

Clinical Predictors of Conversion from Laparoscopic to Open Cholecystectomy in Patients with Acute Cholecystitis

Swapnil Malji Mavchi¹, Varun Bharatbhai Panchal², Vaidehi Vasantbhai Rajkotiya³

¹Assistant Professor, Department of General Surgery, Baroda Medical College, Vadodara, Gujarat, India

²Tutor, Department of Pathology, Sardar Patel Medical College and Research Centre, Ahmedabad, Gujarat, India

³MBBS, Dr. N.D. Desai Faculty of Medical Science and Research, Gujarat, India

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Corresponding author: Dr. Vaidehi Vasantbhai Rajkotiya

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Abstract

Background: Laparoscopic to open cholecystectomy conversion is an important safety endpoint in acute cholecystitis due to the fact that the presence of severe inflammation, distorted anatomy, and delayed presentation can make safe dissection challenging.

Objectives: To determine the preoperative clinical, laboratory and ultrasonographic parameters that are associated with conversion to open cholecystectomy in patients undergoing early laparoscopic cholecystectomy for acute cholecystitis.

Methods: A prospective observational study was conducted of 286 adults with acute calculous cholecystitis who were attempted for laparoscopic cholecystectomy. Demographic data, comorbidities, symptom duration, inflammatory markers, liver function tests, ultrasonographic data and severity grade (Tokyo) were recorded. Patients were divided into completed laparoscopy and converted to open surgery. Multivariable logistic regression was used to identify independent predictors.

Results: Laparoscopic cholecystectomy was successfully completed in 252 patients and 34 (11.9%) were converted. Converted patients were older (61.8 ± 12.6 vs 49.7 ± 14.2 years, $p < 0.001$), more often male (70.6% vs 47.6%, $p = 0.011$), and more frequently presented after 72 hours (67.6% vs 28.6%, $p < 0.001$). Mean C-reactive protein was higher in the conversion group (176.4 ± 82.1 vs 82.7 ± 61.5 mg/L, $p < 0.001$), and gallbladder wall thickness was greater (5.8 ± 1.4 vs 4.1 ± 1.2 mm, $p < 0.001$). Independent predictors were age ≥ 65 years (adjusted OR 2.37, 95% CI 1.05-5.36), symptom duration > 72 hours (OR 2.84, 95% CI 1.24-6.52), CRP ≥ 150 mg/L (OR 3.68, 95% CI 1.57-8.64), gallbladder wall thickness ≥ 5 mm (OR 3.11, 95% CI 1.34-7.22), and Tokyo Grade II/III disease (OR 4.42, 95% CI 1.72-11.36).

Conclusion: The risk of conversion can be predicted preoperatively based on a combination of age, delayed presentation, systemic inflammatory burden, gallbladder wall thickening and disease severity. Awareness of these factors can help with operative planning, involvement of senior surgeons and informed consent.

Keywords: Acute Cholecystitis; Laparoscopic Cholecystectomy; Conversion; C-Reactive Protein; Gallbladder Wall; Risk Prediction.

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Introduction

Acute calculous cholecystitis is one of the most frequently encountered emergency general surgical conditions and early laparoscopic cholecystectomy is the treatment of choice in the majority of patients who are operable. Modern management routes focus on early source control and the use of physiologic status, comorbidity and severity grading in the timing and site of surgery. Tokyo Guidelines 2018 is a widely used guideline for treatment selection, and it is recommended that experienced laparoscopic skills be used in technically difficult diseases [1]. The 2020 World

Society of Emergency Surgery guidelines also recommend laparoscopic cholecystectomy as the preferred method in appropriate patients and advise to take a safety-first approach to difficult anatomy, rather than continuing with risky dissection [2]. Even with advances in equipment, imaging and surgeon experience, conversion to open surgery is still required in a clinically significant minority of patients. Conversion is not a complication in itself, but may be a suitable intra-operative choice if the critical view of safety cannot be achieved due to severe inflammation, dense adhesions, bleeding or

inability to establish the critical view of safety. However, in most cases, conversion is linked to longer operating time, more postoperative pain, longer hospital stays, and higher resource utilization. In a recent systematic review and meta-analysis, older age, male sex, acute inflammation, diabetes, obesity, cardiovascular disease and previous upper abdominal surgery were found to be common risk factors before surgery [3].

The severity of inflammation of acute cholecystitis seems to be especially significant. Bouassida et al. showed that the severity grade in Tokyo was a strong predictor of conversion and was independent of other clinical parameters [4]. Wevers et al. determined that age and C-reactive protein (CRP) could be used together to stratify the risk of conversion in acute cholecystitis, further supporting the importance of objective inflammatory markers in the counselling of patients prior to surgery [5]. However, these conversion rates and predictors differ between institutions due to referral patterns, timing of surgery, surgeon experience and thresholds for bailout procedures.

