IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 3 Ser.13 (March. 2023), PP 01-09
www.iosrjournals.org

Role of Cardiac Magnetic Resonance Imaging in Diagnosis of Myocardial Diseases

Dr. K. Saranya[1], Dr. D. Ankamma Rao[2], Dr. Manswini korsipati[3], Dr. Varun kumar Reddy Anchala[4], Dr. Tata venkata Pavan kumar Gupta[5], Dr. Meghana Meghavath[6], Dr. Husha Priya Laasya Bolla[7], Dr. Siri Chandana Mamillapalli[8], Dr. Sai Krishna Sujith Naidu[9], Dr. V. Lakshmi Meenakshi[10], Dr. S.L.N Monica[11], Dr. Ayisha SK[12].

[1]Junior resident, [2]Professor & HOD, [3-12]Junior resident

[1-1 2(Department of Radio-diagnosis, NRI medical college and general hospital/ Dr. Y.S.R UHS, India)

Abstract:

Background*: Myocardial pathologies are significant causes of morbidity and mortality in patients worldwide. Ischemic and non-ischemic cardiomyopathies have become worldwide epidemic of the 21st century with an increasing impact on health care system. Cardiomyopathies are defined as a heterogenous group of myocardial diseases associated with mechanical and/or electrical dysfunction,which may be accompanied by hypertrophy or dilatation, having various causes, often genetic, in the abscence of hypertension, valvular disease, coronary artery disease and congenital heart disease. Cardiac MRI allows accurate assessment of myocardial anatomy, function, perfusion, and pathology in a non-invasive way. The diagnosis and identification of the underlying disorder are essential for directing appropriate therapy, which would significantly alter morbidity and mortality. Late Gadolinium enhancement cardiac magnetic resonance (LGE-CMR) can effectively differentiate between ischemic and non-ischemic cardiomyopathy, on the basis of the enhancement pattern of myocardial scar. Cardiac magnetic resonance imaging is superior to other cardiac imaging modalities such as echocardiography, cardiac CT angiography and coronary angiography in determining the type of cardiomyopathy and cardiac function.*

Materials and Methods: *The present study is a cross-sectional, observational study undertaken to assess the "Role of Cardiac Magnetic Resonance Imaging in Diagnosis of Myocardial diseases," with patients being referred to the department of radiology at NRI Medical College and GH Chinakakani. A 1.5 Tesla MRI was used to examine all of the study participants.*

Results*: The current study included 63 patients with cardiomyopathies. Ischemic cardiomyopathy was seen in 74.6% of patients and non-ischemic cardiomyopathy in 25.4% of patients. The most common diagnosis was ischemic CM. DCM was seen in 12.69%, HCM in 7.9%, LV non compaction in 3.17% and myocarditis in 1.5% patients.*

Conclusion: *Cardiomyopathies are rare diseases, but common cause for cardiac MRI evaluation. CMPs varies in cause, clinical features, clinical outcomes; so, they should be diagnosed using imaging techniques which warrant accurate assessment of disease like morphology, function, tissue features of damaged myocardium. Cardiac MRI fulfils all these needs, considered most vital imaging technique.*

Key Word*: Cardiac MRI, Cardiomyopathies, Late Gadolinium enhancement, Viability.*

Date of Submission: 08-03-2023 Date of Acceptance: 21-03-2023

I. Introduction

Myocardial disease is broadly divided into ischemic and non ischemic cardiomyopathies. Cardiomyopathies (CMPs) are heterogenous group of disorders of the myocardium. They are divided as primary cardiomyopathies which are confined to the heart and secondary cardiomyopathies that are elated to systemic disorders. Primary cardiomyopathies are subdivided into genetic (include hypertrophic cardiomyopathy, arrhythmogenic right ventricular dysplasia, left ventricular non-compaction, danon glycogen storage diseases and others) and acquired (include acute myocarditis, stress-induced, tachycardia induced and peripartum cardiomyopathies).Secondary cardiomyopathies occur due to amyloidosis, Hunter disease, Gaucher disease, and Hurler disease, drug toxicities, inflammatory disorders and hormonal disorders.

Diagnosing the aetiology of CMP begins with history and physical examination, along with diagnostic modalities like electrocardiogram (ECG), laboratory tests, imaging studies, and may sometimes require a

myocardial biopsy to achieve definitive diagnosis. Cardiac MRI, cardiac CT, and nuclear imaging are some of the primary imaging options used for work up and follow up of cardiomyopathy patients. Cardiac MRI allows reliable assessment of myocardial anatomy, perfusion, function, pathology in a non-invasive way. Detecting the underlying disorder is vital for directing proper therapy, which would modify morbidity and mortality. Late Gadolinium enhancement (LGE) cardiac magnetic resonance (CMR) can distinguish between ischemic and non-ischemic cardiomyopathy, on the basis of enhancement pattern of myocardial scar. Cardiac MRI is superior to imaging modalities like ECHO, coronary angiography and cardiac CT angiography in detecting the type of cardiomyopathy and cardiac function.

