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Original Article

A Comparative Study on Intraoperative Findings of Elective Laparoscopic Cholecystectomy in Diabetics Versus Nondiabetics

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ABSTRACT

Background: Diabetes mellitus is associated with chronic inflammation, impaired gallbladder motility, and altered biliary anatomy, which may increase the technical difficulty of laparoscopic cholecystectomy. This study aimed to compare the intraoperative findings and operative outcomes of elective laparoscopic cholecystectomy between diabetic and nondiabetic patients.

Materials and Methods: This prospective comparative observational study was conducted in the Department of General Surgery, Madhubani Medical College and Hospital, Bihar, India, over a period of one year. A total of 100 patients with symptomatic cholelithiasis scheduled for elective laparoscopic cholecystectomy were enrolled, including 50 patients with type 2 diabetes mellitus and 50 nondiabetic controls. Demographic characteristics, preoperative ultrasonographic findings, intraoperative findings, operative parameters, and postoperative outcomes were compared between the groups. Statistical analysis was performed using IBM SPSS Statistics version 26.0. Continuous variables were analyzed using the Independent Student's *t*-test or Mann–Whitney *U* test, while categorical variables were compared using the Chi-square test or Fisher's exact test. A *p*-value <0.05 was considered statistically significant.

Results: Baseline demographic characteristics were comparable between the groups, except for significantly higher HbA1c levels in diabetic patients ($p<0.001$). Gallbladder wall thickening on ultrasonography was significantly more frequent in diabetic patients (44.0% vs. 24.0%, $p=0.035$). Intraoperatively, diabetic patients had a significantly higher incidence of adhesions (80.0% vs. 50.0%, $p=0.002$), severe/dense adhesions (24.0% vs. 6.0%, $p=0.012$), fibrosis around Calot's triangle (36.0% vs. 16.0%, $p=0.022$), gallbladder wall thickening (44.0% vs. 24.0%, $p=0.035$), and difficult gallbladder bed dissection (32.0% vs. 12.0%, $p=0.016$). Operative time was significantly longer in diabetic patients (78.5 ± 14.2 vs. 65.8 ± 11.6 minutes, $p<0.001$), with a higher proportion requiring more than 90 minutes (28.0% vs. 8.0%, $p=0.009$). Perceived surgical difficulty was also significantly greater in diabetic patients (44.0% vs. 12.0%, $p<0.001$). Postoperatively, diabetic patients experienced delayed recovery from anaesthesia ($p=0.001$), higher pain scores at 48 hours ($p=0.001$), and longer hospital stay ($p<0.001$). Although conversion to open cholecystectomy and postoperative complications were more frequent in diabetic patients, these differences were not statistically significant.

Conclusions: Patients with diabetes mellitus undergoing elective laparoscopic cholecystectomy exhibit significantly greater intraoperative technical difficulty, characterized by increased gallbladder wall thickening, dense adhesions, fibrosis around Calot's triangle, prolonged operative time, and longer postoperative recovery. Careful preoperative assessment, meticulous surgical technique, and appropriate perioperative planning are essential to optimize surgical outcomes in this high-risk population.

Keywords*: Diabetes mellitus; Laparoscopic cholecystectomy; Cholelithiasis; Intraoperative findings; Adhesions; Gallbladder wall thickening; Operative time.*

INTRODUCTION

Gallstone disease remains one of the most prevalent gastrointestinal disorders globally, with laparoscopic cholecystectomy (LC) universally established as the gold standard for the treatment of symptomatic cholelithiasis [1]. The minimally invasive approach provides distinct clinical advantages, including accelerated postoperative recovery, minimized visual pain, reduced hospital stay, and lower overall surgical morbidity compared to traditional open laparotomy [1,2]. However, the procedural ease and safety profile of laparoscopic cholecystectomy can be profoundly influenced by the patient's underlying systemic health and metabolic profile [2]. Diabetes mellitus (DM) is an extensively documented independent risk factor for the development of gallstones [3]. The pathophysiological mechanism driving this predisposition involves a complex interplay of diabetic autonomic neuropathy, altered bile composition, and impaired gallbladder motility [4]. Autonomic nerve dysfunction diminishes the contractility of the gallbladder walls, leading to prolonged bile stasis, incomplete emptying, and a significantly larger resting gallbladder volume [5]. Concurrently, metabolic imbalances such as hyperinsulinemia and dyslipidemia increase hepatic cholesterol secretion, accelerating biliary crystal nucleation [3,5]. This environment not only favours rapid lithogenesis but also promotes bacterial colonization and persistent, low-grade subclinical inflammation within the biliary tract [6].

