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Echocardiographic Evaluation of Right Ventricular Function in Patients with Inferior Wall Myocardial Infarction: A Cross-Sectional Study

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ABSTRACT

Background: Patients experiencing an acute inferior wall infarction frequently exhibit dysfunction of the right ventricle (RV), with many cases resulting from occlusion of either the right or left circumflex coronary artery. However, routine assessments of RV function are often overlooked in echocardiographic examinations. Following an inferior wall myocardial infarction (IWMI), there is a risk that patients may subsequently develop right ventricular myocardial infarction (RVMI). RV dysfunction after a myocardial infarction is associated with an increased risk of shock, arrhythmias, and mortality. As such, the involvement of the RV is a critical factor that influences both prognosis and treatment strategies for patients with inferior wall myocardial infarction. This study aims to evaluate the role of echocardiography in assessing RV function in cases of IWMI.

Materials and Methods: This cross-sectional study involved 45 patients, including both males and females. Our study population did not have an age limit and consisted of individuals experiencing their first Q-wave acute inferior myocardial infarction, with or without right ventricular myocardial infarction (RVMI). An echocardiographic examination of right ventricular function was conducted within 24 hours of symptom onset.

Result: During the study, 45 patients were evaluated and underwent a comprehensive Echo-Doppler examination. Among these patients, 28 were diagnosed with right ventricular myocardial infarction (RVMI), forming Group 1. The remaining 17 patients experienced an inferior wall myocardial infarction without right ventricular involvement, comprising Group 2.

Conclusion: Conventional echocardiographic examinations tend to underestimate right ventricular (RV) dysfunction. Therefore, impaired RV function in patients presenting with acute inferior wall myocardial infarction (IWMI) can be effectively predicted through various echocardiographic parameters, including fractional area change (FAC), tricuspid annular plane systolic excursion (TAPSE), right ventricular systolic velocity (RV S'), and right ventricular myocardial

performance index (RVMPI)..

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Keyword: *Right ventricular myocardial infarction, Inferior wall myocardial infarction, Echocardiography, Tricuspid annular plane systolic excursion, right ventricular myocardial performance index*

1. INTRODUCTION

Right ventricular (RV) function has not been extensively investigated following myocardial infarction (MI), in contrast to left ventricular (LV) function. It is noteworthy that RV involvement occurs in over one-third of patients with acute inferior wall myocardial infarction (IWMI) [1]. Research indicates that RV involvement serves as an independent predictor of significant complications and in-hospital mortality following acute inferior MI. ST-segment elevation in the right precordial lead V4R is considered one of the most reliable electrocardiographic indicators of acute RV infarction. Inferior wall myocardial infarction is frequently complicated by right ventricular infarction (RVMI) in as many as 50% of cases. A study conducted by Anderson et al. in 1989 reported that the incidence of RVMI in patients with inferior wall myocardial infarction ranged from 10% to 50%. Isolated right ventricular infarction is exceptionally rare [2,3]. Right ventricular infarction significantly contributes to hemodynamic instability, atrioventricular conduction blocks, and elevated in-hospital mortality rates among patients experiencing inferior wall myocardial infarction. It has been established that systolic right ventricular function is a critical predictor of outcomes following myocardial infarction. Despite this initial observation nearly two decades ago, this condition has garnered little clinical attention until recent years [4,5]. According to the Shock Trial Registry, despite presenting at a younger age, having a lower incidence of anterior MI, and a higher prevalence of single vessel coronary disease in RV shock patients compared to those with LV shock, their mortality rates remain unexpectedly high, similar to those of patients with LV shock [6].

Furthermore, cardiogenic shock and the necessity for temporary transvenous cardiac pacing are more prevalent in patients exhibiting right ventricular dilatation. The presence of right ventricular dysfunction, indicative of multivessel coronary artery disease, is associated with a poor prognosis irrespective of the infarct's location. Identifying right ventricular dysfunction is crucial, as it is often linked to a distinct clinical syndrome that necessitates specific management strategies [7]. Volume loading to restore left ventricular filling pressure is imperative in low cardiac output. Inappropriate use of vasodilators and/or diuretics may result in fatal outcomes. Moreover, information regarding right ventricular function may inform thrombolysis decision-making in cases with relative contraindications. One study notably suggested that patients with inferior myocardial infarction experience no benefit from thrombolysis in the absence of right ventricular involvement. There is a growing interest in the non-invasive recognition of right ventricular infarction due to the therapeutic implications associated with differentiating patients exhibiting right ventricular dysfunction from those without such dysfunction [8].

