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Frequency of Echocardiographic Changes in Patients with Chronic Liver Disease at a Tertiary Care Hospital in Karachi

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ABSTRACT

Chronic liver disease (CLD) is a major health burden in Pakistan, commonly due to viral hepatitis. Cirrhotic cardiomyopathy (CCM) is an underdiagnosed complication that may impact prognosis and management. **Objectives:** To determine the frequency and spectrum of echocardiographic abnormalities in CLD patients and assess their correlation with disease severity based on the Child-Pugh classification. **Methods:** A cross-sectional study of 187 adult CLD patients was conducted at Dr. Ruth K.M. Pfau Civil Hospital, Karachi, between September 2024 and February 2025. Echocardiographic parameters, including pulmonary artery pressure, ejection fraction, systolic, and diastolic function, were evaluated using a Philips EPIQ 7 (Philips Healthcare, Andover, MA, USA) system. Patients were categorized according to Child-Pugh class (B or C). Associations between echocardiographic findings and Child-Pugh class were analyzed using chi-square and logistic regression tests, with $p < 0.05$ considered significant. **Results:** Mean age was 55.6 ± 13.4 years; 51.9 % were men. The leading etiologies were hepatitis C (46 %) and B (26 %). Diastolic dysfunction was the most frequent abnormality (53.5 %), while systolic dysfunction occurred in 23.5 %—significantly more common in women ($p < 0.001$) and in advanced disease (Child-Pugh C: 67 % vs B: 38 %; OR ≈ 3.4, p=0.0001). Pulmonary hypertension (23.5%) and reduced ejection fraction (10.2%) showed no correlation with Child-Pugh class. **Conclusions:** Echocardiographic abnormalities are common in CLD, particularly diastolic dysfunction. Systolic dysfunction increases with worsening hepatic severity, emphasizing the need for routine cardiac assessment in cirrhotic patients for better risk stratification and management.

INTRODUCTION

In Pakistan, chronic viral hepatitis and delayed access to screening and treatment are major causes of chronic liver disease (CLD), a growing health concern [1]. Cirrhotic cardiomyopathy (CCM), one of the extrahepatic complications that patients with cirrhosis frequently experience, has become a clinically significant but often underdiagnosed condition [2]. In the absence of primary heart disease, CCM includes both structural and functional cardiac alterations, particularly electrophysiological abnormalities, systolic impairment under stress, and left ventricular diastolic dysfunction (LVDD) [2, 3]. Advances in transthoracic echocardiography have made it easier to identify CCM using tissue Doppler and deformation-based indices. Updated consensus criteria published in 2020 incorporate left atrial volume, E/e′ ratio, and septal or lateral e′ velocity to improve diagnostic specificity and to distinguish true diastolic dysfunction from preload-related changes in cirrhosis [4, 5]. The most common abnormality is still diastolic dysfunction, though reported prevalence varies by study population and methodology [3, 6].

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Furthermore, echocardiography is the primary non-invasive screening tool for Porto-pulmonary hypertension (PPH), a clinically significant cardiovascular consequence of cirrhosis [6, 7]. These abnormalities have important clinical consequences. Cirrhotic cardiomyopathy and Porto-pulmonary hypertension have been linked to peri-procedural instability during acute decompensation, trans jugular intrahepatic portosystemic shunt (TIPS) placement, and liver transplantation [8, 9]. Some of these cardiac changes may partially regress following successful liver transplantation, suggesting that they are at least partly reversible and hemodynamically driven [9]. Therefore, current guidance strongly supports routine echocardiographic assessment in cirrhotic patients for early detection and risk stratification [5, 10]. Even though CLD is very common in Pakistan, there is limited local published data on the frequency and pattern of echocardiographic abnormalities, particularly diastolic dysfunction and Porto-pulmonary hypertension in cirrhotic patients [1, 11]. Addressing this gap is relevant to transplant candidacy, intensive care planning, and long-term surveillance.

This study aimed to describe the spectrum and frequency of echocardiographic abnormalities in CLD, and examine their association with liver disease severity using the Child-Pugh classification at a large public-sector tertiary-care hospital in Karachi.

