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Impact of Right Ventricular Dysfunction in Morbidity and Mortality in Patients with Inferior Wall Myocardial Infarction Presenting to a Tertiary Care Center of Nepal

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Abstract

Introduction: In comparison to anterior wall myocardial infarction, inferior wall myocardial infarction is generally regarded as a low risk event. The aim of this study was to evaluate the prognostic impact of right ventricular (RV) myocardial involvement in patients with inferior wall myocardial infarction (IWMI). **Methods:** This is an observational study of 82 consecutive IWMI patients admitted and treated in Manmohan Cardiothoracic, Vascular and Transplant Center (MCVTC) from May 15 2018 to June 15 2019. The clinical characteristics, risk factors profile, electrocardiographic, echocardiographic, including RV function and angiographic characteristics, complications and in-hospital deaths were analyzed. **Results:** The mean age of patients presenting with IMWI was 64.8 ± 13.8 years with predominance of male (67%). Right ventricular myocardial infarction was present in 34.1% of patient with RV dysfunction in 25.6% patients. Mean Tricuspid Annular Plane Systolic Excursion (TAPSE), RV tricuspid annulus (S') and RV Fractional area change (FAC) in patients with RV dysfunction vs patients without RV dysfunction were 12.2 ± 3.3 mm vs 22.5 ± 3.5 mm ($p < 0.001$), 7.54 ± 0.91 cm/s vs. 12.79 ± 2.16 cm/s respectively ($p < 0.001$) and 29.7 ± 2.58 mm^2 vs 39.46 ± 2.85 mm^2 respectively ($p < 0.001$). The in-hospital mortality rate was 8.5%. **Conclusion:** In inferior wall myocardial infarction, RV involvement with RV dysfunction is an independent risk factor for in-hospital mortality along with advanced age, complete atrioventricular block, higher Killip class, delayed hospital presentation, left ventricular ejection fraction < 40% and angiographic evi-

dence of triple vessel disease.

Keywords

Anterior Wall Myocardial Infarction, Inferior Wall Myocardial Infarction, Right Ventricular Infarction, Prognosis

1. Introduction

Coronary artery disease (CAD) is a major health problem in developed as well as developing world. The rising prevalence of chronic diseases like hypertension, diabetes mellitus, obesity and unhealthy lifestyle have all contributed to the increasing burden of coronary artery disease. The increased life expectancy of the population has also contributed to the mounting prevalence of the disease.

ST elevation Myocardial Infarction (STEMI) is life-threatening unless immediate coronary intervention is done. Despite percutaneous intervention, there are various factors that govern the outcome of patients during hospital stay and follow-ups. These factors include left ventricular systolic function, Killip class, renal dysfunction, duration of symptoms, coronary artery involvement, age of the patient and other comorbidities [1].

Inferior wall myocardial infarction (IWMI) occurs from a coronary artery occlusion with the resultant decrease in perfusion to that region of the myocardium. In 80% of cases, the inferior myocardium is supplied by the posterior descending branch of the right coronary artery [1]. Approximately 40% - 50% of all MIs involve the inferior wall [2] [3]. Traditionally, inferior MIs have a better prognosis than those in other regions, such as the involvement of a larger segment of myocardium in anterior wall MI. However, the involvement of right ventricular and atrioventricular (AV) nodal artery has contributed to a poorer prognosis in IWMI [1].

The mortality rate of an inferior wall MI is 2% - 9%. However, several complicating factors that increase the mortality include right ventricular infarction, hypotension [4] [5], bradycardia, heart block [4], and cardiogenic shock [2] [4]. RV involvement is seen in 20% - 50% of IWMI [1] [4]. The clinical consequences of RVMI vary widely, ranging from no hemodynamic compromise to severe hypotension and cardiogenic shock, depending upon the extent of RV ischemia. Around 25% - 50% of RVMI are hemodynamically significant. In patients with moderate or advanced heart failure (HF), right ventricular (RV) dysfunction has been shown to predict a reduced exercise capacity [6], autonomic imbalance and shortened survival [7] [8]. The involvement of RV has been found to be associated with increased incidence of AV Block, hypotension and shock, leading to increased morbidity and mortality, which is unrelated to LV infarct size and LV ejection fraction [2] [5].

