Section: General Surgery

Original Research Article

CORRELATION OF SERUM LIPID PROFILE, THYROID HORMONE LEVEL AND BODY MASS INDEX/WAIST TO HIP RATIO IN PATIENTS WITH GALL STONE DISEASE

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ABSTRACT

Background: Gallstone disease (cholelithiasis) is a common gastrointestinal disorder affecting approximately 10–15% of the population, with 1–4% becoming symptomatic annually, contributing significantly to healthcare burden. Various metabolic factors such as abnormal lipid profile, thyroid hormone imbalance, body mass index (BMI), and waist-to-hip ratio (WHR) have been linked to gallstone formation. Notably, hypothyroidism has been increasingly associated with gallstone disease. This study aims to evaluate the prevalence of previously undiagnosed hypothyroidism and correlation of serum lipid profile, thyroid hormone levels, BMI, and WHR in patients diagnosed with gallstones. The aim is to assess the correlation between serum lipid profile, thyroid hormone levels, BMI, and WHR in patients with gallstones and evaluate their clinical significance. **Materials and Methods:** This prospective observational study was conducted over one year (March 2023 to February 2024) in the Department of General Surgery at a tertiary care hospital in Assam, India. A total of 175 patients diagnosed with gallstones were included. **Result:** Gallstones were most prevalent in individuals aged 41–50 years and were more common in females. Reduced HDL was observed in 50.8% of patients, while elevated LDL, triglycerides, and total cholesterol were found in 45.1%, 48.5%, and 38.3% respectively. Elevated BMI and WHR were noted in 79.4% and 22.8% of patients. Abnormal thyroid profiles were present in 20% of cases. A significant association was observed between gallstones and combined abnormalities in lipid profile and thyroid function. **Conclusion:** Gallstones are more common in females, particularly in the 31–50 age group, and are strongly associated with dyslipidemia and increased BMI. Low HDL emerged as an independent risk factor. Although thyroid dysfunction alone showed limited association, its combination with lipid abnormalities significantly correlated with gallstone formation. Routine evaluation of lipid profile and thyroid function should be included in the assessment of gallstone patients.

INTRODUCTION

Cholelithiasis, commonly known as gallstone disease, is one of the most prevalent gastrointestinal disorders worldwide, affecting approximately 10–15% of the population. Among these individuals, nearly 1–4% become symptomatic each year, contributing significantly to healthcare burden. In India, the prevalence of gallstones has shown a rising trend, particularly among women, and is most frequently observed during the third and fourth decades of life. The etiology of gallstone formation is multifactorial.[1]

The pathogenesis of gallstone disease is primarily explained by four key mechanisms: gallbladder dysmotility, increased bile concentration within the gallbladder, supersaturation of bile with cholesterol, and crystal nucleation.[2] Gallstones are broadly classified into three types—cholesterol, pigment, and mixed stones—with mixed stones being the most common. Cholesterol, an insoluble lipid, is transported in bile in the form of mixed micelles and vesicles. Micelles consist of bile salts, phospholipids, and cholesterol aggregates, whereas vesicles are closed, spherical bilayers composed mainly of phospholipids and cholesterol. The

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formation of gallstones occurs in sequential stages, including bile supersaturation, nucleation of cholesterol crystals, and their subsequent aggregation. These cholesterol crystals develop on vesicle surfaces, grow within mucin gel, and are ultimately bound together by bile proteins to form gallstones.[3]

Emerging evidence has highlighted the role of thyroid dysfunction, particularly hypothyroidism, in gallstone formation. Studies suggest that individuals with hypothyroidism exhibit reduced bile flow, which may predispose them to gallstone formation. Additionally, thyroid hormone receptors are present in the sphincter of Oddi, and thyroxine facilitates its relaxation. Reduced thyroid hormone levels may impair this mechanism, leading to decreased bile flow and sphincter dysfunction—both of which are important contributors to gallstone formation. This suggests that factors beyond bile composition alone may influence gallstone pathogenesis. Interestingly, some studies have proposed that thyroxine supplementation may even contribute to the dissolution of gallstones.

