Original Article

Difficult Laparoscopic Cholecystectomy Predictors and its Significance: Our Experience

Shivam, Tanweer Karim, Sumit Chakravarti, Atul Jain, Gaurav Patel, Subhajeet Dey

Department of Surgery, ESI PGIMSR, New Delhi, India

Abstract

Background: Laparoscopic cholecystectomy (LC) has become the procedure of choice for the management of symptomatic gallstone disease. In LC, the surgeons encountered difficulties with acutely inflamed or gangrenous gallbladder (GB), dense adhesions at Calot's triangle, fibrotic and contracted GB, and cholecystoenteric fistula. Depending on the difficulty faced during the surgery, the outcome of LC may vary from abandoning the procedure or partial cholecystectomy to conversion into open cholecystectomy. Complications related to biliary tract or adjoining structures or vessels may also occur. Our aim was to assess the different preoperative factors in patients of cholelithiasis and ascertain the validity of the scoring system devised by Randhawa and Pujahari in preoperatively predicting the difficult LC in our hospital scenario. **Materials and Methods:** This hospital-based observational study was conducted in the Department of General Surgery for a period of 2 years. All diagnosed cases of cholelithiasis admitted for elective LC during the study period in our hospital were included in the study. **Results:** In total, 154 patients, aged≥50 years, history of hospitalization for acute cholecystitis (AC), body mass index of 25 kg/m^2 and more, abdominal scar, palpable GB, GB wall thickness ≥4 mm, pericholecystic collection, impacted stone found to be significant factors to predict difficult LC preoperatively. Endoscopic retrograde cholangiopancreatography and pancreatitis were found as independent risk factor for difficult LC. **Conclusion:** We recommend that the scoring system should be regularly used as a protocol for predicting difficulty levels preoperatively in LC. It can help to decide the surgical approach, counsel the patients, and reduce the complication rate, rate of conversion, and overall medical cost. The scoring system proposed by Randhawa and Pujahari is effective but has some lacunae.

Keywords: *Cholelithiasis, difficult laparoscopic cholecystectomy, easy laparoscopic cholecystectomy, scoring system*

Introduction

Cholelithiasis was first described in 1420 by a Florentine pathologist, Antonio Benivenius.[1] Further, Jean-Louis Petit, the founder of gallbladder (GB) surgery in 1733, had suggested the removal of gall stones and drainage of GB for gallstone disease.[2]

The first open cholecystectomy was performed on July 15, 1882, by a German surgeon Carl Johann August Langenbuch at the Lazarus Krankenhaus. Phillip Mouret performed the first laparoscopic cholecystectomy (LC) in 1987.[3] In India, Professor Tehempton E Udwadia from Mumbai performed the first LC in 1990 and presented the paper at the 10th world congress of digestive surgery in New Delhi.[4]

LC has become the procedure of choice for the management of symptomatic gallstone disease.[5] In LC, the surgeons encountered difficulties with acutely inflamed or gangrenous GB, dense adhesions at Calot's triangle, fibrotic and contracted GB, and cholecystoenteric fistula.[6] There are many risk factors identified that make laparoscopic surgery difficult such as male sex, old age, obesity, attacks of acute cholecystitis (AC), previous abdominal surgery, and certain ultrasonographic findings, that is, thickened GB wall, distended GB, pericholecystic fluid collection, and impacted stone at GB neck.[7] According to a similar study by Lee *et al*.,[8] the risk factors for conversion included age >65 years, male sex, patients with previous upper abdominal surgery, and a documented history of AC.

Depending on the difficulty faced during the surgery, the outcome of LC may vary

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Address for correspondence:
Dr. Atul Jain,
Department of Surgery,
ESI PGIMSR, M45H+4WX,
Ring Rd, Block W, Basai Dara pur, Bali Nagar, Basaidarapur,
New Delhi, India.
E-mail: docatuljain@gmail.com

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from abandoning the procedure or partial cholecystectomy to conversion into open cholecystectomy. Complications related to the biliary tract or adjoining structures or vessels may also occur.

If surgeons get an indication preoperatively then they may schedule the time and team for the operation appropriately. Patients predicted to have a high risk should be scheduled for longer hospitalization and more intensive postoperative care. This may also help the hospital administration to plan and predict admissions and bed vacancies more efficiently. Different methods have been suggested from time to time using different criteria, further adding to the controversy.

