

One-stage vs two-stage treatment in acute cholecystitis: Comparable morbidity, superior efficiency

 Mesud Fakirullahoğlu,¹  Mehmet Torun²

¹Clinic of General Surgery, Erzurum State Hospital, Erzurum, Türkiye

²Clinic of Gastrointestinal Surgery, Erzurum State Hospital, Erzurum, Türkiye

ABSTRACT

Introduction: Optimal management of patients presenting with acute cholecystitis and suspected choledocholithiasis remains debated, with both one-stage (laparoscopic cholecystectomy with intraoperative cholangiography ± CBD exploration) and two-stage (preoperative ERCP followed by delayed laparoscopic cholecystectomy) strategies widely employed. The objective is to compare clinical outcomes, postoperative morbidity, and length of stay between one-stage and two-stage approaches in patients with acute cholecystitis and radiologic or biochemical suspicion of CBD stones.

Materials and Methods: This retrospective cohort study included 247 consecutive patients treated at a tertiary HPB referral center between 2020–2025. Primary outcomes were total length of hospital stay and 30-day morbidity. Secondary outcomes included residual stones, reintervention, readmission, and predictors of postoperative complications. Multivariable logistic regression, Kaplan–Meier analyses, and ROC modeling were performed.

Results: Of 247 patients, 118 (47.8%) underwent a one-stage strategy and 129 (52.2%) received the two-stage approach. Length of stay was significantly shorter in the one-stage group (8.6±4.4 vs 11.2±4.4 days, $p<0.001$). Overall, 30-day morbidity was comparable between strategies (19.5% vs. 19.4%, $p=1.000$). Logistic regression revealed no independent predictors of morbidity. ROC analysis demonstrated poor diagnostic performance for bilirubin and CBD diameter in predicting CBD stones (AUC=0.53).

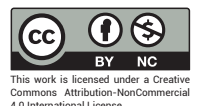
Conclusions: In appropriately selected patients with acute cholecystitis and suspected choledocholithiasis, the one-stage strategy is safe and provides significantly shorter hospitalization while maintaining similar morbidity rates compared with the conventional two-stage approach.

Keywords: Acute cholecystitis, choledocholithiasis, ERCP, laparoscopic CBD exploration, one-stage strategy, postoperative morbidity



Received: 04.12.2025 Revision: 04.12.2025 Accepted: 12.12.2025

Correspondence: Mehmet Torun M.D., Clinic of General Surgery, Erzurum State Hospital, Erzurum, Türkiye
e-mail: drtorun1905@gmail.com



This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Introduction

Acute cholecystitis accompanied by suspected choledocholithiasis represents a common yet challenging clinical scenario in emergency and hepatobiliary surgery. Although early laparoscopic cholecystectomy is the standard of care for acute cholecystitis, the optimal management of concomitant CBD stones remains controversial, with substantial variation between institutions and clinical guidelines.^[1-3] The European Society of Gastrointestinal Endoscopy (ESGE) and Tokyo Guidelines emphasize the importance of accurate risk stratification and timely intervention; however, both one-stage and two-stage therapeutic pathways are considered acceptable depending on local expertise and patient characteristics.^[4-6]

The traditional two-stage approach, consisting of preoperative ERCP followed by delayed laparoscopic cholecystectomy, has long been the dominant strategy. This sequence allows for endoscopic clearance of CBD stones prior to surgery, facilitates decompression in cholangitis, and is widely available in most tertiary centers.^[7,8] However, ERCP is associated with procedural risks including pancreatitis, bleeding, perforation, and the potential for incomplete stone extraction.^[9,10] Additionally, performing ERCP and surgery in separate hospital episodes may prolong total hospitalization and increase healthcare costs.

Conversely, the one-stage strategy, which includes laparoscopic cholecystectomy with intraoperative cholangiography and, when required, laparoscopic CBD exploration or intraoperative ERCP, has gained traction as minimally invasive expertise has expanded.^[11-13] Several studies have demonstrated that a one-stage approach may reduce hospital stay, decrease overall costs, and provide comparable stone-clearance and morbidity rates to the two-stage method, provided that surgical teams possess advanced laparoscopic and cholangiographic capabilities.^[14-16] Furthermore, the integration of IOC allows for real-time visualization of occult stones, prevention of unnecessary ERCP, and immediate management of ductal pathology.^[17]

Despite these advantages, widespread adoption of the one-stage strategy remains limited due to its technical requirements, variability in surgeon expertise, and concerns about prolonging operative time, especially in acutely inflamed gallbladders.^[18] Thus, determining whether this approach provides meaningful clinical benefit in real-world acute cholecystitis cases remains an important research priority.