Both hypothyroidism and hyperthyroidism influence gallstone formation through distinct mechanisms. Hyperthyroidism is associated with increased expression of hepatic nuclear receptor genes involved in cholesterol metabolism, whereas hypothyroidism promotes cholesterol accumulation, thereby increasing the risk of cholesterol gallstones. These findings indicate that thyroid dysfunction may play a crucial role in gallstone pathophysiology and could influence diagnostic and therapeutic approaches in affected patients.[4]

Obesity is another well-established risk factor for gallstone disease. Increased body mass index (BMI) has been strongly associated with a higher incidence of gallstones. Furthermore, central obesity, as measured by waist-to-hip ratio (WHR), has also shown a significant positive correlation with gallstone risk. Kodama H, et. al; 1999, demonstrated that both elevated BMI and WHR are significantly linked with increased gallstone prevalence. These findings underscore the importance of metabolic factors in the development of gallstones and highlight the need for comprehensive evaluation in at-risk individuals.[5-7]

This study aims to demonstrate the incidence of hypothyroidism in individuals with gallstones that have not previously been detected, as well as any link with deranged serum lipid profile, BMI, as well as WHR in formation of gallstones.

MATERIALS AND METHODS

This prospective observational study was conducted at the Department of General Surgery, Jorhat Medical College and Hospital under Srimanta Sankaradeva University of Health Sciences, Guwahati from March 2023 to February 2024. Ethical approval has been obtained from the Ethical Approval Committee of Jorhat Medical College and Hospital.

Study Population: The study population included patients older than 12 years of any gender diagnosed with gallstone disease by ultrasonography. Patients with chronic liver disease, chronic hepatitis, aemolytic anemia, Crohn's disease, cardiac diseases, cystic fibrosis, recurrent biliary infections, those on lipid-lowering or thyroid medications, receiving artificial nutrition, pregnant women, children under 12 years, and non-cooperative individuals unwilling to provide consent were excluded from the study sample.

Data Analysis: Data analysis was performed using Microsoft Excel for data entry, management, and evaluation. Descriptive statistics were used to summarize the collected data. For inferential analysis, the Student's t-test was applied to assess the significance of differences in continuous variables, while the chi-square test was used for categorical variables. A p-value of less than 0.05 was considered statistically significant for determining associations between variables.

RESULTS

Among the 175 patients studied, females constituted the majority (58.3%) compared to males (41.7%). The highest number of patients belonged to the 41–50 years age group (40.6%), followed by 31–40 years (28.6%) and 51–60 years (20%), with fewer cases in younger and older age groups. This trend was consistent across both sexes, with females predominating in most age groups. Regarding lipid profile, 50.8% of patients had below-normal HDL levels, particularly in the 41–50 years group, where females were more affected, indicating a significant association between low HDL and gallstone disease.

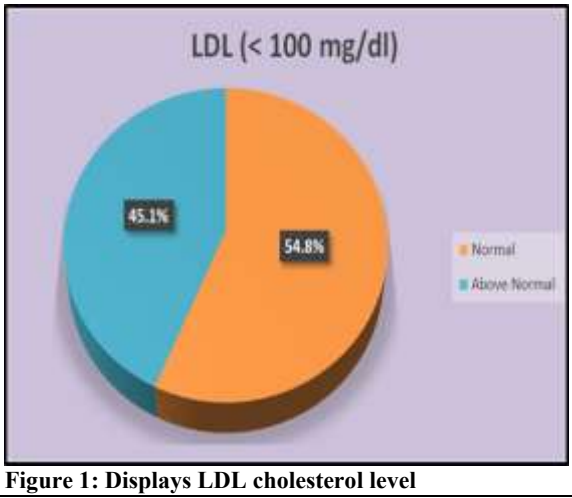

Figure 1: Displays LDL cholesterol level

Out of 175 individuals, 54.8% (96) had normal LDL cholesterol levels (<100 mg/dl), while 45.1% (79) had levels above normal. Overall, more than half of the participants maintained normal LDL levels,

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though a substantial proportion exhibited elevated cholesterol.

