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ORIGINAL ARTICLE

Pattern of Gallstone Disease and Associated Metabolic Risk Factors: A Cross-Sectional Observational Study

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ABSTRACT:

Background: Gallstone disease is a common biliary disorder encountered in tertiary care practice and contributes substantially to abdominal morbidity. Its clinical spectrum ranges from uncomplicated cholelithiasis to complicated disease, and growing evidence suggests a close link with metabolic abnormalities such as obesity, diabetes, hypertension, dyslipidemia, and metabolic syndrome. Understanding the pattern of disease and associated metabolic risk factors is important for early recognition, risk stratification, and comprehensive management. **Aim:** To evaluate the pattern of gallstone disease and determine its association with metabolic risk factors among patients diagnosed with gallstones at a tertiary care hospital. **Material and Methods:** This cross-sectional observational study included 105 adult patients with ultrasonographically confirmed gallstone disease. Demographic and clinical details were recorded using a structured proforma. Anthropometric measurements (BMI, waist circumference, WHR) and blood pressure were documented. Fasting blood samples were analyzed for glycemic indices and lipid profile. Ultrasonography was used to assess number of stones and classify disease into uncomplicated and complicated gallstone disease. Associations between disease pattern and metabolic risk factors were analyzed using appropriate statistical tests, and $p < 0.05$ was considered statistically significant. **Results:** The mean age was 44.62 ± 12.84 years and females constituted 63.81% of patients. Right upper quadrant pain was the commonest symptom (87.62%). Multiple stones were present in 62.86% and were significantly associated with complicated disease ($p = 0.032$). Uncomplicated cholelithiasis was observed in 64.76%, while 35.24% had complicated disease, most commonly acute cholecystitis. Metabolic abnormalities were frequent, including central obesity, diabetes, hypertension, dyslipidemia, and metabolic syndrome. Complicated disease showed significant associations with obesity, central obesity, diabetes, hypertension, dyslipidemia, and metabolic syndrome ($p < 0.05$). Lipid parameters were significantly more adverse in complicated cases, with higher total cholesterol, triglycerides, LDL, and lower HDL. **Conclusion:** Gallstone disease commonly affected middle-aged females, and complications were frequent. Metabolic risk factors were highly prevalent and significantly associated with complicated gallstone disease, supporting the need for integrated metabolic screening and risk-factor modification in routine gallstone management.

Keywords: Gallstone disease; Metabolic syndrome; Central obesity; Dyslipidemia; Cholelithiasis

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INTRODUCTION

Gallstone disease (GSD) remains one of the most frequent disorders of the biliary system and a major contributor to surgical admissions and interventions worldwide. It encompasses a spectrum ranging from incidentally detected, asymptomatic gallstones to symptomatic disease and serious complications such as acute cholecystitis, choledocholithiasis, cholangitis, and gallstone pancreatitis. In tertiary care settings, this spectrum is often seen in its full range because patients may present late, may have coexisting metabolic illnesses, and may be referred after initial evaluation elsewhere. Understanding the pattern of gallstone disease—how patients present clinically, what ultrasonography shows (single vs multiple stones, uncomplicated vs complicated disease), and which complications predominate—helps clinicians prioritize early recognition, streamline diagnostic pathways, and plan timely definitive management. At the same time, these patterns do not occur in isolation; they are increasingly influenced by broader population changes in nutrition, adiposity, and cardiometabolic risk profiles.[1]Cholesterol gallstones form through an interplay of hepatic cholesterol hypersecretion, bile supersaturation, nucleation and crystal retention, gallbladder dysmotility, and inflammatory changes within the gallbladder wall. These processes are not purely local. They are shaped by systemic metabolic states that alter bile composition and gallbladder function—particularly insulin resistance, central obesity, and dyslipidemia, which can modify hepatic lipid handling and influence biliary cholesterol transport. Contemporary concepts therefore view gallstone disease not only as a surgical condition, but also as a disorder with strong metabolic underpinnings. The clinical implication is that gallstone disease may cluster with metabolic abnormalities, and that patients who manifest complications may represent a subgroup with more pronounced or longstanding metabolic dysfunction.[1]The changing epidemiology of gallstone disease parallels rising trends in overweight and obesity, especially abdominal obesity, which is strongly linked to insulin resistance and altered lipid