METHODS

This was an analytical cross-sectional study conducted from September 2024 to February 2025 in the inpatient and outpatient units of the Department of Medicine at Dr. Ruth K.M. Pfau Civil Hospital, Karachi. The study protocol was reviewed and approved by the Institutional Review Board of Dow University of Health Sciences (DUHS) (IRB-3563/DUHS/Approval/2024/230). All participants provided written informed consent before enrollment. The minimum required sample size was calculated using Daniel's formula for prevalence studies ($Z^2 \times p \times (1-p) / d^2$), assuming Z = 1.96 for 95% confidence, expected prevalence of echocardiographic abnormality in cirrhosis of 39% based on prior local data [11], and a margin of error (d) of 8%. This yielded a required sample of approximately 180 patients. To enhance precision and allow subgroup comparisons by Child-Pugh class and gender, and to compensate for anticipated non-response or incomplete studies, we aimed to recruit at least 185 patients. A total of 187 patients were ultimately included. A non-probability consecutive sampling strategy was used. All eligible patients with established cirrhosis presenting during the study period and fulfilling the inclusion criteria were approached. Consecutive non-probability sampling may introduce selection bias; however, this approach was considered appropriate and feasible in a high-volume tertiary-care hospital where true randomization is not practical. Adults between 30 and 80 years of age, of either gender, with clinically, biochemically, and ultrasonographically established cirrhosis of ≥6 months' duration and classified as Child-Pugh class B or C were eligible. Exclusion criteria were: history of primary cardiac disease (including prior acute coronary syndrome, valvular heart disease, known cardiomyopathy, uncontrolled hypertension, or chronic heart failure), chronic kidney disease, chronic primary pulmonary disease, asthma, stroke with residual hemodynamic compromise, or any condition that could independently alter left ventricular function or pulmonary pressures. Clinical and demographic information (including age, sex, known etiology of CLD, and decompensation symptoms) was obtained at the time of presentation using a structured, interviewer-administered proforma. These data were derived from direct patient assessment, bedside examination, and review of hospital records (admission notes, laboratory reports, and abdominal ultrasound findings). Signs and symptoms reported (e.g., abdominal distension, altered sensorium, gastrointestinal bleeding) were recorded prospectively on this proforma at the time of inclusion. The Child-Pugh score (class B or C) was calculated for each patient using standard clinical and laboratory parameters (serum bilirubin, serum albumin, international normalized ratio (INR), presence of ascites, and grade of hepatic encephalopathy). All participants underwent transthoracic echocardiography performed by a consultant cardiologist with ≥5 years' post-fellowship experience, using a Philips EPIQ7 (Philips Healthcare, Andover, MA, USA) cardiac ultrasound system by an experienced consultant cardiologist with a phased-array transducer (2–4 MHz). Standard parasternal long-axis, parasternal short-axis, apical four-chamber, and apical two-chamber views were acquired in the left lateral decubitus position according to ASE/EACVI recommendations. To minimize observer bias, the cardiologist conducting the echocardiography was not informed of the patients' Child-Pugh class at the time of image acquisition and interpretation. The following parameters were assessed and defined: Systolic dysfunction: visually or quantitatively reduced left ventricular systolic performance, including an ejection fraction <55% or impaired global systolic function on standard echocardiographic assessment. Diastolic dysfunction: abnormal left ventricular relaxation/filling consistent with ASE/EACVI criteria, including elevated E/e' ratio (>14), reduced septal or lateral e' velocity (septal e' <7 cm/s or lateral e<10 cm/s), enlarged left atrial volume index (>34 mL/m^2), or reduced deceleration time, in the absence of confounding primary cardiac disease. Pulmonary

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hypertension: elevated estimated pulmonary artery systolic pressure consistent with pulmonary hypertension, inferred from tricuspid regurgitation jet velocity and right ventricular systolic pressure estimation. For descriptive purposes in this study, pulmonary hypertension was recorded when calculated pulmonary artery systolic pressure was >25 mmHg on echocardiography, acknowledging that right-heart catheterization remains the gold standard. Reduced ejection fraction (EF): EF <55%. Data were entered and analyzed using IBM SPSS Statistics version 26.0. Continuous variables (e.g., age, ejection fraction) were summarized as mean ± standard deviation (SD), while categorical variables (e.g., gender, etiology of chronic liver disease, presence of systolic dysfunction, diastolic dysfunction, and pulmonary hypertension) were expressed as frequencies and percentages. Comparisons of categorical variables across groups (e.g., echocardiographic findings by gender and by Child-Pugh class) were evaluated using the chi-square test. To evaluate the association between echocardiographic manifestations and disease severity, binary logistic regression analysis was performed. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate the strength of associations. For these analyses, Child-Pugh Class B was defined as the reference category, and odds for Class C were calculated relative to this baseline. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 187 patients with chronic liver disease were enrolled. The mean age was 55.6 ± 13.4 years, ranging from early adulthood to the late seventies. Male comprised 97 (51.9%) and female 90 (48.1%). The cohort predominantly reflected advanced disease: 45.5% were classified as Child-Pugh class B and 54.5% as class C; no patients met criteria for compensated Child-Pugh class A at presentation. Hepatitis C virus infection was the most common etiology (87 cases; 46%), followed by hepatitis B (48 cases; 26%). Other etiologies included autoimmune hepatitis (19 cases), alcoholic liver disease (14 cases), non-alcoholic steatohepatitis (10 cases), and primary biliary cirrhosis (9 cases). Abdominal distension, reflecting clinically significant ascites and decompensation, was the most frequently reported symptom. Neurological compromise (altered level of consciousness) and bilateral pedal edema were also common, indicating encephalopathy and fluid overload in advanced cirrhosis. Less frequent but clinically important findings included jaundice and upper gastrointestinal bleeding (hematemesis, melena) (Table 1).