Clinically, these metabolic and structural abnormalities mean that diabetic patients frequently exhibit advanced and severe gallbladder pathology even when presenting for elective, non-emergency operations [7]. Chronic inflammatory changes can radically alter tissue planes, causing dense pericholecystic adhesions to surrounding structures like the duodenum and omentum, significant gallbladder wall thickening, and marked friability or hypervascularity of tissues [8]. Furthermore, anatomical distortion within Calot's triangle—the critical anatomical zone bounded by the cystic duct, common hepatic duct, and inferior liver border—often renders structural isolation and the achievement of the "Critical View of Safety" highly challenging for the operating surgeon [9]. Despite widespread clinical consensus that diabetes increases perioperative morbidity, the specific impact of the disease on direct intraoperative findings during elective procedures remains a subject of ongoing study [10]. Some contemporary literature reports that diabetes is an independent predictor of prolonged operating times, technical surgical difficulty, intraoperative complications (such as gallbladder rupture or bleeding), and higher rates of conversion to open cholecystectomy [9,10]. Conversely, other clinical researchers argue that precise preoperative glycemic management, optimal patient selection, and meticulous modern laparoscopic handling mitigate these anatomical challenges, yielding intraoperative outcomes comparable to non-diabetic cohorts [11]. Given the continuously rising global prevalence of diabetes mellitus alongside an increasing volume of day-care and elective laparoscopic procedures, clarifying this relationship is essential [12]. Anticipating distinct intraoperative complexities allows surgical teams to proactively tailor perioperative risk assessment, adjust operative scheduling, and optimise threshold indices for open conversion [11,12]. Therefore, this study was undertaken to perform a prospective, comparative evaluation of the intraoperative findings encountered during elective laparoscopic cholecystectomy in diabetic versus non-diabetic patients, analyzing parameters such as tissue friability, adhesion density, anatomy clarity, operating time, and conversion frequencies.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based prospective comparative observational study was conducted in the Department of General Surgery, Madhubani Medical College and Hospital, Madhubani, Bihar (India), over a period of one year. The study aimed to compare the intraoperative findings of elective laparoscopic cholecystectomy between diabetic and nondiabetic patients presenting with symptomatic cholelithiasis. The study protocol was approved by the Institutional Ethics Committee (IEC). Written informed consent was obtained from all participants after explaining the nature, objectives, risks, and benefits of the study. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Sample Size Calculation

The sample size was calculated using G*Power software (Version 3.1.9.7, Heinrich-Heine-Universität Düsseldorf, Germany) for comparison between two independent groups. Based on data from previous studies and our pilot observations, the primary outcome parameter—mean operative time—was used for sample size estimation. Assuming a two-tailed hypothesis, an effect size (Cohen's d) of 0.80 (based on an expected difference in operative time of 12 minutes with a pooled standard deviation of 15 minutes), a significance level (α) of 0.05, and a statistical power ($1-\beta$) of 80%, the

minimum required sample size was estimated to be 52 participants (26 patients per group). However, considering that certain secondary outcome parameters such as conversion to open surgery and adhesions may require larger sample sizes, and to compensate for possible exclusions, incomplete data, or intraoperative conversions, the sample size was conservatively increased to 100 participants, comprising 50 diabetic and 50 nondiabetic patients.

Study Population

The study included 100 consecutive patients diagnosed with symptomatic gallstone disease who were scheduled for elective laparoscopic cholecystectomy during the study period. Based on diabetic status, patients were categorized into two groups:

- **Group I (Diabetic Group):** Fifty patients with previously diagnosed Type 2 diabetes mellitus receiving treatment with oral hypoglycemic agents and/or insulin.
- **Group II (Nondiabetic Group):** Fifty patients without diabetes mellitus, confirmed by medical history and preoperative blood glucose evaluation.

Patients were enrolled consecutively until the desired sample size was achieved.

Inclusion Criteria

Patients fulfilling all of the following criteria were included in the study:

- Age ≥18 years.
- Ultrasonography-confirmed symptomatic cholelithiasis.
- Patients scheduled for elective laparoscopic cholecystectomy.
- Ability and willingness to provide written informed consent.
- Type 2 diabetes mellitus was defined according to the American Diabetes Association (ADA) criteria as an HbA1c ≥6.5%, fasting plasma glucose (FPG) ≥126 mg/dL (7.0 mmol/L), random plasma glucose (RPG) ≥200 mg/dL (11.1 mmol/L) in the presence of classic symptoms of hyperglycemia, or a documented previous diagnosis of diabetes mellitus receiving antidiabetic therapy.

Exclusion Criteria

Patients meeting any of the following criteria were excluded:

- Acute cholecystitis requiring emergency surgery.
- Gallbladder empyema, perforation, or generalized peritonitis.
- Choledocholithiasis requiring endoscopic or open biliary intervention.
- Gallbladder malignancy or suspicion of malignancy.
- Previous upper abdominal surgery.
- Pregnancy.
- Severe cardiopulmonary disease rendering patients unfit for laparoscopic surgery.
- Patients refusing to participate in the study.

Preoperative Evaluation All patients underwent a detailed clinical assessment, including demographic profile (age and sex), body mass index (BMI), duration and characteristics of symptoms, history of diabetes mellitus, associated comorbidities, previous abdominal surgeries, and medication history.

Routine preoperative investigations included:

- Complete blood count
- Random blood sugar (RBS) and fasting blood sugar (FBS)
- Glycated hemoglobin (HbA1c) for diabetic patients
- Liver function tests
- Renal function tests
- Serum electrolytes
- Coagulation profile
- Viral markers
- Electrocardiography
- Chest radiography (when indicated)
- Ultrasonography of the abdomen to evaluate gallbladder pathology, wall thickness, number and size of gallstones, common bile duct diameter, and pericholecystic changes.

Patients with diabetes underwent optimization of glycemic control before surgery in consultation with the Department of Endocrinology/Medicine whenever required.

