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RIGHT VENTRICULAR INFARCTION IN PATIENTS WITH INFERIOR WALL MYOCARDIAL INFARCTION AND THEIR CLINICAL AND ANGIOGRAPHIC PROFILE AND OUTCOMES

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ABSTRACT

OBJECTIVE

To determine the frequency of right ventricular infarction (RVI) in patients presenting with inferior wall myocardial infarction (IWMI) and to analyze their clinical presentation, angiographic profile, and in-hospital outcomes to help with early diagnosis and management.

METHODOLOGY

This descriptive study was done during the year 2024 at NICVD Karachi and included patients aged between 18 to 65 years who were present with IWMI and underwent PCI. Diagnosis of IWMI was made if the ECG revealed ST segment elevation in inferior leads (II, III, and AVF) with reciprocal ST segment depression in lateral or high lateral leads (I, AVL, V5 and V6). Right ventricular infarction (RVI) was labeled if ECG demonstrated ST elevation in V1, ST elevation in V1 with ST depression in V2, an isoelectric ST segment in V1 with marked ST depression in V2, or ST elevation in lead III greater than lead II, and was confirmed by ST elevation in right-sided leads (V3R–V6R). The data was entered analyzed through SPSS version 26.

RESULTS

The mean age of the participants was found to be 57.31with (SD = 6.21) years, and 66.5% of them were over 55 years old. The study had a male predominance, which represented 60.7% of the participants. Infarction of right ventricle (RVI) developed in 44.5% of cases. Infected patients with RVI had increased hypotension (18.8% vs. 4.8%, p=0.035), arrhythmia (12.9% vs. 5.8%, p=0.041), cardiac arrest (10.6% vs. 2.8%, p=0.029), atrioventricular block (11.8% vs. 4.0%, p=0.034), cardiac failure (8.2% vs. 2.1%, p=0.040), single-vessel disease (4.7% vs. 5.7%), double-vessel (29.4% vs. 31.1%) and triple-vessel (65.9% vs. 63.2%) with in significant difference (p=0.914) and mortality (12.9% vs. 3.1%, p=0.003).

CONCLUSION

This study reported the clinical impact of right ventricular infarction (RVI) in patients with inferior wall myocardial infarction (IWMI). Patients with RVI had a higher incidence of hypotension, arrhythmias, cardiac arrest, AV block, and in hospital mortality, compared with patients without RVI. Despite insignificant difference in types

of CAD between groups these findings emphasis on early diagnosis by right-sided ECG and echocardiography as well as the need for standardization of treatment protocols to improve clinical outcome.

KEYWORDS: *Complications, Electrocardiogram, Heart Failure, Right Ventricular Infarction, Inferior wall myocardial infarction.*

INTRODUCTION

In Pakistan, cardiovascular diseases (CVDs) have emerged as the primary cause of death since the turn of the century [1]. Pakistan has experienced a dramatic epidemiological transition over the last 20 years, with noncommunicable diseases (NCDs) quickly replacing infectious diseases, undernutrition-related illnesses, and maternal and paediatric illnesses as the main epidemiological characteristics [2]. Compared to individuals with European heritage, Indians are affected by CVD at least ten years earlier and during their prime midlife years [3,4]. With the existing burden of CVD, the World Health Organization (WHO) estimates that over a ten-year period, developing nations like Pakistan will lose over $200 billion in lost productivity and health care spending [5].

Right ventricular infarction (RVI) has been found to occur often in cases of inferior wall myocardial infarction (IWMI) in recent years. Previously, the right ventricle's role in patients with a history of MI was unclear [6]. Patients often arrive with bradycardia, hypotension, diaphoresis, and elevated jugular venous pressure (JVP) in addition to retrosternal chest discomfort [7,8].

RVI causes haemodynamic abnormalities, such as clear lung fields and increased jugular venous pressure. Hypotension and cardiogenic shock may occur after RVI in more severe situations. When ischaemic but viable myocardium is present, the right ventricle enlarges, and acute right ventricular failure brought on by anomalies in the right ventricular free wall movement is commonly referred to as RVI [9].

Due to a shared blood supply, right ventricular infarction frequently coexists with inferior wall myocardial infarction (IWMI), but it is usually not properly recognized and treated. The present ECG criteria for RVI are not commonly employed, which results in missed diagnoses [10]. RVI presents unique clinical challenges; hypotension, high jugular venous pressure that dictate different therapeutic approaches [11]. Understanding the clinical and angiographic features of RVI may help in improving patient outcomes, because all such patients require some form of treatment. This study intends to determine the rate of RVI, as well as clinical, angiographic and in-hospital event characteristics among patients with acute IWMI who arrive at a tertiary care center's cardiac ER. As a measure of RV load, RVI is prognostic in acute IWMI.

