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Assessment of difficult Laparoscopic cholecystectomy based on clinical and radiological findings

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Abstract

Background: Laparoscopic cholecystectomy is common procedure done in minimal invasive procedures. It is the treatment of choice for symptomatic gall stone disease all around the world.

Methodology: This is case control study done in 198 patients undergoing laparoscopic cholecystectomy. Patients randomly divided as case and controls based on preoperative clinical criteria and radiological features.

Results: 198 patients underwent laparoscopic cholecystectomy. Their mean age was 46.19 ± 13.03 years. There was female preponderance with 143 (72.2%) females as compared to 55 (27.8%) males. Difficult cholecystectomy was labelled in 55 (27.8%) cases based on intra-operative criteria mentioned in methodology. 13 (6.6%) required conversion to open cholecystectomy. Easy cholecystectomies scored 0.81 as compared to 8.18 in the difficult group. The sensitivity of the preoperative score in predicting difficult cases was 98.2% with the specificity of 95.8%; positive predictive value of 90.0% and the negative predictive value of 99.3%. The accuracy of the pre-operative scoring system was 96.56%. The area under the ROC curve (AUROC) for Preoperative Score predicting Surgery Difficulty: Difficult vs Surgery Difficulty: Easy was 0.992 (95% CI: 0.983 - 1), thus demonstrating excellent diagnostic performance.

Conclusion: The preoperative score has high sensitivity, specificity, and accuracy in predicting difficult cases and can be used for identifying difficult laparoscopic cholecystectomies.

Keywords: Difficult Laparoscopic cholecystectomy, Clinical, Radiological, factors for assessment of difficult cholecystectomy

Introduction

Laparoscopic cholecystectomy is the treatment of choice for the management of symptomatic gallstone disease. Several randomized controlled trials and systematic reviews have demonstrated the effectiveness and safety of Laparoscopic cholecystectomy for the treatment of symptomatic cholelithiasis [1]. Treatment of acute cholecystitis and its complications have been evolved dramatically [2], and there have been significant change in the management of patients since the introduction of the laparoscopic cholecystectomy in the mid 1990 [3]. Nowadays Laparoscopic Cholecystectomy has become the gold standard not only for routine gall bladder removal due to asymptomatic or symptomatic gall stones but also for the treatment of acute gall bladder inflammation [4].

Laparoscopic cholecystectomy is considered as difficult when there is difficult dissection, altered anatomy and increased risk of bleeding compared to standard cholecystectomy [5]. One of the most important aspects of safe Laparoscopic Cholecystectomy is a meticulous dissection of the structures in Calots triangle, i.e Cystic duct and cystic artery. Conversion rate from laparoscopic to open technique can be minimized by proper anatomy and basic principles of surgery and safe and meticulous dissection [6]. Risk factors for laparoscopic cholecystectomy are old age, male gender, attacks of acute cholecystitis, obesity, previous abdominal surgery (supraumbilical > infra-umbilical), clinical signs of acute cholecystitis, and Radiological findings like thickened gall bladder wall, distended gall bladder, pericholecystic fluid collection, and impacted stone in Hartman's pouch [7].

Predilection of complexity of laparoscopic cholecystectomy helps surgeons decide whether to proceed with a minimally invasive approach or perform an open procedure [8]. Hence the predictive score of operative difficulty is more important to identify high risk procedures. Predictive scoring is helpful to improve patient counselling, optimize surgical planning and detect patients at risk of complications and required necessary changes can be done in operative

technique. This study aims at identifying difficult laparoscopic cholecystectomies by clinical and radiological assessment and also the utility of Randhawa's pre-operative scoring based on intra-operative findings (Sugrue *et al*)^[9]. and final outcome of conversion rate and complications