Surgical Procedure

All patients underwent elective laparoscopic cholecystectomy under general anesthesia using the standard four-port technique. Pneumoperitoneum was established with carbon dioxide, and surgery was performed by experienced consultant surgeons following standardized operative protocols to minimize inter-operator variability. The critical view of safety was achieved before clipping and dividing the cystic duct and cystic artery whenever feasible. In cases where safe laparoscopic dissection was not possible, conversion to open cholecystectomy was performed at the discretion of the operating surgeon.

Assessment of Intraoperative Findings

The following intraoperative variables were prospectively recorded on a structured proforma:

- Gallbladder distension or contraction
- Gallbladder wall thickness: Gallbladder wall thickness was assessed intraoperatively by direct visual inspection and palpation by the operating surgeon. The finding was recorded as thickened when gross thickening or fibrosis consistent with the preoperative ultrasonographic assessment (>4 mm) was observed.
- Presence, extent, and severity of adhesions
- Difficulty in identifying and dissecting Calot's triangle
- Presence of fibrosis around Calot's triangle
- Intrahepatic or partially buried gallbladder
- Mucocele or empyema of the gallbladder
- Difficulty in gallbladder bed dissection
- Bile spillage during surgery
- Stone spillage
- Intraoperative bleeding
- Requirement for drain placement
- Operative duration (minutes)
- Conversion to open cholecystectomy
- Any intraoperative complications, including bile duct injury or vascular injury.

Outcome Measures

The primary outcome was to compare intraoperative findings between diabetic and nondiabetic patients undergoing elective laparoscopic cholecystectomy.

The secondary outcomes included:

- Operative duration
- Technical difficulty during surgery
- Intraoperative complications
- Need for drain placement
- Conversion rate to open cholecystectomy.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages. The normality of continuous variables was assessed using the Shapiro–Wilk test. Normally distributed continuous variables were compared using the Independent Student's *t*-test, while non-normally distributed variables were analyzed using the Mann–Whitney *U* test. Categorical variables were compared using the Pearson Chi-square test or Fisher's exact test, as appropriate, with Fisher's exact test applied when the expected cell frequency was less than five. Homogeneity of variances for continuous variables was assessed using Levene's test before applying the Independent Student's *t*-test. All statistical tests were two-tailed, and a p-value <0.05 was considered statistically significant. Ninety-five percent confidence intervals (95% CI) were calculated for the primary outcome measures where appropriate.

RESULTS

A total of 100 patients undergoing elective laparoscopic cholecystectomy were included in the study, comprising 50 patients with type 2 diabetes mellitus and 50 nondiabetic patients. All enrolled patients completed the study and were included in the final analysis.

Baseline Characteristics

The demographic and baseline characteristics of the study participants are summarized in Table 1. The two groups were comparable with respect to age, sex distribution, body mass index (BMI), ASA physical status, and associated comorbidities (all $p>0.05$). The mean age was 48.6 ± 10.2 years in the diabetic group and 46.2 ± 11.4 years in the nondiabetic group ($p=0.268$). Similarly, no significant differences were observed in gender distribution ($p=0.312$), BMI ($p=0.176$), hypertension ($p=0.075$), coronary artery disease ($p=0.217$), dyslipidaemia ($p=0.118$), or other comorbidities ($p=0.507$). As

expected, the mean HbA1c level was significantly higher in diabetic patients than in nondiabetic patients (6.8 ± 0.7% vs. 5.4 ± 0.6%, $p<0.001$). The mean duration of diabetes among diabetic patients was 6.4 ± 3.8 years (Table 1).

Preoperative Ultrasonographic Findings

The preoperative ultrasonographic findings are presented in Table 2 and Figure 1. The overall distribution of gallbladder status (distended, contracted, and normal) was comparable between the two groups ($p=0.084$). However, gallbladder wall thickening (>4 mm) was observed significantly more frequently in diabetic patients than in nondiabetic patients (44.0% vs. 24.0%, $p=0.035$). Although pericholecystic fluid collection, impacted stone at Hartmann's pouch, mucocele, empyema, gangrenous gallbladder, and common bile duct diameter >6 mm were more common in diabetic patients, these differences were not statistically significant (all $p>0.05$) (Table 2).

Intraoperative Findings

The intraoperative findings are summarized in Table 3 and Figure 2. Diabetic patients demonstrated significantly greater operative difficulty than nondiabetic patients. Gallbladder wall thickening was significantly more common in the diabetic group (44.0% vs. 24.0%, $p=0.035$). The intraoperative assessment of gallbladder wall thickness was based on gross operative findings (visual inspection and palpation) and was analyzed independently of the preoperative ultrasonographic assessment. Overall adhesions were significantly more frequent in diabetic patients (80.0% vs. 50.0%, $p=0.002$), with severe/dense adhesions also occurring more commonly (24.0% vs. 6.0%, $p=0.012$). Clear Calot's triangle anatomy was encountered less frequently among diabetic patients (56.0% vs. 76.0%, $p=0.034$), whereas fibrosis around Calot's triangle was significantly more common (36.0% vs. 16.0%, $p=0.022$). Difficult gallbladder bed dissection was also observed more frequently in diabetic patients (32.0% vs. 12.0%, $p=0.016$). No significant differences were observed regarding moderate adhesions, frozen/obscured Calot's triangle, impacted stones at Hartmann's pouch, multiple gallstones, bile spillage, stone spillage, or intraoperative bleeding (all $p>0.05$) (Table 3).