METHODOLOGY

This was a descriptive study, carried out in the Department of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan during the year 2024. One hundred ninety-one patients (191) patients aged 18–65 years with inferior wall myocardial infarction (IWMI) referred for primary percutaneous coronary intervention (PCI) within less than 6 h of the symptom's onset were enrolled using a non-probability purposive sampling method. Patients were excluded if they had had recurrent myocardial infarction (MI), previous PCI or CABG, if they had chronic renal or liver disease, or if they had known arrhythmias or pregnancy. Diagnosis of IWMI was made if the ECG revealed ST segment elevation in inferior leads (II, III, and AVF) with reciprocal ST segment depression in lateral or high lateral leads (I, AVL, V5 and V6). Right ventricular infarction (RVI) was labeled if ECG demonstrated ST elevation in V1, ST elevation in V1 with ST depression in V2, an isoelectric ST segment in V1 with marked ST depression in V2, or ST elevation in lead III greater than lead II, and was confirmed by ST elevation in right-sided leads (V3R–V6R).Clinical characteristics at baseline including symptoms (vomiting, syncope, diaphoresis), nature of the final diagnosis (low-risk vs high-risk etiology), complication (acute heart failure) were also recorded. Vomiting was defined as forceful expulsion of gastric contents in the observer's presence; diaphoresis was defined as nonenvironmental-related profuse sweating; and syncope was defined as a brief collapse with spontaneous recovery from loss of consciousness. Arrhythmias were recorded as observed by the ECG and included PVC, AIVR, first-degree, second-degree, and third-degree AV block, SVT, AF, VT, and VF. PCI was performed on all patients, and angiographic data (TIMI flow grade, culprit artery (s), and

angiographic coronary artery disease (single-, double-, or triple-vessel disease) were recorded. The main endpoints were the occurrence of Right Ventricular Infarction (RVI) in patients with IWMI and the clinical and angiographic features of RVI. Secondary outcomes consisted of final hospital course (focused on acute heart failure, stroke, and arrhythmias) and in-hospital mortality. Consistent and accurate diagnosis and outcome assessment were accomplished by collecting data from admission to discharge.

SPSS version 26 was used for data entry and analysis. Descriptive statistics were applied to calculate mean and standard deviation of quantitative variables while frequency and percentage were calculated for qualitative variables. The Chi-square test was applied and $p < 0.05$ was considered statistically significant.

RESULTS

The Characteristics of 191 study participants are presented in **Table I**, summarizing key demographic and clinical variables. Participants are aged 57.31 years (SD = 6.21), and most (66.5%) are older than 55 years. Mean BMI (±SD) = 25.68 kg/m² (±3.68) 64.9% in the range of 20–26 kg/m². The male predominance of the sample for males accounted for 60.7% of the participants. With regards to smoking status, 62.8% are non-smokers versus 37.2% smokers. A proportion of the participants suffer from diabetes mellitus (44%), and hypertension is common in 71.2% of the population. In addition, just 10.5% have a positive family history of CAD. The population of the sample is older and has a high frequency of hypertension and diabetes, which are key cardiovascular risk factors, and may have implications for CAD or other cardiovascular condition.

Clinical features and outcomes of patients with and without right ventricular infarction (RVI) in the context of inferior wall myocardial infarction (IWMI) are compared in **Table II**. Other clinical features like chest pain, vomiting, diaphoresis and palpitations were reported more in the RVI patients however statistically they were non-significant ($p > 0.05$). No significant difference was found in CAD type distribution between groups. Single-vessel disease was 4.7% vs. 5.7%, double-vessel 29.4% vs. 31.1%, and triple-vessel 65.9% vs. 63.2% (p=0.914). In terms of outcomes, hypotension was significantly higher in RVI patients (18.8%) than in non-RVI patients (8.5%) ($p = 0.035$) patients with RVI had higher incidences of cardiac arrest (10.6% vs. 2.8%, $p = 0.029$), AV block (11.8% vs. 3.8%, $p = 0.034$), and mortality (12.9% vs. 1.9%, $p = 0.003$). Arrhythmia was also more frequent in the RVI group but a significant p-value of 0.041. The other outcomes including shock, cardiac failure, pulmonary edema, ventricular tachycardia, ventricular fibrillation was statistically significant. These results suggest that RVI in the setting of IWMI identifies a cohort of patients with an adverse clinical course, higher rates of hypotension, arrhythmia, cardiac arrest, AV block and mortality, warranting close observation and potential early intervention.