Methodology: A Randomized control study done in 198 patients in tertiary care hospital after obtaining ethical clearance from the institutional ethical committee. All patients undergoing laparoscopic cholecystectomy included in the study. Patients <18 years in age, unfit for anesthesia and those not consenting to join the study were excluded. Details of the patient like demographic data, previous surgery or hospital admissions with cholecystitis, comorbidities, BMI, radiological findings, generalized condition of the patient are collected. A preoperative scoring was done for every patient based on the demographic clinical and imaging findings and the degree of operative difficulty was predicted using the scoring system introduced by Randhawa *et al*. The intra-operative scoring system proposed is based on the degree of potential difficulty with a score from 1 to 10. With this scoring system a score of <2 was considered easy, 2 to 4 moderately difficult, 5–7 very difficult, and 8 to 10, extremely difficult. The scores were compared in each patient to assess the reliability of pre-operative score. The outcome factors were studied in the form of difficult laparoscopic cholecystectomy, conversion to open and intra/post-operative complications

The degree of operative difficulty was assessed based on the

laparoscopic intra-operative findings using the scoring system introduced by Sugrue *et al*.^[9] TABLE 2

Table 1: Preoperative (Randhawa) scoring system.

Scoring factors		Score	Maximum score
History	Age	<50 yrs	0
		>50 yrs	1
	Gender	Male	1
		Female	0
History of hospitalization for acute cholecystitis	Yes	4	
	No	0	
Clinical parameters	BMI	<25	0
		25-27.5	1
		>25.5	2
	Abdominal scar	No	0
		Infraumbilical	1
		Supraumbilical	2
Palpable gall bladder	Yes	1	
	No	0	
Radiological parameters	Gall bladder wall thickness	Thin <4mm	0
		Thick >4mm	2
	Pericholecystic collection	No	0
		Yes	1
	Impacted stone in hartmanns pouch	No	0
		Yes	1
Total maximum score			15

Score up to 5 predicted easy, 6–10 difficult and >10 a very difficult laparoscopic cholecystectomy.

Table 2: Intra-operative Grading system for Difficult Laparoscopic Cholecystectomy

Scoring factors	Score	Maximum score
Gall bladder appearance	Adhesions <50%of gall bladder	1
	Adhesions burying the gall bladder	3
Distension/contraction	Distended or contracted shriveled gall bladder	1
	Unable to grasp the gall bladder with atraumatic laparoscopic forceps	1
	Stone of 1cm or >1cm impacted in the hartmann's pouch	1
Access	BMI >30	1
	Adhesions from previous surgery limiting access	1
Severe sepsis/complications	Bile or pus outside gall bladder	1
	Time to identify cystic artery and cystic duct >90min	1
Total score		10

The intra-operative scoring system proposed is based on the degree of potential difficulty with a score from 1 to 10.

Results: In this study 198 patients underwent laparoscopic cholecystectomy. Their mean age was 46.19 ± 13.03 years with a range of 20 to 80 years. There was female preponderance with 143 (72.2%) females as compared to 55 (27.8%) males. Table 1

Table 3: Summary of Preoperative Factors

Preoperative Factors	Mean ± SD Median (IQR) Min-Max Frequency (%)
Age (Years)	46.19 ± 13.03 44.50 (36.00-56.00) 21.00 - 80.00
Age	
<50 Years	116 (58.6%)
≥50 Years	82 (41.4%)
Gender	
Male	55 (27.8%)
Female	143 (72.2%)
Previous Abdominal Surgery (Present)	32 (16.2%)
Type of Previous Abdominal Surgery	
Supraumbilical	16 (8.1%)
Infraumbilical	16 (8.1%)
Previous Acute Calculus Cholecystis (Present)	42 (21.2%)
BMI	
<25 Kg/m2	137 (69.2%)
25-30 Kg/m2	55 (27.8%)

>30 Kg/m ²	6 (3.0%)
Palpable Gallbladder (Present)	7 (3.5%)
Gallbladder Wall Thickness	
<4 mm	136 (68.7%)
>4 mm	62 (31.3%)
Pericholecystic Fluid (Present)	26 (13.1%)
Stone In Hartman's Pouch (Present)	24 (12.1%)
Preoperative Score	2.86 ± 3.63 1.00 (0.00-6.75) 0.00 - 11.00
Predicted Difficulty	
Easy	143 (72.2%)
Difficult	55 (27.8%)
ERCP	
Done	15 (7.6%)
Not Done	183 (92.4%)

Difficult cholecystectomy was labelled in 55 (27.8%) cases based on intra-operative criteria mentioned in methodology. Of these 198 patients, 13 (6.6%) required conversion to open cholecystectomy. In order to predict difficult laparoscopic cholecystectomy based on preoperative predictors, a sub group analysis was carried out by dividing the patients into difficult cholecystectomy group and easy cholecystectomy group based on the intra-operative findings.