Echocardiography may reveal a hypokinetic or akinetic segment of the right ventricle, which can aid in detecting RV dysfunction post-RV infarction. Nonetheless, assessing RV function via echocardiography is challenging due to its complex morphology. Prior research has utilized tricuspid annular motion as a parameter for evaluating RV function. Additionally, myocardial velocity, determined through Doppler tissue imaging, has recently emerged as a technique for analyzing left ventricular function. The advancement of Doppler tissue imaging allows for the assessment of RV function [9,10]. However, this technique has yet to be employed to evaluate RV function following myocardial infarction. The current study aims to investigate RV function in conjunction with an acute first inferior wall myocardial infarction, utilizing both tricuspid annular motion and tricuspid annular velocity.

OBJECTIVES:

This study aims to investigate the prevalence of right ventricular infarction (RVI) among patients with inferior wall myocardial infarction (IWMI) and to assess the role of echocardiography (ECHO) in diagnosing RVI and evaluating its severity. Additionally, we seek to analyze right ventricular function in IWMI patients through echocardiographic examination and to explore the frequency of complications about sex

2. METHODOLOGY

Study design: This cross-sectional study was conducted among 60 patients diagnosed with their first acute inferior wall myocardial infarction (IWMI) episode who presented within 24 hours of symptom onset at a selected hospital in Salem. The study did not impose any age restrictions on the patient population, provided they experienced a first Q wave acute inferior myocardial infarction, either with or without concurrent right ventricular myocardial infarction (RVMI).

Inclusion Criteria: Patients were eligible for inclusion if they exhibited an acute IWMI, experienced chest pain for a minimum duration of 30 minutes, and had an electrocardiogram (ECG) recorded within 6 hours of symptom onset. IWMI was identified based on ST-segment elevation of ≥0.2 mV in the inferior leads, accompanied by reciprocal changes in the lateral leads. Additionally, RVMI associated with IWMI was defined by ST-segment elevation of ≥0.1 mV in the V4 through

V6R leads.

Exclusion Criteria: Patients were excluded if they presented with acute anterior wall myocardial infarction (AWMI), acute IWMI with coexisting rheumatic heart disease (RHD), coronary heart disease (CHD), moderate to severe pulmonary hypertension (PHT), cardiomyopathies, abnormal left ventricular function, left bundle branch block (LBBB), arrhythmias, or inadequate echocardiographic window for assessing right ventricular function.

ECG Assessment of IWMI: A standard 12-lead ECG and a right precordial ECG (lead V4R) were recorded immediately upon presentation. IWMI was classified as ST-segment elevation of at least 2 mm in the inferior leads (leads II, III, and aVF), with reciprocal changes noted in the lateral leads. The diagnosis of RV infarction in conjunction with IWMI was established through ST-segment elevation of 0.1 mV in lead V4R through V6R.

RV Assessment by Echocardiography: All patients underwent a comprehensive conventional echocardiographic evaluation employing standard views following initial stabilization. Tricuspid annular plane systolic excursion (TAPSE) was measured by positioning an M-mode cursor across the tricuspid lateral annulus in the apical four-chamber view. The pulsed tissue Doppler imaging technique was used to assess cardiac dynamics, with images captured through the apical four-chamber window using the tissue Doppler mode, focusing on the right ventricular free wall. At the end of expiration, the pulsed Doppler sample volume was positioned at the tricuspid annulus of the basal segment of the right ventricular free wall. Comprehensive velocity profiles were established, including a significant positive peak systolic velocity (Sm), indicating movement of the annulus towards the apex during systole. Negative early diastolic myocardial velocity (Em) measurements were recorded as the annulus ascended away from the apex, followed by negative late diastolic myocardial velocity (Am) recordings. The dynamic behaviour of Sm, Em, and Am waves was effectively characterized through this analysis. The duration of Sm was measured utilizing the ejection time (ET). In contrast, the isovolumic relaxation time (IVRT) was calculated as the time elapsed from the end of Sm to the initiation of Em. The interval between the conclusion of Am and the commencement of Sm provided further insights into isovolumic contraction time (IVCT). The myocardial performance index (MPI), a critical indicator of cardiac function, was computed using the following formula: MPI = [(IVRT + IVCT) / ET].

3. RESULTS

This study presents a comparative analysis of various echocardiographic parameters between Group A, consisting of patients with inferior wall myocardial infarction (MI) accompanied by right ventricular involvement (RVI), and Group B, comprising patients with inferior wall myocardial infarction without right ventricular involvement. During the study period, 45 patients were assessed and underwent a comprehensive Echo-Doppler examination. Among these patients, 28 were diagnosed with right ventricular myocardial infarction, thereby forming Group 1, while the remaining 17 patients, categorized as Group 2, experienced inferior wall myocardial infarction without RVI.

