

IMPACT OF DECISION-TO-OPERATING-ROOM DELAY ON SURGICAL OUTCOMES OF EARLY LAPAROSCOPIC CHOLECYSTECTOMY FOR ACUTE CALCULOUS CHOLECYSTITIS: A PROSPECTIVE ANALYTICAL STUDY

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ABSTRACT

Objective: To determine the impact of decision-to-operating-room (OR) delay (≤ 36 hours versus >36 hours) on total hospital length of stay, and to compare operative and postoperative outcomes, among adult patients undergoing early laparoscopic cholecystectomy for acute calculous cholecystitis.

Study Design: Prospective, analytical (observational) study.

Setting: Department of Surgery, Jinnah Postgraduate Medical Centre (JPMC), Karachi.

Period: November 2025 to February 2026.

Material & Methods: Fifty adult patients with Tokyo Guidelines 2018-defined acute calculous cholecystitis, severity grade I or II, planned for early laparoscopic cholecystectomy within the index admission, were enrolled by non-probability purposive sampling (25 per delay category). Clinical decision time and operating-room entry time were recorded prospectively; their difference defined the decision-to-OR delay, dichotomised at 36 hours. Baseline, operative and 30-day outcomes were compared between groups using the independent-samples t-test/Mann-Whitney U test, Chi-square/Fisher's exact test, Spearman correlation and multivariable linear regression, using SPSS version 26.

Results: The ≤ 36 -hour ($n=25$) and >36 -hour ($n=25$) groups were comparable at baseline. Total hospital stay was significantly longer with prolonged delay (113.8 ± 21.6 vs 78.9 ± 16.0 hours; mean difference 34.9 hours, 95% CI 24.1-45.8; $p<0.001$), an association that remained significant after adjustment for age, Tokyo grade, symptom duration, diabetes and ASA class (42.4% longer stay, 95% CI 25.9-61.0%; $p<0.001$). Operative duration, Nassar operative difficulty grade, bailout procedures, conversion and complication rates did not differ significantly between groups. No readmission, reintervention or death occurred in either group.

Conclusion: A decision-to-operating-room delay of more than 36 hours independently prolongs total hospital stay after early laparoscopic cholecystectomy for acute calculous cholecystitis, without measurably worsening operative difficulty or complication rates, supporting theatre-access prioritisation as a modifiable target for reducing bed occupancy.

KEYWORDS: Acute Calculous Cholecystitis, Decision-to-Operating-Room Delay, Early Laparoscopic Cholecystectomy, Length of Hospital Stay, Nassar Operative Difficulty Grade.

INTRODUCTION

Acute calculous cholecystitis is one of the commonest surgical emergencies encountered in general surgical practice, arising from persistent cystic-duct obstruction, gallbladder distension, inflammation and secondary infection.¹ The World Society of Emergency Surgery (WSES) guidance recommends laparoscopic cholecystectomy for suitable patients and defines early surgery as being performed within seven days of hospital admission and within ten days of symptom onset, while the Tokyo Guidelines 2018 (TG18) combine local inflammatory signs, systemic inflammatory response and imaging findings to establish the diagnosis and grade perioperative risk.¹⁻³ Even within this broadly defined "early" window, however, limited operating-room capacity frequently produces an additional, potentially modifiable interval between the clinical decision to operate and the patient's actual entry into the operating room.

Several recent studies have shown that this in-hospital waiting interval, distinct from delay measured from symptom onset or admission, has a measurable effect on outcomes. In a multicentre prospective observational study of 1,117 patients, intraoperative complications increased from 2.8% when surgery occurred within three days of admission to 7.9% when performed at 8-10 days, with a parallel rise in subtotal cholecystectomy rates.⁴ Bressan et al. similarly reported that preoperative waiting time independently predicted a longer hospital stay after

laparoscopic cholecystectomy in an acute-care surgical cohort (median stay 5 versus 9 days for early versus delayed urgent surgery).⁵ A recent meta-analysis of 21 randomised controlled trials confirmed that early laparoscopic cholecystectomy shortens total hospital stay by approximately 3.5 days compared with delayed surgery, without a significant increase in bile-duct injury, conversion or overall complications.⁶ Local Pakistani data corroborate this pattern: a retrospective cohort from a tertiary centre found significantly fewer operative complications with early cholecystectomy (12% versus 34% with an interval approach), while gallbladder wall thickening beyond 7 mm was strongly associated with prolonged operative time and open conversion in another Pakistani series.^{7,8} A regional Australian cohort study has further highlighted that post-decision theatre delay, driven by capacity constraints rather than clinical necessity, is an increasingly common and largely modifiable contributor to prolonged admissions.⁹

