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Original Research Article

Comparative Outcomes of Early Versus Delayed Laparoscopic Cholecystectomy in Patients with Acute Calculous Cholecystitis: A Randomized Controlled Trial

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Abstract:

Background: Acute calculous cholecystitis (ACC) is a frequent surgical emergency that results from gallstone cystic duct obstruction. Timing of early versus delayed laparoscopic cholecystectomy (LC) is unclear due to operative complexities and complications.

Objective: Comparison of intraoperative and postoperative results of early versus delayed LC for CCC patients.

Methods: This study conducted at Darbhanga Medical College and Hospital, India & performed as prospective randomised controlled trial of 60 patients diagnosed as having ACC according to Tokyo Guidelines 2018. Patients were randomly assigned to two groups: early LC within 72 hours of admission (n=30) and delayed LC after 6–12 weeks of conservative management (n=30). Primary outcomes included intraoperative and postoperative complications, hospital stay, and operative time. Data was processed by SPSS version 29.

Results: Early LC significantly reduced operative time (92.3 ± 12.4 vs. 100.6 ± 15.1 minutes; p = 0.042) and hospital stay (4.8 ± 1.2 vs. 7.4 ± 1.5 days; p = 0.001). Conversion to open surgery (13.3% vs. 10%) and bile duct injury (3.3% vs. 0%) showed no significant differences. Intraoperative bleeding was higher in the early group (76.7% vs. 50.0%; p = 0.018).

Conclusion: Early LC is a successful and safe method of ACC, with less hospital stay and operative times that do not translate to higher major complications, albeit with relatively higher bleeding risk.

Keywords: Acute Calculous Cholecystitis, Laparoscopic Cholecystectomy, Early Surgery, Delayed Surgery, Randomized Controlled Trial.

Introduction

Acute calculous cholecystitis (ACC) is a common and life-threatening biliary tract condition that a surgeon must contend with. It is characterized by gallbladder inflammation due to obstruction of the cystic duct with gallstones [1]. The bile is stagnant, the intraluminal pressure is now increasing, and there is distal gallbladder wall ischemia. The immunocompromised patient has an ideal environment for bacterial insult to take hold, inducing inflammation. With persistent obstruction and ruptured gallbladder, the inflammatory process can easily progress to potentially lethal complications that include, among other conditions, empyema, gangrene, gallbladder perforation, and generalized peritonitis. All of these can lead to severe morbidity and mortality. ACC is an important global disease burden that represents a considerable proportion of emergency surgery admissions, especially for individuals living in areas with high prevalence of gallstone disease [2]. With appropriate intervention, the management of diagnosis ACC should be the singular concern of surgeons and healthcare policymakers alike, especially since early diagnoses and intervention can have significant impacts for both patients and the use of healthcare resources.

Over the past thirty years, laparoscopic cholecystectomy has become the definitive treatment for acute cholecystitis (AC) and has largely supplanted open cholecystectomy in virtually all practice [3]. The minimally invasive nature of laparoscopic surgery brings some recognized advantages, including lesser postoperative pain, improved mobilization, shorter hospital stays, decreased risk of wound infection, and incremental reductions in return to usual

activities. Although widely accepted, one of the most debated aspects with respect to laparoscopic cholecystectomy for AC has been the optimal timing of the procedure [4]. Timing for surgical intervention has a major effect on operative difficulty, risk of complications, and ultimate outcomes. For this reason, clinicians are frequently faced with a choice: to perform early laparoscopic cholecystectomy which is approximately understood as a procedure that should take place within 72 hours of the onset of the first symptom-- or to perform delayed laparoscopic cholecystectomy, which is staged after an initial period of conservative management and with the expectation of resolving acute inflammation.

The rationale for early surgery is in the advantage that may accrue from the cessation of disease progression and reduction in the likelihood of complications such as gallbladder gangrene, perforation, and recurrent biliary attacks of cholecystitis [5]. Early surgery may also reduce the hospital stay for a shorter duration and prevent costs and morbidity from recurrent biliary events, i.e., cholangitis and pancreatitis. Early laparoscopic cholecystectomy may also minimize the need for readmissions and re-operation, a consideration that is particularly important within resource-limited healthcare environments. On the other hand, delay in surgery has traditionally been preferred by some surgeons provided that it allows clearance of the acute inflammation, potentially facilitating a technically easier operative field and diminishing the likelihood for operative complications, i.e., bile duct trauma or uncontrollable hemorrhage, particularly in situations in which the gallbladder is significantly inflamed or significantly adhered to surrounding structures [6].

