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DETERMINATION OF INCIDENCE OF RIGHT VENTRICULAR DYSFUNCTION BY ECHOCARDIOGRAPHY IN INFERIOR WALL MYOCARDIAL INFARCTION: A CROSS-SECTIONAL STUDY

General Medicine

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ABSTRACT

Myocardial infarction is among the most common cardiovascular conditions encountered. Inferior wall myocardial infarction (IWMI) cases are frequently associated with right ventricular dysfunction (RVD). RVD adversely influences left ventricle (LV) performance and, thereby increases the risk of complications. Despite its significant contribution to morbidity and mortality, RVD is frequently underrecognized. Hence, we aimed to evaluate the incidence and patterns of RVD in patients with IWMI to facilitate early stabilization and timely admission to the intensive care unit. This is a cross-sectional study comprised of 128 patients admitted with IWMI. 12-lead ECG was taken for diagnosis and V3R, V4R was taken after admission. 2-D echocardiographic analysis was done and RVD was identified and incidence was calculated. Among 128 patients with IWMI, echocardiographic evidence of RVD was observed in 28.1%, while severe RVD was present in 1.6% of cases. Patients with RVD demonstrated significantly lower TAPSE (15.72 ± 2.82 vs. 19.87 ± 1.78 mm; p = 0.001) and RVFAC (37.23 ± 4.62 vs. 45.72 ± 4.42%; p = 0.001), along with significantly higher PASP (37.38 ± 5.71 vs. 29.33 ± 4.19 mmHg; p = 0.001) compared to those without RVD. Significant ST-segment elevation in right-sided ECG leads V3R (0.391 ± 0.14 vs. 0.155 ± 0.11; p = 0.001) and V4R (0.405 ± 0.09 vs. 0.107 ± 0.09; p = 0.001) was strongly associated with RVD. In conclusion, this study emphasizes the importance of routine echocardiographic evaluation and right-sided ECG lead assessment in patients with inferior wall myocardial infarction for timely detection and risk stratification of RVD.

KEYWORDS

Iwmi, Rvd, Echocardiography, Ecg Lead, Tapse, Pasp, V3r, V4r

INTRODUCTION

Inferior myocardial infarctions are generally considered to carry a better prognosis than anterior wall infarctions reporting mortality rates between 2–9%.[1] Patients with inferior myocardial infarction who have concomitant right ventricle (RV) involvement tend to have a poorer prognosis compared with those without RV involvement, and they are at greater risk of severe complications such as left ventricular (LV) failure, cardiogenic shock, serious ventricular arrhythmias, and death.[2]

RV infarction most commonly occurs as a complication of inferior wall myocardial infarction (IWMI), affecting approximately one third of such patients. In nearly half of these cases, RV infarction is hemodynamically significant. However, RV infarction is associated with anterior myocardial infarction in fewer than 10% of cases, while isolated RV infarction is rare.[3] RV infarction leads to reduced RV compliance, impaired RV filling, and a consequent decrease in RV stroke volume. In some cases, RV infarction may be masked by LV systolic dysfunction manifesting as hypotension and pulmonary congestion.[4]

Quantitative evaluation of cardiac function has traditionally focused on the LV, with the RV often described as the "forgotten ventricle," despite the fact that it pumps a volume comparable to that of the LV in most individuals. Recently, the prognostic significance of RV function across various cardiac conditions has gained wider recognition,[5] leading to increased emphasis on improving routine RV assessment.[6] Echocardiography remains the primary imaging modality for assessing RV structure and function,[6] and provides rapid, bedside hemodynamic information that can influence management decisions.[7] ST-segment elevation in the right precordial lead V4R is among the most reliable electrocardiographic indicators of acute RV infarction. ECG-evidence of RV infarction is associated with an adverse prognosis.[8] Literature reports evidenced that RV dysfunction not only contributes to cardiac mortality following myocardial infarction but also exacerbates LV impairment.[9] Echocardiographic detection of hypokinetic or akinetic RV segments can aid in identifying RV dysfunction (RVD) after RV infarction.[10]

