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Original Article

Surgery Section

Association between Gallbladder Wall Thickness and Surgical Outcomes Following Laparoscopic Cholecstectomy in Patients with Gall Stone Disease: A Prospective Observational Study

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ABSTRACT

Introduction: Gallstone disease is a prevalent gastrointestinal disorder, often managed surgically via Laparoscopic Cholecystectomy (LC), which is considered the current gold standard. However, Gallbladder Wall Thickness (GBWT), assessed preoperatively using ultrasonography, is known to influence the complexity and outcomes of LC. Increased GBWT may predict intraoperative challenges and postoperative complications, but standardised risk stratification based on GBWT remains underutilised.

Aim: To evaluate the association between GBWT and intraoperative as well as postoperative outcomes in patients undergoing LC for symptomatic gallstone disease.

Materials and Methods: This prospective observational study was conducted at the Department of General Surgery, SRM Medical College Hospital and Research, Chennai, Tamil Nadu, India from March 2024 to March 2025. included 137 patients undergoing LC. Preoperative GBWT was measured using ultrasonography and patients were stratified into four groups: normal (≤2 mm), mildly thickened (>2-4 mm), moderately thickened (>4-6 mm), and severely thickened (>6 mm). Intraoperative parameters (surgery duration, bleeding, bile duct injury, conversion to open surgery) and postoperative outcomes (bile leak, wound infection, ileus, hospital stay) were assessed. Appropriate statistical tool *chi-square test for categorical variables and Analysis of Variance (ANOVA) or t-test for continuous variables were used.

Results: The mean age of the participants was 46.5±12.7 years. Increasing GBWT was significantly associated with longer operative time, higher conversion rates, increased intra-operative bleeding, and higher rates of bile duct injury, bile leak, wound infection, and prolonged ileus. Mean hospital stay also rose progressively with GBWT, reaching 14±5.7 days in the severely thickened group.

Conclusion: The GBWT is a reliable, non invasive preoperative predictor of surgical difficulty and complications in LC. Incorporating GBWT-based stratification can optimise surgical planning and improve patient outcomes.

Keywords: Bile duct injury, Bile leak, Gallstone disease, Intraoperative bleeding, Laparoscopic cholecystectomy, Prolonged ileus, Surgical risk stratification, Ultrasonography, Wound infection

INTRODUCTION

Gallstone disease (cholelithiasis) remains a common and clinically significant condition affecting the biliary tract, with a global prevalence ranging from 10% to 20% among adults [1]. It is a major contributor to the healthcare burden due to its frequent complications and need for surgical intervention [1]. The preferred treatment for symptomatic gallstones is LC, which has largely replaced open cholecystectomy owing to its minimally invasive approach, reduced postoperative pain, faster recovery, and shorter hospital stays [2,3].

However, the success of LC can be influenced by various anatomical and pathological factors, among which GBWT is emerging as a critical determinant [4]. GBWT, typically assessed preoperatively using ultrasonography, serves as a proxy marker for chronic inflammation, acute cholecystitis, or fibrosis [4,5]. An increase in GBWT has been correlated with a higher risk of intraoperative challenges [1,3,6] such as prolonged operative time, intraoperative bleeding, bile duct injuries, and the need for conversion to open surgery. Similarly, it has prognostic value for postoperative complications, including bile leaks [1,3,6], wound infections, and prolonged ileus [5,6].

Moreover, there is a paucity of standardised protocols incorporating GBWT into surgical risk stratification, especially in resource-limited or high-volume surgical settings [1,3]. This observational study aims to bridge this gap by evaluating the association between GBWT and surgical outcomes in patients undergoing LC.

MATERIALS AND METHODS

The present prospective observational study was conducted at the Department of General Surgery, SRM Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India from March 2024 to March 2025, following approval from the institutional ethics committee (SRMIEC-ST0624-1280).

Inclusion and Exclusion criteria: A total of 137 patients aged 18 to 70 years with symptomatic gallstone disease were included after obtaining informed consent. Patients with choledocholithiasis, suspected malignancy, pregnancy, or prior abdominal surgeries were excluded.

Study Procedure

All participants underwent preoperative ultrasonography to measure GBWT. Based on these measurements, patients were categorised into four groups [1].

