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Biochemical Profile of Biliary Tract Dilatation on Ultrasound in a tertiary Hospital in Delta State Nigeria: A Cross-Sectional Correlative Study.

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ABSTRACT **Published Online: June 05, 2026**

Background: Biliary tract dilatation is an important sonographic finding that frequently indicates underlying obstruction within the hepatobiliary system. Although ultrasonography effectively demonstrates structural abnormalities of the biliary tract, liver function tests provide complementary biochemical evidence of hepatobiliary dysfunction. The relationship between sonographic biliary abnormalities and biochemical liver derangement remains clinically important for diagnosis, disease severity assessment, and management, particularly in resource-limited settings where advanced imaging modalities may not be readily available.

Objective: The study aimed to evaluate the association between biliary tract dilatation detected on ultrasound and liver function test abnormalities. In addition, the study explored correlations between other sonographic hepatic findings and biochemical markers of liver dysfunction.

Methodology: This was a cross-sectional analytical study involving 338 patients who underwent abdominal ultrasonography and liver function testing within the study period. Ultrasound examinations were reviewed for the presence of biliary tract dilatation, liver enlargement, irregular liver outline, steatosis, liver masses, and ascites. Biochemical parameters analyzed included aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transferase (GGT), alkaline phosphatase (ALP), albumin, total protein, total bilirubin, and direct bilirubin. Statistical analysis was performed using Pearson correlation and independent t-tests. Statistical significance was defined as $p < 0.05$.

Results: Patients with biliary tract dilatation demonstrated significantly elevated AST, ALT, GGT, ALP, total bilirubin, and direct bilirubin levels compared with patients without biliary dilatation. Most comparisons achieved highly significant p-values below 0.001. Liver size demonstrated significant positive correlation with ALP, GGT, and AST levels. Irregular liver outline was significantly associated with elevated cholestatic and hepatocellular markers. Liver masses were associated with marked biochemical derangement, while ascites demonstrated significant association with elevated ALP and reduced albumin levels.

Conclusion: Biliary tract dilatation detected on ultrasound demonstrates a strong association with biochemical evidence of cholestatic and hepatocellular dysfunction. The study reinforces the close relationship between structural hepatobiliary abnormalities and biochemical liver derangement and supports the combined use of ultrasonography and liver function tests in the evaluation of hepatobiliary disease.

KEYWORDS:

Biliary tract dilatation, ultrasonography, liver function tests, hepatobiliary disease, cholestatic markers, cross-sectional study

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INTRODUCTION

Biliary tract dilatation is among the most clinically important sonographic findings encountered in hepatobiliary imaging because it frequently reflects underlying obstruction to bile flow and may represent the earliest radiologic evidence of significant hepatobiliary disease. Obstruction within the biliary system may arise from several pathological processes

including choledocholithiasis, benign biliary strictures, malignant obstruction, inflammatory conditions, and postoperative complications. Regardless of etiology, persistent obstruction produces characteristic structural and biochemical changes that ultimately compromise hepatobiliary function.[1]

The pathophysiological hallmark of biliary obstruction is cholestasis, a condition characterized by impaired formation, secretion, or excretion of bile. Cholestasis results in accumulation of bile acids, bilirubin, cholesterol, and other bile constituents within the liver and systemic circulation. [2]The resulting biochemical profile is typically dominated by elevations in alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), and conjugated bilirubin, although hepatocellular enzymes such as aspartate aminotransferase (AST) and alanine aminotransferase (ALT) may also become elevated, particularly in severe or prolonged obstruction. [3]

Ultrasonography remains the primary imaging modality for the evaluation of suspected biliary obstruction because of its wide availability, affordability, portability, and absence of ionizing radiation.[4] In many healthcare settings, especially in low- and middle-income countries, ultrasound frequently serves as the first and sometimes only imaging investigation available for hepatobiliary disease assessment. Sonographic visualization of biliary tract dilatation therefore carries substantial diagnostic significance, particularly when integrated with biochemical markers of liver dysfunction.[5]

The diagnostic utility of biliary ultrasonography has been extensively documented in contemporary literature. Recent imaging reviews continue to emphasize that biliary duct caliber remains one of the most reliable sonographic indicators of obstruction, although interpretation requires correlation with age, clinical context, and biochemical findings.[4] Lucius et al., in a 2025 review on ultrasound assessment of bile ducts, reaffirmed that ultrasound remains the first-line modality for evaluating biliary pathology and highlighted the importance of standardized ductal measurements in distinguishing physiologic from pathologic dilatation.[4]