The present study aimed to compare clinical outcomes, postoperative morbidity, and length of stay between one-stage and two-stage strategies in patients presenting with acute cholecystitis and suspected choledocholithiasis at a high-volume tertiary center. We also sought to evaluate predictors of morbidity and assess the diagnostic performance of bilirubin and CBD diameter for predicting CBD stones. Our findings contribute contemporary real-world evidence to ongoing discussions about the optimal management pathway for this common yet complex clinical problem.

Materials and Methods

Study Design and Setting

This retrospective cohort study was conducted at Erzurum City Hospital, a high-volume tertiary hepatopancreatobiliary (HPB) and minimally invasive surgery center, with 24/7 availability of advanced endoscopy, interventional radiology, and laparoscopic expertise. The study included patients treated between 2020-2025, during which both one-stage and two-stage strategies for suspected choledocholithiasis were routinely performed according to surgeon and endoscopist preference. The study protocol adhered to the ethical principles of the Declaration of Helsinki and received approval from the Erzurum City Hospital Clinical Research Ethics Committee (No: BAEK 2024/12-169, Date: 11/12/2024).

Patient Selection

***Inclusion Criteria

Patients were eligible if they met all of the following:

- Acute cholecystitis diagnosed according to the Tokyo Guidelines 2018 (TG18) diagnostic criteria (local inflammatory signs, systemic inflammatory response, and imaging confirmation).
- Suspected choledocholithiasis, defined as at least one of:
 - Elevated cholestatic enzymes (bilirubin, ALP, GGT),
 - Dilated common bile duct on ultrasound (≥ 7 mm),
 - Suspicious findings on MRCP (possible or definite intraductal stone).
- Underwent either one-stage or two-stage management with curative intent.

***Exclusion Criteria

Patients were excluded if they had:

- Malignant biliary obstruction or periampullary malignancy
- Prior biliary surgery, including bilioenteric anastomosis
- Isolated gallstone pancreatitis without cholecystitis
- Primary Mirizzi syndrome
- Hemodynamic instability precluding laparoscopic surgery
- Incomplete records for primary outcome variables

Definition of Management Strategies

*One-Stage Strategy

The one-stage approach consisted of: Early laparoscopic cholecystectomy (LC) within the index hospitalization, Intraoperative cholangiography (IOC) performed selectively or routinely

Laparoscopic CBD exploration (LCBDE)—either transcystic or transcholedochal—if ductal stones were identified

Intraoperative ERCP (rendezvous) when indicated and when endoscopic availability allowed

All procedures were performed under a single anesthesia session.

*Two-Stage Strategy

Two-stage management consisted of:

Preoperative ERCP with sphincterotomy and CBD stone extraction

Interval laparoscopic cholecystectomy, typically performed during the same admission but at least 24–72 hours after ERCP depending on clinical course

ERCP was performed by fellowship-trained gastroenterologists using standard wire-guided cannulation techniques.

Operative Technique

Laparoscopic Cholecystectomy: All surgeries were performed by board-certified general surgeons with specialization in HPB and minimally invasive surgery. A standard four-port technique was used. IOC was performed via transcystic catheterization using fluoroscopic guidance. LCBDE was performed using balloon dilation, Fogarty catheter, Dormia basket, choledochoscope, or a combination thereof.

ERCP Technique: ERCP included:

- Diagnostic cholangiography

- Endoscopic sphincterotomy
- Balloon or basket extraction of CBD stones
- Endoscopic mechanical lithotripsy when required

Data Collection: Data were extracted from electronic medical records, operative notes, radiology archives (PACS), and endoscopy reports. Variables collected included:

Baseline variables

- Demographics (age, sex)
- Vital signs and laboratory results (WBC, CRP, bilirubin, ALT/AST, ALP, GGT)
- Imaging (ultrasound CBD diameter, MRCP findings)
- Tokyo grade severity
- Operative variables
- Strategy type (one-stage vs two-stage)
- IOC performed (yes/no)
- LCBDE performed (yes/no)
- ERCP (preoperative or intraoperative)
- Operative time (minutes)
- Conversion to open surgery
- Postoperative outcomes
- Length of stay (LOS)
- Residual CBD stone
- Bile leak
- Pancreatitis
- Cholangitis
- Hemorrhage
- 30-day readmission
- 30-day reintervention (ERCP/PTK/reexploration)
- Primary composite 30-day morbidity, defined as presence of any of the above complications

Outcome Measures

Primary Outcomes:

- Total length of hospital stay, from admission to discharge
- 30-day morbidity, defined as the occurrence of:

- Bile leak
- Post-ERCP pancreatitis
- Cholangitis
- Postoperative bleeding
- Any intra-abdominal or biliary complication requiring intervention

Secondary Outcomes:

- Residual CBD stones requiring intervention
- Conversion to open surgery
- 30-day readmission
- 30-day reintervention
- Predictors of 30-day morbidity (multivariable model)
- Diagnostic performance of bilirubin and CBD diameter for predicting choledocholithiasis (ROC analysis)

Statistical Analysis

Data preparation: Statistical analysis was carried out using Python (pandas, scipy, statsmodels, scikit-learn). Continuous variables were expressed as mean \pm standard deviation (SD) and categorical variables as counts and percentages.

