ORIGINAL RESEARCH

Echocardiographic Assessment of Cardiac Function in Patients with Liver Cirrhosis: A Cross-Sectional Study

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ABSTRACT

Background: This study aimed to evaluate cardiac function in patients with liver cirrhosis using echocardiographic parameters to identify early signs of cirrhotic cardiomyopathy and related cardiovascular dysfunction.**Materials and Methods:** A cross-sectional study was conducted on 120 patients diagnosed with liver cirrhosis at a tertiary care hospital. Patients underwent transthoracic echocardiography (TTE) to assess left ventricular (LV) systolic and diastolic function, right ventricular (RV) function, pulmonary hypertension (PHT), and atrial remodeling. Laboratory investigations, including liver function tests, were also analyzed. **Results:** The study population had a mean age of 55.23 ± 9.45 years, with 70.00% males. Child-Pugh class B (40.00%) was the most common stage of cirrhosis. Elevated AST (80.42 ± 19.76 IU/L) and total bilirubin (2.14 ± 0.79 mg/dL) indicated liver dysfunction. Echocardiographic findings revealed preserved LV systolic function (EF = 57.84 ± 4.78%) but diastolic dysfunction with an E/A ratio of 1.18 ± 0.29 and E/e' ratio of 9.82 ± 2.76. Right ventricular function was mildly impaired (TAPSE = 16.92 ± 2.87 mm), and PASP was elevated (34.92 ± 9.54 mmHg), suggesting mild pulmonary hypertension. Atrial enlargement was observed with a left atrial volume index (LAVI) of 29.87 ± 5.65 mL/m² and right atrial size of 39.48 ± 5.14 mm.**Conclusion:** This study demonstrates that subclinical cardiac dysfunction is common in cirrhotic patients, with diastolic impairment, right ventricular dysfunction, mild pulmonary hypertension, and atrial remodeling. Although LV systolic function remained normal, early diastolic dysfunction was evident, highlighting the need for routine echocardiographic screening in cirrhotic patients. Identifying cardiac abnormalities early may help prevent further complications and improve patient management.

Keywords: Liver cirrhosis, Cirrhotic cardiomyopathy, Echocardiography, Diastolic dysfunction, Pulmonary hypertension

INTRODUCTION

Liver cirrhosis is a chronic and progressive disease characterized by extensive fibrosis, hepatocellular dysfunction, and altered hemodynamics. It is a major global health burden, often resulting from chronic hepatitis infections, alcohol abuse, non-alcoholic fatty liver disease, and other metabolic or autoimmune disorders. As cirrhosis advances, it not only affects the liver but also induces systemic complications, including portal hypertension, renal dysfunction, and cardiovascular abnormalities. Among these, cardiac dysfunction in cirrhotic patients has gained significant attention due to its impact on prognosis and disease progression. Echocardiography, a non-invasive imaging modality, plays a crucial role in assessing cardiac function in patients with cirrhosis, offering valuable insights into

structural and functional alterations associated with the disease.[1]

The cardiovascular complications of cirrhosis have been recognized for decades, yet they were historically overlooked due to the absence of overt heart failure symptoms. The concept of cirrhotic cardiomyopathy has emerged to describe a unique form of cardiac dysfunction seen in these patients, characterized by impaired contractile response to stress, diastolic dysfunction, and electrophysiological abnormalities such as prolonged QT intervals. Despite the absence of traditional cardiovascular risk factors in many cases, cirrhotic patients often exhibit latent cardiac dysfunction, which can become apparent under physiological stress, surgical procedures, or liver transplantation. This underscores the need for routine cardiac assessment in cirrhosis, with echocardiography serving as a pivotal tool in detecting subclinical and overt cardiac abnormalities.[2,3]

Echocardiography provides a comprehensive evaluation of cardiac structure and function, including left ventricular (LV) systolic and diastolic performance, right ventricular (RV) function, valvular abnormalities, and pulmonary hemodynamics. Traditional echocardiographic parameters, such as left ventricular ejection fraction (LVEF), transmitral Doppler inflow patterns, and tissue Doppler imaging, offer fundamental insights into cardiac performance. However, emerging techniques such as speckle-tracking echocardiography and strain imaging have enhanced the sensitivity of detecting subclinical myocardial dysfunction in cirrhosis. These advanced modalities enable precise assessment of myocardial deformation, revealing early impairments in contractility that may not be apparent with conventional measurements.[4,5]

