

Pre-operative Predictors for Intraoperative Difficulty in Laparoscopic Cholecystectomy: A Prospective Observational Study

ABSTRACT

Objectives: The objective of this study was to find pre-operative predictors for intraoperative difficulty in laparoscopic cholecystectomy (LC). **Materials and Methods:** This was an observational study of 150 patients at a tertiary healthcare center done over a period of 2 years from March 2022 to March 2024. **Inclusion criteria:** A prospective observational study was done on 150 patients of elective LC, coming to a tertiary healthcare center, admitted and operated by a constant team at the aforementioned center. The average time taken by the said team to operate uncomplicated LC was about 60 min. **Exclusion criteria:** (i) The cases of LC conversion to open cholecystectomy due to equipment failure and surgery in an emergency setting and (ii) also cases of (1) cholecystic intestinal fistula, (2) carcinoma gallbladder (GB), (3) GB perforation/peritonitis, and (4) choledocholithiasis needing choledochotomy were excluded from the study. **Subject withdrawal criteria:** Unwillingness on the part of the patient is the only withdrawal criterion. All patients who were operated were observed for the following pre-operative factors: (1) (a) History, (b) history of attack of acute cholecystitis, (c) history of endoscopic retrograde cholangiopancreatography (ERCP), and (d) history of previous abdominal surgery; (2) clinical examination – (a) body mass index <25 or >25, (b) palpable GB, and (c) P/A - tenderness/guarding; and (3) ultrasonography findings – (a) wall thickness >4 mm, (b) pericholecystic collection, (c) impacted stone, and (d) CBD dilation. **Results:** The pre-operative score was determined to be easy in 33 males and 47 females and postoperatively 29 males (87.87%) were found to be easy cases and all 47 females (100%) were categorized under easy LC. The pre-operative score was determined to be moderate in 23 males and 22 females and postoperatively all 23 males (100%) were found to be moderate LC cases and 19 females (86.36%) were categorized under moderate LC. The pre-operative score was determined to be difficult in 13 males and 12 females and postoperatively 17 males were found to be difficult cases and 15 females were categorized under difficult LC. **Conclusion:** Our study has shown that it is possible to predict difficulty preoperatively during LC and the chances of conversion to open cholecystectomy can be predicted. In our study, we found a history of acute cholecystitis, symptoms and signs of acute cholecystitis, male gender, contracted GB, GB wall thickness >4 mm, presence of pericholecystic fluid, and history of previous abdominal surgery and ERCP to be significant predictors of difficulty in LC.

Key words: Cholelithiasis, Cholecystitis, Difficult laparoscopic cholecystectomy, Frozen Calot's triangle, Aberrant bile ducts, Iatrogenic bile duct injury

INTRODUCTION

Cholecystectomy is one of the most common elective procedures performed on the hepatobiliary system. Laparoscopic cholecystectomy (LC) has become the gold standard for benign gallbladder (GB) disease in a very short time.^[1] LC has many profits over open cholecystectomy in terms of minimum post-operative pain, shorter hospital stay, improved cosmetics, and early recovery. Most of the factors such as morbid obesity and previous upper abdominal surgery which were studied as pure contraindications for pursuing LC have no longer remained as pure contraindications. The number of contraindications has come down undoubtedly over time.^[2] Although LC has become safer and easier, there are many risk factors which make laparoscopic surgery difficult.^[3]

Difficult cases can result in prolonged operative time, bleeding, bile spillage, conversion to open technique, and

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bile duct injury. Such difficulties intra operatively may result in prolonged operative time and hence the extended post

operative stay for monitoring the patient, leading to increase in estimated hospitalization cost. As for the surgeons it leads to increased stress during operation, difficult in arranging help intra operatively or blood and blood products at the given moment, and time constraint to complete the planned OT list. Therefore, the identification of difficult cases has potential advantages for surgeons, patients, and their relatives.

MATERIAL AND METHODS

Study design

This was an observational study.

Study setting

This study was conducted at a tertiary healthcare center.

Study population

Patients admitted at a tertiary healthcare center for LC were enrolled in the study.