The estimated prevalence of heart failure (HF) in India is around 1% of total population. The estimated death rate due to heart failure was about 0.1–0.16 million subjects per year. Indians constitute 16% of the of heart failure patients globally. Two most important causes include rheumatic heart disease (RHD) and coronary artery disease (CAD). Around 33% of patients die during hospital admission and $1/4^{th}$ die within 1^{st} 3 months of discharge[1.] In view of high prevalence and mortality rate, early reliable diagnosis is vital. Hence the current study was taken up to know the reliability of cardiac MRI in myocardial diseases.

II. Material And Methods

This is cross-sectional, observational study to evaluate the role of cardiac magnetic resonance imaging in diagnosis of myocardial diseases, carried out on the patients being referred to the Department of Radiodiagnosis at NRI medical college and general hospital, Chinakakani, Guntur, Andhrapradesh. A total 63 adult subjects (both male and females) of aged ≥ 18 years were included in this study.

Study Design: Cross-sectional, observational study

Study Location: Department of Radiodiagnosis, NRI Medical College and GH, Chinakakani.

Study Duration: December 2021 to December 2022.

Sample size: 63 patients.

Sample size calculation: Convenience sampling

As per Chaturvedi[1], the incidence of heart failure is 1% in India.

$N=Z^2PQ/E^2$

N-sample size

P-Prevalence

P=1%

Q=1-P

E-Error: 3%,

98% confidence limits

N=60

60 is the minimum sample size.

So, we included 63patients in the current study, considering certain lost to follow ups and incomplete data.

All 63 patients provided informed consent for the study.

Subjects & selection method: The study population was drawn from patients referred to the department of Radiodiagnosis from the department of cardiology with suspicion or diagnosed cases of cardiomyopathies. All the study patients were investigated on a 1.5-Tesla GE (general electrical medical systems) Signa Excite MRI system with a phased array 16 channel cardiac coil using conventional CE - MRI and LGE sequences. All the patients with cardiomyopathies are included in the study.

Inclusion criteria:

1. Patients with history or diagnosed cases of cardiomyopathy.
2. patients who have given informed consent.

Exclusion criteria:

1. Patients with contraindications to MRI.
2.Patients whose data is incomplete.
3. Patients with altered renal parameters.

Exclusion criteria was based on oral history from patients, available medical records and as per cardiologist suggestion.

Procedure methodology:

After getting approval from the institutional ethics committee, this study was conducted.

Assurance was provided regarding the maintenance of confidentiality. Thorough history was taken from every parent. Demographics like age and gender were recorded. ECG and ECHO findings were noted. MRI findings

were noted. Data was entered in a case record form designed for the study and it was subjected to statistical analysis.

MRI PROTOCOL:

- Localizers.
- Axial - black blood imaging of Chest
- 2chamber, 4 chamber, 3 chamber, left and right ventricular outflow tracts (LVOT, RVOT) - CINE images
- Short axis – STIR or T2 FS
- Short axis cine stack from base to the apex(without slice gap).
- Dynamic perfusion in short axis from base to apex
- TI scout (mid cavity short axis)
- Delayed enhancement Short axis stack from base to apex
- Delayed enhancement - 2 and 4 chamber
- Phase contrast flow - Aorta & main pulmonary artery.

Contrast: Gadobuterol(1mmol/ml) was administered at a dose of 0.2mmol/kg at an injection rate of 3-7ml/sec followed by atleast 20-30 ml of saline flush(5-7ml/sec).
BLACK BLOOD SEQUENCES: Uses inversion recovery (IR) prepulses to null the signal from blood alone (double IR) or from both blood and fat (triple IR). Used for anatomic evaluation.
BIGHT BLOOD SEQUENCES: are based on balanced steady- state Free precession (b-SSFP). CINE imaging is used for evaluating the myocardial function.
POST CONTRAST SEQUENCES: Uses T1W inversion recovery fast gradient echo sequence. The inversion time (TI) is chosen to null signal from myocardium, typically in the range of 250-350ms. Following the injection, first perfusion imaging done, then the delayed images are taken at 10 minutes.

