



Original Research Article

UTILITY OF ECHOCARDIOGRAPHY IN EARLY DIAGNOSIS AND PREVENTION OF CARDIAC REMODELING IN RHEUMATIC HEART DISEASE: A PROSPECTIVE STUDY

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ABSTRACT

Background: Rheumatic heart disease (RHD) remains a major public health problem in developing countries, leading to significant morbidity and mortality among children and young adults. Early detection of valvular involvement and prevention of cardiac remodeling are essential to improve clinical outcomes. The aim is to assess the utility of echocardiography in the early diagnosis and prevention of cardiac remodeling in patients with rheumatic heart disease.

Materials and Methods: This prospective observational study was conducted in a tertiary care hospital in Delhi from December 2022 to December 2024. A total of 1494 patients were included. All participants underwent detailed clinical evaluation and echocardiographic assessment using standard (STAND) and handheld (HAND) echocardiography.

Results: Out of 1494 participants, 1238 (82.9%) were normal, 180 (12.0%) had borderline RHD, and 76 (5.1%) had definite RHD. Mitral regurgitation was the most common lesion, with severe MR predominantly observed in definite RHD cases (86.8%).

Conclusion: Echocardiography is a highly sensitive and reliable modality for early detection of RHD and assessment of cardiac remodeling.

Keywords: Rheumatic heart disease, Echocardiography, Cardiac remodeling, Mitral regurgitation, Handheld echocardiography, Screening.

INTRODUCTION

Rheumatic heart disease (RHD) remains a significant cause of cardiovascular morbidity and mortality in developing countries, particularly in regions with limited healthcare access and socioeconomic constraints. It is a chronic sequela of acute rheumatic fever (ARF), an autoimmune inflammatory condition triggered by untreated or inadequately treated infection with Group A β -hemolytic streptococci. The disease primarily affects children and young adults, leading to progressive valvular damage, heart failure, arrhythmias, and premature death if not diagnosed and managed early.^[1,2]

Globally, RHD continues to pose a substantial public health burden, with an estimated 40 million people affected worldwide, and a disproportionately higher prevalence in low- and middle-income countries such

as India.^[3] In India, the prevalence varies widely across regions but remains a leading cause of acquired heart disease among the young population. The disease most commonly involves the mitral valve, followed by the aortic valve, leading to complications such as mitral stenosis, mitral regurgitation, or mixed valvular lesions.^[4]

The pathophysiology of RHD is characterized by recurrent inflammatory insults to the cardiac valves, resulting in progressive fibrosis, leaflet thickening, calcification, and ultimately valvular dysfunction. These structural changes lead to altered hemodynamics, increased cardiac workload, and subsequent cardiac remodeling. Cardiac remodeling refers to the changes in size, shape, structure, and function of the heart in response to chronic pressure or volume overload. If left unchecked, remodeling

can progress to irreversible myocardial dysfunction and heart failure.^[5]

Early detection of valvular involvement and subclinical cardiac changes is crucial in preventing disease progression and improving long-term outcomes. Traditionally, clinical examination and auscultation have been the primary tools for diagnosis; however, these methods lack sensitivity, especially in detecting early or asymptomatic disease. In this context, echocardiography has emerged as a highly sensitive and non-invasive imaging modality for the evaluation of cardiac structure and function.^[6] Echocardiography provides comprehensive information regarding valvular morphology, severity of regurgitation or stenosis, chamber dimensions, ventricular function, and pulmonary pressures. Advances in echocardiographic techniques, including Doppler imaging, tissue Doppler, and speckle-tracking echocardiography, have further enhanced its ability to detect subtle myocardial dysfunction even before clinical symptoms become apparent. These capabilities make echocardiography an indispensable tool in the early diagnosis and monitoring of RHD.^[7]

