ORIGINAL ARTICLE

Clinical and Electrocardiographic Profile of Inferior Wall Myocardial Infarction with Right Ventricular Involvement: One Year Hospital Based Cross Sectional Study

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Abstract:

Background: Myocardial infarction (MI) is being recognised as a major non communicable public health problem across the globe. The unique hemodynamic nature of inferior wall MI with Right Ventricle (RV) involvement, highlighted, the need for its clinical diagnosis as the management protocols of Right Ventricle Myocardial Infraction (RVMI) differ in clinical setup. *Aim and Objectives:* To characterize, the clinical and Electrocardiogram (ECG) features of patients who present with ECG findings suggestive of Inferior Wall Myocardial Infarction (IWMI) with right ventricular involvement. *Material and Methods*: The one-year cross sectional study enrolled 40 patients with ECG findings suggestive of right ventricular IWMI and clinical presentation. The categorical data was expressed in terms of rates, ratio and percentage and the continuous data was expressed in terms of mean ± standard deviation. The association between the outcome, clinical and demographic characteristics were analysed by statistical tools. *Results*: Hypotension and raised Jugular Venous Pressure (JVP) were the most commonly observed clinical findings. In the 12 lead ECG recordings, the concomitant presence of ST elevation in lead V1 and ST depression in lead V2 were found to be correlating statistically with the presence of RV dysfunction. The presence of ST elevation in lead V4R was found to be the most consistent finding on the right sided ECG leads. Neutrophil lymphocyte ratio and arrhythmias were positively associated with mortality in right ventricular IWMI. *Conclusion*: The right ventricular IWMI presented most commonly with chest pain and raised JVP. The patterns of ECG changes observed were significant for the diagnosis of right ventricular IWMI.

Keywords: Arrythmia, Chest Pain, Electrocardiogram, Inferior Wall Myocardial Infarction, Right Ventricle Dysfunction

Introduction:

According to the Global Burden of Disease, Risk Factors and Injuries (GBD) Study, the cardiovascular diseases contributed to 28.1% of deaths and 14.1% of total Disease Adjusted Life Years (DALYs) in 2016 compared to a 15.2% contribution to total deaths and 6.9% of total DALYs in 1990 [1]. Acute Coronary Syndrome (ACS) is an umbrella term, applied to patients in whom there is a suspicion or confirmation of myocardial ischemia which is well recognised cause of death among the hospital admissions. The term Right Ventricular (RV) infarction has been considered to be a misnomer to some extent, due to the stark differences in hemodynamic responses to ischaemic insult to the right ventricle, when compared to the same in case of left ventricular involvement [2-3]. The involvement of the right

ventricle was significantly associated with inferior wall infarction, in up to one third to half of the cases. The right ventricular Inferior Wall Myocardial Infarction (IWMI) was found to be an independent predictor of hemodynamic instability and in-hospital mortality in such patients [4-5]. Therefore, its early recognition and appropriate management is crucial. Diagnosis of Right Ventricular Myocardial Infraction (RVMI), requires a high threshold of suspicion. There does not appear to be any pathognomonic clinical sign that accurately predict the occurrence of right ventricular involvement in inferior wall myocardial infarction. So, the burden of diagnosis rests on the typical findings on the electrocardiogram, both the traditional 12 lead Electrocardiogram (ECG) and an ECG with right sided leads in place. Thus, a study detailing the clinical profile and the specific electrocardiographic characteristics of patients with IWMI of the right ventricle, would help in better identification of these patients who can be managed with the appropriate therapeutic options. The objective of this study was to analyse the clinical and electrocardiographic profile of patients presenting with the ECG signs of inferior wall myocardial infarction with involvement of the right ventricle.

Material and Methods:

The hospital based cross sectional study was conducted in the Department of Medicine at KLE's Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi, Karnataka, India during the period of 1st January 2019 to 31st December 2019. All admitted cases of ECG proven IWMI, with right ventricular infarction were considered in the study population**.** The sample size was calculated using formula: Sample size (n) = 4 PQ/$D^{2,}$ P = Prevalence of the disease, Q= 100-P, D = Absolute error taken as 15% (P = 30; Q = 70; D=15)

$n = 4 \times 30 \times 70 / 15^2$, $n = 37.33 \approx 40$. Prevalence is determined as per Albulushi *et al*. [6].