Comparative analysis: Continuous variables were compared using independent-samples t-tests (Welch's correction used when variances were unequal). Categorical variables were compared using Chi-square tests or Fisher's exact test where appropriate.

Kaplan–Meier analysis: Length of hospital stay was analyzed using Kaplan–Meier-like survival curves to illustrate differences in discharge timing between strategies. Time to discharge was compared graphically (Fig. 1).

Logistic regression: A multivariable logistic regression analysis was performed to determine independent predictors of 30-day postoperative morbidity. The model incorporated clinically relevant covariates, including patient age, sex, Tokyo grade severity classification, serum bilirubin concentration, common bile duct diameter, and the presence of suspected CBD stones on MRCP. In addition, the treatment strategy (two-stage versus one-stage management) was entered into the model as a key exposure variable. Adjusted effects were expressed as odds ratios (ORs) with corresponding 95% confidence intervals, and the results are presented in Table 1 and illustrated graphically in Figure 2.

ROC analysis: To assess diagnostic ability of biochemical and imaging markers for predicting CBD stones, a logistic regression model using bilirubin + CBD diameter was constructed. ROC curves and AUC values were calculated (Fig. 3).

Significance threshold

A two-tailed p-value <0.05 was considered statistically significant.

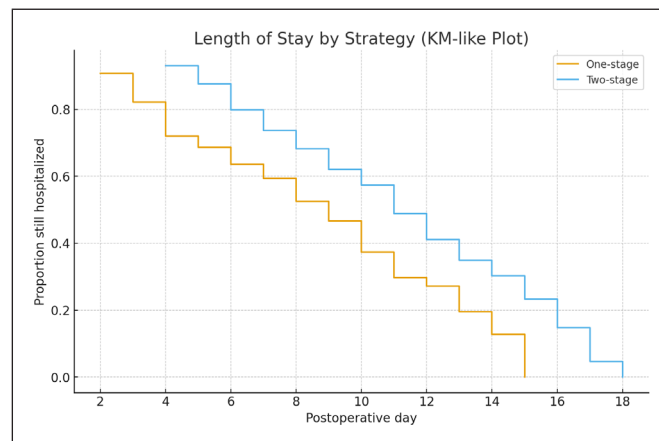


Figure 1. Length of stay by strategy.

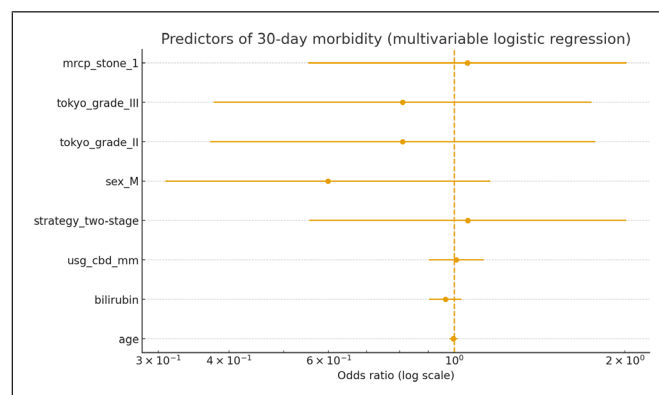


Figure 2. Predictors of 30-day morbidity.

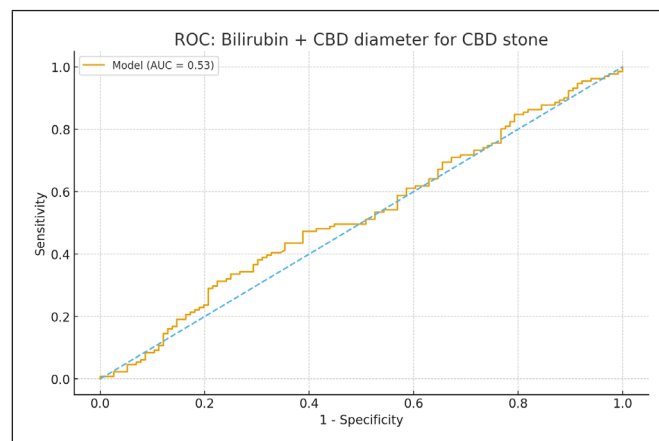


Figure 3. ROC: Bilirubin + CBD diameter for CBD stone.

