

Early Versus Interval Laparoscopic Cholecystectomy in Acute Cholecystitis: A Prospective Comparative Cross-Sectional Study

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Abstract

Background:

Acute cholecystitis is commonly managed by laparoscopic cholecystectomy, but the timing of surgery remains clinically relevant because acute inflammation can increase technical difficulty while delayed surgery requires a second treatment episode.

Objectives:

To compare early and interval laparoscopic cholecystectomy in acute cholecystitis with respect to operative feasibility, intraoperative difficulty, conversion to open surgery, postoperative complications, and hospital stay.

Methods:

This prospective comparative cross-sectional study included 50 adults treated in the Department of General Surgery, Andhra Medical College and King George Hospital, Visakhapatnam, from September 2022 to January 2024. The study prospectively compared two predefined clinical groups at the time of operative management: 25 patients undergoing early laparoscopic cholecystectomy within 7 days of symptom onset and 25 undergoing interval laparoscopic cholecystectomy at least 6 weeks after resolution of the acute episode. All procedures began laparoscopically.

Results:

Mean age was 45.72 ± 13.88 years in the early group and 49.28 ± 11.47 years in the interval group. Conversion to open cholecystectomy occurred in 28.0% and 16.0%, respectively. Intraoperative difficulty occurred in 60.0% versus 36.0%. Transient bile leak (16.0% vs. 12.0%), superficial wound infection (20.0% vs. 8.0%), and atelectasis (24.0% vs. 16.0%) showed no statistically significant between-group differences. Mean hospital stay was 9.80 ± 6.87 versus 9.88 ± 6.75 days. Age correlated positively with hospital stay ($r = 0.36$).

Conclusion:

Early laparoscopic cholecystectomy was feasible in selected patients with uncomplicated acute cholecystitis. Although technical difficulty and conversion were numerically higher, short-term complication rates and hospital stay were not significantly different from interval surgery.

Recommendations:

Early laparoscopic cholecystectomy can be considered for eligible patients when appropriate surgical expertise, perioperative support, and safe bailout strategies are available. Larger multicenter studies should confirm comparative effectiveness and uncommon adverse outcomes.

Keywords: Acute cholecystitis; early laparoscopic cholecystectomy; interval cholecystectomy; conversion; postoperative complications; hospital stay.

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Introduction

Acute calculous cholecystitis is a frequent surgical emergency caused most often by persistent cystic duct obstruction in a patient with gallstones. The resulting inflammation can progress from gallbladder wall edema to suppuration, gangrene, perforation, or systemic illness if definitive treatment is not achieved. Contemporary guidelines place laparoscopic cholecystectomy at the center of management for operable patients and increasingly favor an index-admission strategy rather than routine postponement. The 2020 World Society of Emergency Surgery guideline recommends laparoscopic cholecystectomy as the standard treatment whenever feasible, while the Tokyo Guidelines provide structured diagnostic, severity, and treatment pathways for acute cholecystitis.[1-3] These recommendations reflect the accumulated evidence that definitive surgery during the acute episode can avoid recurrent biliary events and the burden of an additional admission.

The timing question nevertheless remains clinically important. During the acute phase, edema, friability, gallbladder distension, and inflammatory adhesions can make exposure of Calot's triangle difficult. These features raise concerns about hemorrhage, bile leakage, misidentification of biliary anatomy, and conversion to open surgery. Conversely, postponing cholecystectomy allows acute inflammation to settle but can lead to dense fibrotic adhesions and exposes patients to recurrent pain, recurrent cholecystitis, pancreatitis, cholangitis, or emergency surgery while awaiting the planned procedure. TG18 therefore emphasizes safe dissection, attainment of the critical view of safety, and timely use of bailout procedures when standard laparoscopic dissection is unsafe.[4] The relevant comparison is thus not simply early versus late timing, but whether early definitive treatment can achieve acceptable technical and postoperative outcomes without excess harm.

Randomized trials spanning several decades have generally shown that early laparoscopic cholecystectomy is feasible and does not produce a consistent increase in conversion or postoperative complications compared with delayed surgery.[5-8] Meta-analyses have reinforced this pattern, reporting similar major complication and conversion rates with shorter total treatment-course hospitalization for early surgery.[9-11] The multicenter ACDC trial further demonstrated lower morbidity and shorter hospitalization with immediate laparoscopic cholecystectomy, whereas large population-based data have not shown an excess of major bile duct injury with early treatment.[12,13] A later meta-analysis of 15 randomized trials also found comparable mortality, bile duct injury, bile leakage, conversion, and overall complications, alongside shorter hospital stay and lower societal burden with early surgery.[14] However, institutional outcomes vary with case

selection, local expertise, severity profile, and definitions of hospitalization and operative difficulty.

