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RESEARCH ARTICLE
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ASSESSMENT OF RISK FACTORS OF ISCHEMIC MITRAL REGURGITATION POST MYOCARDIAL INFARCTION

Dr Mudassar Iqbal[1]*, Dr Nauman Ali[2], Dr Muhammad Umar Iqbal[3], Dr Muhammad Irfan[4], Dr Muhammad Sarwar Khalid[5], Dr Fouzia Goher[6]

[1]*Assistant Professor, Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan, Pakistan
[2,5]Associate Professor, Department of Cardiology, PIC/Quaid-e-Azam Medical College, Bahawalpur, Pakistan
[3,4,6]Assistant Professor, Department of Cardiology, PIC/Quaid-e-Azam Medical College, Bahawalpur

***Corresponding author:** Dr Mudassar Iqbal,
*Assistant Professor, Department of Cardiology, Ch. Pervaiz Elahi Institute of Cardiology, Multan, Pakistan, Email: mipsk@yahoo.com

ABSTRACT
The study was conducted to assess the incidence of papillary muscle involvement, severity of left ventricular infarction and risk factors of ischemic mitral regurgitation after myocardial infarction. This retrospective study was conducted in the Department of Cardiology of PIC/Quaid-e-Azam Medical College, Bahawalpur from December 2023 to December 2024. A total of 100 patients with severe heart attack as a result of chronic artery disease undergoing cardiac magnetic resonance and ECG were included in the study by consecutive sampling. The degree of ischemic mitral regurgitation was measured by standard PISA method given by European cardiovascular association. The cardiac functionality and structure along with extent of infarcted tissue was examined by cine CMR and LGE CMR, respectively by cardiac magnetic resonance. Among the 100 patients included, 55 patients (55%) had a grade I ischemic mitral regurgitation and 45 patients (45%) had grade II-III ischemic mitral regurgitation. Papillary muscle infarction was found in 20 patients (20%) with posteromedial and anterolateral infarct in 5 patients each and 10 patients had both. Seven patients (35%) had mild regurgitation and 13 patients (65%) had moderate-to-severe regurgitation. Multivariate analysis showed age (OR: 1.08 (95% CI: 1.03-1.23), p=0.001), degree of infarction (OR: 1.16 (95% CI: 1.09-1.20), p=0.000) and global longitudinal strain (OR: 1.28 (95% CI: 1.18-1.47), p=0.000) were independent risk factors of grade II-III regurgitation. It is concluded that there is high incidence of papillary muscle infarction in patients with grade II-III ischemia mitral regurgitation. Age, degree of infarction and global longitudinal strain independent risk factors of grade II-III regurgitation.

Keywords: Ischemic Mitral Regurgitation, Myocardial Infarction, Assessment of Risk Factors

INTRODUCTION
Myocardial infarction is commonly associated to development of ischemic mitral regurgitation in 20-50% patients due to left ventricular remodeling.[1]In rare cases, it can require immediate surgical intervention due rupture of papillary muscle. Common risk factors of occurrence of IMR include

papillary muscle displacement, scaring, left ventricular remodeling and mitral valve tethering.[2]IMR is strongly linked to risk of congestive heart failure and death.[3, 4]

Ischemic and non-ischemic IMR differ with respect to cause and pathogenesis, hence the guidelines for interventions are inconsistent.[5]It is important to assess the accurate degree and duration of IMR to decide surgical method that can be done by CT coronary angiography, PET scan, cardiac magnetic resonance and echocardiography.[6]Cardiac magnetic resonance has also recently been used to characterize the tissue and strain imaging.

Mitral valve surgery in patients with IMR is often predicted by papillary muscle infarction but its postoperative effect on IMR is still unclear.[7,8]CMR is a non-invasive method of evaluating papillary muscle infarction at a high resolution. It can also detect morphology of the papillary muscle, left ventricular and myocardial viability, which is essential information before surgery.

This study was conducted to assess the incidence of papillary muscle involvement, severity of left ventricular infarction and risk factors of ischemic mitral regurgitation after myocardial infarction.