The utility of echocardiography extends beyond diagnosis to risk stratification and guiding therapeutic decisions. Early identification of valvular lesions allows timely initiation of secondary prophylaxis with antibiotics, thereby preventing recurrent streptococcal infections and further valvular damage. Additionally, echocardiographic assessment of cardiac remodeling can help in identifying patients at risk of progression to heart failure, enabling early intervention and optimized management strategies.^[8]

Several studies have demonstrated that echocardiographic screening can detect subclinical RHD cases that are missed by clinical examination alone. The World Heart Federation (WHF) has established standardized echocardiographic criteria for the diagnosis of RHD, emphasizing its role in both clinical and epidemiological settings.^[9] Screening programs using echocardiography, particularly in school-aged children, have shown promise in identifying early disease and reducing long-term complications through timely intervention.^[10]

Despite its proven advantages, the integration of echocardiography into routine screening and early diagnostic protocols remains suboptimal in many resource-limited settings due to factors such as cost, lack of trained personnel, and limited infrastructure. Therefore, there is a need to further evaluate its practical utility, cost-effectiveness, and impact on disease outcomes, particularly in high-burden regions.

Given the progressive nature of cardiac remodeling in RHD and its association with adverse clinical outcomes, early detection using echocardiography may play a pivotal role in altering the disease trajectory. By identifying structural and functional cardiac changes at an early stage, clinicians can

implement targeted interventions aimed at preventing or slowing the progression of remodeling and preserving cardiac function.

In this context, the present prospective study is designed to assess the utility of echocardiography in the early diagnosis of rheumatic heart disease and its role in preventing or minimizing cardiac remodeling. The findings of this study may contribute to improving diagnostic strategies, optimizing patient management, and reducing the overall burden of RHD in the community.

MATERIALS AND METHODS

Study Design: This study was designed as a prospective observational study conducted to evaluate the utility of echocardiography in the early diagnosis and prevention of cardiac remodeling in patients with rheumatic heart disease (RHD).

Study Setting: The study was carried out in a tertiary care hospital in Delhi, India, involving patients attending the outpatient and inpatient departments of cardiology and general medicine.

Study Duration: The study was conducted over a period of two years, from December 2022 to December 2024.

Study Population: The study population consisted of patients clinically suspected or diagnosed with rheumatic heart disease who presented to the study center during the study period.

Sample Size: A total of 1494 patients were included in the study based on predefined inclusion and exclusion criteria.

Inclusion Criteria

- Patients of all age groups diagnosed or suspected to have rheumatic heart disease
- Patients willing to participate and provide informed consent
- Patients undergoing echocardiographic evaluation

Exclusion Criteria

- Patients with congenital heart disease
- Patients with non-rheumatic valvular heart diseases
- Patients with previous cardiac surgery or intervention
- Patients unwilling to participate in the study

Data Collection: After obtaining informed consent, detailed clinical information was collected using a structured proforma.

The data included:

- Demographic details (age, sex)
- Clinical history (symptoms such as dyspnea, palpitations, chest pain, history of rheumatic fever)
- Physical examination findings

Echocardiographic Evaluation: All enrolled patients underwent transthoracic echocardiography (TTE) using standard echocardiographic equipment. The echocardiographic assessment included:

- Valve morphology (thickening, calcification, restricted mobility)
- Presence and severity of valvular lesions (mitral stenosis, mitral regurgitation, aortic stenosis, aortic regurgitation)
- Measurement of cardiac chamber dimensions
- Left ventricular systolic and diastolic function
- Pulmonary artery pressure estimation

Severity of valvular lesions was graded according to standard echocardiographic criteria.

Assessment of Cardiac Remodeling

Cardiac remodeling was assessed using echocardiographic parameters, including:

- Left atrial enlargement
- Left ventricular hypertrophy
- Left ventricular dilatation
- Changes in ejection fraction

Patients were categorized based on the presence or absence of remodeling changes.

Follow-Up: Patients were followed prospectively during the study period, and repeat

echocardiographic evaluation was performed where applicable to assess progression or prevention of cardiac remodeling.