profiles. In routine clinical practice, many gallstone patients demonstrate features such as raised triglycerides, low HDL cholesterol, impaired glycemic status, and hypertension—factors that also define metabolic syndrome. Importantly, these factors may influence not only the occurrence of stones but also the symptomatic course and risk of complications. From a mechanistic standpoint, insulin resistance and compensatory hyperinsulinemia can affect hepatic cholesterol metabolism, while central obesity is associated with dyslipidemia and inflammatory signaling that may promote gallbladder hypomotility and mucosal inflammation—conditions favorable for stone growth and recurrent obstruction.[2]Metabolic syndrome represents a clinically practical framework to capture this clustering of cardiometabolic risk. The syndrome integrates central obesity, hyperglycemia, hypertension, hypertriglyceridemia, and low HDL cholesterol—each of which can plausibly contribute to gallstone pathogenesis, and collectively may amplify risk. Beyond gallstone formation, metabolic syndrome and insulin resistance have been associated with biliary stone outcomes in large population-based investigations, supporting the concept that gallstone disease may be one manifestation within a broader metabolic disorder continuum. This perspective is clinically relevant because it suggests that gallstone patients may benefit from systematic metabolic evaluation, and that prevention strategies might extend beyond surgical management to include weight optimization, improved glycemic control, and lipid management.[3]Population studies conducted in different regions have repeatedly observed that gallstone disease is associated with metabolic characteristics, though the strength and pattern of associations vary by age, sex, and population context. For instance, community-based screening cohorts and health-check populations have shown that gallstone disease coexists with adverse cardiometabolic profiles, with sex-related differences in how risk factors express. Such findings highlight that gallstone disease is not a uniform entity; rather, its patterns and associations can be influenced by demographic structure, lifestyle, and background prevalence of metabolic disorders. These variations become particularly important in tertiary care hospitals, where the case mix may include both uncomplicated biliary colic and advanced complicated disease referred from primary and secondary centers.[4]Within clinical cohorts, the relationship between metabolic syndrome and gallstone disease also appears to show dose-response behavior—meaning the risk is higher when multiple metabolic abnormalities coexist, even in non-diabetic individuals. This is important for clinical reasoning because many patients may not meet full diagnostic thresholds for diabetes or metabolic syndrome, yet still exhibit one or two metabolic abnormalities that could contribute to gallstone risk and progression. Identifying such early metabolic derangements may be especially valuable in preventing recurrent symptoms or complications after initial presentation, and in guiding counseling regarding lifestyle changes that address shared pathways.[5]Diabetes mellitus deserves special attention because it is common among adult surgical patients and is linked to altered gallbladder motility, changes in bile composition, and higher surgical risk profiles. The co-occurrence of gallstones and type 2 diabetes has practical implications for screening, perioperative planning, and long-term management—especially in settings where a large proportion of patients may have undiagnosed impaired glucose tolerance. Systematic reviews focusing on gallstone disease in type 2 diabetics underscore the need for structured approaches to evaluation and prevention, supporting the rationale for documenting glycemic status and related metabolic markers in gallstone cohorts.[6]

MATERIAL AND METHODS

This cross-sectional observational study was conducted at a tertiary care teaching hospital among patients diagnosed with gallstone disease. The hospital serves as a referral center catering to both urban and rural populations, providing comprehensive diagnostic and surgical services. The study was designed to evaluate the pattern of gallstone disease and its association with various metabolic risk factors in patients attending outpatient and inpatient departments.A total of 105 patients diagnosed with gallstone disease were included in the study. Patients were selected consecutively after confirmation of gallstones by ultrasonography. Both symptomatic and asymptomatic individuals identified incidentally during imaging were considered eligible for inclusion. The study population comprised adult patients of both sexes presenting with clinical features suggestive of cholelithiasis or its complications.

