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Factors Associated with Drain Placement and Postoperative Outcomes After Laparoscopic Cholecystectomy: A Retrospective Single-center Cohort Study

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ABSTRACT

Objective: This study aimed to identify preoperative and intraoperative factors associated with selective drain placement during laparoscopic cholecystectomy and to describe early postoperative outcomes in patients with and without drains.

Methods: This retrospective single-center cohort study included adults who underwent laparoscopic cholecystectomy between January 1, 2023, and July 31, 2025. Patients were grouped according to drain placement. Demographic, clinical, laboratory, radiological, intraoperative, and 30-day postoperative data were reviewed. Independent associations between factors and drain placement were assessed using multivariable logistic regression. Postoperative group comparisons were secondary, unadjusted, and descriptive.

Results: Of the 2,800 patients, 556 (19.9%) received a drain and 2,244 (80.1%) did not. The drain group had higher rates of acute cholecystitis, Tokyo grade I-III disease, gallbladder wall thickening, pericholecystic fluid, stone impaction, and emergency surgery, and had higher white blood cell counts, C-reactive protein levels, and bilirubin levels. Operative time was longer, and the following were more frequent in the drain group: difficult laparoscopic cholecystectomy, gangrene or perforation, empyema, bile spillage, bleeding-control problems, subtotal cholecystectomy, conversion to open surgery, and suspected intraoperative bile leakage. In the multivariable analysis, acute cholecystitis, elevated C-reactive protein levels, difficult laparoscopic cholecystectomy, gangrene or perforation, bile spillage, problems with bleeding control, and subtotal cholecystectomy were independently associated with drain placement. In unadjusted comparisons, patients receiving drains had higher 24-hour pain scores, more frequent requirements for additional analgesia, longer hospital stays, and higher composite 30-day complication rates.

Conclusion: Drain placement was predominantly associated with inflammatory severity and operative complexity. The observed postoperative differences cannot be attributed to the drain itself and likely reflect confounding by indication, at least in part. These findings describe the selective use of drains at our institution, but do not establish whether drain placement improves or worsens postoperative outcomes.

Keywords: Laparoscopic cholecystectomy, drain placement, acute cholecystitis, difficult cholecystectomy, postoperative outcomes, selective drainage

INTRODUCTION

Laparoscopic cholecystectomy is the standard surgical treatment for gallstone disease and is widely performed in both elective and emergency settings. It is particularly indicated for patients with symptomatic cholelithiasis or acute cholecystitis (1). Acute inflammation, dense adhesions, gallbladder wall thickening, pericholecystic fluid, unclear anatomy within Calot's triangle, or abnormal biliary anatomy can increase operative difficulty and complicate intraoperative decision-making (2-4). These findings may require modification of the dissection strategy, consideration of a bailout procedure or conversion to open surgery, and in selected cases, drain placement (4,5). Current World Society of Emergency Surgery guidelines recommend early laparoscopic cholecystectomy as the preferred treatment for acute calculous cholecystitis whenever feasible, whereas the Tokyo Guidelines provide standardised criteria for diagnosis and severity grading (2,3).

Routine drain placement after laparoscopic cholecystectomy is not supported by the available evidence; however, surgeons may use drains selectively when bile or blood accumulation is suspected or closer postoperative monitoring for bile leakage or bleeding is considered necessary (5,6). Routine drainage

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is also not supported after uncomplicated laparoscopic cholecystectomy (7,8) or solely on the basis of acute cholecystitis (9). In contemporary practice, drain placement is therefore generally reserved for selected high-risk cases involving severe inflammation, difficult dissection, suspected bile leakage, subhepatic oozing, subtotal cholecystectomy, or other concerning intraoperative findings (5,6). The decision is typically made intraoperatively according to the severity of inflammation, the difficulty of dissection, the contamination or bleeding, and the surgeon's assessment of postoperative risk.

A recent systematic review and meta-analysis of randomised trials found no clear clinical benefit from routine abdominal drainage after laparoscopic cholecystectomy for non-complicated benign gallbladder disease and concluded that routine drain use was not justified (10-12). Meta-analyses focusing on acute cholecystitis similarly indicate that acute cholecystitis alone does not justify routine drain placement and that drain omission is not associated with increased postoperative morbidity (9,10,13). These findings should nevertheless be interpreted cautiously because much of the available evidence comes from uncomplicated elective cases and may not fully represent higher-risk patients undergoing difficult laparoscopic cholecystectomies.

Although routine drainage after laparoscopic cholecystectomy is generally unnecessary, the indications for selective drain placement and their clinical implications remain incompletely defined (5,6,8). In routine practice, drains are most often placed in patients with severe inflammation, difficult dissection, bile contamination, suspected bile leakage, bleeding concerns, or a need for a bailout procedure (4-6,14,15). A large case series from a specialist biliary unit likewise found that drains were used more frequently in technically complex operations, particularly those requiring bile duct exploration, subtotal cholecystectomy, or conversion to open surgery (6). The clinically relevant question is, therefore, which preoperative and intraoperative factors influence selective drain placement and how these patients progress during the early postoperative period.

This study aimed to identify preoperative and intraoperative factors independently associated with drain placement during laparoscopic cholecystectomy and to describe early postoperative outcomes in patients with and without drains. These postoperative comparisons were intended to characterise the clinical course of the two groups rather than estimate a causal effect of drain placement.