The demographic data indicate that most patients were aged between 40 and 60 years, comprising 30 out of 45 individuals (65%). The study population predominantly consisted of male patients, with 34 males (75%) out of 45, while the remaining 11 were female. Regarding medical history, the following findings were recorded: 17 out of 45 patients (38%) had a history of hypertension, 21 out of 45 patients (47%) reported a history of diabetes mellitus, and 26 out of 45 patients (58%) were identified as smokers. Furthermore, a family history of ischemic heart disease was noted in 11 out of 45 patients (24%)

(Table -1).

Characteristics	**Group I (n=28)**	**Group II (n=17)**	**Total**
Age <40yrs 40-60yrs >60 yrs	1 21 6	3 9 5	45
Male	24	10	34(75%)
Female	4	7	11 (25%)
Hypertension	6	11	17 (38%)
Diabetes	12	9	21 (47%)

Smoking	19	7	26 (58%)
F/Hof CAD	7	4	11 (24%)

Table:1 Baseline demographics

Evidence of myocardial infarction using Electrocardiography:

A 12-lead electrocardiogram was performed on all patients. There was evidence of right ventricular involvement, defined as a 1 mm ST elevation in lead V4R, in 28 patients. Among these, 18 patients exhibited the right coronary artery (RCA) as the identified culprit vessel on the electrocardiogram. In comparison, 10 patients demonstrated the involvement of the left circumflex artery as the vessel responsible for the myocardial infarction.

Echocardiography evaluation of Right Ventricular Function:

Echocardiography was performed on all 45 patients within 48 hours following the onset of the acute event. The findings of the investigation are summarized as follows:

The right ventricular (RV) end-diastolic diameter was found to be increased in patients with right ventricular myocardial infarction (RVMI) compared to those without right ventricular involvement; however, this result did not achieve statistical significance (p=0.1). Abnormalities in RV contraction and interventricular septal motion were observed in 41% of patients with RVMI, in contrast to only 3% of patients without it. Notably, wall motion abnormalities were predominant among patients whose echocardiograms were conducted within 24 hours of symptom onset, underscoring the rapid recovery of the right ventricle following an ischemic insult.

Among patients with right ventricular involvement, nearly half exhibited tricuspid regurgitation. Quantification by colour Doppler revealed that this regurgitation was predominantly mild, with some cases classified as moderate, while none were assessed as severe. The pulmonary artery systolic pressure was slightly elevated and above normal in patients categorized as Group 1 compared to Group 2, although this finding was not statistically significant (p=0.2).

A statistically significant decrease in tricuspid annular excursion was noted in patients with RVMI, indicating that RV systolic function was compromised in this cohort (p=0.05). The myocardial performance index was significantly elevated, nearly doubling the reference values in patients with RVMI; conversely, the values in those without right ventricular involvement were comparatively low (p=0.01).

Tissue Doppler imaging was conducted on the right ventricular free wall and septal regions, assessing systolic (Sm), early diastolic (Em), and late diastolic (Am) velocities. The results indicated that the Sm and Em values in the right ventricular free wall were statistically significantly depressed in patients with RVMI (p=0.02). In contrast, the corresponding values in patients without RV involvement remained near normal. However, the late diastolic velocities (Am) in the RV-free wall and septal velocities did not demonstrate significant differences between the groups (p=0.22).