Duration of study

The duration of the study was from March 2022 to July 2023.

Sample size

The sample size was 150.

Sampling technique

Sampling was done in a non-random, purposive manner.

Method of selection of study subjects

Inclusion criteria

- i. A prospective observational study was done on 150 patients of elective LC, coming to a tertiary healthcare center, admitted and operated by a constant team at the aforementioned center. The average time taken by the said team to operate uncomplicated LC is about 60 min.

Exclusion criteria

- i. The cases of LC conversion to open cholecystectomy due to equipment failure and surgery in an emergency setting
- ii. Also cases of
 1. Cholecystic intestinal fistula
 2. Carcinoma GB
 3. GB perforation/peritonitis
 4. Choledocholithiasis needing choledochotomy were excluded from the study.

Subject withdrawal criteria

- i. Unwillingness on the part of the patient is the only withdrawal criterion.

Methods of data collection

All patients who were operated were observed for the following pre-operative factors:

History

- a. History of attack of acute cholecystitis
- b. History of endoscopic retrograde cholangiopancreatography (ERCP)
- c. History of previous abdominal surgery.

Clinical examination

- a. Body mass index (BMI) <25 or >25
- b. Palpable GB
- c. P/A - tenderness/guarding.

Ultrasonography (USG) findings

- a. Wall thickness >4 mm
- b. Pericholecystic collection
- c. Impacted stone
- d. CBD dilation.

These pre-operative factors were used to predict difficult LC which was compared with operative assessment. Preoperatively easy, difficult and difficult LCs were defined as per Table 1.

Procedure

It consists of the following four phases:

1. Preparatory phase
2. Phase of data collection
3. Phase of data analysis
4. Phase of documentation.

Preparatory phase

It is an observational study conducted on patients presenting with symptomatic gallstones as diagnosed on USG. As LC is the gold standard treatment, all such patients were posted for LC. All patients presenting to the Department of General Surgery, meeting the inclusion and exclusion criteria, and consenting to participate in the study were included.

Ethical issues

Institutional Ethical Committee approval was taken before the start of the study. Written and informed consent was taken from the participants before enrolling patients for the study. Each eligible subject was explained about the purpose of the study by the investigator. All patients were explained about the procedure of LC and its complications. They were assured of the complete confidentiality of information and the option of withdrawing from the study at any point of time.

The study did not involve any method that put the subjects, family members, or the investigator at risk.