RVMI is diagnosed if there is at least 1 mm ST elevation in lead V_4R with 12 hours of onset of symptoms with reported 100% sensitivity, 87% specificity and

92% predictive accuracy [9] [10]. RV systolic dysfunction due to RVMI can be assessed by 2D echocardiography by the measurement of TAPSE (Tricuspid Annular Plane Systolic excursion), Pulsed Doppler Peak Velocity at Tricuspid Annulus (S') and 2D fractional area change (2D FAC). TAPSE is easily obtainable and is a measure of RV longitudinal function. TAPSE < 16 mm indicates RV systolic dysfunction. It is measured from the tricuspid lateral annulus. Although it measures longitudinal function, it has shown good correlation with techniques estimating RV global systolic function, such as radionuclide-derived RV EF, 2D RV FAC, and 2D RV EF. Two-dimensional FAC (as a percentage) provides an estimate of RV systolic function. Two-dimensional FAC < 35% indicates RV systolic dysfunction. S' is easy to measure, reliable and reproducible. S' velocity < 10 cm/s indicates RV systolic dysfunction. S' velocity has been shown to correlate well with other measures of global RV systolic function. [11]

2. Methods

This is a prospective study carried out in Manmohan Cardiothoracic and Vascular Transplant Center (MCVTC) from May 15th 2018 to June 15th 2019. After approval from Institutional Review Board, 82 patients who presented to the Cardiology Department of MCVTC in one-year period with acute inferior wall STEMI were included.

2.1. Inclusion and Exclusion Criteria

The inclusion criteria were: 1) Anginal chest pain lasting for more than 30 minutes and 2) ST elevation of more than 1 mm in leads II, III and aVF.

The exclusion criteria were: 1) Patients with previous history of acute myocardial infarction, CABG, PCI prior to the current hospitalization; 2) History of heart failure or coronary artery bypass surgery; 3) Those who refused percutaneous coronary intervention (PCI); 4) Patient who had comorbidities like COPD, severe valvular heart disease, severe arrhythmia, permanent pacemaker, chronic liver or active autoimmune diseases, malignancy, atrial septal defect, pulmonary embolism and primary pulmonary hypertension; 5) Patients who did not give written consent for the study.

2.2. Echocardiographic Evaluation

The echocardiographic parameters for LV systolic function & RV systolic dysfunction were measured as per the guidelines from the American Society of Echocardiography [11].

Significant CAD was defined as a diameter stenosis of >50% in each major epicardial artery. CAD was expressed as Minor CAD for <50% of luminal Stenosis. Patients were classified as having single-vessel disease (SVD), double-vessel disease (DVD) or triple vessel disease (TVD) accordingly.

Dyslipidemia was defined as the presence of any of the following: patients on lipid lowering drugs or total cholesterol > 240 mg/dl, triglycerides (TG) > 150

mg/dl, low-density lipoprotein > 130 mg/dl and high-density lipoproteins (HDL) < 50 mg/dl for female and <40 mg/dl for male. [12] The family history of CAD was defined as first degree relatives having CAD before the age of 55 years in men and 65 years in women. Diabetes Mellitus was defined by the symptoms of diabetes, fasting blood sugar > 126 mg/dl (7.0 mmol/L) or HbA1C level > 6.5 or if patient is on Oral Hypoglycemic agents. [13] Hypertension was defined as systolic blood pressure > 140 and/or diastolic > 90 mmHg and/or if patient is on anti-hypertensive treatment. [14] Obesity was classified as per WHO and Asia-Pacific Guidelines. [15]

2.3. Statistical Analysis

The data were compiled, edited and checked to maintain consistency. Repetitions and omissions of data were corrected before coding and entering them in MS Excel. The recorded data were then exported to SPSS version 25 for further statistical analysis. Descriptive statistics such as mean and standard deviation (SD) for continuous variables and percentages for categorical variables were computed. The association between two categorical variables was assessed using Chi-square test as per the need. For numerical variables, independent sample t-test & one-way ANOVA were used as required. The results were considered statistically significant if $p < 0.05$.

