

Predictors of Difficult Laparoscopic Cholecystectomy and Conversion to Open Surgery: A Prospective Study

Naman K. Patel¹, Nidhiben Pravinbhai Chaudhari², Sandhi Mahammadvasim Rafikbhai³

¹Professor, Department of General Surgery, Bhagyoday Medical College, Kadi, Gujarat, India

²Tutor, Department of Community Medicine, Nootan Medical College & Research Centre, Visnagar, Gujarat, India

³MBBS, Qiqihar Medical University, China

Received: 01-06-2026 / Revised: 15-07-2026 / Accepted: 21-08-2026

Corresponding author: Dr. Sandhi Mahammadvasim Rafikbhai

Conflict of interest: Nil

Abstract

Background: Difficult laparoscopic cholecystectomy (LC) prolongs operative time, raises the risk of complications and the rate of conversion to open surgery. Prospective identification of preoperative predictors of difficult LC and conversion, and assessment of the discriminatory ability of a practical risk model.

Methods: Two hundred and twenty adults who were scheduled for elective or early LC for gallstone disease were studied. Demographic, clinical, biochemical and ultrasonographic parameters were documented preoperatively. Operative difficulty was assessed on the Nassar scale with grades 3-5 considered difficult. Secondary outcome was conversion to open surgery. Multivariable logistic regression and receiver-operating-characteristic analysis were performed.

Results: Difficult LC was seen in 67 patients (30.5%) and 14 procedures (6.4%) were converted to open surgery. Compared with easy cases, difficult cases had longer operative time (91.8 ± 27.4 vs 54.6 ± 16.9 min, $p < 0.001$), higher blood loss (86 ± 57 vs 28 ± 22 mL, $p < 0.001$), and longer postoperative stay (2.6 ± 1.3 vs 1.4 ± 0.7 days, $p < 0.001$). Independent predictors of difficult LC were male sex (adjusted OR 2.35, 95% CI 1.14-4.84), previous hospitalization for acute cholecystitis (OR 2.81, 95% CI 1.33-5.93), gallbladder wall thickness > 4 mm (OR 4.12, 95% CI 1.95-8.69), impacted neck stone (OR 3.56, 95% CI 1.58-8.03), and pericholecystic fluid (OR 3.22, 95% CI 1.21-8.56). The area under the ROC curve of the composite preoperative model was 0.86 (95% CI 0.81-0.91). Nassar grade 4-5, wall thickness > 4 mm and impacted stone were all strongly associated with conversion.

Conclusion: A limited number of easily obtained clinical and ultrasonographic parameters can be used to identify patients with a higher risk of difficult LC and conversion. Preoperative risk stratification can enhance case allocation, counseling, and preparation for bailout strategies.

Keywords: Laparoscopic cholecystectomy; difficult cholecystectomy; conversion; gallbladder; risk factors; prediction.

DOI: 10.25258/ijcpr.18.9.57

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Laparoscopic cholecystectomy is the preferred surgical procedure for symptomatic gallstone disease due to its benefits of less postoperative pain, shorter hospital stays and faster recovery than open surgery. Although it is a routine procedure, the technical challenge of LC is quite variable. Dense adhesions, acute or chronic inflammation, distorted anatomy of Calot's triangle, impacted stones, a contracted or thick-walled gallbladder, obesity, and previous surgery can make an otherwise simple procedure a lengthy one that carries a higher risk of bleeding, bile duct injury, subtotal cholecystectomy, or open surgery. Difficulty prediction has thus developed from a subjective clinical impression to a

formal scoring system before entering the operating room. Nassar and colleagues have shown that age, American Society of Anesthesiologists status, male sex, cholecystitis, common bile duct disease, gallbladder wall thickening, preoperative endoscopic retrograde cholangiopancreatography (ERCP), and non-elective surgery can be combined into a clinically useful preoperative score [1]. Previous prospective studies have also demonstrated that history, examination, and ultrasonography can identify difficult cases, but with inconsistent performance across small cohorts and inconsistent definitions of difficult cases [2,3]. One of the most important methodological problems in this area is

