

PREVALENCE OF RIGHT VENTRICULAR DYSFUNCTION BY ECHOCARDIOGRAPHY PRESENTING WITH ISCHEMIC HEART DISEASE IN SHEIKH ZAYED HOSPITAL RAHIM YAR KHAN

Original Research

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ABSTRACT

Background: Ischemic heart disease (IHD) remains the leading cause of mortality worldwide, contributing significantly to cardiovascular-related deaths. Right ventricular (RV) dysfunction frequently complicates IHD, especially in the presence of left ventricular (LV) failure or infarction. RV impairment is associated with poorer prognoses, including higher rates of heart failure, arrhythmias, and mortality. Echocardiography, being non-invasive, affordable, and widely available, remains the first-line modality for assessing cardiac function, including RV performance in IHD patients.

Objective: To determine the prevalence of right ventricular dysfunction among patients with ischemic heart disease diagnosed on echocardiography in Rahim Yar Khan.

Methods: An analytical cross-sectional study was conducted at Sheikh Zaid Medical College and Hospital, Rahim Yar Khan, over a three-month period from February to April 2025. A total of 110 patients, aged 32 to 75 years, with confirmed ischemic heart disease and left ventricular dysfunction were enrolled through non-probability sampling. Patients with congenital cardiac abnormalities, myocarditis, or peripartum cardiomyopathy were excluded. Echocardiographic assessment was performed using a GE Vivid S6 machine with a 3–5 MHz sector probe, evaluating parameters including Tricuspid Annular Plane Systolic Excursion (TAPSE) and RV systolic tissue Doppler imaging (RVSTDI). Data were analyzed using SPSS version 25.

Results: Of the 110 patients (62 males, 48 females), RV dysfunction was identified in 48 individuals (43.6%), while 62 (56.4%) had preserved RV function. The mean ejection fraction was $36.3\% \pm 7.1$, with a mean TAPSE of $13.65 \text{ mm} \pm 5.85$. TAPSE was significantly lower in patients with RV dysfunction (mean $8.29 \text{ mm} \pm 3.57$) compared to those without (mean $17.81 \text{ mm} \pm 3.33$), $p < 0.001$.

Conclusion: RV dysfunction was prevalent in patients with ischemic heart disease, particularly among those with more severe LV impairment. Early detection through echocardiography is vital for improving clinical outcomes.

Keywords: Echocardiography, Ischemic Heart Disease, Left Ventricular Dysfunction, Right Ventricular Dysfunction, RVSTDI, TAPSE, Ventricular Function.

INTRODUCTION

Ischemic heart disease (IHD) remains the leading cause of morbidity and mortality globally, with its burden continuing to rise in developing countries. In Pakistan, the situation is particularly alarming. In 2016, heart-related illnesses accounted for over 19% of all deaths, a figure that increased to 29% in subsequent years. The most recent data from the World Health Organization revealed that coronary heart disease was responsible for 240,720 deaths in Pakistan in 2020, comprising 16.49% of total deaths, ranking the country 30th globally with a death rate of 193.56 per 100,000 individuals (1). Despite advancements in diagnostic techniques and therapeutic interventions, the clinical outcomes of patients with IHD remain significantly influenced by cardiac complications, particularly those involving the right ventricle. Right ventricular (RV) dysfunction is a frequent but often under-recognized comorbidity in patients with IHD (2). It may result directly from right ventricular infarction or indirectly due to increased afterload stemming from left ventricular (LV) failure. The right ventricle, although structurally and functionally distinct from the left ventricle, plays a critical role in maintaining hemodynamic stability. Its dysfunction contributes to poor clinical outcomes including arrhythmias, heart failure, and increased mortality (3,4). Unfortunately, right ventricular failure (RVF) presents with a heterogeneous clinical picture due to its varied etiologies and the lack of a universally accepted definition. It can be precipitated by acute events such as myocardial infarction (MI) or pulmonary embolism (PE), which cause a sudden increase in RV afterload or impair contractility, leading to systemic venous congestion or reduced cardiac output (5,6). The degree of RV dysfunction often depends on the nature and timing of the underlying pathology (7).

