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Clinical Correlation of Cardiac Dysfunction with Severity of Liver Disease in Liver Cirrhosis Patients: A Hospital-Based Cross-Sectional Observational Study

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ABSTRACT

This study aimed to investigate clinical correlation of cardiac dysfunction in liver cirrhosis patients with Child Pugh score.

Objectives: 1) To analyze and document the cardiac abnormalities in cirrhotic patients. 2) To correlate these cardiac findings with severity of liver disease.

Methodology: This hospital-based cross sectional observational study was conducted on adult patients with cirrhosis at SRMS Institute of Medical Sciences, Bareilly, UP. Data on demographic information, medical history, clinical characteristics, and laboratory tests were collected using a structured questionnaire, Liver cirrhosis was diagnosed as per biochemical, ultrasonographic, and clinical criteria. 2D echocardiography and 12-lead ECG were used for cardiac evaluation. All subjects underwent Child-Pugh scoring.

Results: The mean age of the patients was 57.11 ± 12.40 yrs. Most patients were male (91%). The predominant etiological cause of liver cirrhosis was alcoholic liver disease (74%). Ascites was present in 78%patients. Hepatic encephalopathy was observed in 11% patients. Jaundice was present in 61%, while pedal edema and fatigue/dyspnea were noted in 46% and 51% cases respectively. Most patients belonged to B Child–Pugh Class (47.8%). QTc prolongation prevalence increased progressively with disease severity.

Conclusion: Most liver cirrhosis patients were male, with leading etiological factor as the alcoholic liver disease and cardiac involvement being commonly manifesting as DDF and electrical conduction abnormalities. More than half of the cohort had DDF. The severity of diastolic indices was progressively increased across CPC. The severities of liver disease (CPC) and DDF were strongly correlated.

Keywords: Cardiac dysfunction, Liver cirrhosis; Child Pugh score; Alcoholic liver disease; Ascites; Hepatic encephalopathy

INTRODUCTION

Liver cirrhosis is a potentially life-threatening condition with fibrous scars replacing normal tissue. In cirrhosis, a major global cause of mortality, structural and functional cardiac changes result due to hyperdynamic circulation.[1] For ensuring good prognosis, it is vital to understand the interplay between multifactorial mechanisms underlying liver and cardiac

health. In advanced cases, portal hypertension, due to regenerating nodules encircled by fibrous bands, leads to splanchnic vasodilation and subsequent reduction in effective circulating blood volume and liver failure. Cirrhotic patients may also experience diastolic dysfunction (DDF), electrophysiological abnormalities, and altered myocardial contractility, leading to impaired cardiac functions.[2]

Cirrhosis, a hyperdynamic condition, characterised by decreased peripheral vascular resistance and increased cardiac output, can lead to many cardiac problems like cirrhotic cardiomyopathy (CCM) (altered diastolic relaxation and/or inappropriate contractile response to stress with atypical electrophysiological patterns).[3-5] In cirrhosis management, ECG findings may help in detailed cardiac evaluation, by revealing prolonged QT intervals, arrhythmias etc.[6] A visual representation of cardiac structure and function and identification of cardiomyopathy, valvular dysfunction, and heart failure signs is provided by 2D-Echocardiography.[7]

For the assessment liver disease severity, prognostication and guiding therapeutic decisions the Child-Pugh score categorizes the patients severity wise ranging from A to C classes, incorporating clinical parameters (bilirubin levels, hepatic encephalopathy, prothrombin time, and ascites).[8] In cirrhotic patients, the prevalence and risk of coronary artery disease are increasing.[9] However, in cirrhosis patients not much attention has been given to cardiac dysfunction. So, cardiac function assessment in cirrhosis is important.[10-11] This study aimed to investigate clinical correlation of cardiac dysfunction in liver cirrhosis patients with Child Pugh score.

Objectives

1. To analyze and document the cardiac abnormalities in cirrhotic patients.
2. To correlate these cardiac findings with severity of liver disease.