Inclusion Criteria

All ECG proven cases of Inferior Wall Myocardial Infarction with right ventricular involvement, above the age of 18 years were enrolled for the study.

The diagnosis of IWMI with right ventricular involvement was based on symptom profile characteristic of acute coronary syndrome, ST segment deviation in Leads II, III and aVF and ST Elevation greater than 1 mm in at least one of the right sided leads from V1R to V6R.

Exclusion Criteria

Old cases of myocardial infarction, concomitant involvement of the anterior wall and patients with a known history of Chronic Obstructive Pulmonary Disease (COPD) were excluded from the study.

All the study participants were subjected to a detailed history and examination as per predesigned proforma. A general physical examination and relevant systemic examination was performed. The standard 12 lead ECG as well as the right precordial leads were obtained for all patients. Rhythm tracings were obtained on admission, four hours after admission and 24 hours after admission wherever applicable. 2D ECHO was also obtained for all patients to assess the degree of RV dysfunction and was quantified by the measurement of Tricuspid Annular Plane Systolic Excrusion (TAPSE). Other laboratory parameters including, haemoglobin, Neutrophil to Lymphocyte Ratio

(NLR) and Platelet to Lymphocyte Ratio (PLR), serum creatinine and electrolytes were also obtained.

Statistical Analysis:

The data obtained were coded and entered into Microsoft excel spreadsheet and data were analysed using SPSS version 21 and Statistica 12. The categorical data was expressed in terms of rates, ratio and percentage and the continuous data was expressed in terms of Mean ± Standard Deviation (SD). The association between the outcome, clinical and demographic characteristics were tested using chi-square test. Correlation among the continuous and categorical variables were compared using Spearman's rank method. Correlation was also calculated with Odds ratio. The $p \leqslant 0.05$ was considered as statistically significant when the confidence interval is 95%.

Results:

The present one-year cross sectional study was conducted in the Department of General Medicine, KAHER's Dr Prabhakar Kore Hospital and Medical Research Centre, Belagavi. A total of 40 adult patients with the diagnosis of acute inferior wall RVMI who met the exclusion criteria were enrolled in the study. Table 1 depicts clinical characteristics of the study population. Among 40 patients, 26 (65%) were males and 14 (35%) were females. The majority of patients belonged to 50-80 years age group, 11 (28%) patients in 71-80 years age and 61-70 years age and 10 (25%) patients in 51-60 years age group. The mean age of 59.23 years +/- 13.90 among the male patients and a mean age of 65.21 years +/- 13.0 among the female patients. Sixteen (40%) patients were diabetic, whereas 20 (50%) patients were hypertensive and 7 (17.5%) patients were having both the diseases. Twelve (30%) patients gave a history of alcohol addiction, whereas 6 (15%) patients had smoking and 3 (7.5%) patients had both addictions. The symptom profile observed in our study population was showing a predominance of chest pain as the presenting symptom, observed in 38 (95%) patients followed by diaphoresis in 30 (75%) patients, dyspnoea in 20 (50%) patients, palpitations in 9 (22.5%) and syncope in 7 (17.5%) patients. A total of 21 (52.5%) patients presented with hypotension, 29 (72.5%) patients had raised JVP and 22 (55%) patients had basal crepitations. Table 2 shows the investigation profile of patients with RVMI. Anaemia was noted in 18 patients (45%). NLR >3 was found in 33 patients (83%). The distribution of NLR is shown in Fig. 1. There was statistical significance, P value 0.009, observed between the NLR and mortality in our study population. ECG abnormalities in 12 leads and right sided leads is depicted in Table 3. All patients included in the study had ST elevations in Leads II, III and avF. Thirty four patients with RVMI (85%) had an associated ST segment depression in lead I. Twenty nine (72%) patients had recorded ST elevation in lead V2 on the standard 12 lead ECG. On the right sided ECG leads, the most consistent observation was an ST elevation of >1mm in the V4R lead, which was seen in all the 40 patients (100%). ST elevations in V5R and V6R occurring with a frequency of 31 (77.5%) and 26 (65%) respectively were the next most common finding. On 2D ECHO, RV dysfunction was demonstrated in 30 patients, which comprised 75% of patients (Fig. 2). Mean TAPSE of those with RV dysfunction was 1.1967cm with a standard deviation of 0.341 (Fig. 3). Different type of rhythm present in patients with RVMI on admission, on 4 hr and 24 hr (Fig. 4).