Although left ventricular function has been extensively studied, the evaluation of RV function has historically received less attention. Nonetheless, its prognostic relevance has become increasingly apparent in contemporary cardiology. With the aging population and a growing prevalence of complex comorbid conditions, the clinical importance of assessing RV function in IHD patients has become more critical (8). In most cases, RV infarction occurs in conjunction with inferior LV infarction, and isolated RV infarcts are rare. Early therapeutic strategies, including the use of thrombolytics, vasodilators, and inotropic agents such as dopamine and dobutamine, have been associated with improved outcomes in patients with acute RV involvement (9,10). Among the current diagnostic modalities, echocardiography stands out as the most accessible, non-invasive, and cost-effective tool for evaluating right heart function. Techniques such as tissue Doppler imaging (TDI) allow for the measurement of myocardial velocities, providing valuable insights into both systolic and diastolic RV performance (11,12). A particularly reliable parameter is Tricuspid Annular Plane Systolic Excursion (TAPSE), where values below 17 mm suggest systolic dysfunction and values under 14 mm have been linked to poor prognosis in chronic heart failure patients (13). Despite these established diagnostic approaches, the routine assessment of RV function in patients with IHD remains inconsistent, especially in resource-limited settings. This study aims to investigate the frequency of right ventricular dysfunction in patients with ischemic heart disease using echocardiography at a tertiary care center in Rahim Yar Khan. By evaluating the burden and characteristics of RV dysfunction in this population, the study intends to highlight the importance of timely diagnosis and management, thereby contributing to improved clinical outcomes in affected individuals.

METHODS

An analytical cross-sectional study was conducted over a period of three months, from February to April 2025, at Sheikh Zaid Medical College and Hospital, Rahim Yar Khan, to assess right ventricular dysfunction in patients with ischemic heart disease. A total of 110 participants were enrolled using a non-probability sampling technique. Both male and female patients with a confirmed diagnosis of ischemic heart disease and concurrent left ventricular (LV) dysfunction were included. Exclusion criteria encompassed individuals with congenital heart diseases, non-ischemic myocardial conditions such as myocarditis, and those diagnosed with peripartum cardiomyopathy to ensure homogeneity of the ischemic cohort (2,3). All participants underwent comprehensive transthoracic echocardiographic evaluation using the GE Vivid S6 system, equipped with a 3–5 MHz sector probe. Scans were performed in supine, left lateral decubitus, and right lateral decubitus positions, and in specific cases, such as suprasternal views, the head of the patient was elevated for optimal imaging. Before enrollment, the nature, scope, and purpose of the study were explained to each patient in clear language, and informed written consent was obtained. Ethical approval was secured from the Institutional Ethics Committee of Sheikh Zaid Medical College.

Participants were screened based on presenting symptoms such as chest pain, dyspnea, and generalized fatigue, and underwent echocardiographic imaging to assess cardiac function. A structured data collection sheet was used by the principal investigator to record demographic and clinical parameters, including age, gender, clinical diagnosis, ejection fraction, RV dysfunction, TAPSE, and right ventricular systolic tissue Doppler imaging (RVSTDI). Patients were also specifically queried about their medical history and risk profiles relevant to ischemic heart disease. The collected data were entered and analyzed using SPSS (version not specified) and Microsoft Excel 2021. Descriptive statistics, including mean and standard deviation, were computed for continuous variables such as age, ejection fraction, TAPSE, and RVSTDI. Frequencies and proportions were calculated for categorical variables, including gender distribution, presence of RV dysfunction, RV systolic dysfunction (RVSD) grades, and categorized TAPSE and RVSTDI values. To evaluate associations between echocardiographic parameters and RV dysfunction, independent samples t-tests were applied to compare TAPSE and RVSTDI values between groups with and without RV dysfunction. Bar charts and tables were used for visual representation and clearer interpretation of categorical data trends.

RESULTS

A total of 110 patients diagnosed with ischemic heart disease were included in the study, comprising 62 males (56.4%) and 48 females (43.6%). The mean age of the participants was 49.6 ± 9.87 years, with an age range from 32 to 75 years. The mean ejection fraction across all patients was $36.3\% \pm 7.09$, with values ranging between 25% and 50%. The mean Tricuspid Annular Plane Systolic Excursion (TAPSE) was recorded at 13.65 ± 5.84 mm, with a minimum of 2 mm and a maximum of 21 mm. The right ventricular systolic tissue Doppler imaging (RVSTDI) values ranged from 5 to 15 cm/s, yielding a mean of 10.03 ± 2.54 cm/s. The overall prevalence of right ventricular dysfunction in the study population was 43.6% (n=48), while 56.4% (n=62) did not exhibit any dysfunction. Among patients with RV dysfunction, systolic performance was further graded: 14.5% (n=16) exhibited mild RVSD, 18.2% (n=20) had moderate RVSD, and 10.9% (n=12) showed severe RVSD. The remaining 56.4% (n=62) were classified as having normal RV systolic function. TAPSE values were significantly lower among patients with RV dysfunction. The mean TAPSE among these patients was 8.29 ± 3.56 mm, compared to 17.80 ± 3.33 mm in those without RV dysfunction, indicating a marked reduction in RV longitudinal systolic motion. A similar trend was observed in RVSTDI, although its group-wise breakdown was not statistically detailed in this section and should be considered for comprehensive analysis.

