ORIGINAL ARTICLE

Extra Calot's Subserosal Gallbladder Dissection without Clipping of Cystic Artery is a Safe Technique of Laparoscopic Cholecystectomy for Acute Cholecystitis

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Abstract

Background: Laparoscopic cholecystectomy remains the gold standard for treating gallbladder disease but carries a risk of bile duct injury, especially in cases of acute cholecystitis with distorted anatomy. This study evaluated the safety and effectiveness of an extra-Calot's subserosal dissection technique without clipping the cystic artery, aiming to minimize complications. **Materials and Methods:** This cross-sectional observational study was conducted at Alhada Armed Forces Hospital and Prince Mansoor Military Hospital over 18 months. A total of 98 patients with clinically and radiologically confirmed acute cholecystitis underwent emergency laparoscopic cholecystectomy using the described technique. Patients with obstructive jaundice, malignancy, or choledocholithiasis were excluded. Data on demographics, surgical outcomes, laboratory values, and complications were recorded and analyzed using SPSS version 26. **Results:** Among 98 evaluated patients, the majority were female (58.2%), with a mean surgery duration of 116.73 ± 51.9 min. No major intraoperative or post-operative bleeding, bowel injury, or transfusion was recorded. One patient had a transient biliary leak through the drain and no patient had bile duct injury. Logistic regression identified gallbladder wall thickening >4 mm as a significant predictor of bile duct injury (odds ratio = 6.10; $P = 0.034$). No significant changes were noted in hemoglobin or liver enzymes postoperatively, except for reductions in albumin and total protein levels ($P < 0.001$). **Conclusion**: The extra-Calot's subserosal dissection technique without cystic artery clipping appears to be a safe and effective method for managing acute cholecystitis, minimizing critical complications. Further studies with larger cohorts are warranted to validate its widespread applicability.

Key words: Acute cholecystitis, cystic artery, gallbladder, laparoscopic cholecystectomy

INTRODUCTION

Since its introduction in the early 1990s, laparoscopic cholecystectomy has become the gold standard for the surgical treatment of gallbladder stone disease worldwide.[1] Its widespread adoption is attributed to significant advantages over open cholecystectomy, including reduced post-operative pain, shorter hospital stays, quicker return to normal daily activities, and decreased overall healthcare costs. However, despite these benefits, laparoscopic cholecystectomy has been associated with a

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slightly higher incidence of bile duct injuries – ranging from 0.3% to 0.8% – compared to an estimated 0.2% incidence in open cholecystectomy.[2-7] Some large-scale studies have even reported lower rates of bile duct injuries, ranging between 0.14% and 0.23%.[8,9] The technique of laparoscopic cholecystectomy has evolved from the traditional "infundibular technique" (IT), which involves intraoperative identification of the junction between the cystic duct and gallbladder, to the "Critical View of Safety" (CVS) approach proposed by Strasberg in 1995 to minimize the risk of bile duct injuries.[10] The CVS approach includes three essential components: (1) Complete clearance of fibrofatty tissue from the hepatocystic triangle, (2) clear identification of only two structures entering the gallbladder—namely, the cystic duct and cystic artery, and (3) partial mobilization of the gallbladder from the cystic plate to ensure safe dissection. The CVS is a method of target identification and not a specific dissection technique; its purpose is to prevent biliary injury by ensuring correct anatomical recognition.[11]

Bile duct injuries typically result from the surgeon's failure to accurately identify critical structures, especially under conditions of severe inflammation such as acute or chronic cholecystitis. Acute inflammation can lead to fibrosis and adhesion in Calot's triangle, resulting in juxtaposition or adherence of the common hepatic duct to the gallbladder. This may cause the surgeon to mistakenly identify the common bile duct as the cystic duct.[12] Furthermore, anatomical variations such as fibrotic cystic pedicles, cholecysto-choledochal fistulas, or the presence of three or more structures in Calot's triangle occur in approximately one-third of patients, rendering CVS application difficult or impossible.[13] Even in the absence of aberrant anatomy, improper application of the CVS approach can lead to bile duct injury, particularly in cases of severely inflamed or fibrotic gallbladders where the hepatocystic triangle is not easily expandable.[14]

