Evaluation of Biochemical and Hematological Alterations in Patients with Cholelithiasis: A Hospital-Based Cross-Sectional Study

Abstract:

Background: Cholelithiasis, or gallstone disease, is a common gastrointestinal condition marked by the formation of gallstones within the gallbladder, often leading to biliary obstruction, hepatic dysfunction, and inflammation. It is particularly prevalent in northern India, including Uttar Pradesh. This study was conducted to assess the biochemical and hematological changes in cholelithiasis patients.

Methods: A hospital-based cross-sectional study was conducted at Teerthanker Mahaveer Hospital and Research Centre, Moradabad, Uttar Pradesh, over a duration of 6 months. A total of 240 participants were enrolled, including 118 confirmed cholelithiasis patients and 122 age- and sex-matched healthy controls. Blood samples were analyzed for total, direct, and indirect bilirubin; liver enzymes (AST, ALT, ALP); pancreatic enzymes (amylase, lipase); and inflammatory markers (CRP, TLC). Data analysis was done using SPSS software and statistical comparisons were performed using the Mann-Whitney U test. Ethical approval was obtained from the Institutional Ethical Committee, College of Paramedical Sciences (Ref. No.: PM/ETHICAL/COPS/2024/018).

Results: Cholelithiasis patients showed significantly elevated levels of total bilirubin (2.60 ± 0.11 mg/dL), direct bilirubin (0.64 ± 0.06 mg/dL), and indirect bilirubin (1.96 ± 0.10 mg/dL). Liver enzymes including AST (33.26 ± 1.24 U/L), ALT (31.96 ± 2.20 U/L), and ALP (312.66 ± 17.38 U/L) were significantly increased in the patient group. Inflammatory markers such as CRP (7.38 ± 0.48 mg/dL) and TLC ($6729.17 \pm 409.84 \times 10^3/\mu L$) also showed significant elevations. Pancreatic enzymes (amylase and lipase) showed mild but not statistically significant changes.

Conclusion: The study demonstrates that cholelithiasis is associated with notable biochemical and hematological alterations, particularly in liver function and inflammatory markers. These parameters can be effectively used in the clinical assessment and early detection of gallstone-related complications.

Keywords: Cholelithiasis, Liver Enzymes, Bilirubin, Inflammatory Markers.

Introduction

Cholelithiasis, commonly known as gallstone disease, is a significant global health concern characterized by the formation of gallstones within the gallbladder due to bile composition imbalances (1). It is a prevalent gastrointestinal disorder affecting millions worldwide, with variations in prevalence based on geographical, genetic, and lifestyle factors (2). The global prevalence of gallstones ranges between 5% and 25%, with higher rates observed in developed countries. In the United States, approximately 15% of the population is affected, while in Europe, prevalence varies from 9% to 21%. In contrast, regions such as Africa and Southeast Asia report significantly lower prevalence rates (3). In India, gallstone disease affects an estimated 4% of the population, contributing to nearly 1 million new cases annually. Notably, the northern states, including Uttar Pradesh, exhibit a higher prevalence than southern regions, with North Indians being nearly seven times more at risk than their South Indian counterparts (4). Uttar Pradesh, in particular, has emerged as a high-burden region for gallstone disease, making it crucial to understand its biochemical and hematological implications in this population. Gallstones primarily develop due to an imbalance in bile constituents, including cholesterol, bilirubin, and bile salts, leading to their precipitation and stone formation (5). While many individuals remain asymptomatic, others experience severe complications such as acute cholecystitis, obstructive jaundice, and pancreatitis (6). Timely diagnosis and management are essential to prevent disease progression and associated morbidity (7). Biochemical and hematological alterations play a pivotal role in diagnosing and monitoring gallstone disease (8,9). Liver function tests (LFTs), including total, direct, and indirect bilirubin, aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP), provide insight into hepatobiliary dysfunction. Additionally, serum amylase and lipase are assessed to rule out pancreatic involvement, while inflammatory markers like total leukocyte count (TLC) and C-reactive protein (CRP) help evaluate systemic inflammation. Identifying variations in these parameters can enhance diagnostic accuracy and improve clinical management strategies (10). This study aims to evaluate and compare biochemical and hematological alterations in cholelithiasis patients and healthy controls at a tertiary care hospital in Moradabad, a region within Uttar Pradesh with a high burden of gallstone disease.

