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Diagnostic value of Cardiovascular Magnetic Resonance Imaging in evaluation of Coronary Artery Disease

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ABSTRACT:

Background:Ischemic heart disease (IHD) is the leading cause of death in worldwide, the world health organization (WHO) on the report was published on 2020 was demonstrated that the mortality rate due to IHD has been increased from 6 million on 2000 to 8.9 million on 2019.cardiomagnetic resonance imaging (CMR) is the key steps in heart failure (HF) diagnosis, the assessment of left ventricular systolic function and determination of etiology

Objectives: This study aimed to determine the diagnostic value of (CMR) in evaluation of coronary artery disease(CAD).

Materials and Methods: In this retrospective study, 70 patients with CADunderwent CMR for left ventricleejection fraction (LVEF),myocardial viability and enhanced pattern on early gadolinium enhancement (EGE) and late gadolinium enhancement (LGE).

Results:Among the 70-patients 91.4%were presented with scar in (LGE). The (LVEF) wassignificantly associated with the presence of myocardial scar in(LGE) at P= 0.002 and the presence of EGE pattern were non-significant association with LVEF at P=0.200.The presence of microvascular obstruction (MVO) and Intramyocardial Hemorrhage (IMH) was non-significantly associated with EF at P= 0.400, 0.140respectively, while the presence of thrombus in (EGE) was significantly associated with (LVEF) at P=0.04 Also,the presence of (IMH), thrombus, and (MVO) result in severe reduction of (LVEF) by 32%, 26.24% and 35.66% respectively.

Conclusion: CMR had great role in determination of underline etiology of HF and proved prized evaluation of myocardial tissue.

Key Word:left ventricular ejection fraction; cardiac magnetic resonance imaging; late gadolinium enhancement; coronary artery disease

I. INTRODUCTION

Ischemic cardiomyopathy and CAD were the most common cause of heart failure with high mortality(1), even after perfusion therapy ST-segment elevation myocardial infarction(STEMI) had developed to heart failure HF among old population(2).The amount of ischemia observed on non-invasive imaging can predict the course of treatment and relative risk reduction(3). Echocardiography and CMR the first line for diagnosing and management of CAD(1). CMR was used to differentiate types of cardiomyopathies, accurately quantify the chamber dimensions, volumes, and cardiac function which make it useful for prognosis(4).

Kanagalaet. al (2022) on their clinical trial was reported that CMR has superiority on identifying the underline etiology of heart failure HF in patient with CAD as compared to other imaging techniques(5). CMR Also has a substantial effect on clinical management, diagnosis and decision-making in patients with HF(6). Despite of the superiority of echocardiography compared to other medical imaging ; it has low cost, safe and it is suitable for bedside patient(7),several studies was reported that echocardiographic perfusion analysis was not suited for daily clinical practice as it is un-adequate, and highly cost(8).the American College of cardiology Foundation (ACCF), North American Society for Cardiovascular Imaging (NASCI), American Heart association (AHA), Society of Cardiovascular Magnetic Resonance Imaging (SCMR),guidelines were highly recommended LGE imaging to determinemyocardial viability prior to revascularization(9), while, British society of echocardiography (BSC)andunited states (US) practice guidelines for management of stable CAD or coronary revascularization were considered the viability assessment by LGE is currently notrecommended(10).

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Most of the previous studies evaluated CMR finding either by EGE or LGE, but there is no study evaluated the CMR finding in both EGE and LGE. Therefore, this was done to determine the Diagnostic value of both EGE and LGE pattern in CMR in evaluation of CAD.

II. MATERIAL AND METHODS

The current study was executed in patients who had CAD and referred to cardiac medical imaging department at the Madinah Cardiac Center in king Fahad Hospital Madinah Saudi Arabia from June 2014 to June 2019. Only patients who were diagnosed with IHD and referred for CMR as follow up after revascularization procedure to assess left ventricle function and viability,were included in the study. The IHD was determined according to fourth Universal definition of MI on the imaging-based classification, which was presented by Expert Consensus document of ESC/ACC/AHA/WHF. The MI defined bythe Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality(11).

Sample

A total of 70 patients in both gender with ages ≥ 15 years old were included.

Procedure and technique of scan

The study was performed retrospectively from the hospital information system. After research approval was obtained from the hospital research committee, the data of the recruited patients was collected by using data sheets includedSocio-demographic characteristics: age, gender, and weight.