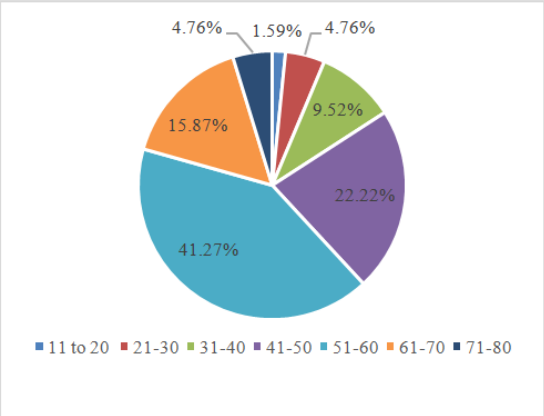
Statistical analysis:
The following assumption on the data was made
The data collected was entered in MS Excel 2019 and analysis was carried out using Microsoft excel and statistical software called Epi info version 7.2.5. Dependent variables are normally distributed.The results were expressed in the form of descriptive and inferential statistics. Frequencies, percentages were also used. Continuous variables were assessed using mean and SD.

III. Result

Age distribution: Most of the patients were aged 51 to 60 years.

Table & Graph 1: Age distribution of patients

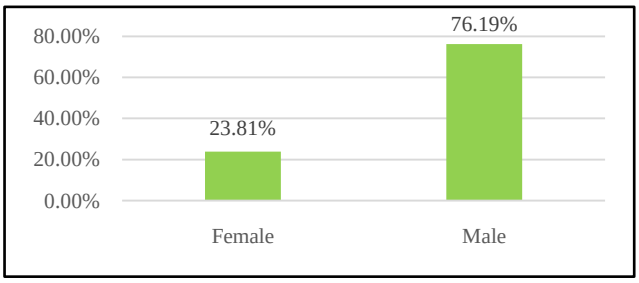
Age group	Frequency	Percent	Cum. Percent
11 to 20	1	1.59%	1.59%
21-30	3	4.76%	6.35%
31-40	6	9.52%	15.87%
41-50	14	22.22%	38.10%
51-60	26	41.27%	79.37%
61-70	10	15.87%	95.24%
71-80	3	4.76%	100.00%
Total	63	100.00%	100.00%



Gender: Only 23% of patients were females. 76% were males

Table &Graph 2: Gender distribution of patients

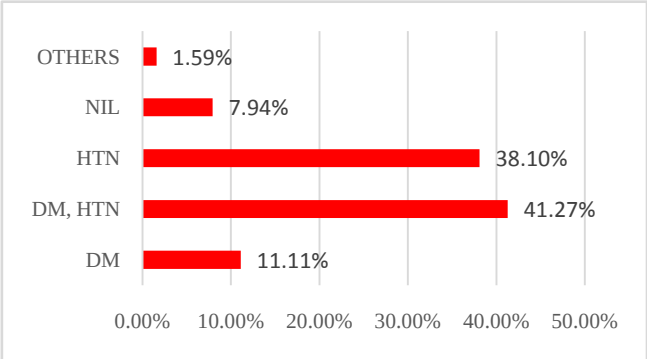
SEX	Frequency	Percent	Cum. Percent
Female	15	23.81%	23.81%
Male	48	76.19%	100.00%
Total	63	100.00%	100.00%



Co-morbidities among patients: Most of the patients had diabetes and hypertension.

Table & Graph 3: Co-morbidities among patients

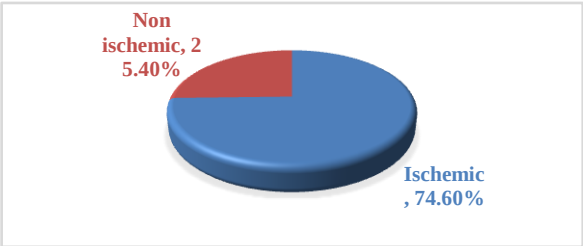
CO-MORBIDITIES	Frequency	Percent	Cum. Percent
DM	7	11.11%	11.11%
DM, HTN	26	41.27%	52.38%
HTN	24	38.10%	90.48%
NIL	5	7.94%	98.41%
OTHERS	1	1.59%	100.00%
Total	63	100.00%	100.00%



Category of cardiomyopathy: Ischemic cardiomyopathy was seen in 74.6% of patients and non-ischemic CM in 25.4% of patients.

Table& Graph 4: Category of cardiomyopathy among patients

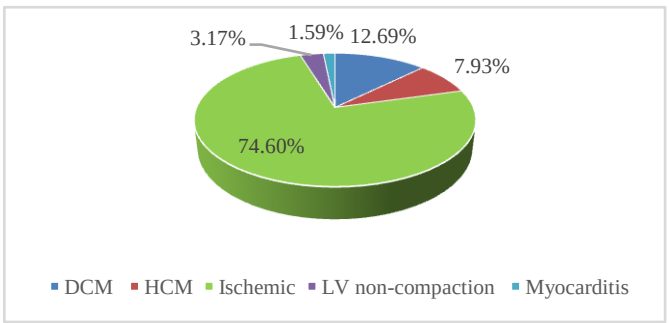
CATEGORY	Frequency	Percent	Cum. Percent
Ischemic	47	74.60%	74.60%
Non ischemic	16	25.40%	100.00%
Total	63	100.00%	100.00%



Diagnosis: The most common diagnosis is ischemic CM. Among the non -ischemic cardiomyopathies DCM is most common.