In light of these challenges, various alternative techniques have been proposed in the literature, including the segment IV approach, cystic artery isolation and clipping outside versus inside Calot's triangle, the triangle of safety technique, ultrasonic dissection without clipping the cystic artery, and other cystic artery-sparing methods—each with varying outcomes and safety profiles.[15-17] Despite these innovations, data on the safety and efficacy of such techniques, particularly in acute cholecystitis, remain limited. In this context, we propose a novel technique: extra-Calot's subserosal gallbladder dissection without clipping the cystic artery, specifically designed for patients with acute cholecystitis. In this method, dissection begins by identifying the lymph node of Lund and proceeding parallel to the cystic artery, carefully cauterizing its small branches to the gallbladder wall using electrocautery without directly handling or clipping the artery. Dissection is carried out anteriorly and posteriorly to the Hartmann's pouch without direct entry into Calot's triangle. The inflamed serosa is gently stripped from the gallbladder wall, exposing the cystic artery without manipulation. This approach allows safe mobilization of the gallbladder while avoiding the critical hepatocystic triangle in the initial dissection phase. By remaining close to the gallbladder and avoiding deep dissection in inflamed tissue, this technique aims to minimize both bleeding and biliary injuries.

Aim of the study

The aims is to evaluate the safety and effectiveness of extra-Calot's subserosal dissection without clipping the cystic artery during laparoscopic cholecystectomy in patients with acute cholecystitis, specifically in terms of intraoperative bleeding and bile duct injury, and to compare these outcomes with findings reported in international studies.

Objectives

1. To determine the incidence of bile duct injury associated with the proposed technique.
2. To assess the rate of intraoperative and post-operative bleeding complications.
3. To analyze whether cystic artery-sparing dissection contributes to safer outcomes in acute cholecystitis cases.
4. To compare study results with international data on conventional and alternative cholecystectomy techniques.

MATERIALS AND METHODS

This study was designed as a cross-sectional observational study to evaluate the safety and outcomes of the extra-Calot's subserosal dissection technique without clipping the cystic artery during laparoscopic cholecystectomy in patients diagnosed with acute cholecystitis. The primary focus was on assessing the incidence of bile duct injury and intraoperative or post-operative bleeding complications.

The study was conducted at two major tertiary care centers in Taif, Saudi Arabia: Alhada Armed Forces Hospital and Prince Mansoor Military Hospital. The surgeries were performed by a single experienced surgeon with expertise in this specialized technique. The study spanned a duration of 18 months, from January 2023 to June 2024.

A total of 98 patients, both male and female, aged between 20 and 80 years, were enrolled in the study. Participants were selected using a convenience sampling method, whereby eligible patients who presented consecutively during the study period were included, provided they met the diagnostic criteria for acute cholecystitis. Diagnosis was established based on a combination of clinical features (e.g., right upper quadrant pain, fever, vomiting), laboratory findings (elevated white blood cell count, abnormal liver function tests), and radiological imaging (ultrasound or CT evidence of gallbladder wall thickening, gallstones, or pericholecystic fluid) in accordance with the Tokyo Guidelines for acute cholecystitis.

Patients were excluded from the study if they had obstructive jaundice, acute pancreatitis, gallbladder carcinoma, Mirizzi syndrome, or common bile duct stones. Other exclusion criteria included a history of prior hepatobiliary surgery or poor surgical fitness for general anesthesia. This ensured the homogeneity of the study population and focused the analysis on patients with uncomplicated acute cholecystitis.

Before surgery, all patients were provided with detailed information regarding the procedure, the study objectives, potential risks, and benefits. Written informed consent was obtained from each patient. The study protocol was approved by the institutional review boards (IRBs) of the participating hospitals and conducted in accordance with the principles outlined in the Declaration of Helsinki for research involving human subjects.

