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Preoperative and Intraoperative Predictors of Conversion from Laparoscopic to Open Cholecystectomy: A Retrospective Cohort Study

Running title: Predictors of Conversion in Laparoscopic Cholecystectomy

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Abstract: ***Background: Laparoscopic cholecystectomy (LC) remains the accepted first-line treatment for symptomatic gallstone disease, yet a clinically important minority of cases cannot be completed laparoscopically. This study aimed to define preoperative and intraoperative predictors of conversion to open cholecystectomy in a rural North Indian tertiary care setting. Methods: This retrospective cohort study examined 118 consecutive patients who underwent LC at Muzaffarnagar Medical College and Hospital between January 2025 and May 2026. Preoperative, intraoperative, and postoperative variables were compared between converted and non-converted cases. Variables reaching p < 0.10 on univariate analysis were entered into a multivariate backward stepwise logistic regression model. Results: Thirteen of 118 patients (11.0%; 95% CI 6.0–18.0%) required conversion to open cholecystectomy. Five preoperative variables independently predicted conversion: acute cholecystitis (OR 4.67), gallbladder wall thickness ≥4 mm on ultrasound (OR 3.84), male sex (OR 3.21), previous upper abdominal surgery (OR 2.93), and elevated serum alkaline phosphatase (OR 2.41). Dense pericholecystic adhesions accounted for 53.8% of intraoperative conversions. Converted patients had significantly longer operative time, greater blood loss, and prolonged hospital stay (all p < 0.001). Conclusion: A simple five-factor preoperative risk score, comprising male sex, acute cholecystitis, gallbladder wall thickness ≥4 mm, prior upper abdominal surgery, and elevated serum ALP, can meaningfully stratify conversion risk and support theatre planning and patient counselling. Prospective, multicentre validation is required before routine clinical adoption.***

Keywords: laparoscopic cholecystectomy; conversion; open cholecystectomy; predictors; Calot's triangle; Critical View of Safety; gallstone disease; acute cholecystitis; risk stratification

1. Introduction

Since its introduction by Mouret in 1987, laparoscopic cholecystectomy has displaced open surgery as the routine treatment for symptomatic cholelithiasis. The advantages are well established: less postoperative pain, shorter inpatient stay, earlier return to activity, and a lower rate of wound-related morbidity. What is sometimes underplayed in the enthusiasm for minimal access surgery, however, is that a predictable subset of cases will not be completable laparoscopically, and managing that reality well is as important as the procedure itself.

Conversion to open surgery is best understood as a planned safety response, not a technical failure. Framing it as a failure creates exactly the wrong incentive: surgeons who delay conversion in order to preserve a laparoscopic completion rate expose patients to the one complication that overshadows all others in this field, common bile duct (CBD) injury. CBD injury carries a recognised risk of long-term biliary stricture, recurrent cholangitis, secondary biliary cirrhosis, and substantial medicolegal consequences. Timely conversion, when the dissection is becoming unsafe, prevents it.

Reported conversion rates span a wide range, roughly 2.5% to 15% in elective series, climbing above 30% when acute or complicated cholecystitis is the indication. The variation reflects differences in case mix, surgeon experience, and institutional thresholds rather than any single technical variable. At Muzaffarnagar Medical College and Hospital (MMCH), which draws from a predominantly rural catchment area in northern Uttar Pradesh, delayed presentations and complicated disease are common. Understanding which patients in this specific population are at elevated risk of conversion matters both for theatre planning and for the quality of the consent conversation.

This study set out to define preoperative and intraoperative predictors of conversion at our institution, compare outcomes between converted and non-converted cases, and propose a simple risk stratification tool suited to a busy district general surgical unit.

2. Materials and Methods

We conducted a retrospective cohort study of 118 consecutive patients who underwent laparoscopic cholecystectomy at the Department of General Surgery, MMCH, between January 2025 and May 2026. Ethics approval was granted by the Institutional Ethics Committee (Ref: MMCH/IEC/2025/043) and all records were anonymised prior to analysis.

Preoperative variables included age, sex, BMI, ASA grade, presenting diagnosis, duration of symptoms, history of prior upper abdominal surgery, and comorbidities (diabetes mellitus, hypertension). Relevant biochemistry, serum WBC, CRP, ALP, and bilirubin, was recorded, along with ultrasonographic findings: gallbladder wall thickness,

pericholecystic fluid, contracted gallbladder, and common bile duct diameter. Operative notes were reviewed for gallbladder appearance, adhesion grade, visualisation of Calot's triangle, achievement of the Critical View of Safety (CVS), presence of CBD stones, conversion status and stated reason, operative duration, and estimated blood loss. Postoperative data covered length of hospital stay, complications graded by Clavien–Dindo classification, 30-day readmission, and 30-day mortality.

