்த திட்டமிடப்பட்டுள்ளது பின்தொடர் நியமனங்கள் வைத்து.

For any queries, kindly contact- **Dr. Grace Rebecca, PG Registrar, Department of Radiology, CMC Vellore. Mobile-+9442249535**

Questionnaire to exclude Cardiac disease in normal subjects

Hospital No.: Name: Age: Sex:

Symptoms	YES	NO
History of chest pain		
Cough / Shortness of breath (both at rest and with exertion)		
Paroxysmal nocturnal dyspnea , Orthopnea		
Edema		
Palpitations		
Dizziness, vertigo, loss of consciousness, fatigue		
Cyanosis		
History		
Have you ever been told that you have heart disease?		
Have you ever been told that you have high blood sugar?		
Do you have high cholesterol or triglycerides?		
Do you have high blood pressure?		
Have you smoked, chewed tobacco, or used snuff in the past?		
Do you have a family history of cardiac disease?		

Examination

Blood pressure :

Height :

Weight :

BMI :

Lab parameters

Available blood reports

Blood sugars : AC: PC: RBS:

Cholesterol :

HDL :

LDL :

Triglycerides :

If ECG and echocardiogram are available: Normal ☐ Abnormal ☐

CONCLUSION:

The status "normal subject" will be based on:

i) uneventful medical history

ii) absence of any symptoms indicating cardiovascular dysfunction

iii) normal cardiac dimensions and function proven by cine CMR

Cardiac disease: Absent ☐ Present ☐

Data Sheet

T1 short	T1 long	bat2-T2	T1 - gado	LGE	Wall mot	badiag	diag code
920	1038	45	601	0	0	Normal	1
878	914	44		0	0	normal	1
887	1053	48		0	0	NORMAL	1
981	1059	47	678	0	0	normal	1
967	1204		690	0	0	normal	1
847	1004		579	0	0	NORMAL	1
959	1044	62	597	0	0	normal	1
1031	1133	59		0	0	normal	1
943	995	53	420	0	0	normal	1
1039	101	54	491	0	0	normal	1
865	1027	49	451	0	0	normal	1
904	983	47	604	0	0	NORMAL	1
991	1069	50	570	0	0	normal	1
943	1072	44		0	0	normal	1
975	1087	62	544	0	0	normal	1
1004	1044	48	447	0	0	normal	1
951	1014	51	565	0	0	normal	1
963	987	50	520	0	0	NORMAL	1
936	1010	44	552	0	0	NORMAL	1
967	1012	54	475	0	0	NORMAL	1
903	1021	44	521	0	0	Normal	1
954	1043	47	592	0	0	Normal	1
528	997	45		0	0	Normal	1
863	995	44	601	0	0	Normal	1
1005	1110	53	622	0	0	Normal	1
908	1079	50	533	0	0	Normal	1
1036	1059	44		0	0	Normal	1
991	1052	57	523	0	0	Normal	1
999	1081	54	641	0	0	Normal	1
1039	1098	57	579	0	0	Normal	1
951	1060	53	537	0	0	Normal	1
966	1043	44	601	0	0	Normal	1
917	951	47		0	0	normal	1
1071	1115	53		0	0	NORMAL	1
1037	1054	54	690	0	0	normal	1
983	1154		753	0	0	normal	1
935	1043		557	0	0	NORMAL	1
1078	979		589	0	0	normal	1
1019	1044	53		0	0	normal	1
924	1019	52	417	0	0	normal	1
1007	1149	56	476	0	0	normal	1
883	1028	49	460	0	0	normal	1
977	1010	53	596	0	0	NORMAL	1
990	1042	51	567	0	0	normal	1
901	1068	42		0	0	normal	1
967	1064	53	514	0	0	normal	1
889	1044	47	493	0	0	normal	1
973	1079	53	546	0	0	normal	1
939	993	52	512	0	0	NORMAL	1
897	1038	42	565	0	0	NORMAL	1
991	1065	54	481	0	0	NORMAL	1
919	1057	50	530	0	0	Normal	1
925	1046	46	558	0	0	Normal	1
967	983	45		0	0	Normal	1
894	1013	43	585	0	0	Normal	1
976	1140	52	610	0	0	Normal	1
946	1092	45	528	0	0	Normal	1
981	1059	51		0	0	Normal	1
1017	1077	51	547	0	0	Normal	1
987	1083	53	580	0	0	Normal	1
916	1037	61	528	0	0	Normal	1
960	1021	52	534	0	0	Normal	1
960	1038	44	566	0	0	Normal	1
949	946	49		0	0	normal	1
1117	1068	54		0	0	NORMAL	1
1022	1046	51	684	0	0	normal	1
968	1063		725	0	0	normal	1
958	1066		557	0	0	NORMAL	1
968	1069	51	603	0	0	normal	1

1011	1031	49		0	0	normal	1
926	1039	53	437	0	0	normal	1
1035	1147	53	481	0	0	normal	1
898	1049	47	461	0	0	normal	1
988	1106	50	608	0	0	NORMAL	1
1001	1091	49	555	0	0	normal	1
972	1111	46		0	0	normal	1
1004	1064	53	544	0	0	normal	1
1002	1064	54	478	0	0	normal	1
996	1028	55	551	0	0	normal	1
956	988	55	479	0	0	NORMAL	1
881	997	46	569	0	0	NORMAL	1
980	1039	54	476	0	0	NORMAL	1
908	1015	42	564	0	0	Normal	1
965	1069	46	552	0	0	Normal	1
969	1011	47		0	0	Normal	1
900	1045	49	591	0	0	Normal	1
967	1097	52	614	0	0	Normal	1
941	1022	51	539	0	0	Normal	1
967	996	52		0	0	Normal	1
1014	1075	51	547	0	0	Normal	1
933	1123	56	596	0	0	Normal	1
1001	1065	60	504	0	0	Normal	1
978	1029	51	516	0	0	Normal	1
908	1056	45	590	0	0	Normal	1
865	941	48		0	0	normal	1
1125	1074	53		0	0	NORMAL	1
1009	1038	52	717	0	0	normal	1
1003	1030		603	0	0	normal	1
1001	1021		554	0	0	NORMAL	1
954	1117	50	626	0	0	normal	1
977	1047	50		0	0	normal	1
908	996	52	462	0	0	normal	1
1035	1124	55	500	0	0	normal	1
903	991	47	463	0	0	normal	1
964	1099	49	588	0	0	NORMAL	1
935	1017	48	558	0	0	normal	1
960	1179	38		0	0	normal	1
1016	1160	66	552	0	0	normal	1
959	996	50	412	0	0	normal	1
978	1035	51	557	0	0	normal	1
945	925	50	525	0	0	NORMAL	1
899	959	43	594	0	0	NORMAL	1
960	1003	51	459	0	0	NORMAL	1
922	969	50	523	0	0	Normal	1
915	1056	45	576	0	0	Normal	1
927	984	47		0	0	Normal	1
853	987	42	641	0	0	Normal	1
968	1096	55	609	0	0	Normal	1
973	1102	48	530	0	0	Normal	1
1034	1080	41		0	0	Normal	1
956	1100	49	523	0	0	Normal	1
937	1035	51	518	0	0	Normal	1
947	1018	56	549	0	0	Normal	1
1003	1068	51	536	0	0	Normal	1
946	1042	45	642	0	0	Normal	1
848	929	47		0	0	normal	1
980	1104	60		0	0	NORMAL	1
935	1037	47	616	0	0	normal	1
817	930		715	0	0	normal	1
964	1023		546	0	0	NORMAL	1
972	990	54	604	0	0	normal	1
961	1041	51		0	0	normal	1
933	989	49		0	0	normal	1
1028	1153	53	482	0	0	normal	1
901	1016	47	462	0	0	normal	1
922	1057	49	594	0	0	NORMAL	1
933	1020	44	518	0	0	normal	1
871	1072	42		0	0	normal	1
1028	1110	58	502	0	0	normal	1
910	1089	46	436	0	0	normal	1

995	1046	50	574	0	0	normal	1
990	942	48	502	0	0	NORMAL	1
880	961	40	574	0	0	NORMAL	1
1061	1011	49	459	0	0	NORMAL	1
920	985	52	598	0	0	Normal	1
954	1091	44	568	0	0	Normal	1
935	1011	46		0	0	Normal	1
886	969	40	619	0	0	Normal	1
948	1074	52	605	0	0	Normal	1
967	1055	48	510	0	0	Normal	1
934	1030	47		0	0	Normal	1
1031	1029	52	574	0	0	Normal	1
973	1071	49	636	0	0	Normal	1
1038	1052		591	0	0	Normal	1
929	1068	49	572	0	0	Normal	1
922	1062	45	641	0	0	Normal	1
855	956	48		0	0	normal	1
829	1084	47		0	0	NORMAL	1
935	1013	44	667	0	0	normal	1
864	982		700	0	0	normal	1
872	1054		566	0	0	NORMAL	1
997	1006	53	610	0	0	normal	1
910	1066	57		0	0	normal	1
928	988	50		0	0	normal	1
1103	1130	53	484	0	0	normal	1
885	968	43	470	0	0	normal	1
894	1030	465	592	0	0	NORMAL	1
932	1124	48	537	0	0	normal	1
839	979	44		0	0	normal	1
990	1063	58	540	0	0	normal	1
924	1065	50	471	0	0	normal	1
995	1052	53	542	0	0	normal	1
936	964	49	497	0	0	NORMAL	1
923	1015	56	549	0	0	NORMAL	1
1004	1106	54	480	0	0	NORMAL	1
911	1050	47	608	0	0	Normal	1
1019	1085	46	566	0	0	Normal	1
940	968	49		0	0	Normal	1
851	992	47	594	0	0	Normal	1
982	1109	52	621	0	0	Normal	1
949	1028	51	508	0	0	Normal	1
897	1030	54		0	0	Normal	1
1036	1068	51	568	0	0	Normal	1
912	1104	51	635	0	0	Normal	1
	1050		491	0	0	Normal	1
941	1038	50	539	0	0	Normal	1
951	1007	45	567	0	0	Normal	1
871	916	51		0	0	normal	1
919	1003	44		0	0	NORMAL	1
953	1032	48	702	0	0	normal	1
922	1027		745	0	0	normal	1
911	1005	48	554	0	0	NORMAL	1
965	1048	51	645	0	0	normal	1
946	936	57		0	0	normal	1
899	982	53	455	0	0	normal	1
1047	1200	58	474	0	0	normal	1
890	935	47	454	0	0	normal	1
889	1040	49	574	0	0	NORMAL	1
914	977	50	572	0	0	normal	1
879	986	41		0	0	normal	1
971	1171	51	529	0	0	normal	1
899	1080	54	528	0	0	normal	1
918	1006	49	568	0	0	normal	1
937	1005	50	497	0	0	NORMAL	1
942	997	49	545	0	0	NORMAL	1
1061	1056	54	481	0	0	NORMAL	1
947	1005	45	547	0	0	Normal	1
926	1029	47	583	0	0	Normal	1
942	954	46		0	0	Normal	1
856	972	46	579	0	0	Normal	1
998	1077	51	678	0	0	Normal	1
1053	1051	52	516	0	0	Normal	1
918	1037	48		0	0	Normal	1
974	1037	56	556	0	0	Normal	1
983	1103	57	536	0	0	Normal	1
902	991	61		0	0	Normal	1
1024	1095	51	541	0	0	Normal	1
979	1027	46	576	0	0	Normal	1
937	967	52		0	0	normal	1
1083	1156	51		0	0	NORMAL	1
1032	1055	49	715	0	0	normal	1
937	1037		718	0	0	normal	1
990	1072	47	544	0	0	NORMAL	1
1029	1057	55	659	0	0	normal	1
924	1046	57		0	0	normal	1
925	1028	57	455	0	0	normal	1
1127	1271	61	472	0	0	normal	1
911	1026	45	431	0	0	normal	1
956	1087	52	586	0	0	NORMAL	1
1035	1033	53	559	0	0	normal	1
900	985	41		0	0	normal	1
1013	1108	57	511	0	0	normal	1
977	1108	55	507	0	0	normal	1
972	1011	50	562	0	0	normal	1