- Normal (≤ 2 mm)
- Mildly thickened (> 2-4 mm)
- Moderately thickened (> 4-6 mm)
- Severely thickened (> 6 mm)

Elective LC was performed in all patients by experienced surgeons. Intraoperative parameters such as duration of surgery, bleeding, bile duct injury, and conversion to open surgery [1,3,6] were recorded. Postoperative outcomes, including bile leak, wound infection, ileus, and hospital stay duration, were monitored.

STATISTICAL ANALYSIS

Statistical analysis was performed using IBM Statistical Packages of Social Sciences (SPSS) Statistics for Windows, version 26.0 (Armonk, NY: IBM Corp). Data were analysed to determine the association between GBWT and intraoperative/postoperative outcomes. Appropriate statistical tool *Chi-square test for categorical variables and ANOVA (Analysis of Variance) or t-test_for continuous variables were used.

RESULTS

The mean age of the participants was 46.5±12.7 years, with the majority falling in the 41-50 year age group (35%), followed by 28% in the 51-60 year group. Preoperative ultrasonographic assessment revealed that 70% of patients had a normal GBWT (≤ 2 mm). GBWT was mildly thickened in 18%, moderately thickened in 10%, and severely thickened (> 6 mm) in 2% [Table/Fig-1].

Intraoperatively, a significant increase in operative time was observed with increasing GBWT. Patients with normal GBWT had an average surgery duration of 40–50 minutes. Those with mildly thickened walls required 60-70 minutes, moderately thickened cases took 75-90 minutes, and severely thickened walls led to operative times exceeding 90 minutes. The difference in duration across groups was statistically significant (p<0.01) [Table/Fig-2].

All outcomes show a statistically significant worsening trend with increasing GBWT (p<0.05 to p<0.01)*.

Characteristic	Value
Total number of patients	137
Mean age (years) (mean+-SD)	46.5±12.7
Age distribution (years)	
18-30	14 (10%)
31-40	21 (15%)
41–50	48 (35%)
51-60	38 (28%)
>60	16 (12%)
Gender distribution	
Female	87 (63.5%)
Male	50 (36.5%)
Mean BMI (kg/m²)	27.8±3.6
Co-morbidities (Total)	33 (24%)
Diabetes mellitus	21 (15%)
Systemic hypertension	12 (9%)
Presenting symptoms	
Upper abdominal pain	117 (85%)
Nausea and vomiting	48 (35%)
Flatulent dyspepsia/bloating	55 (40%)
Pain radiating to right shoulder	14 (10%)
Gallbladder Wall Thickness (GBWT)	
Normal (≤ 2 mm)	96 (70%)
Mildly thickened (>2 to ≤4 mm)	25 (18%)
Moderately thickened (>4 to ≤6 mm)	14 (10%)
Severely thickened (>6 mm)	2 (2%)
Gallstone characteristics	
Single stone	82 (60%)
Multiple stones	55 (40%)
Mean gallstone size (mean+-SD	1.6±0.4 cm
Pericholecystic fluid	17 (12%)
Other risk factors	
History of smoking	25 (18%)
History of alcohol use	16 (12%)

[Table/Fig-1]: Baseline characteristics of participants.

DISCUSSION

The findings demonstrate a strong and statistically significant association between increased GBWT and adverse intraoperative and postoperative events.

The most notable intraoperative parameter influenced by GBWT in present study was conversion to open surgery. Patients with normal GBWT (≤ 2 mm) had a conversion rate of only three patients, while those with moderately thickened walls (> 4-6 mm) had a conversion rate in six patients. This finding is consistent with Sharath Chandra BJ et al., who reported a sharp rise in conversion rates (71.4%) in patients with thickened GBWT compared to only 10.5% in those with normal thickness [1]. Similarly, Alotaibi AM observed a conversion rate of 4.5% in patients with GBWT>5 mm versus 0.3% in those with GBWT ≤5 mm, reinforcing the role of GBWT as a strong predictive factor for conversion [2]. The pathophysiological rationale lies in the inflammation and fibrosis associated with wall thickening, which distorts anatomy and obscures Calot's triangle, thereby increasing surgical difficulty [7].

Another key outcome analysed was intraoperative bleeding. This is echoed in the findings of Khan S et al., who reported bleeding rates of 10%, 22%, and 35% in mild, moderate, and severe GBWT cases respectively [3]. Sharath Chandra BJ et al., also found that bleeding was significantly higher in patients with GBWT >2 mm (20%) as compared to those with normal walls (5%). These findings suggest an association with increased vascularity and adhesions in thickened gallbladders, which can complicate dissection and increase the risk of haemorrhage [1].