METHODS

Study Design and Setting

This retrospective, single-center cohort study was conducted at the Department of General Surgery, University of Health Sciences Türkiye, Mersin City Training and Research Hospital. Patients who underwent laparoscopic cholecystectomy between January 1, 2023, and July 31, 2025, were identified using the hospital information management system and the archived patient records. Operative notes, anesthesia records, laboratory results, radiological reports, inpatient follow-up charts, and postoperative clinical documentation were reviewed for each eligible patient.

The objective of the present study was to determine the preoperative and intraoperative factors associated with drain placement after laparoscopic cholecystectomy. In addition, early postoperative outcomes were compared between patients who did or did not receive a drain. The study was approved by the University of Health Sciences Türkiye, Mersin City Training and Research Hospital Non-Interventional Clinical Research Ethics Committee on April 29, 2026 (approval number: 2026/200). Owing to the retrospective design of the study and anonymized analysis of patient data, the requirement for written informed consent was waived by the ethics committee.

Study Population

Patients aged ≥18 years who underwent laparoscopic cholecystectomy for symptomatic cholelithiasis, acute cholecystitis, or chronic cholecystitis between January 1, 2023, and July 31, 2025, were screened for eligibility. Patients with hospital records containing sufficient information regarding demographic characteristics, comorbidities, preoperative laboratory and radiological findings, operative details, drain placement status, and early postoperative follow-up were included in this study.

Comorbidities and clinical factors that could influence postoperative outcomes were recorded, including diabetes mellitus, hypertension, cardiovascular disease, and anticoagulant use. Patients were classified into two groups based on operative notes: those with intra-abdominal drain placement during laparoscopic cholecystectomy and those without intra-abdominal drains.

Patients younger than 18 years, those who underwent primary open cholecystectomy, those with missing perioperative or early postoperative outcome data, and those whose drain placement status could not be clearly confirmed from the operative notes were excluded from the analysis.

Data Collection

A comprehensive dataset was retrieved from the hospital information management system. Patient files, operative notes, anesthesia records, laboratory results, radiology reports, and postoperative follow-up documents were reviewed. The following data were recorded for each patient: demographic data, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status, admission diagnosis, emergency operation status, anticoagulant use, and history of preoperative endoscopic retrograde cholangiopancreatography (ERCP). Diabetes mellitus, hypertension, and cardiovascular disease were evaluated separately as baseline comorbidities.

Patients admitted with acute cholecystitis were graded for disease severity according to the Tokyo Guidelines. Preoperative laboratory and imaging findings included white blood cell count (WBC), C-reactive protein (CRP) level, total bilirubin level, gallbladder wall thickness, pericholecystic fluid, and impacted

gallstones. Operative notes were reviewed to determine operative time and intraoperative findings that could have influenced the surgeon's decision to place a drain. These included difficult laparoscopic cholecystectomies, moderate or severe adhesions, gallbladder gangrene or perforation, empyema, bile or stone spillage, bleeding-control problems, subtotal cholecystectomies, conversion to open surgery, and suspected intraoperative bile leakage. For patients in whom a drain was placed, the drain type, drain location, indication for drain placement, first 24-hour drain output, drainage content, and day of drain removal were recorded.

Definitions

Drain placement was defined as the insertion of an intra-abdominal drain during laparoscopic cholecystectomy. Acute cholecystitis was diagnosed according to the clinical, laboratory, and radiological findings available in the medical records. In these patients, disease severity was assessed using the Tokyo Guidelines; grades II-III were categorized as moderate-to-severe acute cholecystitis. ASA physical status III or IV was grouped as ASA class ≥III.

A difficult laparoscopic cholecystectomy was identified in the operative note and defined by documented severe inflammation, dense adhesions, difficult dissection, or unclear biliary anatomy, which increased technical complexity. This classification depends on the operating surgeon's intraoperative assessment and documentation. Subtotal cholecystectomy and conversion to open surgery were recorded separately as distinct intraoperative outcomes.

Postoperative complications were assessed during the first 30 days. Major complications were defined as Clavien-Dindo grade III or higher, and the composite outcome comprised any recorded postoperative complication. Bilious drain output was recorded as a descriptive variable based on the macroscopic appearance documented during the first 24 hours. It was not classified as postoperative bile leakage unless the treating team documented a leak, based on persistent or increasing bilious drainage and/or radiologic or endoscopic confirmation. Transient bilious-appearing output that resolved without further diagnostic or therapeutic management was not coded as a 30-day bile leak.

Outcomes

The primary outcome was intra-abdominal drain placement during laparoscopic cholecystectomy. The secondary outcomes reflected the early postoperative course and included pain level, additional analgesic requirements, length of hospital stay, and complications recorded within 30 days after surgery. Postoperative pain was evaluated using a visual analog scale (VAS), with scores recorded at 24 h.

Thirty-day complications included surgical site infection, biliary leak, intra-abdominal collection, need for ERCP or for percutaneous drainage, reoperation, readmission, major complications, and composite complication outcomes. Patients who underwent drain placement were compared with those who did not undergo drain placement in terms of baseline, preoperative, intraoperative, and postoperative findings. Variables associated with drain placement were evaluated using multivariable logistic regression analysis.