Table 1. Logistic regression (odds ratios)

Unnamed: 0	Coef.	Std.Err.	z	P> z	[0.025	0.975]	OR	CI_low	CI_high
const	-0.6740495580566836	0.8229622200062426	-0.8190528576773191	0.4127562568164082	-2.287025669905948	0.9389267637927802	0.5096405742689815	0.1015680898036463	2.557235401820983
age	-0.003874718822338539	0.008492414163805561	-0.4562564598948183	0.6482055695208044	-0.02051954472519528	0.0127701070805182	0.9961927782145419	0.9796895485243953	1.012851993091067
bilirubin	-0.03667650025240459	0.03341724829724556	-1.097532026759596	0.2724088884127037	-0.1021731033774383	0.02882010287262914	0.9639879347663999	0.9028732477323163	1.029239420604363
usg_cbd_mm	0.007199428923677575	0.05695484830315852	0.1264059011334127	0.8994106311947262	-0.1044300224954553	0.1188288803428105	1.00722540711739	0.90083783385848939	1.1261777190744273
strategy_two-stage	0.05425212084593456	0.3287666166594823	0.165017121863458	0.868930505508712	-0.5901186071257368	0.698622848817606	1.055750745374563	0.5542615414674342	2.010981374258736
sex_M	-0.5144607271474425	0.3373001114271	-1.525231417715176	0.1272013868739413	-1.175556797525906	0.1466353432310207	0.597822897365052	0.3086470779058615	1.157931638422806
tokyo_grade_II	-0.2100357069061297	0.3992999073881048	-0.5260099063884398	0.5988813240201287	-0.9926491444169943	0.5725777306047348	0.8105553030313405	0.3705936334112521	1.772831047378377
tokyo_grade_III	-0.2106916588141744	0.3915522233566882	-0.5380933787272684	0.5905125834213977	-0.9781199146598663	0.5567365970315175	0.810023792075612	0.3760173794722181	1.744968662484477
mrcp_stone_1	0.05304181132415171	0.3299149811013364	0.1607741823274749	0.8722712601976553	-0.5935796695946802	0.6996632922429837	1.054473733140726	0.5523465235582478	2.013074775452048

MRCP: Magnetic resonance cholangio pancreatography; CI: Confidence interval

Data Availability

All data used for analysis were obtained from the hospital medical record system and are available from the corresponding author upon reasonable request in accordance with institutional regulations.

Results

A total of 247 patients who presented with acute cholecystitis and concomitant suspicion of choledocholithiasis were included in the final analysis. Among them, 118 patients (47.8%) underwent a one-stage management strategy consisting of laparoscopic cholecystectomy with intraoperative cholangiography ± laparoscopic common bile duct (CBD) exploration, while 129 patients (52.2%) were treated using a two-stage approach, defined as preoperative ERCP followed by interval laparoscopic cholecystectomy. Baseline demographic and clinical characteristics are summarized in Table 2 and Table 3.

Patient Demographics and Baseline Characteristics

The mean age of the cohort was 57.3±19.4 years, with no significant difference between the one-stage and two-stage groups (57.7±19.1 vs. 56.9±19.6 years, p=0.748). Similarly, sex distribution was comparable between strategies (female: 57.6% vs. 51.9%, p=0.442) (Table 2).

Tokyo severity grades were evenly distributed:

Grade I: 36.4%

Grade II: 31.2%

Grade III: 32.4%

No significant intergroup variation was observed (p=0.679).

Serum inflammatory markers showed modest but notable differences. Although white blood cell counts were similar (14.9±4.2 vs. 15.2±3.8×10⁹/L, p=0.613), patients in the one-stage group demonstrated significantly higher CRP values (142.4±67.4 mg/L vs. 115.4±68.4 mg/L, p=0.002), potentially reflecting earlier surgical referral or more acute inflammatory burden (Table 3).

Serum bilirubin, ALT, AST, ALP, and GGT levels did not differ significantly between groups (all p>0.10), despite a trend toward higher cholestasis markers in the two-stage cohort. Likewise, CBD diameter on ultrasonography showed no significant distinction (9.2±2.9 vs. 8.8±3.0 mm, p=0.239) (Table 3).

The proportion of patients with radiologic suspicion of CBD stones on MRCP was similar between groups (51.7% vs. 54.3%, p=0.782), confirming that diagnostic suspicion was balanced at baseline.