Inclusion and Exclusion Criteria

Patients aged 18 years and above with ultrasonographic evidence of gallstones were included in the study. Individuals who provided informed consent and were willing to undergo detailed clinical, biochemical, and anthropometric assessment were enrolled. Patients with a history of previous cholecystectomy, known chronic liver disease, hemolytic disorders, malignancy, pregnancy, severe systemic illness, or those on medications known to significantly alter lipid metabolism were excluded to avoid confounding factors.

Methodology

A structured proforma was used to collect demographic and clinical data from each participant. Detailed history was obtained regarding age, sex, occupation, dietary habits, physical activity level, alcohol consumption, smoking status, family history of gallstone disease, and past medical history including diabetes mellitus, hypertension,

dyslipidemia, and hypothyroidism. Clinical presentation was documented, including symptoms such as right upper quadrant pain, dyspepsia, nausea, vomiting, fever, and jaundice. Physical examination included measurement of height, weight, waist circumference, hip circumference, and calculation of body mass index (BMI) and waist-hip ratio (WHR). Blood pressure was recorded using a standardized sphygmomanometer after adequate rest.

All patients underwent biochemical evaluation after overnight fasting. Blood samples were collected for fasting blood glucose, postprandial blood glucose, glycated hemoglobin (HbA1c), serum insulin levels (where feasible), and lipid profile including total cholesterol, triglycerides, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very low-density lipoprotein (VLDL). Liver function tests comprising serum bilirubin, aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), and serum albumin were performed. Renal function tests including serum urea and creatinine were also assessed. Metabolic syndrome was identified using standard diagnostic criteria based on anthropometric, glycemic, blood pressure, and lipid parameters.

Ultrasonography of the abdomen was performed in all patients using a high-resolution ultrasound machine by experienced radiologists. Parameters recorded included number of stones (single or multiple), size of stones, gallbladder wall thickness, presence of sludge, gallbladder distension, pericholecystic fluid, and associated biliary tract abnormalities such as common bile duct stones. The pattern of gallstone disease was categorized into uncomplicated cholelithiasis and complicated gallstone disease, including acute cholecystitis, chronic cholecystitis, choledocholithiasis, and pancreatitis based on clinical and imaging findings.

Metabolic risk factors were evaluated systematically. Obesity was defined based on BMI classification, and central obesity was assessed using waist circumference and WHR. Diabetes mellitus was diagnosed based on fasting glucose, postprandial glucose, HbA1c levels, or prior medical diagnosis. Hypertension was defined according to standard blood pressure criteria or prior treatment history. Dyslipidemia was determined based on abnormal lipid profile parameters. The presence of metabolic syndrome was identified when patients fulfilled the established criteria involving central obesity, hyperglycemia, hypertension, hypertriglyceridemia, and low HDL levels.

Statistical Analysis

Data were entered into a computerized database and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Associations between gallstone disease patterns and metabolic risk factors were assessed using chi-square test for categorical variables and independent t-test or analysis of variance (ANOVA) for continuous variables where applicable. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 105 patients with ultrasonographically confirmed gallstone disease were included in the final analysis. The findings are elaborated below in detail according to each table.

Table 1: Demographic Characteristics

The majority of patients were in the middle-age group, with the highest proportion observed in the 41–50 years category (30.48%), followed by 31–40 years (25.71%). Younger patients aged 18–30 years constituted 17.14%, while those aged 51–60 years and above 60 years accounted for 16.19% and 10.48%, respectively. The mean age of the study population was 44.62 ± 12.84 years, indicating that gallstone disease was predominantly seen in middle-aged individuals. A clear female predominance was observed, with females comprising 63.81% of the study population compared to 36.19% males, resulting in a male-to-female ratio of 1:1.76. This finding supports the known higher susceptibility of females to gallstone disease. Regarding residence, 58.10% of patients were from urban areas, while 41.90% belonged to rural regions, suggesting a relatively higher representation of urban patients in the study cohort.