Age was found to be one of the risk factors with 46 (83.6%) out of the 55 patients above the age of 50 years undergoing a difficult laparoscopic cholecystectomy and the mean age of cases labelled as difficult was 56.91 ± 10.43 years as compared to 42.06 ± 11.52 years in the cases labelled as easy. (p value < 0.01)

On evaluating gender as a risk factor, it was observed that 21 (38.2%) out of 55 males underwent a difficult laparoscopic cholecystectomy as compared to 34 (61.8%) out of the 143 females. More number of males underwent difficult surgery [p value >0.043].

39 (70.9%) patient had history of hospitalization for prior attack of acute cholecystitis had difficult laparoscopic cholecystectomy 41 patients and its statistically significant (p<0.005). 16 patients

had previous history of abdominal surgery in past had underwent difficult laparoscopy out of 32 patients.

All patients who had palpable gall bladder was underwent laparoscopic cholecystectomy and it is one of the predictors of difficult laparoscopic cholecystectomy.

High BMI as a risk factor for difficult laparoscopic cholecystectomy. 41 (74.5%) patients has BMI of 25-30 underwent difficult laparoscopy as compared to 14 (9.8%) who underwent easy laparoscopic cholecystectomy and it was statistically significant (p<0.005).

It was observed that thickened gall bladder (chronic cholecystitis) was seen in 50 (90.9%) difficult laparoscopic cholecystectomy out of 62 patients which is statistically significant (p<0.005) so thickened gall bladder wall was a statistically significant predictor of difficult laparoscopic cholecystectomy.

Pericholecystic collection was seen in 26 (13.1%) patients; all of them had undergone a difficult laparoscopic cholecystectomy and is statistically significant predictor [p value > 0.05].

Stone impaction of Hartmann's pouch was noticed in 24 (12.1%) cases out of which 22 (40.0%) underwent a difficult laparoscopic cholecystectomy. (p value < 0.05)

Table 4: Association between Surgery Difficulty and Parameters

Parameters	Surgery Difficulty		P value
	Easy (n = 143)	Difficult (n = 55)	
Age (Years)***	42.06 ± 11.52	56.91 ± 10.43	<0.001 ¹
Age***			<0.001 ²
<50 Years	107 (74.8%)	9 (16.4%)	
≥50 Years	36 (25.2%)	46 (83.6%)	
Gender***			0.043 ²
Male	34 (23.8%)	21 (38.2%)	
Female	109 (76.2%)	34 (61.8%)	
Type of Previous Abdominal Surgery			1.000 ³
Supraumbilical	3 (42.9%)	13 (52.0%)	
Infraumbilical	4 (57.1%)	12 (48.0%)	
Previous Acute Calculus Cholecystitis (Present)***	3 (2.1%)	39 (70.9%)	<0.001 ²
BMI***			<0.001 ³
<25 Kg/m ²	128 (89.5%)	9 (16.4%)	
25-30 Kg/m ²	14 (9.8%)	41 (74.5%)	
>30 Kg/m ²	1 (0.7%)	5 (9.1%)	
Palpable Gallbladder (Present)***	0 (0.0%)	7 (12.7%)	<0.001 ³
Gallbladder Wall Thickness***			<0.001 ²
<4 mm	131 (91.6%)	5 (9.1%)	
>4 mm	12 (8.4%)	50 (90.9%)	
Pericholecystic Fluid (Present)***	0 (0.0%)	26 (47.3%)	<0.001 ²
Stone In Hartman's Pouch (Present)***	2 (1.4%)	22 (40.0%)	<0.001 ²
Preoperative Score***	0.81 ± 1.39	8.18 ± 1.73	<0.001 ¹
Predicted Difficulty***			<0.001 ²
Easy	140 (97.9%)	3 (5.5%)	
Difficult	3 (2.1%)	52 (94.5%)	