CMR was performed using(GE) MRI machine at a field strength of 1.5 T. image acquisition was taken during breath-hold were performed using phased array coil. Firstly, scout film was performed to localize heart chamber, followed by imaging sequence, two-chamber, three-chamber, four-chamber and short-axis views with a slice thickness of 8 mm were acquired in the basal-apical direction. To assess left ventricle function, standard steady-state free precession cine imaging (35 phases per cardiac cycle; repetition time3.4 msec; echo time1.4 msec; flip angle, 55º) was performed. Early and delayed contrast enhanced images were obtained after administration of (gadolinium–diethylene triamine, 0.2 mmol/kg). The image acquisition was obtained immediately after contrast administration and late after 20-25 minutes of administration of contrast, with the same patient position and imaging parameter.

MVOappears as a hypointense region in the core of the infarct on T1-weighted images obtained 2 to 5 minutes after contrast administration, and IMH appears asa hypointense region within the infarct on T2-weighted sequences and T2*weighted imaging is thoughtto be more sensitive for the detection of IMH(12).

The heart evaluations were performed using (GE_cvi42 version 5.3). A semi-automatic delineation of myocardial contour and border tracings with manual correction when needed were performed by an expert radiologist and the system, for each short-axis slice separately at end-diastole and end-systole to derive left ventricle volume and ejection fraction. The papillary muscles and trabeculations were performed allocated to the left ventricle cavity.

the determination of number of affected vessel and myocardial segments was based on segmentation model presented byHAH(13).

Statistical analysis

Data were analyzed using SPSS version 25 (SPSS Inc., Chicago, IL).Pearson correlation was used to determine linear relation-ship between continues variables the Independent Samples Test wasused to compare mean of the continues variables, A one-wayANOVA test was used to determine the association between continues and categorical variables.The level $P < 0.05$ was considered as the cutoff value of significance.

III. RESULT

The study was conducted on total sample of 70 patients, 90% of them were males, mean age ± SD 56.27± 12.97. 28.6%of the sample were hypertensive patients and 38.5% werediabetic. and CMR characterization of myocardiumby EGE were included, MVO were 18.6%, thrombus was2.9%,hemorrhage was17.1%,myocardial infarction with non-obstructive coronary artery MINOCAwere 52.9% where the LGE was presented on 91.4%.All were presented on table1.

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Table: 1 general characteristics of study participant

Study variables		Study participant No (70)
Gender	Male	90%
	Female	10%
Late gadolinium enhanced pattern		91.4%
Early gadolinium enhanced pattern	MVO	18.6%
	Thrombus	2.9%
	Hemorrhage	17.1%
	MVO with Thrombus	4.3%
	MVO with Hemorrhage	4.3%
	MINOCA	52.9%
EF of all sample		32.43±14.31

Abbreviation No=number, SD standard deviation, MOV microvascular obstruction, EF ejection fraction. ESV end systolic volume, EDV end diastolic volume.

The association between patients' gender, cardiac risk factors (HTN and diabetes) and CMR finding (EGE and LGE) with LVEF respectively was shown in (Table2).

Table 2: The association between patient's characteristics, cardiac risk factor and CMR finding with LVEF

Study variables	LVEF P-value
Gender	0.560**
Age	0.010*
Patient with HTN	0.160**
Patient with Diabetes	0.110**
Late gadolinium enhanced pattern	0.002**
Early gadolinium enhanced pattern	0.200*
Early and late gadolinium enhanced pattern	0.004***
MVO	0.400*
Thrombus	0.04*
IMH	0.14*

Note: P-value* for Pearson correlation, P value** independent sample T test, P value***for ANOVA test, P<.05 is considered as statically significant

Abbreviation: HTN hypertension, MVO= micro vascular obstruction, IMH intra-myocardial hemorrhage.

Table 3 mean of EF in patient with early gadolinium enhancement findings

early gadolinium enhancement findings	LVEF
MOV	35.66%
Thrombus	26.24%
MINOCA	44.36%
Hemorrhage	32.25%
Hemorrhage withMOV	20.00%
Thrombus withMOV	19.02%

Abbreviation:MOV= microvascular obstruction,MINOCA =myocardial infarction with non-obstructive coronary artery.