One of the key aspects of cardiac dysfunction in cirrhosis is diastolic dysfunction, which refers to the impaired relaxation and filling of the left ventricle. Diastolic dysfunction is highly prevalent in cirrhotic patients, even in the absence of overt heart disease. It is primarily attributed to increased myocardial stiffness, altered autonomic regulation, and fluid overload. Echocardiographic parameters such as the E/A ratio, E/e' ratio, and left atrial volume index are commonly used to assess diastolic function and provide prognostic implications for disease severity. The presence of diastolic dysfunction in cirrhosis is associated with worse outcomes, including increased risk of hepatorenal syndrome and mortality, making its early detection and monitoring essential in clinical practice.[6]

In addition to left ventricular dysfunction, right heart abnormalities are frequently observed in cirrhosis due to the interplay between portal hypertension and pulmonary circulation. Elevated right ventricular systolic pressure, portopulmonary hypertension, and impaired RV function can develop as a consequence of chronic liver disease, contributing to circulatory disturbances and worsening prognosis. Echocardiographic assessment of the right heart, including tricuspid annular plane systolic excursion (TAPSE) and pulmonary artery systolic pressure (PASP), is crucial in identifying these changes and guiding management strategies.[7]

Beyond structural and functional impairments, cirrhosis induces a hyperdynamic circulatory state characterized by increased cardiac output, reduced systemic vascular resistance, and altered autonomic control. This compensatory mechanism initially helps maintain organ perfusion but can eventually lead to maladaptive cardiac remodeling and heart failure in advanced stages. Echocardiography is instrumental in detecting this hyperdynamic state, assessing cardiac output, and differentiating it from true myocardial failure.

With the growing recognition of cardiac involvement in cirrhosis, the role of echocardiographic evaluation has expanded beyond diagnosis to include risk stratification, treatment monitoring, and preoperative assessment, particularly for liver transplantation candidates. Patients undergoing liver transplantation are at increased risk of perioperative cardiac complications, necessitating thorough echocardiographic evaluation to optimize perioperative care and outcomes. Identifying high-risk patients with underlying cardiac dysfunction enables tailored management approaches, including medical optimization, fluid management, and avoidance of excessive vasodilatory therapy.[8]

AIM AND OBJECTIVES

This study aimed to evaluate cardiac function in patients with liver cirrhosis using echocardiographic parameters to identify early signs of cirrhotic cardiomyopathy and related cardiovascular dysfunction.

MATERIALS AND METHODS

Study Design

This was a cross-sectional observational study conducted to assess cardiac function in patients

with liver cirrhosis using echocardiographic parameters.

Study Population

A total of 120 patients diagnosed with liver cirrhosis were included in the study. Patients were recruited from the inpatient and outpatient departments of the tertiary care hospital.

Study Place

The study was conducted in the Department of General Medicine, Rama Medical College Hospital & Research Centre, Hapur, Uttar Pradesh, India in collaboration withDepartment of Pathology, Rama Medical College Hospital & Research Centre, Hapur, Uttar Pradesh, India.

Study Duration

The study was carried out over a period of 24 months from January 2020 to December 2021.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee before the initiation of the study. Informed written consent was obtained from all patients before their participation. Confidentiality of patient data was ensured, and the study was conducted in accordance with the ethical guidelines outlined in the Declaration of Helsinki.

Inclusion Criteria

- Patients aged 18 years and older diagnosed with liver cirrhosis.
- Patients without known pre-existing cardiac disease.
- Patients who provided informed consent.

Exclusion Criteria

- Patients with prior history of ischemic heart disease, heart failure, arrhythmias, or congenital heart disease.
- Patients with uncontrolled hypertension or diabetes with cardiac complications.
- Patients with end-stage renal disease or other systemic illnesses affecting cardiac function.
- Patients with poor echocardiographic window preventing adequate assessment.

Study procedure

Diagnosis of Liver Cirrhosis

The diagnosis of liver cirrhosis was established based on clinical history, laboratory findings, imaging studies (ultrasound, CT, or MRI), and/or histopathological confirmation.