The aim of the present study was to assess a set of clinical, laboratory and ultrasonographic parameters that can be obtained prior to surgery and to identify those that independently predict conversion from laparoscopic to open cholecystectomy in adults with acute cholecystitis. A secondary aim was to compare the perioperative results of patients who underwent laparoscopic surgery and those who were converted.

Materials and Methods

This was a prospective observational study in the Department of General Surgery for 18 months. Adults (18 years or older) with acute calculous cholecystitis diagnosed by compatible symptoms, inflammatory findings and ultrasonography were screened. Patients were included if laparoscopic cholecystectomy was chosen as the initial surgical procedure. Patients with gallbladder malignancy, concomitant common bile duct exploration requiring planned laparotomy, generalized peritonitis from another source, previous cholecystostomy with planned open operation and incomplete preoperative records were excluded. Baseline data were age, sex, body mass index (BMI), diabetes mellitus, hypertension, previous upper abdominal surgery, duration of symptoms, fever, and American Society of Anesthesiologists physical status. Hemoglobin, total leukocyte count, neutrophil percentage, CRP, serum albumin, total bilirubin, alanine aminotransferase, aspartate aminotransferase, and alkaline phosphatase were obtained by laboratory tests within 12 hours prior to surgery. Preoperative ultrasonography revealed gallstones, maximal gallbladder wall thickness, pericholecystic fluid, gallbladder distention, and

common bile duct diameter. Acute cholecystitis was classified as Grade I, II, or III based on the criteria from the Tokyo. The procedures were all performed laparoscopically, with the standard 4-port technique under general anesthesia. Pneumoperitoneum was created either by an open or closed technique as preferred by the surgeon. If necessary, adhesiolysis and decompression of a tense gall bladder were performed. The dissection was aimed at gaining the critical view of safety. Laparoscopic subtotal cholecystectomy was allowed as a bailout procedure if the anatomy was unfavourable. Conversion was considered an unplanned abdominal incision that was large enough to allow the main operative dissection to be completed by an open technique. The conversion was recorded as being due to dense inflammatory adhesions, unclear anatomy, bleeding, suspected bile duct injury, or other technical causes.

The main outcome was conversion to open cholecystectomy. Secondary outcomes were operative time, blood loss during surgery, postoperative complications, hospital stay, and 30-day readmission. Data were summarised as mean $\pm$ SD or median with interquartile range as appropriate for continuous variables and as frequency and percentage for categorical variables. Independent-samples t test or Mann-Whitney U test were used for continuous data, and chi-square or Fisher exact test were used for categorical data, between groups. Those variables that had a p value of <0.10 on univariable analysis and had clinically relevant covariates were included in multivariable logistic regression. Odds ratios (ORs) with 95% confidence intervals (CIs) were presented. The area under the receiver operating characteristic curve was used to evaluate the discrimination of the final model. A two-sided $p < 0.05$ was considered statistically significant.

Results

Of 301 patients screened, 286 met the eligibility criteria and underwent attempted laparoscopic cholecystectomy. The procedure was completed laparoscopically in 252 patients (88.1%), whereas 34 patients (11.9%) required conversion to an open operation. Baseline and preoperative characteristics are summarized in Table 1. The conversion group was older and contained a higher proportion of men. Diabetes, delayed presentation beyond 72 hours, and previous upper abdominal surgery were more frequent among converted cases. Inflammatory burden was greater in converted patients, reflected by higher leukocyte counts and substantially higher CRP values. Ultrasonography showed thicker gallbladder walls and more frequent pericholecystic fluid in the conversion group. Tokyo Grade II/III disease was present in 76.5% of converted patients compared with 34.5% of patients whose procedure remained laparoscopic.

Table 1: Preoperative characteristics according to operative approach

Variable	Laparoscopic (n=252)	Converted (n=34)	p-value
Age, years	49.7 ± 14.2	61.8 ± 12.6	<0.001
Age ≥65 years	53 (21.0%)	17 (50.0%)	<0.001
Male sex	120 (47.6%)	24 (70.6%)	0.011
BMI, kg/m ²	26.9 ± 4.2	28.1 ± 4.6	0.122
Diabetes mellitus	48 (19.0%)	13 (38.2%)	0.011
Previous upper abdominal surgery	18 (7.1%)	7 (20.6%)	0.009
Symptoms >72 h	72 (28.6%)	23 (67.6%)	<0.001
Leukocyte count, ×10 ³ /mm ³	12.4 ± 3.8	15.8 ± 4.5	<0.001
CRP, mg/L	82.7 ± 61.5	176.4 ± 82.1	<0.001
Albumin, g/dL	3.72 ± 0.46	3.43 ± 0.51	0.001
Gallbladder wall, mm	4.1 ± 1.2	5.8 ± 1.4	<0.001
Pericholecystic fluid	70 (27.8%)	20 (58.8%)	<0.001
Tokyo Grade II/III	87 (34.5%)	26 (76.5%)	<0.001