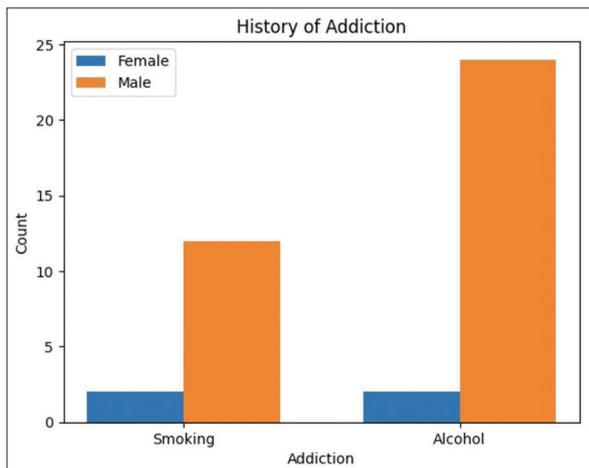


Figure 1: History of addiction

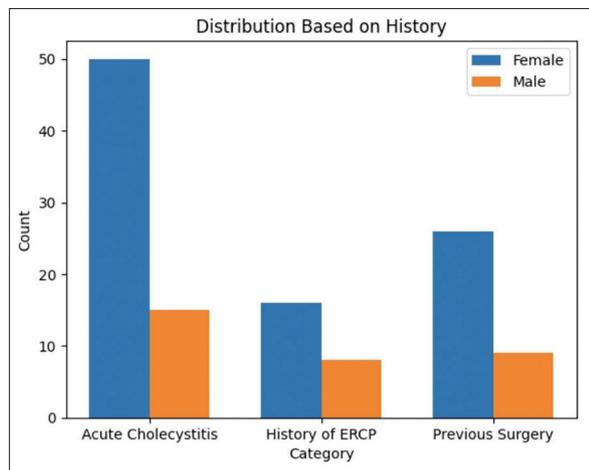


Figure 2: Distribution based on history

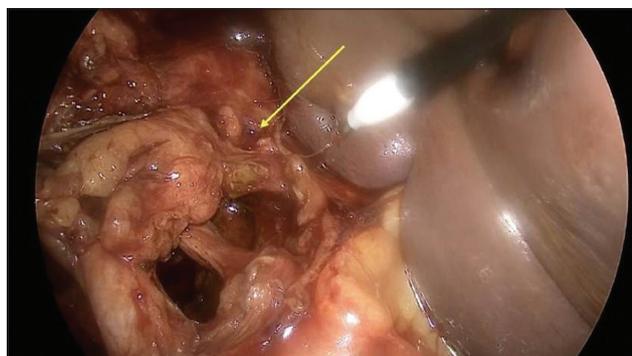


Figure 3: Aberrant right biliary duct

Requirements for the study

- Laparoscopic system with a high-definition camera
- 5 mm, 10 mm telescope with 0° and 30° lens
- Standard laparoscopic instruments.



Figure 4: Gallbladder covered with omentum



Figure 5: Clipping of the cystic artery and cystic duct

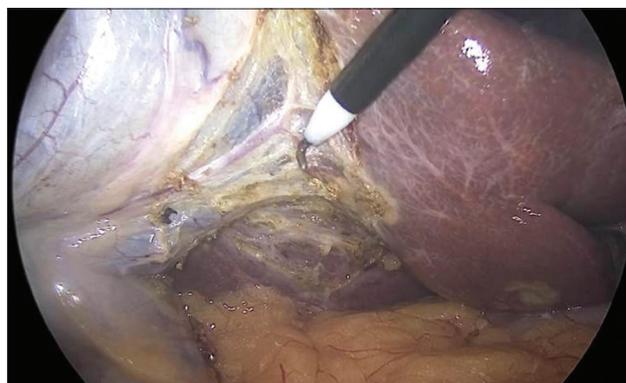


Figure 6: Dissection of GB from GB fossa. GB: Gallbladder

Phase of data collection

Demographic, clinical, laboratory, and radiological data of each patient were collected according to information in the case record sheet. Laboratory workup was done within 48 h of a patient’s admission, and the investigations were entered in the case record sheet. Pre-operative USG abdomen or a targeted GB scan was obtained. Cases were operated by an honorary consultant and professor of surgery. Operations were performed in the supine position, with open/closed



Figure 7: Extraction of GB and GB specimen with stones. GB: Gallbladder

insertion of one 10 mm umbilical port, one 10 mm epigastric port, and two 5 mm ports. The dissection began at Calot's triangle with retrograde dissection of the cystic pedicle using the "flag technique" to ensure the successful achievement of the Strasberg's critical view of safety.^[12] The cystic duct and cystic artery were exposed and then divided between clips. After complete dissection of GB, it was delivered out from the epigastric port.

The surgeries were divided into easy, moderate, or difficult LC as per the above-mentioned criteria in Table 1.

Phase of data analysis

All responses were tabulated in the Microsoft Excel 2021 spreadsheet. Graphical representations were made whenever necessary using Microsoft Excel 2021.

Statistical analysis

Categorical variables are described in terms of frequency (percentages) and continuous variables as the median (range) or mean (\pm standard deviation [SD]). Univariate analyses were conducted using a Student's *t*-test or a Mann–Whitney test for continuous variables as appropriate, and a Chi-square test or Fisher's exact test for categorical variables as appropriate. Predictive factors for intraoperative difficulty were tested using a contingency correlation coefficient. Significant variables were included in the backward stepwise logistic regression model for predicting difficult cholecystectomy. Tests that checked for differences in both directions were used, and if the *p*-value were 0.05 or less, the result were considered statistically significant. Data were analyzed using the IBM-SPSS® statistics application, version 25.