Against this background, locally generated data remain useful for judging the feasibility of early surgery in routine tertiary-care practice. The objective of the present study was to compare early cholecystectomy performed within 7 days of symptom onset with interval cholecystectomy performed at least 6 weeks after resolution of the acute episode in adults with acute cholecystitis. The study specifically evaluated baseline comparability, intraoperative difficulty, completion of laparoscopic surgery or conversion to open cholecystectomy, postoperative bile leak, wound infection, atelectasis, duration of hospital stay, and the relationship between age and hospital stay.

Materials and Methods

Study design

This was a prospective comparative cross-sectional study. Consecutive adults with acute cholecystitis who met the eligibility criteria were enrolled prospectively and classified according to the timing of laparoscopic cholecystectomy. The early-surgery group underwent laparoscopic cholecystectomy within 7 days of symptom onset, whereas the interval-surgery group underwent laparoscopic cholecystectomy at least 6 weeks after resolution of the acute episode. Demographic, clinical, operative, and in-hospital postoperative outcome variables were recorded using the same predefined assessment approach in both groups, and the two groups were compared without random allocation or investigator-assigned exposure.

Study setting

The study was conducted in the Department of General Surgery, Andhra Medical College and King George Hospital, Visakhapatnam, Andhra Pradesh, India, from September 2022 to January 2024. The department functions within a tertiary-care teaching hospital and provides emergency and elective general surgical care, including assessment and operative management of acute biliary disease, laparoscopic surgery, inpatient perioperative care, imaging-supported evaluation, and postoperative follow-up. Eligible patients presenting to the surgical service during the study period were evaluated for participation.

Participants

Adults aged 18-85 years with a preoperative diagnosis of acute cholecystitis who were willing to undergo the required investigations and surgical treatment and who provided consent for participation were considered eligible. Participants were selected from patients presenting to the Department of General Surgery during the study period and were enrolled after confirmation of eligibility. Patients younger than 18 years, those refusing investigations or

treatment, those unwilling to participate, and patients with preoperative biliary complications or conditions including obstructive jaundice, cholangitis, gallbladder perforation, severe comorbid illness, or choledocholithiasis were excluded. Following inclusion, 25 participants underwent early laparoscopic cholecystectomy and 25 underwent interval laparoscopic cholecystectomy according to the timing of surgery documented in the study protocol.

Diagnostic assessment

Diagnosis was based on the combination of clinical findings and ultrasonography. Clinical criteria in the source protocol included acute right upper-quadrant tenderness, temperature above 37.5 degrees C, and total leukocyte count above 12,000/mm³. Ultrasonographic features included a thickened, edematous or distended gallbladder, sonographic Murphy sign, gallstones, and pericholecystic fluid. These clinical, inflammatory, and imaging domains are broadly consistent with the diagnostic framework used in the Tokyo Guidelines.[2] Demographic details were recorded at admission, followed by clinical examination, laboratory testing, imaging, and appropriate preoperative preparation.

Exposure groups and operative approach

Patients in the early group underwent cholecystectomy within 7 days of symptom onset. Patients in the interval group underwent surgery at least 6 weeks after resolution of the acute episode. All patients were initially approached laparoscopically. Conversion to open cholecystectomy was recorded as an operative outcome rather than treatment failure. Intraoperative difficulty included difficult Calot's triangle dissection, difficult separation of the gallbladder from the gallbladder fossa, and omental adhesiolysis. Contemporary safety guidance supports deliberate identification of anatomy and a bailout strategy when a critical view of safety cannot be obtained [3,4]

Outcomes and follow-up

Recorded outcomes were completion of laparoscopic cholecystectomy, conversion to open cholecystectomy, intraoperative difficulty, transient postoperative bile leak, superficial wound infection, atelectasis, and duration of hospital stay. The source dataset also recorded whether high-output biliary fistula or intra-abdominal collection/bilioma occurred. Ultrasonography of the abdomen and liver function tests were performed before discharge in all participants.