Table 2: Clinical Presentation and Ultrasonographic Pattern

Right upper quadrant abdominal pain was the most common presenting symptom, reported in 87.62% of patients, highlighting its importance as the cardinal symptom of gallstone disease. Dyspepsia was present in 55.24% of cases, while 46.67% experienced nausea and vomiting. Fever was documented in 20.00% of patients, and 13.33% presented with jaundice, indicating possible biliary obstruction or complications. Ultrasonographically, multiple gallstones were more common (62.86%) compared to single stones (37.14%). In terms of disease pattern, 64.76% of patients had uncomplicated cholelithiasis, whereas 35.24% developed complicated gallstone disease. Among the complicated cases, acute cholecystitis was the most frequent (18.10%), followed by chronic cholecystitis (9.52%), choledocholithiasis (5.71%), and gallstone pancreatitis (1.90%). Importantly, the presence of multiple stones was significantly associated with complicated gallstone disease ($p = 0.032$), suggesting that stone burden may contribute to adverse clinical outcomes.

Table 3: Distribution of Metabolic Risk Factors

Metabolic abnormalities were highly prevalent among patients with gallstone disease. Overweight status (BMI 25–29.9 kg/m²) was observed in 32.38% of patients, while 27.62% were classified as obese (BMI ≥30 kg/m²). Central obesity was particularly common, affecting 58.10% of the study population, indicating a strong association between abdominal adiposity and gallstone formation. Diabetes mellitus was present in 34.29% of patients, and hypertension in 39.05%. Dyslipidemia was identified in 45.71% of cases, making it one of the most common metabolic risk factors. Additionally, 31.43% of patients fulfilled the criteria for metabolic syndrome. The mean BMI of 27.84 ± 4.12 kg/m² reflects an overall overweight tendency in the population. Elevated mean fasting blood glucose (112.46 ± 28.35 mg/dL) and mean serum triglyceride levels (168.72 ± 46.51 mg/dL) further support the presence of metabolic disturbances in these patients.

Table 4: Association Between Metabolic Risk Factors and Complicated Gallstone Disease

A statistically significant association was observed between several metabolic risk factors and complicated gallstone disease. Obesity was significantly more common in the complicated group (45.95%) compared to the uncomplicated group (17.65%), with a p-value of 0.002. Similarly, central obesity was present in 75.68% of patients with complications versus 48.53% without complications (p = 0.006). Diabetes mellitus was significantly associated with complications, affecting 51.35% of complicated cases compared to 25.00% of uncomplicated cases (p = 0.008). Hypertension also showed a significant relationship, present in 56.76% of complicated cases versus 29.41% of uncomplicated cases (p = 0.007). Dyslipidemia was observed in 64.86% of patients with complications compared to 35.29% without complications (p = 0.004). Furthermore, metabolic syndrome was significantly more prevalent in the complicated group (48.65%) than in the uncomplicated group (22.06%), with a p-value of 0.005.

Table 5: Lipid Profile Comparison

Comparison of lipid parameters between complicated and uncomplicated gallstone disease revealed significant differences. Patients with complicated disease had higher mean total cholesterol levels (212.46 ± 34.18 mg/dL) compared to those with uncomplicated disease (188.52 ± 29.74 mg/dL), with statistical significance (p = 0.001). Mean triglyceride levels were also significantly elevated in the complicated group (192.38 ± 41.27 mg/dL) compared to the uncomplicated group (155.84 ± 38.95 mg/dL), with a highly significant p-value (<0.001). LDL cholesterol levels were significantly higher in the complicated group (134.72 ± 28.63 mg/dL) than in the uncomplicated group (112.46 ± 24.81 mg/dL), with p = 0.002. Conversely, HDL cholesterol levels were significantly lower in patients with complicated disease (38.24 ± 6.12 mg/dL) compared to those without complications (44.86 ± 7.04 mg/dL), with p < 0.001.