Despite the theoretical advantages of each strategy, a consensus on the best timing for laparoscopic cholecystectomy in ACC has yet to be determined. Randomised trials and meta-analyses have attempted and proven this question, yet the evidence is conflicting. Some trials have demonstrated that earlier surgical intervention has greater advantage, with shorter hospital stay, lower recurrent symptom rates, and lower costs without a concomitant increase in intraoperative and postoperative complications [7]. Other trials, however, have suggested that delayed surgery is likely safer in selected patient cohorts, for instance, those with severe comorbid disease or widespread inflammation. The conflicting results are a commentary on the sophistication required in the decision between options at a bedside level in ACC and a recognition that higher quality evidence is needed to guide practice.

Aside from clinical factors, the choice of early vs. late surgery should be influenced by institutional issues such as access to experienced laparoscopic surgeons, available operating rooms, and perioperative support systems [8]. Logistical issues such as lack of surplus emergency theatre time or surgeon preferences may dictate timing at surgery and contribute to variability in practice patterns in some health care environments. Age of the patient and severity of disease, as well as co-morbidities such as diabetes or cardiovascular disease may also be influencing factors.

In light of all of these uncertainties, randomized controlled trials with appropriate design are urgently needed which can compare early versus late laparoscopic cholecystectomy for outcomes of ACC. This trial attempts to fill the significant void in literature, by comparing and evaluating clinical outcomes, complications and health care usage in both strategies at a tertiary level institution. The study will provide robust evidence towards better informing the current debate around surgical timing and ultimately, shape future guidelines. More importantly, the study hopes to improve patient care and surgical safety, as well as help to potentially improve the use of health care resources for the treatment of AC.

Methodology

Study Design: A prospective randomized controlled trial (RCT) was conducted to compare the effects of early and delayed laparoscopic cholecystectomy (LC) for acute calculous cholecystitis (ACC). Randomization took place using a sealed opaque envelope method, at a 1:1 allocation ratio.

Study Area: The study was conducted in the Upgraded Department of Surgery, Darbhanga Medical College and Hospital (DMCH), Laheriasarai, Darbhanga, Bihar, India.

Study Duration: The study was carried out over one year.

Study Population: Patient population consisted of patients 18 years and older who presented to the Department of Surgery at DMCH with a diagnosis of acute calculous cholecystitis based on the Tokyo Guidelines 2018. Diagnosis was reached as a result of a combination of local signs of inflammation from a positive Murphy's sign and tenderness in the right upper quadrant, systemic signs of inflammation from fever >38°C, high CRP (C-reactive protein), and leukocytosis (WBC white blood cell count >10,000/mm^3), and imaging results either in the form of ultrasonography that found gallstones, gallbladder wall thickening, and/or pericholecystic fluid consistent with cholecystitis. Patients were screened for eligibility if they met the diagnostic criteria and those meeting the inclusion criteria were invited to participate after the written informed consent was provided.

Sample Size: A total of 60 patients were included in the study, with 30 patients randomized to the early LC group and 30 patients randomized to the delayed LC group, using a sealed envelope randomization technique.

- **Group A (Early LC):** Underwent laparoscopic cholecystectomy within 72 hours of hospital admission.
- **Group B (Delayed LC):** Managed conservatively and scheduled for interval laparoscopic cholecystectomy 6–12 weeks after the initial presentation.