ST elevations in leads V3R was found in 25 (62.5%) patients. The p value < α; so there is a significant relationship between ST elevation in leads V3R and V4R and RV dysfunction (Table 4). Thirteen (32.5%) patients underwent Percutaneous Transluminal Coronary Angioplasty (PTCA), while 21 (53%) of the patients were managed conservatively on medical management. Mortality was observed in 6 patients (15%) (Table 5). The number of patients who had ST elevations of greater magnitude in lead III compared to lead II was 32 (80%).

Table 1: Clinical Characteristics of Patients with Right Ventricular Myocardial Infraction (RVMI)

Variable	Sub variable	Number of Patients (N=40)	Percentage (%)
Gender	Male	26	65
	Female	14	35
Age (years)	<50	7	17.5
	51-60	10	25
	61-70	11	27.5
	71-80	11	27.5
	81-90	1	2.5
	Chest Pain	38	95
Presenting Symptoms	Diaphoresis	30	75
	Dyspnea	20	50
	Palpitation	9	22.5
	Syncope	7	17.5
Associated Comorbidities	Hypertension	20	50
	Diabetes	16	40
	Hypertension + Diabetes	7	17.5
Addictions	Smoking	6	15
	Alcohol	12	30
	Smoking + Alcohol	3	7.5

Continued...

Variable	Sub variable	Number of Patients (N=40)	Percentage (%)
Clinical signs	Systolic Blood Pressure		
	< 100	21	52.5
	100-120	11	27.5
	>120	8	20
	Raised JVP	29	72.5
	Basal crepitation	22	55
Arrhythmias	At Admission	21	52.5
	4 hr after admission	25	62.5
	24 hr after admission	9	22.5

(JVP: Jugular venous pressure)

Table 2: Investigation Profile in Patients with Right Ventricular Myocardial Infraction (RVMI)

Variable	Sub variable	Number of cases	Percentage	*p* value
Anaemia	<12gm %	18	45	0.258
NLR	≤ 3	7	17	0.009
	> 3	33	83	
PLR	Male (>149)	16	40	0.696
	Female (>172)	7	17	

NLR: Neutrophil Lymphocyte Ratio, PLR: Platelets Lymphocyte Ratio, p<0.05 is considered as significant

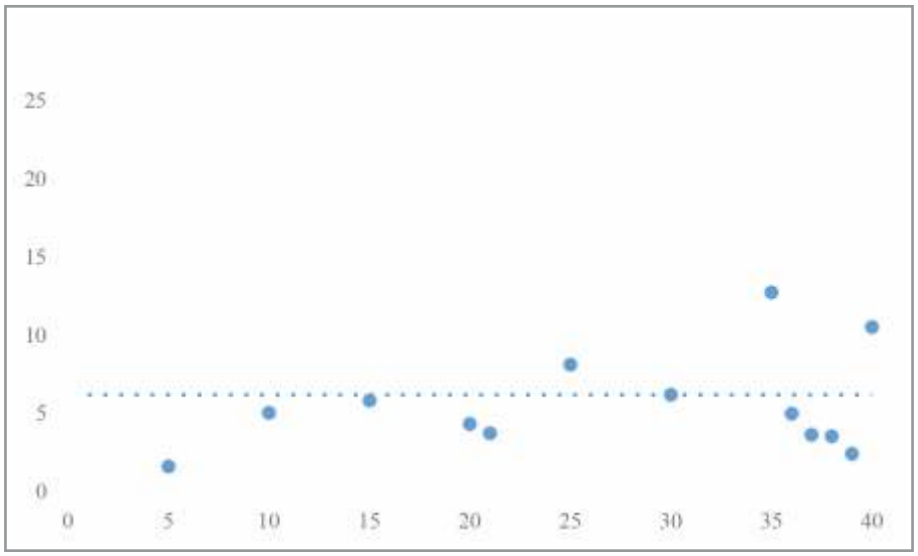

Fig. 1: Distribution of Neutrophil Lymphocyte Ratio (NLR) among Acute Right Ventricle Myocardial Infraction (RVMI) Patients. (Y axis: NLR; X axis: Patients)