RESULTS

A total of 105 patients with ultrasonographically confirmed gallstone disease were analyzed. The demographic profile, clinical presentation, ultrasonographic pattern, metabolic risk factors, and their association with complicated gallstone disease are summarized in the following tables.

Table 1: Demographic Characteristics of Study Population (n = 105)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
18–30	18	17.14%
31–40	27	25.71%
41–50	32	30.48%
51–60	17	16.19%
>60	11	10.48%
Gender		
Male	38	36.19%
Female	67	63.81%
Residence		
Urban	61	58.10%
Rural	44	41.90%

Mean age of patients was 44.62 ± 12.84 years. Female predominance was observed with a male-to-female ratio of 1:1.76.

Table 2: Clinical Presentation and Ultrasonographic Pattern of Gallstone Disease (n = 105)

Variable	Frequency (n)	Percentage (%)
Symptoms		
Right upper quadrant pain	92	87.62%

Dyspepsia	58	55.24%
Nausea/Vomiting	49	46.67%
Fever	21	20.00%
Jaundice	14	13.33%
Number of Stones		
Single	39	37.14%
Multiple	66	62.86%
Pattern of Disease		
Uncomplicated cholelithiasis	68	64.76%
Complicated gallstone disease	37	35.24%
– Acute cholecystitis	19	18.10%
– Chronic cholecystitis	10	9.52%
– Choledocholithiasis	6	5.71%
– Gallstone pancreatitis	2	1.90%

Multiple stones were significantly associated with complicated gallstone disease ($p = 0.032$).

Table 3: Distribution of Metabolic Risk Factors Among Study Population (n = 105)

Metabolic Risk Factor	Frequency (n)	Percentage (%)
Overweight (BMI 25–29.9 kg/m²)	34	32.38%
Obesity (BMI ≥30 kg/m²)	29	27.62%
Central obesity	61	58.10%
Diabetes mellitus	36	34.29%
Hypertension	41	39.05%
Dyslipidemia	48	45.71%
Metabolic syndrome	33	31.43%

Mean BMI was 27.84 ± 4.12 kg/m². Mean fasting blood glucose was 112.46 ± 28.35 mg/dL. Mean serum triglyceride level was 168.72 ± 46.51 mg/dL.

Table 4: Association Between Metabolic Risk Factors and Complicated Gallstone Disease (n = 105)

Risk Factor	Complicated (n=37)	Uncomplicated (n=68)	p-value
Obesity	17 (45.95%)	12 (17.65%)	0.002
Central obesity	28 (75.68%)	33 (48.53%)	0.006
Diabetes mellitus	19 (51.35%)	17 (25.00%)	0.008
Hypertension	21 (56.76%)	20 (29.41%)	0.007
Dyslipidemia	24 (64.86%)	24 (35.29%)	0.004
Metabolic syndrome	18 (48.65%)	15 (22.06%)	0.005

Table 5: Lipid Profile Comparison Between Complicated and Uncomplicated Gallstone Disease

Parameter	Complicated (Mean ± SD)	Uncomplicated (Mean ± SD)	p-value
Total Cholesterol (mg/dL)	212.46 ± 34.18	188.52 ± 29.74	0.001
Triglycerides (mg/dL)	192.38 ± 41.27	155.84 ± 38.95	<0.001
LDL (mg/dL)	134.72 ± 28.63	112.46 ± 24.81	0.002
HDL (mg/dL)	38.24 ± 6.12	44.86 ± 7.04	<0.001

DISCUSSION

In this study, gallstone disease clustered in middle age (mean age **44.62 ± 12.84 years**), with the largest proportion in the **41–50 year** group (**30.48%**) and a clear female predominance (**63.81%**, M:F**1:1.76**). This age–sex distribution is comparable to population epidemiology where women consistently show substantially higher gallbladder disease prevalence than men; for example, Everhart *et al* (1999) reported that gallbladder disease affected **14.2 million women vs 6.3 million men** in the US survey, with female prevalence markedly higher across ethnic groups (e.g., **Mexican-American women 26.7%** vs **non-Hispanic white women 16.6%**).[7]