Material and Methodology

This hospital-based cross-sectional study was conducted at Teerthanker Mahaveer Hospital and Research Center, Moradabad, over six months. A total of 236 participants were enrolled,

comprising 118 USG-confirmed cholelithiasis patients and 118 age- and sex-matched healthy controls on the basis of inclusion and exclusion Blood samples were collected from all participants under aseptic conditions from the antecubital vein using sterile syringes and transferred into EDTA and plain vacutainers. After getting informed consent form from all participants. The collected samples were analyzed for total, direct, and indirect bilirubin, AST, ALT, ALP, serum amylase, serum lipase, TLC, and CRP using standard laboratory protocols. Data were recorded in an Excel sheet and statistically analyzed using SPSS software. Ethical approval for this study was obtained from the Institutional Ethical Committee, College of Paramedical Sciences, (PM/ETHICAL/COPS/2024/018).

Result

Gender Distribution Among Study Populations

The study included a total of 240 participants, comprising 148 females (61.7%) and 92 males (38.3%), indicating a higher prevalence of gallstone disease among females as show in Figure 1 (a). Participants were categorized into two groups: cases (cholelithiasis patients) and controls (healthy individuals). Among the 120 cholelithiasis cases, 80 (66.7%) were female, while 40 (33.3%) were male as show in Figure 1 (b).

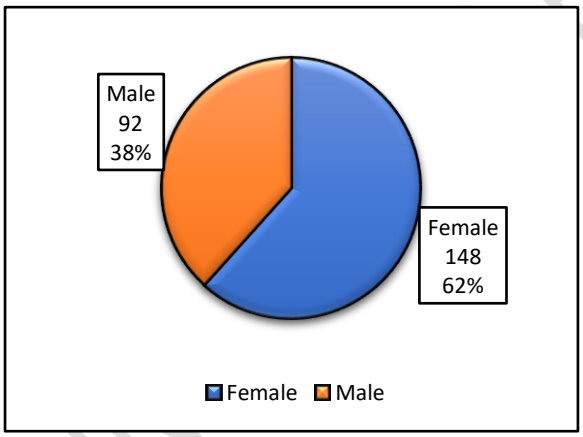

Figure 1 (a) Distribution of gender in study Population

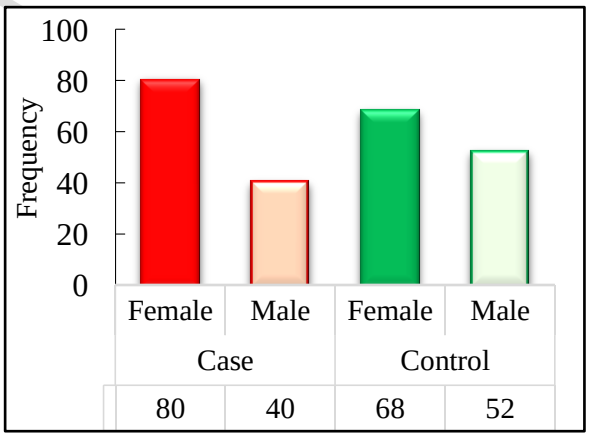

Figure 1 (b) : Groups wise gender distribution

Figure 1. Show the Gender distribution in study populations overall and group wise.

Mean Age Among Study Populations

The mean age of cholelithiasis patients (cases) was 37.23 ± 11.48 years, whereas the mean age of the control group was 39.18 ± 12.34 years as show in Figure 2 (a). Gender-based analysis revealed that the mean age for females in the case group was 36.02 ± 11.45 years,

while males had a mean age of 39.65 ± 11.31 years. Among the control group, females had a mean age of 38.91 ± 12.40 years, and males had a mean age of 39.51 ± 12.37 years as show in Figure 2 (b).