Outcome Measures

The primary outcomes assessed were:

- Early detection of rheumatic valvular lesions using echocardiography
- Identification of subclinical disease
- Detection and progression of cardiac remodeling

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using appropriate statistical software (such as SPSS).

- Continuous variables were expressed as mean \pm standard deviation (SD)
- Categorical variables were expressed as frequencies and percentages
- Association between variables was analyzed using Chi-square test or Student's t-test, as appropriate
- A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographics and Echocardiographic Parameters (n=1494)

Parameter	Normal (1238)	Borderline (180)	Definite (76)
Age (mean SD)	10.8 (2.5)	11.6 (2.2)	11.4 (2.3)
Female (%)	672 (54.3%)	88 (48.9%)	40 (52.6%)
MR 1.5–1.9 cm	210	45	4
MR ≥ 2 cm	28	95	66
MS ≥ 4 mmHg	0	0	10
AR ≥ 1 cm	0	20	18
Borderline Category (n = 180)			
Category	Value		
Borderline A	60 (33.3%)		
Borderline B	95 (52.8%)		
Borderline C	25 (13.9%)		
Definite Category (n = 76)			
Category	Value		
Definite A	50 (65.8%)		
Definite B	8 (10.5%)		
Definite C	4 (5.3%)		
Definite D	14 (18.4%)		

[Table 1] presents demographic distribution and echocardiographic findings among study groups. It shows that definite RHD cases have significantly higher severe mitral regurgitation and aortic

regurgitation, indicating disease progression. Age distribution is similar, but structural abnormalities increase with disease severity.

Table 2: Sensitivity and Specificity of HAND vs STAND

Parameter	Prevalence	Sensitivity	Specificity
All RHD	17.1%	82.6%	90.4%
Borderline RHD	12.0%	75.4%	90.4%
Definite RHD	5.1%	95.2%	90.4%
MV thickness ≥ 3 mm	20.5%	52.8%	75.6%
MR ≥ 2 cm	12.6%	61.3%	96.4%
AR ≥ 1 cm	2.5%	83.7%	99.1%

[Table 2] evaluates diagnostic accuracy of handheld echocardiography (HAND) compared to standard echocardiography (STAND). It shows high

sensitivity for definite RHD and high specificity for MR and AR parameters, indicating that handheld devices are effective screening tools.

Table 3: Clinical Symptoms Distribution

Symptom	Normal	Borderline	Definite
Dyspnea	120 (9.7%)	48 (26.7%)	52 (68.4%)
Palpitations	85 (6.9%)	42 (23.3%)	46 (60.5%)

Chest pain	60 (4.8%)	28 (15.6%)	30 (39.5%)
Asymptomatic	973 (78.6%)	62 (34.4%)	8 (10.5%)

[Table 3] highlights that most normal individuals are asymptomatic, whereas symptoms increase with disease severity. Dyspnea and palpitations are most

common in definite RHD, reflecting worsening cardiac function and remodeling.

Table 4: Valve Involvement Pattern

Valve Involvement	Borderline (n=180)	Definite (n=76)
Isolated Mitral Valve	120 (66.7%)	40 (52.6%)
Isolated Aortic Valve	20 (11.1%)	10 (13.2%)
Combined Lesions	40 (22.2%)	26 (34.2%)

[Table 4] The mitral valve is most commonly affected, consistent with known RHD patterns. Combined valve involvement is more frequent in

definite RHD, indicating disease progression and more severe cardiac involvement.

Table 5: Left Ventricular Function (Ejection Fraction)

Ejection Fraction (%)	Normal	Borderline	Definite
≥55%	1200 (96.9%)	150 (83.3%)	40 (52.6%)
40–54%	38 (3.1%)	25 (13.9%)	26 (34.2%)
<40%	0	5 (2.8%)	10 (13.2%)

[Table 5] shows progressive decline in left ventricular function with increasing disease severity. Most normal individuals have preserved EF, whereas

definite RHD shows significant systolic dysfunction, indicating cardiac remodeling.