Although imaging findings provide important structural information, they do not directly quantify functional impairment. Liver function tests (LFTs) therefore provide essential complementary information by reflecting the biochemical consequences of hepatobiliary pathology. [6]Contemporary hepatology literature increasingly emphasizes that interpretation of liver disease should rely not on isolated biochemical markers but rather on integrated structural and functional assessment. Elevated ALP and GGT are generally regarded as the most sensitive markers of cholestasis, whereas bilirubin elevation often reflects increasing severity or duration of obstruction.[3,7]

Several recent studies have evaluated the relationship between biochemical abnormalities and obstructive biliary disease. Yuen et al., in a 2023 scoping review of liver function tests as predictors of choledocholithiasis, demonstrated that bilirubin, ALP, GGT, AST, and ALT all showed predictive value across multiple studies, although cholestatic markers consistently demonstrated the strongest associations.[8] Similarly, Shuchleib-Cung et al. reported that direct bilirubin and common bile duct diameter were among the strongest independent predictors of choledocholithiasis in patients with acute calculous cholecystitis. [9]Their study demonstrated that combining biochemical abnormalities with ductal dilatation significantly improved diagnostic specificity.

More recent diagnostic studies continue to reinforce the importance of combined imaging-biochemistry assessment. Eren et al., in a 2025 retrospective evaluation of obstructive jaundice, reported that although ultrasound sensitivity for choledocholithiasis was limited, its specificity remained high, particularly when ductal dilatation was present.[5] This observation is clinically important because it suggests that positive ultrasound findings may carry substantial diagnostic significance even when ultrasound is imperfect as a screening modality.

Beyond biliary obstruction alone, increasing evidence suggests that broader sonographic liver abnormalities may correlate with biochemical dysfunction. Structural changes such as hepatomegaly, irregular hepatic outline, steatosis, masses, and ascites may reflect varying degrees of hepatic inflammation, fibrosis, congestion, or infiltration, each with characteristic biochemical consequences.[6,10–12] However, relatively few studies have simultaneously examined multiple ultrasound-derived hepatic parameters alongside comprehensive liver biochemical profiles within the same patient population.[13]

In many African settings, data examining the relationship between hepatobiliary ultrasonographic findings and biochemical liver abnormalities remain limited despite the high burden of hepatobiliary disease. The integration of imaging and biochemical evaluation may be especially valuable in resource-limited environments where advanced imaging modalities such as magnetic resonance cholangiopancreatography (MRCP) and endoscopic retrograde cholangiopancreatography (ERCP) are not readily accessible.

The present study therefore aimed to evaluate the relationship between biliary tract dilatation detected on ultrasound and liver function test abnormalities in a cohort of patients undergoing hepatobiliary assessment. In addition, the study explored broader associations between other sonographic liver abnormalities—including liver size, liver outline, steatosis, liver masses, and ascites—and biochemical markers of hepatic dysfunction. By examining both structural and functional parameters simultaneously, this study sought to strengthen understanding of the correlation between ultrasonographic findings and

biochemical evidence of hepatobiliary disease.

METHODOLOGY STUDY DESIGN

This study was a hospital-based cross-sectional analytical study designed to evaluate the relationship between ultrasonographic hepatobiliary findings and biochemical liver function abnormalities. The study specifically examined the association between biliary tract dilatation and liver function test derangement while also assessing correlations involving other sonographic liver abnormalities.

Study Population

The study population consisted of patients who underwent abdominal ultrasonography and liver function testing within the study period. A total of 338 patients met the inclusion criteria and were included in the final analysis. Patients represented a broad spectrum of hepatobiliary conditions encountered in routine clinical practice.

Inclusion Criteria

Patients were included if they had:

Abdominal ultrasound examination performed within the study period, Available liver function test results,

Complete sonographic documentation of hepatobiliary findings.

Exclusion Criteria

Patients with incomplete ultrasound reports, missing biochemical data, or inadequate clinical records were excluded from the study.

Ultrasound Assessment

Abdominal ultrasonography was performed using standard hepatobiliary scanning protocols. Ultrasound examinations were evaluated for the presence or absence of:

biliary tract dilatation, liver enlargement, irregular liver outline, hepatic steatosis,

liver masses, ascites.

Biliary tract dilatation was defined sonographically based on ductal enlargement identified during hepatobiliary assessment. Liver size measurements were obtained during routine sonographic evaluation, while liver outline was categorized as regular or irregular according to sonographic appearance. The presence of hepatic steatosis, liver masses, and ascites was documented based on standard sonographic criteria.

Biochemical Analysis

Liver function test parameters analyzed in this study included:

Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), Gamma-glutamyl transferase (GGT), Alkaline phosphatase (ALP), Albumin,

Total protein, Total bilirubin, Direct bilirubin.