METHODOLOGY

A retrospective study was conducted in the Department of Cardiology of PIC/Quaid-e-Azam Medical College, Bahawalpur from December 2023 to December 2024. A total of 100 patients with severe heart attack as a result of chronic artery disease undergoing cardiac magnetic resonance and ECG were included in the study by consecutive sampling. All patients had 50% or more coronary artery stenosis as seen in angiography or CT coronary angiography, were admitted 3 months after MI onset and had an incidence of necrotic myocardium. Patients with history of congenital heart disease, valvular heart disease, rheumatic heart disease or dilated cardiomyopathy were excluded. All patients agreed to become a part of the study and ethical committee approved the study.

Transthoracic echocardiography examination was performed in all patients. The degree of ischemic mitral regurgitation was measured by standard PISA method given by European cardiovascular association.[9] The classification was as follows; grade 0 for no regurgitation, grade I for mild regurgitation (<0.2 cm2), grade II for moderate regurgitation (0.2-0.3 cm2) and grade III for severe regurgitation (greater than 0.3 cm2).

Cardiac magnetic resonance was performed by a 3.0-T MRI system using a 32-channel surface phased array cardiac coil. The cardiac functionality and structure along with extent of infarcted tissue was examined by cine CMR and LGE CMR, respectively. Cine CMR was performed by ECG-gated, balanced SSFP sequences with breath holding and LGE CMR was performed by phase-sensitive inversion recovery sequence following gadopentetate dimegulime administration.

Cine CMR images were used to evaluate function and structure of left ventricle including ejection fraction, volumes, CI index and mass index, all indexed to body surface area. Incidence and extent of papillary muscle infarction was classified into posteromedial, anterolateral, or combined. Regional papillary muscle–level strain, including radial and circumferential strain, was measured from mid-cavity short-axis images.

All data analysis was done by SPSS version and presented as mean ± SD. LV parameters were compared between patients with papillary muscle infarction and those without it by t-test. Statistically significant variables in univariate analysis were included in multivariate analysis to evaluate independent risk factors of grade II-III ischemic mitral regurgitation. A p value less than 0.05 was taken significant.

RESULTS

Among the 100 patients included, 55 patients (55%) had a grade I ischemic mitral regurgitation and 45 patients (45%) had grade II-III ischemic mitral regurgitation.Patients of both groups did not differ significantly with respect to demographics and baseline clinical data as shown in Table I.

The severity of global left ventricle infarct was significantly higher in patients with grade II-III regurgitation (t=-5.85, p<0.001). Left ventricle ejection fraction (t=5.12, p<0.001), end-diastolic volume index (t=-5.97, p<0.001), end-systolic volume index (t=-6.23, p<0.001) and mass index (t=-5.74, p<0.001) were also significantly different between both groups. However, stroke volume index

(t=1.51,p=0.138) and cardiac output index (t=0.80, p=0.452) were insignificant. Patients with higher grade of regurgitation had significantly lower global longitudinal strain (t=-6.01, p<0.001) and papillary muscle strains (p<0.001). Left ventricle parameters in both groups are shown in Table II. Papillary muscle infarction was found in 20 patients (20%) with posteromedial and anterolateral infarct in 5 patients each and 10 patients had both. Seven patients (35%) had mild regurgitation and 13 patients (65%) had moderate-to-severe regurgitation. Patients with and without PMI did not differ significantly for LV parameters; ejection fraction (t=1.28, p=0.191), end-diastolic index (t=-1.68, p=0.088), end-systolic index (t=-1.56, p=0.131), stroke volume index (t=0.18, p=0.879), mass index (t=-1.37, p= 0.157) and cardiac output index (t=0.287, p=0.766).
Multivariate analysis showed age (OR:1.08 (95% CI: 1.03-1.23), p=0.001), degree of infarction (OR: 1.16 (95% CI: 1.09-1.20), p=0.000) and global longitudinal strain (OR: 1.28 (95% CI: 1.18-1.47), p=0.000) were independent risk factors of grade II-III regurgitation (Table III).