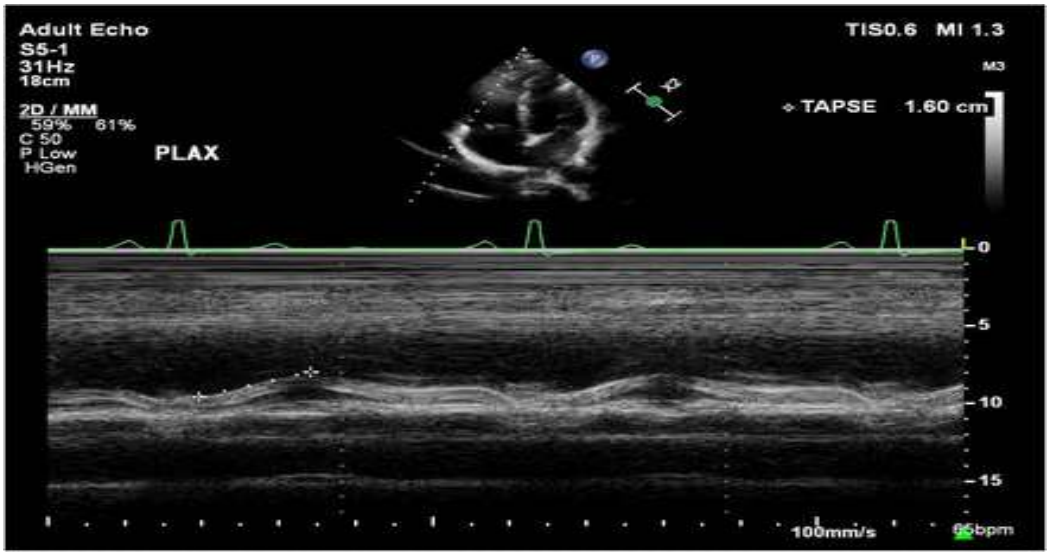

Figure 1: Measurement of Tricuspid annular movement by M-mode in apical 4 chamber view; reduced excursion in a patient of IWMI with associated RVMI.

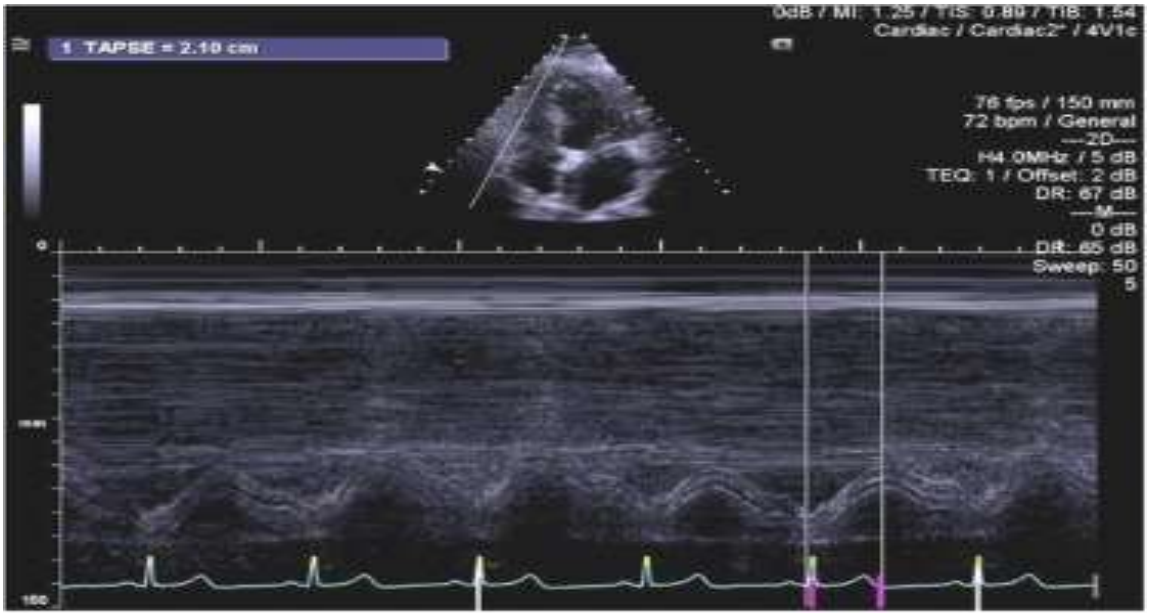

Figure 2: Measurement of Tricuspid annular movement by M-mode in apical 4 chamber view; normal excursion in a patient of IWMI without RVMI.

4. 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 right ventricular (RV) infarction is not uncommon, hemodynamically significant RV infarction is a relatively rare consequence of inferior myocardial infarction (MI). Occlusion of the proximal right coronary artery can result in inferoposterior left ventricular infarction alongside RV infarction and impaired RV function. The assessment of RV function via echocardiography is complex due to the intricate geometry of the right ventricle. The contraction of the interventricular septum and the RV-free wall contributes to the RV ejection fraction. During systole, the motion of the tricuspid annulus toward the cardiac apex reflects RV contraction along the longitudinal axis. Previously, the RV function was evaluated by measuring the amplitude of tricuspid annular motion using M-mode echocardiography. The advantage of this approach is that it minimizes the impact of myocardial dropout.

Our study observed a significant reduction in Tricuspid Annular Plane Systolic Excursion (TAPSE) in patients with inferior wall myocardial infarction (IWMI) who presented with RV involvement compared to those without RV involvement. This reduction likely indicates diminished RV function along the long axis during inferior MI, correlating with findings reported by Mahbubul Alam et al. (2000) in a similar patient population. Research conducted by Kaul et al. utilized cross-sectional echocardiography and radionuclide angiography to demonstrate that tricuspid annular motion can reflect systolic function. Furthermore, Samad BA et al. (2002) concluded from their study of patients with acute MI that echocardiographic recordings of TAPSE can effectively assess RV function in a majority of cases and possess predictive value following acute MI, a conclusion supported by Meluzin et al. (2001) and Moustapha et al. (2001).