Despite this evidence, most published data quantify delay from symptom onset or hospital admission rather than from the point at which a fully assessed, optimised patient is formally listed for surgery — the interval most directly under a hospital's operational control. This distinction is particularly relevant at Jinnah Postgraduate Medical Centre (JPMC), a high-volume tertiary-care hospital in Karachi, where competing emergency-theatre priorities, anaesthesia readiness and bed availability may prolong an already-indicated operation. The present study was therefore designed to prospectively determine the impact of decision-to-operating-room delay, dichotomised at 36 hours following the closest comparable parent study, on total hospital length of stay, and to compare operative duration, operative difficulty, bailout and conversion rates, and 30-day complications between patients experiencing a delay of 36 hours or less and those experiencing a delay of more than 36 hours, among adults undergoing early laparoscopic cholecystectomy for acute calculous cholecystitis.

MATERIAL & METHODS

Study Design: Prospective, analytical (observational) study.

Settings: Department of Surgery, Jinnah Postgraduate Medical Centre (JPMC), Karachi.

Duration: November 2025 to February 2026, following approval of the study synopsis by the ethical approval by the Institutional Review Board (IRB), JPMC.

Sample Size: Calculated using the WHO formula for comparison of two independent means, based on the parent study by Bhandari et al., which reported a mean total hospital stay of 83.3 hours in the no-delay group (<36 hours) and 152 hours in the delayed group (>36 hours), with a pooled standard deviation of 79.8 hours.¹⁰ At 95% confidence and 80% power, with an expected mean difference of 68.7 hours, a minimum of 22 patients per group was calculated; after adding 10% for incomplete records or loss to 30-day follow-up, the final sample size was fixed at 50 patients (25 per delay category).

Sampling Technique: Non-probability purposive sampling; consecutive eligible patients were enrolled until at least 25 observations were available in each prespecified delay category.

Inclusion Criteria: Patients of either gender, aged 18 years or older, with a definite diagnosis of acute calculous cholecystitis per TG18, Tokyo severity grade I or II, considered suitable for early laparoscopic cholecystectomy by the treating surgical and anaesthesia teams, with ASA physical status I-III, planned for surgery within seven days of admission and ten days of symptom onset during the index admission, and providing written informed consent with availability for 30-day follow-up.

Exclusion Criteria: Tokyo grade III cholecystitis with organ dysfunction, acalculous cholecystitis, suspected gallbladder malignancy, gallstone pancreatitis, concurrent cholangitis, confirmed common bile-duct stone requiring preoperative ERCP, previous percutaneous cholecystostomy for the current episode, previous major upper-abdominal surgery, pregnancy/lactation, conversion to an elective/interval strategy before an operating-room decision was documented, or refusal of consent.

Data Collection Procedure: After REU and IRB clearance, eligible patients were approached and written informed consent obtained; participation did not influence clinical priority or management. Clinical decision time was recorded from the signed consultant/senior surgical team note and emergency theatre booking, and operating-room entry time from the operating-room/anaesthesia record; their difference constituted the decision-to-OR delay in hours, analysed both continuously and dichotomised as ≤ 36 hours (short delay) versus > 36 hours (prolonged delay). Baseline demographic, clinical, biochemical and ultrasonographic variables, intraoperative findings (Nassar operative difficulty grade, critical view of safety, operative duration, estimated blood loss, procedure performed, intraoperative complications) and postoperative outcomes (postoperative stay, total hospital stay, 30-day complications graded by Clavien-Dindo classification, readmission, reintervention and mortality) were recorded on a structured proforma by an investigator unaware of the study hypothesis where practicable.