Table 3: Electrocardiography Features in Patients with Right Ventricular Myocardial Infraction

ECG 12 Leads		
Variable	**Number of Patients**	**Percentage**
I ST Depression	34	85
V1 ST Elevation	29	72.5
III=II		
III>II	32	80
III<II	8	20
V2 ST depression	29	72.5
ECG (Right Side Leads)		
V3R ST Elevation	25	62.5
V4R ST Elevation	40	100
V5R ST Elevation	31	77.5
V6R ST Elevation	26	65

ECG: Electrocardiography

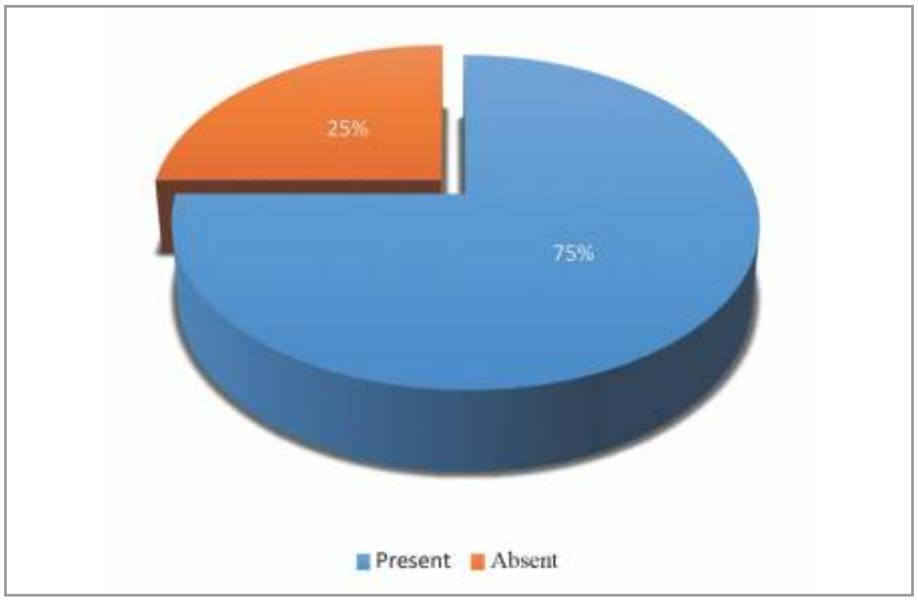

Fig. 2: Right Ventricular (RV) Dysfunction in Patients with Right Ventricular Inferior Wall Myocardial Infarction (IWMI)