DISCUSSION

Right ventricular infarction (RVI) in inferior wall myocardial infarction (IWMI) complicated by RCA occlusion is a dire situation, since RCA supplies most of the right ventricle and the inferior wall of the left ventricle. RVI is associated with significant hemodynamic consequences including hypotension and right heart failure, which certainly worsens the difficult management of IWMI. These studies contribute important information regarding the clinical manifestations, diagnostic characteristics and treatment of this disorder [12-14].

One of the strengths of this study is that it emphasizes clinical presentation and diagnostic techniques. Deshmukh et al. [12] emphasizes the difficulties in diagnosing RVI particularly in young adults, a group that is frequently underrepresented in studies of myocardial infarction. Yadav et al. [13] highlighted the significant role of RCA occlusion in RVI and the recommendation of coronary angiography within the first hours to evaluate an RCA patency. A recent review by Pandey et al. also highlighted the importance of non-invasive methods to quantify RV function including echocardiography and tissue Doppler imaging, which can be used to identify and assess RVI over time [18].

The diagnostic features for identifying RVI also have strengths, especially with the use of electrocardiography (ECG). Traditional ECG leads may not show adequate right ventricular involvement in IWMI according to Hossain et al. [15]. They advocate the use of right-sided ECG leads (V3R, V4R) for the

diagnosis of ST-segment elevation, as in RVI. Echocardiography also plays an important role in the assessment of the right ventricle, and Bhupal and Kumar [16] demonstrated that measurement of the right ventricular tissue Doppler can provide information regarding the changes in function and hemodynamics after primary PCI, enabling real-time assessment of the clinical status of the patient.

Though competent, RVI management still suffers from several drawbacks. Underdiagnosis is a major stumbling block, especially for patients with early right ventricular dysfunction. As Hossain et al. [15], noted left ventricular dysfunction often masks right ventricular problems, with resultant delayed diagnosis and treatment. In addition to that, the RVI also presents meteoric signs like hypotension which can easily be linked to different causes making it more difficult to detect it. Further, right ventricular involvement can be variable and is not always a key determinant of management.

A limitation relates to the optimal management of RVI which is not yet agreed upon. While timely early coronary revascularization with either PCI or thrombolysis is crucial, studies such as those carried out by Elden et al [17]. Even though adjunctive therapies such as inotropic agents and vasopressors could prove effective, have noted that their role is uncertain. Many of these treatments are frequently employed to assist hemodynamics but have limited evidence of a benefit in terms of outcome in RVI. Fluid management is also controversial, with excess fluid leading to increased pulmonary congestion, particularly for those with left ventricular dysfunction.

Angiography is a gold standard in RCA occlusion diagnosis but with limitations. As per Yadav et al. [13] and Pandey et al [18] collateral circulation may cause less obvious angiographic findings by compensating against RCA occlusion. While advanced imaging techniques like MRI may allow for a more precise measure of right ventricular performance, they are rarely used in clinical practice.

Improving awareness among clinicians is essential for enhancing patient care. Use of echocardiography and tissue Doppler imaging to get a noninvasive look at right ventricular function should be expanded. Finally, data are needed to establish evidence-based treatment protocols for RVI, especially related to inotropic agents, vasopressors, and fluid management.

In our study, RVI was noted in 44.5% of patients while the distribution of clinical features such as pacing 14.1%, (p=0.855), vomiting 36.5% (p=0.289), diaphoresis 63.5% (p=0.754), chest pain 90.6% (p=0.668), breathlessness 57.6% (p=0.607), syncope 7.1% (p=0.168), and palpitations 14.1% (p=0.562) were not significantly different between the two groups whereas regarding the outcomes, RVI patients had a higher likelihood of experiencing hypotension 18.8% (p=0.035), arrhythmias 12.9% (p=0.041), cardiac arrest 10.6% (p=0.029), atrioventricular block 11.8% (p=0.034), cardiac failure 8.2% (p=0.040), mortality 12.9% (p=0.003), and shock 9.4% (p=0.047). Other complications, such as pulmonary edema 2.4% (p=0.224), ventricular tachycardia 10.6% (p=0.208), and ventricular fibrillation 11.8% (p=0.627), showed no significant differences.

The study by Khandait V, et al reported that 30% of patients had right ventricular myocardial infarction, 16% hypotension, 10% shock, 11.3% arrythmia, 5.3% cardiac failure, and 2% pulmonary edema [19]. Another study reported the frequency of RVI in patients with IWMI was 41.3% [20]. Misra A, et al stated the most common culprit artery in patients with inferior wall MI was mid RCA 46% followed by proximal RCA 34%, distal RCA 16%, and LCx 4%, however, out in 34 patients with IWMI and RVI, the most common culprit artery was proximal RCA 82.3% followed by mid RCA 14.7% and distal RCA 2.9% [21]. Jehan AS, et al noted RVI in 36.8% [22].