Our aim was to assess the different preoperative factors in patients with cholelithiasis and ascertain the validity of the scoring system devised by Randhawa and Pujahari[9] in preoperatively predicting the difficult LC in our hospital scenario.

Materials and Methods

Study setting

This hospital-based observational study was conducted in the Department of General Surgery after due permission from the Institutional Ethical Committee for a period of 2 years. All diagnosed cases of cholelithiasis admitted for elective LC during the study period in our hospital were included in the study and were operated by an experienced laparoscopic surgeon (operated LC for at least 5 years) in a single unit.

Inclusion criteria

All patients undergoing elective LC

Exclusion criteria

Patients having AC or suspected/proven malignancy and conversion due to technical problems.

Sample size

The sample size was calculated using, Med-Calc9.0.1 software for the area under the receiver-operating characteristic (ROC) curve for our study to compare the effective and non-effective scoring.

For alpha error or level of significance of 0.05 and for the power of study of 80% (or beta error of 20%) with ROC as 0.82.

The value of null hypothesis as 0.9 (if we assume our $H = 0$ the scoring system cannot predict the difficulty preoperatively, and we want to reject it completely so that we can prove that the proposed score can actually predict the difficulty the value of null hypothesis should be 0.9).

Then our sample size was 152.

But the total number of patients that followed us till the completion of the study was 154. Therefore, the final study sample size was 154.

Method for data collection

Patients were evaluated by detailed history and clinical examination. The diagnosis of cholelithiasis was established on ultrasonography and they underwent preoperative workup. The preoperative scoring based on the scoring system given by Randhawa and Pujahari[9] were calculated [Table 1].

Table 1: Preoperative scoring system to preoperatively predict difficulty in laparoscopic cholecystectomy[9]

Parameters			Score	Maximum score
History	Age	< 50 years	0	1
		≥50 years	1	
	Sex	Male	1	1
		Female	0	
	Hospitalization history for acute cholecystitis	Yes	4	4
		No	0	
Clinical	BMI Weight/Height KG/Metre^2	<25	0	2
		25–27.5	1	
		>27.5	2	
	Abdominal Scar	No	0	2
		Infraumbilical	1	
		Supraumbilical	2	
	Palpable gall bladder	Yes	1	1
		No	0	
Sonography	Wall thickness	Thin (<4 mm)	0	2
		Thick (≥4 mm)	2	
	Pericholecystic collection	Yes	1	1
		No	0	
	Impacted stone	Yes	1	1
		No	0	

Preoperative score up to 5 was defined as easy, 6–10 as difficult, and 11–15 as very difficult. By this, we preoperatively defined the difficulty level.

The timing was noted from the first port site incision till the closure of the last ports. All the intraoperative events were recorded. All cases received standard postoperative care and follow-up.

Intraoperative grading done on basis of difficulty levels into easy, difficult, and very difficult LC [Table 2].

Comparison was done between preoperative prediction and intra-operative finding (grading).

Statistical analysis

The presentation of the categorical variables was done in the form of numbers and percentages (%). On the contrary, the quantitative data were presented as the mean ± standard deviation (SD) and median with 25th and 75th percentiles (interquartile range). The data normality was checked by using the Kolmogorov–Smirnov test. For cases in which the data were not normal, we used nonparametric tests.

For quantitative variables, Mann–Whitney test (for two groups) and the Independent *t* test were used. For qualitative variables, chi-square test or Fisher's exact test was used. Inter-rater kappa agreement was used to find out the strength of agreement between preoperative prediction and intraoperative grading. Sensitivity, specificity, PPV (positive predictive value), and NPV (negative predictive value) of preoperative score findings were calculated.

Multivariate logistic regression was used to find out independent risk factors. The data entry was done in the Microsoft EXCEL spreadsheet, and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, version 21.0. For statistical significance, a value of $P < 0.05$ was considered statistically significant.

Results and Analysis

A total of 154 patients were included in the study as per inclusion and exclusion criteria.

The patient's age in our study was from 20 to 75 years with a mean age of 42.16 years. The maximum number of patients were of the age group 31–40 years 54 (31.08%) [Table 3].

Approximately 70.78% of patients were below 50 years of age ($n = 109$). Approximately 45 patients were of 50 years or above comprising 29.22%.

The number of female patients was 74 (48.05%) and male patients was 80 (51.95%). The number of males was more than females with a ratio of 1.08:1 [Table 3].

In total, 95 (61.69%) patients had no history of prior hospitalisation for AC, whereas 59 (38.31%) patients required hospitalisation for AC. None of them were operated in early phase of AC.