Table& Graph 5: Diagnosis among patients

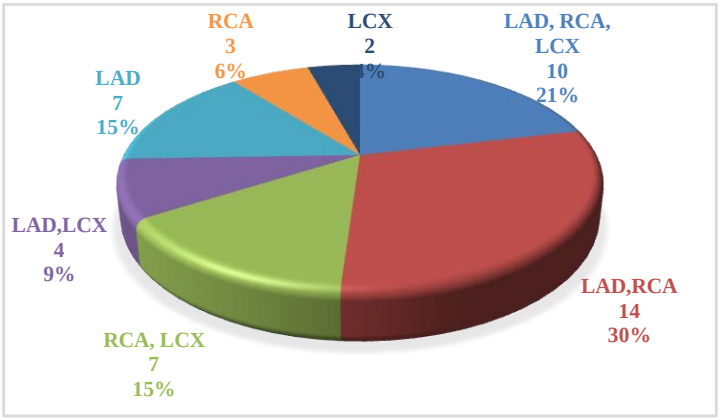
DIAGNOSIS	Frequency	Percent
DCM	8	12.69%
HCM	5	7.93%
Ischemic CMP	47	74.6%
LV non-compaction	2	3.17%
Myocarditis	1	1.59%
Total	63	100.00%



Territories: Combined LAD, RCA territory is mostly commonly involved among 47 ischemic CM patients.

Table& Graph 6-Territories involvement among ischemic CMP patients

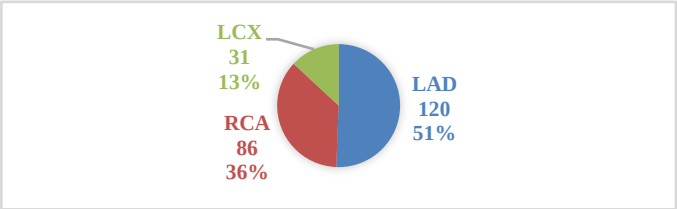
TERRITORIES	Frequency	Percent
LAD, RCA, LCX	10	21%
LAD, RCA	14	30%
RCA, LCX	7	15%
LAD, LCX	4	9%
LAD	7	15%
RCA	3	6%
LCX	2	4%
Total	47	100



Non-Viability of segments: Total 237 segments are non viable.

Table& Graph 7-Non viability of segments in ischemic CMP patients

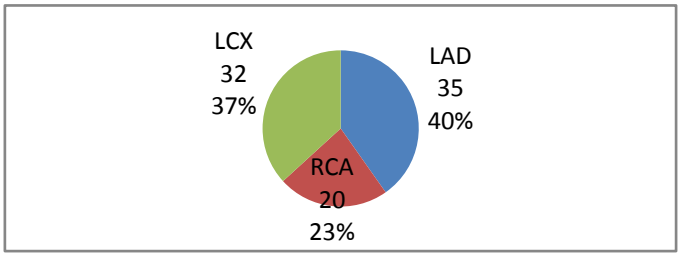
Territories	No. non viable segments	Percentage
LAD	120	51%
RCA	86	36%
LCX	31	13%
Total	237	100%



Total segments showing LGE <50%: Total 87 segments had less than 50% involvement suggestive of viable segments.

Table& Graph 8: Segments showing <50% LGE – Viable segments

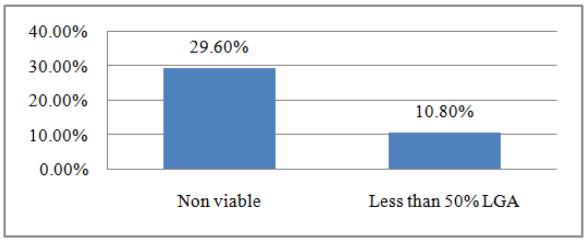
Territories	No. viable segments(LGE-<50%)	Percentage
LAD	35	40%
RCA	20	23%
LCX	32	37%
Total	87	100%



Overall segment analysis: Total segments assessed were 799 in our study (47X17=799)**.** Among them, 237 segments were non- viable. 87 segments had less than 50% LGE (viable).

Table& Graph 9: Overall segment analysis

Segments	Frequency	Percentage
Total	799	100%
Non viable	237	29.6%
Less than 50% LGE(Viable)	87	10.8%



IV. Discussion

Cardiac MR imaging (CMR) is a gold standard method of measurement of structure and function of left ventricle (LV) and right ventricle (RV). Cine imaging covers LV in short axis from apex to base, creating a 3D structure for analysis.
During 1990s, gradient-echo cine imaging was a standard technique but it was now replaced by steady-state free precession cine imaging, as it offers more contrast-to-noise ratio between dark myocardium and bright pool of blood[2] pool.