3. Results

The total number of patients admitted with the diagnosis of Inferior Wall ST Elevation Myocardial Infarction (IWSTEMI) was 82, among which 55 were male (67.1%) and 27 were female (32.9%). The mean age of presentation was 64.8 ± 13.8 years, being 67.22 ± 12.7 years in female and 63.6 ± 13.6 years in male respectively. The baseline characteristics with risk factor analysis are mentioned in Table 1.

RV Infarction and RV dysfunction

The ECG evidence of RV infarction was present in 28 (34.1%) patients with similar incidence in male 18 (32.7%) and female 10 (37%) patients. Posterior wall involvement was seen in 12% of IWMI patients. Reduced TAPSE was seen in 21 (25.6%) patients, reduced RV S' was seen in 20 (24.4%) patients and reduced RV FAC was seen in 19 (23.2%) patients.

RVMI and Ejection Fraction: The mean LVEF in patients with and without RVMI was 41.75% ± 8.06% and 48.84% ± 9.5% ($p = 0.002$). Therefore, patients with RVMI had RV dysfunction as well as lower ejection fraction as compared to those without RVMI.

RVMI and conventional risk factors: The prevalence of conventional risk factors like hypertension, diabetes mellitus, smoking, dyslipidemia, obesity and family history of premature CAD were no different in patients with and without RVMI. (Table 2)

RVMI and Killip Class: RVMI was seen in 22.4% of class I, 28% of class II,

Table 1. Baseline characteristics of study population.

	Total	Male	Female	Significance
No.	82	55 (67.1%)	27 (32.9%)	
Age (years)	64.8 ± 13.8	63.6 ± 13.6	67.22 ± 12.7	0.25
BMI (Kg/m^2)	24.09 ± 3.6	24.2 ± 3.3	23.8 ± 4.1	0.62
Hypertension	33 (40.2%)	18 (32.7%)	15 (55.5%)	0.06
Diabetes	28 (34.1%)	21 (38.18%)	7 (25.9%)	0.32
Smoking	47 (57.3)	35 (63.6%)	12 (44.4%)	0.15
Dyslipidemia	19 (25.6%)	14 (25.4%)	7 (25.9%)	0.68
Family History of premature CAD	4 (4.9%)	3 (5.4%)	1 (3.75)	0.72
Killip Class > 2	24 (29.2%)	15 (27.2%)	9 (33.3%)	0.6
RV infarction	28 (34.1%)	18 (32.7%)	10 (37%)	0.922
HbA1C	6.2 ± 1.75	6.45 ± 1.8	5.7 ± 1.5	0.08
Creatinine (mg/dl)	1.22 ± 0.94	1.24 ± 1.06	1.17 ± 0.68	0.76
LDL (mg/dl)	88.32 ± 30.23	84.01 ± 31.58	97.11 ± 25.61	0.065
TG (mg/dl)	119.48 ± 64.12	122.12 ± 73.72	114.11 ± 38.39	0.59
LVEF (%)	45.86 ± 8.7	46.72 ± 9.34	44.11 ± 7.3	0.2
TAPSE	20.03 ± 5.23	20.14 ± 4.69	19.81 ± 6.51	0.70
RV S'	11.45 ± 3	11.5 ± 2.88	11.33 ± 3.27	0.8
RV FAC	37.32 ± 4.91	37.49 ± 4.16	3706 ± 6.26	0.67

Table 2. Baseline features of patients with RVMI vs Non-RVMI.