The number of patients with body mass index (BMI) below 25 was 93 (60.39%), whereas patients with BMI between 25 and 27.5 were 32 (20.78%) and with BMI above 27.5 was 29 (18.83%). The majority of the patients were with BMI under 25 kg/m^2. The mean BMI of our study group was 24.3 kg/m^2.

Out of 154 patients, only 39 (25.33%) patients had a history of previous abdominal surgery. Of them, 37 (24.03%) had infraumbilical abdominal scar and 2 (1.30%) had the supraumbilical abdominal scar.

In 154 patients, 33 (21.43%) had palpable GB.

On ultrasonography, 98 (63.64%) patients had a thickness of GB wall less than 4 mm, whereas 56 (36.36%) patients had a 4 mm or more thickness of GB wall. A total of 140 (90.91%) patients had no pericholecystic collection but 14 (9.09%) patients had pericholecystic collection. In total, 131 (85.06%) patients did not show any impacted stone, whereas 23 (14.94%) patients showed impacted stone on ultrasonography.

Table 2: Intraoperative grading of difficulty of LC[9]

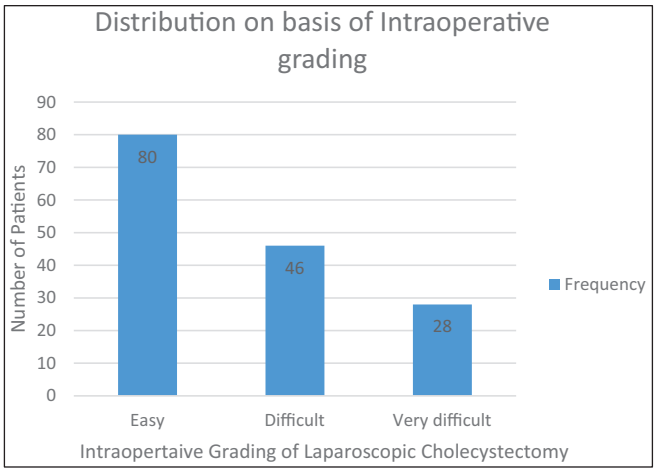
Intraoperative parameters	Grading
Time taken <60 min; no bile spillage; no injury to duct or artery	Easy
Time taken 60–120 min and/or bile or stone spillage and/or injury to duct	Difficult
Time taken >120 min or conversion	Very difficult

Table 3: Distribution of participants on basis of gender and age

Age (years)	Female ($n = 74$)	Male ($n = 80$)	Total
20–30	12 (16.22%)	13 (16.25%)	25 (16.23%)
31–40	23 (31.08%)	31 (38.75%)	54 (35.06%)
41–50	15 (20.27%)	17 (21.25%)	32 (20.78%)
51–60	21 (28.38%)	17 (21.25%)	38 (24.68%)
>60	3 (4.05%)	2 (2.50%)	5 (3.25%)
Total	74 (100%)	80 (100%)	154 (100%)

Table 4: Distribution on the basis of preoperative score for laparoscopic cholecystectomy

Preoperative score	Preoperative prediction of laparoscopic cholecystectomy	Frequency	%
Up to 5	Easy	92	59.74%
6–10	Difficult	41	26.62%
11–15	Very difficult	21	13.64%
Total		154	100%



Graph 1: Distribution on basis of intraoperative grading

Out of 154 patients, 92 (59.74%) patients had a preoperative score of 0 to 5 (easy LC), 41 (26.62%) patients had a preoperative score between 6 and 10 (difficult LC) and 21 (13.64%) patients had preoperative scores 11 to 15 (very difficult LC) [Table 4].

On basis of intraoperative parameters, 80 (51.95%) patients had easy LC, 46 (29.87%) patients had difficult LC, and 28 (18.18%) patients had very difficult LC [Graph 1].

Intraoperatively 7 (4.55%) patients had bile or stone spillage, whereas 1 (0.65%) patient had bile duct injury. In 24 (15.58%) patients, LC was converted to open cholecystectomy [Table 5].

The mean operative for cholecystectomy was 73.56 min with a range of 40–140 min. 80 (51.95%) patients LC was finished in less than 60 min, 67 (43.51%) patients' LC was finished in 60–120 min, and 7 (4.54%) patients cholecystectomy surgery was finished in more than 120 min.