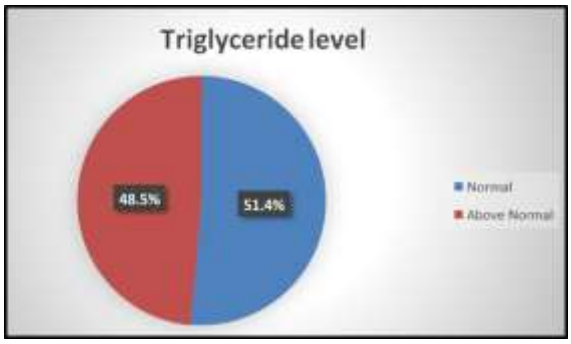

Figure 2: Displays the triglyceride level

Increased LDL was most commonly observed in the 41–50 years age group, followed by 31–40 years, with a higher predominance among female patients. Notably, among those with elevated LDL, a significant number belonged to the 41–50 years group. These findings suggest that raised LDL levels, particularly in middle-aged females, may play an important role in the development of gallstone disease.

Among the 175 patients studied, 51.4% had normal triglyceride levels, while a considerable proportion (48.5%) showed elevated levels. Increased triglycerides were predominantly observed in the 31–50 years age group, accounting for the majority of abnormal cases, with a higher prevalence among female patients. The 41–50 years group showed the highest frequency, followed by 31–40 years. These findings indicate that elevated triglyceride levels, especially in middle-aged females, may contribute significantly to the risk and development of gallstone disease.

Table 1: Distribution of Total Cholesterol Levels in the Study

Cholesterol (<200mg/dl)	Frequency	Percent
Normal	108	61.7
Above Normal	67	38.3
Total	175	100.0

Among the 175 patients studied, 61.7% had normal total cholesterol levels, while 38.3% exhibited elevated levels. Higher cholesterol levels were predominantly observed in the 31–50 years age group, accounting for the majority of abnormal cases, with a greater prevalence among female patients. The 41–50 years group showed the highest frequency, followed by 31–40 years. These findings suggest that increased total cholesterol, particularly in middle-aged females, may play a significant role in the development and risk of gallstone disease.

Table 2: Distribution of BMI in the Study

BMI (18.5-25kg/m2)	Frequency	Percent
Normal	36	20.5
Above Normal	139	79.4

Among the 175 patients studied, only 20.5% had a normal BMI, while a significant majority (79.4%) had above-normal BMI, indicating a high prevalence of overweight and obesity. Elevated BMI was most commonly observed in the 41–50 years age group, followed by 31–40 years, with a higher predominance among female patients. These findings highlight a strong association between increased BMI and gallstone disease, suggesting that obesity is a major contributing factor and emphasizing the importance of weight management and lifestyle modifications in reducing disease risk.

Table 3: Distribution of WHR in the Study

WHR (<0.9 in male, <0.85 in female)	Frequency	
	Male	Female
Normal	55	80
Above Normal	18 (24.6%)	22 (21.5%)
Total	73	102

Among the 175 patients studied, elevated waist-to-hip ratio (WHR) was observed in 24.6% of males and 21.5% of females, indicating a moderate prevalence of central obesity. Regarding thyroid function, 80% of patients had normal serum TSH levels, while 20% showed elevated values. Increased TSH levels were more commonly observed in the 31–40 and 41–50 years age groups. These findings suggest that although abnormal WHR and thyroid dysfunction are present in a subset of patients, their overall association with gallstone disease appears less prominent compared to other risk factors.

Table 4: Distribution of Serum TSH according to age

Age distribution (years)	Normal		Above normal	
	Male	Female	Male	Female

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12-20	4	3	1	1
21-30	1	3	2	1
31-40	12	25	6	7
41-50	25	38	4	4
51-60	16	11	0	8
61-70	1	1	1	0

The data show that 80% of the 175 patients had normal serum TSH levels, while 20% had above-normal levels, suggesting possible thyroid dysfunction. Elevated TSH levels were most common in the 31–40 age group, with a higher prevalence among females, emphasizing the need for regular thyroid monitoring.