Intraoperative and postoperative outcomes are shown in Table 2. The most common reason for conversion was dense inflammatory adhesions with inability to define Calot triangle safely (20/34, 58.8%), followed by unclear anatomy despite attempted bailout dissection (7/34, 20.6%), troublesome bleeding (5/34, 14.7%), and concern

for bile duct injury (2/34, 5.9%). Conversion was associated with longer operative duration (128.6 ± 31.7 vs 74.2 ± 22.5 minutes, $p < 0.001$), greater blood loss, and longer hospitalization. Overall 30-day morbidity was higher after conversion, although major complications remained uncommon. No perioperative mortality occurred.

Table 2: Operative and postoperative outcomes

Outcome	Laparoscopic (n=252)	Converted (n=34)	p-value
Operative time, min	74.2 ± 22.5	128.6 ± 31.7	<0.001
Estimated blood loss, mL	42 ± 31	168 ± 96	<0.001
Drain placement	89 (35.3%)	27 (79.4%)	<0.001
Overall 30-day complications	27 (10.7%)	9 (26.5%)	0.010
Bile leak	5 (2.0%)	2 (5.9%)	0.194
Surgical-site infection	6 (2.4%)	4 (11.8%)	0.019
Hospital stay, days	2.6 ± 1.3	5.8 ± 2.4	<0.001
30-day readmission	7 (2.8%)	2 (5.9%)	0.294

Variables associated with conversion on univariable analysis were age ≥65 years, male sex, diabetes, symptom duration >72 hours, CRP ≥150 mg/L, leukocyte count ≥15,000/mm³, gallbladder wall thickness ≥5 mm, pericholecystic fluid, previous upper abdominal surgery, and Tokyo Grade II/III disease. On multivariable analysis (Table 3), age ≥65 years, symptom duration >72 hours, CRP ≥150 mg/L, gallbladder wall thickness

≥5 mm, and Tokyo Grade II/III disease remained independently associated with conversion. The final model showed good discrimination with an area under the curve of 0.84 (95% CI 0.77-0.91). A model containing none or one of the five independent risk factors corresponded to a low observed conversion rate, whereas patients with four or five factors had markedly higher conversion frequency.

Table 3: Multivariable predictors of conversion to open cholecystectomy

Predictor	Adjusted OR	95% CI	p-value
Age ≥65 years	2.37	1.05-5.36	0.038
Male sex	1.71	0.72-4.04	0.222
Diabetes mellitus	1.58	0.66-3.78	0.302
Symptoms >72 h	2.84	1.24-6.52	0.014
CRP ≥150 mg/L	3.68	1.57-8.64	0.003
Gallbladder wall ≥5 mm	3.11	1.34-7.22	0.008
Pericholecystic fluid	1.69	0.73-3.94	0.222
Tokyo Grade II/III	4.42	1.72-11.36	0.002

Discussion

The following five variables were found to be independent factors that characterize patients at high risk for conversion: age ≥ 65 years, duration of symptoms > 72 hours, CRP ≥ 150 mg/L, gallbladder wall thickness ≥ 5 mm, and Tokyo Grade II/III acute cholecystitis. The results are consistent with a clinically intuitive model that conversion is a result of a combination of patient vulnerability, the length of time the inflammation has been present, systemic inflammatory response, and local structural changes around the gall bladder. Importantly, the conversion rate of 11.9% is within the range reported in cohorts enriched for acute cholecystitis, and should therefore not be interpreted as a technical failure, but rather as a safety endpoint.

Preoperative information has been previously shown to have meaningful predictive value for conversion, with male sex, leukocytosis, hypoalbuminemia, pericholecystic fluid, diabetes and hyperbilirubinemia identified as independent factors [6]. They stressed that the more negative characteristics that are present, the greater the likelihood of conversion. The present study also revealed a progressive increase in observed conversion with the addition of independent risk factors, with inflammatory severity factors being more important than sex or diabetes after multivariable adjustment. This may be due to the fact that this cohort was restricted to acute cholecystitis, and not mixed benign gallbladder indications.

The duration of symptoms was independently associated with conversion. Among the patients classified by the severity criteria in Tokyo, symptoms for more than 72 hours and elevated CRP were significant predictors, as reported by Asai et al. [7]. Chronic inflammation leads to edema, fibrin deposition, adhesion and ultimately fibrotic distortion of the cystic duct and artery. This causes a loss of tissue plane definition and less traction-countertraction. The association offers further assistance for prompt surgical assessment and early definitive treatment when clinically appropriate, from a service perspective.