Bias

Potential selection bias was addressed by applying the same prespecified inclusion and exclusion criteria to patients

evaluated for the two timing groups. Information bias was reduced by using the same diagnostic criteria, preoperative evaluation, operative outcome definitions, and postoperative assessments in both groups. All operations were initiated laparoscopically, and conversion to open surgery was recorded as an outcome rather than as exclusion from analysis. Objective clinical records, ultrasonography, laboratory tests, and predefined postoperative complications were used where available to reduce subjective outcome classification. Baseline age and sex distributions were compared to assess group comparability. Because treatment timing was not randomized, residual confounding and treatment-selection bias could not be eliminated and were acknowledged as study limitations.

Statistical analysis

Continuous variables were summarized as mean, standard deviation, minimum, and maximum where available. Independent-samples t-tests compared mean age, symptom duration, and hospital stay between groups. Categorical outcomes were summarized as frequency and percentage and compared using the chi-square test. Pearson correlation assessed the association between age and hospital stay in the overall sample. A two-sided p-value below 0.05 was considered statistically significant. The source document did not specify a statistical software package; therefore, no software name or version was inferred.

Ethical considerations

The study was approved by the Institutional Ethics Committee, Andhra Medical College. Participants were informed about the study and provided written informed consent before inclusion. Confidentiality of participant information was maintained during data handling and manuscript preparation.

Results

A total of 50 participants were analyzed, with 25 in the early cholecystectomy group and 25 in the interval group. Sex distribution was comparable: males constituted 60.0% of the early group and 56.0% of the interval group (chi-square = 0.082, p = 0.774). Mean age was 45.72 ± 13.88 years in the early group and 49.28 ± 11.47 years in the interval group, without a significant difference (t = -0.989, p = 0.328). As expected from the timing definitions, mean symptom duration before surgery was substantially shorter in the early group (4.28 ± 1.57 days) than in the interval group (33.56 ± 6.90 days; t = -20.677, p < 0.001). Mean hospital stay was almost identical between groups (9.80 ± 6.87 vs. 9.88 ± 6.75 days; t = -0.042, p = 0.967) (Table 1).

Table 1: Baseline characteristics, symptom duration, and hospital stay by study group

Variable	Early (n = 25)	Interval (n = 25)	Test statistic	p value
Age, years, mean $\pm$ SD	45.72 $\pm$ 13.88	49.28 $\pm$ 11.47	t = -0.989	0.328
Age range, years	20-72	23-68	-	-
Female, n (%)	10 (40.0)	11 (44.0)	Chi-square = 0.082	0.774
Male, n (%)	15 (60.0)	14 (56.0)		
Symptom duration, days, mean $\pm$ SD	4.28 $\pm$ 1.57	33.56 $\pm$ 6.90	t = -20.677	<0.001
Symptom duration range, days	2-7	14-44	-	-
Hospital stay, days, mean $\pm$ SD	9.80 $\pm$ 6.87	9.88 $\pm$ 6.75	t = -0.042	0.967
Hospital stay range, days	4-28	5-28	-	-

Note. Values are mean $\pm$ standard deviation, range, or n (%), as indicated. Independent-samples t-test was used for continuous variables and chi-square test for sex distribution.

All patients were initially approached laparoscopically. Laparoscopic cholecystectomy was completed without conversion in 18 of 25 patients (72.0%) in the early group and 21 of 25 (84.0%) in the interval group. Conversion to open cholecystectomy occurred in 7 (28.0%) and 4 (16.0%) patients, respectively; the difference was not statistically significant (chi-square = 1.049, p = 0.306). Intraoperative

difficulty was documented in 15 patients (60.0%) undergoing early surgery compared with 9 (36.0%) undergoing interval surgery. This numerical difference also did not reach statistical significance (chi-square = 2.885, p = 0.089). Reported technical difficulties included Calot's triangle dissection, separation of the gallbladder from the gallbladder fossa, and omental adhesiolysis (Table 2).

Table 2: Operative outcomes and intraoperative difficulty

Outcome	Early (n = 25), n (%)	Interval (n = 25), n (%)	Chi-square	p value
Laparoscopic cholecystectomy completed	18 (72.0)	21 (84.0)	1.049*	0.306
Converted to open cholecystectomy	7 (28.0)	4 (16.0)	-	-
Intraoperative difficulty - Yes	15 (60.0)	9 (36.0)	2.885	0.089
Intraoperative difficulty - No	10 (40.0)	16 (64.0)	-	-

*Note. *Chi-square statistic applies to the overall laparoscopic completion/conversion distribution. All cases were initially approached laparoscopically.*

Transient postoperative bile leak occurred in 4 patients (16.0%) in the early group and 3 (12.0%) in the interval group (p = 0.684). Superficial wound infection occurred in 5 (20.0%) and 2 (8.0%) patients, respectively (p = 0.221), while atelectasis occurred in 6 (24.0%) and 4 (16.0%) patients (p = 0.480). None of these differences were

statistically significant. No participant in either group developed a high-output biliary fistula or an intra-abdominal collection/bilioma. Ultrasonography of the abdomen and liver function tests were performed before discharge for all participants (Table 3).