the lack of an objective reference standard during surgery. Sugrue et al. proposed an operative grading system based on the appearance, access, distention, inflammatory changes, and time needed to identify key structures of the gallbladder [4]. The Nassar difficulty scale has since been confirmed in large prospective datasets, with higher grades associated with conversion, longer operative time, complications, reintervention and mortality [5]. Such a structured intraoperative grading allows for a more clinically interpretable study of predictors than does a study based on operative time or a surgeon's subjective impression.

Failure to convert to open surgery is no longer a failure, but a safety decision when anatomy cannot be defined or complications cannot be safely managed laparoscopically. However, there is a higher morbidity and higher resource use associated with conversion, and the likelihood of conversion should be expected. Previous systematic reviews have consistently reported that older age, male sex, acute cholecystitis, obesity, previous upper abdominal surgery and gallbladder wall thickening are important predictors [6,7]. A more recent meta-analysis also revealed significant correlations with acute inflammation and with thickening of the gallbladder wall and highlighted the cumulative effect of several risk factors [8].

Guidelines for acute cholecystitis have also moved away from the concept of completing the dissection laparoscopically, and towards the concept of safety. Tokyo Guidelines 2018 suggest bailout procedures such as subtotal cholecystectomy or conversion in case of severe inflammation or fibrosis that prevents the critical view of safety [9]. This emphasizes the importance of the practical application of the preoperative risk recognition: a high-risk patient can be referred to an experienced surgeon, booked for the time when advanced support is available, and informed about the realistic possibility of a subtotal or open surgery.

Preoperative risk classification has been recently validated prospectively and has been found to be correlated with Nassar intraoperative grades and to aid in operative planning, but there is some population-specific discrimination [10]. Trehan et al. reported excellent discriminatory performance of a score based on easily available variables in 2023 [11]. Further assessment across a variety of cohorts is required as the incidence of acute cholecystitis, obesity, previous interventions and delayed presentation varies across health systems.

The present prospective study sought to determine independent predictors of difficult LC and conversion to open surgery based on routinely collected preoperative variables and an objective intraoperative definition of difficult LC. A secondary objective was to test the discriminatory

accuracy of a compact risk model to be used in the routine assessment of surgical patients.

Materials and Methods

Study Design & Participants: A prospective observational cohort study was performed in the Department of General Surgery of a tertiary care teaching hospital. All consecutive adults aged 18 years or older undergoing elective, interval or early laparoscopic cholecystectomy for symptomatic cholelithiasis or acute calculous cholecystitis were screened. The exclusion criteria included known gallbladder malignancy, major surgery of the upper abdomen planned for open cholecystectomy, severe acute pancreatitis requiring delayed management, pregnancy, and incomplete ultrasonography before surgery. Written informed consent was obtained.

Preoperative variables: Demographic variables were age, sex, BMI, diabetes, hypertension and previous upper abdominal surgery. Disease-related variables were prior hospitalization for acute cholecystitis, number of biliary attacks, duration of current symptoms, prior ERCP, and emergency versus elective admission. Laboratory tests consisted of total leukocyte count, C-reactive protein (CRP), bilirubin, alkaline phosphatase, and transaminases. The gallbladder wall thickness, gallbladder distention/contraction, impacted neck/Hartmann's pouch stone, pericholecystic fluid, largest stone diameter, and common bile duct diameter were recorded using standardized ultrasonography. Wall thickness >4 mm and common bile duct diameter >7 mm were considered as categorical risk factors.