RV systolic function can be assessed using multiple parameters, including the TAPSE, two-dimensional RV fractional area change (2D RV FAC). Among these, TAPSE, 2D FAC, have demonstrated the greatest clinical utility and validation.[11] Diagnosis of acute ST-elevation IWMI primarily relies on characteristic electrocardiographic criteria. Several ECG-based algorithms have been proposed to predict the culprit artery in IWMI, though adequate sensitivity is generally achieved only in cases with extensive ST-segment deviation.[12]

Myocardial infarction is among the most common cardiovascular conditions encountered in patients presenting to our tertiary care centre. IWMI cases admitted to the medical intensive care unit are frequently associated with RVD. RVD adversely influences LV performance by reducing preload and through ventricular interdependence, thereby increasing the risk of complications such as arrhythmias and conduction blocks.[13] In view of these considerations, the present study was undertaken to evaluate the incidence and patterns of RVd in patients with IWMI, with the main purpose of facilitating early stabilization and timely admission to the intensive care unit.

METHODOLOGY

Ethical approval

The approval of study conduction was obtained from Institutional Ethical Committee and Review Board of Hassan Institute of Medical Sciences (HIMS), Hassan, Karnataka (Ref No.IAEC/HIIMS/RR526/29-02-2024; Dated: 29/02/2024. A written informed consent was obtained from all the patients participated in the study.

Study design and patients

This is a cross-sectional study conducted among 128 patients who are admitted with IWMI in the Department of General Medicine, Hassan Institute of Medical Sciences (HIMS), Hassan, Karnataka. The study was conducted over a period of 12 months from March 2024 to March 2025.

Inclusion criteria

1. Isolated IWMI [ST segment elevation >1mm in II, III and aVF, presence of Q waves in lead II, III and aVF, after confirming from cardiac biomarker]
2. Patients age above 18

Exclusion criteria

Patients with:
1. Anterior, anteroseptal, lateral wall MI
2. COPD with cor pulmonale, pulmonary hypertension, cardiomyopathy, valvular heart disease with left to right shunt lesions

3. Pervious history of coronary artery bypass graft surgery

Data collection and Assessment parameters

A through physical examination was done with emphasis on the cardiovascular system. 12-lead ECG was taken for diagnosis and V3R, V4R was taken after admission. 2-D echocardiographic analysis was done and RVD was identified and incidence was calculated.

STATISTICALANALYSIS

Data were entered in Microsoft Excel 2021 and statistical analysis was done using IBM Statistical Software for Social Sciences (SPSS) version 23. Categorical variables were represented in the form of percentages and frequencies. Continuous variables were presented as descriptive statistics such as mean and standard deviation (SD). Categorical variables were analysed using the Chi-square test. Comparison of continuous variables between the groups was done using independent sample t-test. $p \leq 0.05$ was considered statistically significant.

RESULTS

The study population had a mean age of 57.3 ± 10.4 years, with the majority of participants belonging to the 51–60 years age group (39.8%), followed by 61–70 years (27.3%). Male patients predominated, accounting for 75.0% of the cohort. A high burden of comorbidities was observed, with diabetes mellitus present in 83.6% and hypertension in 73.4% of participants. The mean heart rate (HR) and systolic blood pressure (SBP) were 81.7 ± 14.0 bpm and 119.2 ± 18.7 mmHg, respectively, indicating relatively stable baseline hemodynamic parameters among the study population (Table 1).