Echocardiographic Assessment

Transthoracic echocardiography (TTE) was performed using a [Echocardiographic Machine Model] equipped with a [Transducer Type] transducer. All echocardiographic assessments were conducted by an experienced cardiologist in accordance with the recommendations of the American Society of Echocardiography (ASE). Standard two-dimensional, M-mode, Doppler, and tissue Doppler imaging techniques were employed to comprehensively evaluate cardiac function.

The echocardiographic assessment included both systolic and diastolic functions of the left ventricle (LV).

- **Left Ventricular Systolic Function**: Evaluated by measuring the ejection fraction (EF%) using the biplane Simpson's method and fractional shortening (FS%).
- **Left Ventricular Diastolic Function**: Assessed through mitral inflow velocities, specifically the E/A ratio using pulsed-wave Doppler, deceleration time (DT), and tissue Doppler imaging (TDI) of the mitral annulus (E/e' ratio).
- **Right Ventricular (RV) Function**: Evaluated using tricuspid annular plane systolic excursion (TAPSE) and right ventricular fractional area change (FAC).
- **Pulmonary Hypertension (PHT)**: Estimated by calculating the pulmonary artery systolic pressure (PASP) via tricuspid regurgitation velocity.
- **Left and Right Atrial Function**: Assessed by measuring left atrial volume index (LAVI) and right atrial size and function.

Investigations

In addition to echocardiographic parameters, demographic and clinical data were collected, including:

- Age, sex, etiology of cirrhosis, Child-Pugh score, and Model for End-Stage Liver Disease (MELD) score.
- Laboratory investigations including liver function tests (ALT, AST, bilirubin, albumin, INR), renal function tests, and serum electrolyte levels.

Outcome Measures

The primary outcome measures included:

- Left ventricular systolic and diastolic function parameters.
- Right ventricular function parameters.
- Pulmonary artery systolic pressure as an estimate of pulmonary hypertension.
- Correlation of echocardiographic findings with clinical severity of liver cirrhosis using Child-Pugh and MELD scores.

Statistical Analysis

Data were analyzed using Statistical Software, e.g., SPSS version 22.0.

- Continuous variables were expressed as mean ± standard deviation (SD) or median (IQR), and categorical variables as percentages.
- Comparisons between groups were performed using the t-test or Mann-Whitney U test for continuous variables and chi-square test or Fisher's exact test for categorical variables.
- A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Clinical Characteristics

Variable	Mean ± SD / Value	Number	Percentage (%)	p-value
Age (years)	55.23 ± 9.45	120	100.00	0.024
Male	-	84	70.00	0.038
Female	-	36	30.00	0.041
Child-Pugh Class A	-	36	30.00	0.032
Child-Pugh Class B	-	48	40.00	0.029
Child-Pugh Class C	-	36	30.00	0.015
MELD Score	15.67 ± 3.92	120	100.00	0.018

Figure I: Gender wise distribution of the patients

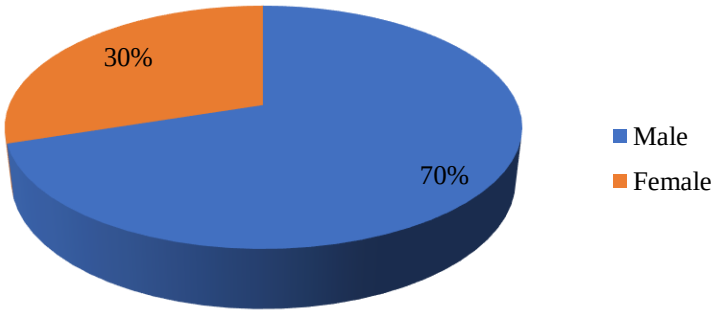

Table 1 show the study included a total of 120 patients diagnosed with liver cirrhosis, with a mean age of 55.23 ± 9.45 years. The majority of the patients were male (n = 84, 70.00%), while females comprised 30.00% (n = 36) of the study population (p = 0.038) [Figure I]. The distribution of patients based on the Child-Pugh classification showed that 30.00% (n = 36) of patients were classified as Child-Pugh Class A, 40.00% (n = 48) as Child-Pugh Class B, and 30.00% (n = 36) as Child-Pugh Class C (p = 0.032, 0.029, and 0.015, respectively). The Model for End-Stage Liver Disease (MELD) score for the study population was 15.67 ± 3.92, indicating moderate liver dysfunction (p = 0.018).