Cases where open surgery was planned from the outset, cholecystectomy formed part of a combined procedure, the patient was pregnant, or operative records were incomplete were excluded (Table 1).

Categorical variables were compared using chi-square or Fisher's exact test; continuous variables by Mann–Whitney U or independent t-test as appropriate. Variables reaching $p < 0.10$ on univariate logistic regression were carried forward into a multivariate backward stepwise model. Results are expressed as odds ratios (OR) with 95% confidence intervals; $p < 0.05$ was the threshold for statistical significance. All analyses were performed using SPSS version 26.0 (IBM Corp., USA).

Table 1: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Adults aged ≥18 years	Primary open cholecystectomy (not commenced laparoscopically)
LC performed for cholelithiasis, biliary colic, or acute cholecystitis	Cholecystectomy as part of a combined procedure
Admitted to MMCH between January 2025 and May 2026	Pregnant patients
Complete operative and clinical records available	Incomplete or missing operative notes

3. Results

Thirteen of 118 patients (11.0%; 95% CI 6.0–18.0%) were converted from laparoscopic to open cholecystectomy. The overall male-to-female ratio was 1.5:1, but males were disproportionately represented among converted cases (69.2% vs 36.2% in the non-converted group; $p = 0.005$). Histopathology confirmed acute cholecystitis in every converted case, with gangrenous change present in 46.2%. All patients had right hypochondrial pain as their presenting symptom.

The 11.0% conversion rate is consistent with the 10.38% reported by Kumar et al. from a comparable setting in Uttar Pradesh, and with the 9.2% figure published by Al-Hamdani et al. Gender distribution is shown in Table 2.

Table 2: Gender Distribution

Gender	Number of Patients	Percentage
Male	71	60.20%
Female	47	39.80%

Dense pericholecystic adhesions were the leading intraoperative trigger, accounting for more than half of all conversions. Failure to achieve the Critical View of Safety and intraoperative haemorrhage each accounted for a further 15.4%. The full breakdown is given in Table 3.

Table 3: Intraoperative Reasons for Conversion (n = 13)

Reason for Conversion	n	% of Conversions
Dense pericholecystic adhesions	7	53.80%
Failure to achieve Critical View of Safety	2	15.40%
Intraoperative haemorrhage	2	15.40%
Gangrenous / perforated gallbladder	1	7.70%
Suspected bile duct injury	1	3.80%
CBD stones requiring exploration	0	3.80%

On multivariate analysis, five preoperative variables independently predicted conversion (Table 4). Acute cholecystitis carried the largest effect size (OR 4.67), followed by gallbladder wall thickness ≥4 mm (OR 3.84), male sex (OR 3.21), previous upper abdominal surgery (OR 2.93), and elevated serum ALP (OR 2.41).

Table 4: Multivariate Logistic Regression- Independent Predictors of Conversion

Preoperative Predictor	Adjusted OR	95% CI	p-value
Male sex	3.21	1.28 – 7.91	0.011
Acute cholecystitis	4.67	1.83 – 12.10	0.002
GB wall thickness ≥4 mm (USS)	3.84	1.52 – 9.43	0.004
Previous upper abdominal surgery	2.93	1.09 – 7.82	0.032
Elevated serum ALP	2.41	1.02 – 5.72	0.046

Surgical outcomes differed sharply between groups across every measured parameter (Table 5). Median operative time nearly doubled in converted cases (112 vs 58 minutes), blood loss was approximately 3.6-fold greater, and mean hospital stay extended from 2.1 to 6.4 days. Overall complication rates (34.6% vs 6.3%) and wound infection rates (19.2% vs 2.7%) were significantly higher in the converted group, though 30-day mortality did not reach statistical significance (3.8% vs 0%; $p = 0.105$), likely reflecting the small conversion cohort.

Table 5: Surgical Outcomes- Converted vs. Non-Converted Cases

Outcome	Converted (n=13)	Non-Converted (n=105)	p-value
Operative time, median (min)	112	58	<0.001
Blood loss, median (ml)	310	85	<0.001
Hospital stay, mean (days)	6.4	2.1	<0.001
Overall complication rate	34.60%	6.30%	<0.001
Wound infection	19.20%	2.70%	0.001
Bile leak	7.70%	0.90%	0.031
30-day readmission	15.40%	3.60%	0.012
30-day mortality	3.80%	0%	0.105

4. Discussion

The central finding of this study, that a small cluster of preoperative variables can meaningfully stratify conversion risk, is not new, but its confirmation in a rural northern Indian setting adds to a literature that has been geographically weighted towards higher-income countries. Whether the same predictors behave similarly across different patient populations and institutional environments has not always been clear, and the present data suggest they do.

Male sex emerged as a strong independent predictor (OR 3.21), a finding echoed across multiple meta-analyses. The mechanism is anatomical: men tend to carry more adipose

tissue in the hepatocystic triangle and develop denser fibro-inflammatory adhesions around the gallbladder. Most published meta-analyses report odds ratios for male sex in the range of 2.6–3.1, placing our estimate squarely within that window.