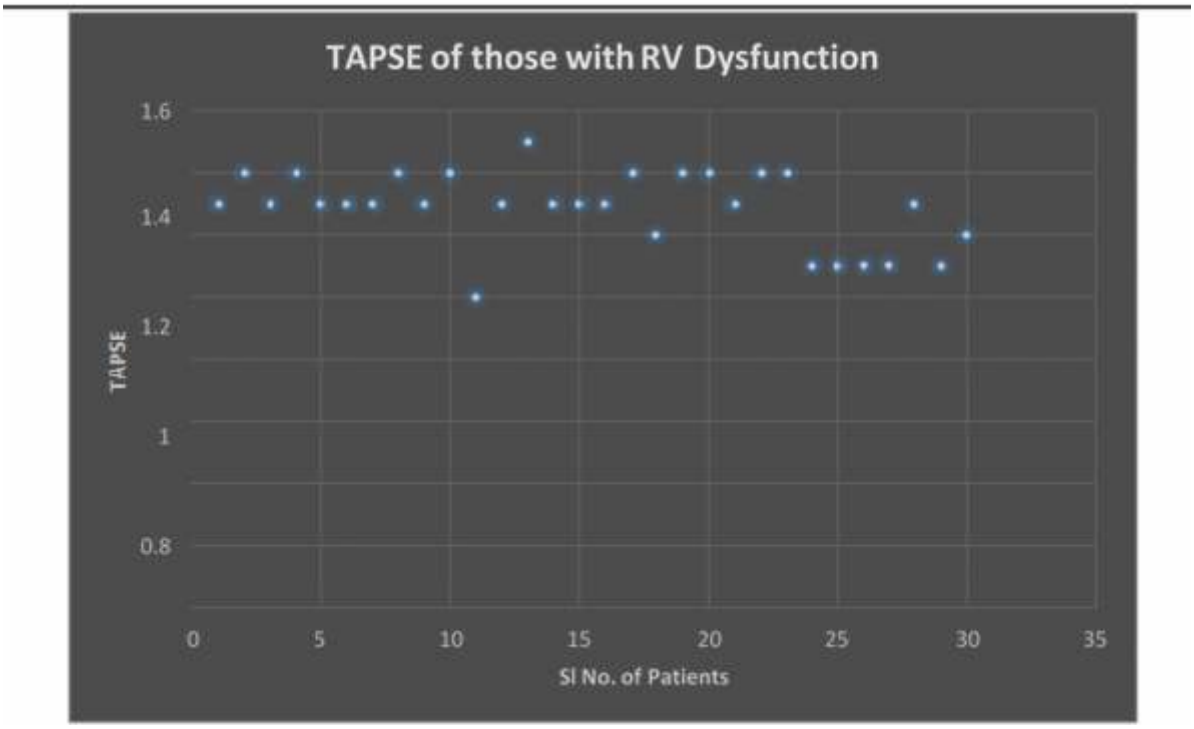

Fig. 3: Tricuspid Annular Plane Systolic Excursion (TAPSE) in Patients with Right Ventricle Myocardial Infraction (RVMI) and Right Ventricle (RV) Dysfunction