Operative Parameters and Intraoperative Outcomes

The operative parameters and intraoperative outcomes are shown in Table 4. The mean operative time was significantly longer in diabetic patients than in nondiabetic patients (78.5 ± 14.2 vs. 65.8 ± 11.6 minutes, $p<0.001$). Operative time exceeding 90 minutes was also significantly more frequent in diabetic patients (28.0% vs. 8.0%, $p=0.009$). Surgeons perceived significantly greater operative difficulty in diabetic patients (44.0% vs. 12.0%, $p<0.001$). Although drain placement, conversion to open cholecystectomy, subtotal cholecystectomy, and overall intraoperative complications were numerically more frequent in diabetic patients, these differences were not statistically significant (all $p>0.05$). No bile duct injury, vascular injury, or bowel injury occurred in either group (Table 4).

Postoperative Outcomes

The postoperative outcomes are summarized in Table 5. Postoperative complications, including fever, surgical site infection, wound infection, bile leak, intra-abdominal collection, bleeding, respiratory complications, urinary tract infection, and ICU admission, were more common among diabetic patients; however, none of these differences reached statistical significance (all $p>0.05$). Recovery from anaesthesia taking more than 20 minutes occurred significantly more frequently in diabetic patients (56.0% vs. 24.0%, $p=0.001$). Diabetic patients also had significantly higher postoperative pain scores at 48 hours (5.8 ± 1.2 vs. 5.1 ± 0.8, $p=0.001$) and a significantly longer mean hospital stay (6.2 ± 1.4 vs. 4.7 ± 0.9 days, $p<0.001$). No mortality was recorded in either group during the study period (Table 5).

Table 1: Demographic and Baseline Characteristics of Study Participants

Parameter	Diabetic Group (n=50)	Nondiabetic Group (n=50)	p-value
Age (years)*	48.6 ± 10.2	46.2 ± 11.4	0.268
Gender [n (%)]			
Male	22 (44.0%)	18 (36.0%)	0.312
Female	28 (56.0%)	32 (64.0%)	
BMI (kg/m²)*	26.1 ± 2.8	25.4 ± 2.3	0.176
HbA1c (%)*	6.8 ± 0.7	5.4 ± 0.6	<0.001
Duration of diabetes (years)*	6.4 ± 3.8	-	-
Comorbidities [n (%)]			
Hypertension	18 (36.0%)	10 (20.0%)	0.075
CAD	8 (16.0%)	4 (8.0%)	0.217
Dyslipidaemia	12 (24.0%)	6 (12.0%)	0.118
Others	6 (12.0%)	4 (8.0%)	0.507
ASA Grade [n (%)]			
I	22 (44.0%)	30 (60.0%)	0.183
II	24 (48.0%)	18 (36.0%)	

III	4 (8.0%)	2 (4.0%)	

*[*Values expressed as mean ± SD; CAD: Coronary Artery Disease; ASA: American Society of Anaesthesiologists]*

Table 2: Comparison of Preoperative Ultrasonographic Findings

USG Findings [n (%)]	Diabetic Group (n=50)	Nondiabetic Group (n=50)	p-value
Gallbladder distension	18 (36.0%)	22 (44.0%)	
Contracted gallbladder	19 (38.0%)	9 (18.0%)	
Normal gallbladder	13 (26.0%)	19 (38%)	0.084
Gallbladder wall thickening (>4 mm)	22 (44.0%)	12 (24.0%)	0.035
Pericholecystic fluid/collection	10 (20.0%)	4 (8.0%)	0.083
Impacted stone at Hartmann's pouch	7 (14.0%)	3 (6.0%)	0.184
Mucocele	6 (12.0%)	2 (4.0%)	0.142
Empyema	2 (4.0%)	0 (0.0%)	0.153
Gangrenous gallbladder	4 (8.0%)	0 (0.0%)	0.059
CBD diameter >6 mm	5 (10.0%)	3 (6.0%)	0.463