Phase of documentation

The analyzed data were compared and presented in the form of tables/graphs and the same is documented. The end point of the study was 1 month post-operative.

Table 1: Criteria used for operative assessment

	Easy	Moderate	Difficult
Time taken for surgery	< 60 mins	60–120 mins	> 120 mins
Injury to duct or artery	No	Yes	Yes/No
Conversion to open cholecystectomy	No	No	Yes
Need for blood transfusion	No	Yes	Yes/No

Table 2: Demographic data

Parameter	Value
Age (Mean \pm SD)	51.42 \pm 15.32
M: F Ratio	69M : 81F
BMI (Mean \pm SD)	24.39 \pm 2.06

Table 3: Distribution of comorbidities

Disease	Number (%)
DM	48 (32%)
HTN	36 (24%)
Hypothyroidism	13 (8.67%)
IHD	10 (6.67%)
Stroke	2 (1.33%)
CKD	2 (1.33%)
DM + HTN	20 (13.33%)

RESULTS

Gender

150 patients undergoing LC at our center were included in this study from March 2022 to March 2024. There are 69 males (46%) and 81 females (54%).

Age

The mean age (SD) of all the study participants was 51.42 (15.32) years.

Comorbidities

Diabetes mellitus (DM) was most commonly found in 48 (32%) study participants followed by hypertension (HTN) in 36 participants (24%). Around 20 participants (13.33%) had both DM and HTN. Hypothyroidism was found in 13 participants (8.67%) and ischemic heart disease in 10 participants (6.67%). A history of stroke and chronic kidney disease was reported in 2 participants each.

Addiction

A history of smoking was given by 12 male participants and 2 female participants, whereas a history of alcohol consumption was given by 24 male participants and 2 female participants.

Table 4: Clinical data of previous history

Parameter	Number (%) / Value
Previous Attack of Acute Cholecystitis	75 (50%)
History of ERCP	41 (27.33%)
History of Previous Abdominal Surgery	42 (28%)
Palpable Gall Bladder	3 (2%)
Peri Cholecystic Collection	15 (10%)
Impacted Stone	28 (18.67%)
CBD Dilatation	15 (10%)
Injury to Duct or Artery	15 (10%)
Conversion to Open Cholecystectomy	32 (21.33%)
Need for Blood Transfusion	11 (7.33%)
BMI	24.39 ± 2.06
Time Taken for Surgery	73.93 ± 31.08

Table 5: Comparison of results based on gender

Difficulty Level	Pre-operative Score		Post-operative Score	
	Male	Female	Male	Female
Easy	33 (48%)	47 (58%)	29 (42%)	47 (58%)
Moderate	23 (33%)	22 (27%)	23 (33%)	19 (23%)
Difficult	13 (19%)	12 (15%)	17 (25%)	15 (18%)
Total	69	81	69	81

The distribution is as follows (Figure 1):

Previous history

A history of previous attack of acute cholecystitis was found in 50 female and 15 male participants. A history of ERCP with stenting prior to surgery was reported in 16 females and 8 males. A history of previous abdominal surgery was noted in 25 females and 9 males. The distribution is as follows (Figure 2):

USG findings

The GB wall thickness of more than 4 mm was considered significant and was found in 26 males (17.33%) and 25 females (16.66%), whereas thin-walled GB less than or equal to 4 mm was found in 43 males (28.66%) and 56 females (46.66%). The pericholecystic collection was noted in 7 males (4.66%) and 8 females (6.66%). Impacted gallstones were found in 12 males (8%) and 16 females (10.66%). Common bile duct (CBD) dilation was noted in 9 males (6%) and 6 females (4%).

Operative data

Injury to duct, artery, or bowel was noted in 15 participants (10%). 32 cases (21.33%) were converted into open cholecystectomy. 11 cases (7.33%) needed blood transfusion intraoperatively or during immediate post-operative period.

The average time taken for surgery (SD) was 73.93 (31.08) min.