Various studies previously demonstrated the reproducibility of CMR in measuring LV volumes, ejection fraction (EF), and regional function[3.]

Measurements done using 3D dataset doesn't not need geometric assumptions and are so, less prone to errors compared to 2D methods like 2D ECHO in cases of MI or CMPs. Interscan reproducibility is more, allowing for decreased sample size in trials of HF patients[4].

Techniques like myocardial tissue tagging or cine displacement– stimulated-echo allow better analysis of myocardial motion and deformation compared to cine imaging and was applied to studies of MI and hypertrophic cardiomyopathy[5,6,7,8,] (HCM).

Age, gender, ejection fraction, territories and diseased segments: Most of the patients were aged 51 to 60 years, in the current study. Only 23% of patients were females. 76% were males.
Ejection fraction was 11 to 20 among 1.59% patients, 21 to 30 among 22.22% patients, 31 to 40 among 36.5% patients. 41 to 50 among 19.05% patients, 51 to 60 among 17.46% patients, 61 to 70% among 3.17% patients.

Combined RCA, LAD and LCX territories were abnormal in 21% patients in the current study. Combined LAD, RCA was abnormal in 30% of patients. RCA, LCX were abnormal in 15% of patients. LAD and LCX were abnormal in 9% patients. LAD, RCA, LCX territories were abnormal in 15%, 6% and 4% of patients respectively.

In the current study, 799 segments (47*17=799) and 141 coronary territories were assessed among 47 patients with ischemic CMP.

In the study of Viraj Shah[9], 50 patients were included. 850 myocardial segments and 150 coronary territories were assessed. 68% were males. Male preponderance was similar to the current study. The mean age was 54.04 years and age ranged from 30 to 77 years. The mean ejection fraction was 30.11% and it ranged from 12% to 67%.

There was total 378 diseased segments on LGE. 36.2% segments showed below 50% LGE and 63.8% segments showed above 50% LGE. LGE showed akinesia or dyskinesia commonly. Number of diseased segments were more in males compared to females. There was no significant difference in age between patients with various age groups. Among the 241 segments with more than 50% LGE, 178 (73.9%)segments showed involvement of LAD territory, 27(11.2%)segments showed involvement of LCX territory, and 36(14.9%) segments showed RCA involvement.

In the current study total 324 segments were diseased, total 237 segments showed >50% LGE and 87 segments showed less than 50% involved.The segments showing below 50% LGE had normokinesia or hypokinesia.

In current study among 237 segments with more than 50% LGE, 120 (50.2%) segments showed involvement of LAD territory, 31(13 %) segments shoed involvement of LCX territory and 86 (36.2%)segments showed RCA involvement

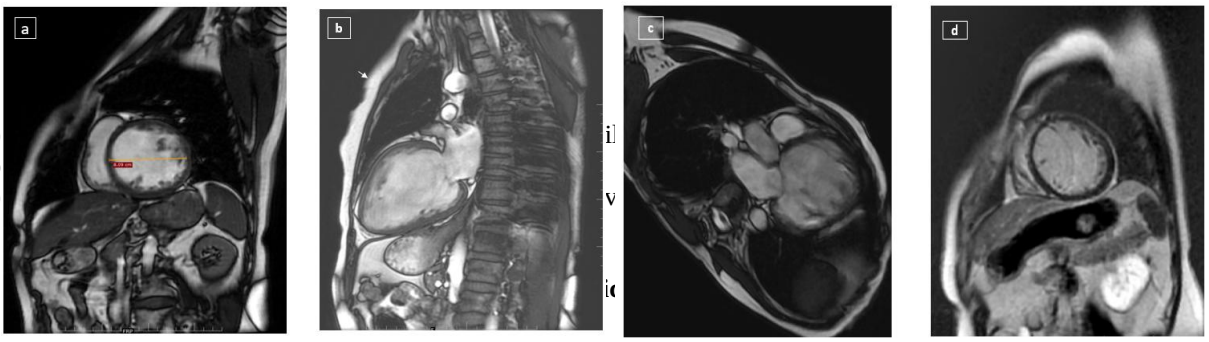
Type of CMP, Diagnostic accuracy of CMR:

The most common diagnosis was ischemic CM. DCM was seen in 12.69% patients, HCM in 7.9% patients, LV non compaction in 3.17% patients and myocarditis in 1.5% patients. Ischemic cardiomyopathy was seen in 74.6% of patients and non-ischemic CM in 25.4% of patients in the current study.
Diagnostic accuracy of CMR was not assessed in the current study, as it was not compared with other diagnostic tests.