939	1038	48	511	0	0	NORMAL	1
967	1027	50	590	0	0	NORMAL	1
973	1091	49	491	0	0	NORMAL	1
924	994	49	551	0	0	Normal	1
951	1081	47	592	0	0	Normal	1
980	1076	43		0	0	Normal	1
865	1031	44	582	0	0	Normal	1
1009	1108	54	654	0	0	Normal	1
1063	1047	52	499	0	0	Normal	1
948	1074	50		0	0	Normal	1
990	1081	52	554	0	0	Normal	1
952	1065	52	569	0	0	Normal	1
887	990	57	555	0	0	Normal	1
969	1022	51	541	0	0	Normal	1
961	1018	47	580	0	0	Normal	1
915	967	47		0	0	normal	1
1081	1086	49		0	0	NORMAL	1
1013	1038	46	707	0	0	normal	1
967	1039		747	0	0	normal	1
920	1018	46	563	0	0	NORMAL	1
988	1061	50	663	0	0	normal	1
959	1043	54		0	0	normal	1
942	1025	53	467	0	0	normal	1
1074	1199	54	484	0	0	normal	1
876	1015	45	438	0	0	normal	1
1005	1087	47	593	0	0	NORMAL	1
925	1014	50	586	0	0	normal	1
932	1025	42		0	0	normal	1
1024	1062	57	509	0	0	normal	1
939	1072	54	511	0	0	normal	1
968	1004	53	561	0	0	normal	1
877	1001	49	514	0	0	NORMAL	1
913	996	47	574	0	0	NORMAL	1
961	1110	49	482	0	0	NORMAL	1
887	983	43	605	0	0	Normal	1
937	1058	45	594	0	0	Normal	1
936	1036	47		0	0	Normal	1
883	1014	48	600	0	0	Normal	1
983	1113	53	669	0	0	Normal	1
975	1071	50	515	0	0	Normal	1
931	1029	50		0	0	Normal	1
939	1092	47	580	0	0	Normal	1
935	1032	58	567	0	0	Normal	1
893	952	60	564	0	0	Normal	1
1038	1046	48	548	0	0	Normal	1
942	1035	43	562	0	0	Normal	1
918	941	51		0	0	normal	1
951	1139	55		0	0	NORMAL	1
1117	1051	46	711	0	0	normal	1
975	1053		698	0	0	normal	1
910	1010	48	567	0	0	NORMAL	1
937	1048	53	653	0	0	normal	1
955	1183	51		0	0	normal	1
965	1026	53	459	0	0	normal	1
994	1149	53	497	0	0	normal	1
759	1039	44	461	0	0	normal	1
894	1039	49	590	0	0	NORMAL	1
1001	1067	46	589	0	0	normal	1
805	942	40		0	0	normal	1
939	1081	43	554	0	0	normal	1
907	1094	53	530	0	0	normal	1
986	987	53	559	0	0	normal	1
869	965	48	469	0	0	NORMAL	1
889	1020	46	609	0	0	NORMAL	1
897	957	48	490	0	0	NORMAL	1
916	987	45	534	0	0	Normal	1
925	1006	44	589	0	0	Normal	1
912	1060	47		0	0	Normal	1
792	949	43	582	0	0	Normal	1
970	1065	53	666	0	0	Normal	1
1031	1173	44	521	0	0	Normal	1
940	1041	47		0	0	Normal	1
995	1012	54	572	0	0	Normal	1
956	1019	53	556	0	0	Normal	1
906	996	58	492	0	0	Normal	1
1029	1101	47	544	0	0	Normal	1
951	1004	45	555	0	0	Normal	
878	862	51		0	0	normal	1
1122	1058	56		0	0	NORMAL	1
1045	1003	42	700	0	0	normal	1
917	1036		675	0	0	normal	1
931	1007	47	557	0	0	NORMAL	1
956	1039	50	619	0	0	normal	1
957	1066	51		0	0	normal	1
898	1011	53	468	0	0	normal	1
1053	1154	54	488	0	0	normal	1
915	1029	46	461	0	0	normal	1
948	1083	53	585	0	0	NORMAL	1
949	1053	45	568	0	0	normal	1
818	941	44		0	0	normal	1
942	1106	55	543	0	0	normal	1
948	1075	47	531	0	0	normal	1
955	994	54	562	0	0	normal	1
948	1001	50	475	0	0	NORMAL	1

961	1036	47	564	0	0	NORMAL	1
897	957	48	490	0	0	NORMAL	1
875	1044	44	563	0	0	Normal	1
960	1027	44	592	0	0	Normal	1
924	1034	44		0	0	Normal	1
870	977	42	616	0	0	Normal	1
981	1097	53		0	0	Normal	1
1041	1137	46	513	0	0	Normal	1
942	1041	51		0	0	Normal	1
983	1021	51	554	0	0	Normal	1
	1046	55	566	0	0	Normal	1
879	1016	51	498	0	0	Normal	1
978	1007	53	522	0	0	Normal	1
979	995	45	561	0	0	Normal	1
878	908	53		0	0	normal	1
1342	1183	62		0	0	NORMAL	1
1011	1027	46	672	0	0	normal	1
881	1003		718	0	0	normal	1
904	962	49	558	0	0	NORMAL	1
1012	1100	49	617	0	0	normal	1
928	914	58		0	0	normal	1
922	984	48	474	0	0	normal	1
982	1139	61	496	0	0	normal	1
952	998	47	447	0	0	normal	1
982	1078	50	568	0	0	NORMAL	1
925	1023	51	582	0	0	normal	1
881	1031	41		0	0	normal	1
992	1082	50	531	0	0	normal	1
1032	1080	50	505	0	0	normal	1
955	1068	54	556	0	0	normal	1
872	980	44	505	0	0	NORMAL	1
993	996	48	561	0	0	NORMAL	1
845	1018	46	489	0	0	NORMAL	1
897	962	45	606	0	0	Normal	1
942	1066	46	568	0	0	Normal	1
959	1022	47		0	0	Normal	1
871	967	44	598	0	0	Normal	1
1003	1124	54		0	0	Normal	1
985	1059	50	522	0	0	Normal	1
896	1021	48		0	0	Normal	1
931	1094	51	570	0	0	Normal	1
	1036	55	568	0	0	Normal	1
960	1011	56	523	0	0	Normal	1
988	1050	54	549	0	0	Normal	1
925	1022	47	561	0	0	Normal	1
958	920	52		0	0	normal	1
1123	1158	54		0	0	NORMAL	1
966	994	51	669	0	0	normal	1
1031	1034		684	0	0	normal	1
931	989	50	526	0	0	NORMAL	1
1118	1048	64	564	0	0	normal	1
828	1034	57		0	0	normal	1
903	970	51	434	0	0	normal	1
987		61	496	0	0	normal	1
	986		428	0	0	normal	1
964	1080	49	560	0	0	NORMAL	1
	1000	46	602	0	0	normal	1
842	935	40		0	0	normal	1
1031	1001	55	536	0	0	normal	1
996	953	55	518	0	0	normal	1
985	1025	52	550	0	0	normal	1
	1086	52	495	0	0	NORMAL	1
884	950	48	535	0	0	NORMAL	1
941	1090	50	477	0	0	NORMAL	1
949	996	52	495	0	0	Normal	1
929	1073	48	595	0	0	Normal	1
930	960	50		0	0	Normal	1
	969	45	597	0	0	Normal	1
1003	1083	52	630	0	0	Normal	1
983	1029	49	507	0	0	Normal	1
984	955	46		0	0	Normal	1
1028	1096	57	546	0	0	Normal	1
969	1114	61	573	0	0	Normal	1
909			522	0	0	Normal	1
	1036	57	541	0	0	Normal	1
942	1041	48	559	0	0	Normal	1
972	965	51		0	0	normal	1
1063	1298	55		0	0	NORMAL	1
1012	1003	48	693	0	0	normal	1
985	1105		777	0	0	normal	1
998	1118	58	543	0	0	NORMAL	1
1049	1049	53	598	0	0	normal	1
859	1010	57		0	0	normal	1
961	1044	55	444	0	0	normal	1
1078	1217	60	482	0	0	normal	1
898	941		446	0	0	normal	1
940	1012	50	575	0	0	NORMAL	1
	904	51	573	0	0	normal	1
837	916	42		0	0	normal	1
1091	1086	61	540	0	0	normal	1
1097	1064	58	526	0	0	normal	1
962	1074	58	552	0	0	normal	1
	1051	51	486	0	0	normal	1
949	1016	53	549	0	0	NORMAL	1

	952	57	483	0	0	NORMAL	1
936	992	54	496	0	0	Normal	1
950	1070	52	604	0	0	Normal	1
959	1060	48		0	0	Normal	1
	1020	47	586	0	0	Normal	1
960	1083	56	638	0	0	Normal	1
988	1167	59	491	0	0	Normal	1
932	998	45		0	0	Normal	1
965	1096	54	547	0	0	Normal	1
1042	1075	57	578	0	0	Normal	1
881			537	0	0	Normal	1
	1056	56	548	0	0	Normal	1
933	1020	46	575	0	0	Normal	1
896	948	50		0	0	normal	1
1160	1434	50		0	0	NORMAL	1
1043	1044	48	654	0	0	normal	1
965	1058		723	0	0	normal	1
927	1014	51	531	0	0	NORMAL	1
982	1048	57	583	0	0	normal	1
888	1046	54		0	0	normal	1
951	1032	50	445	0	0	normal	1
1085	1186	54	499	0	0	normal	1
829	965		450	0	0	normal	1
939	1097	49	586	0	0	NORMAL	1
	950	43	604	0	0	normal	1
827	939	43		0	0	normal	1
1086	1181	57	541	0	0	normal	1
987	1064	51	481	0	0	normal	1
948	1061	51	573	0	0	normal	1
	1075	50	445	0	0	NORMAL	1
891	1024	48	572	0	0	NORMAL	1
	1096	55	488	0	0	NORMAL	1
911	1028	54	544	0	0	Normal	1
945	1039	49	604	0	0	Normal	1
908	1062	47		0	0	Normal	1
	957	45	567	0	0	Normal	1
989	1077	56	635	0	0	Normal	1
918	1155	54	484	0	0	Normal	1
907	976	46		0	0	Normal	1
960	1073	59	544	0	0	Normal	1
1053	1064	58	597	0	0	Normal	1
894			531	0	0	Normal	1
	1088	57	545	0	0	Normal	1
908	1014	48	570	0	0	Normal	1
854	958	52		0	0	normal	1
1037	1264	55		0	0	NORMAL	1
1052	1045	44	691	0	0	normal	1
956	1033		667	0	0	normal	1
933	1063	49	543	0	0	NORMAL	1
926	1039	62	598	0	0	normal	1
842	1077	60		0	0	normal	1
941	1032	48	434	0	0	normal	1
1042	1173	58	460	0	0	normal	1
852	1059		439	0	0	normal	1
949	1077	55	561	0	0	NORMAL	1
	978	52	568	0	0	normal	1
831	986	42		0	0	normal	1
1045	1109	55	493	0	0	normal	1
1083	1110	48	489	0	0	normal	1
1008	1013	49	545	0	0	normal	1
	1031	42	471	0	0	NORMAL	1
937	1025	48	442	0	0	NORMAL	1
	1077	60	487	0	0	NORMAL	1
938	987		521	0	0	Normal	1
954	1080	47	596	0	0	Normal	1
919	1054	49		0	0	Normal	1
	998	45	605	0	0	Normal	1
972	1105	54	645	0	0	Normal	1
			522	0	0	Normal	1
937	1001	47		0	0	Normal	1
952	1085	58	548	0	0	Normal	1
961	1080	54	552	0	0	Normal	1
909			529	0	0	Normal	1
	1044	59	552	0	0	Normal	1
				0	0	Normal	1
1030	990	58		0	0	normal	1
				0	0	NORMAL	1
970	1129	60	700	0	0	normal	1
1071	1104		692	0	0	normal	1
	1072	67	512	0	0	NORMAL	1
1104	1094			0	0	normal	1
978	1436	58	467	0	0	normal	1
				0	0	normal	1
				0	0	normal	1
				0	0	NORMAL	1
				0	0	NORMAL	1