Comparison of results based on gender

- The pre-operative score was determined to be easy in 33 males and 47 females and postoperatively 29 males (87.87%) were found to be easy cases and all 47 females (100%) were categorized under easy LC.
- The pre-operative score was determined to be moderate in 23 males and 22 females and postoperatively all 23 males (100%) were found to be moderate LC cases and 19 females (86.36%) were categorized under moderate LC.
- The pre-operative score was determined to be difficult in 13 males and 12 females and postoperatively 17 males were found to be difficult cases and 15 females were categorized under difficult LC.

Comparison of results based on age distribution

- Pre-operative determination of easy LC was made in 34 cases in the age group of 20–40 years, 39 cases in the age group of 41–60 years, and 7 cases in the age group of more than 60 years. Postoperatively, 33 cases turned out to be easy in the age group of 20–40 years, 37 cases in the age group of 41–60 years, and 6 cases in the age group of more than 60 years.
- Pre-operative determination of moderate LC was made in 1 case in the age group of 20–40 years, 25 cases in the age group of 41–60 years, and 9 cases in the age group of more than 60 years. Postoperatively, 2 cases turned out to be moderate in the age group of 20–40 years, 22 cases in the age group of 41–60 years, and 18 cases in the age group of more than 60 years.
- Pre-operative determination of difficult LC was made in 8 cases in the age group of 41–60 years and 17 cases in the age group of more than 60 years and none in the age group of 20–40 years. Postoperatively, 13 cases turned out to be difficult in the age group of 41–60 years and 19 cases in the age group of more than 60 years.

DISCUSSION

In the last decades, the number of cholecystectomies has increased worldwide. This rising trend is mainly attributable to the diffusion of LC (about 90% of all the cholecystectomies) even in population where patients are covered by a national health system.^[4,5] When surgery is performed for gallstones, LC is surely the treatment of choice for the acute setting, with more than 80% of the procedures done with a laparoscopic approach. Primary open cholecystectomy is done by surgeons when the patient is elderly, in cases of gangrenous cholecystitis or if adhesions are expected due to previous abdominal surgery. The conversion rate ranges from 3% to 30%.^[6,7]

Some significant predictive factors are taken into consideration which could predict high-risk patients, so that the patient and the relatives could be counseled before about the probability of conversion into open surgery.

Table 6: Comparison of results based on age distribution

Age Group (years)	Pre-operative Score			Post-operative Score		
	20-40	41-60	>61	20-40	41-60	>61
Easy	34 (97%)	39 (54%)	7 (16%)	33 (94%)	37 (51%)	6 (14%)
Moderate	1 (3%)	25 (35%)	19 (44%)	2 (6%)	22 (31%)	18 (42%)
Difficult	0 (0%)	8 (11%)	17 (40%)	0 (0%)	13 (18%)	19 (44%)
Total	35	72	43	35	72	43

Table 7: Operative assessment result

Preoperative Score	Easy	Moderate	Difficult	Total
Easy	71	6	3	80
Moderate	5	33	7	45
Difficult	0	3	22	25
Total				150

Studies have shown that certain factors such as age, history of previous hospitalization, palpable GB, and GB thickness are statistically significant factors in prediction of difficult LC.

In this study, a total of 150 patients with symptomatic gallstone disease who underwent LC were included based on the inclusion and exclusion criteria. The period of the study was for 2 years, that is, from March 2022 to March 2024. The most common age group was between 45 and 55 years.

Poonam Gupta, Shesh Kumar, and Anil Kumar Keshari in their paper "Assessment of pre-operative factors for challenging LC" concluded that conversion or difficult LC was associated with age >50 years. Furthermore, age, sex, obesity, a raised total leucocyte count, and previous upper abdominal surgery are significant in predicting the conversion to open cholecystectomy.^[8]

The results of the study by Nikhil Agrawal, Sumitoy Singh, and Sudhir Khichy in their article "Preoperative Prediction of Difficult LC: A Scoring Method" stated that factors such as previous history of hospitalization, clinically palpable GB, impacted GB stone, pericholecystic collection, and abdominal scar due to previous abdominal surgery were found statistically significant in predicting difficult LC.^[9]