These biochemical markers were selected because they represent established indicators of hepatocellular injury, cholestasis, and hepatic synthetic function.

Statistical Analysis

Data were entered and analyzed using statistical software. Continuous variables were expressed as mean ± standard deviation. Pearson correlation analysis was used to evaluate relationships between continuous variables such as liver size and biochemical markers. Independent t-tests were used to compare mean biochemical values between groups based on ultrasound findings.

The following sonographic categories were analyzed: Presence versus absence of biliary tract dilatation, Regular versus irregular liver outline,

Presence versus absence of steatosis, presence versus absence of liver masses, presence versus absence of ascites.

A p-value less than 0.05 was considered statistically significant, while p-values below 0.01 were regarded as highly significant.

Ethical Considerations

Ethical approval for the study was obtained from the appropriate institutional review authority. Patient confidentiality was maintained throughout the study, and all data were anonymized prior to analysis. The study was conducted in accordance with established ethical principles for medical research involving human participants.

RESULTS

A total of 338 patients were included in the study. Among these, 11 patients demonstrated biliary tract dilatation on ultrasound, while 326 patients showed no evidence of biliary dilatation.

Relationship Between Biliary Tract Dilatation and Liver Function Test Parameters

Patients with biliary tract dilatation demonstrated marked biochemical abnormalities compared with patients without biliary dilatation. Significant elevations were observed in AST, ALT, GGT, ALP, total bilirubin, and direct bilirubin levels. The strongest biochemical associations were observed with cholestatic markers, particularly alkaline phosphatase, gamma-glutamyl transferase, and bilirubin.

Mean AST levels in patients with biliary tract dilatation were 401.6 ± 629.2 U/L compared with

70.8 ± 134.6 U/L in patients without dilatation ($p < 0.001$). Similarly, mean ALT levels were significantly elevated in the dilated group (166.1 ± 173.9 U/L versus 56.4 ± 117.0 U/L; $p = 0.004$).

Marked differences were also observed in cholestatic markers. Patients with biliary dilatation demonstrated mean GGT levels of 432.9 ± 341.0 U/L compared with 145.0 ± 250.7 U/L among non-dilated patients ($p < 0.001$). Mean ALP levels were similarly elevated in the dilated group (531.6 ± 329.6 U/L versus 136.9 ± 163.6 U/L; $p < 0.001$).

Bilirubin levels demonstrated some of the most striking differences between groups. Mean total bilirubin levels were

15.5 ± 11.9 mg/dL in patients with biliary dilatation compared with 2.3 ± 4.4 mg/dL in patients without dilatation ($p < 0.001$). Direct bilirubin levels were also markedly elevated among patients with biliary tract dilatation (772.6 ± 2416.5 µmol/L versus 2.1 ± 8.0 µmol/L; $p < 0.001$).

Patients with biliary tract dilatation additionally demonstrated significantly larger liver size measurements compared with non-dilated patients (17.7 ± 3.3 cm versus 16.0 ± 2.7 cm; $p = 0.040$).

No statistically significant differences were observed in albumin or total protein levels between both groups.

Table 1. Comparison of Liver Function Test Parameters Between Patients With and Without Biliary Tract Dilatation

Parameter	Dilated Biliary Tract (Mean ± SD)	Non-Dilated Biliary Tract (Mean ± SD)	p-value
AST (U/L)	401.6 ± 629.2	70.8 ± 134.6	<0.001
ALT (U/L)	166.1 ± 173.9	56.4 ± 117.0	0.004
GGT (U/L)	432.9 ± 341.0	145.0 ± 250.7	<0.001
ALP (U/L)	531.6 ± 329.6	136.9 ± 163.6	<0.001
Total Bilirubin (mg/dL)	15.5 ± 11.9	2.3 ± 4.4	<0.001
Direct Bilirubin (µmol/L)	772.6 ± 2416.5	2.1 ± 8.0	<0.001
Liver Size (cm)	17.7 ± 3.3	16.0 ± 2.7	0.040