				0	0	Normal	1
	1118			0	0	Normal	1
				0	0	Normal	1
				0	0	Normal	1
				0	0	Normal	1
				0	0	Normal	1
				0	0	Normal	1
				0	0	Normal	1
913	1019	54	573	0	0	Normal	1
848	916	48		0	0	normal	1
1023	1055	56		0	0	NORMAL	1
1005	976	53	736	0	0	normal	1
990	1026		755	0	0	normal	1
954	1028	49	564	0	0	NORMAL	1
	1023	53	680	0	0	normal	1
946	1015	54		0	0	normal	1
939	1008	49	614	0	0	normal	1
937	1056	46		0	0	normal	1
	1095	52	560	0	0	normal	1
1029	1198	49	535	0	0	normal	1
932	963	50	578	0	0	normal	1
922	983	48	503	0	0	NORMAL	1
853	1010	48	568	0	0	NORMAL	1
1004	1039	56	498	0	0	NORMAL	1
911		54	560	0	0	Normal	1
890	1041	43		0	0	Normal	1
939		48		0	0	Normal	1
868	993	45	564	0	0	Normal	1
952	1101	49	655	0	0	Normal	1
1017	1006	44	454	0	0	Normal	1
938	1032	47		0	0	Normal	1
1028	1106	54	545	0	0	Normal	1
1025	1133	63	590	0	0	Normal	1
999	930	57	522	0	0	Normal	1
996	1103	60	544	0	0	Normal	1
917	1097	47	581	0	0	Normal	1
833	858	49		0	0	normal	1
1175	1170	64		0	0	NORMAL	1
1007	1129	50	750	0	0	normal	1
964	1035		783	0	0	normal	1
917	1001	52	533	0	0	NORMAL	1
	1102	52	666	0	0	normal	1
894	958	58		0	0	normal	1
908	945	55	584	0	0	normal	1
919	935	56		0	0	normal	1
812	1092	58	503	0	0	normal	1
1011	1031	58	500	0	0	normal	1
950	1019	54	556	0	0	normal	1
965	967	51	516	0	0	NORMAL	1
901	961	50	556	0	0	NORMAL	1
1061	1086	59	484	0	0	NORMAL	1
963	960	48	521	0	0	Normal	1
934	1035	42		0	0	Normal	1
903		52		0	0	Normal	1
854	947	47	549	0	0	Normal	1
920	1094	55	643	0	0	Normal	1
954	1093	47	455	0	0	Normal	1
945	1029			0	0	Normal	1
958	1049	60	546	0	0	Normal	1
1051	1064	53	567	0	0	Normal	1
919	949	58	533	0	0	Normal	1
1009	1013	58	562	0	0	Normal	1
939		52	572	0	0	Normal	1
888	941	48		0	0	normal	1
1178	1143	60		0	0	NORMAL	1
929	977	52	722	0	0	normal	1
971	1061		693	0	0	normal	1
921	1027	50	512	0	0	NORMAL	1
	1087	48	655	0	0	normal	1
1009	1061	50		0	0	normal	1
934	984	53	582	0	0	normal	1
924	966	48		0	0	normal	1
995	1073	57	557	0	0	normal	1
985	1291	49	501	0	0	normal	1
1027	1080	52	558	0	0	normal	1
962	993	52	503	0	0	NORMAL	1
991	1036	49	566	0	0	NORMAL	1
969	1126	52	499	0	0	NORMAL	1
973	1072	50	547	0	0	Normal	1

952	1088	48		0	0	Normal	1
867		48		0	0	Normal	1
926	1035	45	615	0	0	Normal	1
1040	1024	52		0	0	Normal	1
999	1085	48	487	0	0	Normal	1
902	982	52		0	0	Normal	1
1012	1131	55	566	0	0	Normal	1
	1113	55	575	0	0	Normal	1
945	930	61	547	0	0	Normal	1
1016	1089	54	563	0	0	Normal	1
940		47	578	0	0	Normal	1
899	966	49		0	0	normal	1
1031	1129	52		0	0	NORMAL	1
970	1041	52	725	0	0	normal	1
1055	1075		699	0	0	normal	1
910	1072	52	545	0	0	NORMAL	1
	1071	52	666	0	0	normal	1
957	1051	53		0	0	normal	1
903	1031	46	586	0	0	normal	1
906	915	50		0	0	normal	1
558	1050	52	981	0	0	normal	1
1005	1225	48	522	0	0	normal	1
969	1052	55	567	0	0	normal	1
910	993	47	489	0	0	NORMAL	1
992	1018	48	564	0	0	NORMAL	1
1071	1186	48	497	0	0	NORMAL	1
952	1042	54	537	0	0	Normal	1
976	1054	45		0	0	Normal	1
842		51		0	0	Normal	1
907	1019	47	609	0	0	Normal	1
1011	1137	55		0	0	Normal	1
1026	988	45	418	0	0	Normal	1
985	1040			0	0	Normal	1
964	1055	59	534	0	0	Normal	1
	1098	55	580	0	0	Normal	1
896	982	55	522	0	0	Normal	1
1006	1113	51	545	0	0	Normal	1
967	997	47	575	0	0	Normal	1
943	957	52		0	0	normal	1
1035		65		0	0	NORMAL	1
891		46	629	0	0	normal	1
1026	1042		755	0	0	normal	1
967	1020	52	554	0	0	NORMAL	1
	1115	49	628	0	0	normal	1
957	1016	52		0	0	normal	1
915	1019		589	0	0	normal	1
	961	43		0	0	normal	1
961	1103	54	551	0	0	normal	1
987	1153	51	462	0	0	normal	1
988	1055	49	597	0	0	normal	1
959	1007	46	522	0	0	NORMAL	1
893	1008	41	561	0	0	NORMAL	1
979	1086	55	495	0	0	NORMAL	1
988	1035	48	528	0	0	Normal	1
934	1084	50	614	0	0	Normal	1
952		52		0	0	Normal	1
884	1042	49	607	0	0	Normal	1
995	1098	53	657	0	0	Normal	1
977	1003	53	514	0	0	Normal	1
965	1032	45		0	0	Normal	1
1008	1060	52	563	0	0	Normal	1
985	1106	63	585	0	0	Normal	1
890	1102	51	544	0	0	Normal	1
989	1006	54	533	0	0	Normal	1
920	1019	48	574	0	0	Normal	1
1013	965	54		0	0	normal	1
1049		61		0	0	NORMAL	1
987		49	764	0	0	normal	1
992	1089		783	0	0	normal	1
913	1013	53	540	0	0	NORMAL	1
	1246	52	624	0	0	normal	1
942	966	59		0	0	normal	1
908	994		595	0	0	normal	1
	906	42		0	0	normal	1
1020	1091	54	529	0	0	normal	1
1040	1126	51	526	0	0	normal	1
973	1028	54	566	0	0	normal	1
933	1002	51	520	0	0	NORMAL	1
980	1016	53	535	0	0	NORMAL	1
993	1096	57	482	0	0	NORMAL	1
971	1040	50	527	0	0	Nrmal	1
990	1066	50	575	0	0	Normal	1

918		46		0	0	Normal	1
910	1011	49	596	0	0	Normal	1
1020	1127	55	658	0	0	Normal	1
1035	1011	54	503	0	0	Normal	1
995	985	47		0	0	Normal	1
1088	1122	58	547	0	0	Normal	1
1053	1133	64	606	0	0	Normal	1
919	998	56	523	0	0	Normal	1
1049	1000	59	545	0	0	Normal	1
926	1032	48	557	0	0	Normal	1
867	901	50		0	0	normal	1
1203		54		0	0	NORMAL	1
953		49	722	0	0	normal	1
993	984		693	0	0	normal	1
931	976	46	568	0	0	NORMAL	1
	1040	49	609	0	0	normal	1
947	1024	54		0	0	normal	1
918	928		586	0	0	normal	1
	920	38		0	0	normal	1
967	1127	55		0	0	normal	1
965	1079	48	519	0	0	normal	1
983	987	49	569	0	0	normal	1
900	953	49	512	0	0	NORMAL	1
919	1061	45	563	0	0	NORMAL	1
1011	985	55	442	0	0	NORMAL	1
997	1007	47	521	0	0	Normal	1
968	1031	49	577	0	0	Normal	1
955		47		0	0	Normal	1
892	985	44	610	0	0	Normal	1
970	1089	54	652	0	0	Normal	1
1068	1096	52	482	0	0	Normal	1
940	974	49		0	0	Normal	1
965	1132	54	562	0	0	Normal	1
948	1133	65	596	0	0	Normal	1
893	940	51	525	0	0	Normal	1
967	1083	52	565	0	0	Normal	1
953	1024		573	0	0	Normal	1
868	941	53		0	0	normal	1
		50		0	0	NORMAL	1
993		47	721	0	0	normal	1
990	827		699	0	0	normal	1
982	1026	49	553	0	0	NORMAL	1
	1107	47	588	0	0	normal	1
1008	991	55		0	0	normal study	1
						normal study	
						normal	
						normal	
896	960			0	0	normal	1
	922	37		0	0	normal	1
978	1111	54	554	0	0	normal	1
959	1113	47	511	0	0	normal	1
979	998	48	576	0	0	normal	1
941	941	51	533	0	0	NORMAL	1
937	1055	48	578	0	0	NORMAL	1
961	1063	50	500	0	0	NORMAL	1
973	1064	46	522	0	0	Normal	1
998	1049	47	581	0	0	Normal	1
		47		0	0	Normal	1
884		46	602	0	0	Normal	1
1009	1043	56	643	0	0	Normal	1
1084	1117	51	549	0	0	Normal	1
945	952	48		0	0	Normal	1
1014	1038	63	589	0	0	Normal	1
976	1035	54	621	0	0	Normal	1
897	988	52	555	0	0	Normal	1
974	1136	51	552	0	0	Normal	1