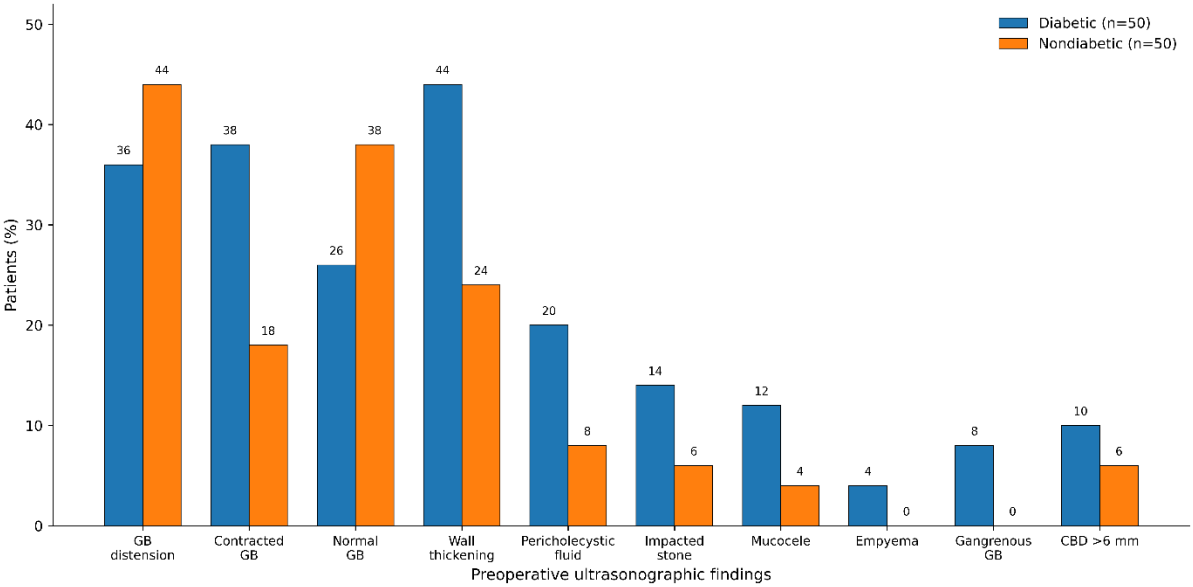

Figure 1: Comparison of preoperative ultrasonographic findings between diabetic and nondiabetic patients undergoing elective laparoscopic cholecystectomy. Bars represent the percentage of patients in each group.

Table 3: Comparison of Intraoperative Findings

Intraoperative Parameter [n (%)]	Diabetic Group (n=50)	Nondiabetic Group (n=50)	p-value
Gallbladder Status			
Distended	20 (40.0%)	26 (52.0%)	0.229
Contracted	19 (38.0%)	9 (18.0%)	0.026
Gallbladder Wall			
Normal	28 (56.0%)	38 (76.0%)	0.035
Thickened (>4 mm)	22 (44.0%)	12 (24.0%)	
Adhesions			
Present	40 (80.0%)	25 (50.0%)	0.002
Mild	10 (20.0%)	12 (24.0%)	0.630
Moderate	18 (36.0%)	10 (20.0%)	0.075
Severe/Dense	12 (24.0%)	3 (6.0%)	0.012
Calot's Triangle			
Clear anatomy	28 (56.0%)	38 (76.0%)	0.034

Frozen/obscured Calot's	12 (24.0%)	6 (12.0%)	0.118
Fibrosis around Calot's	18 (36.0%)	8 (16.0%)	0.022
Stone Characteristics			
Impacted at Hartmann's pouch	8 (16.0%)	3 (6.0%)	0.112
Multiple stones	32 (64.0%)	28 (56.0%)	0.415
Bile Spillage			
Present	12 (24.0%)	6 (12.0%)	0.118
Stone Spillage			
Present	8 (16.0%)	4 (8.0%)	0.217
Intraoperative Bleeding			
Present	10 (20.0%)	4 (8.0%)	0.083
Gallbladder Bed Dissection			
Difficult	16 (32.0%)	6 (12.0%)	0.016
Easy	34 (68.0%)	44 (88.0%)	0.016

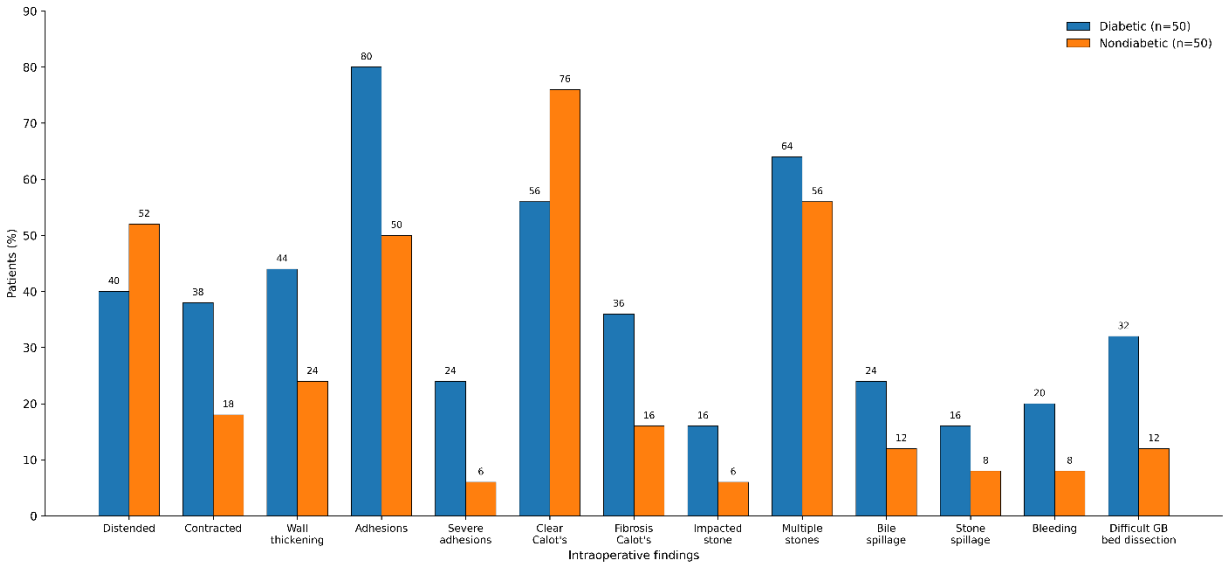

Figure 2: Comparison of intraoperative findings between diabetic and nondiabetic patients undergoing elective laparoscopic cholecystectomy.