Clinically, pain was the dominant symptom in our cohort (**right upper quadrant pain 87.62%**), followed by dyspepsia (**55.24%**) and nausea/vomiting (**46.67%**); systemic or obstructive features were less frequent (fever **20.00%**, jaundice **13.33%**). This pattern aligns with classic descriptions that biliary colic-type pain is the key symptom driving presentation and evaluation in symptomatic gallstone disease, while other symptoms are variably present and less specific; Portincasa*et al* (2006) emphasize the central diagnostic value of typical pain patterns in distinguishing gallstone-related symptoms from dyspeptic complaints.[8]

On ultrasonography, **multiple stones (62.86%)** were more common than single stones (**37.14%**), and over

one-third had complications (**35.24%**), with **acute cholecystitis 18.10%** being the leading acknowledged complication, followed by chronic cholecystitis (**9.52%**), choledocholithiasis (**5.71%**), and pancreatitis (**1.90%**). The finding that stone burden correlated with worse clinical pattern in our dataset (multiple stones associated with complications, **p = 0.032**) is biologically plausible because repeated cystic duct obstruction and inflammation are more likely when the gallbladder contains a higher stone load; broader reviews also frame gallstone disease as increasingly linked to modifiable metabolic drivers that may influence cholesterol supersaturation and gallbladder motility, thereby shaping disease behavior. Stinton *et al* (2012) highlight obesity and sedentary lifestyle as key modifiable risks alongside age and female sex, supporting the interpretation that "pattern" and severity may rise as metabolic risk accumulates.[9]

Metabolic abnormalities were frequent in our patients: **overweight 32.38%**, **obesity 27.62%**, **central obesity 58.10%**, **diabetes 34.29%**, **hypertension 39.05%**, **dyslipidemia 45.71%**, and **metabolic syndrome 31.43%**, with mean BMI **27.84 ± 4.12 kg/m²** and mean triglycerides **168.72 ± 46.51 mg/dL**. This metabolic clustering is consistent with longstanding natural-history observations that age, sex, and obesity are major determinants of gallstone disease risk; Diehl *et al* (1991) noted that gallstones affect roughly **one fourth of women** and **10–15% of men** over age 50 and explicitly identified **obesity** among the principal risk factors, reinforcing the high burden of adiposity-related risk in gallstone populations like ours.[10]

When we compared uncomplicated vs complicated disease, adiposity showed one of the strongest gradients: **obesity 45.95% vs 17.65% (p = 0.002)** and **central obesity 75.68% vs 48.53% (p = 0.006)** in complicated vs uncomplicated cases. Similar directionality is reported in prospective evidence connecting abdominal adiposity with clinically meaningful (symptomatic) gallstone disease; Tsai *et al* (2004) demonstrated that men with higher waist circumference (≥**102.6 cm**) had a substantially increased risk of incident symptomatic gallstones (**RR 2.29**) compared with those with lower waist circumference (<**86.4 cm**), even after adjustment, supporting our observation that central obesity tracks with more severe/complicated patterns.[11]

Metabolic syndrome itself was common in our cohort (**31.43%**) and was significantly more prevalent in complicated disease (**48.65%**) than uncomplicated disease (**22.06%**, **p = 0.005**). This is comparable to the magnitude of association shown in earlier cross-sectional work; Méndez-Sánchez *et al* (2005) reported that the presence of metabolic syndrome increased the likelihood of gallstone disease (reported OR around **3.20**) and also documented higher central obesity among gallstone cases (e.g., high waist circumference **52.3%** in cases vs **22.2%** in controls), which mirrors our finding that central obesity was frequent overall (**58.10%**) and enriched in complicated disease (**75.68%**).[12]