Operative Technique and Definition of Difficulty: LC was performed by consultants or senior surgeons with experience in the laparoscopy of the biliary tract using a conventional 4 port technique. The critical view of safety was attempted in all cases. The operative difficulty scale of Nassar was used to grade intraoperative findings. For the primary analysis, grades 1-2 were classified as easy/moderate, and grades 3-5 as difficult. Operative time was defined as the time from skin incision to skin closure. Conversion was considered to be an unplanned laparotomy necessary to complete the cholecystectomy or to safely resolve an intraoperative problem. Laparoscopic subtotal cholecystectomy was also documented as a bailout procedure, but was not considered a conversion.

Outcomes: The main outcome was difficult LC (Nassar grade 3-5). The primary secondary outcome was conversion to open surgery. Other outcomes included were operative time, estimated blood loss, bile or stone spillage, subtotal cholecystectomy, placement of a drain, bile duct or major vascular injury, postoperative complications, and length of stay. Complications were reported at 30 days.

Data Analysis: SPSS version 29.0 was used for statistical analysis.

Results

A total of 220 patients were analyzed. Mean age was 47.9 ± 14.2 years, 82 (37.3%) were male, and mean BMI was 26.7 ± 3.8 kg/m². Forty-eight patients (21.8%) had a previous hospitalization for acute cholecystitis and 31 (14.1%) underwent LC during an index admission for acute cholecystitis. Nassar grade 3-5 difficulty was observed in 67 patients (30.5%). Fourteen procedures (6.4%) were converted to open surgery, most often because of dense inflammatory adhesions with unsafe Calot's triangle dissection (n=8), uncontrolled bleeding or concern regarding vascular injury (n=3), and inability to define biliary anatomy despite bailout maneuvers (n=3). Patients with difficult LC were older, more often male, and more likely to have prior cholecystitis-related hospitalization. Ultrasound findings of wall thickness >4 mm, impacted neck stone, pericholecystic fluid, and contracted gallbladder were substantially more common in the difficult group. Mean CRP was also higher. Previous lower abdominal surgery was not associated with difficulty, while previous upper abdominal surgery showed a trend that did not remain significant after adjustment.

Operative consequences of difficult LC were clinically important. Mean operative time was 91.8 ± 27.4 minutes compared with 54.6 ± 16.9 minutes for easy/moderate cases ($p < 0.001$). Estimated blood loss was 86 ± 57 mL versus 28 ± 22 mL ($p < 0.001$). Subtotal cholecystectomy was required in 10.4% of difficult cases and in none of the easy cases. Conversion occurred in 17.9% of difficult cases compared with 1.3% of easy/moderate cases ($p < 0.001$). Postoperative stay was also longer (2.6 ± 1.3 vs 1.4 ± 0.7 days, $p < 0.001$). No major bile duct injury occurred; one converted case required repair of a small right hepatic arterial branch injury. On multivariable analysis, male sex, previous hospitalization for acute cholecystitis, gallbladder wall thickness >4 mm, impacted neck stone, and pericholecystic fluid were independent predictors of difficult LC. Age ≥ 60 years and BMI ≥ 30 kg/m² showed increased odds but did not reach statistical significance after adjustment. The resulting preoperative model produced an AUC of 0.86 (95% CI 0.81-0.91). At the selected probability threshold, sensitivity was 80.6%, specificity 78.4%, positive predictive value 62.1%, and negative predictive value 90.2%. Conversion was most strongly associated with Nassar grade 4-5, wall thickness >4 mm, and impacted stone.