Table 4: Comparison of Operative Parameters and Outcomes

Parameter	Diabetic Group (n=50)	Nondiabetic Group (n=50)	p-value
Mean operative time (minutes)*	78.5 ± 14.2	65.8 ± 11.6	<0.001
Operative time >90 minutes [n (%)]	14 (28.0%)	4 (8.0%)	0.009
Perceived surgical difficulty [n (%)]	22 (44.0%)	6 (12.0%)	<0.001
Drain placement [n (%)]	12 (24.0%)	6 (12.0%)	0.118
Conversion to open cholecystectomy [n (%)]	6 (12.0%)	1 (2.0%)	0.112
Subtotal cholecystectomy [n (%)]	4 (8.0%)	1 (2.0%)	0.170
Intraoperative complications [n (%)]	4 (8.0%)	1 (2.0%)	0.170
Bile duct injury	0 (0.0%)	0 (0.0%)	-
Vascular injury	0 (0.0%)	0 (0.0%)	-
Bowel injury	0 (0.0%)	0 (0.0%)	-
Uncontrolled bleeding	4 (8.0%)	1 (2.0%)	0.170

*[*Values expressed as mean ± SD]*

Table 5: Comparison of Postoperative Outcomes

Parameter	Diabetic Group (n=50)	Nondiabetic Group (n=50)	p-value

Postoperative Complications [n (%)]			
Fever	8 (16.0%)	4 (8.0%)	0.217
Surgical site infection	12 (24.0%)	5 (10.0%)	0.063
Wound infection	8 (16.0%)	3 (6.0%)	0.112
Bile leak	4 (8.0%)	0 (0.0%)	0.059
Intra-abdominal collection	2 (4.0%)	0 (0.0%)	0.153
Bleeding	2 (4.0%)	0 (0.0%)	0.153
Respiratory complications	4 (8.0%)	2 (4.0%)	0.400
Urinary tract infection	3 (6.0%)	1 (2.0%)	0.309
Recovery Parameters			
Recovery from anaesthesia >20 min [n (%)]	28 (56.0%)	12 (24.0%)	0.001
Mean VAS score at 48 hours*	5.8 ± 1.2	5.1 ± 0.8	0.001
Mean hospital stay (days)*	6.2 ± 1.4	4.7 ± 0.9	<0.001
ICU admission [n (%)]	2 (4.0%)	0 (0.0%)	0.153
Mortality [n (%)]			
Overall mortality	0 (0.0%)	0 (0.0%)	-

*[*Values expressed as mean ± SD; VAS: Visual Analogue Scale; ICU: Intensive Care Unit]*

DISCUSSION

The baseline demographic characteristics (age, gender, BMI, ASA grade, and comorbidities) of both groups were comparable, minimizing confounding variables. As expected, HbA_{1c} levels were significantly higher in diabetic patients, indicating poorer glycaemic status. This demographic comparability aligns with findings by Luthra et al. [13], as well as Bhalgat et al. and Malik et al. [14,15], suggesting that the differences observed in operative findings are primarily driven by diabetes-related pathological changes rather than demographic variance.

Preoperative Ultrasonography and Gallbladder Wall Thickening

Preoperative ultrasonography plays a vital role in anticipating surgical complexity. In this study, gallbladder wall thickening ($>$ 4 mm) was significantly more prevalent in diabetic patients. While other adverse ultrasonographic parameters were numerically higher in the diabetic cohort, they did not reach statistical significance. This association between diabetes and chronic inflammatory wall thickening echoes findings by Luthra et al. [13], Bhalgat et al. [14], and Malik et al. [15], highlighting its value for preoperative risk stratification.

Intraoperative Adhesions and Calot's Triangle Fibrosis

A key finding was the significantly higher prevalence and severity of intraoperative adhesions in diabetic patients (80% vs. 50%), driven by chronic hyperglycaemia, low-grade inflammation, and progressive fibrosis. These results match data from Luthra et al. (74.7% vs. 46.7%) [13], Bhalgat et al. (83% vs. 47%) [14], and Malik et al. [15]. Furthermore, diabetic patients exhibited significantly greater fibrosis around Calot's triangle, which distorts biliary anatomy and complicates dissection. Similar anatomical challenges were noted by Luthra et al. [13] and Bhalgat et al. [14]. Crucially, adhering to the "Critical View of Safety" prevented bile duct injuries in both groups.

Contracted Gallbladder and Gallbladder Bed Dissection

Contracted gallbladders occurred significantly more frequently in diabetic individuals due to long-standing inflammation and loss of wall compliance. This is consistent with findings by Luthra et al. [13] and Aldaqal et al. [16], though Malik et al. reported comparable contraction rates but similar overall surgical difficulty [15]. Additionally, diabetic patients experienced significantly more difficult gallbladder bed dissections due to the obliteration of natural tissue planes, corroborating the experiences of Luthra et al. [13], Bhalgat et al. [14], and Mahapure and Metgud [17].

