

PREVALENCE OF RIGHT VENTRICULAR INVOLVEMENT FOLLOWING INFERIOR WALL MYOCARDIAL INFARCTION

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ABSTRACT

Background: Ischemic heart disease remains a leading non-communicable disease worldwide. Acute myocardial infarction (AMI) causes major morbidity and mortality. Right ventricular myocardial infarction (RVMI), commonly associated with inferior wall myocardial infarction (IWMI), is an important clinical entity due to distinct hemodynamic consequences. Early diagnosis using ECG and echocardiography is essential for timely management and improved outcomes, particularly in resource-limited settings. The aim & objective is to evaluate right ventricular involvement in patients with inferior wall myocardial infarction using ECG and echocardiography and to assess associated clinical features, complications, and in-hospital outcomes. **Materials and Methods:** This prospective observational study included 50 consecutive patients with electrocardiographically confirmed IWMI admitted to the Intensive Coronary Care Unit of Saifee Hospital, Mumbai. Detailed clinical evaluation, risk factor assessment, ECG analysis, and echocardiography were performed. Routine laboratory investigations and serial cardiac enzyme measurements were obtained. Patients were monitored for in-hospital complications and outcomes. Data were analyzed using SPSS. **Result:** Right ventricular involvement was observed in approximately one-third of IWMI patients. Presentation included chest pain with hypotension and bradycardia. ECG, particularly ST-segment elevation in right precordial V4R, correlated with severity. Complications included bradyarrhythmias and AV conduction disturbances. Delayed presentation associated with worse outcomes, while early thrombolysis improved recovery and reduced mortality. **Conclusion:** RVMI is a frequent complication of IWMI and contributes significantly to hemodynamic instability and adverse outcomes. ECG, especially right-sided leads, is a simple and effective diagnostic tool. Early recognition and timely thrombolytic therapy improve prognosis, emphasizing the importance of prompt intervention in resource-limited settings.

INTRODUCTION

Ischemic heart disease (IHD) or coronary artery disease remains one of the most prevalent non-communicable diseases worldwide and continues to be a major public health problem in India.^[1] Acute Myocardial Infarction (AMI), the most severe manifestation of IHD, is associated with significant morbidity and mortality. In India, AMI tends to occur nearly a decade earlier than in Western populations, affecting individuals during their economically productive years and imposing a substantial socioeconomic burden.^[1] Right Ventricular Myocardial Infarction (RVMI) represents a distinct clinical entity with differences in presentation, management, and prognosis

compared with left ventricular infarction. Early recognition of RVMI is essential because its hemodynamic consequences can occur unpredictably and may be effectively managed through timely interventions such as intravenous fluid administration.^[2] Isolated RVMI is uncommon and most frequently occurs in association with Inferior Wall Myocardial Infarction (IWMI). Right ventricular involvement contributes significantly to hypotension, bradycardia, atrioventricular conduction disturbances, and increased clinical instability.^[2] The reported incidence of RVMI among patients with IWMI ranges from 25% to 52%.^[3] Right ventricular involvement is generally associated with severe atherosclerotic occlusion of the right

coronary artery and often coexists with infarction of the inferoposterior wall and posterior interventricular septum.^[4] Clinically, RVMI may be suspected in patients presenting with elevated jugular venous pressure, positive Kussmaul's sign, hypotension, right-sided third or fourth heart sounds, tender hepatomegaly, oliguria, and clear lung fields.^[2]

Several electrocardiographic criteria have been proposed for the diagnosis of RVMI.^[5] Chou et al. suggested that ST-segment elevation in lead V1 may indicate right ventricular involvement,^[6] while Candell et al. demonstrated the diagnostic value of ST-segment elevation in lead V4R and its correlation with hemodynamic and scintigraphic findings.^[7] Advances in diagnostic modalities such as radionuclide ventriculography, hemodynamic studies, scintigraphy, phonocardiography, and two-dimensional echocardiography have further improved the detection of RVMI, including subclinical cases.^[8]

Despite improvements in diagnostic techniques and therapeutic strategies, RVMI continues to be associated with adverse outcomes. Delayed diagnosis, rapid progression of complications, limited access to specialized cardiac care, and financial constraints contribute to increased morbidity and mortality. In developing countries such as India, where healthcare resources may be limited, electrocardiography (ECG) remains the most accessible, inexpensive, and widely available diagnostic tool.