Preoperative score for predicting difficult LC has the following features: 83.78% sensitivity with a 95% confidence interval of 73.39% to 91.33%; 100% specificity with a 95% confidence interval of 95.49% to 100.00%; and 100% PPV with a 95% confidence interval of 94.22% to 100.00%. It has an 86.96% NPV with a 95% confidence interval of 78.32% to 93.07%. Preoperative score for predicting difficult LC has 92.21% diagnostic accuracy [Table 6].

Fisher's exact test and Mann–Whitney test were used for preoperative score and it was found there is a significant association between preoperative score and difficult LC. It means our chosen preoperative score significantly predicts difficult LC [Table 7].

In 15 cases, the preoperative score and intraoperative grading did not match. Out of them, four patients had a history of endoscopic retrograde cholangiopancreatography (ERCP), in which there was difficult and very difficult LC. Four patients with a history of pancreatitis, and LC was also difficult to very difficult in contrast to preoperative score. Four patients had a history of ERCP as well as pancreatitis and LC was difficult or very difficult in contrast to preoperative score. In three cases preoperative score predicted easy LC, but we found difficult to very difficult LC because of more time taken or conversion to open cholecystectomy intraoperatively due to dense adhesions at Calot's triangle and between GB and surrounding structures with no factor predicting difficulty in LC preoperatively [Tables 5 and 8].

Multivariate logistic regression was used to find out the independent risk factors of the above variables for difficult LC and it was found that a history of ERCP and pancreatitis are independent risk factors for difficult LC [Table 9].

Discussion

Cholecystectomy is the most commonly performed surgery and after its introduction in 1985, LC has been termed as gold standard management for the disease of gallstone. Through the years LC has become a relatively safe procedure though occasionally it can be difficult due to certain reasons. Due to various difficulties faced while performing the LC, approximately 3%–35% of attempted LC have to be converted to the open procedure.[10,11] Preoperative assessment using clinical and radiological tools to predict the possibility of difficulty in carrying out LC can help in counseling patients.

In our study, age ≥50 years was found to be a significant factor that results in difficult LC. It correlates with different studies available in the literature.[8,12-16]

The possible reason for difficult cholecystectomy among patients with age ≥50 years could be that with age there is increased possibility of multiple attacks of AC and also increased frequency of abdominal surgeries. Therefore, there is an increased probability of fibrosis and adhesions in the hepatic hilum.[16] Similarly, studies in the western world in the past have implicated ages more than 65 years with difficulty in dissection of Calot's triangle and adhesiolysis.

Table 5: Distribution on the basis of preoperative score and intraoperative outcome of laparoscopic cholecystectomy (LC)

S. no.	Preoperative score		Intraoperative grading of LC		Time taken intraoperatively (min)			Conversion to open	Bile/stone spillage	Bile duct/Artery injury	Reasons for mismatch preop score and intraoperative grading			
					<60	60 to 120	>120				ERCP (E)	Pancreatitis (P)	E + P	Dense adhesions
1	0–5 (easy)	92	Easy	80	80	–	–	–	–	–	0	0	0	0
			Difficult	8	0	8	0	-	1	0	3	2	2	1
			Very difficult	4	0	3	1	4	0	0	1	0	2	1
			Total	92										
2	6–10 (difficult)	41	Easy	0	–	–	–	–	–	–	–	–	–	–
			Difficult	38	0	38	0	-	1	1	0	0	–	0
			Very difficult	3	0	2	1	2	0	0	0	2	–	1
			Total	41										
3	11–15 (very difficult)	21	Easy	0	–	–	–	–	–	–	–	–	–	–
			Difficult	0	–	–	–	–	–	–	–	–	–	–
			Very difficult	21	0	16	5	18	5	0	0	0	–	0
			Total	41										
Total		154	154					24	7	1	4	4	4	3

Generally, cholelithiasis is three times more common in females than men.[17] But in our study, the male:female ratio was 1.08:1 which may be due to the relatively small sample size limited to single-centre catering to labourer population.

Many studies have found the male gender as a significant factor that results in difficult LC.[8,13-16,18] In male patients, there is more intense inflammation and fibrosis that lead to more dense adhesions and further making dissection more difficult in LC.[16] There is a more frequent association with a severe form of the disease, that is, both acute and chronic cholecystitis and because of a higher percentage of intra-abdominal and visceral adipose tissue in men than women. Men are also less likely to seek medical attention than women.[13] In our study, there were difficult LC cases in male gender but statistically that was not significant. A small sample size could be the reason for this variation from the literature.