Table 1: Preoperative characteristics according to operative difficulty

Variable	Easy/moderate n=153	Difficult n=67	p value
Age, years	45.8 ± 13.5	52.7 ± 14.5	0.001
Male sex	46 (30.1%)	36 (53.7%)	0.001
BMI ≥ 30 kg/m ²	21 (13.7%)	18 (26.9%)	0.018
Prior hospitalization for cholecystitis	22 (14.4%)	26 (38.8%)	<0.001
Previous upper abdominal surgery	9 (5.9%)	8 (11.9%)	0.121
GB wall >4 mm	20 (13.1%)	34 (50.7%)	<0.001
Impacted neck stone	13 (8.5%)	24 (35.8%)	<0.001
Pericholecystic fluid	6 (3.9%)	15 (22.4%)	<0.001
CRP, mg/L	12.8 ± 19.4	38.6 ± 43.2	<0.001

Table 2: Intraoperative and postoperative outcomes

Outcome	Easy/moderate n=153	Difficult n=67	p value
Operative time, min	54.6 ± 16.9	91.8 ± 27.4	<0.001
Estimated blood loss, mL	28 ± 22	86 ± 57	<0.001
Bile/stone spillage	18 (11.8%)	21 (31.3%)	<0.001
Subtotal cholecystectomy	0	7 (10.4%)	<0.001
Conversion to open	2 (1.3%)	12 (17.9%)	<0.001
Drain placement	16 (10.5%)	35 (52.2%)	<0.001
Postoperative stay, days	1.4 ± 0.7	2.6 ± 1.3	<0.001
30-day complications	6 (3.9%)	9 (13.4%)	0.012

Table 3: Multivariable predictors of difficult laparoscopic cholecystectomy

Predictor	Adjusted OR	95% CI	p value
Male sex	2.35	1.14-4.84	0.021
Prior hospitalization for acute cholecystitis	2.81	1.33-5.93	0.007
GB wall thickness >4 mm	4.12	1.95-8.69	<0.001
Impacted neck stone	3.56	1.58-8.03	0.002
Pericholecystic fluid	3.22	1.21-8.56	0.019
Age ≥60 years	1.72	0.81-3.65	0.157
BMI ≥30 kg/m ²	1.69	0.74-3.88	0.214

Discussion

In this prospective study, about one-third of the laparoscopic cholecystectomies were classified as difficult surgery and 6.4% were converted to open surgery. Factors useful for the preoperative prediction of the presence of difficulty were male sex, previous hospitalization for acute cholecystitis, gallbladder wall thickness >4 mm, impacted neck stone, and pericholecystic fluid. A model based on these variables that are routinely available had good discrimination and importantly a high negative predictive value, indicating that this model may have utility for identifying patients who are unlikely to have an uncomplicated procedure.

The direction and strength of the observed associations are in line with previous research. Male sex, older age, acute cholecystitis, diabetes, obesity and previous upper abdominal surgery are associated with increased risk of conversion based on systematic review data [12]. The above-mentioned systematic review of over 100,000 patients also highlighted that older male patients, acute cholecystitis, prolonged symptoms, elevated inflammatory markers, diabetes, obesity, and high intraoperative difficulty scores are consistently linked to conversion [13]. Our findings in particular highlight the importance of inflammatory disease burden, in addition to demographic factors.

In our model, the best independent preoperative predictor was gallbladder wall thickness >4 mm. Wall thickening is an easily obtained sonographic sign of edema, chronic fibrosis or acute inflammatory infiltration. It is closely related to difficult traction, impaired tissue planes and inability to define structures safely. Wall thickening has been found to be a consistent predictor of conversion in the literature based on meta-analytic evidence [6,8]. Likewise, a stone in the neck or Hartmann's pouch may alter the infundibulum, impair the ability to grasp it, and provide an inaccurate relationship between the cystic duct and common bile duct. The higher odds we found in our cohort are therefore both statistically and anatomically reasonable.

The adjusted results showed that previous hospitalization for acute cholecystitis was still significant. Even if surgery is performed after the acute inflammation has resolved, the inflammation can have a tendency to recur and lead to dense

adhesions and chronic scarring. This may account for the fact that an apparently elective interval LC may behave intraoperatively as a difficult inflammatory gallbladder. In delayed LC, recent studies using objective TG18 difficulty assessment have also shown that higher wall thickness, BMI, and younger age at surgery are associated with higher operative difficulty [14]. Technical consequences of past inflammatory episodes are not ruled out by the absence of current fever or leukocytosis.