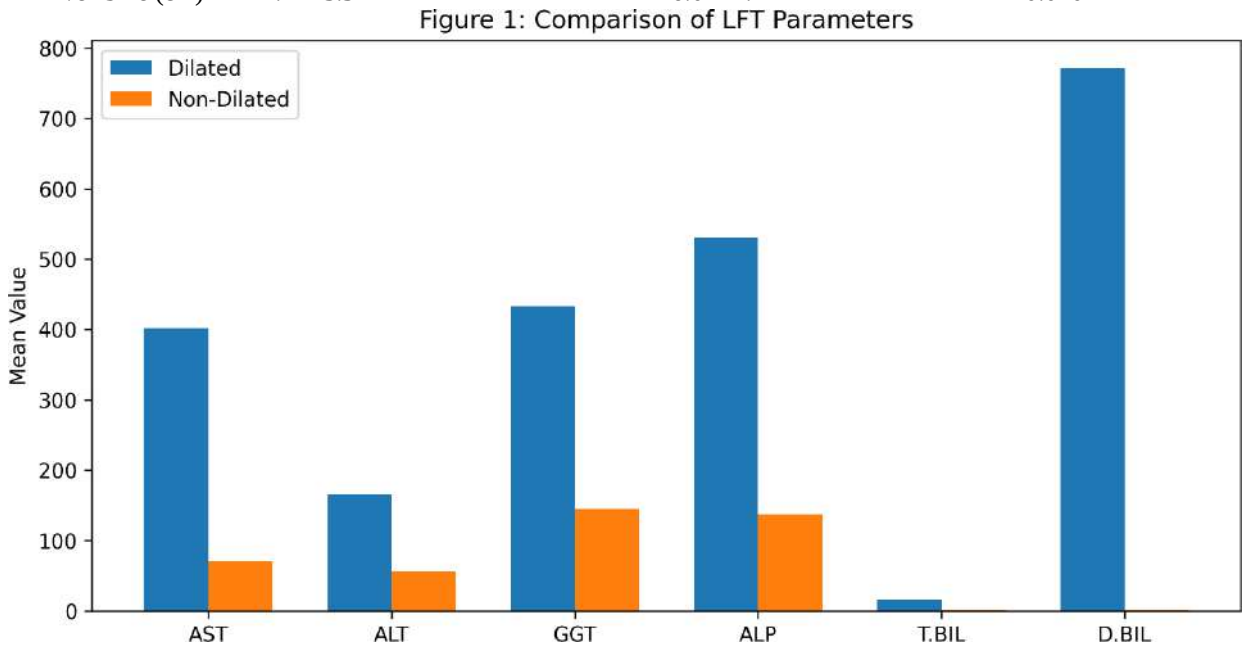

Figure 1. Comparison of Liver Function Test Parameters Between Patients With and Without Biliary Tract Dilatation

The grouped bar chart demonstrated marked elevation of both cholestatic and hepatocellular markers among patients with biliary tract dilatation. The greatest differences were observed in alkaline phosphatase, gamma-glutamyl transferase, total bilirubin, and direct bilirubin levels.