Statistical Analysis

All analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was evaluated using histograms, Q-Q plots, and the Kolmogorov-Smirnov test. Because continuous variables were not normally distributed, they were summarized as medians and interquartile ranges. Categorical variables are presented as numbers and percentages.

The Mann-Whitney U test was used to compare continuous variables between the drain and no-drain groups. For categorical variables, the chi-squared test was used when adequate expected cell counts were obtained; otherwise, Fisher's exact test was applied.

Multivariable logistic regression was used to identify factors associated with intraoperative drain placement. The initial candidate pool comprised the baseline, inflammatory, imaging, and operative variables presented in Tables 1 and 2. The final model was constructed based on clinical relevance and univariable associations, avoiding simultaneous entry of variables representing the same inflammatory or operative construct. Age, sex, and ASA class ≥III were retained regardless of univariable significance. The final model included acute cholecystitis, CRP per 10 mg/L increase, emergency operation, difficult laparoscopic cholecystectomy, gangrene or perforation, bile spillage, bleeding-control problems, subtotal cholecystectomy, and suspected intraoperative bile leak, together with age, sex, and ASA class ≥III. Adjusted odds ratios (aORs), 95% confidence intervals (CIs), and p-values are reported. A two-sided p-value was considered statistically significant.

RESULTS

A total of 2,800 patients who underwent laparoscopic cholecystectomy were included in the study. Drain placement was performed in 556 patients (19.9%), whereas 2,244 patients (80.1%) did not receive a drain. The two groups were similar in terms of age, sex, BMI, ASA class ≥III, diabetes mellitus, hypertension, cardiac disease, anticoagulant use, and preoperative ERCP rate. However, acute cholecystitis was significantly more frequent in the drain group than in the no-drain group (46.9% vs. 19.1%, $p<0.001$). Tokyo grade II-III acute cholecystitis was also more common in the drain group (23.9% vs. 7.3%, $p<0.001$). The median WBC [9.5 (7.4-13.8) vs. 8.2 (6.8-9.9)$\times 10^9$/L, $p<0.001$], the CRP level [13.7 (4.9-72.2) vs. 7.4 (2.0-15.4) mg/L, $p<0.001$], the total bilirubin level [0.81 (0.56-1.12) vs. 0.72 (0.54-0.93) mg/dL, $p<0.001$] were significantly higher in the drain group. Gallbladder wall thickening, pericholecystic fluid, stone impaction, and emergency surgery were also significantly more frequent among patients with drain placement (Table 1).

Intraoperative findings and surgical complexity parameters are presented in Table 2. Operative time was significantly longer in the drain group than in the no-drain group [67.0 (51.0-87.0) vs. 58.0 (47.0-71.0) minutes, p<0.001]. Difficult laparoscopic cholecystectomies were more frequent among patients with drain placement (34.0% vs. 11.0%, p<0.001). Moderate-to-severe adhesions, gangrene or perforation, empyema, bile spillage, bleeding-control problems, subtotal cholecystectomy, conversion to open surgery, and suspected intraoperative bile leak were also significantly more common in the drain group. Stone spillage did not differ significantly between groups (p=0.179).

Drain-related characteristics are shown in Table 3. The most commonly used drain was a Jackson-Pratt drain (66.5%), followed by a Hemovac drain (26.1%), a Penrose drain (5.2%), and other types (2.2%). Drains were most often placed in the subhepatic area (89.7%). The most commonly recorded indications were contamination (22.7%), observation for minimal leakage (20.1%),

Table 1. Baseline demographic and preoperative clinical characteristics according to drain use

Characteristic	Overall (n=2800)	No drain (n=2244)	Drain (n=556)	p-value
Age, years	53.0 (42.0-62.2)	53.0 (42.0-63.0)	52.0 (43.0-62.0)	0.77
Female sex	1887 (67.4)	1529 (68.1)	358 (64.4)	0.091
BMI, kg/m^2	28.8 (25.7-31.9)	28.8 (25.7-31.8)	28.8 (25.5-32.0)	0.975
ASA class ≥III	1187 (42.4)	940 (41.9)	247 (44.4)	0.279
Diabetes mellitus	442 (15.8)	356 (15.9)	86 (15.5)	0.818
Hypertension	630 (22.5)	514 (22.9)	116 (20.9)	0.302
Cardiac disease	222 (7.9)	175 (7.8)	47 (8.5)	0.609
Anticoagulant use	138 (4.9)	113 (5.0)	25 (4.5)	0.599
Acute cholecystitis	689 (24.6)	428 (19.1)	261 (46.9)	<0.001
Tokyo grade II-III	296 (10.6)	163 (7.3)	133 (23.9)	<0.001
WBC, ×10^9/L	8.3 (6.9-10.4)	8.2 (6.8-9.9)	9.5 (7.4-13.8)	<0.001
CRP, mg/L	8.2 (2.6-18.3)	7.4 (2.0-15.4)	13.7 (4.9-72.2)	<0.001
Total bilirubin, mg/dL	0.74 (0.54-0.96)	0.72 (0.54-0.93)	0.81 (0.56-1.12)	<0.001
Gallbladder wall thickening	803 (28.7)	556 (24.8)	247 (44.4)	<0.001
Pericholecystic fluid	337 (12.0)	228 (10.2)	109 (19.6)	<0.001
Stone impaction	620 (22.1)	461 (20.5)	159 (28.6)	<0.001
Preoperative ERCP	165 (5.9)	124 (5.5)	41 (7.4)	0.098
Emergency operation	492 (17.6)	310 (13.8)	182 (32.7)	<0.001