Although numerous studies have evaluated RVMI in association with IWMI, there remains a need to assess the clinical utility of basic and readily available investigations such as ECG and echocardiography in identifying right ventricular involvement and predicting complications. Correlating these findings with clinical presentation, in-hospital complications, and treatment response may provide valuable information for improving patient management.

Therefore, the present study aims to evaluate right ventricular involvement in patients with inferior wall myocardial infarction using ECG and echocardiography, assess associated complications,

and examine their relationship with clinical outcomes. The findings may help strengthen evidence-based approaches for early diagnosis and management, particularly in resource-constrained settings, and contribute toward reducing the burden of this common yet potentially fatal condition.

MATERIALS AND METHODS

This prospective observational study was conducted at Saifee Hospital, Mumbai, over 18 months and included 50 patients with acute inferior wall myocardial infarction (IWMI) presenting within 12 hours of symptom onset. Patients with ST-segment elevation >1 mm in at least two inferior leads (II, III, aVF), including those with right ventricular involvement (ST elevation >1 mm in V1 and V4R), were enrolled irrespective of gender. Patients with non-inferior myocardial infarction, previous myocardial infarction, or unwillingness to participate were excluded. Detailed clinical evaluation, including presenting symptoms, cardiovascular risk factors, vital signs, and signs of heart failure or cardiogenic shock, was performed. Laboratory investigations included fasting and postprandial blood glucose, lipid profile, and cardiac biomarkers (CK-MB and Troponin I/T). Diagnostic assessment comprised chest radiography, serial 12-lead ECG with right and posterior chest leads (V3R, V4R, V7–V9), echocardiography, and coronary angiography to identify coronary artery involvement. Clinical outcomes, including post-infarction angina, arrhythmias, and congestive cardiac failure, were assessed during hospitalization and up to 7 days after admission. Statistical analysis was performed using the Chi-square test and unpaired Student's t-test, with $p < 0.05$ considered statistically significant.

RESULTS

A total of 283 patients with acute myocardial infarction were admitted, of whom 148 had inferior wall MI and 53 had associated right ventricular MI. The incidence of RVMI in IWMI was 35%.

Table 1: Gender distribution of the patients

Gender	Number	Percentage (%)
Male	40	75.47
Female	13	24.53
Total	53	100

[Table 1] analyses the distribution of 53 patients fulfilling inclusion criteria were included for detailed analysis.

Table 2: Age distribution with gender

Age ranges	Male (%)	Female (%)	P value
30-39	5 (9.44)	1 (1.89)	0.635
40-49	9 (16.98)	2 (3.77)	0.583
50-59	15 (28.3)	4 (7.55)	0.66
60-69	8 (15.09)	3 (5.66)	0.81
70-80	3 (5.66)	3 (5.66)	0.124
Total	40 (75.47)	13 (24.53)	

Although there was no significant relation between gender and age distribution, but the highest incidence was in the 6th decade (19/53= 35.85%) [Table 2].

Table 3: Occupation distribution

Occupation	Number	Percentage (%)
Professional	4	7.5
Teachers, Clerical staff, Sedentary workers	11	20.75
Housewives	13	24.53
Labourers, Coolies	25	47.17
Total	53	100

It is seen that people with heavy labour formed the highest percentage of cases ie labourers and coolies (25/53=47.17%) followed by housewives (13/53=24.53%) [Table 3].

Table 4: Time to reach hospital with gender

Time interval	Male (%)	Female (%)	P value
<3hour	14 (26.42)	2 (3.77)	0.181
3-6hour	14 (26.42)	6 (11.32)	0.471
6-12hour	11 (20.74)	4 (7.55)	0.82
12-24hour	1 (1.89)	1 (1.89)	0.393
Total	40 (75.47)	13 (24.53)	

Although there were no significant relation between the groups, maximum patients reached hospital between the 3-6 hours window. Only 2 patients reached later than 12 hours [Table 4].

Table 5: Distribution of time of presentation with occupation

Occupation	<3hrs	>3hrs	P value
Professional	3	1	0.04
Teachers, Clerical staff, Sedentary workers	3	8	0.813
Housewives	2	11	0.181
Labourers, Coolies	8	17	0.743
Total	16	37	

It is seen that professional workers were significantly associated with presentation inside 3 hours [Table 5].