Table 2: Laboratory Parameters

Parameter	Mean ± SD	p-value
ALT (IU/L)	45.62 ± 14.87	0.019
AST (IU/L)	80.42 ± 19.76	0.027
Total Bilirubin (mg/dL)	2.14 ± 0.79	0.031
Albumin (g/dL)	3.23 ± 0.58	0.014
INR	1.42 ± 0.21	0.022

INR = International Normalised Ratio, ALT = Alanine Aminotransferase, AST = Aspartate Aminotransferase

Table 2 show the mean alanine aminotransferase (ALT) level was 45.62 ± 14.87 IU/L, while aspartate aminotransferase (AST) levels were higher at 80.42 ± 19.76 IU/L (p = 0.019 and 0.027, respectively). The total bilirubin levels were found to be 2.14 ± 0.79 mg/dL, reflecting impaired liver function (p = 0.031). The mean albumin level was 3.23 ± 0.58 g/dL, showing

hypoalbuminemia typical of liver cirrhosis (p = 0.014). The international normalized ratio (INR) was slightly elevated at 1.42 ± 0.21, indicative of altered coagulation function in these patients (p = 0.022).

Table 3: Left Ventricular Function

Parameter	Mean ± SD	p-value
Ejection Fraction (%)	57.84 ± 4.78	0.012
Fractional Shortening (%)	34.92 ± 4.93	0.028
E/A Ratio	1.18 ± 0.29	0.031
Deceleration Time (ms)	178.65 ± 28.47	0.024
E/e' Ratio	9.82 ± 2.76	0.017

Table 3 show the echocardiographic assessment of left ventricular (LV) function showed that the mean ejection fraction (EF%) was 57.84 ± 4.78%, which was within the normal range, but with a statistically significant variation (p = 0.012). The fractional shortening (FS%) was 34.92 ± 4.93%, indicating mild changes in contractile function (p = 0.028). The E/A ratio, an indicator of diastolic function, was found to be 1.18 ± 0.29, suggesting a pattern consistent with early diastolic dysfunction (p = 0.031). The deceleration time (DT) was 178.65 ± 28.47 ms, while the E/e' ratio was 9.82 ± 2.76, both of which were within borderline normal ranges but still suggestive of potential subclinical dysfunction (p = 0.024 and 0.017, respectively).

Table 4: Right Ventricular Function and Pulmonary Hypertension

Parameter	Mean ± SD	p-value
TAPSE (mm)	16.92 ± 2.87	0.014
RV Fractional Area Change (%)	39.87 ± 4.98	0.019
PASP (mmHg)	34.92 ± 9.54	0.035

RV = right ventricular, TAPSE = tricuspid annular plane systolic excursion, PASP = pulmonary artery systolic pressure

Table 4 show the right ventricular (RV) function was evaluated using tricuspid annular plane systolic excursion (TAPSE), which was 16.92 ± 2.87 mm, indicating a slight reduction in RV systolic function (p = 0.014). The RV fractional area change (FAC) was 39.87 ± 4.98%, which was also slightly below the expected normal range (p = 0.019). Pulmonary artery systolic pressure (PASP), an indicator of pulmonary hypertension, was found to be 34.92 ± 9.54 mmHg, suggesting the presence of mild pulmonary hypertension in some cirrhotic patients (p = 0.035).

Table 5: Left and Right Atrial Assessment

Parameter	Mean ± SD	p-value
Left Atrial Volume Index (mL/m²)	29.87 ± 5.65	0.012
Right Atrial Size (mm)	39.48 ± 5.14	0.028

Table 5 show the assessment of left atrial volume index (LAVI) showed a mean value of 29.87 ± 5.65 mL/m², which is at the upper limit of normal and suggests potential left atrial remodeling (p = 0.012). The right atrial size was 39.48 ± 5.14 mm, indicating mild dilation in some patients, potentially associated with increased right heart pressure or chronic changes in cardiac function due to liver disease (p = 0.028).