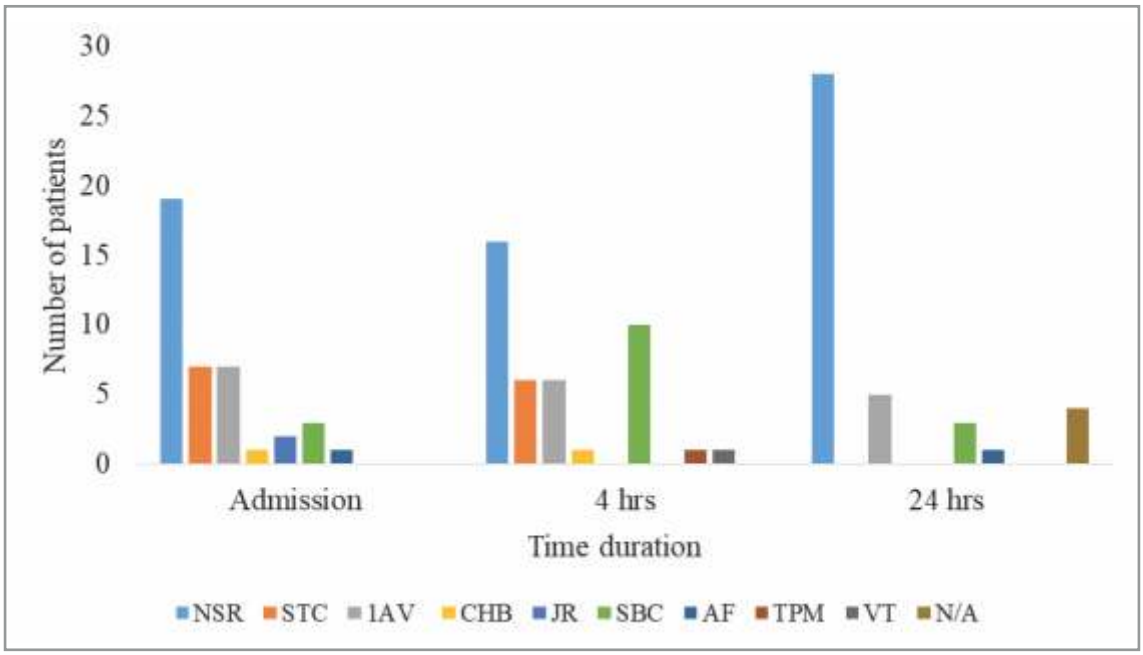

Fig. 4: Different Type of Rhythm Present in Patients with Right Ventricular Myocardial Infarction (RVMI) on Admission on 4 hours and 24 hours (NSR: Normal Sinus Rhythm; STC: Sinus Tachycardia; 1AV: 1st Degree AV Block; CHB: Complete Heart Block; JR: Junctional Rhythm; SBC: Sinus Bradycardia; AF: Atrial Fibrillation)

Table 4: Statistical Analysis of Right Ventricular Dysfunction with Abnormal Electrocardiography Features

ECG Features	Number of Patients with RV Dysfunction	*p* value	α	Odds Ratio (95% CI)
V3 to V6 ST Elevation	19	0.001	0.05	35.60
V1 ST Elevation and V2 ST Depression	23	0.007	0.05	7.67

Table 5: Outcome of the Patients with Right Ventricle Myocardial Infraction

Outcome of right ventricular IW MI	Number of Patients	Percentage
PTCA	13	32.5
Death	6	15
Successful Conservative Management	21	52.5

PTCA: Percutaneous Transluminal Coronary Angioplasty

Discussion:

A total of 40 patients (26 male and 14 females) with right ventricular IWMI were studied during one year period. Involvement of right ventricle increases rate of complications as well as the mortality rate in patients with inferior wall myocardial infarction [7]. Almost 60% of them were senior citizens. There is varied reporting of age and gender in right ventricular MI in literature. Few studies are showing increased mortality in elderly and frequent occurrence of RVMI in females [8-9]. Whereas other studies demonstrated male predominance [5, 10]. A study by Ali *et al*. showed higher incidence in younger age group 30-40 years [5]. The same study also showed different social and clinical factors such as smoking addiction and comorbidities like hypertension and diabetes commonly noticed among RVMI individuals. It also found increased prevalence of hypertension and addictions such as alcohol and smoking in right ventricular IWMI. The most common symptom occurring in 38 (95%) patients was chest pain in our study. According to Iqbal *et al*. chest pain was seen in all the study participants with RVMI [10]. The higher occurrence of diaphoresis and syncope as symptoms have been linked to the possible activation of the Bezold Jarisch reflex concurrent with the involvement of the RV [11]. The classic triad of symptoms associated with RVMI are hypotension, raised JVP and clear lung fields were observed in only 13 (32.5%) patients of the study population. It was found the raised JVP in 29 (72.5%) patients. These findings are also supported by other studies where hypotension and raised JVP to be a common manifestation of IWMI in right ventricle involvement [9, 11-12]. The overall percentage of patients who had the classical triad of symptoms was comparable to the aforementioned studies [10, 12-13]. All patients included in the study had varying degrees of LV dysfunction, the mean Ejection Fraction (EF) in our study population was 42.75% SD 4.99. There occurs a decrease in LV function, both systolic and diastolic, in response to an acute RV failure. This phenomenon has been called the, "Ventricular Interdependence". The presence of LV dysfunction did not have a statistically significant correlation with the hypotension observed in our patients. Though few studies have reported positive association between the risks of baseline anaemia, PLR on outcome in patients of ST Elevation Myocardial Infarction (STEMI), we could not find positive association between these variables in our study sample [14-15]. There was a positive correlation observed between the NLR and mortality (p =0.009, Spearman's R 0.408) in our study. Similar results were obtained in studies conducted by Núñez *et al.* and Akpek *et al.* [16-17]. The mean TAPSE to detect RV dysfunction in study was 1.28 cm. According to the European Association of Cardiovascular Imaging recommendations a TAPSE of <1.7cm would represent RV systolic dysfunction [18]. TAPSE has a high sensitivity and specificity for the identification of RV dysfunction and predicting proximal right coronary artery stenosis [17]. The ECG patterns, in addition to the ST Elevations in lead II and III and avF observed in the standard 12 lead ECG were, ST depression in lead I in 85% of patients, ST elevations in V1 in 57% of patients. Seventy seven percent of the patients observed had ST elevations