The distribution of ejection fraction revealed that 25.5% (n=28) of patients had an EF of 40%, 23.6% (n=26) had 45%, and 20% (n=22) had 30%, while only one patient (0.9%) had a preserved EF of 50%. This highlights that most participants had moderate to severe left ventricular systolic dysfunction. The extended analysis provided additional insights into the association between right ventricular dysfunction and key variables. A statistically significant difference was observed in RVSTDI values between patients with and without RV dysfunction ($p < 0.001$), confirming that reduced systolic tissue Doppler velocity is associated with RV impairment. Gender-based analysis also revealed a statistically significant relationship ($p < 0.001$), suggesting a notable difference in the prevalence of RV dysfunction between male and female participants. However, no significant correlation was found between left ventricular ejection fraction and the presence of right ventricular dysfunction ($p = 0.213$), indicating that while LV dysfunction often coexists with RV dysfunction, the severity of LV impairment does not directly predict RV involvement in this study population. These findings underscore the importance of independently evaluating RV function, rather than inferring it solely based on LV performance.

Table 1: shows Descriptive Statistics for Age, Ejection fraction, TAPSE and RVSTDI

	N	Minimum	Maximum	Mean	Std. Deviation
Age	110	32.00	75.00	49.6000	9.87741
Ejection fraction	110	25.00	50.00	36.3182	7.09300
TAPSE	110	2.00	21.00	13.6545	5.84735
RVSTDI	110	5.00	15.00	10.0318	2.54345

Table 2: Descriptive Frequency of Ejection Fraction

Ejection Fraction	Frequency	Percent
25.00	16	14.5
30.00	22	20.0
35.00	17	15.5
40.00	28	25.5
45.00	26	23.6
50.00	1	.9
Total	110	100.0

Table 3: shows the Frequency Distribution of Right ventricular dysfunction.

RV dysfunction	Frequency	Percent
No	62	56.4
Yes	48	43.6
Total	110	100.0

Table 4: Frequency distribution of RVSD (Right Ventricular Systolic Dysfunction) grades.

RVSD grades	Frequency	Percent
Normal	62	56.4
Mild	16	14.5
Moderate	20	18.2
Severe	12	10.9
Total	110	100.0

Table 5: Group statistics for TAPSE Values with or without RV dysfunction

Group Statistics				
	RV dysfunction	Mean	Std. Deviation	Std. Error Mean
TAPSE	Yes	8.2917	3.56674	.51481
	No	17.8065	3.33800	.42393

Table 6: statistical analysis

Comparison	Test Statistic	p-Value	Significance (p < 0.05)
RV Dysfunction vs. RVSTDI (T-test)	-11.49	0.0000	True
Gender vs. RV Dysfunction (Chi-square)	62.82	0.0000	True
EF vs. RV Dysfunction (Pearson Correlation)	-0.12	0.2126	False