Table 1. Demographic and patient characteristics

Variables	N (%)
Age (Years)	
29 to 40	7 (5.5)
41 to 50	22 (17.2)
51 to 60	51 (39.8)
61 to 70	35 (27.3)
> 70	13 (10.2)
Mean ± SD	57.3 ± 10.4
Gender	
Male	96 (75.0)
Female	32 (25.0)
Comorbidities	
Hypertension	94 (73.4)
Diabetes mellitus	107 (83.6)
Hemodynamic variables	
HR (bpm), Mean ± SD	81.7 ± 14.0
SBP (mmHg), Mean ± SD	119.2 ± 18.7

Values were N (%) unless otherwise stated

Most participants had no evidence of RVD, accounting for 71.9% of the study population. Mild and moderate RVD were observed in 14.8% and 11.7% of patients, respectively, while severe RVD was uncommon, identified in only 1.6% of cases (Figure 1).

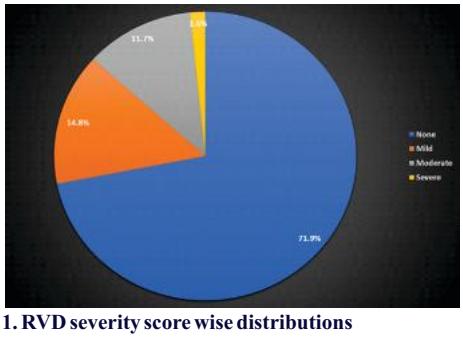

Figure 1. RVD severity score wise distributions

Echocardiographic evidence of RVD was present in 28.1% of participants, whereas the majority of patients (71.9%) showed no RVD on echocardiographic evaluation. These findings suggest that nearly one-third of the study population had impaired right ventricular function (Figure 2).

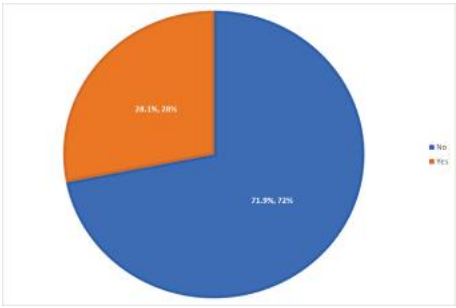

Figure 2. Echo RVD wise distributions

ST-segment elevation in V3R and V4R was significantly higher in patients with RVD compared to those without RVD (0.391 ± 0.14 vs. 0.155 ± 0.11 mV and 0.405 ± 0.09 vs. 0.107 ± 0.09 mV, respectively; p = 0.001 for both). In contrast, no significant differences were noted in Lead II (p = 0.176), Lead III (p = 0.912), aVF (p = 0.653), or V1 ST-segment changes (p = 0.100). These findings suggest that right-sided precordial leads, particularly V3R and V4R, may serve as important electrocardiographic markers of RVD (Table 2).

Table 2. Comparison of ECG lead parameters based on RVD severity

ECG Lead Parameters	RVD Severity	Mean ± SD	Mean Diff.	p-value
Lead II ST (Mv)	Absent	0.860 ± 0.43	-0.12	0.176
	Present	0.981 ± 0.50		
Lead III ST (Mv)	Absent	1.174 ± 0.52	0.011	0.912
	Present	1.163 ± 0.54		
aVF ST (mV)	Absent	0.988 ± 0.48	-0.042	0.653
	Present	1.031 ± 0.44		
V1 ST (mV)	Absent	0.262 ± 0.23	0.072	0.100
	Present	0.189 ± 0.19		
V3R ST (mV)	Absent	0.155 ± 0.11	-0.235	0.001
	Present	0.391 ± 0.14		
V4R ST (mV)	Absent	0.107 ± 0.09	-0.297	0.001
	Present	0.405 ± 0.09		

TAPSE and RVFAC were significantly lower in patients with RVD (15.72 ± 2.82 mm and 37.23 ± 4.62%, respectively) than in those without RVD (19.87 ± 1.78 mm and 45.72 ± 4.42%, respectively; p = 0.001 for both). In contrast, PASP was significantly higher among patients with RVD (37.38 ± 5.71 mmHg) compared to those without RVD (29.33 ± 4.19 mmHg; p = 0.001). These findings indicate significant deterioration in right ventricular systolic function and elevated pulmonary pressures in patients with RVD (Table 3).