Data/Statistical Analysis: Data were entered and analysed using IBM SPSS Statistics version 26. Normality of quantitative variables was assessed using the Shapiro-Wilk test. Normally distributed continuous variables were compared between delay groups using the independent-samples t-test and reported as mean $\pm$ standard deviation; non-normally distributed variables were compared using the Mann-Whitney U test and reported as median (interquartile range). Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate, and risk ratios with 95% confidence intervals were calculated. Spearman correlation assessed the relationship of delay (hours) with operative duration and total hospital stay. A multivariable linear regression, using log-transformed total hospital stay as the dependent variable, estimated the adjusted association between

delay category and total stay, controlling a priori for age, Tokyo grade, symptom duration, diabetes and ASA class. A two-tailed p-value ≤ 0.05 was considered statistically significant.

Ethical Approval: The study was approved by the Institutional Review Board, JPMC, prior to patient enrolment; written informed consent was obtained from all participants.

RESULTS

Fifty patients were enrolled, 25 with a decision-to-OR delay of 36 hours or less and 25 with a delay exceeding 36 hours. The two groups were comparable for age, body mass index, gender distribution, diabetes, hypertension, ASA class, Tokyo severity grade, symptom duration and inflammatory markers (all $p > 0.05$), confirming adequate baseline balance for outcome comparison (Table-I).

Total hospital length of stay, the primary outcome, was significantly longer in the prolonged-delay group than the short-delay group (113.8 $\pm$ 21.6 vs 78.9 $\pm$ 16.0 hours; mean difference 34.9 hours, 95% CI 24.1 to 45.8 hours; independent-samples t-test, $t=6.50$, $p < 0.001$) (Table-II). A non-parametric sensitivity analysis using the Hodges-Lehmann estimator gave a concordant median difference of 36.2 hours. Spearman correlation showed a strong positive relationship between delay in hours and total hospital stay ($\rho=0.81$, $p < 0.001$), but no meaningful correlation between delay and operative duration ($\rho=0.07$, $p=0.655$), indicating that the excess stay associated with delay was not mediated through greater intraoperative difficulty.

Operative duration (83.3 $\pm$ 19.5 vs 91.8 $\pm$ 25.4 minutes, $p=0.192$) and Nassar operative difficulty grade (median grade II in both groups, Mann-Whitney $U=347.0$, $p=0.474$) did not differ significantly between groups (Table-III). Categorical secondary outcomes — difficult laparoscopic cholecystectomy (Nassar III-V), bailout procedures, conversion to open surgery, intraoperative complications and clinically significant postoperative complications (Clavien-Dindo $\geq$ II) — likewise showed no statistically significant between-group difference, although postoperative complications were numerically more frequent with prolonged delay (16.0% vs 4.0%; risk ratio 4.00, 95% CI 0.51-31.19; Fisher's exact $p=0.349$) (Table-IV). No readmission, reintervention or death occurred in either group within 30 days.

On multivariable linear regression of log-transformed total hospital stay, decision-to-OR delay of more than 36 hours remained an independent predictor of longer stay after adjustment for age, Tokyo grade, symptom duration, diabetes and ASA class ($B=0.353$, 95% CI 0.230-0.476, $p < 0.001$), corresponding to a 42.4% longer total hospital stay (95% CI 25.9-61.0%) in the prolonged-delay group. None of the adjusted covariates was independently significant (Table-V). The overall model was statistically significant ($F(6,43)=7.24$, $p < 0.001$, $R^2=0.502$).

Table-I: Baseline and clinical characteristics by decision-to-OR delay category (n=50)

Variable	$\leq 36h$ (n=25)	$> 36h$ (n=25)	Test statistic	p-value
Age, years (mean $\pm$ SD)	50.4 $\pm$ 14.5	42.6 $\pm$ 13.7	$t=1.95$, $df=47.8$	0.057
BMI, kg/m ² (mean $\pm$ SD)	28.5 $\pm$ 4.7	26.5 $\pm$ 3.9	$t=1.57$, $df=46.4$	0.124
Symptom duration, h, median (IQR)	35.0 (21.0-66.0)	46.0 (32.0-64.0)	MWU=268.0	0.393
WBC, $\times 10^9/L$, median (IQR)	12.4 (11.6-14.9)	13.2 (11.2-14.8)	MWU=319.0	0.907
CRP, mg/L, median (IQR)	50.0 (35.0-77.0)	64.0 (39.0-99.0)	MWU=274.5	0.467
GB wall thickness, mm (mean $\pm$ SD)	5.9 $\pm$ 1.0	5.5 $\pm$ 1.1	$t=1.32$, $df=47.8$	0.194
Gender, female, n (%)	14 (56.0)	18 (72.0)	$\chi^2=1.39$	0.239
Diabetes, n (%)	6 (24.0)	5 (20.0)	$\chi^2=0.12$	0.733
Hypertension, n (%)	7 (28.0)	9 (36.0)	$\chi^2=0.37$	0.544
ASA class I/II/III, n	5/16/4	7/16/2	$\chi^2=1.00$	0.607
Tokyo grade I/II, n	19/6	19/6	$\chi^2=0.00$	1.000