Table 3: Postoperative complications by study group

Complication	Early (n = 25), n (%)	Interval (n = 25), n (%)	Chi-square	p value
Transient bile leak	4 (16.0)	3 (12.0)	0.166	0.684
Superficial wound infection	5 (20.0)	2 (8.0)	1.495	0.221
Atelectasis	6 (24.0)	4 (16.0)	0.500	0.480

Note. No high-output biliary fistula or intra-abdominal collection/bilioma was recorded in either group.

Across the entire cohort, age showed a moderate positive correlation with duration of hospital stay (Pearson $r = 0.36$, $p = 0.010$), indicating that older participants tended to remain hospitalized longer. This association was statistically significant (Table 4).

Table 4: Correlation between age and duration of hospital stay in the overall sample

Variables	Pearson r	p value
Age vs. hospital stay	0.36	0.010

Note. Pearson correlation was calculated using the full sample (n = 50).

Discussion

The principal finding was that early laparoscopic cholecystectomy within 7 days of symptom onset achieved measured short-term outcomes that were broadly comparable with interval surgery in this cohort. Conversion to open surgery was more frequent in the early group (28.0% vs. 16.0%), although the difference was not statistically significant ($p = 0.306$). This pattern can be interpreted as reflecting the greater technical complexity of operating during active inflammation rather than demonstrating a clear disadvantage of early surgery. Edema, tissue friability, and obscuration of normal tissue planes can make safe laparoscopic dissection more difficult; therefore, conversion may represent an appropriate safety response when the critical anatomy cannot be defined confidently. Previous randomized studies by Lo et al., Lai et al., Johansson et al., and Kolla et al. similarly reported that an early strategy did not produce a consistent increase in conversion to open surgery.[5-8] Meta-analyses have also shown broadly comparable conversion rates between early and delayed approaches.[9-11,14]

Intraoperative difficulty was documented in 60.0% of early procedures compared with 36.0% of interval procedures ($p = 0.089$). The higher numerical frequency in the early group is clinically plausible because acute inflammation may produce gallbladder distension, inflammatory adhesions, edema around Calot's triangle, and tissue friability. The lack of statistical significance indicates that the present sample cannot establish a definitive between-group difference, but the observed direction suggests that early surgery requires careful dissection and readiness to modify the operative strategy. Importantly, technical difficulty should be interpreted in the context of operative safety rather than as an isolated adverse outcome. TG18 emphasizes

achievement of the critical view of safety and the use of bailout strategies, including conversion, when safe anatomic identification cannot be obtained.[4] Thus, the present findings support early surgery when experienced laparoscopic expertise and safe bailout options are available. Postoperative complications were also similar between groups. Transient bile leak occurred in 16.0% of early cases and 12.0% of interval cases ($p = 0.684$), superficial wound infection in 20.0% and 8.0% ($p = 0.221$), and atelectasis in 24.0% and 16.0% ($p = 0.480$), respectively. These differences were numerical rather than statistically demonstrated. A reasonable interpretation is that, despite the greater inflammatory burden and operative difficulty during early surgery, this did not translate into a measurable increase in short-term postoperative morbidity in the present cohort. No high-output biliary fistula or intra-abdominal collection/bilioma was recorded, although the sample was too small to draw firm conclusions about uncommon complications. Pooled randomized evidence has likewise reported no material increase in bile leakage, major complications, or overall morbidity with early laparoscopic cholecystectomy.[10,11,14] The ACDC trial reported lower overall morbidity with immediate surgery, while the population-based analysis by de Mestral et al. did not show worse major operative outcomes with early treatment.[12,13]

Mean hospital stay was comparable between the early and interval groups (9.80 ± 6.87 vs. 9.88 ± 6.75 days; $p = 0.967$), indicating that the timing of cholecystectomy did not significantly affect the duration of hospitalization in the present study. This finding differs from several randomized trials and meta-analyses, which have reported a shorter overall hospital stay with early laparoscopic cholecystectomy. [7-12,14] One possible explanation is that

the present study recorded hospital stay associated with surgical management but did not separately quantify the cumulative duration of the initial admission and subsequent operative admission among patients undergoing interval cholecystectomy. Therefore, the total treatment-related hospital burden in the interval group may not have been fully captured.