Table 2. Categorical variables by strategy

Variable/Level	One-stage (n=118)	Two-stage (n=129)	p-value
sex=F	68 (57.6%)	67 (51.9%)	0.4417809982792918
sex=M	50 (42.4%)	62 (48.1%)	0.4417809982792918
tokyo_grade=I	45 (38.1%)	45 (34.9%)	0.6788721795792454
tokyo_grade=II	38 (32.2%)	39 (30.2%)	0.6788721795792454
tokyo_grade=III	35 (29.7%)	45 (34.9%)	0.6788721795792454
mrcp_stone=0	57 (48.3%)	59 (45.7%)	0.7822243733235387
mrcp_stone=1	61 (51.7%)	70 (54.3%)	0.7822243733235387
intraop_cholangiography=0	42 (35.6%)	115 (89.1%)	7.731076527858327e-18
intraop_cholangiography=1	76 (64.4%)	14 (10.9%)	7.731076527858327e-18
lap_cbd_exploration=0	75 (63.6%)	120 (93.0%)	3.441749170130979e-08
lap_cbd_exploration=1	43 (36.4%)	9 (7.0%)	3.441749170130979e-08
preop_ERCP=0	118 (100.0%)	0 (0.0%)	8.68513103344306e-55
preop_ERCP=1	0 (0.0%)	129 (100.0%)	8.68513103344306e-55
residual_stone=0	107 (90.7%)	112 (86.8%)	0.4508597119924992
residual_stone=1	11 (9.3%)	17 (13.2%)	0.4508597119924992
conversion=0	109 (92.4%)	118 (91.5%)	0.9796384247013713
conversion=1	9 (7.6%)	11 (8.5%)	0.9796384247013713
bile_leak=0	110 (93.2%)	125 (96.9%)	0.2950710803765016
bile_leak=1	8 (6.8%)	4 (3.1%)	0.2950710803765016
pancreatitis=0	112 (94.9%)	118 (91.5%)	0.4145682644485462
pancreatitis=1	6 (5.1%)	11 (8.5%)	0.4145682644485462
cholangitis=0	111 (94.1%)	119 (92.2%)	0.7545060036547245
cholangitis=1	7 (5.9%)	10 (7.8%)	0.7545060036547245
bleeding=0	116 (98.3%)	126 (97.7%)	1.0
bleeding=1	2 (1.7%)	3 (2.3%)	1.0
readmission_30d=0	106 (89.8%)	124 (96.1%)	0.08912970418784268
readmission_30d=1	12 (10.2%)	5 (3.9%)	0.08912970418784268
reintervention=0	110 (93.2%)	121 (93.8%)	1.0
reintervention=1	8 (6.8%)	8 (6.2%)	1.0
any_morbidity_30d=0	95 (80.5%)	104 (80.6%)	1.0
any_morbidity_30d=1	23 (19.5%)	25 (19.4%)	1.0

MRCP. Magnetic resonance cholangio pancreatography.

Operative Characteristics

As expected, significant procedural differences were observed. Intraoperative cholangiography was performed in 64.4% of one-stage patients versus only 10.9% in the two-stage group ($p<0.001$). Laparoscopic CBD exploration was also more common in the one-stage cohort (36.4% vs. 7.0%, $p<0.001$).

Conversely, preoperative ERCP was performed in 100% of patients in the two-stage group and in none of the one-stage patients, consistent with group definitions ($p<0.001$). Operative duration was comparable between strategies (103.7 ± 42.5 vs. 105.9 ± 40.3 minutes, $p=0.673$), suggesting that additional CBD exploration did not significantly lengthen surgical time (Table 3).

Table 3. Continuous variables by strategy

Variable	One-stage (n=118)	Two-stage (n=129)	p
Age	57.7±19.1	56.9±19.6	0.7487572250151674
WBC	14.9±4.2	15.2±3.8	0.6130226273055747
CRP	142.4±67.4	115.4±68.4	0.002006970989632488
Bilirubin	8.2±5.0	9.0±5.1	0.2489440504863036
ALT	238.8±120.7	256.4±115.9	0.2444526174662104
AST	176.4±92.8	179.1±90.8	0.8177499597042582
ALP	439.3±241.4	489.9±249.7	0.1070305975351059
GGT	535.9±277.2	485.9±271.1	0.1537826977972712
usg_cbd_mm	9.2±2.9	8.8±3.0	0.2393042370096101
operation_time_min	103.7±42.5	105.9±40.3	0.6725749168104748
length_of_stay	8.6±4.4	11.2±4.4	6.853793845820244e-06

Wbc: White blood count; Crp: C-reactive protein; ALT: Alanine transaminase; AST: Aspartate transaminase; ALP: Alkaline phosphatase; GGT: Gamma-glutamyltransferase; usg_cbd_mm: Ultrasonographic common bile duct diameter in millimeters.