Table 5: Distribution of Serum Free T3 and Free T4 Levels in the Study (n = 175)

Parameter	Reference Range	Category	Frequency	Percent
Free T3	2.77–5.27 pg/ml	Normal	143	81.7%
		Below Normal	32	18.3%
		Total	175	100.0%
Free T4	0.78–2.19 ng/dl	Normal	139	79.4%
		Below Normal	36	20.6%
		Total	175	100.0%

Among 175 individuals, 81.7% had normal Free T3 levels and 79.4% had normal Free T4 levels, while 18.3% and 20.6% showed below-normal values respectively. Overall, most participants had normal thyroid hormone levels, though a notable proportion exhibited reduced Free T3 and T4, indicating potential thyroid dysfunction.

The correlation analysis demonstrated significant relationships among various lipid profile parameters and thyroid hormone levels. LDL cholesterol showed a positive correlation with triglycerides and total cholesterol ($p<0.05$), indicating that elevated LDL is often associated with increased levels of these lipids. Triglycerides and total cholesterol also exhibited a moderate positive correlation, suggesting their interrelated role in gallstone pathogenesis. In contrast, HDL cholesterol and thyroid hormones showed weak or non-significant associations with other variables. Additionally, BMI did not demonstrate a strong correlation with thyroid hormone levels. Overall, lipid parameters were more closely interrelated, while associations with thyroid function and anthropometric measures were less exhibited.

Table 6: Correlation of BMI/WHR and thyroid hormone level with gallstone

	Thyroid Hormone Level (Normal)	Thyroid Hormone Level (Abnormal)
BMI/WHR(Normal)	30	3
BMI/WHR(Abnormal)	110	32

The data show that most individuals with abnormal BMI/WHR had normal thyroid hormone levels (110), while a smaller proportion had abnormal thyroid levels (32). Statistical analysis ($\chi^2 = 3.025$, $p = 0.082$) indicates no significant association between BMI/WHR and thyroid hormone levels in relation to gallstones.

Table 7: Correlation of BMI/WHR and Thyroid Hormone Levels with Lipid Profile in Gallstone Patients

Variable	Category	Lipid Profile (Normal)	Lipid Profile (Abnormal)	Total
BMI/WHR	Normal	9	24	33
	Abnormal	52	90	142
Thyroid Hormone Level	Normal	43	97	140
	Abnormal	18	17	35

The individuals with normal BMI/WHR, 9 had normal and 24 had abnormal lipid profiles, while among those with abnormal BMI/WHR, 52 had normal and 90 had abnormal lipid profiles. Similarly, among patients with normal thyroid hormone levels, 43 had normal and 97 had abnormal lipid profiles, whereas those with abnormal thyroid levels had 18 normal and 17 abnormal lipid profiles. Statistical analysis indicates no significant association between BMI/WHR and lipid profile ($\chi^2 = 1.030$, $p = 0.310$), while a significant association exists between thyroid hormone levels and lipid profile ($\chi^2 = 5.291$, $p = 0.021$).

DISCUSSION

Understanding the complex relationship between cholelithiasis, thyroid hormone levels, lipid metabolism, and anthropometric parameters such as body mass index (BMI) and waist-to-hip ratio (WHR) has important clinical implications. Identifying abnormalities in lipid profile and thyroid

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function among patients with gallstone disease can assist in risk stratification and help design individualized treatment strategies. Moreover, such insights may contribute to the development of preventive and therapeutic approaches aimed at reducing the burden of gallstone disease and its associated metabolic disorders. Although growing evidence supports a link between these factors, further comprehensive studies are required to clearly define their interactions in well-characterized populations.[1]

The present prospective study included 175 patients diagnosed with cholelithiasis by ultrasonography over a one-year period from March 2023 to February 2024 at Jorhat Medical College and Hospital. Various parameters, including BMI, thyroid hormone levels, lipid profile, and WHR, were evaluated. The majority of patients belonged to the 41–50 years age group, followed by 31–40 years, with a predominance of female patients. This observation is consistent with earlier findings of Novacek G, that gallstone disease is more common in women, particularly during childbearing age, and occurs two to three times more frequently in females than males.[8]