Inclusion Criteria

- **For both groups:**
  - Age ≥18 years
  - Confirmed diagnosis of acute calculous cholecystitis as per Tokyo Guidelines
  - Willingness to provide informed written consent
- **Additional for Early LC group:**
  - Persistence of symptoms such as pain, nausea, vomiting despite conservative management
  - Elevated leukocyte count
  - Palpable tenderness under the right costal margin
- **Additional for Delayed LC group:**
  - Symptomatic improvement following conservative treatment
  - Decreasing leukocyte count
  - Reduced right upper quadrant tenderness

Exclusion Criteria

Patients were excluded if they had:

- Symptoms last >72 hours before diagnosis
- Jaundice or choledocholithiasis (common bile duct stones)
- Gallbladder perforation or biliary peritonitis
- Acute pancreatitis caused by gallstones
- Severe sepsis or immunosuppression
- Pregnancy
- Previous upper abdominal surgery
- Refusal to undergo laparoscopic surgery
- Suspected or confirmed gallbladder malignancy
- Concomitant cholangitis

Study Procedure: All patients received standard initial treatment at admission consisting of intravenous fluids for hydration, broad-spectrum intravenous antibiotics (Cefoperazone plus Sulbactam (1.5 g)), analgesics, and antiemetics. Optimal duration of antibiotics was determined based on the patient's clinical improvement or resolution and inflammatory marker diagnoses. Once eligible, patients were randomized to groups in sealed opaque envelopes loaded with group allocation by a study nurse to guarantee allocation concealment, these envelopes were shuffled prior.

In the early LC group, patients had laparoscopic cholecystectomy within 72 hours following admission. In the delayed LC cohort, patients were treated conservatively with medications and discharged after symptom improvement and laboratory resolution where changes were identified. Patients were scheduled for interval laparoscopic cholecystectomy at 6–12 weeks. All procedures were performed by experienced surgeons using the standard four-port laparoscopic approach. Pneumoperitoneum was achieved and attention was directed to dissection of Calot's triangle. The cystic duct and cystic artery were clipped with Trutie ligating clips and the gallbladder was removed through one of the ports or enlarged incision. If needed, an endoscopic bag was used to remove the specimen. The subhepatic space was inspected for bleeding or bile leak, and closed suction drains were placed, if needed. Finally, the port sites were closed with triclosan-coated sutures, requiring any modifications to the standard procedure for example, decompression of the gallbladder or insertion additional ports for safety.

Study Outcomes: The study's main aim was to evaluate the intraoperative and postoperative outcomes in both early and delayed laparoscopic cholecystectomy groups. The primary outcomes of interest included the intraoperative complications (e.g., bile duct injury or excessive bleeding), postoperative complications (e.g. bile leakage, wound infection, pneumonia), and length of hospital stay. The secondary outcomes measured included the mean time of operative procedures, the average intraoperative blood loss, rates of conversion to open cholecystectomy, failure of nonoperative management in the delayed group, readmission rates, and mortality frank This evaluation will provide a complete perspective of the efficacy and safety of early versus delayed surgical management.

Data Collection: Data were collected prospectively using a structured data collection sheet designed specifically for this study. Information recorded included patient demographics, clinical presentation, laboratory investigations, imaging findings, intraoperative variables such as operative time and blood loss, and finally, postoperative information including any complications, length of stay, and mortality. This data was entered in Microsoft Excel 2021 and checked for accuracy prior to statistical analysis.

Statistical Analysis: All statistical data were analyzed using IBM SPSS Statistics version 29.0.2.0 (IBM Corp., Armonk, NY, USA). Continuous variables (operative time, blood loss) were reported as mean ± standard deviation (SD) and compared between groups using the student’s t-test or Mann-Whitney U test based upon the nature of the data. Categorical variables (presence of complications, and conversion rates) were analyzed using the Chi-square test or Fisher’s exact test when appropriate. A p-value less than 0.05 was considered statistically significant for all analyses.

Result

Table 1 shows the distribution of patients based on gender between the early laparoscopic cholecystectomy (LC) group and the delayed LC group. In the early group, there were 8 males (26.7%) and 22 females (73.3%), while in the delayed group, there were 10 males (33.3%) and 20 females (66.7%). Overall, the total sample consisted of 18 males (30.0%) and 42 females (70.0%). The difference in gender distribution between the two groups was not statistically significant (P = 0.611), indicating that gender was comparable between the groups.