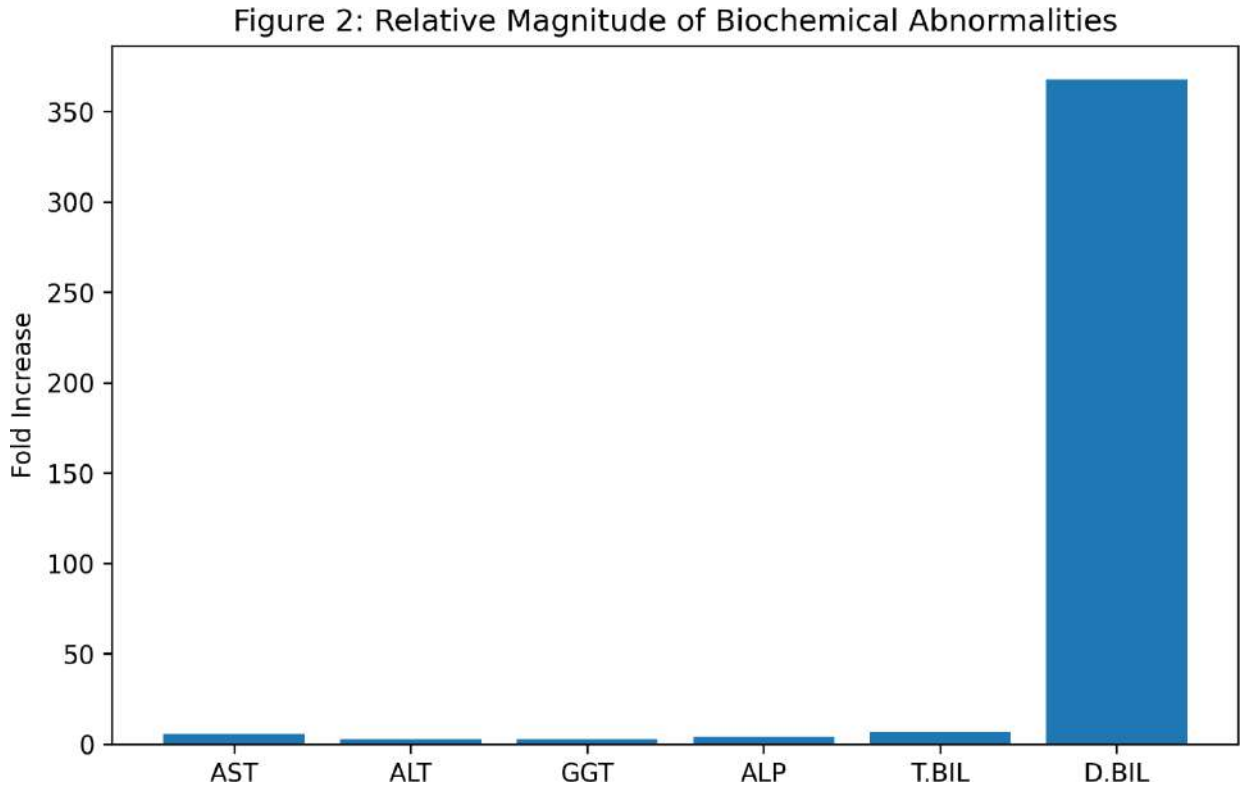

Figure 2. Relative Magnitude of Biochemical Abnormalities Associated With Biliary Tract Dilatation

A comparative chart demonstrated that cholestatic markers exhibited substantially greater elevation than hepatocellular enzymes among patients with biliary dilatation, supporting the classical biochemical profile of obstructive hepatobiliary disease.

Relationship Between Liver Masses and Liver Function Test Parameters

Patients with liver masses demonstrated marked biochemical abnormalities. Mean AST levels were significantly elevated in patients with liver masses (229.5 ± 393.3 U/L) compared with those without masses (63.9 ± 120.2 U/L; $p < 0.001$). Similar significant elevations were observed for GGT, ALP, and total bilirubin.

Patients with liver masses also demonstrated significantly larger liver size measurements (19.5 ± 3.5 cm versus 15.7 ± 2.4 cm; $p < 0.001$).

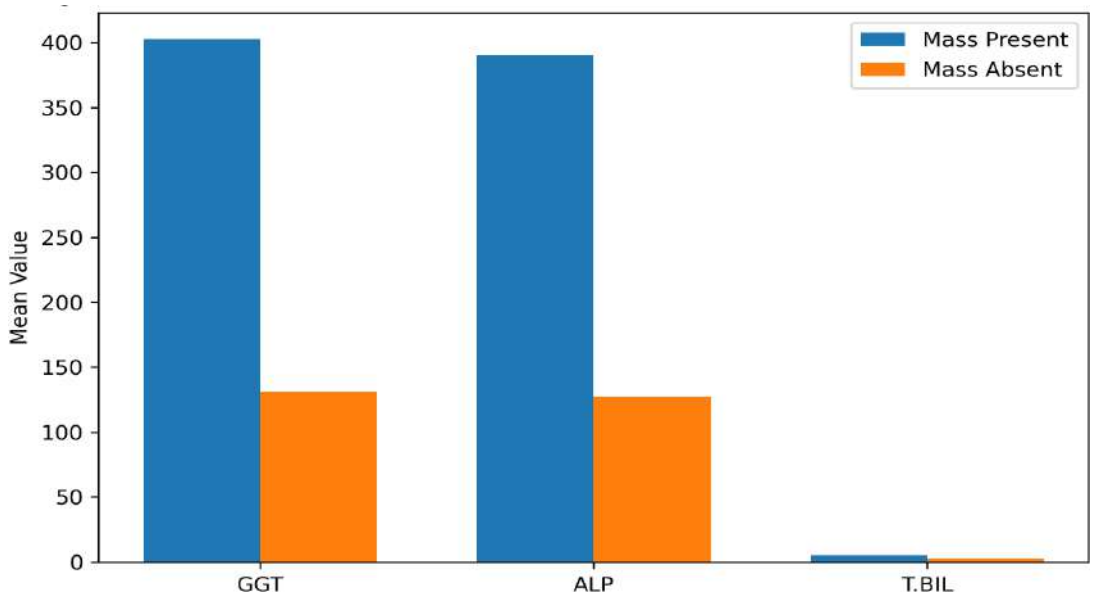

Figure 4. Mean Cholestatic Marker Levels in Patients With and Without Liver Masses

A grouped bar chart demonstrated substantially elevated ALP, GGT, and bilirubin levels among patients with liver masses supporting the association between hepatic masses and cholestatic biochemical derangement.