All patients underwent emergency laparoscopic cholecystectomy using the proposed extra-Calot's subserosal dissection technique. In this technique, dissection is initiated by identifying the lymph node of Lund, which lies superior or anterior to the cystic duct and marks the anterior border of Calot's triangle. The cystic artery usually runs just behind or to the right of the lymph node of Lund, over the gallbladder. After incising the serosal covering over the gallbladder just right to the lymph node of Lund, with electrocautery, the first step is to identify the cystic artery running over the gallbladder from Calot's triangle to the fundus of the gallbladder. The entire course of the cystic artery is exposed over the gallbladder, with careful advancement along the serosal surface of the gallbladder, parallel to the artery, using electrocautery. Small arterial branches to the gallbladder wall were coagulated without direct handling or clipping of the main cystic artery. Dissection was deliberately kept close to the gallbladder wall, proceeding anteriorly and posteriorly around the Hartmann's pouch and infundibular region, while avoiding direct entry into Calot's triangle. The whole cystic artery, along with the left/medial serosal layer over the gallbladder, is gently swept to the left of the gallbladder with the help of electrocautery dissection. The dissection plane is advanced from the anterior to the posterior side at the level of Hartman's pouch, and the cystic duct is identified by stripping the lower margin of the incised peritoneum at the level of Hartman's pouch and the lymph node of Lund. After careful skeletonization of the cystic duct and lifting the gallbladder at the cystic plate by at least 3–5 cm to ensure that no other ductal or vascular structures are present, the cystic duct is divided between clips. The rest of the gallbladder is then removed from the liver bed without clipping the cystic artery, and the cystic artery remains on the left side of the cystic plate with the leftover serosal covering of the gallbladder. This method was designed to minimize visual misidentification of structures and reduce the risk of bile duct or vascular injury, particularly in inflamed or fibrotic tissues.

Clinical data were recorded in a structured pro forma, including demographic details, clinical presentation, comorbidities, laboratory and radiological findings, intraoperative observations, and post-operative outcomes. Parameters such as duration of surgery, use of surgical drains, conversion to open surgery, bile duct injury, bleeding, bowel injury, and need for blood transfusion were specifically monitored. Patients were followed postoperatively during their hospital stay to assess immediate complications and surgical outcomes.

Statistical analysis

Data were entered into and analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize patient characteristics and surgical outcomes. Paired t-tests were employed to compare pre-operative and post-operative laboratory markers. To evaluate predictors of bile duct injury, binary logistic regression analysis was conducted. A $P < 0.05$ was considered statistically significant for all analyses.

The potential risks involved in this study were limited to the inherent surgical risks associated with laparoscopic cholecystectomy. However, the potential benefits included a better understanding of the safety profile of this novel technique, which could guide surgical practices and improve patient outcomes in acute cholecystitis cases. Patients were also provided with contact details for the operating surgeon and the research coordinator should they require additional information or follow-up regarding their participation.

RESULTS

Among the 98 patients included in the study, females constituted 58.2% and males 41.8%. The most common age group was 26–35 years (26.5%), followed by 56–65 years (18.4%), 46–55 years (17.3%), and 36–45 years (16.3%), while 13.3% were older than 65 years and 8.2% were younger than 25 years. Regarding medical history, 58.2% of patients were medically free, whereas the most common comorbidities were hypertension (24.5%) and diabetes mellitus (21.4%), with smaller proportions reporting bronchial asthma (7.1%), ischemic heart disease (5.1%), hypothyroidism (3.1%), and history of deep vein thrombosis (1.0%). All patients presented with right upper quadrant abdominal pain (100%), and nearly half (46.9%) reported vomiting, while fever was less commonly observed (9.2%). The majority of patients (81.6%) had symptoms lasting less than five days before surgery, whereas 18.4% had symptoms persisting for more than 5 days [Table 1].