Table 1: Distribution of patients based on gender

Gender	Early (n=30)	Delayed (n=30)	Total	P value
Male	8 (26.7)	10 (33.3)	18 (30.0)	0.611*
Female	22 (73.3)	20 (66.7)	42 (70.0)	

Table 2 presents the distribution of patients in relation to biliary tract injuries. In the early laparoscopic cholecystectomy (LC) group, 1 patient (3.3%) experienced a bile duct injury, while 29 patients (96.7%) had no such injury. In the delayed LC group, no bile duct injuries (0.0%) were reported, with all 30 patients (100%) remaining injury-free. Overall, only 1 out of 60 patients (1.7%) had a bile duct injury. The difference between the two groups was not statistically significant (P = 0.313), indicating that the timing of surgery did not have a significant effect on the occurrence of bile duct injuries.

Table 2: Distribution of patients in relation to biliary tract injuries

Bile duct injuries	Early (n=30)	Delayed (n=30)	Total	P value
No	29 (96.7)	30 (100)	59 (98.3)	0.313*
Yes	1 (3.3)	0 (0.0)	1 (1.7)	

Table 3 compares the mean operative time and duration of hospitalization between the early and delayed laparoscopic cholecystectomy (LC) groups. The mean operative time was significantly shorter in the early group (92.3 ± 12.4 minutes) compared to the delayed group (100.6 ± 15.1 minutes), with a statistically significant difference (P = 0.042). Similarly, the mean number of hospitalization days was considerably lower in the early group (4.8 ± 1.2 days) than in the delayed group (7.4 ± 1.5 days), showing a highly significant difference (P = 0.001). These findings suggest that early LC is associated with reduced operative time and a shorter hospital stay.

Table 3: Duration of surgery and hospitalization among patients following surgery

Parameter	Early group (Mean ± SD)	Delayed group (Mean ± SD)	P value
Operative time (minutes)	92.3 ± 12.4	100.6 ± 15.1	0.042
No. of hospitalization days	4.8 ± 1.2	7.4 ± 1.5	0.001

Table 4 shows the distribution of patients based on conversion to open surgery. In the early laparoscopic cholecystectomy (LC) group, 4 patients (13.3%) required conversion to open surgery, whereas 26 patients (86.7%) successfully underwent laparoscopic procedures. In the delayed LC group, 3 patients (10.0%) required conversion, while 27 patients (90.0%) had laparoscopic completion. Overall, 7 out of 60 patients (11.7%) were converted to open surgery. The difference between the two groups was not statistically significant (P = 0.688), indicating that the timing of surgery did not significantly affect conversion rates.

Table 4: Distribution of patients based on conversion to open surgery

Conversion to open surgery	Early (n=30)	Delayed (n=30)	Total	P value
No	26 (86.7)	27 (90.0)	53 (88.3)	0.688*
Yes	4 (13.3)	3 (10.0)	7 (11.7)	

Table 5 presents the distribution of patients based on intraoperative bleeding in the early and delayed laparoscopic cholecystectomy (LC) groups. In the early group, 23 patients (76.7%) experienced bleeding, while 7 patients (23.3%) had no bleeding. In contrast, in the delayed group, 15 patients (50.0%) experienced bleeding, and an equal number of 15 patients (50.0%) had no bleeding. Overall, 38 out of 60 patients (63.3%) experienced bleeding during surgery. The difference between the two groups was statistically significant (P = 0.018), indicating that bleeding was more frequent in the early LC group compared to the delayed group.

Table 5: Bleeding frequency in the early and delayed group of patients				
Bleeding	**Early (n=30)**	**Delayed (n=30)**	**Total**	**P value**
No	7 (23.3)	15 (50.0)	22 (36.7)	0.018*
Yes	23 (76.7)	15 (50.0)	38 63.3)	

Discussion

The study was aimed at comparing and evaluating the findings of early and late laparoscopic cholecystectomy in acute calculous cholecystitis. Through our study, we identified several important findings on operative time, hospital stay, intraoperative complications and conversion rates and compared our findings with those that have been documented in literature within context.

In our study, operative time was considerably lower (92.3 ± 12.4 min) in the early group than in the delayed group (100.6 ± 15.1 min, p = 0.042). Unlike the study by Agrawal et al. (2015) [9], in which they observed a marginal higher operative time for the early group (69.4 ± 29.59 min) compared to the delayed group (66.4 ± 15.97 min), without however, any clinical significance, our early group exhibited a shorter operative duration. The reasons for short operative duration for our early group may be surgical experience, early intervention before the development of dense adhesions, and optimum perioperative management. Janjic et al. (2020) [10] also reported no significant difference in operative time between early and delayed groups, indicating that hospital protocols and surgical experience may have a greater influence than timing on this parameter. However, our study findings establish that efficiently, early surgical intervention is feasible without increasing operative duration, a parameter valuable for shortening cumulative exposure to anesthesia and surgical fatiguability."