Table 6: Relation of timing of symptom with occupation

Occupation	12am-6am	6am to 12 midnight	P value
Professional	1	3	0.753
Teachers, Clerical staff, Sedentary workers	3	8	0.701
Housewives	4	9	0.908
Labourers, Coolies	9	16	0.563
Total	17	36	

There was no association between the timing of symptom onset and occupation [Table 6].

Table 7: Distribution of timing of onset of symptoms with timing of presentation

Time range	<3hrs	>3hrs	P value
12A.M. to 6.00A.M	7	10	0.231
6A.M. to 12P.M	3	16	0.088
12P.M. to 6P.M	5	8	0.455
6P.M. to 12A.M	1	3	0.814
Total	16	37	

There was no relation between the parameters [Table 7].

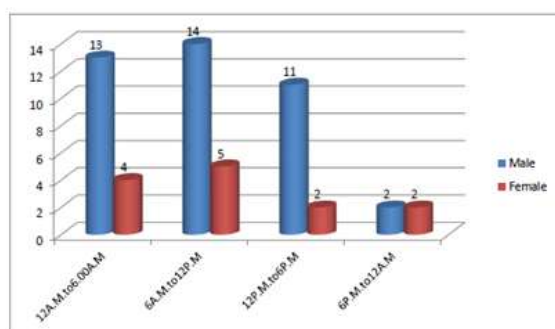


Figure 1: Distribution of timing of initial symptom with gender

Although the difference was not significant, but maximum patients (19/53= 35.85) had symptoms between 6am-12noon followed by 17 patients (32.08) between 12midnight to 6am [Figure 1].

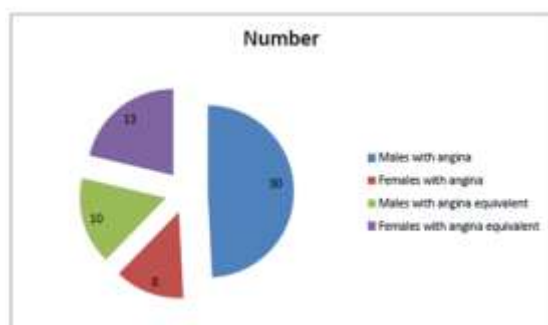


Figure 2: Presenting symptoms by gender

Symptoms by gender [Figure 2].

Table 8: Relation with age distribution

Age ranges	Angina	Angina equivalent	P value
30-39	4	2	0.771
40-49	9	2	0.403
50-59	16	3	0.131
60-69	9	2	0.403
70-80	0	6	Not calculable
Total	38	15	

Every patient over 69years had Angina equivalent rather than angina [Table 8].

Table 9: Analysis of symptoms

Gender	Angina Equivalent	Dyspnoea	Syncope	Giddiness	Nausea/ Vomiting	Palpitation	Indigestion
Male	10	11	4	8	9	5	3
Female	5	2	2	2	3	1	2

Because patients had multiple symptoms, the total exceeds 53. Chest pain was consistently associated with sweating. In younger patients, nausea, vomiting, and indigestion were common angina

equivalents, while dyspnoea predominated in the elderly. Most patients with angina equivalents were diabetic [Table 9].

Table 10: Risk factors with gender

Risk factor	Male	Female
Diabetes Mellitus	11	3
Hypertension	15	4
Smoking	26	0
Obesity	14	4
Family History of CAD	3	1

Diabetes mellitus was present in 14 patients, hypertension in 19, smoking in 26, obesity in 18,

and a family history of coronary artery disease in 4 patients [Table 10].

Table 11: Relation of comorbidities with timing of presentation of symptoms

Risk factor		12am-6am	6am to 12midnight	P value
Diabetes Mellitus	Yes	7	7	0.094
	No	10	29	
Hypertension	Yes	7	12	0.578
	No	10	24	
Smoking	Yes	8	18	0.842
	No	9	18	
Obesity	Yes	3	15	0.085
	No	14	21	
Family History of CAD	Yes	0	4	Not calculable
	No	17	32	

No patient with a family h/o CAD had symptom onset between 12midnight and 6am [Table 11].

Table 12: Relation of comorbidities with angina/angina equivalent

Risk factor		Angina	Angina equivalent	P value
Diabetes Mellitus	Yes	5	9	0.0005
	No	33	6	
Hypertension	Yes	12	7	0.302
	No	26	8	
Smoking	Yes	21	5	0.15

Obesity	No	17	2	0.177
	Yes	15	3	
Family History of CAD	No	23	12	0.316
	Yes	2	2	
	No	36	13	

Absence of diabetes was significantly associated with the presence of angina compared to angina

equivalents, while no other significant associations were observed [Table 12].