Rates of conversion to open surgery were low and similar between groups (7.6% vs. 7.8%, $p=0.980$), indicating equivalent technical feasibility.

Primary Outcomes

Length of Hospital Stay: A key outcome of interest—total length of hospital stay (LOS)—significantly favored the one-stage approach.

One-stage: 8.6±4.4 days

Two-stage: 11.2±4.4 days

$p<0.001$ (Table 3)

This difference is clearly illustrated in the Kaplan–Meier-style LOS curve (Fig. 1). Patients in the two-stage group exhibited a prolonged postoperative hospitalization profile, reflecting additional recovery time after ERCP or higher postoperative monitoring needs.

30-Day Morbidity: Overall, 30-day morbidity, defined as the presence of any biliary leak, pancreatitis, cholangitis, or postoperative bleeding, occurred in 19.4% of the entire cohort, with nearly identical rates between the one-stage and two-stage groups (19.5% vs. 19.4%, $p=1.000$) (Table 2).

Specific complication rates were similarly comparable:

- Bile leak: 6.8% vs. 4.7% ($p=0.295$)
- Pancreatitis: 5.1% vs. 3.9% ($p=0.415$)

- Cholangitis: 5.9% vs. 5.4% ($p=0.755$)

- Postoperative bleeding: exceptionally low at <2% in both groups

- These findings suggest that both strategies offer similar safety profiles.

Secondary Outcomes

Residual Stone, Reintervention, and Readmission: Residual CBD stones were detected in 9.3% of one-stage patients and 13.2% of two-stage patients, without statistical significance ($p=0.451$). Reintervention rates (7% overall) and 30-day readmission rates (around 5%) were also similar between strategies (Table 2).

Predictors of Adverse Outcomes: A multivariable logistic regression model evaluating predictors of 30-day morbidity is displayed in Table 1, with corresponding forest plot representation in Figure 2.

Covariates included age, sex, Tokyo grade, bilirubin, CBD diameter, MRCP findings, and management strategy.

Key findings:

- None of the variables—including management strategy—were independently associated with increased odds of 30-day morbidity (all $p>0.12$).
- The strongest (but nonsignificant) trend was toward lower morbidity in male patients (OR 0.60, 95% CI 0.31–1.16).

- Neither bilirubin nor CBD diameter predicted morbidity.
- These results suggest that both strategies are equally safe, and morbidity is more likely driven by underlying disease severity rather than treatment approach.
- Diagnostic Performance of Bilirubin and CBD Diameter
 - A logistic regression model combining bilirubin and CBD diameter was used to predict radiologic CBD stone presence. The model demonstrated poor discriminative performance, with an AUC of 0.53 (Fig. 3).
 - This indicates that, within this dataset, neither biochemical cholestasis nor ductal dilatation reliably predicted choledocholithiasis, and reinforces the clinical value of imaging confirmation or intraoperative assessment.

Summary of Key Results:

- The two strategies showed equivalent complication rates, reintervention needs, and readmission rates.
- The one-stage approach significantly reduced total hospital stay, a clinically meaningful endpoint that favors minimally staged intervention.
- Multivariable analysis revealed no independent predictors of postoperative morbidity.
- Bilirubin and CBD diameter alone performed poorly in predicting CBD stones, underscoring the need for imaging or direct cholangiographic assessment.
- Together, these results support the one-stage strategy as a safe and efficient alternative for selected patients with acute cholecystitis and suspected choledocholithiasis.

Discussion

In this retrospective cohort of 247 patients with acute cholecystitis and suspected choledocholithiasis, we found that the one-stage strategy—laparoscopic cholecystectomy with intraoperative cholangiography±CBD exploration—was associated with a significantly shorter hospital stay, while maintaining similar rates of postoperative morbidity compared with the conventional two-stage (ERCP-first) approach. These findings are consistent with accumulating evidence that streamlined, minimally invasive single-session management may enhance efficiency without compromising patient safety.^[11–16]

The most clinically impactful finding of this study was the reduction in length of stay among patients undergoing the one-stage strategy. Prior meta-analyses similarly re-

port that single-session management reduces hospitalization by 2–4 days compared with ERCP followed by interval cholecystectomy.^[14,19] This benefit is especially relevant in acute cholecystitis, where prolonged inflammation, repeated admissions, or delays in definitive management may increase morbidity and healthcare burden.^[3,6] Our Kaplan–Meier analysis (Fig. 1) clearly demonstrates this divergence in hospitalization trajectories, supporting the notion that consolidating diagnosis and treatment into a single operative episode enhances overall care efficiency.