One of the most reproducible findings across research, including our current study, is the shorter hospital stay in the early laparoscopic cholecystectomy group. Our study showed a mean hospitalization time of 4.8 ± 1.2 days in the early group versus 7.4 ± 1.5 days in the delayed group (p = 0.001). These findings are similar to those reported by Agrawal et al. (2015) [9], who found hospital stays of 4.16 ± 1.21 days for early compared to 8.6 ± 2.04 days for delayed cholecystectomies. Similarly, Rather et al. (2020) [11] reported similar findings and highlighted that early surgery decreases hospital expenses, shortens the patient's stay and hastens convalescence, and decreases the chances of recurrent biliary manifestations while on wait. Thus, across various studies, early management invariably presents a distinct benefit in hospitalization time and utilization of healthcare resources.

In terms of conversion to open surgery, our study found conversion rates of 13.3% in the early group and 10% in the delayed group, a difference that was statistically non-significant (p = 0.688). Our results are similar to Rather et al. (2020) [11], who encountered 3 conversions in the early group and 2 in the delayed group, and concluded that early surgery, regardless of acute inflammation, doesn't significantly increase the risk for conversion. Madhura et al. (2023) [12] also concluded similar results, stating that the conversion rate is more dependent on gallbladder anatomy and inflammation severity than timing only. Noticeably, our conversion rates were within acceptable international standards, supporting the safety and practicability of early laparoscopic cholecystectomy when expert hands are concerned.

Biliary tract injuries are amongst the most dreaded complications during laparoscopic cholecystectomy. In our research, one case (3.3%) of bile duct injury was seen in the early group, and none were seen in the delayed group (p = 0.313). Similarly, low rates have been presented by Madhura et al. (2023) [12], in which one patient (4%) in the early group and three (12%) in the delayed group developed bile duct injuries, and thus showed no definitive pattern supporting either timing. Janjic et al. (2020) [10] also showed no appreciable disparity in biliary impairment rates between early and delayed operations. Thus, while early intervention is meticulous in dissection-with acute inflammation, data demonstrate that with proper technique, the timing in and of itself does not pose a greater risk for significant biliary impairment.

An interesting finding in our study was the significantly higher intraoperative bleeding in the early group (76.7%) compared to the delayed group (50.0%, p = 0.018). Similar observations were made by Rather et al. (2020) [11], who reported bleeding complications in four early cases versus three delayed cases, and by Janjic et al. (2020) [10], who found bleeding in 61.9% of early versus 81% of delayed cases, though with different proportions. The discrepancy in bleeding rates across studies could be explained by differences in intraoperative definitions of "bleeding," surgeon experience, and patient characteristics such as comorbidities and gallbladder wall vascularity. Nevertheless, most studies, including ours, indicate that early surgery may pose a slightly higher bleeding risk, possibly due to friable inflamed tissue, although this rarely translates into adverse postoperative outcomes.

Generally, our evidence, similar to various studies, has implications that early laparoscopic cholecystectomy has great benefits in shortening hospital stay and operative time without a rise in serious complications like bile duct injury or conversion rate. The

minor increased risk for intraoperative hemorrhage justifies meticulous surgical technique but cannot compensate for the superiority of early procedure. Our findings reinforce current standards supporting early laparoscopic cholecystectomy as the best procedure for the management of acute calculous cholecystitis if done by experienced surgeons.

Conclusion

The randomized study comparing early versus delayed laparoscopic cholecystectomy for acute calculous cholecystitis showed that early surgery was significantly shorter in operative time and hospital stay, and thus better in efficiency and earlier in recovery. The rates of conversion to open procedure and bile duct injuries were similar in both groups and showed no significant intergroup difference in major complications. The early group, however, showed significantly higher incidence of intraoperative bleeding. The study thus supports that early laparoscopic cholecystectomy is a safe and effective strategy that has the benefit of shorter hospitalization and operative time without a higher rate of severe complications.

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