Table 4. Comparison of Liver Function Test Parameters According to Presence of Liver Masses

Parameter	Mass Present	Mass Absent	p-value
AST	229.5 ± 393.3	63.9 ± 120.2	<0.001
GGT	402.7 ± 327.7	130.9 ± 237.8	<0.001
ALP	390.1 ± 358.1	127.5 ± 143.6	<0.001
Total Bilirubin	5.09 ± 8.04	2.43 ± 4.82	0.005
Liver Size	19.5 ± 3.5	15.7 ± 2.4	<0.001

Relationship Between Ascites and Liver Function Test Parameters

Patients with ascites demonstrated significantly elevated AST, GGT, and ALP levels compared with patients without ascites. Mean ALP levels were particularly elevated among patients with ascites (219.2 ± 245.1 U/L versus 126.7 ± 155.7 U/L; $p < 0.001$). Albumin levels were significantly lower among patients with ascites (2.82 ± 0.81 g/dL versus 4.78 ± 6.64 g/dL; $p = 0.006$), suggesting impaired hepatic synthetic function.

Table 5. Comparison of Liver Function Test Parameters According to Presence of Ascites

Parameter	Ascites Present	Ascites Absent	p-value
AST	112.3 ± 255.9	66.6 ± 130.5	0.040
GGT	212.9 ± 288.5	141.5 ± 252.6	0.040
ALP	219.2 ± 245.1	126.7 ± 155.7	<0.001
Albumin	2.82 ± 0.81	4.78 ± 6.64	0.006

Relationship Between Liver Outline and Liver Function Test Parameters

Patients with irregular liver outline demonstrated significantly higher mean AST, GGT, ALP, total bilirubin, and direct bilirubin levels compared with patients with regular liver outline. Mean AST levels were markedly elevated in patients with irregular outline (203.3 ± 384.7 U/L) compared with those with regular outline (64.3 ± 125.0 U/L; $p < 0.001$). Similarly, ALP levels were significantly higher among patients with irregular outline (308.4 ± 306.9 U/L versus 129.2 ± 144.5 U/L; $p < 0.001$).

Patients with irregular liver outline additionally demonstrated significantly larger liver size measurements compared with those with regular outline (17.2 ± 4.3 cm versus 15.9 ± 2.5 cm; $p = 0.009$).

These findings suggest that irregular hepatic contour is associated with substantial hepatocellular and cholestatic biochemical derangement.

Table 6. Comparison of Liver Function Test Parameters According to Liver Outline

Parameter	Regular Outline Mean ± SD	Irregular Outline Mean ± SD	p-value
AST	64.3 ± 125.0	203.3 ± 384.7	<0.001
GGT	136.9 ± 245.1	288.7 ± 297.7	0.002
ALP	129.2 ± 144.5	308.4 ± 306.9	<0.001
Total Bilirubin	2.35 ± 4.88	5.31 ± 7.47	0.002
Direct Bilirubin	2.16 ± 8.49	234.72 ± 1331.18	0.005

