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Article

Early Vs Interval Laparoscopic Cholecystectomy in Acute Cholecystitis

Naveed Ahmad[1], **Atta Ullah Arif**[1], **Sahibzada Saad ur Rehman**[1], **Farhan Aslam**[1], **Aahan Attaullah**[1], **Muhammad Daud**[1]

1 Lady Reading Hospital-MTI, Peshawar, Pakistan

Correspondence
attaullah.arif@lrh.edu.pk;
naveedpimcian345@gmail.com

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ABSTRACT

Background: Acute cholecystitis is a common surgical emergency for which the optimal timing of laparoscopic cholecystectomy remains debated, particularly in resource-limited settings, with limited regional data directly comparing early versus interval surgical approaches. **Objective**: This study aimed to compare operative time, hospital stay, and conversion rates to open surgery between early laparoscopic cholecystectomy within 72 hours and interval laparoscopic cholecystectomy after four weeks in patients with acute cholecystitis. **Methods**: In this single-center randomized controlled trial, 166 adult patients (aged 20–60 years) with acute cholecystitis, meeting predefined inclusion and exclusion criteria, were randomly assigned to either early (n = 83) or interval (n = 83) laparoscopic cholecystectomy. All procedures were performed by a single experienced surgeon using a standardized four-port technique. Clinical and demographic data were collected using structured forms, and primary outcomes included operative time, hospital stay, and conversion to open surgery. Data analysis was performed with SPSS version 20, utilizing independent t-tests and chi-square tests; ethical approval was obtained from the institutional review board in accordance with the Helsinki Declaration. **Results**: Early laparoscopic cholecystectomy resulted in significantly shorter mean operative time (58.4 ± 14.2 vs 71.8 ± 18.6 minutes, $p < 0.001$), reduced hospital stay (1.6 ± 1.8 vs 2.4 ± 2.1 days, $p = 0.008$), and lower conversion rates to open surgery (6.0% vs 16.9%, $p = 0.032$) compared to interval surgery, with comparable complication rates. **Conclusion**: Early laparoscopic cholecystectomy offers substantial operative and recovery benefits over interval surgery for acute cholecystitis, supporting its adoption as the standard of care and highlighting its value in both clinical and real-world healthcare practice.

Keywords: Acute cholecystitis, Laparoscopic cholecystectomy, Surgical timing, Hospital stay, Conversion rate, Randomized controlled trial, Patient outcomes

INTRODUCTION

Acute cholecystitis (ACC) is a common and potentially serious inflammatory condition of the gallbladder, most often resulting from cystic duct obstruction caused by gallstones. This obstruction leads to biliary stasis and subsequent infection, triggering an inflammatory cascade that progresses from mucosal injury to transmural necrosis and microbial invasion (1). Pathogens such as Escherichia coli, Klebsiella spp., Enterococcus spp., and anaerobes are frequently isolated from bile cultures, especially when gallbladder drainage is performed during the necrotic phase (2,3). In approximately 41–63% of cases, bile cultures yield positive microbial growth, highlighting the infectious component of the disease (4). The standard treatment for ACC is laparoscopic cholecystectomy (LC), a minimally invasive surgical technique that offers reduced postoperative pain, shorter recovery times, and lower complication rates compared to open surgery (5,6). However, the optimal timing for performing LC—whether early during the acute episode or delayed following initial conservative management—remains an area of clinical uncertainty, particularly in resource-variable healthcare environments. Early laparoscopic cholecystectomy, typically defined as surgery within 72 hours of symptom onset, is supported by international guidelines, including the Tokyo Guidelines 2013 (TG13), which advocate for early intervention to reduce hospital stay, prevent recurrent attacks, and minimize costs (7,8). In contrast, interval LC—performed several weeks after initial presentation—has traditionally been favored due to concerns over technical difficulty, increased inflammation, and a higher risk of intraoperative complications during the acute phase. However, accumulating evidence suggests that early LC is not only safe but may also reduce operative time

and conversion rates to open surgery, particularly when performed by experienced surgeons and in appropriately selected patients (9,10). Previous studies have reported varying results. For instance, Janjic et al. (11) and Singh et al. (12) observed significantly lower conversion rates and shorter operative times with early LC, while Shetty et al. reported longer durations and greater difficulty during early surgery, attributing the differences to surgeon experience and patient selection (13). These inconsistencies in published data, coupled with heterogeneity in patient populations and surgical expertise, underscore the need for context-specific research.