MATERIALS & METHODS

This hospital-based cross sectional observational study was conducted during 2024-25 in General Medicine OPD/IPD patients, at SRMS Institute of Medical Sciences, Bareilly, UP. The study included patients with cirrhosis with age > 18 yrs irrespective of etiology, diagnosed by an altered liver function test, ultrasound showing coarse, altered hepatic echo texture with irregular margins and features of portal hypertension. A consecutive sampling technique was used to enroll 92 patients as per the sample size calculated. The study excluded patients with active infection, hypertension, severe anemia, primary cardiac / pulmonary disease. Data on demographic information, medical history, clinical characteristics, and laboratory tests were collected using a structured questionnaire, a 12-lead ECG was performed to measure heart rate variability, rhythm abnormalities, and QT interval to establish /evaluate for cirrhosis, ascites, splenomegaly, and portal hypertension. A two-dimensional echocardiography (2D-ECHO) was used to evaluate abnormalities in ejection fraction, wall motion, and left ventricular diastolic / systolic function. Each patient was categorized into Class A, B, or C based on albumin, INR, serum bilirubin, hepatic encephalopathy, and ascites. Liver cirrhosis was diagnosed as per biochemical, ultrasonographic, and clinical criteria. 2D echocardiography and 12-lead ECG were used for cardiac evaluation and to interpret according to international standard guidelines. All subjects underwent Child-Pugh scoring.

Ethical Approval: The study was approved by the Institutional Ethics Committee with ethical Clearance No.: SRMSIMS/ECC/ 2025/154. Written informed consent was obtained from all participants.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 27.0. Continuous variables were expressed as mean ± standard

deviation (SD), while categorical variables were presented as frequencies and percentages. The association between categorical variables was assessed using the Chi-square test when the assumptions for its application were satisfied. In cases where the expected frequency in any cell was less than 5, Fisher's exact test was applied instead.[12] Comparison of continuous variables across different Child–Pugh classes was performed using one-way analysis of variance (ANOVA). A p-value of less than 0.05 was considered statistically significant.

RESULT

The mean age of the patients was 57.11 ± 12.40 years. More than half (53.3%) of them were between 41 and 60 years, followed by 34.8% in the 61–80-year age group. Most patients were male (91.3%). The etiological distribution of liver cirrhosis included alcoholic liver disease (73.9%), viral hepatitis (10.9%), HBV / HCV (6.5%), NASH (4.3%), autoimmune hepatitis (2.2%), and cryptogenic cirrhosis (2.2%). Ascites was the commonest clinical finding (78.3%) with moderate grade in 44.6% patients. Hepatic encephalopathy was observed in 10.9% of patients, predominantly of Grade II severity. Other signs / symptoms were jaundice (60.9%), pedal edema (45.7%) gastrointestinal bleeding (27.2%) esophageal varices (8.7%) and fatigue/dyspnea (51.1%).

The mean hemoglobin level was 10.49 ± 1.31 g/dL, the mean prothrombin time prolongation was 5.98 ± 1.63 seconds, and the mean INR was 1.70 ± 0.32. The mean total bilirubin level was 3.85 ± 1.35 mg/dL, and the mean serum albumin was 2.90 ± 0.65 g/dL. The mean AST and ALT levels were 79.85 ± 33.44 U/L and 53.21 ± 27.94 U/L. The mean ALP (179.37 ± 60.02 U/L) and GGT (138.12 ± 46.39 U/L) were elevated. Mean serum creatinine was 1.09 ± 0.25 mg/dL. The mean serum sodium level was 132.16 ± 4.92 mmol/L. Mean potassium (4.26 ± 0.51 mmol/L) and calcium (2.13 ± 0.13 mmol/L) levels were within normal limits.

The most common ultrasonographic (USG) feature was coarse parenchyma with a recanalized umbilical vein and collateral formation, (31.5%), followed by coarse echotexture with irregular liver surface (26.1%) and splenomegaly with varices (21.7%). Features of portal hypertension were present in a substantial proportion (20.7%). According to the Child–Pugh score (CPS) classification. The majority of patients belonged to Class B (47.8%), followed by Class A (30.4%) and Class C (21.7%). The mean CPS was 8.04 ± 2.42, the mean heart rate was 85.95 ± 12.38 bpm. The most frequent ECG changes included QTc prolongation (57.6%), prolonged PR interval (16.3%), ST–T wave changes (8.7%), wide QRS complex (7.6%), and low-voltage QRS (5.4%). The mean RR interval was 0.856 ± 0.110 sec, while the mean QT interval measured 0.418 ± 0.042 sec. The mean corrected QT interval (QTc) was 452.65 ± 37.73 ms.