Table 6: Cardiac Remodeling Parameters

Parameter	Normal	Borderline	Definite
Left atrial enlargement	50 (4.0%)	70 (38.9%)	60 (78.9%)
LV hypertrophy	30 (2.4%)	40 (22.2%)	45 (59.2%)
LV dilatation	20 (1.6%)	35 (19.4%)	50 (65.8%)

[Table 6] demonstrates that cardiac remodeling is strongly associated with disease severity. Left atrial enlargement and LV dilatation are markedly

increased in definite RHD, supporting the role of echocardiography in early detection of structural changes.

Table 7: Severity of Mitral Regurgitation

Severity	Borderline (n=180)	Definite (n=76)
Mild	85 (47.2%)	8 (10.5%)
Moderate	70 (38.9%)	28 (36.8%)
Severe	25 (13.9%)	40 (52.6%)

[Table 7] shows that severe mitral regurgitation is predominantly seen in definite RHD, while borderline cases mainly have mild to moderate MR. This reflects disease progression and worsening valve dysfunction.

previous studies, which have demonstrated that RHD predominantly affects children and adolescents, particularly in endemic regions.^[11] The slightly higher mean age in borderline and definite RHD groups suggests that disease progression occurs gradually over time, reinforcing the importance of early screening. A mild female predominance was observed, which aligns with findings from earlier epidemiological studies, although gender differences in RHD prevalence are generally not pronounced.^[12] Echocardiographic findings in this study demonstrated a clear progression in disease severity across groups. Mitral regurgitation (MR) ≥2 cm was significantly higher in definite RHD (86.8%) compared to borderline and normal groups, indicating its strong association with advanced valvular involvement. Similarly, the presence of aortic regurgitation (AR) ≥1 cm was more frequent in definite cases. These findings are in agreement with established literature, which identifies MR as the most common valvular lesion in RHD, followed by

DISCUSSION

The present prospective study evaluated the utility of echocardiography in the early diagnosis and prevention of cardiac remodeling in patients with rheumatic heart disease (RHD). The findings highlight the significant role of echocardiography not only in identifying subclinical disease but also in detecting progressive structural and functional cardiac changes.

The demographic distribution in the present study revealed a mean age of approximately 10–11 years across all groups, with no significant variation between normal, borderline, and definite RHD categories. This observation is consistent with

AR.^[13] The absence of significant mitral stenosis in early disease stages further supports the concept that regurgitant lesions predominate initially, with stenotic lesions developing later due to chronic fibrosis and calcification.^[14]

The classification of borderline and definite RHD based on WHF criteria in this study further emphasizes the spectrum of disease severity. The predominance of Definite A category (65.8%) suggests that most patients had pathological MR with morphological valve changes, which is considered a hallmark of RHD. This is consistent with prior studies highlighting the diagnostic value of combined Doppler and morphological features.^[15]

A key objective of the study was to evaluate the diagnostic performance of handheld echocardiography (HAND) compared to standard echocardiography (STAND). The results demonstrated high sensitivity (95.2%) for definite RHD and good overall sensitivity (82.6%) for all RHD cases. These findings indicate that HAND is highly effective in detecting clinically significant disease. Moreover, the specificity remained consistently high (90.4%), suggesting a low rate of false-positive diagnoses. Similar findings have been reported in previous studies, which have shown that portable echocardiography devices can be effectively used in large-scale screening programs, particularly in resource-limited settings.^[16]

Among individual echocardiographic parameters, MR ≥ 2 cm and AR ≥ 1 cm demonstrated very high specificity (96.4% and 99.1%, respectively), indicating their reliability as diagnostic markers. However, the relatively lower sensitivity of anterior mitral leaflet thickness (52.8%) suggests that morphological changes alone may not be sufficient for early detection and should be interpreted in conjunction with Doppler findings. This observation supports existing evidence that combined criteria improve diagnostic accuracy.^[17]