Table I: Baseline features of patients

	Grade I regurgitation (n=55)	**Grade II-III regurgitation (n=45)**	**X2 value**	**P value**
Mean age	52.53 ± 9.38	60.81 ± 7.74	-4.38	0.093
Gender				
Men	46 (83.7%)	36 (80%)	0.05	0.801
Women	9 (16.3%)	7 (15.6%)	0.05	0.799
Hypertension	22 (40%)	24 (53.5%)	1.82	0.177
Diabetes	17 (31%)	18 (45%)	0.87	0.360
Nicotine abuse	33 (60%)	27 (60%)	0.03	0.876
Hyperlipoproteinemia	6 (11%)	9 (20%)	1.84	0.176
PVD	3 (5.5%)	3 (6.7%)	0.11	0.759

Table II: Cardiac magnetic resonance findings

	Grade I regurgitation	**Grade II-III regurgitation**	**T value**	**P value**
Ejection fraction	40.58 ± 15.03	23.57 ± 14.68	5.12	<0.001
End-diastolic volume index	88.61 ± 36.13	141.42 ± 56.79	-5.97	<0.001
End-systolic volume index	55.60 ± 34.38	115.07 ± 59.74	-6.23	<0.001
Stroke volume index	31.05 ± 8.06	29.46 ± 10.16	1.51	0.138
Cardiac output index	2.19 ± 0.68	2.08 ± 0.85	0.80	0.452
Mass index	64.03 ± 14.27	81.71 ± 20.23	-5.74	<0.001
Infarct extent	15.38 ± 7.07	25.12 ± 9.96	-5.85	<0.001
Global longitudinal strain	-10.59 ± 4.08	-5.90 ± 3.49	-6.01	<0.001
Papillary muscle level radial strain	41.68 ± 26.04	22.87 ± 22.36	3.89	<0.001
Papillary muscle level circumferential strain	-10.77 ± 5.55	-6.45 ± 4.38	-3.76	<0.001

Table III: Risk factors of ischemic mitral regurgitation

	Univariable analysis		**Multivariable analysis**	
		P		**P**
Age	1.13 (1.07-1.22)	<0.001	1.08 (1.03-1.23)	0.001
Sex	1.28 (0.40-3.10)	0.629	-	-
Severity of infarct	1.09 (1.03-1.23)	<0.001	1.16 (1.09-1.20)	0.000
Global longitudinal strain	1.27 (1.21-1.52)	<0.001	1.28 (1.18-1.47)	0.000
Circumferential strain	1.10 (1.03-1.19)	0.017		
Radial strain	1.01 (1.00-1.03)	<0.001		
Ejection fraction	0.89 (0.85-0.95)	<0.001		
End-diastolic volume index	1.08 (0.98-1.06)	<0.001		
End-systolic volume index	1.05 (1.04-1.06)	<0.001		
Mass	1.11 (1.06-1.13)	<0.001		
Papillary muscle infarction	0.51 (0.22-1.19)	0.120		

DISCUSSION

This study was conducted to identify risk factors of ischemic mitral regurgitation after heart attack. The incidence of papillary muscle infarct was in 20patients (20%) among whom 65% had moderate to severe regurgitation. Age, global longitudinal strain and global infarction severity were risk factors of grade II-III regurgitation. These results are similar to previous studies conducted in myocardial infarction patients.[2, 10]

In Sharma et al, the mitral regurgitation was found in 29% patients out of 1000 myocardial infarction patients.[11]Among these patients, majority (76%) had a mild regurgitation. MR was significantly associated with age, ejection fraction, creatinine clearance and hypertension (p<0.001). Age and left ventricular ejection fraction were recognized as independent predictors of death.

Cavalcante et al conducted an average of 4.9 years in patients with ischemic cardiomyopathy.[12]It was found that risk score, revascularization, surgical valvular intervention and use of cardioverter defibrillator were predictors of adverse outcomes when controlled for IMR severity and infarct size.

Ji et al analyzed the recurrence and improvement in ischemic mitral regurgitation 2-year post CABG surgery.[13]Endo-diastolic diameters (sensitivity: 80%, p=0.025), use of complete rigid ring (p<0.001) and repair techniques were strong risk factors of long-term survival and outcomes of moderate IMR.

Among 242 patients with posteromedial papillary muscle infarction after ST elevation myocardial infarction, Klug et al reported old age, longer duration between pain onset and PCI and non-anterior infarction location as predictors of incidence of mitral regurgitation.[14] In addition, posteromedial papillary muscle infarction was an independent risk factor of regurgitation (p=0.031).

Zhang et al analyzed patients with moderate ischemic mitral regurgitation due to coronary heart disease who underwent CABG.[15] It was reported that improvement in mitral regurgitation was strongly and independently associated to number of myocardial segmentsof papillary muscle (p<0.001). A 5-year follow-up showed that unimproved IMR was related to frequency of severe cerebrovascular and cardiovascular events (p=0.041).