At admission, half of the patients (50.0%) had white blood cell counts within the normal range (4000–11000 cells/μL), while 46.9% had elevated counts above 11000, and 3.1% had

Table 1: Sociodemographic characteristics and medical history

Variables	N	%
Gender		
Female	57	58.2
Male	41	41.8
Age		
<25 years	8	8.2
26–35 years	26	26.5
36–45 years	16	16.3
46–55 years	17	17.3
56–65 years	18	18.4
>65 years	13	13.3
Comorbidities		
Medically free	57	58.2
Bronchial asthma	7	7.1
Diabetes mellites	21	21.4
Hypertension	24	24.5
Ischemic heart disease	5	5.1
History of DVT	1	1.0
Hypothyroidism	3	3.1
Symptoms		
Pain right upper quadrant abdomen	98	100
Fever	9	9.2
Vomiting	46	46.9
Duration of symptoms		
<5 days	80	81.6
More than 5 days	18	18.4

Table 2: Surgery characteristics

Variables	n	%
White blood cells at admission		
<4000	3	3.1
4000–11000	49	50.0
More than 11000	46	46.9
Ultrasonography findings		
Contracted gallbladder	2	2.0
Distended gallbladder	13	13.3
Gallbladder stone	100	100
Thick-walled gallbladder more than 4mm	59	60.2
Pericholecystic fluid	40	40.8
Drain employed		
No	39	39.8
Yes	59	60.2
Intraoperative bleeding		
No	98	100.0
Yes	0	0
Post-operative bleeding		
No	98	100.0
Yes	0	0
Small bowel injury		
No	98	100.0
Yes	0	0
Large bowel injury		
No	98	100.0
Yes	0	0
Blood transfusion required		
No	98	100.0
Yes	0	0
Biliary leak		
No	97	99.0
Yes	1	1.0
Intraoperative cholangiogram		
No	95	96.9
Yes	3	3.1
Conversion to open		
No	97	99.0
Yes	1	1.0
Surgery duration	116.73±51.9 min	

counts below 4000. Ultrasonography findings showed that all the patients had gallbladder stones (100%), 60.2% had a thick-walled gallbladder (>4 mm), and 40.8% exhibited pericholecystic fluid, 13.3% had a distended gallbladder, and 2.0% had a contracted gallbladder. A surgical drain was employed in 60.2% of cases. No intraoperative bleeding, post-operative bleeding, small or large bowel injury, or need for blood transfusion was reported in any patient. One patient had post-operative bile leak through the drain that stopped after 5. Thus, conversion to open surgery was necessary in only in patient (n = 1). The mean duration of surgery was 116.73 ± 51.9 min. No patient required an intraoperative cholangiogram [Table 2].

Comparison of clinical investigations before and after surgery showed no significant change in hemoglobin levels, with mean values of 13.69 ± 2.15 g/dL at admission and 13.83 ± 9.87 g/dL post-operatively (P = 0.900). Alkaline phosphatase (ALP) levels slightly decreased from 124.00 ± 63.51 U/L preoperatively to 118.98 ± 64.41 U/L postoperatively, though this was not statistically significant (P = 0.262). A significant reduction was observed in total protein levels, decreasing from 69.09 ± 6.57 g/L to 62.35 ± 7.89 g/L (P < 0.001), and in albumin levels, from 38.19 ± 5.00 g/L to 33.59 ± 5.36 g/L (P < 0.001). No significant differences were noted in total bilirubin (P = 0.305), alanine transaminase (ALT) (P = 0.414), or aspartate transaminase

(AST) ($P = 0.615$) levels between the pre- and post-operative periods [Table 3].

A binary logistic regression analysis was done to identify predictive factors for bile duct injury following surgery. It was observed that gallbladder wall thickening >4 mm was a significant independent predictor of bile duct injury, with an odds ratio (OR) of 6.10 (95% confidence interval [CI]: 1.15–32.16, $P = 0.034$). Age >55 years showed a trend toward an increased risk of bile duct injury (OR = 3.80, 95% CI: 0.92–15.68), although this did not reach statistical significance ($P = 0.066$). Other factors, including gender ($P = 0.745$), diabetes mellitus ($P = 0.517$), hypertension ($P = 0.601$), duration of symptoms >5 days ($P = 0.266$), elevated white blood cell count ($P = 0.353$), drain placement ($P = 0.700$), longer surgery duration ($P = 0.450$), and conversion to open surgery ($P = 0.126$), were not significantly associated with bile duct injury [Table 4].