The echocardiographic characteristics of liver cirrhosis patients included the mean LVEF (62.60 ± 5.10%); mean E/A ratio (0.91 ± 0.25) and septal e′ (6.66 ± 1.35 cm/s), mean TRV (2.43 ± 0.38 m/s), E/e′ ratio (12.95 ± 2.55) and LAVI (36.75 ± 7.84 mL/m²). Structural parameters - IVS (10.73 mm) and LVPW (10.75 mm) were within normal limits.DDF was identified in 52.2% patients (Grade I 28.3%; Grade II-16.3% Grade III – 5.4%, and Grade IV – 2.2%). LVH was present in 25% of patients. Pericardial effusion was detected in 3.3% of patients. The prevalence of QTc prolongation increased progressively with disease severity from 46.4% in Class A to 56.8% in Class B and 75.0% in Class C patients. (p = 0.141). A clear stepwise increase in DDF prevalence was observed with advancing liver disease from 32.1% in Class A to 50% in Class B, reaching 85% in Class C. The severity of DDF increased significantly with advancing liver disease. In CPC - A, most patients had either no dysfunction (67.9%) or Grade I (21.4%),

whereas in CPC - C, Grade II (35%) and Grade I (45%) predominated (Table 1).

Table 1: Association between Grade of DDF and CP Class (n = 92)

Category	CPC-A (n=28)	CPC-B (n=44)	CPC-C (n=20)	Total (n=92)	p-value
DDF Status					**0.001** (*Chi square test)*
Absent	19 (67.9%)	22 (50%)	3 (15%)	44 (47.8%)	
Present	9 (32.1%)	22 (50%)	17 (85%)	48 (52.2%)	
DDF Grade					**0.022** (*Fisher exact test)*
Grade I	6 (21.4%)	11 (25%)	9 (45%)	26 (28.3%)	
Grade II	2 (7.1%)	6 (13.6%)	7 (35%)	15 (16.3%)	
Grade III	1 (3.6%)	3 (6.8%)	1 (5%)	5 (5.4%)	
Grade IV	0 (0%)	2 (4.5%)	0 (0%)	2 (2.2%)	
None	19 (67.9%)	22 (50%)	3 (15%)	44 (47.8%)	
Total	28	44	20	92	

The mean LVEF showed a mild, non-significant decline from 64.16 ± 4.42% in Class A to 60.65 ± 4.87% in Class C. Multiple indices of diastolic function demonstrated statistically significant deterioration with increasing CTP class (Table 3).

Table 2: Comparison of Echocardiographic Parameters across CPC (n = 92)

Parameter	CPC A (Mean± SD)	CPC B (Mean± SD)	CPC C (Mean± SD)	*Anova test* p-value
LVEF (%)	64.16 ± 4.42	62.50 ± 5.37	60.65 ± 4.87	0.059
E/A Ratio (Mitral Inflow)	1.07 ± 0.25	0.87 ± 0.21	0.77 ± 0.23	**0.000**
Septal e′ velocity (cm/s)	7.79 ± 0.98	6.54 ± 1.11	5.35 ± 0.90	**0.000**
E/e′ ratio (LV filling pressure)	11.81 ± 1.92	13.13 ± 2.64	14.13 ± 2.59	**0.006**
LAVI (mL/m²)	30.08 ± 4.63	38.31 ± 6.40	42.65 ± 7.98	**0.000**
TRV (m/s)	2.20 ± 0.28	2.46 ± 0.30	2.70 ± 0.47	**0.000**
IRT (ms)	116.00 ± 16.99	108.64 ± 13.84	113.45 ± 13.94	0.114
Mitral Deceleration Time (ms)	195.39 ± 28.46	201.77 ± 35.63	194.95 ± 30.01	0.626

DISCUSSION

Due to its significant morbidity / mortality, liver cirrhosis, is a major preventable public health problem, whose global burden is underestimated. Cirrhosis reflects a progression of chronic liver disease, which may be caused by chronic hepatitis B / C, alcoholic / non-alcoholic fatty liver disease.[13]

In the present study, most patients were male (91%; mean age 57.11 ± 12.4 yrs). In Prost study, 81% were men (median age -62 yrs); CPS C was 43%.[14] In Elsiddig study, 69% were males (mean age - 52 ± 13 yrs).[15] In the study *by* Nirmal et al, male to female ratio was - 8:1(mean age - 45.15 yrs);62% had history of alcoholism. Overall, 28% cases had DDF and 6% showed systolic dysfunction. Aetiology of liver cirrhosis had no correlation with the DDF; but significant correlation was there of DDF with the disease severity.[16] In Sahu et al study, 96% cases were males and most cardiac dysfunctions occurred in 51-60 yrs old CLD patients. QTc prolongation was found in 28% patients. Systolic dysfunctions were seen in 20% and DDF in 24% patients. Many CLD patients have subclinical cardiovascular dysfunctions, with complications when subjected to liver transplantation, TIPS etc.[17]