Operative Time and Surgical Difficulty

The mean operative time was significantly longer in the diabetic group (78.5 ± 14.2 vs. 65.8 ± 11.6 minutes), with a higher proportion of cases exceeding 90 minutes. This prolongation stems directly from dense adhesions, wall thickening, and fibrosis. These findings align with reports by Luthra et al. [13], Bhalgat et al. [14], Malik et al. [15], and Al-Mulhim (85.4 vs. 68.2 minutes) [18]. Consequently, the perceived degree of surgical difficulty was significantly higher in diabetic patients, supporting prior data from Bhalgat et al. [14], Malik et al. [15], and Hosseini et al. [19].

Conversion Rates and Complications

Although open conversion and subtotal cholecystectomy rates were numerically higher in diabetic patients, the differences were not statistically significant. While some authors noted significantly higher conversion rates due to severe inflammation [14,16,20], our findings mirror those of Luthra et al. [13] and Paajanen et al. [21], where elective scheduling, patient optimization, and surgical expertise mitigated conversion risks. Reassuringly, major intraoperative complications

(e.g., vascular or bile duct injuries) were absent in both cohorts, confirming that meticulous technique can overcome these anatomical barriers [13,14,22]. Similarly, postoperative complications (e.g., surgical site infections, bile leaks) were numerically higher in diabetics but statistically insignificant, likely due to optimization, antibiotics, and enhanced recovery pathways, despite the known inhibitory effects of hyperglycaemia on wound healing [14,15].

Postoperative Recovery, Pain, and Hospital Stay

Diabetic patients experienced significantly delayed recovery from anaesthesia ($>$ 20 minutes), a phenomenon also documented by Luthra et al. [13] and Sudhakaran and Surani [23], who attributed it to metabolic alterations and autonomic dysfunction. Furthermore, diabetic patients reported significantly higher postoperative pain scores at 48 hours due to increased tissue manipulation, contrasting with Luthra et al. and Malik et al. who found no difference [13,15]. Finally, hospital stay was significantly longer for diabetic patients, reflecting delayed recovery and the need for close glycaemic monitoring, consistent with previous literature [13,14,15].

Clinical Implications

Preoperative identification of high-risk sonographic features allows for improved planning, glycemic control, and the deployment of experienced surgeons. The strength of this study lies in its prospective, comparative design and comprehensive multi-parameter intraoperative tracking.

Limitations of the study: This study has certain limitations. It was conducted at a single tertiary care center with a relatively modest sample size, which may limit the generalizability of the findings. Additionally, the observational study design precludes establishing a causal relationship between diabetes mellitus and intraoperative outcomes. Rare complications such as bile duct injury and mortality were infrequent, limiting the statistical power for these outcomes. Nevertheless, the prospective design, standardized surgical technique, and comprehensive evaluation of intraoperative findings provide valuable evidence regarding the impact of diabetes on elective laparoscopic cholecystectomy and offer a foundation for larger multicenter studies.

CONCLUSIONS

Patients with type 2 diabetes mellitus undergoing elective laparoscopic cholecystectomy demonstrated significantly greater intraoperative technical difficulty than nondiabetic patients. Diabetic patients were more likely to have gallbladder wall thickening, dense pericholecystic adhesions, fibrosis around Calot's triangle, difficult gallbladder bed dissection, prolonged operative time, delayed postoperative recovery, higher postoperative pain scores, and longer hospital stay. Although conversion to open surgery and postoperative complications were more frequent among diabetic patients, these differences were not statistically significant. These findings highlight the importance of thorough preoperative assessment, optimization of glycaemic control, meticulous surgical technique, and careful perioperative planning to improve surgical outcomes in diabetic patients undergoing elective laparoscopic cholecystectomy. Further large-scale multicentre studies are warranted to validate these findings and better evaluate infrequent complications.

REFERENCES

1. Keus F, Gooszen HG, van Laarhoven CJ. Open, small-incision, or laparoscopic cholecystectomy for patients with symptomatic cholecystolithiasis. An overview of Cochrane Hepato-Biliary Group reviews. Cochrane Database Syst Rev. 2010 Jan 20;2010(1):CD008318. doi: 10.1002/14651858.CD008318. PMID: 20091665; PMCID: PMC7180153.
2. Eikermann M, Siegel R, Broeders I, Dziri C, Fingerhut A, Gutt C, Jaschinski T, Nassar A, Paganini AM, Pieper D, Targarona E, Schrewe M, Shamiyeh A, Strik M, Neugebauer EA; European Association for Endoscopic Surgery. Prevention and treatment of bile duct injuries during laparoscopic cholecystectomy: the clinical practice guidelines of the European Association for Endoscopic Surgery (EAES). Surg Endosc. 2012 Nov;26(11):3003-39. doi: 10.1007/s00464-012-2511-1. Epub 2012 Oct 6. PMID: 23052493.
3. Ali G. Impact of Diabetes on Outcomes of Laparoscopic Cholecystectomy: A Prospective Study. Journal of Surgical Research and Clinical Practice. 2026;12(2):88-95.
4. Feldman M, Schiller LR. Disorders of gastrointestinal motility associated with diabetes mellitus. Ann Intern Med. 1983 Mar;98(3):378-84. doi: 10.7326/0003-4819-98-3-378. PMID: 6402969.
5. Jawade K. Diabetic Populations and Surgical Challenges in Laparoscopic Interventions. International Journal of Medical Science and Current Research. 2024;7(6):1008-1014.
6. Polderman J, van Wilpe R, Eshuis J, Preckel B, Hermanides J. Ambulatory anesthesia: optimal perioperative management of the diabetic patient. Ambulatory Anesthesia. 2016;3:13-22.
7. Feng H. Effects of diabetes on laparoscopic cholecystectomy in elderly patients. Journal of Shanghai Jiaotong University (Medical Science). 2014;34(2):201-205.
8. Jiang J, Wang S, Sun R, Zhao Y, Zhou Z, Bi J, Luo A, Li S. Postoperative short-term mortality between insulin-treated and non-insulin-treated patients with diabetes after non-cardiac surgery: a systematic review and meta-analysis. Front Med (Lausanne). 2023 May 2;10:1142490. doi: 10.3389/fmed.2023.1142490. PMID: 37200964; PMCID: PMC10185903.