Table-II: Primary outcome — total hospital length of stay by delay category

Outcome	$\leq 36h$ (n=25)	$> 36h$ (n=25)	Mean difference (95% CI)	p-value
Total hospital stay, hours (mean $\pm$ SD)	78.9 $\pm$ 16.0	113.8 $\pm$ 21.6	34.9 (24.1 to 45.8)	< 0.001

Table-III: Secondary continuous outcomes — operative duration and Nassar grade

Variable	$\leq 36h$ (n=25)	$> 36h$ (n=25)	Test statistic	p-value
Operative duration, min (mean $\pm$ SD)	83.3 $\pm$ 19.5	91.8 $\pm$ 25.4	$t=1.32$, $df=44.9$	0.192
Nassar grade, median	II	II	MWU=347.0	0.474

Table-IV: Categorical operative and postoperative outcomes by delay category

Outcome	≤36h, n(%)	>36h, n(%)	RR (>36h vs ≤36h, 95% CI)	p-value
Difficult LC (Nassar III-V)	10 (40.0)	8 (32.0)	0.80 (0.44-1.46)	0.556
Bailout procedure	1 (4.0)	2 (8.0)	2.00 (0.21-19.42)	1.000*
Conversion to open surgery	1 (4.0)	0 (0.0)	not estimable	1.000*
Intraoperative complication	1 (4.0)	1 (4.0)	1.00 (0.07-14.31)	1.000*
Postop. complication (CD≥II)	1 (4.0)	4 (16.0)	4.00 (0.51-31.19)	0.349*
30-day readmission	0 (0.0)	0 (0.0)	no events	—
30-day reintervention	0 (0.0)	0 (0.0)	no events	—
30-day mortality	0 (0.0)	0 (0.0)	no events	—

*Fisher's exact test. LC = laparoscopic cholecystectomy; CD = Clavien-Dindo grade; RR = risk ratio.

Table-V: Multivariable linear regression for log-transformed total hospital stay

Predictor	B (log scale)	95% CI	p-value
Decision-to-OR delay >36h (vs ≤36h)	0.353	0.230 to 0.476	<0.001
Age (years)	-0.002	-0.007 to 0.003	0.359
Tokyo grade (II vs I)	0.035	-0.113 to 0.184	0.634
Symptom duration (hours)	0.000	-0.003 to 0.003	0.887
Diabetes (yes vs no)	-0.094	-0.253 to 0.065	0.242
ASA class	0.032	-0.090 to 0.154	0.598

Model: $F(6,43)=7.24$, $p<0.001$, $R^2=0.502$, adjusted $R^2=0.433$.

DISCUSSION

In this prospective analytical study of 50 patients undergoing early laparoscopic cholecystectomy for acute calculous cholecystitis at JPMC, a decision-to-operating-room delay exceeding 36 hours was independently associated with a significantly longer total hospital stay, even after adjustment for age, Tokyo severity grade, symptom duration, diabetes and ASA class. This finding is consistent with the parent study by Bhandari et al., who first described the 36-hour threshold and reported a comparable, if numerically larger, difference in stay between no-delay and delayed groups.¹⁰ It also aligns with the landmark analysis by Zafar et al. of 95,523 patients, who found that outcomes were best when surgery occurred within two days of presentation and progressively worsened with later operation, and with the more recent multicentre and randomised-trial evidence of Fugazzola et al., Bressan et al., Khan et al. and the meta-analysis of randomised trials by Borzellino et al., all of which link earlier surgical timing to shorter hospitalisation.^{4-6,11,12} Unlike most of this literature, however, the present study measured delay from the point of clinical decision rather than from symptom onset or hospital admission, isolating specifically the theatre-access-related component of delay that is most directly modifiable by hospital operational policy.