In our study, we found the history of hospitalisation for AC is a significant factor for predicting pre-operatively difficult LC. This may be due to difficult anatomy due to repeated cholecystitis causing adhesions of GB with adjacent organs.[19] Each attack of cholecystitis increases the GB wall thickness and the GB becomes scarred and fibrosed. It also increases the adhesions at Calot's triangle and between GB and fossa.[10] Dense adhesions cause difficult handling of GB and difficulty in dissection at Calot's triangle making LC difficult. Many studies have shown that a history of hospitalisation for AC is a significant factor for difficult LC.[5,9,10,12,16,19-23]

In our study, we found BMI 25 or more as a significant factor for predicting pre-operatively difficult LC by chi-square test ($P < 0.0001$) and independent t-test ($P < 0.0001$). Port placement in an obese patient takes a longer time due to thick abdominal wall. Dissection at the Calot's triangle is also technically difficult due to the obscure anatomy because of larger intraperitoneal fat and difficulty in manipulating the instruments through an highly thick abdominal wall.[10] Similar results were seen in different studies in the literature.[9,12,13,16,19]

In our study, we found previously abdominal scar is a significant factor for predicting preoperatively difficult LC. Supra-umbilical surgical scars led to the difficult creation of pneumoperitoneum and difficulty in accessing of the peritoneal cavity.[24] Previous upper abdominal surgery scar is associated with the higher rate of adhesions, an increased risk of operative complications, a greater conversion rate, a prolonged operating time and longer stay.[6] Abdominal scars (signifying previous abdominal surgeries) may cause the intraperitoneal adhesions formation that may cause an increased possibility of injury and bleeding during the placement of umbilical port.[6] Authors in different studies also found that previously abdominal surgery scar to be associated with difficult LC.[8,10,16,18]

Table 6: Sensitivity, specificity, PPV, and NPV of preoperative score for predicting difficult laparoscopic cholecystectomy

Preoperative score diagnostic accuracy	Values
Sensitivity (95% CI)	83.78% (73.39% to 91.33%)
Specificity (95% CI)	100% (95.49% to 100.00%)
Area under curve (AUC) (95% CI)	0.92 (0.86 to 0.96)
Positive predictive value (95% CI)	100% (94.22% to 100.00%)
Negative predictive value (95% CI)	86.96% (78.32% to 93.07%)
Diagnostic accuracy	92.21%

Table 7: Association of preoperative score with difficult laparoscopic cholecystectomy

Preoperative score	Easy (n = 80)	Difficult (n = 74)	Total	P Value	Significant/not significant
Preoperative prediction					
Easy (0–5)	80 (86.96%)	12 (13.04%)	92 (100%)	<.0001‡	Significant
Difficult (6–15)	0 (0%)	62 (100%)	62 (100%)		
Preoperative score					
Mean ± SD	0.88 ± 0.7	8.16 ± 3.28	4.38 ± 4.33	<.0001†	Significant
Median (25th–75th percentile)	1(0–1)	8(7–11)	2(1–8)		
Range	0–3	0–13	0–13		

‡ Fisher's exact test
† Mann–Whitney test
*For statistical purpose difficult and very difficult cases are counted together

Table 8: Distribution on the basis of P value of other variables

Other variables	Easy (n = 80)	Difficult (n = 74)	Total	P Value	Significant/nNot Significant
ERCP					
No	80 (54.79%)	66 (45.21%)	146 (100%)	0.002‡	Significant
Yes	0 (0%)	8 (100%)	8 (100%)		
Pancreatitis					
No	80 (54.79%)	66 (45.21%)	146 (100%)	0.002‡	Significant
Yes	0 (0%)	8 (100%)	8 (100%)		
Time more taken due to dense adhesions					
No	80 (52.98%)	71 (47.02%)	151 (100%)	0.109‡	Not significant
Yes	0 (0%)	3 (100%)	3(100%)		

‡ Fisher's exact test

Table 9: Multivariate logistic regression to find out independent risk factors of difficult laparoscopic cholecystectomy

Variable	Beta coefficient	Standard error	P Value	Odds ratio	Odds ratio lower bound (95%)	Odds ratio upper bound (95%)
Difficult	2.955	2.630	0.261	19.201	0.111	3326.205
ERCP	3.853	1.836	0.036	47.132	1.289	1723.463
Pancreatitis	5.541	2.000	0.006	254.844	5.053	12853.871