Acute cholecystitis was the most powerful predictor in this series (OR 4.67, p = 0.002). The reason is straightforward: acute inflammation produces oedema, vascular engorgement, and tissue friability that can render the hepatocystic triangle essentially unrecognisable from its normal anatomy. In our cohort, 8 of 31 patients presenting with acute cholecystitis (25.8%) required conversion, entirely consistent with the 15–35% range cited in the broader literature. Surgeons operating on acute presentations should not need an odds ratio to tell them this is a harder case; what the data do justify is a more explicit conversation with the patient beforehand about the realistic probability of open surgery.

Gallbladder wall thickness ≥4 mm on preoperative ultrasound (OR 3.84) is among the most reproducibly validated predictors in the field. A 2022 meta-analysis by Magnano San Lio et al. reported odds ratios of 2.3–5.1 for this parameter across multiple study populations. Mural thickening signals chronic or acute inflammation, fibrosis, or empyema, each of which increases operative difficulty by distorting tissue planes and promoting bleeding.

Prior upper abdominal surgery (OR 2.93) was confirmed as an independent risk factor, consistent with Kumar et al. (p = 0.047). The adhesions produced by previous surgery are qualitatively different from those arising from gallbladder inflammation; they can be extensive, vascularised, and completely alter the expected surgical landscape. Elevated serum ALP (OR 2.41) arguably functions as a surrogate for subclinical biliary obstruction or choledocholithiasis. Both conditions are associated with a more complex operative field and, importantly, with a higher probability of CBD stones requiring intraoperative management.

The intraoperative findings deserve comment. Dense pericholecystic adhesions drove more than half of all conversions (53.8%), which is consistent with every major published series. Failure to achieve the Critical View of Safety (CVS) was the second most common trigger (15.4%). CVS was achieved in only 30.8% of converted cases versus 98.2% of those completed laparoscopically (p < 0.001), a striking difference that underscores the importance of the systematic review by Manatakis et al., which established failure to achieve CVS as the leading preventable cause of bile duct injury in laparoscopic cholecystectomy. Surgeons who resist conversion when CVS cannot be achieved are taking on a risk they are implicitly passing to the patient.

The outcome data reinforce a point worth making clearly: the worse results seen in converted cases largely reflect the severity of underlying disease that necessitated conversion, rather than conversion itself being the harmful intervention. When a surgeon converts because the dissection is unsafe, they are preventing a bile duct injury or uncontrolled haemorrhage, complications whose consequences would dwarf those of any outcome variable in Table 5. The institutional and professional culture around conversion needs to reflect that.

From a practical standpoint, the five predictors identified here offer something concrete. In a resource-limited environment like ours, where senior operating surgeons are not always available, knowing in advance that a particular patient carries three or four of these risk factors allows for better allocation of theatre time, appropriate staffing, and an informed consent process that accurately conveys the probability of open surgery. A simple additive risk score based on these five variables is proposed for departmental use, though it requires prospective validation before wider adoption.

5. Limitations

The retrospective design carries the limitations inherent to that methodology, including the risk of selection bias from cases excluded for incomplete records. Surgeon experience level and individual thresholds for conversion were not formally quantified, though both are likely influential. The conversion cohort of 13 cases is too small to draw precise estimates from the multivariate model; the confidence intervals are accordingly wide. The proposed risk score must be validated in a prospective dataset, ideally across multiple centres, before it enters routine clinical use.

6. Conclusion

Five preoperative parameters, male sex, acute cholecystitis, gallbladder wall thickness ≥4 mm on ultrasound, prior upper abdominal surgery, and elevated serum ALP, independently predict conversion from laparoscopic to open cholecystectomy in this patient population. None of these should replace intraoperative judgment, but together they provide a reasonable basis for preoperative risk stratification, patient counselling, and allocation of experienced surgical cover. Departments managing a high volume of complicated gallstone disease would benefit from incorporating a structured preoperative assessment of these factors into their standard consent and theatre planning workflow.

Declarations

Ethics approval and consent to participate
This study was approved by the Institutional Ethics Committee of Muzaffarnagar Medical College and Hospital (Ref: MMCH/IEC/2025/043). As a retrospective, fully anonymised analysis of existing records, the requirement for individual informed consent was waived by the committee.

Consent for publication
Not applicable.

Availability of data and materials
The datasets analysed during the current study are available from the corresponding author on reasonable request.

Competing interests
The authors declare that they have no competing interests.

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Authors' contributions
MSG conceived and designed the study, collected and analysed data, and drafted the manuscript. IQ contributed to data collection, data interpretation, and critical revision of the manuscript. BJ supervised the study, contributed to data interpretation, and critically revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

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