Our study has some limitations. Since the sample size is small and we opted for a retrospective analysis, separate groups for moderate and severe IMR could not be made. Additionally, we recommend evaluating ischemia through PET scan or CT to gain better information about IMR.

CONCLUSION

There is high incidence of papillary muscle infarction in patients with grade II-III ischemia mitral regurgitation. Age, degree of infarct and GLS are risk factors of grade II-III regurgitation.

REFERENCES

1. Hadjadj S, Marsit O, Paradis J-M, Beaudoin J. Pathophysiology, diagnosis, and new therapeutic approaches for ischemic mitral regurgitation. Canadian Journal of Cardiology. 2021;37(7):968-79.
2. Dufendach K, Aranda-Michel E, Sultan I, Gleason TG, et al. Outcomes of mitral valve surgery for severe ischemic mitral regurgitation. Journal of Cardiac Surgery. 2020;35(2):390-6.
3. Onohara D, Corporan D, Hernandez-Merlo R, Guyton RA, et al. Mitral regurgitation worsens cardiac remodeling in ischemic cardiomyopathy in an experimental model. The Journal of thoracic and cardiovascular surgery. 2020;160(3):e107-e25.
4. Gamal MA, El-Fiky MM, Gamea MM, Ali I. Mitral valve repair versus replacement in severe ischemic mitral regurgitation systematic review and meta-analysis. Journal of Cardiac Surgery. 2022;37(6):1591-8.
5. Haberman D, Estévez-Loureiro R, Benito-Gonzalez T, Denti P, et al. Conservative, surgical, and percutaneous treatment for mitral regurgitation shortly after acute myocardial infarction. European heart journal. 2022;43(7):641-50.
6. Nappi F, Nenna A, Mihos C, Spadaccio C, et al. Ischemic functional mitral regurgitation: from pathophysiological concepts to current treatment options. A systemic review for optimal strategy. General Thoracic and Cardiovascular Surgery. 2021;69(2):213-29.
7. Estevez-Loureiro R, Lorusso R, Taramasso M, Torregrossa G, et al. Management of severe mitral regurgitation in patients with acute myocardial infarction: JACC focus seminar 2/5. Journal of the American College of Cardiology. 2024;83(18):1799-817.
8. Huang AL, Dal-Bianco JP, Levine RA, Hung JW. Secondary mitral regurgitation: cardiac remodeling, diagnosis, and management. Structural Heart. 2023;7(3):100129.
9. Lancellotti P, Tribouilloy C, Hagendorff A, Popescu BA, et al. Recommendations for the echocardiographic assessment of native valvular regurgitation: an executive summary from the European Association of Cardiovascular Imaging. European Heart Journal–Cardiovascular Imaging. 2013;14(7):611-44.
10. Zhang C, Zhao L, Zhu E, Schoenhagen P, et al. Predictors of moderate to severe ischemic mitral regurgitation after myocardial infarction: a cardiac magnetic resonance study. European Radiology. 2021;31(8):5650-8.
11. Sharma H, Radhakrishnan A, Nightingale P, Brown S, et al. Mitral regurgitation following acute myocardial infarction treated by percutaneous coronary intervention—prevalence, risk factors, and predictors of outcome. The American journal of cardiology. 2021;157:22-32.
12. Cavalcante JL, Kusunose K, Obuchowski NA, Jellis C, et al. Prognostic impact of ischemic mitral regurgitation severity and myocardial infarct quantification by cardiovascular magnetic resonance. Cardiovascular Imaging. 2020;13(7):1489-501.
13. Ji Q, Zhao Y, Shen J, Ding W, et al. Predictors of ischemic mitral regurgitation improvement after surgical revascularization plus mitral valve repair for moderate ischemic mitral regurgitation. Journal of Cardiac Surgery. 2020;35(3):528-35.
14. Klug G, Feistritzer H-J, Reinstadler SJ, Reindl M, et al. Impact of posteromedial papillary muscle infarction on mitral regurgitation during ST-segment elevation myocardial infarction. The International Journal of Cardiovascular Imaging. 2020;36(3):503-11.
15. Zhang K, Fu W, Dai Q, Zheng J, et al. The number of myocardial infarction segments connected to papillary muscle is associated with the improvement in moderate ischemic mitral regurgitation. Cardiovascular Diagnosis and Therapy. 2022;12(6):828.