Operative duration and Nassar operative difficulty grade did not differ significantly between the short- and prolonged-delay groups, and delay in hours showed no meaningful correlation with operative duration. This suggests that, within the 36-hour and mildly prolonged windows observed in this cohort, waiting for theatre access did not translate into a technically more difficult operation, in contrast to reports in which longer waiting from symptom onset produces oedematous, densely adherent gallbladders.^{4,7} The Nassar grading scale used here, validated by Griffiths et al. as a reproducible measure of intraoperative difficulty, showed a similar distribution in both groups (median grade II), and rates of difficult cholecystectomy, bailout procedures and conversion to open surgery were statistically comparable, echoing the Pakistani cohort of Raja et al., in which delay-related complications were driven more by gallbladder contraction over prolonged waiting periods than by short in-hospital theatre delay.^{7,13}

Postoperative complications (Clavien-Dindo grade ≥II) were numerically four-fold more frequent with prolonged delay (16.0% vs 4.0%), consistent with the direction, though not the statistical significance, of findings by Iftikhar et al. and Mansor et al., both of whom reported higher complication rates with delayed intervention.^{14,15} The absence of statistical significance here most likely reflects the modest sample size and the low absolute event rate rather than a true absence of clinical effect. Conversion to open surgery occurred in only one patient overall, in keeping with contemporary conversion rates of 3-6% reported in recent systematic reviews and single-centre series, in which male gender, longer symptom duration, gallbladder wall thickening and elevated white-cell count

— rather than in-hospital theatre delay per se — were the dominant predictors.^{16,17} No readmission, reintervention or death occurred in either group, limiting the ability to draw firm conclusions about these rarer outcomes. The strong correlation between decision-to-OR delay and total hospital stay ($\rho=0.81$), together with the absence of a corresponding correlation with operative duration, supports the interpretation that prolonged in-hospital waiting itself — rather than any downstream intraoperative difficulty — is the principal driver of extended admission. This has direct service-planning implications: as highlighted by Kalra et al. in a regional Australian cohort and by Vidal and Neychev in their commentary on contemporary emergency cholecystitis management guidelines, decision-to-theatre delay is increasingly recognised as a capacity-driven, largely modifiable bottleneck rather than a clinically necessary interval, and dedicated emergency theatre prioritisation for early cholecystectomy may reduce avoidable bed occupancy without compromising operative safety.^{9,18} These findings support incorporating a decision-to-OR delay target, rather than symptom-to-admission delay alone, into local care pathways at JPMC and similar high-volume tertiary centres.

This study has several limitations. It was conducted at a single tertiary-care centre using non-probability purposive sampling, which may limit generalisability to other settings with different theatre capacity or case-mix. The sample size, though adequately powered for the primary outcome based on the parent study, was too small to detect plausible but modest differences in infrequent secondary outcomes such as postoperative complications, conversion and bailout procedures, and no events of readmission, reintervention or mortality were observed in either group, precluding meaningful between-group comparison for these outcomes. The four-month recruitment window did not allow analysis of seasonal variation in theatre capacity, and the dichotomisation of delay at 36 hours, while consistent with the parent study, may not represent the only clinically meaningful threshold. Larger, multicentre prospective studies with longer follow-up are recommended to confirm these findings and to better power the analysis of postoperative morbidity.

CONCLUSION

A decision-to-operating-room delay exceeding 36 hours independently and significantly prolongs total hospital stay after early laparoscopic cholecystectomy for acute calculous cholecystitis, without a measurable increase in operative difficulty, conversion or complications in this cohort. Prioritising timely theatre access after the decision to operate may reduce avoidable hospital stay in patients with acute calculous cholecystitis.

CONFLICT OF INTEREST / DISCLOSURE

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

#	Author	Contribution
1	[Author Name]	Conception, data collection, manuscript drafting.
2	[Co-Author Name]	Data analysis, statistical interpretation.
3	[Senior Author / Supervisor Name]	Study supervision, critical revision, final approval.