Note: Data are shown as median (IQR) or n (%). Continuous variables were compared using the Mann-Whitney U test, and categorical variables were compared using the chi-square test. ASA ≥III denotes ASA III-IV; Tokyo grade II-III denotes moderate-to-severe acute cholecystitis
ASA: American Society of Anesthesiologists, BMI: Body mass index, WBC: White blood cell count, CRP: C-reactive protein, ERCP: Endoscopic retrograde cholangiopancreatography, IQR: Interquartile range

Table 2. Intraoperative findings and surgical complexity according to drain use

Characteristic	Overall (n=2800)	No drain (n=2244)	Drain (n=556)	p-value
Operative time, min	59.0 (48.0-73.0)	58.0 (47.0-71.0)	67.0 (51.0-87.0)	<0.001
Difficult LC	435 (15.5)	246 (11.0)	189 (34.0)	<0.001
Moderate/severe adhesions	530 (18.9)	355 (15.8)	175 (31.5)	<0.001
Gangrene/perforation	44 (1.6)	19 (0.8)	25 (4.5)	<0.001
Empyema	25 (0.9)	13 (0.6)	12 (2.2)	0.001
Bile spillage	275 (9.8)	164 (7.3)	111 (20.0)	<0.001
Stone spillage	95 (3.4)	71 (3.2)	24 (4.3)	0.179
Bleeding control problem	25 (0.9)	13 (0.6)	12 (2.2)	0.001
Subtotal cholecystectomy	34 (1.2)	13 (0.6)	21 (3.8)	<0.001
Conversion to open surgery	21 (0.8)	12 (0.5)	9 (1.6)	0.023
Suspected intraoperative bile leak	21 (0.8)	9 (0.4)	12 (2.2)	<0.001

Note: Data are shown as median (IQR) or n (%). Continuous variables were compared using the Mann-Whitney U test. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. Moderate/severe adhesions denotes moderate or severe adhesion grade
LC: Laparoscopic cholecystectomy, IQR: Interquartile range

surgeon preference (20.0%), difficult dissection (16.5%), and subhepatic oozing (11.2%). Because indications were not mutually exclusive, more than one indication could be recorded for a patient. Median time to drain removal was on postoperative day 2.0 (2.0-3.0), and median output during the first 24 hours was 59.0 (42.0-79.0) mL. Drain contents were most commonly serous (70.7%); bilious-appearing output was documented in 26 patients (4.7%). This descriptive finding was distinct from clinically diagnosed 30-day biliary leakage, which occurred in 7 patients (1.3%) in the drain group.

Postoperative outcomes according to drain use are presented in Table 4. In unadjusted comparisons, patients with a drain had higher 24-hour VAS pain scores [4.9 (4.0-5.6) vs. 3.8 (3.0-4.7), p<0.001], more frequent use of additional analgesics (25.7% vs. 13.6%, p<0.001), and longer hospital stays [2.8 (2.0-3.8) vs. 1.6 (1.1-2.2) days, p<0.001] than patients without a drain. Surgical site infection (2.9% vs. 1.3%, p=0.011), intra-abdominal collection (2.2% vs. 1.0%, p=0.031), and composite 30-day complications (8.3% vs. 5.3%, p=0.009) were also more frequent in the drain group. Biliary leak, ERCP, percutaneous drainage, reoperation, readmission, and major complications, defined as Clavien-Dindo grade III or higher, did not differ significantly between groups. These comparisons describe the observed group differences and were not adjusted for baseline characteristics or operative complexity.

Factors associated with drain placement, as determined by multivariable logistic regression analysis, are shown in Table 5. Age (aOR: 0.997 per 1-year increase, 95% CI: 0.989-1.004, p=0.364), female sex (aOR: 0.879, 95% CI: 0.711-1.086, p=0.232), and ASA class ≥III (aOR: 1.140, 95% CI: 0.913-1.423, p=0.247) were not independently associated with drain placement. Acute cholecystitis was independently associated with drain placement

Table 3. Drain-related characteristics among patients with drain placement

Variable	Drain group (n=556)
Drain type	
Jackson-Pratt	370 (66.5)
Hemovac	145 (26.1)
Penrose	29 (5.2)
Other	12 (2.2)
Drain location	
Subhepatic	499 (89.7)
Douglas pouch	28 (5.0)
Both subhepatic and Douglas	19 (3.4)
Other	10 (1.8)
Indication for drain placement	
Contamination	126 (22.7)
Minimal leakage follow-up	112 (20.1)
Surgeon preference	111 (20.0)
Difficult dissection	92 (16.5)
Subhepatic oozing	62 (11.2)
Severe inflammation	34 (6.1)
Subtotal cholecystectomy	20 (3.6)
Bleeding control	12 (2.2)
Suspected bile leak	12 (2.2)
Drain removal day, postoperative day	2.0 (2.0-3.0)
First 24-hour drain output, mL	59.0 (42.0-79.0)
Drain content	
Serous	393 (70.7)
Serohemorrhagic	112 (20.1)
Bilious	26 (4.7)
Hemorrhagic	25 (4.5)