The observed conversion rate of 6.4% is within the range as reported in the contemporary reviews. The conversion was largely limited to high Nassar grades and was generally in response to unsafe anatomy and not uncontrolled complication. This is a key conceptual difference. In modern safe-cholecystectomy practice, conversion and subtotal cholecystectomy are bailout procedures when the critical view of safety cannot be achieved. Tokyo Guidelines 2018 specifically state that bailout procedures should be considered in cases of nondissectable scarring or severe fibrosis [9]. Preoperative prediction should not be used to define a surgeon or procedure as being likely to fail, but rather to make the team more aware of the need to have a lower threshold to select the safest endpoint.

Our data also show the clinical implications of struggle not to convert. Difficult procedures lasted almost 40 minutes longer on average, had greater blood loss, more spillage and drain placement, and nearly doubled postoperative length of stay.

The same graded relationship of operative difficulty with conversion, complications, reintervention, and length of stay has been demonstrated in large scale validation of the Nassar scale [5]. These downstream effects warrant the inclusion of a difficulty prediction in operating room scheduling. A high-risk case might not be suitable as the last case in an overcrowded elective list, or as an unsupervised training case.

The AUC of 0.86 is comparable to several published preoperative tools, with the caveat that direct comparisons are limited by the differences in case mix and outcome definitions. Previously, a scoring system using age, sex, prior hospitalization, obesity, abdominal scar, palpable gallbladder, wall thickness, pericholecystic fluid and impacted stone was reported to have an AUC of 0.86 [3]. Predictive

performance has been shown to vary between institutions, as more recent prospective validation of a Nassar-based preoperative scale showed lower discrimination [10]. This is a reminder of the importance of local validation prior to formal triage with a threshold. There are some limitations of the study. It was performed in a single center and the operator experience could affect the Nassar grade and the conversion threshold. Others, like ultrasound wall thickness and pericholecystic fluid, are image quality and image timing dependent.

The number of conversions was relatively small and only a few independent covariates could be safely modeled for this outcome. The model predicts technical complexity, and difficult LC was defined as an intraoperative grade, so this should be kept in mind when comparing it to conversion-only scores. Lastly, advanced imaging data and surgeon-specific factors were not included.

The strengths are that the data was collected prospectively, the variables were sonographic, the grading was objective and operative, and the clinically meaningful outcomes were assessed in parallel. The model does not need complex calculations and has variables that are available prior to surgery. It may be most useful in defining a low risk group appropriate for routine schedule and a high risk group that should be referred to senior surgical care, discussed as subtotal or open conversion, and where adjuncts can be used to define anatomy.

To conclude, difficult LC is clinically predictable with a good degree of predictability if inflammatory history and targeted ultrasound findings are combined. The prediction of difficulty should not be a mere prediction of conversion, but incorporated into safe surgical planning.

Conclusion

The presence of pericholecystic fluid, impacted neck stone, male sex, previous hospitalization for acute cholecystitis, and gallbladder wall thickness >4 mm were independent risk factors for difficult laparoscopic cholecystectomy. The operative time, blood loss, length of hospital stay and conversion rate were significantly higher for difficult procedures. A model of this nature is feasible in the pre-operative setting, and could help counsel patients, plan operating rooms, allocate senior cases and implement bailout strategies on time.

References

1. Nassar AHM, Hodson J, Ng HJ, Vohra RS, Katbeh T, Zino S, et al. Predicting the difficult laparoscopic cholecystectomy: development and validation of a pre-operative risk score using an objective operative difficulty grading system. *Surg Endosc.* 2020;34(10):4549-4561.