Lipid profile abnormalities were prominently observed in patients with gallstones. Previous studies have demonstrated that elevated levels of total cholesterol, low-density lipoprotein (LDL), triglycerides, and reduced high-density lipoprotein (HDL) contribute significantly to gallstone formation.[3] In the present study, elevated LDL and triglyceride levels were noted, along with comparatively higher total cholesterol levels. Batajoo H, Hazra NK. 2013, reported where LDL levels showed statistical significance, particularly in women above 40 years of age.[9] Sabanathan S, et. al; 2008, reported a high prevalence of abnormal lipid profiles among gallstone patients, with elevated LDL and hypercholesterolemia being the most common abnormalities.[10] However, in the current study, reduced HDL levels were the most frequent lipid abnormality, followed by elevated triglycerides and LDL. Fu C, et. al; 2024, supported evidence from Chang Fu et al. demonstrated a strong association between obesity-related lipid indices and gallstone disease, highlighting the predictive value of metabolic markers.[11]

Obesity, particularly increased BMI, has been consistently identified as a major risk factor for gallstone disease. Large-scale studies, included those by Stender S, et. al; 2013, have shown that higher BMI significantly increases the likelihood of symptomatic gallstones.[12] Chen L, et. al; 2022 and Lyu J, et. al; 2022, reported a strong association between increased BMI, body fat percentage, and gallstone risk, suggesting weight control as a potential preventive strategy. In the present study, a substantial proportion of patients had elevated BMI, reinforcing the role of obesity in gallstone pathogenesis.[13,14]

Thyroid dysfunction, especially hypothyroidism, has also been implicated in gallstone formation. Several studies have reported a higher prevalence of hypothyroidism among patients with cholelithiasis. Issa AH, et. al; 2018 and Sanniyasi S, et. al; 2018, found a significant association between hypothyroidism and gallstone disease.[15,16] Jabini R, et. al; 2020 and Ghafoor MT, et.al; 2019, supported the increased occurrence of subclinical and overt hypothyroidism in gallstone patients.[17,18] Ghimire et. al in 2017, reported that a notable proportion of gallstone patients had hypothyroidism.[19] In the present study, 20% of patients exhibited abnormal thyroid profiles, primarily elevated serum TSH levels, indicating a comparable trend.

Abdominal obesity, measured by WHR, has also been associated with gallstone disease. Tsai CJ, et. al; 2004, demonstrated a strong correlation between increased WHR and gallstone risk, independent of BMI. In the present study, a proportion of patients exhibited elevated WHR, supporting the role of central obesity in gallstone formation.[20]

Correlation analysed in this study revealed significant relationships between lipid parameters, particularly LDL, triglycerides, and total cholesterol, indicating their interconnected role in gallstone pathogenesis. However, BMI and thyroid hormone levels showed weaker correlations with other variables. Importantly, the combined presence of abnormal lipid profile and thyroid dysfunction showed a significant association with gallstone formation. Similar findings were reported by Vadhvana SK & Makwana TD, highlighted the influence of thyroid dysfunction on lipid metabolism and its contribution to gallstone risk.[21] Diwakar G, et. al; 2024, emphasized the importance of screening for both lipid abnormalities and thyroid disorders in patients with gallstones.[22] These findings suggested that integrated metabolic evaluation should be considered an essential component in the management of gallstone disease.

CONCLUSION

The study concludes that gallstone disease is more prevalent in females, particularly in the 31–50 years age group, with significant associations observed with abnormal lipid profiles, thyroid hormone levels, and increased BMI. Dyslipidemia, including low HDL, high LDL, triglycerides, and cholesterol, emerged as a key risk factor, with low HDL constituted a separate risk factor. Although elevated TSH and WHR showed limited association individually, their combination with lipid abnormalities was significant. Hence, routine evaluation of lipid profile and thyroid function is recommended, and larger population-based studies are needed to explore additional risk factors.

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