Note: Data are shown as median (IQR) or n (%). This table includes only patients with drain placement. Indications for drain placement were not mutually exclusive; therefore, percentages may exceed 100%. Bilious drain content refers to macroscopic appearance documented during the first 24 hours and was not itself classified as a postoperative biliary leak
IQR: Interquartile range

(aOR): 2.24, 95% CI: 1.49-3.35, p<0.001. Higher CRP levels were also associated with drain placement (aOR: 1.04 per 10 mg/L increase, 95% CI: 1.01-1.08, p=0.017). Among the intraoperative variables, difficult laparoscopic cholecystectomy (aOR: 2.61, 95% CI: 2.04-3.33, p<0.001); gangrene or perforation (aOR: 2.59, 95% CI: 1.33-5.04, p=0.005); bile spillage (aOR: 2.31, 95% CI: 1.73-3.07, p<0.001); bleeding-control problem (aOR: 2.68, 95% CI: 1.12-6.41, p=0.027); and subtotal cholecystectomy (aOR: 3.23, 95% CI: 1.49-6.96, p=0.003) were independently associated with drain placement. Emergency operation was not independently associated with drain placement after adjustment (p=0.461). Suspected intraoperative bile leak was associated with a trend toward increased odds of drain placement, but this did not reach statistical significance (aOR: 2.55, 95% CI: 0.98-6.65, p=0.055).

DISCUSSION

In this retrospective cohort study, drain placement after laparoscopic cholecystectomy was primarily associated with inflammatory severity and operative complexity rather than with baseline demographic characteristics. Acute cholecystitis, elevated CRP levels, difficult laparoscopic cholecystectomy, gangrene or perforation, bile spillage, bleeding control problems, and subtotal cholecystectomy were independently associated with drain use. These findings indicate that drains were used

Table 4. Postoperative outcomes according to drain use

Outcome	Overall (n=2800)	No drain (n=2244)	Drain (n=556)	p-value
VAS pain score at 24 h	4.0 (3.1-4.9)	3.8 (3.0-4.7)	4.9 (4.0-5.6)	<0.001
Additional analgesic requirement	449 (16.0)	306 (13.6)	143 (25.7)	<0.001
Length of hospital stay, days	1.8 (1.2-2.5)	1.6 (1.1-2.2)	2.8 (2.0-3.8)	<0.001
Surgical site infection within 30 days	46 (1.6)	30 (1.3)	16 (2.9)	0.011
Biliary leak within 30 days	26 (0.9)	19 (0.8)	7 (1.3)	0.364
Intra-abdominal collection within 30 days	35 (1.3)	23 (1.0)	12 (2.2)	0.031
ERCP requirement within 30 days	17 (0.6)	12 (0.5)	5 (0.9)	0.357
Percutaneous drainage within 30 days	18 (0.6)	14 (0.6)	4 (0.7)	0.769
Reoperation within 30 days	3 (0.1)	2 (0.1)	1 (0.2)	0.485
Readmission within 30 days	114 (4.1)	89 (4.0)	25 (4.5)	0.571
Major complication, Clavien-Dindo ≥III	46 (1.6)	33 (1.5)	13 (2.3)	0.15
Composite 30-day complication	166 (5.9)	120 (5.3)	46 (8.3)	0.009

Note: Data are presented as median (IQR) or n (%). Continuous variables were compared using the Mann-Whitney U test. Categorical variables were compared using the chi-square test, and Fisher's exact test was used for low-frequency outcomes. Comparisons were unadjusted and descriptive. A 30-day biliary leak required a clinical diagnosis based on persistent or increasing bilious drainage and/or radiologic or endoscopic confirmation; transient bilious-appearing output alone was not coded as a leak. Major complications were defined as Clavien-Dindo grade III or higher
VAS:Visual analog scale, ERCP: Endoscopic retrograde cholangiopancreatography, IQR: Interquartile range

Table 5. Multivariable logistic regression analysis for factors associated with drain placement

Variable	Adjusted OR	95% CI	p-value
Age, per 1-year increase	0.997	0.989-1.004	0.364
Female sex	0.879	0.711-1.086	0.232
ASA class ≥III	1.140	0.913-1.423	0.247
Acute cholecystitis	2.24	1.49-3.35	<0.001
CRP, per 10 mg/L increase	1.04	1.01-1.08	0.017
Emergency operation	0.87	0.61-1.26	0.461
Difficult LC	2.61	2.04-3.33	<0.001
Gangrene/perforation	2.59	1.33-5.04	0.005
Bile spillage	2.31	1.73-3.07	<0.001
Bleeding control problem	2.68	1.12-6.41	0.027
Subtotal cholecystectomy	3.23	1.49-6.96	0.003
Suspected intraoperative bile leak	2.55	0.98-6.65	0.055

Note: The dependent variable was drain placement. The final model included age, female sex, ASA class ≥III, acute cholecystitis, CRP per 10 mg/L increase, emergency operation, difficult laparoscopic cholecystectomy, gangrene or perforation, bile spillage, bleeding-control problems, subtotal cholecystectomy, and suspected intraoperative bile leak. Variables were selected on clinical grounds and univariable associations while avoiding redundant measures of the same inflammatory or operative construct
OR: Odds ratio, CI: Confidence interval, CRP: C-reactive protein, LC: Laparoscopic cholecystectomy, ASA: American Society of Anesthesiologists

selectively in patients with more severe inflammation and in those undergoing technically demanding operations. Patients receiving drains had higher postoperative pain scores, more frequent requirements for additional analgesics, longer hospital stays, and higher rates of early postoperative complications. However, these were unadjusted comparisons between clinically dissimilar groups. Therefore, the observed postoperative differences cannot be attributed to the drain itself and likely reflect c onfounding by indication, at least in part.