Table 1: Frequency of Symptoms at Presentation in Chronic Liver Disease (n=187)

Symptoms	n (%)
Abdominal Distension	163 (87.2%)
Bilateral Pedal Edema	81 (43.3%)
Altered Level of Consciousness	48 (25.7%)
Melena	34 (18.2%)
Jaundice	33 (17.6%)
Hematemesis	24 (12.8%)
Low Appetite	14 (7.5%)
Decrease Urine Output	5 (2.7%)

A higher proportion of male were categorized as Child-Pugh class C, suggesting that male patients more frequently presented with more advanced hepatic decompensation (Table 2).

Table 2: Child-Pugh Class Distribution by Gender (n=187)

Child-Pugh Class	Gender	n (%within gender)
B	Female	51 (56.7%)
B	Male	34 (35.1%)
C	Female	39 (43.3%)
C	Male	63 (64.9%)

Overall, 33.2% of patients had a "normal" echocardiogram, defined as the absence of systolic dysfunction, diastolic dysfunction, pulmonary hypertension, and reduced EF. Male were significantly more likely to have a normal echocardiogram (45.4%) compared to female to female (20.0%, p<0.001*). Systolic dysfunction was present in 23.5% overall and showed a marked female predominance (37.8% in female vs. 10.3% in male, p<0.001*). Diastolic dysfunction was the most common abnormality (53.5% overall), with no statistically significant difference between female and male (p = 0.323). Pulmonary hypertension, defined as estimated pulmonary artery systolic pressure >25 mmHg, was observed in 23.5% of patients with no significant gender difference. A reduced ejection fraction (<55%) was present in 10.2% of the cohort and was similar across genders (Table 3).

Table 3: Echocardiographic Manifestations by Gender (n=187)

Echo Manifestation	Female, n (%)	Male, n (%)	Overall, n (%)	p-value
Normal Echo (Both Diastolic and Systolic Normal)	18 (20.0%)	44 (45.4%)	62 (33.2%)	<0.001*
Systolic Dysfunction	34 (37.8%)	10 (10.3%)	44 (23.5%)	<0.001*
Diastolic Dysfunction	52 (57.8%)	48 (49.5%)	100 (53.5%)	0.323
Pulmonary Hypertension (PA > 25 mmHg)	19 (21.1%)	25 (25.8%)	44 (23.5%)	0.563
Reduced Ejection Fraction (< 55 %)	9 (10.0%)	10 (10.3%)	19 (10.2%)	1.000

> p<0.05 considered statistically significant; *p<0.001 indicates highly significant result.

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Systolic dysfunction showed a significant association with worsening liver disease and was more frequent in patients with Child-Pugh Class C compared to Class B. In contrast, diastolic dysfunction did not show a statistically significant association with Child-Pugh class. Pulmonary hypertension and reduced ejection fraction were observed at comparable frequencies across both classes and were not significantly associated with liver disease severity (Table 4).

Table 4: Association Between Child-Pugh Class (B vs. C) and Echocardiographic Abnormalities

Echo Findings	Child-Pugh Class	Odds Ratio (95% CI)	p-value
Systolic Dysfunction	Class B (ref) Class C	1.0 3.4 (2.0 – 5.6)	-<0.0001*
Diastolic Dysfunction	Class B (ref) Class C	1.0 0.65 (0.35 – 1.2)	-0.17
Pulmonary Hypertension	Class B (ref) Class C	1.0 1.0 (0.55 – 1.8)	-0.92
Reduced EF (<55%)	Class B (ref) Class C	1.0 1.0 (0.40 – 2.5)	-0.99

Abbreviations: OR = Odds Ratio; CI = Confidence Interval; Ref = Reference category; EF = Ejection Fraction. *p<0.001 highly significant; p<0.05 considered significant.