Table 3: Comparison of clinical investigations before and after surgery

Variables	Mean	SD	P value
Hemoglobin			
At admission	13.694	2.1468	0.900
Post-operative	13.829	9.8653	
ALP			
Pre-operative	124.00	63.514	0.262
Post-operative	118.98	64.413	
Total protein level			
Pre-operative	69.09	6.566	<0.001
Post-operative	62.35	7.889	
Albumin			
Pre-operative	38.19	5.003	<0.001
Post-operative	33.59	5.363	
T-bilirubin			
Pre-operative	20.006	17.0944	0.305
Post-operative	17.548	23.4829	
ALT			
Pre-operative	68.78	106.257	0.414
Post-operative	77.40	72.854	
AST			
Pre-operative	79.30	162.449	0.615
Post-operative	70.84	71.683	

ALT: Alanine transaminase, ALP: Alkaline phosphatase, AST: Aspartate transaminase

DISCUSSION

This study evaluated the safety and clinical outcomes of performing laparoscopic cholecystectomy using the extra Calot's subserosal dissection technique without clipping the cystic artery in patients diagnosed with acute cholecystitis. The key objective was to assess the incidence of bleeding and bile duct injury, the two most concerning complications of laparoscopic cholecystectomy in the context of acute inflammation. Among the 98 patients included in the study, the majority were female (58.2%), which aligns with the known higher prevalence of gallstone disease among women, particularly in the middle-aged groups.[18,19] The most common age group was 26–35 years, although a significant proportion of patients were over 55 years of age. Comorbid conditions such as hypertension and diabetes mellitus were observed in 24.5% and 21.4% of patients, respectively. These findings are consistent with previous reports indicating that metabolic comorbidities are common among patients presenting with gallbladder disease.[20,21] Also, more than 80% of patients presented within 5 days of symptom onset, indicating relatively early intervention, which is generally associated with better outcomes in acute cholecystitis. Majority of our patients operated on by this technique had surgery before 1 week of their presentation. This really gives the advantage of identifying the cystic artery in the Calot's area due to minimal wall edema and thickness, and without having vascular and fibrous adhesions that happen

Table 4: Logistic regression to assess predictive factors of bile injury as a complication of surgery (laparoscopic cholecystectomy)

Variable	Odds ratio	95% confidence interval	*P*-value
Age (>55 years vs. ≤55)	3.80	0.92–15.68	0.066
Gender (Female vs. Male)	1.25	0.32–4.82	0.745
Diabetes Mellitus (Yes vs. No)	1.60	0.38–6.78	0.517
Hypertension (Yes vs. No)	1.45	0.36–5.90	0.601
Duration of symptoms (>5 days vs. ≤5 days)	2.20	0.55–8.85	0.266
WBC count >11,000 (vs. ≤11,000)	1.90	0.49–7.30	0.353
Gallbladder thickening (>4 mm vs. ≤4 mm)	6.10	1.15–32.16	0.034
Drain placement (Yes vs. No)	1.30	0.34–5.06	0.700
Surgery duration (per 10-min increase)	1.05	0.92–1.19	0.450
Conversion to open surgery (Yes vs. No)	3.00	0.73–12.29	0.126

in late presentation after 1 week. Ultrasonographic features typical of acute cholecystitis were frequently observed, with gallbladder wall thickening (>4 mm) present in 60.2% of cases, and pericholecystic fluid in 40.8%. These findings correlate with the diagnostic criteria outlined in the Tokyo Guidelines and are typical of inflammatory changes seen in acute cases.[22] Elevated white blood cell counts were found in 46.9% of patients, further supporting the acute nature of the disease.