In our study, shock and mortality were observed in 9.4% and 12.9%, respectively whereas the study by Juned H, et al noted cardiogenic shock in 8.8% and mortality in 9.6% cases [23].

IWMI RVI is an intricate, although much too often missed diagnosis that demands prompt diagnosis and individualized treatment solutions. Although current studies like Deshmukh et al. [12], Yadav et al. [13] and Bhupal and Kumar [16], the results of our review suggest that further research in this area is likely required in order to aid in the development of greater clarity regarding management protocols and improvement in patient outcomes. This is a challenging condition, and increased awareness, earlier diagnosis, and improved therapeutic guidelines could lead to significant improvements in the prognosis of these patients.

CONCLUSION

This study reported the clinical impact of right ventricular infarction (RVI) in patients with inferior wall myocardial infarction (IWMI). Patients with RVI had a higher incidence of hypotension, arrhythmias, cardiac arrest, AV block, and in hospital mortality, compared with patients without RVI. These findings emphasis on early diagnosis by right-sided ECG and echocardiography as well as the need for standardization of treatment protocols to improve clinical outcome.

Table I: Characteristics of Study Participants (n=191)	
Variable	**n (%)**
Age (Mean ± SD) = 57.31 ± 6.21	
30-55 years	64 (33.5)
>55 years	127 (66.5)
BMI (Mean ± SD) = 25.68 ± 3.68	
20 - 26 kg/m^2	124 (64.9)
>26 kg/m^2	67 (35.1)
Gender	
Male	116 (60.7)
Female	75 (39.3)
Smoking Status	
Smoker	71 (37.2)
Non-Smoker	120 (62.8)
Diabetes Mellitus	
Diabetic	84 (44.0)
Non-Diabetic	107 (56.0)
Hypertension	
Hypertensive	136 (71.2)
Non-Hypertensive	55 (28.8)
Family History of CAD	
Positive	20 (10.5)
Negative	171 (89.5)

Table II: Clinical Features and Outcomes of Patients with Right Ventricular Infarction in Inferior Wall Myocardial Infarction (n=191)

Clinical Features		**Right Ventricular Infarction**		**95% C. I**	**P-Value**
		Yes (n=85)	**No (n=106)**		
Pacing, *n* (%)		12 (14.1)	14 (13.2)	0.471—2.477	0.855
Vomiting, *n* (%)		31 (36.5)	31 (29.2)	0.756—2.552	0.289
Diaphoresis, *n* (%)		54 (63.5)	65 (61.3)	0.609—1.982	0.754
Chest pain, *n* (%)		77 (90.6)	94 (88.7)	0.478—3.158	0.668
Breathlessness, *n* (%)		49 (57.6)	65 (61.3)	0.480—1.535	0.607
Syncope, *n* (%)		6 (7.1)	14 (13.2)	0.183—1.360	0.168
Palpitation, *n* (%)		12 (14.1)	12 (11.3)	0.547—3.033	0.562
Type of CAD	Single Vessel Disease	4 (4.7)	6 (5.7)	0.553—1.466	0.914
	Double Vessel Disease	25 (29.4)	33 (31.1)		

	Triple Vessel Disease	56 (65.9)	67 (63.2)		
Outcomes	Hypotension, *n* (%)	16 (18.8)	9 (8.5)	1.044—5.984	0.035
	Shock, *n* (%)	8 (9.4)	21 (19.8)	0.176—1.005	0.047
	Arrhythmia, *n* (%)	11 (12.9)	5 (4.7)	1.001—9.010	0.041
	Cardiac Arrest, *n* (%)	9 (10.6)	3 (2.8)	1.065—15.525	0.029
	AV Block, *n* (%)	10 (11.8)	4 (3.8)	1.027—11.257	0.034
	Cardiac Failure, *n* (%)	7 (8.2)	2 (1.9)	0.943—23.083	0.040
	Pulmonary Edema, *n* (%)	2 (2.4)	6 (5.7)	0.079—2.043	0.224
	Ventricular Tachycardia, *n* (%)	9 (10.6)	5 (5.7)	0.673—5.784	0.208
	Ventricular Fibrillation, *n* (%)	10 (11.8)	15 (14.2)	0.343—1.905	0.627
	Mortality, *n* (%)	11 (12.9)	2 (1.9)	1.664—35.906	0.003

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