bat1s	bat1s1	bat2	bat1gad	balge	bawall	badiag	badiagnos
1020	1143	49	583	0	0	normal	1
989	1039	48		0	0	normal	1
	1046	57		0	0	normal	1
978	1089	48	631	0	0	normal	1
884	1003	49	484	0	0	Normal	1
1005	1324	46	486	0	0	normal	1
985	1057	54	495	0	0	normal	1
1122	1178	53	555	0	0	normal	1
1072	1147	54	439	0	0	NORMAL	1
955	975	50	444	0	0	NORMAL	1
932	997	50	570	0	0	normal	1
1037	1025	45	676	0	0	NORMAL	1
1004	1085	52	478	0	0	normal	1
1014	1041	50	579	0	0	normal	1
984	1087	54	522	0	0	NORMAL	1
982	1053	50		0	0	NORMAL	1
917	1189	51	539	0	0	NORMAL	1
999	1109	51	571	0	0	normal	1
916	979	47	448	0	0	normal	1
948	999	50		0	0	NORMAL	1
975	1035	49	482	0	0	NORMAL	1
965	1074	53	521	0	0	normal	1
982	1021	50		0	0	NORMAL	1
777	1152	59	429	0	0	NORMAL	1
971	969	59	523	0	0	normal	1
995	1052	49	431	0	0	normal	1
987	1027	64	470	0	0	normal	1
987	1147	52	615	0	0	normal	1
983	1078	50		0	0	normal	1
	1082	56		0	0	normal	1
1039	1125	51	626	0	0	normal	1
1042	1165	57	433	0	0	normal	1
1045	1189	55	422	0	0	NORMAL	1
956	1040	50	458	0	0	normal	1
956	1088	47	637	0	0	NORMAL	1
1046	1117	56	456	0	0	normal	1
1311	1219	60		0	0	NORMAL	1
992	1108	59	538	0	0	NORMAL	1
984	1022	49	490	0	0	NORMAL	1
951	1007	48		0	0	NORMAL	1
1029	979	53	526	0	0	normal	1
1023	1054	52		0	0	NORMAL	1
1040	1036	56	509	0	0	normal	1
1114	1103	50	391	0	0	normal	1
980	1136	49	605	0	0	normal	1
988	1037	52		0	0	normal	1
	1090	56		0	0	normal	1
940	1031	52	520	0	0	normal	1
1053	1198	61	437	0	0	NORMAL	1
942	988	50	571	0	0	normal	1
1064	1143	53	550	0	0	normal	1
1184	1168	56		0	0	NORMAL	1
1068	1118	64		0	0	NORMAL	1
961	1011	46	524	0	0	NORMAL	1
1070	1151	66	420	0	0	NORMAL	1
944	973	48		0	0	NORMAL	1
1016	1077	53		0	0	NORMAL	1
1014	978	56	526	0	0	normal	1
970	1086	52	447	0	0	normal	1
990	1140	51	835	0	0	normal	1
	1104	53		0	0	normal	1
984	1027	50	530	0	0	normal	1
1099	1157	53	533	0	0	normal	1
937	1137	49	529	0	0	normal	1
1011	1088	51	448	0	0	NORMAL	1
965	1029	49	578	0	0	normal	1
979	1387	56	376	0	0	NORMAL	1
1076	1058	58		0	0	NORMAL	1
1046	1093	56		0	0	NORMAL	1
934	1189	51	505	0	0	NORMAL	1
975	1078	50	459	0	0	NORMAL	1
1044	1167	60	418	0	0	NORMAL	1
1012	1124	57	527	0	0	NORMAL	1
1035	1022	57	526	0	0	normal	1
1066	1183	53	1159	0	0	normal	1
1019	1089	54	473	0	0	normal	1
971	1059	54	463	0	0	normal	1
946	1041	50	514	0	0	normal	1
993	1066	49	413	0	0	normal	1
1040	1105	56	527	0	0	normal	1
1054	1133	49	562	0	0	normal	1
1007	1139	51	462	0	0	NORMAL	1
1014	918	48	398	0	0	NORMAL	1
997	1110	57	426	0	0	NORMAL	1
1074	1052	64		0	0	NORMAL	1
929	1098	54	556	0	0	NORMAL	1
993	1092	52		0	0	NORMAL	1
926	1061	52	549	0	0	NORMAL	1
1021	1069	50	580	0	0	NORMAL	1
950	1013	49	461	0	0	NORMAL	1
1045	1270	51	431	0	0	NORMAL	1
1001	1104	49	519	0	0	NORMAL	1
1035	1255	53	463	0	0	normal	1
1005	1002	55	520	0	0	normal	1
972	1070	49	486	0	0	normal	1
975	1059	52	785	0	0	normal	1
953	1029	50		0	0	normal	1
1021	1119	53	499	0	0	normal	1
905	1012	46	514	0	0	normal	1

934	1315	48	446	0	0	normal	1
987	1050	53	511	0	0	normal	1
1044	1191	50	560	0	0	normal	1
994	1107	53	454	0	0	NORMAL	1
997	1046	54	435	0	0	NORMAL	1
956	1057	45	647	0	0	normal	1
1022	1031	51	478	0	0	NORMAL	1
1051	1005	58		0	0	NORMAL	1
948	991	56	539	0	0	NORMAL	1
983	1064	55		0	0	NORMAL	1
946	1020	47	558	0	0	NORMAL	1
992	1069	50	572	0	0	NORMAL	1
910	969	51	487	0	0	NORMAL	1
1012	1094	51	439	0	0	NORMAL	1
951	1087	57	510	0	0	NORMAL	1
875	1251	52	502	0	0	NORMAL	1
963	1020	50	529	0	0	normal	1
1003	1084	51		0	0	NORMAL	1
844	986	54	443	0	0	normal	1
928	1042	50	424	0	0	NORMAL	1
983	972	57	518	0	0	normal	1
1003	1035	51	480	0	0	normal	1
	1045	48		0	0	normal	1
947	1221	46	633	0	0	normal	1
1022	1060	47	444	0	0	normal	1
988	1025	55	497	0	0	normal	1
901	972	50	584	0	0	normal	1
914	1038	49	636	0	0	NORMAL	1
978	1110	57	465	0	0	normal1	1
1028	1045	60	511	0	0	NORMAL	1
978	974	48		0	0	NORMAL	1
978	980	54	562	0	0	normal	1
1005	1057	51		0	0	NORMAL	1
	1045	46		0	0	normal	1
997	1042	50	637	0	0	normal	1
1011	1109	50	435	0	0	normal	1
921	997	50	581	0	0	normal	1
952	1028	42	638	0	0	NORMAL	1
1051	1191	62	437	0	0	normal	1
1055	1134	62	519	0	0	NORMAL	1
951	1035	51		0	0	NORMAL	1
1004	1040	54	565	0	0	normal	1
963	1029	50		0	0	NORMAL	1
	1071	44		0	0	normal	1
989	1043	50	620	0	0	normal	1
999	1048	47	476	0	0	normal	1
1075	1189	59	449	0	0	NORMAL	1
955	1015	48	587	0	0	normal	1
1039	1125	58	399	0	0	normal	1
923	975	48		0	0	NORMAL	1
1012	1052	52		0	0	NORMAL	1
1041	991	53	535	0	0	normal	1
929	1044	45	487	0	0	normal	1
1061	1188	55	483	0	0	normal	1
1014	1160	51	546	0	0	NORMAL	1
962	1012	50	583	0	0	normal	1
997	1073	62		0	0	NORMAL	1
972	1062	52		0	0	NORMAL	1
960	1037	47	587	0	0	normal	1
913	1086	44	478	0	0	NORMAL	1
1007	1121	59	428	0	0	NORMAL	1
940	1007	48		0	0	NORMAL	1
1012	1058	47	495	0	0	NORMAL	1
1081	991	52	545	0	0	normal	1
936	989	39	457	0	0	normal	1
980	998	48	434	0	0	normal	1
1040	1133	55	535	0	0	normal	1
1028	1125	48	578	0	0	normal	1
1032	1115	49	453	0	0	NORMAL	1
905	984	51	480	0	0	NORMAL	1
1226	1001	55	497	0	0	NORMAL	1
936	1054	56		0	0	NORMAL	1
1048	1140	57	579	0	0	NORMAL	1
938	967	48		0	0	NORMAL	1
941	1047	50	581	0	0	normal	1
979	1056	50	581	0	0	NORMAL	1
919	1039	53	491	0	0	NORMAL	1
946	1069	53	442	0	0	NORMAL	1
933	989	53		0	0	NORMAL	1
1006	1063	43	534	0	0	NORMAL	1
995	1182	51	441	0	0	normal	1
965	970	52	568	0	0	normal	1
973	1192	51	588	0	0	normal	1
952	1145	46	458	0	0	normal	1
1003	1034	57	488	0	0	normal	1
1204	1043	49	459	0	0	NORMAL	1
916	1007	48	609	0	0	NORMAL	1
980	1063	56	470	0	0	normal	1
977	1055	75		0	0	NORMAL	1
972	1026	55	535	0	0	NORMAL	1
948	1034	52		0	0	NORMAL	1
958	915	51	558	0	0	normal	1
958	1052	54	578	0	0	NORMAL	1
925	1082	55	495	0	0	NORMAL	1
952	1030	54	436	0	0	NORMAL	1
989	1058	56	526	0	0	NORMAL	1
946	943	47		0	0	NORMAL	1
969	1001	51	563	0	0	normal	1
939	1004	49		0	0	NORMAL	1
988	1156	54	455	0	0	normal	1

984	1062	45	440	0	0	NORMAL	1
	1028			0	0	normal	1
986	1149	51	614	0	0	normal	1
953	1057	48	450	0	0	normal	1
887	917	53	575	0	0	normal	1
938	987	49	610	0	0	NORMAL	1
1126	1166	70	491	0	0	NORMAL	1
978	1070	51		0	0	NORMAL	1
926	1055	51	582	0	0	normal	1
923	1069	53		0	0	NORMAL	1
	1101			0	0	normal	1
1029	1169	49	629	0	0	normal	1
1084	1176	56	415	0	0	normal	1
922	956	53	569	0	0	normal	1
1159	1166	72	516	0	0	NORMAL	1
936	1004	48		0	0	NORMAL	1
1075	1110	53	558	0	0	normal	1
906		52	1074	0	0	NORMAL	1
903	1009		522	0	0	normal	1
983	1113	47	465	0	0	normal	1
1032	1123	52	488	0	0	normal	1
1002	1159	52	570	0	0	normal	1
961	974	52	567	0	0	normal	1
1054	1118			0	0	NORMAL	1
918	1051		499	0	0	NORMAL	1
994	1113	49	426	0	0	NORMAL	1
929	1085	47		0	0	normal	1
825	1057	47	490	0	0	NORMAL	1
965	1037	48	536	0	0	normal	1
876	1097	56	443	0	0	normal	1
1021	1087	52	498	0	0	normal	1
1013	1080	57	432	0	0	NORMAL	1
948	966	54	568	0	0	normal	1
1041	1020	43	289	0	0	NORMAL	1
1035	1034			0	0	NORMAL	1
1179	1229	75	498	0	0	NORMAL	1
1118	1005	68		0	0	NORMAL	1
921	1008		477	0	0	NORMAL	1
983	1119	51	412	0	0	NORMAL	1
929	1058			0	0	NORMAL	1
1073	1171	60	440	0	0	normal	1
986	1034	48	455	0	0	NORMAL	1
	1288			0	0	normal	1
	1122	61	600	0	0	normal	1
1064	1277	48	390	0	0	normal	1
1009	1093	52	588	0	0	NORMAL	1
1197	1179		478	0	0	NORMAL	1
				0	0	NORMAL	1
1089		59		0	0	normal	1
1096	1042	70		0	0	NORMAL	1
	1086	53		0	0	normal	1
	1080			0	0	normal	1
	1210	55	632	0	0	normal	1
1011	1119	53	446	0	0	normal	1
	1154	60	503	0	0	normal	1
924	996	50	590	0	0	normal	1
939	996	45	667	0	0	NORMAL	1
1038	1141	53	479	0	0	NORMAL	1
1055	1030	51	645	0	0	normal	1
1040	1100	58		0	0	NORMAL	1
969	1018	53	547	0	0	NORMAL	1
954	1047	52	455	0	0	normal	1
914	972	46		0	0	NORMAL	1
1014	1112	50	538	0	0	normal	1
968	983	56		0	0	NORMAL	1
948	1023	80	427	0	0	NORMAL	1
	1081			0	0	normal	1
	1140	49	645	0	0	normal	1
973	1050	61	401	0	0	normal	1
	1123	59	540	0	0	normal	1
898	952	52	593	0	0	normal	1
876	1001	46	639	0	0	NORMAL	1
961	1119	52	463	0	0	NORMAL	1
1022	1105	59	517	0	0	NORMAL	1
906	964	53		0	0	NORMAL	1
1017	1085	51	540	0	0	normal	1
1007	1027	55		0	0	NORMAL	1
	1071			0	0	normal	1
983	1337	49		0	0	normal	1
	1155	56	507	0	0	normal	1
	1170	48	562	0	0	normal	1
1000	1149	58	440	0	0	NORMAL	1
964	1031	55	571	0	0	normal	1
1059	1086	62		0	0	NORMAL	1
1088	1068	62		0	0	NORMAL	1
985	1090	52	824	0	0	NORMAL	1
955	1085	51	468	0	0	NORMAL	1
1000	1096	56	441	0	0	NORMAL	1
1035	1076	54	500	0	0	NORMAL	1
1101	1263	61	431	0	0	normal	1
1018	1019	51	518	0	0	normal	1
950	1348	48		0	0	normal	1
1024	1132	70	516	0	0	normal	1
	1213	58	583	0	0	normal	1
	1166	52	593	0	0	normal	1
960	1034	46		0	0	NORMAL	1
951	991	56	587	0	0	normal	1
1088	1141	59		0	0	NORMAL	1
1031	1129	52		0	0	NORMAL	1
953	1094	56	502	0	0	NORMAL	1