One of the most significant and reassuring findings of this study is the absence of intraoperative and post-operative bleeding in all 98 patients. Majority of such bleeding happened due to clip slippage from the divided cystic artery. Common reasons for this problem are an improperly placed clip on the cystic artery, short cystic artery stump, thickened and inflamed tissue, high arterial pressure, thermal injury to the artery, or inappropriate clip size. Since in our study we only cauterize the twigs of the cystic artery supplying the gallbladder wall and the main cystic artery stays on the left margin of the gallbladder bed with left over serosal covering of gallbladder, this artery stays as a thrombosed artery without risk of bleeding.[23,24] This strongly supports the efficacy of the cystic artery-sparing technique in minimizing vascular injury, even in the setting of inflammation. Furthermore, no patients required blood transfusions, nor was there any bowel injury or related morbidity. The overall conversion rate to open surgery was 12.2%, which is relatively low compared to other studies on acute cholecystitis, where conversion rates can range from 10–35% depending on the severity of inflammation and anatomical distortion.[25,26] Reasons for conversion were cases in which we failed to identify the anatomy of Calot's triangle, fibrous adhesions, and inability to identify the cystic artery and duct due to massive adhesions, late presentations, or frankly gangrenous gallbladder. The relatively low conversion rate to open surgery compared to rates reported in other studies further supports the potential benefits of this approach in minimizing the need for more invasive procedures.[27,28] It is important to consider that the severity of inflammation and anatomical distortion can significantly influence conversion rates.[28]

Bile duct injury is one of the dreadful complications of laparoscopic cholecystectomy with prolonged morbidity re-operation, due to bile peritonitis, bile leak, biliary fistula, bile duct strictures, and cholangitis.[29] The main reasons for bile duct injury in acute cholecystitis are distorted anatomy due to acute inflammation and infection, false identification of the common bile duct as cystic duct, short or buried cystic duct, bleeding obscuring the field, failure to obtain CVS, poor judgment by an inexperienced surgeon.[15,30] Fibrosis, gallbladder wall edema, and adhesions that obscure normal landmarks in Calot's triangle and cystic duct, cystic artery, common bile duct, and gallbladder neck become difficult to distinguish. When Calot's triangle structures are not properly identified, common bile duct is sometimes mistaken as the cystic duct and clipped and cut off, sometimes buried, and a short cystic duct becomes difficult to dissect and isolate and increasing the risk of clipping of common bile duct. Excessive use of diathermy to control bleeding from the inflamed gallbladder and Calot's area leads to thermal injury to the common bile duct. All this happened since majority of surgeons start dissection directly in the Calot's triangle in which structures are adhered to each other, inflamed, and easy to bleed. Critical view safety is not a way to do laparoscopic cholecystectomy, rather it is a way to avoid biliary injury while adhering to certain rules such as clearance of Calots's triangle from fatty and fibrous tissue, mobilization of lower third of gallbladder from cystic plate before clipping and division of cystic artery and cystic duct, and to ensure only two structures entering the gallbladder. In theory, this looks simple, but in the presence of acute cholecystitis, things may not be simple and require extreme caution and meticulous technique, and judgment during surgery. The start of dissection directly in Calot's triangle in acute cholecystitis, in the presence of all the above factors, can even lead to misjudgment by an experienced surgeon and resultant vascular-biliary injury. In our technique, since dissection is started in extra-Calots, by identification of lymph node of lund and incising the serosa first parallel and just right to cystic artery and coursing the serosal incision over anterior and then posterior aspect of Hartman's pouch and not directly over Calot's area, once cystic artery is pushed gently to the left bluntly with the help of even shoulder of cautry hook, helps to splay Calot's area structures more precisely and surgeon have time to orient itself with the anatomy of Calot's triangle structures and avoidance of biliary and vascular injuries.[11,31] One patient in the study group had a bile leak through the drain that stopped after 5 days. This patient had a gangrenous gallbladder, and gangrene extended to the cystic duct as well. And while doing lateral traction at Hartman's pouch, the cystic duct avulsed from its junction with the common hepatic duct. Open conversion to correctly identify the integrity and anatomy of the common bile duct is followed by closure of the defect with a 3/0 Vicryl suture at the insertion of the cystic duct. Previous studies have reported bile duct injury rates between 0.14% to 0.8% in laparoscopic cholecystectomy, with higher incidences observed in cases of difficult anatomy or delayed presentation.[32,33] However, it is important to note that bile duct injuries are more common in inflamed gallbladders due to the fusion of Calot's triangle structures, making visual misperception a serious risk.[16,34] The technique applied in this study avoids entering Calot's triangle directly and stays close to the gallbladder wall, thus potentially reducing the chances of misidentifying key structures. Interestingly, when analyzing predictors of bile duct injury through binary logistic regression, gallbladder wall thickening >4 mm emerged as the only statistically significant predictor. This finding is important and clinically relevant, as thickened gallbladder walls are commonly encountered in acute cholecystitis and represent a marker of disease severity.[35] A similar association between thickened gallbladder walls and increased surgical risk has been reported in earlier studies.[36,37]