Age showed a moderate positive correlation with hospital stay ($r = 0.36$, $p = 0.010$), suggesting that older patients tended to require longer hospitalization. This may be related to greater requirements for perioperative evaluation, postoperative monitoring, and recovery among older individuals. Taken together, these findings indicate that early laparoscopic cholecystectomy can achieve hospital-stay outcomes comparable to interval surgery in appropriately selected patients. However, considering the non-randomized design and relatively small sample size, the findings should be interpreted as evidence of feasibility and comparable short-term outcomes rather than superiority of one surgical timing strategy over the other.

Generalizability

The findings are most applicable to adults with uncomplicated acute cholecystitis treated in tertiary teaching hospitals with access to laparoscopic expertise, conversion capability, imaging, and perioperative monitoring. Because patients with obstructive jaundice, cholangitis, choledocholithiasis, gallbladder perforation, or severe comorbidity were excluded, the results should not be extended directly to complex biliary disease or physiologically high-risk patients. Similar centers can use these data as supportive local evidence when designing early-surgery pathways.

Conclusion

Early laparoscopic cholecystectomy within 7 days of symptom onset was feasible in selected adults with uncomplicated acute cholecystitis. Although intraoperative difficulty (60.0% vs. 36.0%) and conversion to open surgery (28.0% vs. 16.0%) were numerically more frequent with early surgery, neither difference was statistically significant. Postoperative bile leak, superficial wound infection, atelectasis, and hospital stay were also comparable. These findings suggest that the technical challenges of operating during active inflammation did not translate into a demonstrable increase in measured short-term morbidity in this cohort when laparoscopic surgery was undertaken with appropriate safety measures and conversion when required. This interpretation is consistent with previous randomized trials and meta-analyses reporting broadly similar conversion and complication outcomes between early and delayed approaches.[5-11,14] The findings therefore support the feasibility of early surgery in appropriately

selected patients, while larger studies are required to assess uncommon complications and cumulative hospitalization more precisely.

Limitations

This single-center study had a modest sample of 50 participants, and the source protocol did not report random allocation, leaving potential selection and treatment-timing bias. The dataset did not report operative duration, blood loss, standardized severity grade, cumulative hospitalization across both admissions, readmissions, cost, quality of life, or long-term follow-up. Rare outcomes such as major bile duct injury could not be estimated reliably. Group differences therefore require cautious interpretation.

Recommendations

Eligible patients with uncomplicated acute cholecystitis should be evaluated early for index-admission laparoscopic cholecystectomy rather than being routinely deferred for interval surgery. The decision should account for physiological fitness, inflammatory severity, surgeon experience, operating-room access, and the ability to use safe bailout strategies when anatomy is unclear. Institutions should standardize documentation of critical view of safety, reasons for conversion, operative duration, blood loss, and postoperative complications. Future multicenter prospective studies should use uniform severity grading, capture cumulative hospitalization and readmissions, assess cost and quality of life, and include adequate sample sizes for uncommon biliary injuries and other clinically important outcomes.

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Abbreviations

AC: acute cholecystitis; ACDC: Acute Cholecystitis - early laparoscopic surgery versus antibiotic therapy and Delayed elective Cholecystectomy; BDI: bile duct injury; DLC: delayed/interval laparoscopic cholecystectomy; ELC: early laparoscopic cholecystectomy; GB: gallbladder; IEC: Institutional Ethics Committee; LC: laparoscopic cholecystectomy; LFT: liver function test; SD: standard deviation; TG18: Tokyo Guidelines 2018; USG: ultrasonography; WBC: white blood cell; WSES: World Society of Emergency Surgery.

Original Article

Conflict of Interest

The authors declare no conflict of interest related to this study or manuscript.

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The study received no external funding

Data Availability

The data supporting the findings of this study are available from the corresponding author on reasonable request, subject to institutional and ethical requirements for participant confidentiality.

AUTHOR CONTRIBUTIONS

Dr. Venkata Rama Krishna Reddy Avula: Contributed to study conception, patient recruitment, data collection, literature review, data analysis and interpretation, and preparation of the initial manuscript draft.

Dr. ADV Lavanya: Contributed to study design, methodology, clinical supervision, interpretation of results, and critical revision of the manuscript for important intellectual content.

Dr. A. Shivakumar: Contributed to conceptualization of the study, methodological guidance, supervision, validation of the findings, interpretation of the results, and critical review of the manuscript.

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