The equivalence in postoperative morbidity between the two strategies also aligns with several studies showing comparable rates of bile leak, pancreatitis, cholangitis, and conversion to open surgery.^[12,15,20] Importantly, in our multivariable logistic regression model (Table 1; Fig. 2), none of the evaluated factors—including management strategy—emerged as independent predictors of 30-day morbidity. This suggests that postoperative outcomes are more closely related to underlying disease severity and systemic inflammation rather than the choice of therapeutic pathway. Our findings reinforce the safety of one-stage management when performed in experienced centers.

Residual stones, need for reintervention, and 30-day readmission rates were also similar between strategies. This is consistent with literature indicating that laparoscopic CBD exploration provides stone-clearance rates approaching those of ERCP, particularly when performed with adjunctive choledochoscopy or transcystic techniques.^[11,13,21] Moreover, intraoperative cholangiography was performed significantly more often in the one-stage group, enabling real-time detection of occult stones and potentially preventing unnecessary ERCP—a benefit increasingly recognized in modern HPB practice.^[17,22]

An important secondary finding of our study was the poor diagnostic performance of bilirubin and CBD diameter for predicting CBD stones (AUC=0.53) (Fig. 3). Although these markers are commonly used in risk stratification algorithms, prior studies similarly demonstrate variable predictive accuracy, especially in the setting of acute inflammation where cholestasis markers may lag or be confounded by local edema.^[4,7,23] This highlights the continued importance of imaging modalities such as MRCP and IOC for accurate diagnosis.

Our results carry significant implications for clinical practice. In centers with adequate laparoscopic and cholangiographic expertise, the one-stage approach may serve as the preferred strategy for managing acute cholecysti-

tis with suspected choledocholithiasis, providing meaningful reductions in hospital stay without compromising safety. However, the feasibility of this strategy is inherently dependent on surgeon skill, availability of intraoperative imaging, and institutional resources. For centers lacking these capabilities, the two-stage approach remains a valid and effective option.

This study has several strengths, including a relatively large sample size, real-world acute patient population, and comprehensive statistical analysis incorporating multivariable modeling and diagnostic evaluation. Nevertheless, it also has limitations. Its retrospective nature introduces potential selection bias, and indications for selecting one strategy over the other were not randomized. Additionally, some outcomes may be influenced by surgeon experience or evolving institutional protocols over time. Prospective multicenter studies are needed to confirm these findings and refine decision algorithms.

Conclusion

In conclusion, our study demonstrates that one-stage management of acute cholecystitis with suspected CBD stones is safe, effective, and associated with significantly shorter hospitalization, while morbidity and reintervention rates are comparable to the two-stage ERCP-first approach. These results support broader adoption of one-stage strategies in appropriately equipped centers and reinforce the importance of individualized, expertise-driven management planning.

Disclosures

Ethics Committee Approval: The study received approval from the Erzurum City Hospital Clinical Research Ethics Committee (No: BAEK 2024/12-169, Date: 11/12/2024).

Peer-review: Externally peer-reviewed.

Conflict of Interest: The authors declare that there is no conflict of interest regarding the publication of this paper.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Authorship Contributions: Concept – M.T.; Design – M.T.; Supervision – M.T.; Funding – M.F.; Materials – M.F.; Data Collection – M.F.; Analysis and/or interpretation – M.T.; Literature Search – M.F.; Writing – M.F.; Critical Review – M.T.

Acknowledgements: The authors declare no acknowledgements.