	RV infarction	No RV infarction	Significance
Age (yrs)	65.6 ± 14.1	64.4 ± 13.02	0.7
Female Sex (%)	35.7	31.5	
Hypertension (%))	28.5	42.5	0.29
Diabetes (%)	35.7	33.3	0.98
Smoking (%)	57.1	57.4	0.87
Dyslipidemia (%)	25	25.9	0.44
Killip Class > 2 (%)	54	18	0.002
Second- or third-degree AV Block (%)	32	5.5	<0.001
Duration of hospital stay (days)	6.7 ± 2.6	5.96 ± 3.7	0.6
HbA1C	6.17 ± 1.76	6.24 ± 1.76	0.87
Creatinine	1.33 ± 0.67	1.15 ± 1.06	0.42
LDL	82.2 ± 27.9	91.48 ± 31.58	0.2
TG	113.89 ± 50.0	122.38 ± 70.51	0.57

Continued

LVEF	41.75 ± 8.06	48.84 ± 7.57	0.002
TAPSE (mm)	12.2 ± 3.3	22.5 ± 3.5 mm	<0.001
RV S' cm/s	7.54 ± 0.91	12.79 ± 2.16	<0.001
RV FAC	29.7 ± 2.58	39.46 ± 2.85	<0.001
Death during initial hospital stay	7	0	<0.001

23.5% of class III and 90% of class IV patients. Killip Class ≥ II occurred in 15 (54%) RVMI patients while it was present in 8 (18%) non-RVMI patients. Thus, there was a positive association between occurrence of RVMI and Killip class IV or cardiogenic shock ($p = 0.002$).

RVMI and AV Block: AV block prevalence was higher in patients who had RV involvement. Only 3 (5.5%) patients without RV involvement had second- or third-degree AV Block while 11 (32%) patients with RV involvement had second- or third-degree AV Block ($p < 0.001$).

Angiographic profile: Of the 82 patients, SVD was seen in 33.3%, DVD in 29.5%, TVD in 35.9% patients and left main disease in 1.2% patients.

There were total 7 (8.5%) deaths during index hospital admission in which 3 were male and 4 were female patients ($p = 1.0$). Hence, there was no gender difference in mortality rates. The mean age of those who died was 81.42 ± 10.61 years compared to 63.26 ± 12.54 years of our baseline population ($p < 0.001$). Mortality in age group ≥ 75 was 26.3% and in age group < 75 was 3.8%. Thus, age > 75 was an independent risk factor for in-hospital mortality. The time from onset of symptom to hospital presentation was 37.57 ± 33.33 hours in mortality group compared to 32.86 ± 34.7 hours ($p = 0.73$). However, there was no death in those who presented to the hospital within 4 hours of symptom onset. There was death of one patient who attended at 4-12 hours and 6 deaths in those who attended at > 12 hours after the onset of symptoms ($p < 0.001$) (Figure 1).

There was no difference in the prevalence of conventional risk factors like diabetes, hypertension, smoking, dyslipidemia, family history and obesity in the mortality group and the survival group (Table 3).

Killip class III and IV comprised 2 and 5 deaths respectively, thereby accounting for 28.5% and 50% mortality in each. There was no mortality in Killip I and II groups. Of those who died, 3 patients had no AV Block while 4 had 3rd degree AV block. There was 33% mortality in those who had complete heart block (CHB) and 4.4% mortality in those who had no AV block. Thus, CHB is an independent risk factor for mortality ($p = 0.001$). In all, 5 patients had undergone temporary pacemaker insertion (TPI) as well before they succumbed. Of the 5, 1 had TPI induced pericardial tamponade, for which emergency pericardiocentesis was performed, but the patient couldn't be revived.