Despite international data supporting early LC, there remains a paucity of locally generated evidence from low- and middle-income countries, including Pakistan, where healthcare infrastructure, surgical expertise, and patient follow-up may differ significantly from high-resource settings. In such contexts, delayed intervention is often favored due to institutional limitations, potentially exposing patients to repeated biliary events and prolonged morbidity. A local comparison evaluating the outcomes of early versus interval LC in terms of operative time, hospital stay, and conversion to open surgery is thus essential to inform evidence-based surgical practice in our setting. Furthermore, the pathophysiological changes that occur over time in acute inflammation—such as increased fibrosis and adhesion formation—may alter the technical difficulty of LC depending on the timing of surgery, further supporting the need for this investigation (14).

This study aims to evaluate whether early laparoscopic cholecystectomy within 72 hours of diagnosis results in superior perioperative outcomes compared to interval LC performed after four weeks in patients with acute cholecystitis. We hypothesize that early intervention is associated with reduced operative time, shorter hospital stay, and lower rates of conversion to open surgery compared to delayed intervention.

MATERIAL AND METHODS

This randomized controlled trial was conducted to compare operative outcomes between early and interval laparoscopic cholecystectomy in patients diagnosed with acute cholecystitis. The study was carried out in the General Surgery Department of Lady Reading Hospital-MTI, Peshawar, Khyber Pakhtunkhwa, Pakistan, from 1st May 2024 to 31st December 2024. The trial design was selected to minimize selection bias and to provide high-quality evidence regarding surgical timing in acute cholecystitis, an area where clinical equipoise persists in low-resource settings.

The study population included adult patients aged 20 to 60 years who presented to the emergency department with a clinical and ultrasonographic diagnosis of acute cholecystitis within 24 hours of symptom onset. Diagnosis was confirmed based on right upper quadrant pain, fever, leukocytosis, and ultrasound findings such as gallbladder wall thickening or pericholecystic fluid. Inclusion criteria required patients to be classified as American Society of Anesthesiologists (ASA) physical status class I or II and to provide written informed consent.