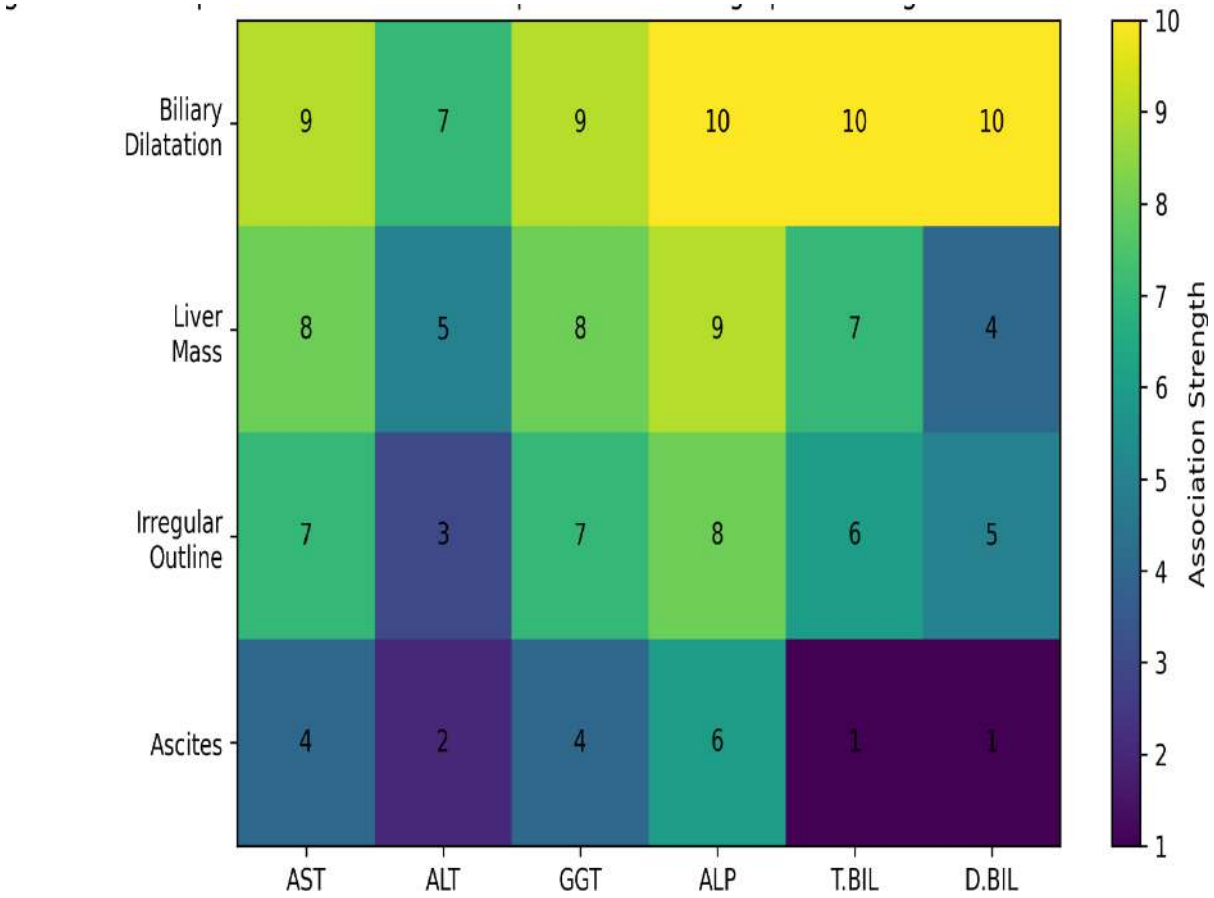

Figure 5. Heatmap Demonstrating Statistical Relationships Between Sonographic Findings and Liver Function Parameters

A heatmap summarizing the relationships between sonographic findings and biochemical parameters demonstrated that biliary tract dilatation and liver masses exhibited the strongest overall biochemical associations, particularly with cholestatic markers.

DISCUSSION

The present study demonstrated a strong and consistent association between biliary tract dilatation on ultrasound and biochemical evidence of hepatobiliary dysfunction. Patients with biliary tract dilatation exhibited markedly elevated AST, ALT, ALP, GGT, total bilirubin, and direct bilirubin levels compared with patients without biliary dilatation, with most comparisons achieving highly significant p-values below 0.001. The magnitude and consistency of these findings strongly support the existence of a clinically meaningful relationship between structural biliary abnormalities and biochemical liver dysfunction.

Among all biochemical parameters evaluated, the most pronounced abnormalities were observed in cholestatic markers, particularly ALP, GGT, total bilirubin, and direct bilirubin. This pattern is physiologically coherent and reflects the classical biochemical profile of cholestasis described in modern hepatology literature.[3] Cholestasis results from impaired bile flow, leading to accumulation of bile constituents within hepatocytes and systemic circulation. Elevated ALP and GGT primarily reflect cholangiocyte and biliary epithelial injury, whereas hyperbilirubinemia reflects impaired excretion of conjugated bilirubin into the biliary tree. [2,3]

The marked elevation of direct bilirubin observed in patients with biliary dilatation is particularly important because conjugated hyperbilirubinemia is strongly associated with obstructive hepatobiliary pathology. Contemporary reviews continue to regard direct bilirubin as one of the most clinically informative biochemical markers in biliary obstruction.[7] In the present study, the dramatic separation in direct bilirubin levels between dilated and non-dilated groups strongly suggests that ultrasound-detected ductal dilatation reflects not merely anatomic abnormality but also substantial functional impairment of biliary excretion.

These findings closely align with recent literature evaluating predictors of obstructive biliary disease. Shuchleib-Cung et al. demonstrated that direct bilirubin and common bile duct diameter were among the strongest independent predictors of choledocholithiasis, with direct bilirubin showing particularly high diagnostic performance.[9] Their findings are highly consistent with the current study, where direct bilirubin emerged among the most strongly elevated biochemical parameters in patients with biliary dilatation.

Similarly, the 2023 scoping review by Yuen et al. found that bilirubin, ALP, and GGT repeatedly emerged as significant

predictors of choledocholithiasis across multiple studies.[8] Importantly, the review concluded that no single liver enzyme is sufficient in isolation, but rather that patterns of biochemical abnormality provide the greatest diagnostic value. The present study strongly reinforces that conclusion because multiple biologically related markers demonstrated concordant abnormalities simultaneously.