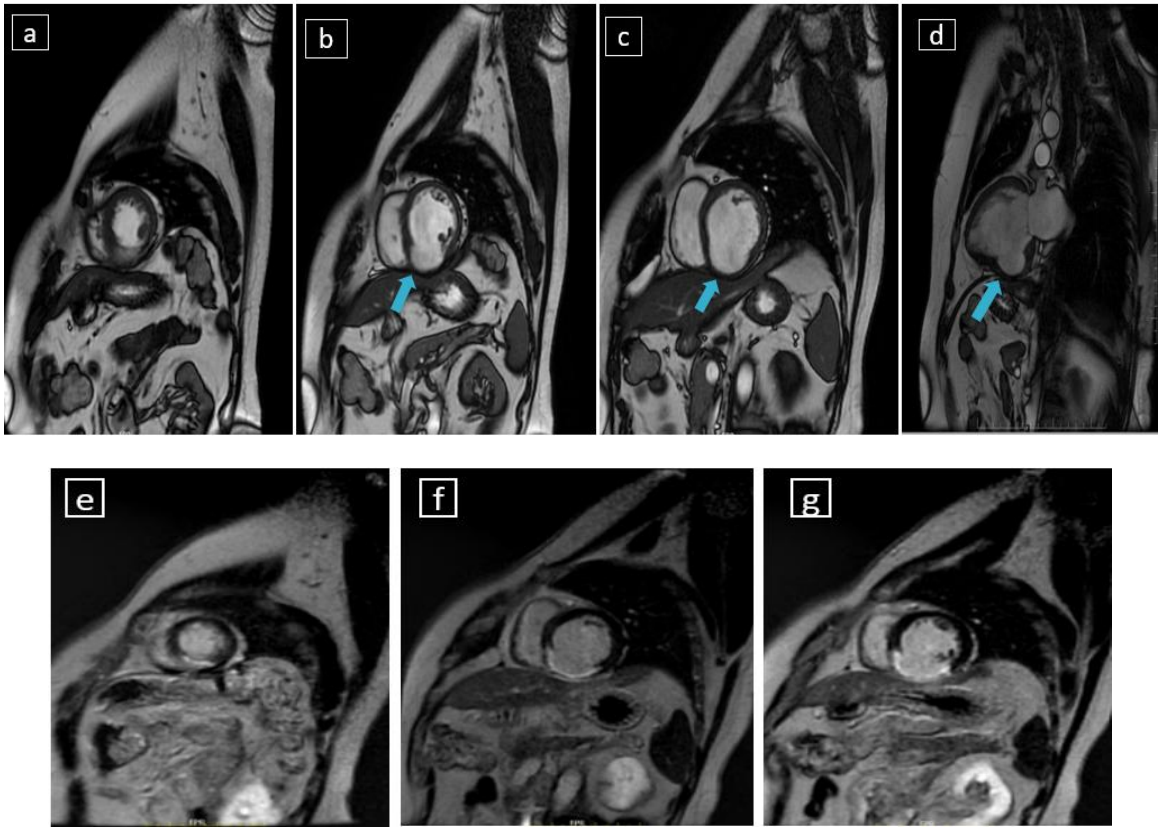
In the review done by Henry Mayala[10], authors considered various study on CMP from January 2013 to April 2017. 12 were included in among 63 studies reviewed. The sensitivity and specificity of CMR in the diagnosis of CMP was found to be 86.75%, 81.75% and the PPV, NPV were 80.17% and 86.75%. Total 999 patients were included. Sample size of studies ranged from 23 to 150. Age of patients ranged from 18 to 87 years. Ischemic CMP was seen in 193 patients and DCM among 337 patients. 337 Dual pathologies were included 16 HCM patients were there. 70 Tachycardia-induced cardiomyopathy were seen and 138 cases of cardiac amyloidosis were seen. 119 cases of cardiac sarcoidosis were seen.
While in the current study, ischemic CMP was more common compared to non-ischemic CMP like DCM. In the current study, no patient had cardiac amyloidosis or cardiac sarcoidosis.
In the study of Ximenos[11], 93 trained athletes were included. The mean age was 36 years. 53% were males. They were matched with age and gender matched normal patients or controls. Linked to with larger ventricular and atrial sizes and a decrease in biventricular EF, as compared to controls. Focal LGE was high significantly among athletes compared to normal subjects. In T1 mapping, athletes who had focal LGE had more extracellular volume at remote myocardium compared to normal subjects.