of greater magnitude in lead III than in lead II. About 47.5% of our patients had ST elevations in all the right sided leads from V3R to V6R. Among the right sided leads, the most consistent finding was ST elevation in lead V4R, occurring in 100% of the patients. The frequency of occurrence of ST elevation being the maximum in lead V4R was in concordance with studies conducted by Chhapra *et al*. [12].

Disproportionate ST segment elevation with greater ST elevation in lead III than in lead II is diagnostic for an RVMI 47.5% of our patients had ST elevations in all the right sided leads from V3R to V6R [15]. The combination of ST elevation in lead V3R and V4R was found to have statistically significant correlation with the presence of RV dysfunction on 2D ECHO, p=0.014. There was no statistically significant correlation between the presence of ST elevation in lead V1 and the presence of RV dysfunction on 2D ECHO. But when the ST depression in V2 was considered in combination with ST elevation in V1, the presence of both in combination had a significant correlation with the presence of RV dysfunction with a p=0.007. We recommend larger studies to validate the significance of this correlation between the echocardiographic confirmation of RV dysfunction and the specific patterns of ECG changes. Multiple studies have shown that a concomitant presence of ST elevation in lead V1 and ST depression lead V2 was sensitive for the detection of RVMI. Bischof *et al*. had tested a hypothesis, wherein the sensitivity of the presence of ST depression in lead V1 was postulated to increase if considered in the absence of ST depression in lead V2, but there was no statistical significance in their study [19].

According to Magesh and Karthikeyan, all cases of IWMI should have right sided chest leads recorded during ECG examination as more the ST elevation more the severity of RVMI and its complications and mortality rate [20]. There was a significant association between the presence of arrhythmias on admission and at 4 hours after admission with mortality in our patients. About 62.5% of our patients had arrhythmias recorded on their ECG tracings. The most common among these patients was sinus bradycardia, followed by 1st degree AV blocks and sinus tachycardia. Normal sinus rhythm was seen to be restored in 68% of our patients 24 hour post admission. Complete Atrioventricular (AV) or sinoatrial blocks occurred in one-half of cases in which ST segment elevation or a QS pattern in V3R and/or V4R were present. Zehender *et al*. demonstrated a higher incidence of following arrhythmias in RVMI, sustained ventricular tachycardia (16% versus 8%; P=0.08) and ventricular fibrillation (21% versus 9%; P=0.05) complete AV block (17% versus 4%; P=0.06) and severe bradycardias (9% versus 3%; P=0.09) with pacing requirements (18% versus 3%; P=0.01) [4]. We could manage 21 (52.5%) patients successfully with medical management using inotropes, thrombolytic agents and IV fluids. Reperfusion strategies, either by way of thrombolytic agents or percutaneous revascularization, a Central Venous Pressure (CVP) guided approach to fluid resuscitation, use of IABP (Intra-Aortic Balloon Pump) to avoid overzealous fluid resuscitation improves the outcome in RVMI [20-22]. We observed 13% mortality in our study among right ventricular IWMI. Among the expired patients, 67% had

presented with hypotension, 66% had conduction defects, Sinus Tachycardia and Sinus Bradycardia (STC and SBC) whereas 83% had RV dysfunction at admission. A meta-analysis concluded that patients with RVMI were at increased risk of death due to arrhythmias and shock and they attributed it to RV involvement in IWMI rather than extent of left ventricular damage [23-24].

Conclusion:

Right Ventricular IWMI presents with specific ECG findings which can be reliable signs for diagnosis like >1mm ST elevation in V4R lead. This simple approach of using right sided leads in presence of symptoms, facilitates early identification of this entity and it also accelerates appropriate management of such patients to prevent complications. NLR proves to be an inexpensive and easily measurable laboratory variable, which is positively associated with mortality in right ventricular IWMI.

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