984	1118	52	461	0	0	NORMAL	1
972	1042	47		0	0	NORMAL	1
1009	1100	52	490	0	0	NORMAL	1
1039	1183	61	448	0	0	normal	1
1022	1008	54	561	0	0	normal	1
	1130			0	0	normal	1
1161	1280	66	369	0	0	normal	1
1107	1235	63	447	0	0	NORMAL	1
943	1009	52	592	0	0	normal	1
1006	1111	60	571	0	0	NORMAL	1
1111	1144	57	384	0	0	NORMAL	1
1099	1079	55	548	0	0	normal	1
	1185	63		0	0	NORMAL	1
1044	1092	62	506	0	0	NORMAL	1
1068	1135	60		0	0	NORMAL	1
935	980	52		0	0	NORMAL	1
1002	1066	60	556	0	0	NORMAL	1
999	1117	51	456	0	0	normal	1
		56	558	0	0	normal	1
954	1016	53	583	0	0	normal	1
1047	1029	69	528	0	0	NORMAL	1
1048	1108	70	490	0	0	NORMAL	1
969	971	49		0	0	NORMAL	1
985	1063	61		0	0	NORMAL	1
	1067			0	0	normal	1
1129	1079	59	462	0	0	normal	1
	1105	54	499	0	0	normal	1
920	991	52	470	0	0	NORMAL	1
962		59	489	0	0	NORMAL	1
1008	1087	52	491	0	0	NORMAL	1
	1074	52		0	0	NORMAL	1
1055	1078	65	508	0	0	NORMAL	1
1051	1108	53		0	0	NORMAL	1
954	1071	55	570	0	0	NORMAL	1
979	1055	47	577	0	0	normal	1
932	1067	49	489	0	0	NORMAL	1
1003	1070	54	432	0	0	NORMAL	1
983	1108	53	520	0	0	NORMAL	1
1012	1034	48	521	0	0	NORMAL	1
996	1067	54	583	0	0	normal	1
962	1034	51		0	0	NORMAL	1
1077	1035	57	477	0	0	normal	1
963	1089	47	454	0	0	NORMAL	1
		49	619	0	0	normal	1
1039	1119	55	468	0	0	normal	1
	1099	56	500	0	0	normal	1
962	995	56	575	0	0	normal	1
	1091	58		0	0	NORMAL	1
970	1072	59	502	0	0	NORMAL	1
972	1132	73	466	0	0	NORMAL	1
1016	1077	54	419	0	0	NORMAL	1
993	1117	51	544	0	0	NORMAL	1
883	919	55		0	0	NORMAL	1
1069	1180	52	554	0	0	normal	1
965	1058	52		0	0	NORMAL	1
1074	1082	64	503	0	0	normal	1
994	1103	52	468	0	0	NORMAL	1
967	1018	46	381	0	0	NORMAL	1
1043	1058	52	402	0	0	NORMAL	1
948	1050	51	424	0	0	NORMAL	1
949	952	48	437	0	0	NORMAL	1
948	937	50	445	0	0	NORMAL	1
992	1048	53	439	0	0	NORMAL	1
878	912	51	444	0	0	NORMAL	1
987	1168	53	529	0	0	NORMAL	1
999	1055	55	448	0	0	NORMAL	1
989	1082	52		0	0	NORMAL	1
992	1089	46	597	0	1	hibernating myocardium	2
1029	1162	54	620	0	1	hibernating myocardium	2
972	1139	64		0	1	hibernating myocardium	2
987	1124	50	551	0	1	Hibernating myocardium	2
918	1036	58	445	0	1	hibernating myocadium	2
958	1004	56	403	0	2	Hibernating myocardum LAD & RCA	2
1135	1085	52	500	0	1	hibernating myocardium	2
1066	1180	50	617	0	1	hibernating myocardum	2
1161	1151	76	409	0	1	Hibernating myocardium	2
953	1088	62	455	0	1	hibernating myocadium	2
1136	1088	49	327	0	1	hibernating myocardium	2
1107	1127	53	504	0	1	hibernating myocardium	2
951	1106	52	474	0	1	Hibernating myocardium	2
959	1090	55	503	0	1	hibernating myocadium	2
1103	1129	61	586	0	1	hibernating myocardium	2
1028	1161	53	461	0	1	hibernating myocardium	2
967	1100	49	499	0	1	hibernating myocardium	2
1104	1080	54	341	0	1	hibernating myocardium	2
993	1063	47	569	0	1	Hibernating myocardium	2
1020	1059	49	493	0	1	Hibernating myocardium	2
984	1118	60	484	0	1	hibernating myocadium	2
1028	1116	49	595	0	1	hibernating myocardium	2
1153	1180	63	428	0	1	hibernating myocardium	2
1004	1043	49	590	0	1	Hibernating myocardium	2
1023	1172	57	613	0	1	hibernating myocardium	2
959	917	51	487	0	1	Hibernating myocardium	2
944	1079	57	515	0	1	hibernating myocadium	2
1007	1099	52	599	0	1	hibernating myocardium	2
1106	1221	57	484	0	1	hibernating myocardium	2
1091	1126	58	555	0	1	hibernating myocardium	2
1201	1115	57	617	0	1	HIBERNATING MYOCARDIUM	2
979	1015	51	589	0	1	Hibernating myocardium	2
992	1173	58	619	0	1	hibernating myocardium	2

964	1110	49	517	0	1	Hibernating myocardium	2
928	1051	55	445	0	1	hibernating myocadium	2
992	1048	52	609	0	1	hibernating myocardium	2
1035	1040	61	361	0	0	normal	2
1054	1216	54	638	0	1	HIBERNATING MYOCARDIUM	2
976	1056	48	524	0	1	Hibernating myocardium	2
945	1009	48	618	0	1	hibernating myocardium	2
1063	1101	58	490	0	1	hibernating myocardium	2
1004	1121	53	497	0	2	hibernating myocardium	2
1106	1183	56	640	0	1	HIBERNATING MYOCARDIUM	2
1071	1163	53	485	0	2	hibernating myocardium	2
983	1082	50	318	0	1	hibernating myocardium	2
1029	1166	50	457	0	1	hibernating myocardium	2
978	1048	51	556	0	1	Hibernating myocardium	2
939	1023	49	496	0	1	Hibernating myocardium	2
1040		49	468	0	1	hibernating myocadium	2
958	1091	49	644	0	1	hibernating myocardium	2
1169	1082	51	405	0	1	hibernating myocardium	2
1071	1159	50	403	0	1	hibernating myocardium	2
987	1063	52	582	0	1	Hibernating myocardium	2
	1121		619	0	1	hibernating myocardium	2
935	932	50	518	0	1	Hibernating myocardium	2
926	1069	45	507	0	1	hibernating myocadium	2
994	1056	44	650	0	1	hibernating myocardium	2
1018	1152	55	523	0	1	hibernating myocardium	2
1069	1115	65	359	0	1	hibernating myocardium	2
972	1074	58	439	0	1	hibernating myocardium	2
1123	1228	51	645	0	1	HIBERNATING MYOCARDIUM	2
967	1032	52	588	0	1	Hibernating myocardium	2
	1117		608	0	1	hibernating myocardium	2
931	1040	47	534	0	1	Hibernating myocardium	2
946	1019	53	565	0	1	hibernating myocadium	2
955	1061	45	627	0	1	hibernating myocardium	2
997	1056	51	424	0	1	hibernating myocardium	2
967	1053	58	481	0	2	hibernating myocardium	2
861	1096	54	661	0	1	HIBERNATING MYOCARDIUM	2
982	1054	51	587	0	1	hibernating myocardium	2
992	1082	54	511	0	1	hibernating myocardium	2
1053	1145	55	479	0	1	hibernating myocardium	2
1074	1153	55	518	0	2	hibernating myocardium	2
1042	1158	59	654	0	1	HIBERNATING MYOCARDIUM	2
1159			620	0	1	hibernating myocardium	2
1012	1109	54	532	0	1	hibernating myocardium	2
1007	1127	53	455	0	1	hibernating myocardium	2
1003	1179		618	0	1	hibernating myocardium	2
8148	1113	58	539	0	1	hibernating myocadium	2
987	960	47	647	0	1	hibernating myocadium	2
1014	1118	49	518	0	1	hibernating myocardium	2
1011	1068	43	478	0	1	hibernating myocardium	2
1057	1079	50	401	0	1	hibernating myocardium	2
881	1159	50	678	0	1	HIBERNATING MYOCARDIUM	2
936	1006	54	546	0	1	hibernating myocardium	2
1011	1064	53	625	0	1	hibernating myocardium	2
1040	1107	53	548	0	1	hibernating myocardium	2
1044	996	62	402	0	1	hibernating myocardium	2
	1239	63	583	0	4	hibernating myocardium	2
1047	1156	65	528	0	1	hibernating myocardium	2
	1494		409	0	1	hibernating myocardium	2
1024	1060	52	653	0	1	HIBERNATING MYOCARDIUM	2
1086	1119	53	578	0	1	hibernating myocardium	2
933	1066	53	540	0	1	Hibernating myocardium	2
1086	1179	53	454	0	1	hibernating myocardium	2
980	1032	51	584	0	1	hibernating myocardium	2
1087	1136	52	554	0	1	hibernating mycardium	2
1147	1146	52	676	0	1	HIBERNATING MYOCARDIUM	2
888	1050	56	533	0	1	hibernating myocardium	2
1165	1202	60	497	0	1	hibernating myocardium	2
979	945	49	478	0	1	hibernating myocardium	2
1026	1103	51	607	0	1	hibernating myocardium	2
950	1044	51	517	0	1	hibernating myocardium	2
1025	1423	48	506	0	1	hibernating myocadium	2
999	1099	57	610	0	1	hibernating myocardium	2
1030	1076	49	422	0	1	hibernating myocardium	2
1049	1112	50	543	0	1	hibernating myocardium	2
959	1374	49	516	0	1	hibernating myocadium	2
1007	1063	52	590	0	1	hibernating myocardium	2
1163	1145	51	520	0	1	hibernating myocardium	2
1081	1153	51	434	0	1	hibernating myocardium	2
1043	1139	46	363	0	1	hibernating myocardium	2
	1159	57	489	0	2	hibernating myocardium	2
1188	1128	63		0	1	HIBERNATING MYOCARDIUM	2
921	1121	48	491	0	1	hibernating myocardium	2
1095	1081	48	533	0	1	hibernating myocadium	2
943	1100	55	484	0	1	hibernating myocardium	2
	1161	55	508	0	2	hiberrnating myocardium	2
1040	1110	54	515	0	1	hibernating myocardium	2
		54	605	0	2	Hibernating myocardium	2
1050	1124	54	437	0	1	hibernating myocardium	2
1008	1039	63	644	0	1	HIBERNATING MYOCARDIUM	2
999	1123	55	539	0	1	hibernating myocardium	2
1021	1106	56	633	0	1	hibernating myocardium	2
972	1066	45	546	0	1	hibernating myocardium	2
973	1043	54	504	0	1	hibernating myocadium	2
962	1059	52	622	0	1	hibernating myocardium	2
1022	1096	54	422	0	2	hibernating myocardium	2
1082	1059	67	424	0	1	hibernating myocardium	2
1029	1121	64	645	0	1	hibernating myocardium	2
976	1063	51	620	0	1	hibernating myocardium	2
1024	1078	52	450	0	2	hibernating myocardium	2
1148	1151	64	411	0	1	hibernating myocardium	2