Mizia[12]wanted to evaluate the use of CMR in CMP patients. 3208 patients were included. 34% were females and the mean age was 53 years. 1260 had DCM, 1739 had HCM and 66 had RCM. 143 with arrhythmogenic right ventricular CMP. CMR scans were done at baseline in 29% of patients. CMR use among referral centres differed from 1% to 63.2%. Patients who underwent CMR were younger, had less symptoms, less commonly had implantable defibrillator, had less cardiovascular risk factors and comorbidities In 28.6% of patients, CMR was used along with ECHO. Very less patients underwent CMR. The study suggested that the gap in various current guidelines should be revised by scientific societies to promote more availability and use of CMR in patients with CMPs.
In the study of A Raja[13], CMR scans of 195 patients aged below 21 years were assessed. Their observational, retrospective study, included 155 patients with HCM and 40 patients with sarcomere mutation carriers. LGE extent was quantified by measuring regions with SI more than 6 SD more than remote myocardium. The mean age was 14.3 years and 68% were males. Male preponderance was similar to the current study.
LGE was seen in 46% patients with overt HCM but absent in mutation carriers. 31 patients had >1 CMR. LGE was detected in 42% at baseline and in 52% at follow-up CMR. There was statistically significant increase in LGE, ventricular mass, and left atrial size denoting disease progression over time. More prospective studies are needed to confirm these findings .

CASE 1: A 52 year old male patient presented with chief complaint of dyspnea on exertion and PND. He is non alcoholic.

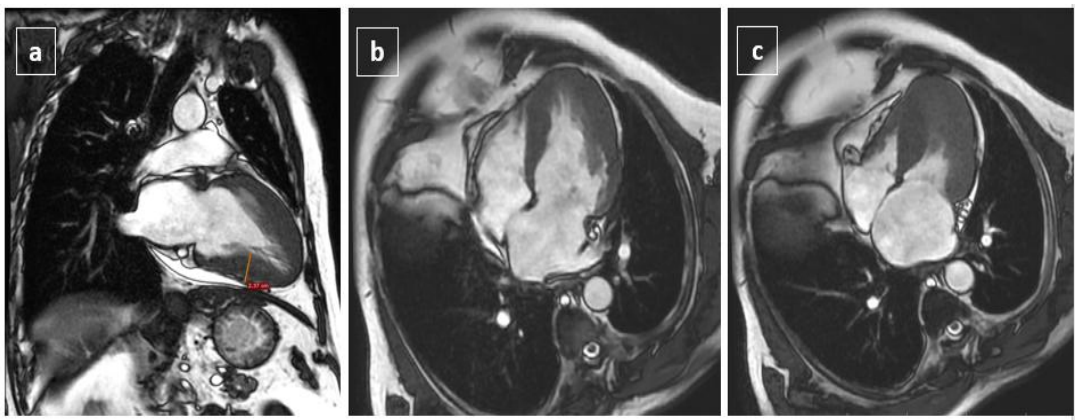


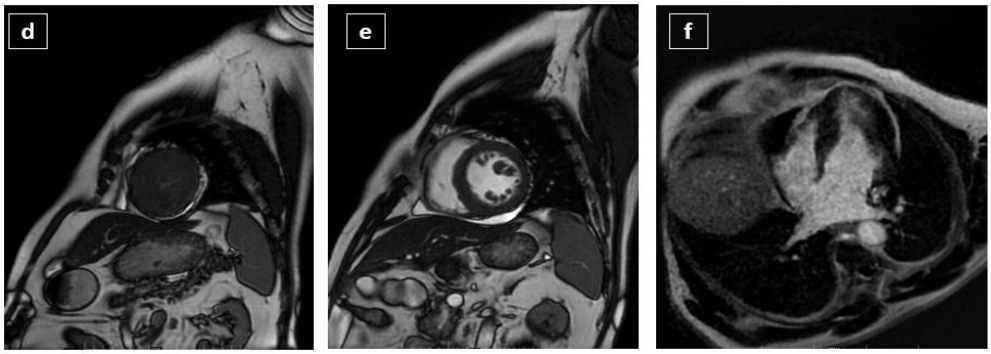
CASE 2:A 50 y old male patient presented with chief complaint of chest pain CAD, He had old inferior wall myocardial infarction , PTCA for RCA was done 2 months back



(a),(b),(c) Short axis view at apical, mid and basal regions of LV showing thinning of the wall and akinesia in the inferior, inferoseptal segments of RCA territory, with focal outpouching (aneurysm)
(d) 2 chamber view showing focal outpouching in the inferior wall in mid and basal regions.
(e),(f),(g)- short axis LGE at apical mid , basal regions showing transmural infarct in the all segment of RCA territory **--- Transmural infarct in 5 segments of RCA territory with true aneurysm**
Ischemic cardiomyopathy

CASE 3:
A 55y old male patient presented with chief complaint of shortness of breath. ECHO – showed hypertrophic cardiomyopathy.