Table 13: Signs of RVMI with gender

Clinical signs	Male	Female
Hypotension SBP <90	19	7
Bradycardia	25	9
Elevated JVP	11	5
Kussmaul's Sign	8	2
Basal Rales	13	3
Cardiogenic shock	5	2

Signs of RVMI according to gender showed no significant differences between males and females,

with a comparable distribution of clinical findings in both groups [Table 13].

Table 14: Correlation of clinical signs with timing of onset of symptoms

Clinical signs		12 am-6 am	6 am to 12 midnight	P value
Hypotension SBP <90	Yes	5	9	0.0005
	No	33	6	
Bradycardia	Yes	9	25	0.242
	No	8	11	
Elevated JVP	Yes	5	11	0.933
	No	12	25	
Kussmaul's Sign	Yes	5	5	0.178
	No	12	31	
Basal Rales	Yes	11	5	0.0002
	No	6	31	
Cardiogenic shock	Yes	3	4	0.512
	No	14	32	

Patients with symptom onset between midnight and 6 a.m. were significantly more likely to present with basal rales, while no other signs of RVMI showed a significant association with the time of symptom onset [Table 14].

[Figure 3] shows that there is no significant difference between the groups, however majority of patients (37/53=69.81%) were in class 1. All 3 who died belonged to class 4.

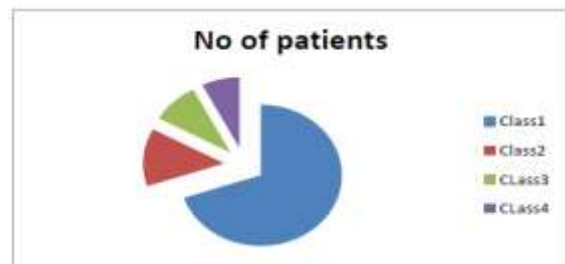


Figure 3: Diagram showing distribution of patients as per Killip's classification.

Table 15: Relation of Killip's class with age distribution

Age ranges	Kilip's 1	Kilip's 2-4	P value
30-39	5	1	0.444
40-49	11	0	Na
50-59	13	6	0.869
60-69	7	4	0.616
70-80	1	5	0.003
Total	37	16	

Patient's below 70 years age were significantly associated with Kilip's class 1 compared to age over 70 years [Table 15].

Table 16: Relation of Killip's class with occupation

Occupation	Kilip's 1	Kilip's 2-4	P value
Professional	4	0	na
Teachers, Clerical staff, Sedentary workers	6	5	0.215
Housewives	9	4	0.958
Labourers, Coolies	18	7	0.743
Total	37	16	

No significant relation between Killip's class and Occupation between the groups [Table 16].

Table 17: Relation of Killip's class and comorbidities/risk factors

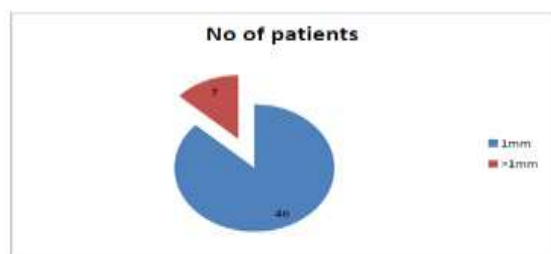
Risk factor	Kilip's 1	Kilip's 2-4	P value
Diabetes Mellitus	9	5	0.599
Hypertension	11	8	0.158
Smoking	20	6	0.268
Obesity	14	4	0.365
Family History of CAD	3	1	0.814

There is no relation between the groups [Table 17].

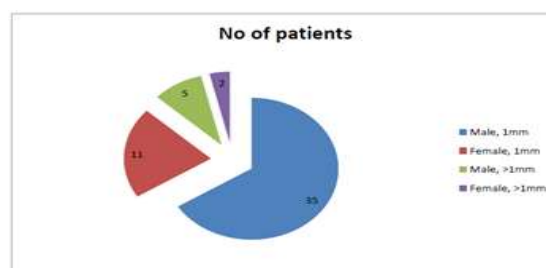
Table 18: Relation between ST elevation and age distribution

Age ranges	1mm	>1mm	P value
30-39	6	0	na
40-49	11	0	Na
50-59	18	1	0.202
60-69	8	3	0.122
70-80	3	3	0.005
Total	46	7	

Patients aged >70 years were significantly more likely to have ST-segment elevation >1 mm, whereas all patients aged <50 years had ST-segment elevation ≤1 mm [Table 18].