9. Nuzzo G, Giuliante F, Giovannini I, Ardito F, D'Acapito F, Vellone M, Murazio M, Capelli G. Bile duct injury during laparoscopic cholecystectomy: results of an Italian national survey on 56 591 cholecystectomies. Arch Surg. 2005 Oct;140(10):986-92. doi: 10.1001/archsurg.140.10.986. PMID: 16230550.
10. Lauro A, Cervellera M, D'Andrea V, Casella G, Di Matteo FM, Di Matteo FM, Santoro A, Panarese A, Palazzini G, Cirocchi R, Agastra E, Falvo L, Talarico E, Cicia S, Tonini V. Impact of cardiovascular/diabetic comorbidity on conversion rate during laparoscopic cholecystectomy for acute cholecystitis: a multi-center study on early versus very delayed approach. G Chir. 2019 Mar-Apr;40(2):95-104. PMID: 31131807.
11. Drayton DJ, Birch RJ, D'Souza-Ferrer C, Ayres M, Howell SJ, Ajjan RA. Diabetes mellitus and perioperative outcomes: a scoping review of the literature. Br J Anaesth. 2022 May;128(5):817-828. doi: 10.1016/j.bja.2022.02.013. Epub 2022 Mar 14. PMID: 35300865; PMCID: PMC9131255.
12. Garg R, Schuman B, Bader A, Hurwitz S, Turchin A, Underwood P, Metzger C, Rein R, Lortie M. Effect of Preoperative Diabetes Management on Glycemic Control and Clinical Outcomes After Elective Surgery. Ann Surg. 2018 May;267(5):858-862. doi: 10.1097/SLA.0000000000002323. PMID: 28549013.
13. Luthra A, Behura A, Behera CR, Mishra A, Mohanty S, Panda B. Intraoperative Findings of Elective Laparoscopic Cholecystectomy in Diabetics Versus Nondiabetics: A Comparative Study. Cureus. 2022 Jan 3;14(1):e20886. doi: 10.7759/cureus.20886. PMID: 35145791; PMCID: PMC8807453.
14. Bhalgat M, Choudhari K, Jawade K, Vichare S. A comparative study of intraoperative findings and complications of laparoscopic cholecystectomy in diabetic and non-diabetic patients. Int J Surg Sci. 2023;7(3):45-51.
15. Malik M, Bhimani Z, Singh S, Shah N, Eswar PS. Observational study to compare surgical outcome in diabetics and non-diabetics patients undergoing laparoscopic cholecystectomy. Int J Hepatol Res. 2025;7(1):4-10.
16. Aldaqal SM, Albaghdadi AT, Tashkandi HM, Eldeek BS, Al-Malki GA, Turki AM. Effect of diabetes mellitus on patients undergoing laparoscopic cholecystectomy: a comparative cross-sectional study. Life Sci J. 2012;9(1):431-439.
17. Mahapure KS, Metgud SC. Effect of diabetes mellitus on operative outcome following laparoscopic cholecystectomy: a one-year cross-sectional study at tertiary care hospital. Arch Int Surg. 2019;9(3):78-83.
18. Al-Mulhim AR. The outcome of laparoscopic cholecystectomy in diabetic patients: a prospective study. J Laparoendosc Adv Surg Tech A. 2010 Jun;20(5):417-20. doi: 10.1089/lap.2009.0436. PMID: 20518693.
19. Hosseini SV. Evaluation postoperative complication of laparoscopic cholecystectomy in diabetic patients. Int J Curr Res Aca Rev. 2014;2(11):107-116.
20. Bedirli A, Sozuer EM, Yuksel O, Yilmaz Z. Laparoscopic cholecystectomy for symptomatic gallstones in diabetic patients. J Laparoendosc Adv Surg Tech A. 2001;11(5):281-284.
21. Paajanen H, Suuronen S, Nordstrom P, Miettinen P, Niskanen L. Laparoscopic versus open cholecystectomy in diabetic patients and postoperative outcome. Surg Endosc. 2011 Mar;25(3):764-70. doi: 10.1007/s00464-010-1248-y. Epub 2010 Jul 27. PMID: 20661751.
22. Karamanos E, Sivrikoz E, Beale E, Chan L, Inaba K, Demetriades D. Effect of diabetes on outcomes in patients undergoing emergent cholecystectomy for acute cholecystitis. World J Surg. 2013;37(10):2257-2264.
23. Sudhakaran S, Surani SR. Guidelines for perioperative management of the diabetic patient. Surg Res Pract. 2015;2015:284063.