(a)2 chamber (b) 4 chamber view showing left ventricular hypertrophy in the apical and mid regions giving ace of spade appearance at end diastole.
(C) 4 chamber (d) short axis view showing obliteration of the apical cavity the end systole.
(e) Short axis view at the mid cavity region showing accessory papillary muscles and hypertrophy of papillary muscles.
(f) Delayed contrast enhancement 4 chamber view showing patchy LGE in the apex. EF- 64%.(preserved EF)
---- Features suggestive of apical HCM

V. Conclusion

CMPs are a group of rare diseases, but common cause for cardiac MRI evaluation. CMPs varies in cause, clinical features, histologic features, and clinical outcomes; for these reasons, they should be diagnosed and studied using imaging techniques which warrant accurate assessment of the many aspects of disease like morphology, function, and tissue features of damaged myocardium. Cardiac MRI fulfils all these needs and may be considered the most vital imaging technique for CMP.

LGE sequences, in addition to the routine MR sequences, can help in differentiating various types of cardiomyopathies of different etiologies. It is of great significance in specifying treatment and helps in improving patient's quality of life.

References

[1]. Chaturvedi V, Parakh N, Seth S, Bhargava B, Ramakrishnan S, Roy A, Saxena A, Gupta N, Misra P, Rai SK, Anand K. Heart failure in India: the INDUS (INDiaukieri study) study. Journal of the Practice of Cardiovascular Sciences. 2016;2(1):28-35.
[2]. Miller S, Simonetti OP, Carr J, Kramer U, Finn JP. MR imaging of the heart with cine true fast imaging with steady-state precession: influence of spatial and temporal resolutions on left ventricular functional parameters. Radiology. 2002 Apr;223(1):263-9.
[3]. Isbell DC, Kramer CM. Cardiovascular magnetic resonance: structure, function, perfusion, and viability. Journal of nuclear cardiology. 2005 May;12(3):324-36.
[4]. Grothues F, Smith GC, Moon JC, Bellenger NG, Collins P, Klein HU, Pennell DJ. Comparison of interstudy reproducibility of cardiovascular magnetic resonance with two-dimensional echocardiography in normal subjects and in patients with heart failure or left ventricular hypertrophy. The American journal of cardiology. 2002 Jul 1;90(1):29-34.
[5]. Zerhouni EA, Parish DM, Rogers WJ, Yang A, Shapiro EP. Human heart: tagging with MR imaging--a method for noninvasive assessment of myocardial motion. Radiology. 1988 Oct;169(1):59-63.
[6]. Kim D, Gilson WD, Kramer CM, Epstein FH. Myocardial tissue tracking with two-dimensional cine displacement-encoded MR imaging: development and initial evaluation. Radiology. 2004 Mar;230(3):862-71.
[7]. Kramer CM, Rogers WJ, Theobald TM, Power TP, Petruolo S, Reichek N. Remote noninfarcted region dysfunction soon after first anterior myocardial infarction: a magnetic resonance tagging study. Circulation. 1996 Aug 15;94(4):660-6.
[8]. Kramer CM, Reichek N, Ferrari VA, Theobald T, Dawson J, Axel L. Regional heterogeneity of function in hypertrophic cardiomyopathy. Circulation. 1994 Jul;90(1):186-94.
[9]. Shah V, Kalekar T, Gupta A, Lamghare P. Role of Late Gadolinium Enhancement in the Assessment of Myocardial Viability. Cureus. 2022 Mar 4;14(3).
[10]. Mayala HA. The role of cardiac magnetic resonance (CMR) in the diagnosis of cardiomyopathy: A systematic review. Malawi Medical Journal. 2018 Dec 31;30(4):291-5.
[11]. Domenech-Ximenos B, Sanz-de la Garza M, Prat-González S, Sepúlveda-Martínez A, Crispi F, Duran-Fernandez K, Perea RJ, Bijnens B, Sitges M. Prevalence and pattern of cardiovascular magnetic resonance late gadolinium enhancement in highly trained endurance athletes. Journal of Cardiovascular Magnetic Resonance. 2020 Dec;22(1):1-9.
[12]. Mizia-Stec K, Charron P, GimenoBlanes JR, Elliott P, Kaski JP, Maggioni AP, Tavazzi L, Tendera M, Felix SB, Dominguez F, Ojrzynska N. Current use of cardiac magnetic resonance in tertiary referral centres for the diagnosis of cardiomyopathy: the ESC EORP Cardiomyopathy/Myocarditis Registry. European Heart Journal-Cardiovascular Imaging. 2021 Jul;22(7):781-9.
[13]. Axelsson Raja A, Farhad H, Valente AM, Couce JP, Jefferies JL, Bundgaard H, Zahka K, Lever H, Murphy AM, Ashley E, Day SM. Prevalence and progression of late gadolinium enhancement in children and adolescents with hypertrophic cardiomyopathy. Circulation. 2018 Aug 21;138(8):782-92.