The selective pattern observed in our cohort is consistent with previous studies and meta-analyses that did not demonstrate a clear benefit of routine drainage after laparoscopic cholecystectomy (7,16,17). Evidence from patients with acute cholecystitis similarly indicates that diagnosis alone should not be considered a sufficient indication for drain placement (9,10,13,18,19). Accordingly, the clinically relevant issue is which inflammatory and operative factors influence selective drain placement and how these patients progress during the early postoperative period. Observational studies have also reported selective drain use in patients with cholecystitis, technically difficult procedures, concerns about bleeding, or other intraoperative risk factors (5,20,21).

Preoperative inflammatory severity was associated with drain placement in our cohort. The Tokyo Guidelines combine local inflammatory signs, systemic markers such as WBC and CRP, and compatible imaging findings to diagnose acute cholecystitis and grade its severity (2,3). Elevated CRP and imaging findings, including gallbladder wall thickening, pericholecystic fluid, and impacted stones, have also been associated with difficult dissection and conversion to open surgery (22-24). Consistent with this evidence, unadjusted comparisons showed that the drain group had higher rates of acute cholecystitis, Tokyo grade II-III disease, gallbladder wall thickening, pericholecystic fluid, stone impaction, and emergency surgery, and higher WBC, CRP, and bilirubin levels. Among the preoperative variables, acute cholecystitis and higher CRP remained independently associated with drain placement after multivariable adjustment. These findings suggest that preoperative inflammatory burden may have informed the decision to place a drain in addition to intraoperative findings; however, CRP should be interpreted as a marker of inflammatory severity rather than a standalone indication for drainage.

Intraoperative findings appear to play a central role in the selective placement of drains. Difficult anatomy, severe inflammation, dense adhesions, bleeding, or failure to obtain a reliable critical view of safety may require modification of the operative strategy, including bailout procedures such as subtotal cholecystectomy or conversion to open surgery (1,2,4,25,26). Calini et al. (5), reported more frequent drain placement in patients with cholecystitis, technical difficulty, longer operative times, need for an additional trocar, or greater blood loss. Similarly, a large series from a specialist biliary unit reported more frequent drain use after technically demanding procedures, including subtotal cholecystectomy, conversion to open surgery, empyema, and bile duct exploration, as well as when bile leakage or bleeding was suspected (6). Studies on subtotal cholecystectomy have also reported an increased risk of postoperative bile leakage in technically difficult cases, which may influence surgeons to place a drain; however, these findings do not establish that drainage prevents this complication (27-29). Consistent with the literature, difficult laparoscopic cholecystectomy, gangrene or perforation, bile spillage, problems controlling bleeding, and subtotal cholecystectomy were independently associated with drain placement in our multivariable model. Suspected intraoperative bile leakage had an elevated but imprecise effect estimate (aOR 2.55, 95% CI 0.98-6.65; p=0.055) and did not reach statistical significance, possibly because of the small number of events included in the study. Overall, drains were primarily used in operations characterized by greater technical complexity, contamination, and concerns about postoperative bile leakage or bleeding.

In unadjusted comparisons, patients receiving drains had higher 24-hour pain scores, more frequent requirements for additional analgesics, longer hospital stays, and higher rates of surgical-site infection, intra-abdominal collections, and composite 30-day complications. Previous studies evaluating routine drainage similarly found no reduction in postoperative morbidity (7,16,17), and some reported higher pain scores, greater analgesic use, and longer hospital stays among patients with drains (16,17). More recent observational studies have reported similar patterns but have also emphasized the difficulty of separating the effects of drainage from the clinical indications for drain placement (12,15,30). Delayed drain removal has also been associated with prolonged hospitalization and a higher risk of surgical site infection (14). The interpretation of postoperative pain requires further consideration because its association with drainage may vary depending on the pain component assessed. Yang et al. (31), reported that drain-assisted evacuation of residual intraperitoneal gas may reduce post-laparoscopic shoulder pain. In our study, pain was assessed using a general 24-hour VAS score, and shoulder-tip pain was not evaluated separately; therefore, these findings are not directly comparable. Drains were placed selectively in patients with more severe inflammation and in those undergoing technically complex operations. The observed postoperative differences, therefore, cannot be attributed to the drain itself and likely reflect confounding by indication, at least in part.

Taken together, these findings characterize the clinical and operative circumstances in which drains were used selectively, rather than establish the effectiveness of drain placement. Because drain use was concentrated among patients with more severe inflammation and those who underwent technically complex operations, future outcome studies should account for confounding by indication and surgeon-level practice variation. Prospective multicenter studies using standardized definitions and indications for drain placement are needed to determine

whether combinations of preoperative inflammatory markers, imaging findings, and intraoperative variables can support more consistent clinical decision-making.