RVMI with RV dysfunction was observed in all those patients who succumbed. There was no mortality in group with no RVMI and no RV dysfunction. The mean TAPSE was 11 ± 2.0 mm, mean RV S' was 6.71 ± 0.48 cm/s and

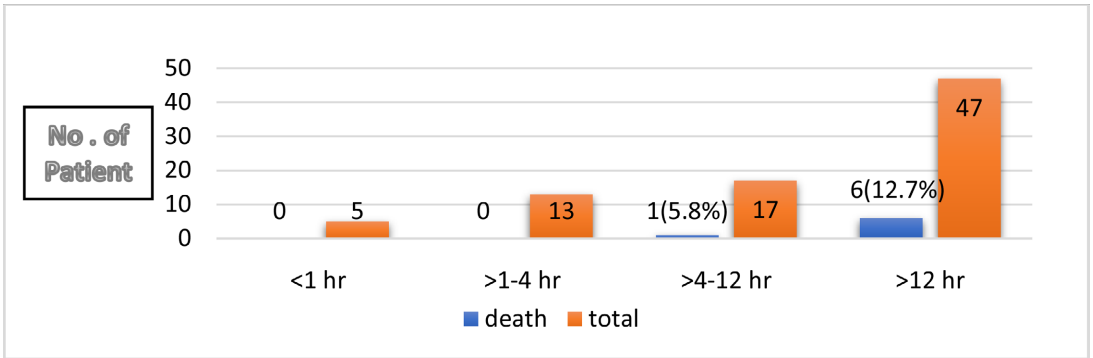

Figure 1. Bar diagram showing mortality rates at different times of hospital presentation.

Table 3. Baseline features of mortality vs survival groups.

	Mortality group	Survival group	Significance (p-value)
Age	81.42 ± 10.61	63.26 ± 12.54	<0.001
Time to hospital presentation	37.57 ± 33.33	32.86 ± 34.7	0.73
DM	40%	34.6%	0.74
HTN	36%	38.6%	0.34
Dyslipidemia	40%	25.3%	0.851
Smoking	42.8%	57.9%	0.42
Family history	0	5.3%	0.53
TAPSE (mm)	11 ± 2.0	20.88 ± 4.72	<0.001
RV S' (cm/s)	6.7 ± 0.48	11.89 ± 2.74	<0.001
RV FAC (mm^2)	27.7 ± 2.49	38.22 ± 4.05	<0.001
LVEF (%)	35 ± 9.12	46.88 ± 8.07	<0.001
Creatinine (mg/dl)	1.78 ± 0.73	1.16 ± 0.95	0.09

mean RV FAC was 27.7 ± 2.49 mm^2 in the mortality group with significant difference compared to those who survived ($p < 0.001$). The mean LV ejection fraction was 35% ± 9.12% in mortality group while it was 46.88% ± 8.07% in the survival group ($p = 0.001$).

Amongst those who died, higher baseline creatinine value was observed compared to the mean of survival group even though it was not statistically significant. The mean creatinine was 1.78 ± 0.73 mg/dl in mortality group vs 1.16 ± 0.95 mg/dl in the survival group ($p = 0.09$). Of those who expired, 5 patients had TVD, 1 had SVD while 1 hadn't undergone CAG.

4. Discussion

Left ventricular function is a known predictor of cardiovascular morbidity and mortality after MI. [16] [17] Inferior wall MI is generally regarded as being low

risk compared to anterior wall MI. However, RV infarction and complete AV block have also been identified as high-risk subsets in IWMI. [18] Postmortem studies have revealed that almost 50% of the patients who suffer myocardial infarction of the inferior wall undergo extension of the ischemic process to the right ventricle. [10] In the present study, we compared the clinical findings and in-hospital outcomes in patients with inferior MI with and without RV involvement.