Clinical symptom analysis revealed that a large proportion of normal individuals were asymptomatic (78.6%), whereas symptoms such as dyspnea and palpitations increased markedly with disease severity. In definite RHD, dyspnea was present in 68.4% of patients, reflecting impaired cardiac function. These findings highlight the limitation of clinical examination alone, as a substantial number of borderline cases were either asymptomatic or had mild symptoms. This underscores the importance of echocardiographic screening for early diagnosis.^[18]

The pattern of valve involvement observed in this study is consistent with classical descriptions of RHD. The mitral valve was the most commonly affected valve in both borderline (66.7%) and definite RHD (52.6%), followed by combined valvular involvement. The higher proportion of combined lesions in definite RHD (34.2%) indicates disease progression and more extensive cardiac involvement. These findings are in agreement with previous studies that have reported similar patterns of valvular damage.^[19]

Assessment of left ventricular function revealed a progressive decline in ejection fraction (EF) with increasing disease severity. While most normal individuals had preserved EF ($\geq 55\%$), only 52.6% of definite RHD patients maintained normal systolic function, and a significant proportion exhibited moderate to severe dysfunction. This suggests that chronic valvular lesions lead to volume overload and myocardial impairment, ultimately resulting in cardiac remodeling.^[20]

The evaluation of cardiac remodeling parameters further strengthens this observation. Left atrial enlargement, left ventricular hypertrophy, and left ventricular dilatation were significantly more prevalent in definite RHD compared to borderline and normal groups. Notably, left atrial enlargement was present in 78.9% of definite cases, reflecting chronic volume overload due to mitral regurgitation. Similarly, LV dilatation (65.8%) and hypertrophy (59.2%) indicate advanced structural changes. These findings are consistent with the established pathophysiology of RHD, where persistent hemodynamic stress leads to remodeling and eventual heart failure.^[21]

The severity of mitral regurgitation also showed a clear association with disease progression. Severe MR was observed in more than half of definite RHD cases (52.6%), whereas borderline cases predominantly exhibited mild to moderate MR. This progression highlights the importance of early intervention to prevent worsening valvular dysfunction and subsequent cardiac remodeling. Similar trends have been reported in longitudinal studies of RHD patients.^[22]

Overall, the findings of the present study strongly support the utility of echocardiography as a primary diagnostic and monitoring tool in RHD. The ability of echocardiography to detect subclinical disease, assess valve morphology, quantify regurgitation, and evaluate cardiac remodeling makes it indispensable in both clinical and screening settings. Furthermore, the high diagnostic accuracy of handheld echocardiography suggests its potential application in large-scale community screening programs, particularly in resource-constrained regions.

Early detection of RHD through echocardiographic screening allows timely initiation of secondary prophylaxis and appropriate clinical management, thereby preventing disease progression and reducing morbidity. The study also highlights the importance of integrating echocardiographic evaluation into routine clinical practice for at-risk populations.

CONCLUSION

The present prospective study demonstrates that echocardiography is a highly effective and reliable tool for the early diagnosis, prevention and evaluation of rheumatic heart disease (RHD). It enables the detection of both subclinical and clinically significant valvular lesions, which are often

missed on routine clinical examination, particularly in asymptomatic individuals.

The study findings highlight that mitral regurgitation is the most common valvular abnormality, with its severity increasing significantly in definite RHD cases. Aortic regurgitation and combined valvular lesions were also more prevalent in advanced disease, indicating progressive cardiac involvement. Importantly, echocardiographic parameters revealed a clear trend of worsening cardiac remodeling, including left atrial enlargement, left ventricular hypertrophy, and dilatation, along with declining left ventricular function as disease severity increased.

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