Palpable GB was a significant factor for predicting preoperatively difficult LC. Palpable GB could be due to a distended GB, mucocele GB, thick-walled GB, inflammation of GB (AC) or due to adhesions between the GB and the omentum.[10] Distended GB without inflammation may even have difficulty in holding GB intraoperatively and may need time to aspirate before removing from the port.[19] Similar results were seen in different studies.[5,9,10,12,20,21]

In our study, we found that GB wall thickness 4 mm or more on ultrasonography is a significant factor for predicting preoperatively difficult LC. GB wall thickness is related to the inflammation or fibrosis that follows previous attacks of AC and thus may reflect the difficulty in the delineation of the anatomy during surgery.[19] The presence of a thick GB wall may cause grasping and manipulation of GB difficult. This makes dissection at Calot's triangle and the GB bed to be the difficult and limits the extent of anatomical definition. Singh and Ohri[6] in their study also found that there is a statistically significant association of difficulty in GB grasping in pericholecystic inflammation and in distended GB. Similar results were found in different studies.[5,8,9,12,14,18-23,25]

In our study, we found the pericholecystic collection of GB on ultrasonography as a significant factor for predicting laparoscopic difficult cholecystectomy pre-operatively. In cases of pericholecystic fluid presence, there is an inflamed field with adhesions. The achievement of the critical view of safety (CVS) requires complete dissection of the fat and fibrous tissue in the Calot's triangle which cannot be performed easily in an inflamed field.[24] Similar results were found in different studies.[5,8,10,20,22]

In our study, we found impacted stone on ultrasonography as a significant factor for predicting preoperatively difficult LC. Impacted stone makes it difficult holding of the GB.[19] While performing LC, stone impacted at neck of GB poses few technical problems due to distension of the GB as it is with thick-walled GB. It is difficult to grasp the GB neck and we did not get adequate retraction for performing dissection at the Calot's triangle.[6] Similar results were found in different studies.[5,10,12,20,21]

In our study, we found that Randhawa and Pujahari's[9] scoring system significantly predicts pre-operatively difficult LC by Fisher's exact test ($P < 0.0001$) and Mann Whitney test ($P < 0.0001$).

In their studies, Randhawa and Pujahari,[9] Agarwal *et al.*,[10] Khetan and Yeola,[23] and Kumar and Baderiya[12] used Randhawa and Pujahari scoring system (the scoring system that we used) and it was able to predict preoperatively difficult LC significantly. It can be used effectively for preoperative prediction of difficult LC and further planning of surgery and post-operative care.

In our study, we found the past history of ERCP is a significant factor for predicting preoperatively difficult LC by fisher's exact ($P < 0.002$). Multivariate logistic regression was done and it was concluded that past history of ERCP is an independent risk factor to predict difficult LC pre-operatively with $P = 0.036$. We found dense adhesions at Calot's triangle and thickened GB in patients who had a past history of ERCP.

Raza and Venkata[20] found difficult LC in post-ERCP patients and advised modified Randhawa and Pujahari scoring system including post-ERCP as one additional parameter in the scoring system. Vivek *et al.*[16] and Nassar *et al.*[14] also found difficult LC in post-ERCP patients. These all studies had advised for scoring of 2 for past history of ERCP and 0 score for no ERCP history.

In our study, we concluded that the past history of pancreatitis is a significant factor for predicting pre-operatively difficult LC by fisher's exact ($P < 0.002$). Multivariate logistic regression was done and it was concluded that the past history of pancreatitis is the independent risk factor to predict difficult LC pre-operatively with $P = 0.006$. We found dense adhesions at Calot's triangle, between GB and surrounding structures and thickened GB in patients who had past history of pancreatitis. Vivek *et al.*[16] also found difficult LC in patients with peri-pancreatic fluid (suggesting pancreatitis) and given 1 score for pancreatitis and 0 for no history of pancreatitis.

Conclusion

We recommend that scoring system should be regularly used as a protocol for predicting difficulty level preoperatively in LC. It can help to decide the surgical approach, counsel the patients, reduce the complication rate, rate of conversion, and overall medical cost. Scoring system proposed by Randhawa and Pujahari is effective but has some lacunae. Keeping other factors (like pancreatitis and ERCP) in mind and incorporating them along with this scoring system can help the surgeon to plan the surgery with better vision of challenges that can come intraoperatively. However large sample size studies should be done to further evaluate these scoring systems.

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Conflicts of interest

There are no conflicts of interest.

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