The total number of patients enrolled in the study was 82. Of them, majority was male (67.1%) while only 32.9% were female. The mean age of presentation was 64.8 ± 13.8 yrs. Mean age of presentation in female was 67.22 ± 12.7 years and mean age of presentation in male was 63.6 ± 13.6 yrs. In a similar study by Mehta *et al.*, [19] the mean age of the study population with inferior wall MI was 59.7 years, and the majority was male (79%). Likewise, in another study by Smartz *et al.*, [20] the mean age of presentation was 61 ± 10 years with the majority being male (74%).

4.1. Risk Factor Analysis

Smoking is an established risk factor for coronary artery disease. In our study, smoking was the most prevalent risk factor seen in 57% of the population. Smoking was higher in males (63.6%) compared to females (44.4%), although it didn't reach a statistical significance. In a study done by Adhikari *et al.* [21] regarding STEMI, similar prevalence of smoking of 57% and more male patients (76%) with smoking status compared to female (49%) was found.

Followed by smoking, hypertension was the most common risk factor with 40.2% patients being hypertensive. The prevalence of hypertension in the South Asian Cohort of INTERHEART Study [22] was 31.1% which is much lower than that in our study. However, studies done in India [23] and Pakistan [24] have shown 48% and 55% prevalence respectively, which is alike our study.

Diabetes is another important risk factor which was found in 34.1% of study population. This was again higher than that shown by INTERHEART study [22] in South Asian cohort but similar to South Asian studies. A study from Bangladesh [25] showed that 29% of MI patients were diabetics. Additionally, another study from North India [23] showed 40% prevalence of diabetes in MI patients. Dyslipidemia is also an established risk factor which was present in 21 (25.6%) of our patients. The prevalence of dyslipidemia in STEMI population was similar (26%) to a study conducted in Nepal by Gajurel *et al.* [26]

Obesity is yet another established risk factor which is emerging in our part of the world. Schargrodsky *et al.* [27] demonstrated that being overweight is an independent risk factor for MI. This was validated by our study where 40.7% of females and 41.8% of males were obese. A similar prevalence of obesity (43%) was seen in a study done by Basoor *et al.* [28]. A family history of premature CAD was found in 4 (4.9%) patients. This is quite low compared to a Western study [29] where it is reported as 15%. However, in a Korean study, [30] family

history was seen in 6.3%, which is low and similar to our study.

4.2. Clinical Presentation

The majority of patients (57.3%) presented at >12 hours of onset of chest pain. Similarly, as per the registry in India, [31] median time to hospital presentation was 13 hrs. This is different from a study of IWMI in Singapore, [18] where >70% presented at <6 hours of symptom onset. This observation is likely owing to Singapore being a developed Asian country with better health care facilities and easy access to hospitals, compared to Nepal where health care facilities are not easily accessible. Meanwhile, there are few hospitals that admit and treat patients with heart attacks in Nepal, which can account for delay in hospital presentation.

AV Block: Of all patients, 14.6% had third degree AV Block, 2.4% had second degree AV block while 3.6% had first degree AV Block at the time of hospital admission. This was similar to another study [18] where CHB was seen in 12.8% of IWMI and second-degree AV block in 4.6%.

RVMI and RV dysfunction: ECG evidence of RV infarction was present in 28 (34.1%) patients with similar incidence in males (32.7%) and females (37%). Reduced TAPSE was seen in 21 (25.6%) patients, reduced RV S' was seen in 20 (24.4%) patients while reduced RV FAC was seen in 19 (23.2%) patients. Various studies have shown 20% - 50% incidence of RVMI in IWMI. [32] In a study by Pandey *et al.*, [33] 32% of patients with IWMI had an evidence of RVMI on echocardiography. There was no age difference between those with and without RV involvement. The mean age of patients with/out RVMI were 65.6 ± 14.1 years vs. 64.4 ± 13.02 years ($p = 0.7$). This finding corroborates with a study done by Khosoosi *et al.* [34] where the mean age of the patients with and without RV infarction were 60.59 ± 12.9 and 60.9 ± 12.2 years respectively ($p = 0.883$).