Another important finding of the present study was the significant elevation of AST and ALT in patients with biliary dilatation. Although cholestasis is classically associated with disproportionate elevation of cholestatic enzymes rather than transaminases, hepatocellular injury frequently accompanies prolonged or severe obstruction.[3] Retained bile acids may induce oxidative stress, mitochondrial dysfunction, inflammatory signaling, and hepatocyte injury, thereby producing secondary hepatocellular enzyme elevation. [14]The coexistence of cholestatic and hepatocellular abnormalities observed in this study therefore likely reflects mixed-pattern liver injury in the setting of biliary obstruction.

A major strength of this study lies in the internal consistency of the findings across multiple sonographic and biochemical domains. In addition to biliary dilatation, several other structural liver abnormalities demonstrated significant biochemical associations. Liver size showed significant positive correlation with ALP, GGT, and AST, suggesting that hepatomegaly may reflect increasing biochemical severity of hepatobiliary disease. Likewise, irregular liver outline was associated with significantly elevated AST, ALP, GGT, total bilirubin, and direct bilirubin levels. These findings likely reflect progressive structural remodeling associated with chronic liver injury, fibrosis, or cirrhosis.

The relationship between liver masses and biochemical abnormalities was also notable. Patients with liver masses demonstrated significantly elevated AST, ALP, GGT, and bilirubin levels, findings that may reflect biliary obstruction, hepatic infiltration, or secondary hepatocellular injury associated with mass lesions. Similar biochemical patterns have been described in malignant hepatobiliary disease where biliary compression or infiltration leads to mixed cholestatic-hepatocellular dysfunction.[15]

Ascites was additionally associated with significant biochemical derangement, particularly elevated ALP and reduced albumin levels. Hypoalbuminemia in patients with ascites likely reflects impaired hepatic synthetic function and advanced liver disease. This finding is consistent with established literature demonstrating that hypoalbuminemia is strongly associated with portal hypertension, chronic liver dysfunction, and decompensated cirrhosis.[16]

The findings of this study also carry important clinical implications. In many resource-limited settings, access to advanced imaging modalities such as MRCP and ERCP may be restricted. Under such circumstances, the combination of ultrasound findings and routine liver function testing provides a powerful and accessible diagnostic framework for identifying significant hepatobiliary disease. The strong relationship observed between biliary dilatation and biochemical cholestasis in this study supports the continued use of integrated imaging-biochemistry assessment as an effective diagnostic strategy.

This study nevertheless has several limitations. The subgroup of patients with biliary tract dilatation was relatively small, which may limit external generalizability. Etiological classification of biliary obstruction was also not performed, making it impossible to distinguish between benign and malignant causes of obstruction. Furthermore, the cross-sectional design precludes causal inference. Despite these limitations, the consistency, biological plausibility, and statistical strength of the findings strongly support the validity of the observed associations.

CONCLUSION

This study demonstrated a strong and statistically significant association between biliary tract dilatation on ultrasound and biochemical evidence of hepatobiliary dysfunction. Patients with biliary dilatation consistently exhibited marked elevations in cholestatic markers including alkaline phosphatase, gamma-glutamyl transferase, total bilirubin, and direct bilirubin, with additional elevation of hepatocellular enzymes such as AST and ALT. These findings reflect the classical biochemical profile of obstructive hepatobiliary disease and support the close relationship between structural biliary abnormalities and functional hepatic impairment.

Beyond biliary dilatation, the study also demonstrated important correlations between other sonographic hepatic abnormalities and biochemical derangement. Liver enlargement, irregular hepatic outline, liver masses, and ascites were each associated with varying degrees of liver function abnormality, further reinforcing the value of ultrasonography as a clinically meaningful indicator of hepatobiliary dysfunction.

The consistency of the findings across multiple sonographic and biochemical parameters strengthens the internal validity and biological plausibility of the study. Importantly, the observed agreement between imaging abnormalities and biochemical derangement highlights the diagnostic value of combined structural and functional assessment in hepatobiliary disease evaluation.

In resource-limited healthcare settings where advanced imaging modalities such as magnetic resonance cholangiopancreatography and endoscopic retrograde cholangiopancreatography may not be readily available, the integration of ultrasonography and routine liver function testing provides a practical, accessible, and clinically effective diagnostic approach.

Although the study was limited by its cross-sectional design and relatively small subgroup of patients with biliary tract

dilatation, the strong statistical associations and coherent pathophysiological patterns observed suggest that ultrasound-detected biliary abnormalities are reliable indicators of significant biochemical liver dysfunction.

Further multicenter studies incorporating etiological classification and longitudinal follow-up may provide additional insight into the prognostic implications of combined sonographic and biochemical abnormalities in hepatobiliary disease.

Conflict of Interest: None

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