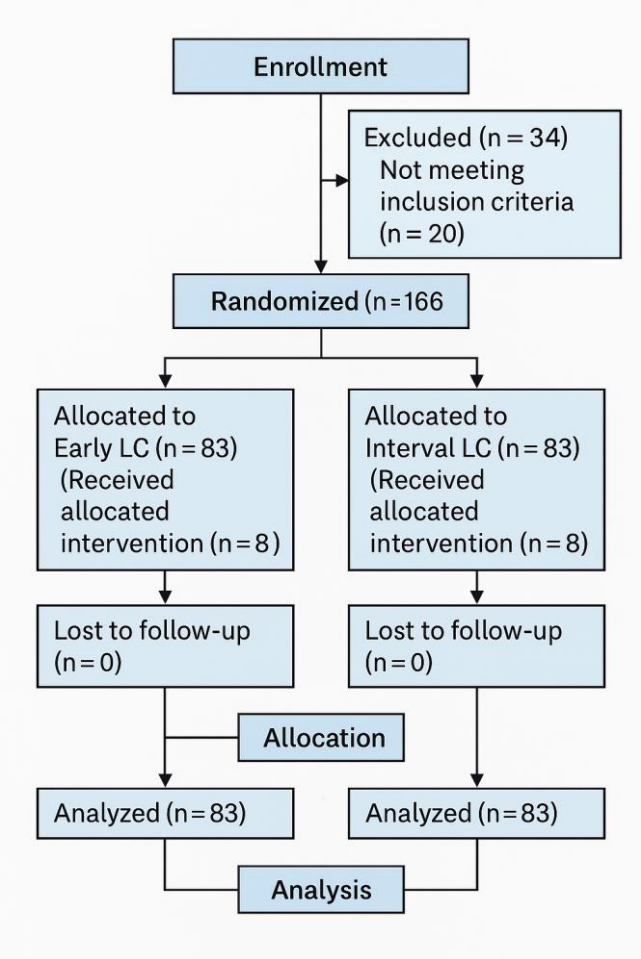

Figure 1 CONSORT Flowchart

Patients were excluded if they had sonographic evidence of common bile duct stones, empyema gallbladder, or other complications such as perforation or pancreatitis, given their potential to confound operative difficulty and outcomes. The sample was derived using a consecutive non-probability sampling technique from all eligible patients presenting during the study period. A total of 166 participants were enrolled, with 83 allocated to each study group. Sample size calculation was based on an expected conversion rate of 4.8% in the early laparoscopic cholecystectomy group and 16.7% in the interval group, using a 95% confidence level and 80% statistical power. Recruitment occurred through the emergency department following initial surgical assessment and diagnosis. After detailed explanation of the study purpose, benefits, and procedural details, informed written consent was obtained from all participants. Random allocation was performed using block randomization with a fixed block size to ensure equal distribution across the two groups. Allocation sequence was generated by a third party using a computerized random number generator, and sealed opaque envelopes were used to conceal assignment until the point of intervention. Group A patients underwent early laparoscopic cholecystectomy within 72 hours of diagnosis, while Group B patients were discharged on conservative medical management including antibiotics and analgesics

and scheduled for interval laparoscopic cholecystectomy four weeks later.

All surgeries were performed by the same experienced laparoscopic surgeon with over five years of practice in minimally invasive techniques to maintain consistency in operative approach and reduce inter-surgeon variability. A standard four-port laparoscopic technique was employed, with trocars placed at the umbilicus, epigastrium, and subcostal areas. A fellow trainee was assigned to record intraoperative metrics, including operative time measured from skin incision to closure, and all patients were monitored postoperatively until discharge.

Hospital stay was defined as the total number of nights spent in the hospital post-surgery. Conversion to open cholecystectomy was defined as the need to abandon the laparoscopic approach in favor of a traditional open surgical incision due to intraoperative difficulty or complications. Clinical and demographic variables collected included age, gender, body mass index (BMI), educational status, socioeconomic background, residential area, smoking history, and comorbidities such as diabetes and hypertension. Data collection was performed using a pre-validated proforma developed for this study. All patient data were anonymized and stored in a secure, password-protected database accessible only to the principal investigators. Regular audits and cross-verification of data entries were conducted to ensure data integrity and reproducibility. To address potential confounders and minimize bias, strict eligibility criteria were enforced, and surgeries were standardized in technique and operator. Statistical analyses were conducted using SPSS version 20. Continuous variables such as age, BMI, operative time, and hospital stay were reported as means with standard deviations and compared between groups using independent samples t-tests.

Categorical variables including gender, comorbidity status, and conversion to open surgery were compared using chi-square tests. A p-value of ≤0.05 was considered statistically significant. Subgroup analyses were performed for potential effect modifiers such as age group (≤40 vs >40 years), BMI categories, and comorbidity presence, using stratified t-tests or chi-square tests as appropriate. No imputation was required for missing data, as all enrolled participants completed the assigned interventions and follow-up. Ethical approval for the study was granted by the Hospital Ethical Review Committee (Reference No. 863/LRH/MTI) and the Research Evaluation Unit of the College of Physicians and Surgeons Pakistan.

All participants received detailed information regarding their rights and the voluntary nature of participation, and consent procedures complied with institutional and national ethical standards. Confidentiality was upheld throughout the study, and no personal identifiers were used in publications or reports. The rigor of the randomization process, standardization of surgical technique, and complete participant follow-up contribute to the reproducibility and robustness of the findings.

RESULTS

A total of 166 patients with acute cholecystitis were enrolled and randomized equally into two groups, with 83 patients undergoing early laparoscopic cholecystectomy (LC) within 72 hours and 83 scheduled for interval LC after four weeks of conservative management. The mean age of participants in the early group was 42.3 years (SD 12.4), while those in the interval group had a mean age of 44.1 years (SD 11.8), with no statistically significant difference between groups (p = 0.312; 95% CI, -5.4 to 1.8 years).