**Figure 4: Distribution of ST elevation**

[Figure 4] evaluates a distribution of ST-Segment Elevation Among Patients

**Figure 5: ST elevation with gender distribution**

[Figure 5] shows that no significant association between the groups.

Table 19: Relation of ST elevation with onset of symptoms

	1mm	>1mm	P value
12am to 6am	14	3	0.512
6am to 12midnight	32	4	

No significant association between the groups [Table 19].

Table 20: Relation of ST elevation with risk factors

Risk factor	1mm	>1mm	P value
Diabetes Mellitus	13	1	0.435
Hypertension	17	2	0.666
Smoking	22	4	0.646
Obesity	18	0	-
Family History of CAD	4	0	-

Every patient with Obesity or family h/o CAD had ST elevation 1mm or less [Table 20].

Table 21: Other Arrhythmias

Arrhythmia	No of patients	%
LAHB	2	3.77
RBBB	2	3.77
AF	1	1.89
VT/VF	3	

Distribution of Other Arrhythmias [Table 21].

Table 22: Improvement of symptoms

Presenting complaints	Number of patients	Number of patients improved	Percentage
Chest pain	38	34	89.47
Nausea vomiting	12	12	100
Syncope	6	6	100
Dyspnea	13	7	53.85

Chest pain, syncope, nausea, and vomiting improved markedly following thrombolysis, while dyspnoea improved in 53.85% of affected patients [Table 22].

Table 23: Deaths with age distribution

Age group	No of patients	No of deaths	%
30-39	6	0	0
40-49	11	0	0
50-59	19	1	5.2
60-69	11	1	9.09
70-80	6	1	16.67

Among the 3 deaths, 2 were males and 1 female; 2 were labourers and 1 a housewife. All presented more than 5 hours after symptom onset and had a Killip score of IV. One patient was a smoker, one was hypertensive, and one had atrial fibrillation. Conduction abnormalities included complete heart block in 2 patients and second-degree heart block in 1. ST-segment elevation >1 mm was present in 2 patients [Table 23].

[Figure 6] shows that no significant relation between the groups.

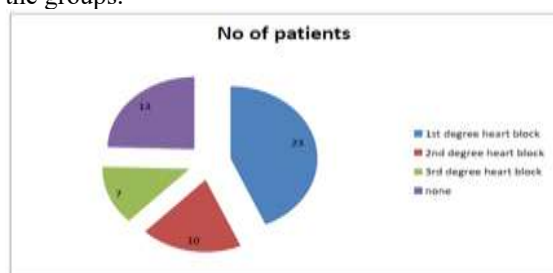


Figure 6: Frequency of Non-adherence and common reasons.

DISCUSSION

A steady decline in mortality from acute myocardial infarction (AMI) has been observed since 1970, largely due to advances in diagnosis and the widespread use of thrombolytic therapy.^[9] However, right ventricular myocardial infarction (RVMI), commonly associated with inferior wall myocardial infarction (IWMI), continues to be associated with significant morbidity and mortality because of its unique hemodynamic consequences. In the present study, 283 patients with AMI were evaluated, of whom 148 had IWMI and 53 had associated RVMI, giving an incidence of 35%, which is comparable to the incidence reported in previous studies.^[3]

A predominance of male patients was observed, consistent with earlier reports [2,8,14,32,54,85-87]. This may be attributed to a higher prevalence of cardiovascular risk factors such as smoking, hypertension, alcohol consumption, and occupational stress among men. Most patients belonged to the 50–59-year age group, although 32% were younger than 50 years, supporting the observation that coronary artery disease develops at a younger age in Indians compared with Western populations.^[1] Female patients were generally older, possibly due to the protective effects of estrogen during the premenopausal period.^[9] A significant proportion of patients were laborers and manual workers, highlighting the burden of cardiovascular disease among lower socioeconomic groups and

emphasizing the need for targeted health education and preventive strategies.

Delayed hospital presentation was associated with poor outcomes. All three deaths occurred in patients who presented more than five hours after symptom onset. Similar observations have been consistently reported in the literature, where early medical intervention significantly improves prognosis following AMI. Patients with higher educational and professional backgrounds tended to reach the hospital earlier, reflecting greater awareness regarding the seriousness of cardiac symptoms. These findings emphasize the importance of public education and efficient emergency transport systems.