Table 3. Comparison of echocardiographic parameters based on RVD severity

Echocardiographic Parameters	RVD Severity	Mean ± SD	Mean Diff.	p-value
TAPSE (mm)	Absent	19.87 ± 1.78	4.15	0.001
	Present	15.72 ± 2.82		
RVFAC (%)	Absent	45.72 ± 4.42	8.03	0.001
	Present	37.23 ± 4.62		
PASP (mmHg)	Absent	29.33 ± 4.19	-8.04	0.001
	Present	37.38 ± 5.71		

DISCUSSION

Echocardiography has evolved significantly over the past three decades, becoming an integral extension of the physical examination in the contemporary assessment of patients with heart disease. A thorough review of various studies indicates that this distinctive non-invasive technique is instrumental in identifying anatomical and pathophysiological alterations and in the hemodynamic evaluation of conditions leading to heart failure. Although RV infarction is not uncommon, hemodynamically significant RV infarction is a relatively rare consequence of IWMI. Occlusion of the proximal right coronary artery can result in inferoposterior LV infarction alongside RV infarction and impaired RV function.[14] The present cross-sectional study was conducted with the main objective to evaluate the incidence and patterns of RVD in patients with IWMI, with the purpose of facilitating early stabilization and timely admission to the intensive care unit.

In the current study, the mean age of the participants was 57.3 years,

with most patients belonging to the 51–60 and 61–70-year age groups. This distribution aligns with the well-recognized epidemiological trend of acute myocardial infarction occurring predominantly in middle-aged and older adults. Comparable findings have been reported in earlier studies, which observed a greater incidence of myocardial infarction after the 5th decade of life.[15,16] Relatively younger onset of myocardial infarction in developing countries has been attributed to early exposure to cardiovascular risk factors such as unhealthy diet, physical inactivity, psychosocial stress, and limited preventive healthcare access.[17] A clear male predominance was noted in our study, with males constituting 75% of the study population. This observation is consistent with prior reports showing a higher prevalence of myocardial infarction among men than women.[18,19] Biological factors, particularly the cardioprotective effects of estrogen in premenopausal women, are thought to delay the onset of coronary artery disease in females.[20]

Hypertension and diabetes mellitus were the most prevalent comorbidities in the current study, present in 48.4% and 39.1% of patients, respectively. These findings are consistent with existing literature that identifies both conditions as major contributors to coronary artery disease and adverse outcomes following myocardial infarction.[21,22] Hypertension accelerates atherosclerosis through endothelial injury and increased arterial stiffness, whereas diabetes mellitus promotes diffuse and accelerated coronary disease via chronic inflammation, dyslipidemia, and microvascular dysfunction. The coexistence of these conditions exacerbates myocardial damage and impairs ventricular function, thereby increasing complication risk.[23]

The incidence of RVD in the present study was 28.1% based on echocardiographic assessment. This rate is comparable to those reported in previous studies, which documented RVD in approximately 25–33% of patients with IWMI.[24,25] Variations across studies may be attributed to differences in study design, patient selection, timing of echocardiography, and diagnostic criteria. Early echocardiographic evaluation may identify transient dysfunction, whereas delayed assessment may underestimate the true prevalence.

Most patients in this study exhibited mild to moderate RVD, with severe dysfunction observed in only 1.6% of cases. Similar trends have been reported previously, where severe RVD was less common but associated with poorer outcomes and higher mortality.[26] The predominance of mild to moderate dysfunction highlights the importance of sensitive diagnostic techniques. Echocardiography remains central to evaluating right ventricular size, systolic function, and hemodynamic impact. Early detection of even mild RVD is clinically important, as it may progress or predispose patients to complications if not adequately managed.[27]

Electrocardiographic evaluation demonstrated that ST-segment elevation in right-sided leads V3R and V4R was significantly more frequent in patients with RVD compared with those without RVD. In contrast, no significant differences were observed in conventional inferior leads (II, III, aVF) or V1. These findings underscore the limited sensitivity of standard ECG leads for detecting RV involvement and highlight the diagnostic value of right-sided precordial leads.[28]