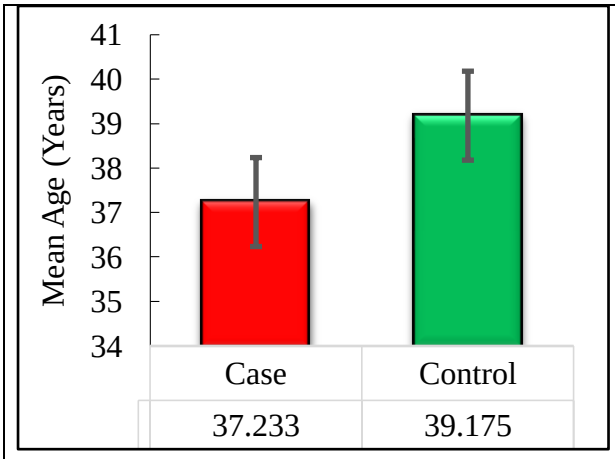

Figure 2 (a) Mean Age of Study Participants

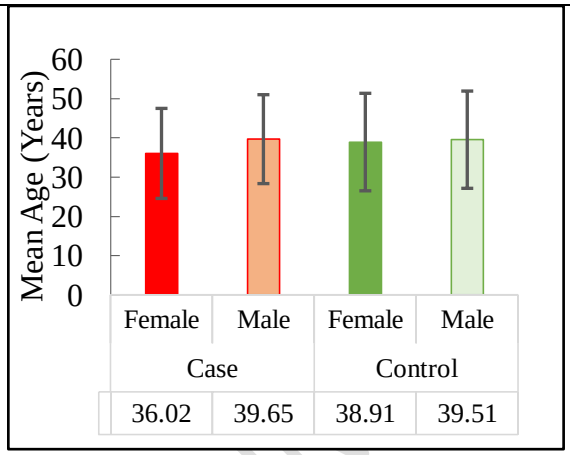

Figure 2 (b) Mean Age of Study Participants group wise

Figure 2. Show the mean age of study populations overall populations and group wise.

Biochemical and Hematological Biomarkers in Study Populations

Significant differences were observed in biochemical and hematological markers between cholelithiasis patients and healthy controls as show in Table 1. Total bilirubin (2.60 ± 0.11 mg/dL vs. 0.91 ± 0.04 mg/dL, $p < 0.01$), direct bilirubin (0.64 ± 0.06 mg/dL vs. 0.23 ± 0.02 mg/dL, $p < 0.01$), and indirect bilirubin (1.96 ± 0.10 mg/dL vs. 0.68 ± 0.04 mg/dL, $p < 0.01$) were markedly elevated in cholelithiasis patients. Liver enzymes, including AST (33.26 ± 1.24 U/L) and ALT (31.96 ± 2.20 U/L), were significantly higher in cases compared to controls ($p < 0.01$). ALP, a marker of biliary obstruction, was significantly increased (312.66 ± 17.38 U/L vs. 143.31 ± 2.78 U/L, $p < 0.01$).

Inflammatory markers, CRP (7.38 ± 0.48 mg/dL) and TLC (6729.17 ± 409.84 (10^3/µL)), were also elevated in cholelithiasis patients ($p < 0.01$), indicating systemic inflammation. Amylase levels were slightly higher in cases (46.94 ± 1.07 U/L) than in controls (44.60 ± 1.44 U/L, $p < 0.01$), while lipase levels showed no significant difference ($p = 0.107$). These findings confirm biochemical alterations associated with gallstone disease, highlighting liver dysfunction and inflammation as show in Table 1.

Table 1. Comparison of Study Parameters in Study Populations According to Groups

Parameters	Control	Case	Z-Vale	P-Value
Total Bilirubin (mg/dl)	0.91 ± 0.04	2.60 ± 0.11	-13.95	<0.00**
Direct Bilirubin (mg/dL)	0.23 ± 0.02	0.64 ± 0.06	-13.40	<0.00**
Indirect Bilirubin (mg/dL)	0.68 ± 0.04	1.96 ± 0.10	-13.39	<0.00**
AST (U/L)	26.74 ± 3.43	33.26 ± 1.24	-13.03	<0.00**
ALT (U/L)	26.42 ± 4.23	31.96 ± 2.20	-9.99	<0.00**
ALP (U/L)	143.31 ± 2.78	312.66 ± 17.38	-13.38	<0.00**
Amylase (U/L)	44.60 ± 1.44	46.94 ± 1.07	-10.61	<0.00**
Lipase (U/L)	76.78 ± 18.81	80.74 ± 16.29	-1.61	0.107
CRP (mg/dL)	4.39 ± 0.70	7.38 ± 0.48	-13.38	<0.00**
TLC ((10^3/µL))	6444.17 ± 467.39	6729.17 ± 409.84	-4.66	<0.00**

All values were mean and standard deviation (SD), AST (Aspartate Aminotransferase); ALT (Alanine Aminotransferase); ALP (Alkaline Phosphatase); Amylase; Lipase; CRP (C-Reactive Protein); TLC (Total Leukocyte Count), mg/dL (milligrams per deciliter); U/L (units per liter); (10^3/µL) is thousands per microliter. The statistical analysis was performed using the Mann-Whitney U test (a non-parametric test), as indicated by the Z-values. Asterisks (**) indicate highly significant p-values ($p < 0.01$).