In the present study, the mean hemoglobin level was 10.49 ± 1.31 g/dL, indicating mild to moderate anemia, which is a common finding in patients with advanced liver disease due to hypersplenism and nutritional deficiency. The mean prothrombin time prolongation was 5.98 ± 1.63 seconds, and the mean INR was 1.70 ± 0.32, reflecting impaired hepatic synthetic function and coagulopathy. The mean total bilirubin level was 3.85 ± 1.35 mg/dL, and the mean serum albumin was 2.90 ± 0.65 g/dL, indicating impaired hepatic excretory and synthetic

function, respectively. The mean AST and ALT levels were 79.85 ± 33.44 U/L and 53.21 ± 27.94 U/L, showing a moderate transaminase elevation typical of cirrhotic liver injury rather than acute hepatocellular necrosis. The mean ALP (179.37 ± 60.02 U/L) and GGT (138.12 ± 46.39 U/L) were elevated. In the present study, the predominant etiological cause of liver cirrhosis was alcoholic liver disease, accounting for 74% of cases. Ascites was a common finding, present in 78% of patients, with moderate ascites (45%) being the most frequent grade. Hepatic encephalopathy was observed in 11% of patients, predominantly of Grade II severity. In the study *by* Fierro-Angulo et al. thrombocytopenia was mentioned as the most frequent hematological abnormality of cirrhosis patients with multifactorial origin. [18] In the study *by* Bashour et al, platelet counts were below 150,000 in more cirrhotic patients (64%) vs 5.5% in no cirrhotic patients.[19] In a study, 80.5% patients had coagulation dysfunctions (prothrombin / thrombin / activated partial thromboplastin time, fibrinogen, and prothrombin activity).[20] In the present study, the most common USG feature was coarse parenchyma with a recanalized umbilical vein and collateral formation (31.5%), followed by coarse echotexture with irregular liver surface (26%) and splenomegaly with varices (22%). This pattern indicates that most patients presented with moderately advanced liver dysfunction, reflecting a predominance of decompensated cirrhosis. The mean CP score was 8.04 ± 2.42; the mean heart rate was 85.95 ± 12.38 bpm, reflecting a trend toward tachycardia. The most frequent ECG abnormality was QTc prolongation (>440 ms), observed in 58% patients with cirrhosis, suggesting a high prevalence of electrical conduction disturbances in CCM. In the present study, the mean RR interval was 0.856 ± 0.110 sec, while the mean QT interval measured 0.418 ± 0.042 sec. The mean corrected QT interval (QTc) was 452.65 ± 37.73 ms, which is above the normal range in a substantial proportion of patients, reflecting a high prevalence of QTc prolongation. In the study *by* Lee et al 63% decompensated LC patients had LVDD, significantly associated with poor survival. There was significantly lower survival rates were associated with a higher E/e' ratio (≥10). In LVDD and normal groups, systolic function was well preserved. Prolonged QTc was seen in LVDD group. In this study, CPC score also predicted survival, while pro-BNP QTc, hs-CRP, did not. LVDD had a significantly higher HR (4.69) than the CPC (1.37).[10] In the present study, a clear stepwise statistically significant increase in DDF prevalence was observed with advancing liver disease from 32% in Class A to 50% in Class B, and 85% in Class C. The severity of DDF increased significantly with advancing liver disease.

CONCLUSION

Most liver cirrhosis patients were male, with leading etiological factor as the alcoholic liver disease and cardiac involvement being commonly manifesting as DDF and electrical conduction abnormalities. QTc prolongation (>440 ms) was the most frequent ECG abnormality, with increase in prevalence from CPC Class A to C. More than half of the cohort had DDF as the predominant cardiac abnormality. The severity of diastolic indices was progressively increased across CPC.

Recommendations

Cirrhotic patients should undergo routine echocardiography and ECG evaluation for early detection of cardiac dysfunctions. Closer monitoring is needed in B / C class of CPC, since with worsening liver disease, cardiac changes become more prominent. Multi-centric studies are needed for validating QTc prolongation / diastolic indices for prognostication / prediction in cirrhotic cardiomyopathy.

Declaration by Authors

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