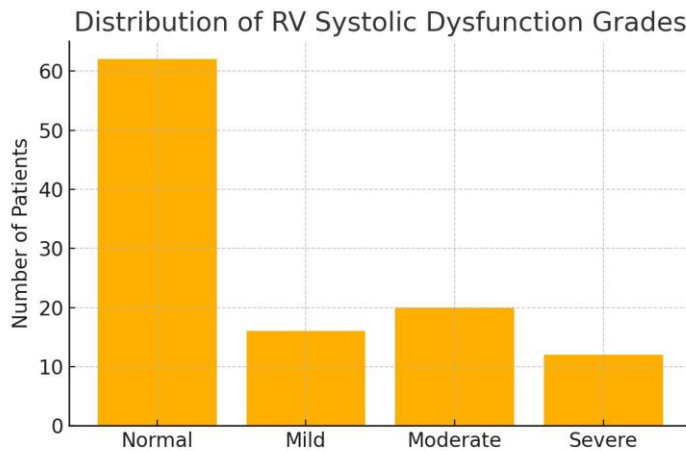


Figure 1 Distribution of RV Systolic Dysfunction

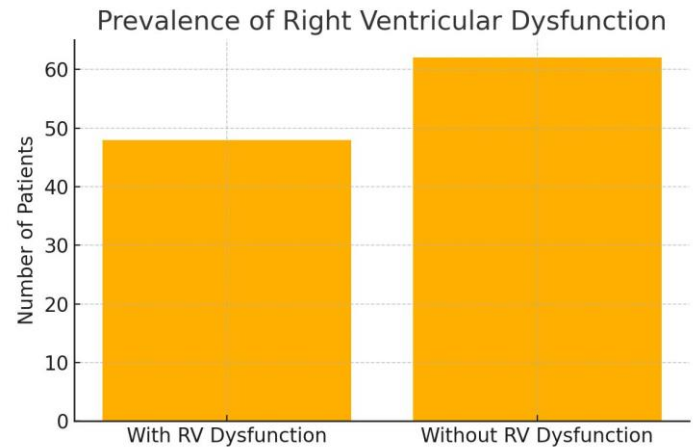


Figure 2 Prevalence of Right Ventricular Dysfunction

DISCUSSION

This study investigated the prevalence of right ventricular (RV) dysfunction among patients with ischemic heart disease (IHD), with findings reinforcing the clinical importance of evaluating RV function in this population, particularly in the presence of advanced disease or left ventricular (LV) dysfunction. The observed prevalence of RV dysfunction was 43.6%, indicating that nearly half of the study population had measurable impairment in RV performance. This figure is notably higher than reported in several earlier studies, where prevalence ranged between 25% and 35% (14,15). The elevated rate in the present study is likely attributed to a combination of factors, including more severe underlying ischemic pathology, the use of enhanced imaging techniques, and potential regional variations in comorbid risk factors. Comparative analysis with previous literature showed that similar studies in populations with inferior myocardial infarction reported RV dysfunction in approximately one-third of cases, while cohorts limited to heart failure showed even lower prevalence. Studies utilizing traditional two-dimensional echocardiography or fractional area change (FAC) tended to report underestimations due to lower sensitivity (16,17). Conversely, investigations using more advanced imaging methods, such as strain-based speckle-tracking echocardiography or cardiac magnetic resonance imaging (MRI), identified RV dysfunction in over 40% of patients, aligning closely with the current findings. These results suggest that diagnostic modality plays a substantial role in detecting subclinical or early-stage RV impairment. Furthermore, regional data from South Asia and the Middle East have consistently shown higher prevalence, which may reflect the higher burden of cardiovascular risk factors such as diabetes, hypertension, and metabolic syndrome in these populations (18,19).

The association observed between RV dysfunction and markers of disease severity, including reduced ejection fraction and higher grades of LV dysfunction, supports the interdependent nature of ventricular performance (20). However, statistical correlation analysis revealed no direct linear relationship between the severity of LV impairment and RV dysfunction, underscoring the need for independent assessment of RV function in clinical settings. Additionally, gender-based differences in RV dysfunction prevalence were statistically significant, which may warrant further exploration into sex-specific pathophysiology or differences in symptom reporting and health-seeking behavior (21,22). A strength of this study lies in its structured assessment of RV function using TAPSE and RV tissue Doppler imaging (RVSTDI), both of which provide quantifiable and reproducible measures of systolic performance. The inclusion of a well-defined IHD population with confirmed diagnoses enhances the internal validity of the findings. Moreover, the use of echocardiographic techniques available in routine clinical practice makes the findings highly relevant for real-world settings, especially in low-resource environments.

Nonetheless, the study has limitations that must be acknowledged. The non-probability sampling method may introduce selection bias, limiting generalizability. The absence of advanced imaging modalities such as 3D echocardiography or cardiac MRI, while pragmatic, may have restricted the detection of subtle RV changes. Furthermore, the cross-sectional design precludes assessment of causal relationships or progression over time. No longitudinal follow-up was performed to correlate RV dysfunction with clinical outcomes,

such as heart failure hospitalization or mortality, which could have enhanced the prognostic implications of the findings. Future research should focus on multicenter longitudinal studies incorporating advanced imaging modalities and diverse populations to validate and expand upon these results. Additionally, exploring the impact of early detection and targeted management of RV dysfunction on clinical outcomes in IHD may provide actionable insights for improving patient care. Standardization of diagnostic protocols and integration of RV assessment into routine IHD evaluations are essential steps toward optimizing cardiovascular risk stratification and therapeutic decision-making.

CONCLUSION

This study concludes that right ventricular dysfunction is a common and clinically significant comorbidity in patients with ischemic heart disease, particularly among those with advanced left ventricular impairment. The findings underscore the importance of routinely assessing right ventricular function during the evaluation of ischemic heart disease to ensure timely diagnosis and appropriate management. Recognizing the interplay between left and right ventricular dysfunction is crucial, as early detection and intervention may help prevent clinical deterioration and improve patient outcomes. Integrating right heart assessment into standard cardiac evaluations represents a meaningful step toward more comprehensive and effective cardiovascular care.

AUTHOR CONTRIBUTION

Author	Contribution
Saba Ajmal*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Khadija Tahir	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Bushra Islam	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Zainab Mehboob	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Aqsa Khalid	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Rabeel Arif	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Hafsa Umair	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Maria Yaseen	Writing - Review & Editing, Assistance with Data Curation
Ahmad Bilal	Writing - Review & Editing, Assistance with Data Curation

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