1050	1102	50	391	0	2	Hibernating myocardum LAD & RCA	2
1003	1087	50	402	0	2	Hibernating myocardum LAD & RCA	2
1001	1101	49	427	0	2	Hibernating myocardum LAD & RCA	2
924	935	51	416	0	2	Hibernating myocardum LAD & RCA	2
917	1022	51	401	0	2	hibernating myocardium	2
945	1068	52	410	0	2	hibernating myocardium	2
1011	1109	50	396	0	2	hibernating myocardium	2
1016	1102	48	391	0	2	hibernating myocardium	2
1055	1106	51	438	0	2	hibernating myocardium	2
1019	1076	53	436	0	2	hibernating myocardium	2
951	1037	52	402	0	2	hibernating myocardium	2
1004	1031	52	422	0	2	hibernating myocardium	2
987	1042	50	420	0	2	hibernating myocardium	2
1009	1104	50	423	0	2	hibernating myocardium	2
956	1127	54	424	0	2	hibernating myocardium	2
1017	1073	48	417	0	2	hibernating myocardium	2
1030	1120	49	432	0	2	hibernating myocardium	2
1124	1193	60	468	1	1	<25% subendocardial infarct (FOCAL	3
1031	1299	60	606	1	1	< 25% subendocardial infarct	3
1067	1162	53	533	1	3	<25% sub endocardial viable infarct	3
1000	1143	51	635	1	1	<25% sub endocardial infarct (partly	3
1082	1196	51	614	1	1	< 25% viable infarct LAD TERRITORY	3
1030	1403	69	591	1	1	< 25% subendocardial infarct	3
1009	1131	59	634	1	1	< 25% subendocardial infarct (patch	3
1064	1239	55	459	1	0	<25% sub endocardial infarct	3
1003	1039	51		1	1	< 25 % sub endocardial infarct	3
	1136		608	1	1	<25% subendocardial infarct	3
1086	1224	54	635	1	1	< 25% VIABLE LAD INFARCT	3
	1169		592	1	1	<25% subendocardial infarct	3
1023	1217	53	437	1	0	<25% subendocardial infarct	3
960	1054	51	652	1	1	< 25% sub endo cardial infarct	3
986	999	54	472	1	1	< 25% sub endocardial enhancemen	3
943	964	49	491	1	1	< 25% sub endocardial enhancemen	3
976	1089	51		1	1	< 25 % subendocardial infarct	3
	1089	52		1	1	<25% sub endocardial infarct	3
		53	619	1	1	<25 % sub endocardial infarct	3
1069	1163	66	606	1	1	< 25% sub endocardial infarct	3
	1091	54		1	1	<25% subendocardial infarct	3
1218	1156	59		1	1	<25% VIABLE INFARCT LAD TERRITO	3
1102	1124	72	623	1	1	< 25% sub endocardial infarct	3
942	1033	56	468	2	2	< 50% VIABLE INFARCT LAD TERRITO	4
943	1076	56	354	2	1	< 50% sub endocardial infarct	4
1057	1109	51	461	2	1	<50% infarct (partly extending)	4
984	1078	53	485	2	1	< 50 % infarct	4
1003	1091	52	347	2	1	< 50% sub endocardial infarct	4
1036	1125	47	488	2	1	<50% INFARCT	4
963	1066	48	483	2	3	<50% Viable LAD TERRITORY INFARC	4
1005	1071	49	550	2	1	<50% VIABLE RCA INFARCT	4
1048	1061	56		2	1	<50% VIABLE CX/ RCA INFARCT	4
951	1043	48	572	2	1	< 50% infarct	4
985	1088	61		2	1	<50% VIABLE CX/ RCA INFARCT	4
945	996	48	584	2	2	< 50% infarct	4
980	1079	63		2	1	<50% VIABLE CX/ RCA INFARCT (par	4
892	976	52	432	2	2	<50% subendocardial infarct	4
917	1022	52	400	2	2	< 50 % infarct	4
1039	1099	60	461	2	2	<50% Viable LAD territory infarct	4
969	1104	53	453	2	2	< 50% INFARCT IN LAD TERRITORY	4
1006	1068	54	499	2	2	<50% viable LAD infarct	4
940	1072	51	422	2	2	< 50 % infarct	4
1147	1210	64	443	2	2	< 50% Viable LAD territory infarct	4
1035	1160	54	457	2	1	<50% VIABLE INFARCT LAD TERRITO	4
988	1118	51	466	2	2	<50% INFARCT IN LAD TERRITORY	4
1067	1137	55	430	3	1	<50% infarct	4
49	1079	47		2	1	<50 % infarct	4
996	1035	50	406	3	1	< 50 % infarct	4
1081	1173	60	436	2	2	<50% Viable LAD territory infarct	4
992	1076	49	467	2	1	<50% VIABLE INFARCT LAD TERRITO	4
986	1117	48	487	2	2	<50% INFARCT IN LAD TERRITORY	4
1065	1127	51	489	2	1	<50% infarct LAD	4
1110	1116	50	478	3	1	<50% infarct	4
	1110		557	2	1	<50% infarct (patchy)	4
988	1111	47	538	2	1	<50% Viable infarct RCA TERRITORY	4
1061	1176	53	469	2	1	<50% VIABLE RCA INFARCT	4
1002	1037	53	442	2	1	<50% infarct	4
977	1050	51	593	2	1	< 50% infarct	4
915	973	43	400	2	2	< 50 % infarct	4
885	972	51	571	2	1	<50% infarct	4
1193	961	55	533	2	1	< 50% infarct (partly extending)	4
933	1056	53	506	2	2	<50% infarct	4
1045	1230	60	407	3	1	<50% infarct(partly extending)	4
916	1114	56	548	2	1	26 to 50 % infarct	4
1226	1304	52	515	2	1	< 50% infarction (partly extending)	4
1073	958	48	466	2	1	< 50% infarct	4
948	1230		584	2	1	<50% infarct	4
899	1143	48		2	2	< 50 % infarct	4
820	998	53	490	3	2	< 50% VIABLE INFARCT LAD TERRITO	4
1024	1024	50	502	2	2	<50% LAD infarct	4
985	1175	63	624	2	1	<50% infarct	4
987	1077	48	558	2	3	<50% viable RCA INFARCT	4
1074	1161	54	454	2	1	< 50% VIABLE RCA INFARCT	4
1010	1085	45		2	1	<50% VIABLE CX/ RCA INFARCT	4
993	1190	59	636	2	1	<50% infarct	4
1058	1068	60		2	2	< 50 % infarct	4
974	1030	47	421	3	1	< 50 % infarct	4
1003	1129	49	559	2	3	<50% viable LAD INFARCT	4
1026	1119	54	396	3	2	< 50 % infarct	4
1078	1038	54	550	2	1	<50% LAD INFARCT	4
977	1153	69	424	2	1	<50% infarct	4
967	1001	47		2	2	<50% infarct	4
993	995	52	574	2	1	< 50% infarct	4

1034	963	48		2	1	<50% VIABLE CX/ RCA INFARCT	4
965	992	52	522	2	1	<50% infarct	4
917	1038	51	475	2	2	<50% sub endocardial infarct	4
938	964	54	535	3	1	<50% infarct	4
957	1103	51	502	3	2	<50% transmural infarct	4
1009	1055	67	340	3	1	<75% infarct	5
1001	1012	47	231	3	1	<75% Ischemic cardiomyopathy with	5
1148	1225	61	395	3	1	<75% Ischemic cardiomyopathy with	5
957	1078	46		3	2	< 75 % infarct	5
977	1091	50	526	3	2	<75% transmural infarct	5
1045	1105	54		3	2	<75% infarct	5
951		49		3	2	< 75 % infarct	5
999	1122	56	586	3	2	<75% transmural infarct	5
1049	1100	53		3	2	<75% infarct	5
1044	1121	48	391	3	2	<75% transmural infarct	5
952	1052	51		3	2	< 75 % infarct	5
1291	1133	60	483	3	2	<75% transmural infarction	5
1126	1188	57	474	3	2	<75% transmural infarction	5
1103	1236	64	403	3	1	<75% non viable infarction LAD & R	5
910	1055	49		3	2	< 75 % transmural infarct	5
	1074	46		3	1	<75% infarct	5
1049	1095	50	504	3	2	<75% transmural infarct	5
849	1022	55		3	2	<75 % transmural infarct	5
1101	1115	47	432	3	2	<75% transmural infarct	5
1075	1175	58	422	3	2	< 75% transmural infarct	5
932	1047	48	618	3	1	50 to 75 % infarct (partly extending)	5
871	894	57		3	2	< 75% infarct	5
966	950	90	541	3	3	< 75 % transmural infarct	5
946	1069	57		3	2	< 75 % infarct	5
1143	1228	61	427	3	3	<75% transmural infarct -non viable	5
671	1108	62	245	3	3	<75% infarct	5
1127	1181	55	412	3	2	<75% transmural infarction	5
931	1103	57	276	3	2	<75% infarct	5
1059	1147	54	484	3	2	<75% transmural infarction	5
1001	1226	47		3	2	< 75 % infarct	5
967	1221	56	601	3	2	<75% tramural infarct	5
970	1074	52	335	3	2	<75% infarct	5
919	1059	59		3	2	< 75% infarct	5
938	1205	46	613	3	2	<75% transmural infarct	5
849	1064	55	297	3	2	<75% infarct	5
1059	1136	74	555	3	4	<75 % trans mural infarct	5
1089	1239	58		3	4	< 75 % infarct (partly extending)	5
1095	1593	53		3	3	< 75 % infract	5
1236	1134	55	329	3	2	<75% infarct	5
1102	1124	55	492	3	2	<75% transmural infarction	5
916	910	50	364	4	2	< 75 % transmural infarct	5
983	1026	61	267	3	2	<75% infarct	5
1111	1176	57	334	3	2	<75% transmural infarction	5
	1092	55		3	2	<75% infarct	5
771	816	68	296	4	2	< 75 % transmural infarct	5
1092	1173	61	497	3	3	<75% transmural infarct -non viable	5
1022	1030	51	238	3	2	<75% infarct	5
1160	1106	60	339	3	2	<75% transmural infarction	5
	1086	59		3	2	<75% trans mural infarct	5
	1159	45	621	3	2	<75% transmural infarct	5
1086	1165	59	268	3	3	<75% infarct	5
	1147	58		3	2	< 75% transmural infarct	5
	1158	53	592	3	2	< 75% trans mural infarct	5
1015	1220	60	474	3	3	<75% transmural infarct -non viable	5
1089	1104	55	289	3	3	<75% infarct	5
966	1024	49	565	3	2	<75% transmural infarct	5
1038	1132	50	483	3	2	<75% NON VIABLE INFARCT LAD TER	5
965	1137	52	411	3	1	<75% non viable infarction LAD & RC	5
1098	1229	58	536	3	1	<75% transmural infarction	5
1080	1043	52		3	2	< 75 % trans muralinfarct	5
1071	1229	52	402	3	2	<75% transmural infarction	5
	1089	53		3	2	<75% transmural infarct	5
979	1025	56	427	3	2	<75% infarct	5
	1195	52		3	2	<75% transmural infarct	5
1095	1083	56	428	3	2	<75% infarct	5
1020	1085	49	444	4	2	> 75% transmural infarct	6
1057	1056	57		4	2	>75% transmural infarct	6
1009	1078	59	390	4	2	>75% non viable transmural infact LA	6
1149	1278	64	380	4	3	>75% Ischemic cardiomyopathy with	6
1084	1151	53	503	4	3	> 75% trans mural infarct	6
970	1163	56	404	4	2	> 75% transmural infarct	6
981	1111	59		4	3	>75% TRANSMURAL INFARCT	6
950	1096	58	303	4	3	> 75% non viable LAD INFARCT	6
1021	1171	70	452	4	4	> 75% NON VIABLE INFARCT LAD	6
1060	1154	56	350	4	2	>75% non viable transmural infact LA	6
1049	1152	53	401	4	3	>75% NON VIABLE INFARCT LAD TER	6
1032	1131	47	385	4	2	>75% NON VIABLE INFARCT LAD TER	6
905	1041	66	349	4	2	>75% Trans mural LAD non viable int	6
1174	1363	76	323	4	4	>75% transmural infarct with aneurs	6
1043	1126	53	495	4	2	> 75 % trans mural infarct (partly ext	6
1121	1139	60	400	4	2	> 75% transmural infarct	6
1026	1004	47	462	4	2	> 75% transmural infarct (partly exte	6
1012	1072	54	427	4	3	> 75% transmural infarct	6
1022	1110	55	484	4	2	>75% transmural infarct	6
976	1094	48	383	4	2	> 75% NON VIABLE LAD infarct (part	6
1016	1149	50	473	4	2	>75% NON VIABLE INFARCT LAD TER	6
1104	1131	68	391	4	3	>75% non viable infarct RCA territor	6
1114	1242	70	271	4	3	>75% transmural infarct	6
1031	1155	64	329	4	2	>75% Trans mural LAD non viable int	6
1475	1269	59	323	4	4	> 75% trans mural infarct with aneu	6
1066	1364	71	449	4	2	> 75% transmural infarct	6
917	1144	59	361	4	3	> 75% transmural infarct	6
1069	1175	46	620	4	3	> 75% NON VIABLE RCA INFARCT (PA	6
961	1130	60	530	4	2	>75% transmural infarct	6
1110	1261	53	427	4	2	> 75% nonviable RCA infarct	6