Although age >55 years showed a trend toward increased risk, it did not reach statistical significance, possibly due to the small number of bile duct injury events. Other variables such as gender, diabetes, hypertension, elevated WBC count, longer symptom duration, and conversion to open surgery were not independently associated with bile duct injury in this cohort.

The biochemical analysis showed significant post-operative reductions in total protein and albumin levels, which could be attributed to systemic inflammatory response and perioperative stress, as supported by studies that report transient hypoalbuminemia following acute surgical events.[38,39] However, hemoglobin levels remained stable postoperatively, reinforcing the absence of intraoperative bleeding. Liver function enzymes, including ALT, AST, and ALP, did not significantly change postoperatively, indicating that liver injury or bile duct obstruction was not a common post-operative concern in this cohort. In cases of acute cholecystitis, due to inflammation and infection, as well as wall edema involving the gallbladder and adjacent liver parenchyma, surgeons using the traditional technique sometimes enter the liver parenchyma, resulting in liver injury, intraoperative and sometimes post-operative bleeding, and a transient increase in liver enzymes in the post-operative period. Since in this technique our dissection plane always stays near the gallbladder wall, none of our patients had inadvertent liver injury and post-operative raised liver enzymes.[40,41] Overall, the findings suggest that the extra-Calot's subserosal dissection technique without clipping the cystic artery is a safe and effective option for managing acute cholecystitis. It avoids the complexities of dissecting an inflamed Calot's triangle and maintains proximity to the gallbladder wall, thus minimizing risk to vital biliary structures. These results are in agreement with previous experimental techniques, such as ultrasonic dissection and posterior approach methods, that aim to reduce biliary complications by minimizing manipulation in high-risk anatomical zones.[42,43] However, unlike most previous techniques, the current approach uniquely avoids handling the cystic artery altogether, potentially reducing vascular trauma and improving safety.

This study has several limitations that should be acknowledged. First, the sample size was relatively small, with only 98 patients included in the final analysis, which may limit the generalizability of the findings. In addition, the study was conducted at only two centers, and all surgeries were performed by a single experienced surgeon, which could introduce operator bias and limit the reproducibility of results in other settings with varying surgical expertise. The cross-sectional observational design also restricts the ability to establish causal relationships between the technique and outcomes. Furthermore, the follow-up period was limited to the immediate post-operative phase, and long-term complications such as delayed bile leaks or strictures were not assessed.

CONCLUSION

The current study demonstrates that the extra-Calot's subserosal dissection technique without clipping the cystic artery is a safe and effective approach for laparoscopic cholecystectomy in patients with acute cholecystitis. The technique was associated with minimal intraoperative complications, no cases of intra- or post-operative bleeding, and a low incidence of bile duct injury. By avoiding direct dissection within the inflamed Calot's triangle and maintaining proximity to the gallbladder wall, this method minimizes the risk of anatomical misidentification and vascular trauma. The findings support the feasibility of this technique in challenging inflammatory settings and highlight gallbladder wall thickening as a significant predictor of bile duct injury. Further multicenter studies with larger sample sizes and long-term follow-up are recommended to validate these results and assess broader applicability across diverse surgical teams.

Informed consent

Written informed consent was obtained from all individual participants included in the study.

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ETHICAL APPROVAL

Informed consent was obtained from each participant after explaining the study in full and clarifying that participation was voluntary. Data collected was securely saved and used for research purposes only.

DATA AND MATERIALS AVAILABILITY

All data associated with this study are presented in the paper.

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