A clear circadian variation in symptom onset was observed, with the highest frequency occurring between 6 AM and 12 PM. This finding correlates with the MILIS study,^[10] and may be explained by early morning surges in catecholamines and cortisol. A substantial proportion of patients also developed symptoms during the midnight-to-6 AM period, when access to transportation and healthcare services may be limited, potentially contributing to delays in treatment.

Chest pain remained the most common presenting symptom; however, nausea and vomiting were frequently observed in patients with RVMI. Angina equivalents were present in approximately 30% of patients and were more common among women, elderly individuals, and diabetic patients. These findings are consistent with previous studies and standard cardiology literature.^[11] The higher frequency of atypical presentations in diabetics may be due to autonomic neuropathy, while inferior wall infarction is known to produce increased vagal stimulation, resulting in gastrointestinal symptoms. The major cardiovascular risk factors identified were diabetes mellitus, hypertension, smoking, and obesity, consistent with observations by Garg et al,^[12] and Croft et al.^[13] Hypertension was present in 36% of patients, smoking was predominantly observed among males, and central obesity was more common among women. These findings reinforce the need for early screening and preventive interventions, particularly at the primary healthcare level.

Hypotension with bradycardia was the most characteristic clinical feature and was observed in nearly 60% of patients. Similar incidences have been reported by Cohn et al,^[2] and Cintron et al.^[14] These manifestations are largely attributed to reduced right ventricular output and activation of the Bezold–Jarisch reflex. Raised jugular venous pressure, Kussmaul's sign, oliguria, and right

ventricular third heart sound were also observed. However, these signs were absent in some patients, indicating that clinical evidence of right ventricular failure may not always be present and often depends on the extent of ventricular involvement.^[8,15]

Electrocardiography remains the most practical and cost-effective method for diagnosing RVMI. Consistent with previous studies,^[3] ST-segment elevation in lead V4R was used as the primary diagnostic criterion. While some investigators have reported that ST-segment elevation in right precordial leads is transient,^[15] persistent elevation was observed in several patients for up to 48 hours, similar to the findings of Croft et al.^[13] Furthermore, the magnitude of ST-segment elevation was associated with disease severity and prognosis. Patients with ST elevation greater than 1 mm experienced more complications, including cardiogenic shock, arrhythmias, and mortality. These observations suggest that ST-segment elevation in V4R can serve as a simple and inexpensive prognostic marker, particularly in resource-limited settings.

Bradyarrhythmias were the most common electrical complication and occurred in approximately two-thirds of patients. Most improved following thrombolytic therapy, supporting earlier observations.^[14,15] Atrioventricular conduction disturbances were observed in 77.36% of patients, exceeding the rates reported by Victor Legrand,^[16] and Garg et al.^[12] Complete heart block occurred in seven patients, of whom two died during hospitalization. Intraventricular conduction defects and atrial fibrillation occurred less frequently and were comparable to previously reported data.^[15]

Thrombolytic therapy resulted in significant improvement in symptoms such as chest pain, nausea, vomiting, hypotension, and cardiogenic shock. The overall mortality rate was low, with three deaths among 53 patients. Notably, all deaths occurred in patients with delayed presentation, emphasizing the critical importance of early diagnosis and treatment. The findings of this study demonstrate that RVMI commonly accompanies IWMI and contributes substantially to hemodynamic instability and conduction disturbances. Early recognition using ECG, especially assessment of ST-segment elevation in V4R, along with timely reperfusion therapy, can significantly improve outcomes. These observations support the continued use of ECG as a valuable diagnostic and prognostic tool in resource-constrained healthcare settings.

CONCLUSION

The present study demonstrated that right ventricular myocardial infarction (RVMI) is a frequent complication of inferior wall myocardial infarction (IWMI), occurring in about 35.8% of cases, predominantly among males and patients aged 50–59 years. Smoking and hypertension were

the most common risk factors. Early hospital presentation and timely thrombolytic therapy were associated with better outcomes, whereas delayed presentation increased complications and mortality. Right-sided ECG leads, particularly V4R, were highly useful for detecting RV involvement, and greater ST-segment elevation correlated with more severe disease and poorer prognosis. Bradyarrhythmias and conduction disturbances were common adverse events. Prompt recognition of RVMI using simple ECG-based assessment can facilitate early intervention and improve outcomes, especially in resource-limited settings.

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