Previous studies have shown that ST-segment elevation in V4R is a particularly sensitive and specific indicator of RV infarction and dysfunction.[29] The present study findings reinforce the importance of routinely recording right-sided ECG leads in patients with IWMI. Early ECG-based identification of RV involvement can prompt timely echocardiographic evaluation and appropriate hemodynamic management. Thus, combining ECG and echocardiography provides a complementary and effective approach for detecting and assessing RVD in IWMI. Echocardiographic evaluation in the present study demonstrated significant differences in all assessed RV parameters between patients with and without RVD. Patients with RVD showed a reduced TAPSE, RVFAC. These findings confirm the pivotal role of echocardiography in identifying both structural and functional alterations of the right ventricle in the setting of IWMI.

RV dilatation observed in patients with RVD likely represents acute pressure and volume overload due to ischemia and reduced contractility. While dilatation may initially serve as a compensatory mechanism to preserve stroke volume, progressive enlargement leads to ventricular interdependence, septal displacement, and compromised left ventricular filling. Similar findings have been described in earlier studies, emphasizing the prognostic importance of RV size and systolic performance in IWMI.[30,31]

TAPSE, both markers of longitudinal RV systolic function, were significantly reduced in patients with RVD. These indices are widely used because of their simplicity, reproducibility, and strong correlation with RV ejection fraction. Prior studies have demonstrated that reduced TAPSE velocity are associated with increased morbidity and mortality in acute myocardial infarction and other cardiac conditions.[32] RVFAC, a robust measure of global RV systolic function, was also significantly lower in patients with RVD in the current study, further confirming substantial RV impairment.

RV strain analysis provided additional mechanistic insight, showing significantly reduced strain values in patients with RVD. RV strain is a sensitive parameter capable of detecting subclinical dysfunction before conventional indices become abnormal. Previous studies have shown that reduced RV strain predicts adverse outcomes, including heart failure and mortality, in myocardial infarction patients.[33] Incorporating RV strain strengthened the evaluation of RV function and highlighted its prognostic value.

In our study, PASP was significantly higher in patients with RVD, reflecting increased RV afterload and impaired RV–pulmonary artery coupling. Elevated pulmonary pressures may result from increased left-sided filling pressures, pulmonary vasoconstriction, or direct RV ischemia. Similar observations by Majumder et al., demonstrated that elevated PASP further compromises RV performance and is associated with poorer outcomes.[34] These findings highlight the close interplay between RV function and pulmonary hemodynamics in the acute phase.

This study has several strengths. It included an adequate sample size of 128 patients, utilized echocardiography as a reliable noninvasive modality, and performed a comprehensive RV assessment using multiple parameters. Correlation of echocardiographic findings with ECG changes enhanced diagnostic relevance, while evaluation of in-hospital complications and mortality added prognostic value. The routine use of right-sided ECG leads further improved detection of RV involvement. Nevertheless, certain limitations should be acknowledged. The single-center design limits generalizability. Long-term outcomes were not evaluated, coronary angiographic correlation was not included, and serial echocardiographic assessments were not performed to assess RV recovery. The influence of treatment variations on RVD was not analyzed.

CONCLUSION

In conclusion, RVD was identified in nearly one-third of patients with IWMI, indicating a substantial burden of RV involvement in this population. Echocardiographic assessment demonstrated significantly reduced TAPSE and RVFAC, along with elevated PASP, confirming impaired RV systolic function in affected patients. Among electrocardiographic parameters, significant ST-segment elevation in right-sided leads V3R and V4R showed strong association with RVD, highlighting their diagnostic utility for early identification of RV involvement. Thus, this study emphasizes the importance of routine echocardiographic evaluation and right-sided ECG lead assessment in patients with IWMI for timely detection and risk stratification of RVD.

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