1186	1144	72	450	4	3	>75% non viable infarct RCA trritory	6
1082	1198	61	246	4	3	>75% transmural infarct	6
1169	1344	78	275	4	3	>75%	6
	1181	73		4	3	>75% transmural infarct	6
1001	1074	47	668	4	2	> 75% transmural infarct (partly exte	6
1202	1187	58	615	4	3	> 75% NON VIABLE RCA INFARCT	6
1044	1064	54	428	4	3	>75% non viable infarct RCA territor	6
1080	1132	56	230	4	3	>75% transmural infarct	6
1106	1284	60	393	4	3	>75% transmural infarct	6
968	1096	66	422	4	3	>75% non viable infarction LAD & R	6
	1092	48		4	3	>75% transmural infarct (partly exte	6
984	951	49	532	4	3	> 75 % trans mural infarct	6
1123	1239	61	416	4	3	> 75% transmural infarct	6
1068	1129	57	395	4	3	> 75 % transmural infarct	6
840	931	55	450	4	2	> 75 % transmural infarct	6
1019	1019	51	462	4	2	> 75% transmural infarct	6
1007	1005	61		4	2	>75% transmural infarct	6
	1108		512	4	2	>75% transmural infarct	6
921	898	75		4	3	>75% TRANSMURAL INFARCT	6
839	915	60	454	4	2	>75% transmural infarct	6
958	1112	56	534	4	3	>75% transmural LAD Infarct	6
918	1064	51	326	4	3	> 75% non viable LAD INFARCT (part	6
1029	1071	63	272	4	2	>75% non viable transmural infact L	6
915	1105	50	397	4	2	>75% NON VIABLE INFARCT LAD TEF	6
989	1069	64	241	3	2	<75% infarct	6
664	1071	73	306	4	2	>75% Trans mural LAD non viable in	6
1267	1258	67	277	4	3	>75% non viable infarction LAD & RC	6
1234	1267	57	260	4	3	>75% transmural infarct LAD territo	6
1182	1063	72	404	4	3	>75% transmural LAD territory infarc	6
1005	1151	53	519	4	2	> 75% trans mural infarct	6
1138	1284	63	410	4	3	> 75% transmural infarct	6
1063	1186	56	403	4	3	> 75 % transmural infarct(partly exte	6
1023	1137	55	435	4	2	> 75% transmural infarct	6
1126	1219	56		4	2	>75% transmural infarct	6
1138	1213	82		4	1	>75% TRANSMURAL INFARCT	6
966	1010	56	366	4	2	>75% transmural infarct	6
1023	1112	50	526	4	3	>75% transmural LAD Infarct	6
980	1168	59	285	4	3	> 75% non viable LAD INFARCT	6
929	1017	54	396	4	4	> 75% NON VIABLE INFARCT LAD	6
1060	1137	60	365	4	2	>75% non viable transmural infact L	6
1032	1120	55	514	4	2	>75% non viable infrct LAD	6
1031	1060	53	359	4	2	>75% NON VIABLE INFARCT LAD TEF	6
962	1099	60	235	4	3	>75% transmural infarct	6
824	1083	65	313	4	2	>75% Trans mural LAD non viable in	6
864	952	52	252	4	1	Ischemic cardiomyopathy with non v	6
1027	1084	61	261	4	3	>75% transmural infarct LAD territor	6
1244	1433	84	328	4	3	>75% transmural LAD territory infarc	6
1049	1184	51	540	4	2	> 75 % transmural infarct	6
1089	1248	55	366	4	4	> 75% trans mural infarct with aneu	6
1022	1185	51	452	4	3	> 75% transmural infarct	6
1037	996	53	387	4	2	> 75% transmural infarct	6
949	1044	49	636	4	2	> 75% transmural infarct (partly exte	6
1068	1193	61	411	4	2	> 75% transmural infarct	6
1027	1130	57		4	2	>75% transmural infarct	6
1110	1101	54	507	4	2	>75% transmural infarct	6
1031	1081	51		4	1	>75% TRANSMURAL INFARCT (partly	6
994	1058	52	512	4	2	>75% transmural infarct	6
1038	1145	54	522	4	3	>75% transmural LAD Infarct	6
958	1056	49	384	4	3	> 75% non viable LAD INFARCT (part	6
1058	1082	46	408	4	4	>75% NON VIABLE INFARCT LAD (pa	6
1034	1031	55	444	4	2	>75% NON VIABLE INFARCT LAD TEF	6
1096	1156	58	358	4	3	>75% non viable infarct RCA territor	6
1144	1216	86	274	4	3	>75% transmural infarct	6
944	1109	48	350	4	2	>75% Trans mural LAD non viable in	6
1103	1067	60	424	4	3	>75% transmural LAD territory infarc	6
988	1057	49	488	4	2	>75 % trans mural infarct	6
1219	1305	49	323	4	4	>75% trans mural infarct with aneur	6
1081	1104	58	487	4	2	> 75% transmural infarct	6
1084	1074	92	451	4	2	> 75% transmural infarct	6
1059	1166	59	339	4	2	> 75% transmural infarct	6
1099	1192	64	638	4	3	> 75% NON VIABLE RCA INFARCT (PA	6
1116	1171	57	539	4	2	>75% transmural infarct	6
1125	1108	73	335	4	3	>75% non viable infarct RCA territor	6
1120	1150	59	280	4	3	>75% transmural infarct	6
1058	1047	47		4	2	>75% TRANSMURAL INFARCT	6
1128	1250	61	277	4	3	>75% non viable infarction LAD & RC	6
	1204	46		4	3	>75% transmural infarct	6
942	1037	47	625	4	2	> 75% transmural infarct (partly exte	6
1132	1344	58	641	4	3	> 75% NON VIABLE RCA INFARCT	6
1157	1159	60	342	4	3	> 75% non viable infarct RCA territor	6
994	1133	55	237	4	3	>75% transmural infarct	6
1018	1068	54		4	2	>75% TRANSMURAL INFARCT	6
1108	1021	53	338	4	3	>75% transmural infarct	6
1022	1111	51	460	4	3	>75% non viable infarction LAD & RC	6
	1081	44		4	3	> 75% transmural infarct (partly exte	6
992	1195	51	561	4	3	> 75% transmural infarct	6
871	1070	54	602	4	2	>75% NON VIABLE INFARCT LAD TEF	6
984	1041	59	384	3	2	<75% infarct	6
1069	1057	49	397	4	3	>75% transmural infarct	6
948	866		347	4	3	> 75 % transmuralinfarct	6
1110	1127	71	398	4	3	> 75% transmural infarct	6
1056	1069	59	326	4	3	> 75 % transmural infarct	6
824	928	62	266	4	3	> 75 % transmural infarct	6
930	1017	54	319	4	2	> 75% transmural infarct	6
982	1074	55	442	4	3	> 75% transmural infarct & THROME	6
961	947			4	2	>75% transmural infarct	6
1010	1116		505	4	2	>75% transmural infarct	6
1011	1050	68		4	3	>75% TRANSMURAL INFARCT	6
1066	1143	48	455	4	3	> 75% NON VIABLE INFARCT LAD TEI	6
995	1063	52	445	4	2	>75% trans mural infarct	6