Surgical duration was significantly prolonged with increasing GBWT in this study, ranging from 40-50 minutes in normal GBWT to >90 minutes in severely thickened cases. Alotaibi AM et al., (2023) reported similar trends, with average durations of 67±38 minutes for GBWT > 5 mm versus 54±29 minutes for thinner walls (p=0.001) [2]. The increased operative time may be attributed to difficult anatomical identification, dense adhesions, and greater technical complexity requiring cautious and prolonged dissection.

The risk of bile duct injury, though low in present study, increased in the severely thickened group. Khan S et al., highlighted increased bleeding complications in the moderately (5-6 mm) and severely thickened groups (>6 mm), attributing this to difficult dissection and vascular injury [3] and Sharath Chandra BJ et al., also reported higher rates of bile duct injury in moderate and severe GBWT categories, reaching up to 7% in severe cases [1]. These complications are most likely due to misidentification of structures in an inflamed surgical field and lack of clear tissue planes. Such findings underscore the importance of surgical expertise and meticulous technique in high-GBWT cases.

Sharath Chandra BJ et al., reported a 20% bile leak rate in thickened GBWT cases versus 5% in normal walls [1]. Khan S et al., found an even higher rate of 35% in severely thickened cases [3]. This highlights the technical challenge in ensuring secure closure of the cystic duct in inflamed or fibrotic gallbladders. Many of these cases required Endoscopic Retrograde Cholangiopancreatography (ERCP) and stenting postoperatively.

The incidence of prolonged ileus, though relatively less common, also followed a GBWT-dependent gradient. Khan S et al., reported similar findings with ileus rates of 5% (mild), 12% (moderate), and 20% (severe) [3]. Ileus in such patients may result from prolonged anaesthesia, peritoneal inflammation, and delayed gastrointestinal motility due to surgical stress.

GBWT category	Mean surgery duration in min (mean±SD)	Conversion to open surgery (n%)	Intraoperative bleeding (n%)	Bile duct injury (n%)	Bile leak (n%)	Wound infection (n%)	Prolonged ileus (n%)	Mean hospital stay (days) (mean+-SD)	p-value
Normal (≤ 2 mm)	45±2.5	3 (3.1%)	7 (7.3%)	1 (1.0%)	3 (3.1%)	4 (4.1%)	1 (1%)	4.7±2.4	Reference group
Mild (2-4 mm)	65±2.5	9 (36%)	16 (64%)	2 (8%)	11 (44%)	14 (56%)	7 (28%)	8±3	p<0.05
Moderate (4-6 mm)	82.5±3.75	6 (42.9%)	5 (35.7%)	4 (28.6%)	3 (21.4%)	2 (14.3%)	14 (100%)	12.1±4.2	p<0.01
Severe (>6 mm)	>90±2.5	-	1 (50%)	1 (50%)	-	-	-	14±5.7	p<0.01

[Table/Fig-2]: Association between GBWT and surgical outcomes.
*Chi-square test for categorical variables and ANOVA for continuous variables was used.

Lastly, hospital stay duration was significantly affected. Patients with normal GBWT had an average stay of 4.7±2.4 days, whereas those with severely thickened walls stayed for a mean of 14±5.7 days. Sharath Chandra BJ et al., and Khan S et al., documented parallel findings with increased stay durations in high GBWT groups (7 to 15 days) [1,3]. The longer hospitalisation in these patients reflects the compounded effect of complications such as bile leaks, infections, and delayed recovery.

Predictive models incorporating GBWT as a key parameter will significantly may improve the preoperative assessment and risk stratification for LC. Future advancements in imaging technologies and predictive analytics are expected to enhance the accuracy and applicability of these models.

Limitation(s)

Although comprehensive, the sample size may limit generalisability to broader populations and measurement of GBWT may vary based on the operator and equipment used, introducing potential bias. The findings are based on data from a single centre, limiting external validity. and certain patients (e.g., with malignancy or acute cholecystitis) were excluded, potentially underestimating the overall complication rates.

CONCLUSION(S)

The present study validates the predictive utility of GBWT for surgical difficulty and complications in LC. It highlights the need for thorough preoperative assessment, informed surgical consent, appropriate allocation of resources, and readiness for potential conversion. The study also supports the incorporation of GBWT-based risk stratification into routine clinical protocols and recommends further multicenter validation.

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