- doi:10.1007/s00464-019-07244-5. PMID:31732855.
2. Vivek MK, Augustine AJ, Rao R. A comprehensive predictive scoring method for difficult laparoscopic cholecystectomy. *J Minim Access Surg.* 2014;10(2):62-67. doi:10.4103/0972-9941.129947. PMID:24761077.
3. Gupta N, Ranjan G, Arora MP, Goswami B, Chaudhary P, Kapur A, et al. Validation of a scoring system to predict difficult laparoscopic cholecystectomy. *Int J Surg.* 2013;11(9):1002-1006. doi:10.1016/j.ijsu.2013.05.037. PMID:23751733.
4. Sugrue M, Sahebally SM, Ansaloni L, Zielinski MD. Grading operative findings at laparoscopic cholecystectomy-a new scoring system. *World J Emerg Surg.* 2015;10:14. doi:10.1186/s13017-015-0005-x. PMID:25870652.
5. Griffiths EA, Hodson J, Vohra RS, Marriott P, Katbeh T, Zino S, et al. Utilisation of an operative difficulty grading scale for laparoscopic cholecystectomy. *Surg Endosc.* 2019; 33(1):110-121. doi:10.1007/s00464-018-6281-2. PMID:29956029.
6. Hu ASY, Menon R, Gunnarsson R, de Costa A. Risk factors for conversion of laparoscopic cholecystectomy to open surgery-a systematic literature review of 30 studies. *Am J Surg.* 2017;214(5):920-930. doi:10.1016/j.amjsurg.2017.07.029. PMID:28739121.
7. Yang TF, Guo L, Wang Q. Evaluation of Preoperative Risk Factor for Converting Laparoscopic to Open Cholecystectomy: A Meta-Analysis. *Hepatogastroenterology.* 2014. PMID:26158149.
8. Magnano San Lio R, Barchitta M, Maugeri A, Quartarone S, Basile G, Agodi A. Preoperative Risk Factors for Conversion from Laparoscopic to Open Cholecystectomy: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health.* 2022;20(1):408. doi:10.3390/ijerph20010408. PMID:36612732.
9. Wakabayashi G, Iwashita Y, Hibi T, Takada T, Strasberg SM, Asbun HJ, et al. Tokyo Guidelines 2018: surgical management of acute cholecystitis: safe steps in laparoscopic cholecystectomy for acute cholecystitis. *J Hepatobiliary Pancreat Sci.* 2018;25(1):73-86. PMID:29095575.
10. Martínez-Mier G, Uria-Torija T, Méndez-Rico D, Ávila-Mercado O, Reyes-Ruiz JM, Solórzano-Rubio JR. Prospective validation of a preoperative scoring system for difficult laparoscopy cholecystectomy. *Updates Surg.* 2024;76(5):1833-1841. doi:10.1007/s13304-024-01925-0. PMID:39039356.
11. Trehan M, Mangotra V, Singh J, Singla S, Gautam SS, Garg R. Evaluation of Preoperative Scoring System for Predicting Difficult

- Laparoscopic Cholecystectomy. *Int J Appl Basic Med Res.* 2023;13(1):10-15. doi:10.4103/ijabmr.ijabmr_553_22. PMID:37266522.
12. Chin X, et al. Preoperative and Intraoperative Risk Factors for Conversion of Laparoscopic Cholecystectomy to Open Cholecystectomy: A Systematic Review of 30 Studies. *Cureus.* 2023. PMID:38021611.
 13. Agrawal N, Singh S, Khichy S. Preoperative Prediction of Difficult Laparoscopic Cholecystectomy: A Scoring Method. *Niger J Surg.* 2015;21(2):130-133. doi:10.4103/1117-6806.162567. PMID: 26425067.
 14. Naito K, Suda K, Shinoda K, Hashiba T, Sano W, Chiku T, et al. Preoperative difficulty factors in delayed laparoscopic cholecystectomy: Tokyo Guidelines 2018 surgical difficulty score analysis. *Asian J Endosc Surg.* 2024;17(2):e13309. doi:10.1111/ases.13309. PMID:38584140.