Study Limitations

This study had several limitations. First, the retrospective, single-center design precluded causal inference and may have limited generalizability to institutions with different case mixes and surgical practices. Second, drain placement was not governed by a standardized protocol. Patients receiving drains had more severe inflammation and underwent more difficult operations, thereby introducing substantial selection bias and confounding factors. The postoperative comparisons were unadjusted, and should therefore be interpreted as descriptive rather than as estimates of harm or benefit attributable to the drain. Third, difficult laparoscopic cholecystectomy was classified based on operative reports and therefore incorporated surgeon-dependent judgment and variability in documentation. Drain indications were also derived from operative notes, which may not have captured the same level of detail in each case. Fourth, drain placement and removal practices may have varied according to the surgeons' experience and individual preferences, and surgeon-level variation was not modeled. Fifth, pain was assessed using a general 24-hour VAS score; shoulder-tip pain was not analyzed. Finally, follow-up was limited to 30 days; therefore, chronic pain, late biliary complications, and quality of life were not evaluated.

CONCLUSION

In this retrospective cohort study, drain placement after laparoscopic cholecystectomy was predominantly associated with inflammatory severity and operative complexity rather than with baseline demographic characteristics. Acute cholecystitis, elevated CRP levels, difficult laparoscopic cholecystectomy, gangrene or perforation, bile spillage, bleeding-control problems, and subtotal cholecystectomy were independently associated with drain use. Patients who received drains had higher pain scores, required additional analgesia more frequently, longer hospital stays, and experienced a higher incidence of early postoperative complications; however, these comparisons were unadjusted and involved clinically dissimilar groups. Accordingly, the observed postoperative differences cannot be attributed to the drain itself and likely reflect confounding by indication, at least in part. These findings describe the selective use of drains at our institution, but do not establish whether drain placement improves or worsens postoperative outcomes. Prospective multicenter studies using standardized indications for drain placement are needed to inform consistent clinical practice.

Ethics

Ethics Committee Approval: Ethical approval for this study was obtained from the University of Health Sciences Türkiye, Mersin City Training and Research Hospital Non-Interventional Clinical Research Ethics Committee before data collection and analysis (decision no: 2026/200, date: 29.04.2026).

Informed Consent: Owing to the retrospective design of the study and anonymized analysis of patient data, the requirement for written informed consent was waived by the ethics committee.

Footnotes

Author Contributions:

Surgical and Medical Practices - S.A., G.E.; Concept - S.A., S.S.; Design - G.D., G.E.; Data Collection and/or Processing - S.A., H.V.S.; Analysis and/or Interpretation - S.A., S.S.; Literature Search - H.V.S., G.D.; Writing - S.A., H.V.S.

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REFERENCES

1. de'Angelis N, Catena F, Memeo R, Coccolini F, Martínez-Pérez A, Romeo OM, et al. 2020 WSES guidelines for the detection and management of bile duct injury during cholecystectomy. World J Emerg Surg. 2021; 16: 30.
2. Pisano M, Allievi N, Gurusamy K, Borzellino G, Cimbanassi S, Boerna D, et al. 2020 World Society of Emergency Surgery updated guidelines for the diagnosis and treatment of acute calculus cholecystitis. World J Emerg Surg. 2020; 15: 61.
3. Yokoe M, Hata J, Takada T, Strasberg SM, Asbun HJ, Wakabayashi G, et al. Tokyo Guidelines 2018: diagnostic criteria and severity grading of acute cholecystitis (with videos). J Hepatobiliary Pancreat Sci. 2018; 25: 41-54.
4. Brunt LM, Deziel DJ, Telem DA, Strasberg SM, Aggarwal R, Asbun H, et al.; Prevention of Bile Duct Injury Consensus Work Group. Safe cholecystectomy multi-society practice guideline and state-of-the-art consensus conference on prevention of bile duct injury during cholecystectomy. Surg Endosc. 2020; 34: 2827-55.
5. Calini G, Brollo PP, Quattrin R, Bresadola V. Predictive factors for drain placement after laparoscopic cholecystectomy. Front Surg. 2022; 8: 786158.
6. Qandeel H, Hayyawi I, Nassar AHM, Ng HJ, Khan KS, Hasanat S, et al. The rationale of sub-hepatic drainage on a specialist biliary unit: a review of 6140 elective and urgent laparoscopic cholecystectomies and bile duct explorations. Langenbecks Arch Surg. 2024; 409: 271.
7. Gurusamy KS, Koti R, Davidson BR. Routine abdominal drainage versus no abdominal drainage for uncomplicated laparoscopic cholecystectomy. Cochrane Database Syst Rev. 2013; 2013: CD006004.
8. Chuklin S, Chooklin S. Laparoscopic cholecystectomy with or without drainage: a systematic review and meta-analysis. Emergency Medicine. 2024; 20: 237-50.
9. Xu M, Tao YL. Drainage *versus* no drainage after laparoscopic cholecystectomy for acute cholecystitis: a meta-analysis. Am Surg. 2019; 85: 86-91.
10. Picchio M, De Cesare A, Di Filippo A, Spaziani M, Spaziani E. Prophylactic drainage after laparoscopic cholecystectomy for acute cholecystitis: a systematic review and meta-analysis. Updates Surg. 2019; 71: 247-54.
11. Arnaout AY, Kadoura L, Masri R, Nerabani Y, Atli AA, Arnaout K, et al.; Aleppo University Hospital Team. The efficacy and safety of using prophylactic abdominal drainage after laparoscopic cholecystectomy: a randomized control trial. Health Sci Rep. 2024; 7: e2284.
12. Zhu H, Liu D, Zhou D, Wu J, Yu Y, Jin Y, et al. Effectiveness of no drainage after elective day-case laparoscopic cholecystectomy, even with intraoperative gallbladder perforation: a randomized controlled trial. Langenbecks Arch Surg. 2023; 408: 112.
13. Cirocchi R, Kwan SH, Popivanov G, Ruscelli P, Lancia M, Gioia S, et al. Routine drain or no drain after laparoscopic cholecystectomy for acute cholecystitis. Surgeon. 2021; 19: 167-74.
14. Lee SJ, Choi IS, Moon JI, Yoon DS, Choi WJ, Lee SE, et al. Optimal drain management following complicated laparoscopic cholecystectomy for acute cholecystitis: a propensity-matched comparative study. J Minim Invasive Surg. 2022; 25: 63-72.
15. Brucchi F, Mehmeti M, Lauricella S, Faillace G. The use of intra-abdominal prophylactic drainage in laparoscopic cholecystectomy:

does it change in relation to surgical expertise? A multicenter case-control retrospective study on postoperative outcomes. Minerva Surg. 2024; 79: 155-60.

16. Antoniou S, Koch O, Antoniou G, Köhler G, Chalkiadakis G, Pointner R, et al. Routine versus no drain placement after elective laparoscopic cholecystectomy: meta-analysis of randomized controlled trials. Minerva Chir. 2014; 69: 185-94.
17. Yong L, Guang B. Abdominal drainage versus no abdominal drainage for laparoscopic cholecystectomy: a systematic review with meta-analysis and trial sequential analysis. Int J Surg. 2016; 36: 358-68.
18. Park JS, Kim JH, Kim JK, Yoon DS. The role of abdominal drainage to prevent of intra-abdominal complications after laparoscopic cholecystectomy for acute cholecystitis: prospective randomized trial. Surg Endosc. 2015; 29: 453-7.
19. Valappil MV, Gulati S, Chhabra M, Mandal A, Bakshi S, Bhattacharyya A, et al. Drain in laparoscopic cholecystectomy in acute calculous cholecystitis: a randomised controlled study. Postgrad Med J. 2020; 96: 606-09.
20. Khanal S. Indications and outcomes of abdominal drain in laparoscopic cholecystectomy in a tertiary care center in central Nepal:a descriptive cross-sectional study. J Soc Surg Nepal. 2022; 25: 40-5.
21. Abozied MA, Mohamed MB, Elsayed Ahmed AS, Ahmed Saleh MA. Predictive factors for drain placement after laparoscopic cholecystectomy. Zagazig Univ Med J. 2025; 31: 5302-10.
22. Ng HJ, Ahmed Z, Khan KS, Katbeh T, Nassar AHM. C-reactive protein level as a predictor of difficult emergency laparoscopic cholecystectomy. BJS Open. 2019; 3: 641-45.
23. Stoica PL, Serban D, Bratu DG, Serboiu CS, Costea DO, Tribus LC, et al. Predictive factors for difficult laparoscopic cholecystectomies in acute cholecystitis. Diagnostics (Basel). 2024; 14: 346.
24. Bayram H, Sulu B, Diken Allahverdi T, Binnetoğlu K, Gönüllü D. Prediction of difficulty level of laparoscopic cholecystectomy according to preoperative findings. J Acad Res Med 2023; 13: 50-7
25. Griffiths EA, Hodson J, Vohra RS, Marriott P; CholeS Study Group; Katbeh T, et al.; West Midlands Research Collaborative. Utilisation of an operative difficulty grading scale for laparoscopic cholecystectomy. Surg Endosc. 2019; 33: 110-21.
26. Strasberg SM, Pucci MJ, Brunt LM, Deziel DJ. Subtotal cholecystectomy"fenestrating" vs "reconstituting" subtypes and the prevention of bile duct injury: definition of the optimal procedure in difficult operative conditions. J Am Coll Surg. 2016; 222: 89-96.
27. Toro A, Teodoro M, Khan M, Schembari E, Di Saverio S, Catena F, et al. Subtotal cholecystectomy for difficult acute cholecystitis: how to finalize safely by laparoscopy-a systematic review. World J Emerg Surg. 2021; 16: 45
28. Elshaer M, Gravante G, Thomas K, Sorge R, Al-Hamali S, Ebdewi H. Subtotal cholecystectomy for "difficult gallbladders": systematic review and meta-analysis. JAMA Surg. 2015; 150: 159-68.
29. Koo SS, Krishnan RJ, Ishikawa K, Matsunaga M, Ahn HJ, Murayama KM, et al. Subtotal vs total cholecystectomy for difficult gallbladders: a systematic review and meta-analysis. Am J Surg. 2024; 229: 145-50.
30. Strzępek Ł, Czerw A, Curyło M, Mikos M, Florek M, Charkiewicz D, et al. The time to discharge and pain reliever ıntake depending on the use of a drain after laparoscopic cholecystectomy. J Clin Med. 2025; 14: 8752.
31. Yang SC, Chang KY, Wei LF, Shyr YM, Ho CM. To drain or not to drain: the association between residual intraperitoneal gas and post-laparoscopic shoulder pain for laparoscopic cholecystectomy. Sci Rep. 2021; 11: 7447.