DISCUSSION

In this analytical cross-sectional study of 187 patients with advanced chronic liver disease, echocardiographic abnormalities were common. Diastolic dysfunction was the most frequent abnormality overall, whereas systolic dysfunction—although less prevalent, demonstrated a strong stepwise association with worsening Child-Pugh class and a higher prevalence among female. These findings are consistent with the evolving concept of cirrhotic cardiomyopathy, which encompasses impaired systolic contractile reserve, altered diastolic relaxation, and electrophysiologic changes in the absence of primary structural heart disease [12, 13]. Our finding that systolic dysfunction increased significantly in Child-Pugh class C supports prior evidence that systolic reserve deteriorates as cirrhosis progresses, even when resting ejection fraction appears "normal" [14, 15]. Studies using strain imaging and tissue Doppler have demonstrated that subclinical systolic impairment becomes more prominent in decompensated cirrhosis and may correlate with portal hypertension severity [15]. Some studies, however, have not consistently reproduced this association, likely due to heterogeneous definitions, different diagnostic cut-offs, and varying echocardiographic protocols [16, 17]. Diastolic dysfunction (often analogous to HFpEF-like physiology) was frequent in our cohort and affected both sexes, but numerically more women were classified as having diastolic dysfunction. This parallels broader cardiology literature showing that females are more likely to manifest impaired ventricular relaxation and elevated filling pressures consistent with preserved ejection fraction heart failure physiology [18]. Hormonal modulation, ventricular compliance, and remodeling patterns have been proposed as contributors. Similar gender-related patterns in cirrhotic populations suggest that female patients may represent a subgroup at particular risk of diastolic filling abnormalities in the context of cirrhosis. Pulmonary hypertension was observed in nearly one-quarter of our cohort. We did not detect a statistically significant association between estimated pulmonary pressures and Child-Pugh class or gender. This aligns with previous work showing that transthoracic echocardiography is useful as a screening tool but may overestimate the prevalence of Porto-pulmonary hypertension when compared with invasive right-heart catheterization [19–21]. Current international recommendations define Porto-pulmonary hypertension based on invasive hemodynamics (mean pulmonary artery pressure >20 mmHg, pulmonary vascular resistance ≥2 Wood units, normal pulmonary capillary wedge pressure) rather than echocardiographic surrogates alone [19–21]. Current findings reinforce the need for confirmatory right-heart catheterization in cirrhotic patients with elevated right ventricular systolic pressure on screening echocardiography, especially in pre-transplant evaluation. Importantly, reduced ejection fraction (<55%) was relatively uncommon (10.2%) and did not differ by Child-Pugh class. This supports the concept that overt systolic failure with depressed EF is not the typical presentation of cirrhotic cardiomyopathy. Instead, subtle contractile impairment, abnormal strain patterns, and blunted response to physiological stress are more characteristic [14, 15]. This has practical relevance: relying only on resting EF may underestimate clinically meaningful cardiomyopathy in cirrhosis. However, several limitations should be acknowledged. First, the analytical cross-sectional design precludes causal inference and does not allow us to evaluate progression or reversibility of the observed abnormalities. Second, although the cardiologist performing echocardiography was not informed of the Child-Pugh class, we cannot entirely exclude residual observer bias or inter-operator variability. Third, echocardiographic assessment—while practical and widely available—has known limitations for estimating pulmonary pressures; right-heart catheterization was not performed, which may lead to overestimation of Porto-pulmonary hypertension prevalence. Fourth, strain imaging and stress echocardiography were not systematically applied; incorporating these modalities in future work could help clarify whether the higher burden of diastolic and systolic dysfunction among female reflects

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true biological susceptibility or methodological sensitivity. Finally, because consecutive non-probability sampling was used in a single public-sector tertiary-care center, external generalizability to compensated (Child-Pugh A) outpatients or private-sector settings may be limited.

CONCLUSIONS

In cirrhotic patients presenting to a high-volume tertiary-care center, echocardiographic abnormalities were common. Diastolic dysfunction emerged as the most frequent abnormality, whereas systolic dysfunction showed a strong association with advanced Child-Pugh class and appeared more common among female patients. Pulmonary hypertension was not clearly linked to liver disease severity but was prevalent enough to warrant systematic screening. These findings support routine echocardiographic evaluation in patients with CLD to guide peri-procedural decision-making, transplant candidacy assessment, and long-term cardiovascular surveillance.

Authors Contribution

Conceptualization: MTA, HL
Methodology: HB, SMK, BI, SB
Formal analysis: HL
Writing review and editing: HB, MTA, SMK, BI, SB

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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