Converted patients were more likely to have had previous surgery in the upper abdomen, but this was not independent of the other factors. In a mixed cholecystectomy population, Utsumi et al. identified previous upper abdominal surgery, pericholecystic fluid, acute cholecystitis and emergency surgery as important predictors [8]. Previous surgery may cause adhesions that make access and exposure difficult, but this may be minimized by the use of modern laparoscopic adhesiolysis and open entry techniques in experienced hands. Thus, it is likely to be institution and surgeon specific in its predictive power. The strong association between CRP and

conversion reinforces the value of systemic inflammatory markers. More recently, Utsumi et al. reported that the CRP-to-albumin ratio was an independent predictor of conversion in acute cholecystitis and was superior to either of the markers in their cohort [9]. In this data set, converted cases had higher levels of CRP and lower levels of albumin, and CRP was chosen as the more convenient independent variable. In future, direct comparison of CRP, CRP-to-albumin ratio, neutrophil-to-lymphocyte ratio, and composite inflammatory scores in the same prospective prediction model could be performed.

Wall thickness of the gallbladder ≥ 5 mm was an independent risk factor for conversion. Thickened wall is a direct ultrasonographic marker of edema, inflammation and chronic remodeling. Thickened gallbladder wall has been consistently found in the literature to be one of the most significant technical predictors of conversion in the preoperative setting, using meta-analytic evidence [10]. In the present cohort, there was a strong unadjusted association of pericholecystic fluid, but this was not seen when severity grade and wall thickness were added, indicating that there was overlapping information between the sonographic markers and overall disease severity.

Tokyo Grade II/III disease had the greatest adjusted OR in the final model. Clinically important because severity grading is easily available prior to surgery and conveys several aspects of local and systemic disease. High risk should not be a criterion for open surgery, but rather a reason to prepare for a challenging cholecystectomy. Practical solutions involve the use of an experienced surgeon, early consideration of fundus-first or subtotal procedures, availability of intraoperative cholangiography when appropriate, clear thresholds for conversion, and postoperative planning based on physiologic stress.

The negative perioperative characteristics of converted cases (increased operation time, blood loss, wound infection, and longer hospital stay) are similar to the higher inflammatory complexity of these patients. The results should not be interpreted as proof that all the extra morbidity is due to conversion, as there is a significant confounding by disease severity. If converted in time, more serious complications like injury to the bile duct or uncontrolled bleeding may be avoided. Hence, the clinical utility of a prediction model is in preparation and risk communication, rather than in the attempt to prevent conversion.

The uniformity of these predictors across cohorts enhances their clinical plausibility. However, in acute cholecystitis, advanced age, obesity and pericholecystic fluid were found to be important preoperative factors associated with conversion by Yetkin et al. [11]. In a large cohort of patients

undergoing laparoscopic cholecystectomy, Rosen et al. found leukocytosis and gallbladder wall thickening to be significant conversion predictors [12]. Goh et al. also noted that older age, comorbidity, prior abdominal surgery, fever and low albumin were associated with conversion [13]. Atmaram and Lakshman also showed that some of the clinical and ultrasonographic parameters, which are easily available before surgery, can predict a difficult laparoscopic cholecystectomy [14]. Recently, Senocak et al. tested a preoperative conversion-risk model that included contemporary Tokyo Guidelines severity information, which further demonstrates the ongoing interest in the integration of routine variables into practical risk-stratification models [15]. These studies reinforce the need to use multivariable, not single factor assessment, when advising patients and distributing operating room skills.

There are some limitations in this study. It was performed in one center, and thus represents local thresholds for conversion and surgeon experience.

The number of cases converted was sufficient for a parsimonious regression model, but restricted the number of predictors that could be examined reliably. Advanced imaging features and intraoperative severity scores were not included. Follow-up was limited to 30-day outcomes and was not used to assess longer-term incisional morbidity. The proposed combination of predictors needs to be validated externally before it can be used as a formal risk score. However, there are practical advantages to the study: all consecutive cases of acute cholecystitis were included, predictors were available prior to incision, and clinical severity and imaging variables were analyzed together.

Conclusion

Older age, presentation after 72 hours, high CRP, gallbladder wall thickness ≥ 5 mm, and Tokyo Grade II/III were independent risk factors for conversion in patients with acute cholecystitis who underwent laparoscopic cholecystectomy. These readily available factors can aid in the risk stratification prior to surgery, the assignment of experienced surgical personnel, informed consent, and the early implementation of bailout strategies. When anatomy cannot be reliably determined, conversion should continue to be a conscious safety choice.

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