The mean TAPSE in patients with RVMI vs. in those without RVMI was 12.2 ± 3.3 mm vs. 22.5 ± 3.5 mm ($p < 0.001$). The mean RV S' in patients with/out RVMI were 7.54 ± 0.91 cm/s and 12.79 ± 2.16 cm/s respectively ($p < 0.001$). Furthermore, the mean RV FAC in patients with/out RVMI were 29.7 ± 2.58 mm^2 vs. 39.46 ± 2.85 mm^2 respectively ($p < 0.001$). In a study done by Kanar *et al.*, [35] RV function analysis showed TAPSE (12.7 ± 2.9 mm vs. 17.9 ± 3.3 mm, $p < 0.001$) and tricuspid annular systolic velocity (RVS; 9.4 ± 1.7 cm/s vs.12.3± 2.3 cm/s, $p < 0.001$) which were significantly lower in the patients with RVMI. Similarly, in another study by Zornoff *et al.*, [36] RV FAC (%) was 25.8 ± 4.8 vs. 45.2 ± 7.8 in those with and without RVMI respectively.

There was no statistically significant difference between groups with regard to baseline variables like age, sex, obesity, body mass index (BMI), type 2 diabetes mellitus, hypertension, smoking and family history. This finding was akin to a study done by Pandey *et al.* [33]

The AV block prevalence was higher in patients who had RV involvement.

Only 5.5% of patients without RV involvement had second- or third-degree AV Block while 32% of patients with RV involvement had second- or third-degree AV block ($p < 0.001$). Similar finding was seen in study by Smarz *et al.* [20] where 21% of RVMI and 9% of non-RVMI had second- or third-degree AV Block. Our finding is also comparable with a study by Garg *et al.* [37] who have reported a high incidence of second- or third-degree AV block associated with RVMI.

Mortality: There were a total of 7 (8.5%) in-hospital deaths while no further deaths were found during follow-up period. There was 12.6% in hospital mortality in a study done by Jim *et al.* [18] and 6.25% in another study by Ribeiro *et al.* [38]. In our study, all the deaths occurred in RVMI group with RV dysfunction. This accounted for 25% in-hospital mortality in RVMI group. This demonstrated that RVMI is an important risk factor for mortality in IWMI. This finding is in accord with other study [37] which showed that the mortality rate was higher in patients with RVMI (21.1% vs. 2.3%; $p = 0.011$) and the mortality group had significantly lower TAPSE (11.4 ± 4.0 mm vs. 16.0 ± 3.8 mm; $p = 0.001$ and 8.6 ± 1.1 cm/s vs. 11.2 ± 2.5 cm/s; $p = 0.001$). Another study showed that the mortality group had lower RV FAC compared to survival group (45.2% ± 7.8% vs 25.8% ± 4.8%). Similarly, Artha *et al.* [39] evaluated the prognostic implications of RV infarction in patients with acute MI treated with primary PCI. In that study, patients with RV involvement had much poorer prognosis compared with those without RV infarction 38]. Hamon *et al.* [40] performed a meta-analysis and illustrated that the presence of RV involvement was a strong independent predictor of 30-day mortality.

Advanced age was found to be a risk factor for mortality in our study. The mean age of those who died was 81.42 ± 10.61 years compared to 63.26 ± 12.54 years of our baseline population ($p < 0.001$). Mortality in age group ≥ 75 was 26.3% and that in age group < 75 was 3.8%. In another study, [37] the mean age of those who died vs. those who survived was 76.0 ± 5.9 years vs. 58.9 ± 12 years respectively ($p < 0.001$). Another study [18] showed age >75 years to be an independent risk factor for mortality with the odds ratio of 3.369.