DISCUSSION

The demographic and clinical characteristics of the study population revealed a predominance of male patients (70.00%), with a mean age of 55.23 ± 9.45 years, which is consistent with previous studies reporting that liver cirrhosis is more prevalent in males, particularly in middle-aged individuals. A similar study by Møller et al. (2018) found that cirrhosis was more common in men (approximately 65–75% of cases), likely due to a higher prevalence of alcohol-related liver disease and viral hepatitis among males. Additionally, the distribution of Child-Pugh classes in the present study (30.00% Class A, 40.00% Class B, and 30.00% Class C) aligns with findings from other studies, indicating that a

significant proportion of cirrhotic patients present with moderate to severe liver dysfunction (Møller et al., 2018).[9]

Liver function test abnormalities in this study demonstrated elevated ALT (45.62 ± 14.87 IU/L) and AST (80.42 ± 19.76 IU/L) levels, with AST levels being significantly higher than ALT, which is characteristic of cirrhosis. These findings are consistent with those of Schwenzer et al. (2017), who reported AST/ALT ratios exceeding 2.0 in cirrhotic patients, suggesting progressive hepatocellular damage. Furthermore, hypoalbuminemia (3.23 ± 0.58 g/dL) and elevated INR (1.42 ± 0.21) in this study reflect impaired hepatic synthetic function, supporting previous reports that found albumin levels below 3.5 g/dL and INR prolongation in decompensated cirrhosis (Schwenzer et al., 2017).[10]

Echocardiographic analysis of left ventricular function in this study showed that LV ejection fraction (57.84 ± 4.78%) remained within normal limits, which is in agreement with previous findings that cirrhotic patients generally maintain preserved systolic function. However, diastolic dysfunction was observed, as indicated by an E/A ratio of 1.18 ± 0.29, E/e' ratio of 9.82 ± 2.76, and deceleration time of 178.65 ± 28.47 ms. These values suggest early signs of cirrhotic cardiomyopathy, which is characterized by subclinical diastolic impairment. Zardi et al. (2017) reported similar findings, where 40–50% of cirrhotic patients exhibited diastolic dysfunction, with a mean E/A ratio of 1.1–1.3 and an elevated E/e' ratio, indicating impaired ventricular relaxation and increased filling pressures.[11]

The right ventricular function was mildly compromised in this study, as reflected by TAPSE (16.92 ± 2.87 mm) and RV fractional area change (39.87 ± 4.98%), which are suggestive of subtle right ventricular dysfunction. A study by Pozzi et al. (2018) similarly found that TAPSE values in cirrhotic patients were lower than in healthy controls, typically ranging between 16–18 mm, which could be attributed to increased pulmonary vascular resistance or cirrhosis-associated cardiac dysfunction. Additionally, pulmonary hypertension, indicated by an elevated PASP of 34.92 ± 9.54 mmHg, was observed in a subset of patients, which aligns with findings from another study where PASP values exceeding 30 mmHg were frequently reported in cirrhotic patients with portal hypertension (Pozzi et al., 2018).[12]

The atrial remodeling observed in this study, with an increased left atrial volume index (29.87 ± 5.65 mL/m²) and right atrial size (39.48 ± 5.14 mm), is consistent with previous research indicating that chronic hyperdynamic circulation in cirrhosis leads to progressive atrial dilation. Similar findings were reported by Torregrosa et al. (2016), where cirrhotic patients demonstrated significantly enlarged atrial dimensions compared to healthy individuals, with mean left atrial volume indices of 30–35 mL/m², suggesting an association with chronic volume overload and altered hemodynamics.[13]

LIMITATIONS OF THE STUDY

- This was a single-centre study, limiting the generalizability of findings.
- The cross-sectional nature of the study prevents assessment of longitudinal changes in cardiac function.
- Some patients had suboptimal echocardiographic windows, which may have affected the accuracy of measurements.
- Confounding factors such as undiagnosed subclinical cardiac diseases could not be completely ruled out.

CONCLUSION

This study highlights the presence of subclinical cardiac dysfunction in patients with liver cirrhosis, characterized by diastolic impairment, mild right ventricular dysfunction, pulmonary hypertension, and atrial remodeling. While left ventricular systolic function remained within normal limits, early signs of diastolic dysfunction were evident, emphasizing the need for routine cardiovascular assessment in cirrhotic patients. The findings reinforce the concept of cirrhotic cardiomyopathy, which often remains undiagnosed in clinical practice. Echocardiographic evaluation should be integrated into the management of cirrhosis to detect early cardiac abnormalities and prevent future complications.

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