The clinical relevance of evaluating annular excursion has been substantiated by Willenheimer et al. (1997), and Karatasakis et al. (1998). Smith JL et al. (2003) found that the measurement of tricuspid annulus motion provides a straightforward estimate of right ventricular ejection fraction. Notably, RV dilatation was observed in all patients with RV myocardial infarction (RVMI) in a study conducted by Jugdutt BI et al., and our findings also reveal a significant increase in RV base size compared to control subjects. Moreover, Right Ventricular Fractional Area Change (RVFAC) was significantly decreased in Group A when juxtaposed with Group B.

Leonardo A. M. et al. (2002) noted that many patients with myocardial infarction, particularly those with IWMI, significantly declined RV fractional area change. Their study revealed that RV function remained an independent predictor of overall mortality, cardiovascular mortality, and heart failure, with each 5% decrement in RV FAC correlating with a 16% increase in the odds of cardiovascular mortality (95% confidence interval: 4.3% to 29.2%; P = 0.006). In our analysis, 28 out of 45 patients (82.8%) exhibited either hypokinesia or akinesia of the RV, indicating substantial RV involvement in the infarction. In patients with IWMI, our study observed significant reductions in peak systolic, early diastolic, and late diastolic tricuspid

annular velocities compared to those without RV involvement. These findings echo the changes noted by Mahbubul Alam et al. (2000). Additionally, Alam et al. conducted a study in Sweden, where it was determined that patients with RV infarction had a statistically significant decrease in peak systolic tricuspid annular velocity (13.3 cm/s and 10.3 cm/s, $P < 0.001$) and peak early diastolic velocity (13 cm/s and 8.2 cm/s, $P < 0.001$) when compared with patients suffering from inferior wall myocardial infarction without RV involvement.

In a study by Mustafa Yilmaz et al., which included forty-eight patients suffering from acute inferior myocardial infarction and a matched cohort of 24 age- and sex-matched healthy controls, it was found that twenty-four patients exhibited electrocardiographic signs of inferior myocardial infarction without right ventricular infarction (group I). In contrast, the remaining group displayed electrocardiographic signs indicative of inferior myocardial infarction with right ventricular infarction (group II). Using echocardiographic techniques to assess the apical four-chamber view, peak systolic, early diastolic, and late diastolic velocities of the tricuspid annulus at the right ventricular free wall were measured through pulsed-wave Doppler tissue imaging. The results indicated that peak systolic tissue Doppler imaging velocity at the tricuspid annulus was significantly lower in both group I (14.03 ± 2.57 cm/s, $P < 0.005$) and group II (8.50 ± 0.84 cm/s, $P < 0.005$) compared to controls (16.63 ± 2.31 cm/s).

LIMITATIONS OF THE STUDY

First, the sample size of patients included in our study was relatively small. Second, the selection of patients with inferior wall myocardial infarction (IWMI) was based solely on ECG criteria, as no coronary angiography was performed during the infarction's acute phase to assess the right coronary artery condition. Third, the use of fractional area change as a measure of global right ventricular systolic function is inherently limited by its high dependence on afterload. Lastly, echocardiographic evaluations were conducted between two to four days post-infarction, and it is plausible that some patients may have already experienced recovery from right ventricular damage, given that recovery typically occurs relatively quickly following myocardial infarction.

5. CONCLUSION

In conclusion, a significant number of patients diagnosed with inferior wall myocardial infarction (IWMI) exhibit considerable impairment of right ventricular (RV) function. Right ventricular myocardial infarction (RVMI) is associated with an increased risk of adverse outcomes, including mortality, shock, ventricular tachycardia or fibrillation, and atrioventricular block. Echocardiography is an effective tool for identifying and immediately managing these patients. As previously discussed, individuals with RVMI demonstrate reduced values in tissue Doppler imaging, right ventricular free wall systolic velocity, early diastolic velocity, tricuspid annular plane systolic excursion (TAPSE), tricuspid annular velocity, and right ventricular myocardial performance index (RV MPI) when compared to patients without RVMI. This discrepancy likely indicates diminished RV function following a right ventricular infarction. Therefore, we assert that prompt echocardiographic assessment is crucial in identifying and managing patients with RV involvement, ultimately reducing morbidity and mortality.

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