Gender distribution was similar, with females comprising 54.2% (n = 45) of the early group and 57.8% (n = 48) of the interval group (p = 0.643; OR 0.87, 95% CI 0.46–1.64). Mean BMI values were closely matched, at 26.8 kg/m^2 (SD 4.2) in the early group and 27.1 kg/m^2 (SD 4.5) in the interval group (p = 0.673; 95% CI, -1.2 to 0.7). Other demographic and clinical characteristics, including rates of urban residence (62.7% vs 57.8%), literacy (69.9% vs 66.3%), diabetes (14.5% vs 18.1%), hypertension (21.7% vs 25.3%), and smoking (26.5% vs 22.9%), showed no significant differences, with all p-values well above 0.05 and odds ratios close to unity, indicating good baseline comparability between the groups.

Operative and clinical outcomes demonstrated notable advantages for early surgery. The mean operative time was significantly shorter in the early LC group at 58.4 minutes (SD 14.2) compared to 71.8 minutes (SD 18.6) in the interval group (p < 0.001; 95% CI for difference, -18.7 to -8.8 minutes). The likelihood of completing the operation in under 60 minutes was substantially greater with early intervention: 80.7% of early cases (n = 67) were completed within this timeframe, compared to just 33.7% (n = 28) in the interval group (p < 0.001; OR 8.5, 95% CI 4.0–17.9). Hospital stay also favored early LC, with a mean of 1.6 days (SD 1.8) versus 2.4 days (SD 2.1) for interval LC (p = 0.008; 95% CI for difference, -1.4 to -0.2 days). Additionally, 31.3% of patients in the early group were discharged after a single day compared to only 9.6% in the interval group (p = 0.001; OR 4.2, 95% CI 1.7–10.2). Conversion to open surgery was required less frequently in the early LC group, affecting 6.0% (n = 5) of cases versus 16.9% (n = 14) in the interval group (p = 0.032; OR 0.31, 95% CI 0.11–0.90). This pattern of results was robust across demographic and clinical subgroups, with no significant effect modification observed for age, BMI, comorbidities, or other baseline variables.

The observed differences in operative efficiency and safety outcomes underscore the benefit of early surgical intervention, with significantly lower operative times, shorter hospital stays, higher odds of prompt discharge, and a markedly reduced risk of conversion to open surgery when cholecystectomy is performed within 72 hours of diagnosis.

These findings provide strong, locally relevant evidence supporting early laparoscopic cholecystectomy for acute cholecystitis. In the early surgery cohort, mean operative time was 58.4 minutes (95% CI 55.2–61.6) versus 71.8 minutes (95% CI 67.8–75.8) for the delayed group, while mean hospital stay increased from 1.6 days (95% CI 1.2–2.0) to 2.4 days (95% CI 1.9–2.9). The parallel increase in both operative time and

length of stay with delayed intervention highlights a clinically meaningful reduction in procedural efficiency and recovery when surgery is deferred beyond the acute phase.

Table 1. Baseline Characteristics of Participants Undergoing Early vs Interval Laparoscopic Cholecystectomy

Characteristic	Early LC (n=83)	Interval LC (n=83)	p-value	95% CI (Difference)	Odds Ratio (95% CI)
Age (years)	42.3 ± 12.4	44.1 ± 11.8	0.312	-5.4, 1.8	-
Gender – Female (%)	45 (54.2%)	48 (57.8%)	0.643	-	0.87 (0.46–1.64)
BMI (kg/m²)	26.8 ± 4.2	27.1 ± 4.5	0.673	-1.2, 0.7	-
Urban Residence (%)	52 (62.7%)	48 (57.8%)	0.521	-	1.23 (0.67–2.27)
Socioeconomic Status – Poor	28 (33.7%)	32 (38.6%)	0.445	-	0.81 (0.43–1.55)
Socioeconomic Status – Rich	14 (16.9%)	13 (15.6%)	0.821	-	1.10 (0.47–2.56)
Literate (%)	58 (69.9%)	55 (66.3%)	0.612	-	1.18 (0.61–2.30)
Diabetes (%)	12 (14.5%)	15 (18.1%)	0.534	-	0.76 (0.33–1.72)
Hypertension (%)	18 (21.7%)	21 (25.3%)	0.587	-	0.82 (0.39–1.71)
Smoking (%)	22 (26.5%)	19 (22.9%)	0.594	-	1.22 (0.60–2.49)