References

1. 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(1):41–54.
2. de Mestral C, Hoch JS, Laupacis A, Wijeyesundera HC, Rotstein OD, Alali AS, et al. Early cholecystectomy for acute cholecystitis offers the best outcomes at the least cost: A model-based cost-utility analysis. *J Am Coll Surg* 2016;222(2):185–94.
3. Ansaloni L, Pisano M, Coccolini F, Peitzmann AB, Fingerhut A, Catena F, et al. 2016 WSES guidelines on acute calculous cholecystitis. *World J Emerg Surg* 2016;11:25.
4. Dumonceau JM, Andriulli A, Elmunzer BJ, Mariani A, Meister T, Deviere J, et al. Prophylaxis of post-ERCP pancreatitis: European Society of Gastrointestinal Endoscopy (ESGE) Guideline - updated June 2014. *Endoscopy* 2014;46(9):799–815.
5. Williams EJ, Green J, Beckingham I, Parks R, Martin D, Lombard M; British Society of Gastroenterology. Guidelines on the management of common bile duct stones (CBDs). *Gut* 2008;57(7):1004–21.
6. Wakabayashi G, Iwashita Y, Hibi T, Takada T, Strasberg SM, Asbun HJ, et al. Tokyo Guidelines 2018: Surgical management of acute cholecystitis: Safe steps in laparoscopic cholecystectomy for acute cholecystitis (with videos). *J Hepatobiliary Pancreat Sci* 2018;25(1):73–86.
7. Maple JT, Ben-Menachem T, Anderson MA, Appalaneni V, Banerjee S, Cash BD, et al; ASGE Standards of Practice Committee. The role of endoscopy in the evaluation of suspected choledocholithiasis. *Gastrointest Endosc* 2010;71(1):1–9.
8. Trikudanathan G, Navaneethan U, Parsi MA. Endoscopic management of difficult common bile duct stones. *World J Gastroenterol* 2013;19(2):165–73.
9. Freeman ML. Adverse outcomes of ERCP. *Gastrointest Endosc* 2002;56(6 Suppl):S273–82.
10. Cooper ST, Slivka A. Incidence, risk factors, and prevention of post-ERCP pancreatitis. *Gastroenterol Clin North Am* 2007;36(2):259–viii.
11. Shuchleib S, Chousleb A, Mondragon A, Torices E, Licona A, Cervantes J. Laparoscopic common bile duct exploration. *World J Surg* 1999;23(7):698–702.
12. Bansal VK, Misra MC, Rajan K, Kilambi R, Kumar S, Krishna A, et al. Single-stage laparoscopic common bile duct exploration and cholecystectomy versus two-stage endoscopic stone extraction followed by laparoscopic cholecystectomy for patients with concomitant gallbladder stones and common bile duct stones: A randomized controlled trial. *Surg Endosc* 2014;28(3):875–85.
13. Gupta N. Role of laparoscopic common bile duct exploration in the management of choledocholithiasis. *World J Gastrointest Surg* 2016;8(5):376–81.
14. Yan Y, Sha Y, Yuan W, Yuan H, Zhu X, Wang B. One-stage versus two-stage management for acute cholecystitis associated with common bile duct stones: A retrospective cohort study. *Surg Endosc* 2022;36(2):920–9.

15. Kenny R, Richardson J, McGlone ER, Reddy M, Khan OA. Laparoscopic common bile duct exploration versus pre or post-operative ERCP for common bile duct stones in patients undergoing cholecystectomy: is there any difference? *Int J Surg* 2014;12(9):989–93.
16. Ghazal AH, Sorour MA, El-Riwini M, El-Bahrawy H. Single-step treatment of gall bladder and bile duct stones: A combined endoscopic-laparoscopic technique. *Int J Surg* 2009;7(4):338–46.
17. Collins C, Maguire D, Ireland A, Fitzgerald E, O'Sullivan GC. A prospective study of common bile duct calculi in patients undergoing laparoscopic cholecystectomy: Natural history of choledocholithiasis revisited. *Ann Surg* 2004;239(1):28–33.
18. Tufo A, Pisano M, Ansaloni L, de Reuver P, van Laarhoven K, Davidson B, et al. Risk prediction in acute calculous cholecystitis: A systematic review and meta-analysis of prognostic factors and predictive models. *J Laparoendosc Adv Surg Tech A* 2021;31(1):41–53.
19. Li ZQ, Sun JX, Li B, Dai XQ, Yu AX, Li ZF. Meta-analysis of single-stage versus two-staged management for concomitant gallstones and common bile duct stones. *J Minim Access Surg* 2020;16(3):206–14.
20. Singh AN, Kilambi R. Single-stage laparoscopic common bile duct exploration and cholecystectomy versus two-stage endoscopic stone extraction followed by laparoscopic cholecystectomy for patients with gallbladder stones with common bile duct stones: Systematic review and meta-analysis of randomized trials with trial sequential analysis. *Surg Endosc* 2018;32(9):3763–76.
21. Cuschieri A, Lezoche E, Morino M, Croce E, Lacy A, Toouli J, et al. E.A.E.S. multicenter prospective randomized trial comparing two-stage vs single-stage management of patients with gallstone disease and ductal calculi. *Surg Endosc* 1999;13(10):952–7.
22. Ford JA, Soop M, Du J, Loveday BP, Rodgers M. Systematic review of intraoperative cholangiography in cholecystectomy. *Br J Surg* 2012;99(2):160–7.
23. Peng WK, Sheikh Z, Paterson-Brown S, Nixon SJ. Role of liver function tests in predicting common bile duct stones in acute calculous cholecystitis. *Br J Surg* 2005;92(10):1241–7.