678	910	53	358	4	3	>75% transmural infarct	6
990	1146	61	456	4	3	>75% non viable LAD infarct	6
917	1046		293	4	3	> 75% non viable LAD INFARCT	6
1038	1062	62	245	4	2	>75% non viable transmural infact L/	6
1056	1053	49	332	4	2	>75% NON VIABLE INFARCT LAD TEI	6
780	1044	79	349	4	3	>75% Trans mural LAD non viable in	6
1264	841	62	278	4	3	>75% non viable infarction LAD & R	6
847	1154	73	255	4	3	>75% transmural infarct LAD territor	6
1403	960	52	330	4	3	>75% transmural LAD territory infar	6
1052	1262	79	528	4	3	> 75 % transmural infarct	6
838	899		370	4	2	> 75 % trans mural infarct	6
1091	1320	60	481	4	3	> 75% transmural infarct	6
1125	1283	61	396	4	3	> 75 % transmural infarct	6
999	1047	53	276	4	3	> 75 % transmural infarct	6
1047	1042	62	370	4	2	> 75% transmural infarct	6
1022	1041	49	650	4	2	> 75% transmural infarct (partly exte	6
1006	1090	54	440	4	3	> 75% transmural infarct & THROME	6
1151	1265	64	409	4	3	>75% transmural infarct -non viable	6
1140	1231			4	2	>75% transmural infarct	6
1011	1192	81		4	3	>75% TRANSMURAL INFARCT	6
1018	1110	52	475	4	3	> 75% NON VIABLE INFARCT LAD TEI	6
1026	1112	58	422	4	3	>75% transmural infarct	6
1026	1142	54	464	4	3	>75% non viable LAD infarct	6
952	1016		299	4	3	> 75% non viable LAD INFARCT	6
984	1111	73	408	4	4	>75% NON VIABLE INFARCT LAD	6
1023	1132	55	257	4	2	>75% non viable transmural infact L/	6
1023	1057	55	410	4	2	>75% NON VIABLE INFARCT LAD TEF	6
1098	1126	67	318	4	3	>75% Trans mural LAD non viable in	6
957	1116	52	352	4	3	>75% non viable infarction LAD & RC	6
1050	982	72	293	4	2	>75% transmural infarct LAD territor	6
1151	1217	67	282	4	3	>75% transmural LAD territory infar	6
930	1129	54	525	4	2	> 75 % transmural infarct	6
	1214			4	3	> 75% transmural infarct	6
1031	1061	49	253	4	3	> 75 % transmural infarct	6
1035	1166	58	443	4	2	> 75% transmural infarct	6
972	999	39	447	4	2	> 75% transmural infarct	6
982	1066	48	352	4	3	> 75% transmural infarct & THROME	6
1062	1282	56	594	4	3	>75% NON VIABLE RCA INFARCT	6
1000	1095	65	538	4	3	>75% transmural infarct -non viable	6
1132	1212	70	526	4	2	>75% transmural infarct	6
1214	1118	53		4	3	>75% TRANSMURAL INFARCT	6
942	1061	47	529	4	3	> 75% NON VIABLE INFARCT LAD TE	6
988	1218	52	604	4	3	>75% transmural infarct	6
955	1066	49	555	4	3	>75% non viable LAD infarct	6
1204	1263	62	320	4	3	>75% non viable RCA territory infarc	6
980		53	1174	4	2	>75% TRANSMURAL INFARCT	6
1022	1133	56	404	4	3	>75% Trans mural LAD non viable in	6
1061	1201	55	268	4	3	>75% non viable infarction LAD & RC	6
1117	1006	53	401	4	3	>75% transmural LAD territory infar	6
	1129			4	3	>75% transmural infarct	6
926	871		398	4	2	> 75 % trans mural infarct	6
1007	1248	56	462	4	3	> 75% transmural infarct	6
796	1012	54	335	4	3	> 75 % transmural infarct	6
972	974	49	473	4	2	> 75% transmural infarct	6
1033	1161	55	407	4	3	> 75% transmural infarct & THROME	6
1030	1155		601	4	1	> 75% transmural infarct (extending	6
981	1094	50	512	4	3	> 75% NON VIABLE INFARCT LAD TEI	6
823	1070	53	506	4	2	> 75% transmural infarct	6
937	1006	59	519	4	3	>75% transmural infarct (partly exte	6
925	1044	57	590	4	3	>75% non viable LAD infarct	6
765	1160	42	483	4	2	>75% NON VIABLE INFARCT LAD TEF	6
1140	974	56	557	4	3	> non viable infarct RCA territory (pa	6
985	1119	55		4	2	>75% TRANSMURAL INFARCT(partly	6
1017	1086	51	377	4	3	>75% transmural infarct	6
1213	1186	88		4	4	> 75 % transmural infarct	6
1120	1105	77	332	4	4	> 75 % transmural infarct	6
	1111		345	4	4	> 75 % transmural infarct	6
1013	1115			4	3	> 75% transmural infarct	6
1125	1509	73	479	4	3	> 75% transmural infarct & THROME	6
1283	1434	52	641	4	3	> 75% NON VIABLE RCA INFARCT	6
1091	1259	65	452	4	3	> 75% transmural infarct -non viable	6
	1170			4	2	>75% transmural infarct	6
				4	3	>75% TRANSMURAL INFARCT	6
1163	1327	90	397	4	3	> 75% NON VIABLE INFARCT LAD TEI	6
980	1392	62	471	4	2	>75% Transmural infarct	6
1067	1057	53	445	4	3	>>75% transmural infarct (calcified t	6
1033	1131	59	402	4	3	>75% non viable LAD infarct	6
1067	1157	48	395	4	4	> 75% non viable LAD INFARCT (BAL	6
1477	1414	70	391	4	4	>75% NON VIABLE INFARCT LAD	6
1161	1214	71	294	4	4	>75% non viable transmural infact L/	6
1257	1087	62	367	4	3	>75% NON VIABLE INFARCT LAD TEF	6
1071	1150	73	390	4	3	>75% Trans mural LAD non viable in	6
1048	1159	49	325	4	3	>75% infarct LAD & RCA	6
1324	1358	72	247	4	4	>75% transmural infarct LAD territor	6
1490	1377	66	422	4	3	>75% transmural LAD territory infar	6
1047	1149	58	561	4	3	> 75 % transmral infarct	6
	1178	50	408	4	3	> 75 % transmural infarct	6
1105	1231	60	393	4	3	> 75 % transmural infarct	6
948	1081	49	439	4	2	> 75% transmural infarct	6
1060	1103	54		4	2	>75% transmural infarct	6
1027	1147	59	500	4	3	>75% non viable infarct LAD territory	6
1009	1077	55	300	4	2	>75% non viable transmural infact L/	6
979	1149	61	440	4	2	>75% NON VIABLE INFARCT LAD TEF	6
855	774	56	407	4	2	>75% Trans mural LAD non viable in	6
1273	1219	49	237	4	3	>75% non viable infarction LAD & R	6
1165	1129	64	285	4	2	>75% transmural infarct LAD territor	6
1018	1103	52	569	4	3	> 75 % transmural infarct	6
808	1266	58		4	3	> 75 % trans mural infarct	6
	1064	67	418	4	3	> 75 % transmural infarct	6
1100	1213	62	345	4	3	> 75 % transmural infarct	6

938	1058	54	363	4	2	> 75% transmural infarct	6
1096	1140	62		4	2	>75% transmural infarct	6
994	1091	55	569	4	2	>75% transmural infarct	6
982	1014	75		4	3	>75% TRANSMURAL INFARCT	6
993	1120	53	484	4	3	>75% NON VIABLE INFARCT LAD TER	6
955	1120	61	695	4	2	>75% transmural infarct	6
950	1119	66	381	4	3	>75% non viable infarct LAD territory	6
942	1076	45	336	4	3	> 75% non viable LAD INFARCT	6
956	990	55	411	4	4	> 75% non viable infarct LAD	6
1101	1229	67	313	4	2	>75% non viable transmural infact L	6
958	1081	68	335	4	2	>75% NON VIABLE INFARCT LAD TER	6
806	757	82	387	4	2	>75% Trans mural LAD non viable in	6
1144	1302	73	246	4	3	>75% non viable infarction LAD & RC	6
1178	1146	64	276	4	2	>75% transmural infarct LAD territor	6
574	646	70	260	4	3	>75% transmural infarct	6
1075	1111	65	555	4	2	> 75 % transmural infarct	6
1253	1371	50	329	4	4	> 75% trans mural infarct with aneu	6
998	1138	83	453	4	2	>75% transmural infarct	6
1026	1192	54	274	4	3	> 75% transmural infarct	6
1059	1109	52	632	4	3	> 75% NON VIABLE RCA INFARCT	6
1084	1154	62	488	4	2	>75% transmural infarct	6
1109	1189	66	364	4	3	>75% non viable RCA infarct	6
1010	1063	50		4	2	>75% TRANSMURAL INFARCT	6
1195	1306	66	292	4	3	>75% non viable infarction LAD & RC	6
949	1031	53	478	4	3	>75% transmural infarct	6
981	1056	52	562	4	2	> 75 % transmural infarct	6
	1078			4	3	>75% transmural infarct	6
1056	1199	57	441	4	3	> 75 % transmural infarct	6
991	1110	52	424	4	2	> 75% transmural infarct	6
1100	1214	67	464	4	2	> 75% transmural infarct	6
998	1045	55	419	4	3	> 75% transmural infarct	6
1106	1193	52	579	4	3	> 75% NON VIABLE RCA INFARCT	6
1132	1168	70	518	4	2	>75% transmural infarct	6
1089	1157	79		4	3	>75% TRANSMURAL INFARCT	6
893	1062	51	552	4	3	>75% NON VIABLE INFARCT LAD TER	6
999	1052	53	740	4	3	>75% transmural infarct	6
1017	1128	46	491	4	3	>75% NON VIABLE LAD infarct	6
1089	1160	60	352	4	3	>75% non viable RCA INFARCT	6
971	1006	52		4	2	>75% TRANSMURAL INNFARCT (part	6
1132	1274	55	271	4	3	>75% non viable infarction LAD & RC	6
1018	1011	56	458	4	3	>75% transmural infarct	6
1079		54	601	4	2	> 75 % transmural infarct	6
1040	1223	52	477	4	3	> 75 % transmural infarct	6
1075		49	417	4	2	> 75% transmural infarct	6
913	1029	49	286	4	3	> 75% non viable LAD INFARCT	6
1008	1098	50	416	4	4	> 75% NON VIABLE INFARCT LAD	6
1009	1116	48	411	4	2	>75% non viable transmural infact L	6
1026	1055	57	482	4	2	>75% NON VIABLE INFARCT LAD TER	6
1138	1149	72	287	4	3	>75% transmural infarct	6
1054	1135	70	347	4	2	>75% Trans mural LAD non viable in	6
1061	1041	55	296	4	2	>75% transmural infarct LAD territor	6
1150		52	619	4	2	> 75 % trans mural infarct	6
	1164			4	3	>75% transmural infarct	6
1095	1278	48	419	4	4	>75% trans mural infarct with aneur	6
1060	1188	42	459	4	3	> 75 % transmural infarct	6
1119	1247	66	419	4	3	> 75 % transmural infarct	6
967		53	319	4	2	> 75% transmural infarct	6
995	1090	56	375	4	3	> 75% transmural infarct & THROME	6
1219	1106	56	467	4	3	>75% transmural infarct -non viable	6
	1164	57		4	2	>75% transmural infarct	6
1095	1144	60		4	3	>75% TRANSMURAL INFARCT	6
1000	1132	60	488	4	3	>75% NON VIABLE INFARCT LAD TER	6
995	1076	54	463	4	3	>75% transmural infarct	6
1113	1138	51	480	4	3	>75% Non viable LAD infarct	6
867	955	50	280	4	3	> 75% non viable LAD INFARCT	6
983	1095	61	404	4	4	>75% NON VIABLE INFARCT LAD	6
1028	1133	55	372	4	2	>75% non viable transmural infact L	6
1046	1070	59	491	4	2	>75% NON VIABLE INFARCT LAD TER	6
1045	1118	64	537	4	3	>75% NON VIABLE RCA INFARCT	6
977	1019	60	260	4	3	>75% transmural infarct	6
1025	1099	68	337	4	3	>75% Trans mural LAD non viable in	6
902	1099	43	269	4	3	>75% non viable infarction LAD & RC	6
1144	1114	66	308	4	2	>75% transmural infarct LAD territor	6
966	961	60	266	4	3	>75% transmural infarct	6
1327		62	596	4	2	> 75 % transmural infarct (partly ext	6
986	1208	52	562	4	3	> 75 % transmural infarct (partly ext	6
970	1500	46	591	4	2	> 75% transmural infarct (partly ext	6
848	1101	51	369	4	2	>75% transmural infarct	6
1190		46	605	0	0	> 75 % transmural infarct	6
	1354			4	3	>75% transmural infarct	6
928	1028	53		4	2	> 75 % transmural infarct	6
1093	1541	54	423	4	3	> 75 % transmural infarct	6
1089	1150	59	421	4	3	>75% transmural infarct	6
935	991	52	361	3	2	> 75% transmural infarct	6
1013		47	473	4	2	> 75% transmural infarct	6
912	1237	46	498	4	2	> 75% transmural infarct (partly exte	6
1094	1128	52	499	4	3	> 75% transmural infarct & THROME	6
1127	1199	64	666	4	3	> 75% NON VIABLE RCA INFARCT	6
1103	1267	66	560	4	3	>75% transmural infarct -non viable	6
1003	1069	54		4	3	>75% TRANSMURAL INFARCT	6
1057	1066	54	543	4	3	>75% NON VIABLE INFARCT LAD TER	6
1036	1068	57	531	4	2	>75% TRANSMURAL INFARCT	6
887	1065	56	536	4	3	>75% transmural infarct (calcified th	6
973	1034	50	445	4	3	>75% non viable LAD infarct	6
1093	1099	56	526	4	2	>75% NON VIABLE INFARCT LAD TER	6
848	1020	56	389	4	2	>75% transmural infarct	6
1005	1072	52	401	4	3	>75% Non viable LAD INFARCT	6
1068	1131	52	430	4	3	>75% Non viable LAD INFARCT	6
1056	1102	53	405	4	3	>75% Non viable LAD INFARCT	6
1161	1306	67	282	4	3	> 75% Non viable LAD INFARCT	6
1039	1111	53	426	4	3	>75% non viable LAD infarct	6