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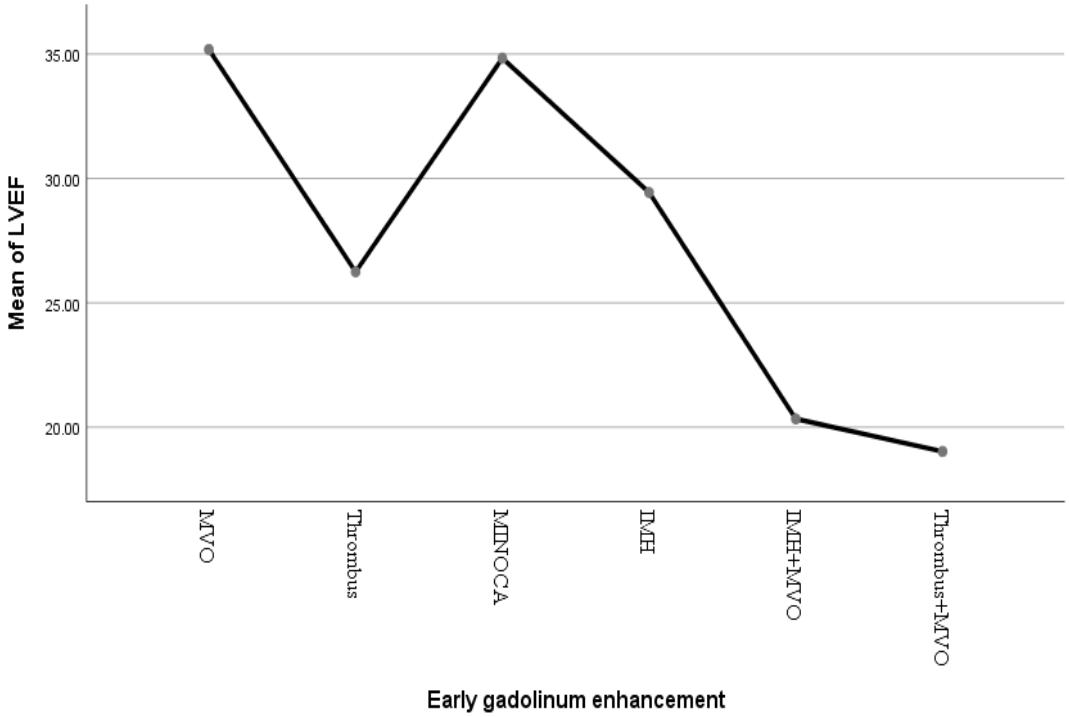

Figure 1 mean of LVEF in comparison to distribution of EGE

IV. DISCUSSION

The current study aimed to evaluate diagnosticvalueof CMR indeterminationof myocardial destruction due CAD and itsassociation LVEF variation.

A total of 70 patients complete CMR study for assessment of cardiac function and viability.

The LGE was presentedin 91.4% of patients, while EGE was presented as: MVOwas 18.6%, thrombus was2.5%, hemorrhage was17.1%, MVOwith thrombus was4.3%, MVO with hemorrhage were 4.3%, and MINOCA were 52.9% table (1).

The current study showed that LVEF was significantly associated with patients age at P= 0.01 this was disagreed with Shih et al (2019)(14), while Kaku et al (2011) studyshowed a significant association of LV function with age(15).

The current studyshowed that EF had non-significant association with the presence of EGE pattern at P= 0.200this finding was inconsistence with the study done by Hamirani et al(2014)(4).

The current study showed non-significant association between IMH and EFat P=0.14. This finding agreed withHamirani et al (2014) who reported that the IMH was not a predictor of LVEF on multivariable analysis(4), while, O'Regan et al (2010) study showed significant reduction of LVEF and increasing of LV volumes in patients with IMH(16), also the current study showed significant association between presence of thrombus and EF at P=0.040. These findings disagreed with Delewi et al (2012) finding who showed no significant association between LVEF and the presence of thrombus in EGE(17).

Also, the study found that LGEwas significantlyassociated with LVEF at (P-value 0.002), these findings agreed with Buckert et. Al (2017) study was found that the presence of LGE pattern was considered very accurate predictor of clinical major cardiac events (MACE) and was strongly correlated with LVEF(18).Moreover, Wu et al 2012 reported that the LGE high associated with reduction of CMR LVEF <35%(19). Also, Kaolawanichet al (2022)study showed that the presence of LGE on CMR increases both the hazards of death and MACE(20). in the current study the multivariable analysis was showed significant association with the presence of both EGE and LGE patterns with LVEF at P 0.004.

In the current study Among the patients with enhanced pattern in EGE, MOV had high estimated marginal mean of LVEF=35.66% when compared to presence of thrombus LVEF=26.24% and hemorrhage 32% table (3). This was disagreed with Hamirani et. Al (2014) as considered MVO was frequent complication after CAD revascularization, Moreover, on meta-analysis presented by Hamirani et al identified the Impact of

MVO on EF p < 0.00001,and predicted a greater reduction in LVEF(4).

These findings explained that the IMH result in greater cellular damage which may lead to LV remodeling and poorer outcomes this was justified by study done by Hamirani et. Al (2014)(4).

V. CONCLUSION

CMR was significantly influences clinical management, decision-making, and diagnosis of HF patient. There was significant relationship between ischemic pattern detected LGE and the comparative EF reduction, also CMR provide diagnosis of underlying pathophysiology which help in patient diagnosis and management.

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