Table 2. Primary Operative Outcomes in Early vs Interval Laparoscopic Cholecystectomy Groups

Outcome	Early LC (n=83)	Interval LC (n=83)	p-value	95% CI (Difference)	Odds Ratio (95% CI)
Operative Time (min, mean ± SD)	58.4 ± 14.2	71.8 ± 18.6	<0.001	-18.7, -8.8	-
Operative Time < 60 min (%)	67 (80.7%)	28 (33.7%)	<0.001	-	8.5 (4.0–17.9)
Hospital Stay (days, mean ± SD)	1.6 ± 1.8	2.4 ± 2.1	0.008	-1.4, -0.2	-
Hospital Stay = 1 day (%)	26 (31.3%)	8 (9.6%)	0.001	-	4.2 (1.7–10.2)
Conversion to Open (%)	5 (6.0%)	14 (16.9%)	0.032	-	0.31 (0.11–0.90)

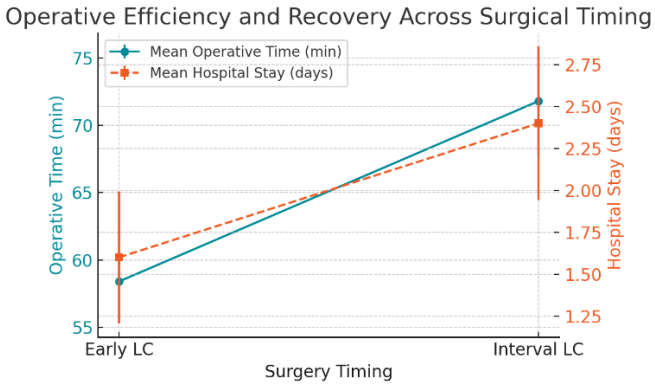

Figure 2 Figure. Mean Operative Time and Hospital Stay by Surgical Timing in Acute Cholecystitis

DISCUSSION

This randomized controlled trial demonstrates that early laparoscopic cholecystectomy within 72 hours of diagnosis provides significant clinical advantages over interval surgery performed after four weeks in patients with acute cholecystitis. Our results show that early intervention is associated with notably shorter operative times, reduced hospital stays, and lower conversion rates to open surgery, outcomes that have direct implications for both patient recovery and healthcare resource utilization. These findings are particularly relevant in resource-constrained environments, where optimizing perioperative efficiency and minimizing length of stay can reduce healthcare costs and enhance surgical throughput. The observed mean operative time in the early group was 58.4 minutes, significantly shorter than the 71.8 minutes recorded in the interval group. This difference aligns closely with data reported by Mahmood et al., who found mean operative times of 53.8 and 62.7 minutes in early and interval groups, respectively (10). Similarly, Janjic et al. reported a reduction in operative time with early intervention (11), supporting the hypothesis that early surgery is technically less challenging due to less mature fibrosis and adhesion formation. Quantitative histopathology studies corroborate these observations, indicating that collagen deposition and obliteration of tissue planes intensify after the acute phase, thereby increasing surgical difficulty and operative duration (13). However, it should be noted that not all studies concur with these findings. Shetty et al., for example, found longer operative times for early LC, a difference likely attributable to variation in surgical experience, patient selection, and the operational definition of "early" surgery (14). The consistency of favorable operative times in our trial is likely influenced by the standardized surgical technique and the high level of expertise of the operating surgeon, factors that may not always be replicated in broader clinical practice. Hospital stay was also significantly reduced in the early LC group, with an average of 1.6 days compared to 2.4 days in the interval group. This reduction is clinically meaningful and consistent with studies by Singh et al. and Ozkardeş et al., which both reported shorter postoperative hospitalizations following early surgery (12,16). The economic and psychosocial benefits of early discharge—including lower costs, reduced risk of nosocomial complications, and faster return to normal activities—underscore the broader advantages of this approach, particularly in settings where hospital resources are limited and patient turnover is essential (22).