Individual metabolic components in our study—particularly **diabetes (51.35% vs 25.00%, p = 0.008)** and **hypertension (56.76% vs 29.41%, p = 0.007)**—were significantly associated with complicated gallstone disease. Large-scale analyses also support a component-count effect, where accumulating metabolic abnormalities increases gallstone prevalence and risk. Chen *et al* (2012) reported metabolic syndrome to be associated with gallstone disease (overall age-adjusted **OR 1.42**) and noted that having all **five** metabolic syndrome components markedly increased gallstone risk (reported several-fold increase), paralleling our observation that patients with "clustered" metabolic illness were more likely to fall into the complicated disease category.[13]

Our lipid and metabolic pattern further supports insulin-resistance biology: dyslipidemia was common overall (**45.71%**) and significantly higher in complicated disease (**64.86% vs 35.29%, p = 0.004**), while central obesity was the most prevalent anthropometric abnormality (**58.10%**) and strongly linked to complications. This aligns with mechanistic and epidemiologic observations that abdominal adiposity and insulin resistance are closely tied to gallstone risk and may outperform BMI alone in some settings; Chang *et al* (2008) highlighted that waist circumference was a better predictor of gallstones than BMI in their analysis and discussed how metabolic syndrome definitions emphasizing central obesity can better capture gallstone risk, consistent with our data where waist/central obesity separated complicated from uncomplicated disease.[14]

Biochemically, our complicated group demonstrated a more atherogenic profile—**total cholesterol 212.46 ± 34.18 vs 188.52 ± 29.74 (p = 0.001)**, **triglycerides 192.38 ± 41.27 vs 155.84 ± 38.95 (p < 0.001)**, **LDL 134.72 ± 28.63 vs 112.46 ± 24.81 (p = 0.002)**, and **lower HDL 38.24 ± 6.12 vs 44.86 ± 7.04 (p < 0.001)**—suggesting that dyslipidemia accompanies not only gallstone presence but also more severe patterns. Prior work also links serum lipid abnormalities with cholesterol gallstone characteristics: Atamanalp*et al* (2013) reported that patients with higher serum cholesterol had a much higher rate of cholesterol stones (**86.7%**) compared with those with normal/low cholesterol (**40.0%**), supporting a plausible connection between systemic lipid milieu and cholesterol-driven gallstone pathology that could contribute to more complicated presentation in metabolically high-risk patients like ours.[15]

CONCLUSION

Gallstone disease in this tertiary care cohort showed a clear predominance among middle-aged individuals and females, with most patients presenting symptomatically and a substantial proportion

developing complications. Metabolic risk factors were highly prevalent and demonstrated significant association with complicated gallstone disease. Patients with complicated disease also exhibited a more adverse lipid profile compared to uncomplicated cases. These findings support the need for routine metabolic assessment and integrated risk-factor modification as part of gallstone disease management to reduce morbidity and prevent complications.