Discussion

The present study evaluated biochemical and hematological parameters in cholelithiasis patients, revealing significant alterations compared to healthy controls. These findings align with existing literature and provide insights into the pathophysiological mechanisms underlying gallstone disease. The present study evaluated biochemical and hematological alterations in patients with cholelithiasis, revealing significant differences compared to healthy controls. Elevated levels of total bilirubin (2.60 ± 0.11 mg/dL), direct bilirubin (0.64 ± 0.06 mg/dL), and indirect bilirubin (1.96 ± 0.10 mg/dL) were observed in the case group, which is indicative of biliary obstruction. Similar findings have been reported by **Aslam et al.**

(2013), who found a strong correlation between hyperbilirubinemia and the presence of gallstones. Elevated bilirubin levels suggest impaired hepatic function due to obstructed bile flow, which is commonly seen in cholelithiasis patients (11). Moreover, our study showed a significant increase in alkaline phosphatase (ALP) levels (312.66 ± 17.38 U/L) in cases compared to controls (143.31 ± 2.78 U/L), supporting the findings of **L et al. (2009),** who suggested that ALP serves as a key biomarker for biliary obstruction (12). Liver enzymes were significantly elevated in cholelithiasis patients, with AST (33.26 ± 1.24 U/L) and ALT (31.96 ± 2.20 U/L) levels higher than in controls (26.74 ± 3.43 U/L and 26.42 ± 4.23 U/L, respectively). These results align with the findings of **Hawar and Lor (2022),** who reported a significant rise in transaminase levels in cholelithiasis patients, particularly in those with obstructive pathology (13). Elevated AST and ALT levels are likely due to hepatocellular injury caused by bile stasis and inflammation, as reported by **Rangaswamy et al. (2017)** (14)**.** This indicates the need for routine liver function testing in suspected gallstone cases for early detection and intervention. The inflammatory markers in our study showed a considerable rise in CRP (7.38 ± 0.48 mg/dL) and total leukocyte count (TLC) (6729.17 ± 409.84 (10^3/μL)) in cholelithiasis patients compared to controls (4.39 ± 0.70 mg/dL and 6444.17 ± 467.39 (10^3/μL), respectively). These findings agree with **Rajab et al. (2020),** who reported that elevated CRP levels in gallstone patients indicate an ongoing inflammatory response, which may be due to recurrent biliary irritation (15). Likewise, **Napolitano et al. (2021)** demonstrated that higher leukocyte counts in cholelithiasis patients are associated with an increased risk of gallstone-related complications, such as acute cholecystitis (16). Elevated inflammatory markers suggest that gallstone disease is not merely a structural disorder but also involves an active inflammatory component. Our study also assessed pancreatic enzymes, showing a slight increase in amylase levels (46.94 ± 1.07 U/L) in cholelithiasis patients compared to controls (44.60 ± 1.44 U/L), while lipase levels remained statistically insignificant. Similar observations were made by **DM et al. (2017),** who noted that isolated amylase elevation without lipase involvement is not uncommon in gallstone disease unless pancreatitis is present (17). This suggests that routine assessment of pancreatic enzymes in uncomplicated gallstone cases may not provide significant diagnostic value, as also reported by **Napolitano et al. (2021)** (16)**.** Overall, our findings align with multiple studies emphasizing the diagnostic value of biochemical and hematological markers in gallstone disease. The significant alterations in bilirubin, liver enzymes, and inflammatory markers highlight their clinical relevance in evaluating cholelithiasis patients. However, our study's cross-sectional design limits causal interpretation, and larger longitudinal studies are

needed to confirm these associations. Future research should focus on correlating these biochemical markers with disease severity and treatment outcomes to improve clinical decision-making in cholelithiasis management.

Conclusion

Cholelithiasis is associated with significant biochemical and hematological alterations, reflecting hepatic dysfunction, biliary obstruction, and systemic inflammation. Elevated bilirubin levels indicate impaired bile flow, while increased liver enzymes suggest hepatocellular damage. The rise in inflammatory markers, including CRP and TLC, highlights the role of inflammation in disease progression. These findings support the clinical relevance of routine biochemical assessments for early diagnosis and effective management of gallstone disease. Further studies are needed to explore the underlying pathophysiological mechanisms and potential therapeutic targets.

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Acknowledgment: I sincerely thank the Department of Medical Laboratory Techniques, College of Paramedical Sciences, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India, for their continuous support. I extend my gratitude to the Principal, Head of Department, my Guide, esteemed faculty members, and dedicated laboratory staff for their valuable guidance and encouragement throughout this research. I am also deeply grateful to the Teerthanker Mahaveer Hospital and Research Center and the patients for their kind cooperation and contribution.

Conflict of Interest: No