Time is muscle. The longer the duration that has lapsed before presentation to the hospital, worse the prognosis. This was depicted in our study as well. There was 1 in-hospital mortality of a patient who presented at 4 - 12 hours and 6 deaths in those who presented at >12 hours after the onset of symptoms while there was no mortality when duration of presentation was <4 hours ($p < 0.001$). Watanabe *et al.* [41] showed that presentation at >12 hours after the onset of symptoms is an independent risk factor for mortality, a finding supported by our study as well.

There was no difference in the prevalence of conventional risk factors like diabetes, hypertension, smoking, dyslipidemia, family history and obesity in the mortality group and the survival group. Similarly, a study by Adhikari *et al.* [21] showed no difference in the prevalence of conventional risk factors in the mortality and survival groups.

The higher the Killip class at the time of hospital presentation, worse the prognosis in our study. The mortality rate in Killip class III was 28.5% while it was 50% in Killip class IV. The in-hospital mortality in patients in Killip class II or more was 23.2% in a STEMI series done by Zeymer *et al.* [42]. The mortality rate in RVMI with cardiogenic shock was reported to be 53.6% in a study by Ryu *et al.* [43]. This further establishes that higher Killip class and particularly cardiogenic shock in the context of RVMI is an important risk factor for mortality likewise is in the case of LV myocardial infarction. [43] In our study, there was 33% mortality in those who had CHB while 4.4% in those without AV block. Thus, CHB was found to be a risk factor for mortality ($p = 0.001$) in IWMI. This finding was in accord with another study [18] which conferred that CHB is an independent risk factor for mortality in IWMI with odds ratio of 3.3 ($p < 0.001$).

Our study demonstrated LV systolic dysfunction to be another important prognostic factor for in-hospital outcome in patient with IWMI. The mean LV ejection fraction was 35% ± 9.12% in mortality group while it was 46.88% ± 8.07% in survival group ($p = 0.001$). In a study done by Watanabe *et al.* [41], LVEF was an important determinant of outcome in patients with RVMI with LVEF ≤ 40%, suffering more hemodynamic compromise and markedly higher in-hospital mortality (33% vs. 7%, $p < 0.0001$).

Amongst those who died, higher baseline creatinine value was observed compared to the mean of survival group, however not being statistically significant. The mean creatinine was 1.78 ± 0.73 mg/dl in mortality group vs. 1.16 ± 0.95 mg/dl in survival group ($p = 0.09$). In another study, [37] the mean creatinine level was 1.6 ± 0.6 mg/dl in the mortality group vs. 1.2 ± 1.3 mg/dl in the non-mortality group ($p = 0.003$).

In our study, among those who expired, 5 patients had TVD, 1 had SVD while 1 hadn't undergone CAG at all. Compared to AMI with SVD or DVD, AMI with TVD is associated with higher mortality as shown in a study by Watanabe *et al.* [41] This was again supported by other studies [42] [43] where multi-vessel disease was shown to be a risk factor for prognosis in STEMI.

4.3. Limitations

Even though our study has some important clinical implications, it is a single-center observational study with a relatively small number of patients with a short follow-up period. A longer follow-up would have further highlighted the long-term prognostic implications of RV involvement in IWMI. In addition, the echocardiographic estimation of RV FAC is dependent upon image quality which can sometimes be difficult to interpret and have inter-operator variability.

5. Conclusion

Inferior wall myocardial infarction is frequently associated with RV involvement and RV dysfunction which has an important prognostic implication. RV involvement has higher incidence of higher degree AV block, cardiogenic shock

and higher in-hospital mortality compared to those without RVMI. Thus, it is imperative that right-sided ECG be taken at the initial time of hospital presentation and RV function be assessed at the time of echocardiographic assessment. The routine adoption of this approach will facilitate the early identification of patients with RV myocardial involvement who are at high risk of life-threatening complications and who may warrant more aggressive treatment. RV function improves in many patients after successful revascularization of the culprit artery. Apart from RV involvement, advanced age, higher Killip class, delayed hospital presentation and presence of TVD are other factors that govern the in-hospital outcomes in patients in IWMI.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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