REFERENCES

1. Venneman NG, van Erpecum KJ. Pathogenesis of gallstones. **Gastroenterol Clin North Am.** 2010;39(2):171-183. Available from: https://pubmed.ncbi.nlm.nih.gov/20478481/
2. Kim SS, Lee JG, Kim DW, Kim BH, Jeon YK, Kim MR, **et al.** Insulin resistance as a risk factor for gallbladder stone formation in Korean postmenopausal women. **Korean J Intern Med.** 2011;26(3):285-293. doi:10.3904/kjim.2011.26.3.285. Available from: https://pubmed.ncbi.nlm.nih.gov/22016589/
3. Shebl FM, Andreotti G, Meyer TE, Gao YT, Rashid A, Yu K, **et al.** Metabolic syndrome and insulin resistance in relation to biliary tract cancer and stone risks: a population-based study in Shanghai, China. **Br J Cancer.** 2011;105(9):1424-1429. doi:10.1038/bjc.2011.363. Available from: https://pubmed.ncbi.nlm.nih.gov/21915122/
4. Shen HC, Chang YW, Chen JY, Lin YC, Chen YW, Huang CC. Prevalence and associated metabolic factors of gallstone disease in an elderly agricultural and fishing population of Taipei, Taiwan. **Biomed Res Int.**2014;2014:876918. Available from: https://pubmed.ncbi.nlm.nih.gov/24707283/
5. Lin IC, Yang YW, Wu MF, Yeh YH, Liou JC, Lin YL, **et al.** The association of metabolic syndrome and its factors with gallstone disease. **BMC Fam Pract.**2014;15:138. doi:10.1186/1471-2296-15-138. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC4118643/
6. Chen L, Peng YT, Chen FL, Tung TH. Epidemiology, management, and economic evaluation of screening of gallstone disease among type 2 diabetics: a systematic review. **World J Clin Cases.** 2015;3(7):599-606. doi:10.12998/wjcc.v3.i7.599. Available from: https://pubmed.ncbi.nlm.nih.gov/26244151/
7. Everhart JE, Khare M, Hill M, Maurer KR. Prevalence and ethnic differences in gallbladder disease in the United States. **Gastroenterology.** 1999;117(3):632-639. doi:10.1016/S0016-5085(99)70456-7. Available from: https://pubmed.ncbi.nlm.nih.gov/10464139/
8. Portincasa P, Moschetta A, Petruzzelli M, Palasciano G, Di Ciaula A, Pezzolla A. Gallstone disease: symptoms and diagnosis of gallbladder stones. **Best Pract Res Clin Gastroenterol.** 2006;20(6):1017-1029. doi:10.1016/j.bpg.2006.05.005. Available from: https://pubmed.ncbi.nlm.nih.gov/17127185/
9. Stinton LM, Shaffer EA. Epidemiology of gallbladder disease: cholelithiasis and cancer. **Gut Liver.** 2012;6(2):172-187. doi:10.5009/gnl.2012.6.2.172. Available from: https://pubmed.ncbi.nlm.nih.gov/22570746/
10. Diehl AK. Epidemiology and natural history of gallstone disease. **Gastroenterol Clin North Am.** 1991;20(1):1-19. Available from: https://pubmed.ncbi.nlm.nih.gov/2022415/
11. Tsai CJ, Leitzmann MF, Willett WC, Giovannucci EL. Prospective study of abdominal adiposity and gallstone disease in US men. **Am J Clin Nutr.** 2004;80(1):38-44. Available from: https://pubmed.ncbi.nlm.nih.gov/15213025/
12. Méndez-Sánchez N, Chávez-Tapia NC, Motola-Kuba D, Sánchez-Lara K, Ponciano-Rodríguez G, Baptista H, **et al.** Metabolic syndrome as a risk factor for gallstone disease. **World J Gastroenterol.** 2005;11(11):1653-1657. doi:10.3748/wjg.v11.i11.1653. Available from: https://pubmed.ncbi.nlm.nih.gov/15786544/
13. Chen LY, Qiao QH, Zhang SC, Chen YH, Chao GQ, Fang LZ. Metabolic syndrome and gallstone disease. **World J Gastroenterol.** 2012;18(31):4215-4220. doi:10.3748/wjg.v18.i31.4215. Available from: https://pubmed.ncbi.nlm.nih.gov/22919256/
14. Chang Y, Noh YH, Suh BS, Ryu S, Sung E, Jang YM, **et al.** Insulin resistance is associated with gallstones even in non-obese, non-diabetic Korean men. **J Korean Med Sci.** 2008;23(4):644-650. doi:10.3346/jkms.2008.23.4.644. Available from: https://pubmed.ncbi.nlm.nih.gov/18756051/
15. Atamanalp SS, Keles MS, Atamanalp RS, Acemoglu H, Laloglu E. The effects of serum cholesterol, LDL, and HDL levels on gallstone cholesterol concentration. **Pak J Med Sci.** 2013;29(1):187-190. doi:10.12669/pjms.291.2798. Available from: https://pubmed.ncbi.nlm.nih.gov/24353537/