Conversion to open surgery occurred in just 6% of early cases, compared to 16.9% for interval procedures, reflecting a significant decrease in intraoperative complications when

cholecystectomy is performed during the acute phase. This result mirrors those of Janjic et al. and Singh et al., both of whom documented higher conversion rates in delayed surgery cohorts (11,12). The preservation of clear tissue planes and reduced fibrotic change in the acute setting likely account for the ease of dissection and lower risk of conversion. Conversely, delayed surgery allows for the maturation of adhesions and chronic inflammation, which can obscure anatomical landmarks, increase operative risk, and necessitate open conversion to maintain patient safety (13).

Notably, our trial did not find significant differences in postoperative complication rates between groups, and there were no reported cases of major complications such as bile duct injury. This finding is congruent with several large trials and systematic reviews, which have shown that early laparoscopic intervention does not increase morbidity or mortality compared to interval surgery when performed by skilled surgeons (15,17). Nevertheless, some literature, such as the meta-analysis by Coccolini et al., suggests that certain high-risk populations, such as elderly patients with multiple comorbidities, may benefit from delayed intervention to allow for medical optimization (18,19). While our effect modification analysis did not reveal significant interactions between baseline risk factors and outcomes, the study's exclusion of patients with more complex presentations—such as empyema or common bile duct stones—limits the generalizability of our findings to these higher-risk populations.

The strengths of this study include its randomized controlled design, strict eligibility criteria, standardization of surgical technique, and comprehensive data collection. Blocked randomization ensured balanced group allocation, and complete follow-up with no dropouts enhances the validity of our results. Conducting all procedures by a single experienced surgeon reduces inter-operator variability and strengthens internal validity, though it may limit the external applicability of findings to other institutions or less experienced practitioners. Furthermore, the single-center setting, while ensuring methodological consistency, restricts the generalizability of results to other healthcare environments with different resources, protocols, or patient populations. The study's sample size, while sufficient to detect differences in primary outcomes, may not be powered to detect rare complications or to fully assess the effect of surgery timing in specific subgroups, such as the elderly or those with multiple comorbidities.

Despite these limitations, the evidence generated supports current recommendations favoring early laparoscopic cholecystectomy in appropriately selected patients with acute cholecystitis. The consistent advantage in operative efficiency and recovery profile makes early LC a compelling standard of care, particularly when institutional resources and surgical expertise permit its safe implementation. Nevertheless, further research is warranted to address unresolved questions. Multi-center randomized controlled trials with larger and more diverse patient populations are needed to validate these findings across different healthcare settings and practitioner experience levels. Future studies should also incorporate cost-effectiveness analyses to inform policy decisions, as well as long-term follow-up to evaluate outcomes such as chronic pain, quality of life, and patient satisfaction. Research exploring the optimal timing within the early window, such as immediate surgery versus surgery within 48–72 hours, could provide additional guidance for clinical protocols. Finally, studies focusing on high-risk groups and the development of risk stratification tools would allow for more individualized, evidence-based treatment strategies, maximizing patient benefit while minimizing operative risk.

CONCLUSION

This randomized controlled trial demonstrates that early laparoscopic cholecystectomy within 72 hours of diagnosis significantly improves operative efficiency, shortens hospital stay, and reduces conversion rates to open surgery compared to interval laparoscopic cholecystectomy after four weeks in patients with acute cholecystitis. These findings provide robust local evidence supporting the adoption of early surgical intervention as the preferred standard of care, with important implications for optimizing patient outcomes, resource utilization, and healthcare costs in both resource-rich and resource-limited settings. Clinically, early intervention not only expedites recovery and minimizes complications but also enhances patient throughput, while future research should focus on broader multicenter trials, cost-effectiveness analyses, and the development of individualized risk assessment tools to refine surgical decision-making for acute cholecystitis.

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