The research article "Study of a preoperative scoring system to predict difficult LC" published in the *Journal of Surgery and Surgical Research* by Ali et al. concluded that with the help of preoperative prediction, high-risk patients may be informed and counseled before about the probability of open conversion. Age >50 years, male sex, history of hospitalization due to acute cholecystitis, palpable GB, BMI >27.5, abdominal scar, thick-walled GB (>4 mm), and pericholecystic collection were found to be significant predictive factors for difficult LC through this study.^[10]

The research article "Validation of a scoring system to predict difficult LC" published in the *International Journal of Surgery* by Gupta et al. concluded that with the help of accurate prediction, high-risk patients may be informed beforehand regarding the probability of conversion of LC to open cholecystectomy.^[11]

Furthermore, there are other complications due to which conversion to open surgery might be needed. The blood supply to the GB is from the cystic artery. There is great variation in the course and origin of the cystic artery. The triangle of Calot or hepatocystic triangle is a surgical anatomical landmark created by the cystic duct on the lateral side, the common hepatic duct on the medial aspect, and the liver edge superiorly.^[12] Injury to the cystic artery in the region can lead to bleeding, and cauterizing the artery could compromise a certain amount of blood supply to the liver.

Another complication could be bile duct injury which can occur due to excessive upward traction on the GB and dissection at its infundibulum; at times the CBD can be parallel to the cystic duct, so unduly pulled upward while operating can appear in line with the cystic duct and be mistakenly injured.^[13,14]

It is important to avoid a rise in surgically induced morbidity,^[15] since the rate of iatrogenic major biliary injury (0.4%) counts for an almost threefold increase when compared to the traditional open cholecystectomy.^[16]

The anatomical variations are quite common in the triangle of Calot.^[17,18] Dissection of Calot's triangle is done to provide a critical view of safety which is necessary to minimize the risk of bile duct injury during cholecystectomy.^[19] Figure 3 is an image of aberrant right biliary duct noted while dissecting Calot's Triangle which can be damaged if critical view of safety is not defined.

If estimated prior, an expert surgeon along with his team can reduce the conversion to open surgery and this will definitely benefit the patient.^[20]

Time taken for surgery increases due to various factors such as:

1. Access related - More than 2 Veress needle attempts or alternate methods like open technique to be used.
2. Identification of GB - If GB covered with omentum/bowel loops and adhesions have to be divided (not separable by pulling) by the use of electrocautery (Figure 4).
3. Grasping of GB - Need of special instruments (with bigger jaw) for grasping or need of evacuation of GB before grasping required.
4. Adhesiolysis - Adhesions requiring cutting by electrocautery.
5. Calot's triangle dissection - More than 20 min time needed for Calot's triangle dissection.
6. Duct clipping - Wide/short duct requiring suture rather than

clipping or inadequate length to put two proximal and one distal clip (Figure 5).

7. Dissection from liver bed - Dissection of GB from liver bed requiring more than 20 min or perforation of GB (Figure 6).
8. Extraction of GB - Skin incision needs to be increased, piecemeal removal of GB, spillage of stones/bile during extraction (Figure 7).

CONCLUSION

Our study has shown that it is possible to predict difficulty preoperatively during LC and the chances of conversion to open cholecystectomy can be predicted. In our study, we found a history of acute cholecystitis, symptoms and signs of acute cholecystitis, male gender, contracted GB, GB wall thickness >4 mm, presence of pericholecystic fluid, and history of previous abdominal surgery and ERCP to be significant predictors of difficulty in LC.

Difficult LC or conversion to open surgery may result in prolonged operative time and hence the extended post operative stay for monitoring the patient, leading to increase in estimated hospitalization cost. As for the surgeons it leads to increased stress during operation, difficult in arranging help intra operatively or blood and blood products at the given moment, and time constraint to complete the planned OT list.

Therefore, it is an essential component of LC to identify the high-risk factors.

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How to cite this article: Desai S, Mehta K, Jeyakumar S, Chatterjee S. Pre-operative Predictors for Intraoperative Difficulty in Laparoscopic Cholecystectomy: A Prospective Observational Study. *Bombay Hosp J* 2024;66(3):6-12.

Source of support: Nil, **Conflicts of interest:** None

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