Adhesions***			<0.001 ²
<50% to Gall Bladder	140 (97.9%)	16 (29.1%)	
>50% to Gall Bladder	3 (2.1%)	39 (70.9%)	
Thick Gall Bladder (Present)***	0 (0.0%)	19 (34.5%)	<0.001 ²
Gallbladder Distension			0.235 ³
Contracted	0 (0.0%)	25 (53.2%)	
Distended	2 (100.0%)	22 (46.8%)	
Adhesions Due To Previous Suergery (Present)***	0 (0.0%)	44 (80.0%)	<0.001 ²
Duration For Identification Of Cystic Duct And Artery***			<0.001 ²
<90 Minutes	133 (93.0%)	6 (10.9%)	
>90 Minutes	10 (7.0%)	49 (89.1%)	
Impacted Stone In Hartaman's Pouch (Present)***	1 (0.7%)	27 (49.1%)	<0.001 ²
Ruptured Gallbladder (Present)***	0 (0.0%)	4 (7.3%)	0.005 ³
Lap Converted to Open (Yes)***	1 (0.7%)	12 (21.8%)	<0.001 ³
Post Operative Complications			0.479 ³
Absent	142 (99.3%)	54 (98.2%)	
Wound Infection	1 (0.7%)	1 (1.8%)	
ERCP (Done)***	4 (2.8%)	11 (20.0%)	<0.001 ³

***Significant at p<0.05, 1: Wilcoxon-Mann-Whitney U Test, 2: Chi-Squared Test, 3: Fisher's Exact Test

Based on intra-operative findings, difficulty of laparoscopic cholecystectomy was graded; they are gall bladder adhesions, distended or contracted gall bladder, inability to grasp the gall bladder using atraumatic laparoscopic forceps, stone impaction of Hartmann's pouch, time taken to identify and ligate the cystic artery > 90 minutes and intra-operative spillage of gall bladder contents. All of them had p value < 0.05 which was statistically significant. [Table 2].

Randhawa's pre-operative score evaluated based on the intraoperative findings; it was found that easy cholecystectomies scored 0.81 as compared to 8.18 in the difficult group. The sensitivity of the preoperative score in predicting difficult cases was 98.2% with the specificity of 95.8%; positive predictive value of 90.0% and the negative predictive value of 99.3% %. The accuracy of the pre-operative scoring system was 96.56%.

Table 5: Primary Diagnostic Parameters (sensitivity and specificity)

Variable	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy
Age (Years) (Cutoff: 48 by ROC)	87.3% (76-95)	72.7% (65-80)	55.2% (44-66)	93.7% (87-97)	76.8% (70-82)
Age	83.6% (71-92)	74.8% (67-82)	56.1% (45-67)	92.2% (86-96)	77.3% (71-83)
Gender	38.2% (25-52)	76.2% (68-83)	38.2% (25-52)	76.2% (68-83)	65.7% (59-72)
Previous Abdominal Surgery	45.5% (32-59)	95.1% (90-98)	78.1% (60-91)	81.9% (75-87)	81.3% (75-86)
Type of Previous Abdominal Surgery	52.0% (31-72)	57.1% (18-90)	81.2% (54-96)	25.0% (7-52)	53.1% (35-71)
Previous Acute Calculus Cholecystis	70.9% (57-82)	97.9% (94-100)	92.9% (81-99)	89.7% (84-94)	90.4% (85-94)
BMI	9.1% (3-20)	99.3% (96-100)	83.3% (36-100)	74.0% (67-80)	74.2% (68-80)
Palpable Gallbladder	12.7% (5-24)	100.0% (97-100)	100.0% (59-100)	74.9% (68-81)	75.8% (69-82)
Gallbladder Wall Thickness	90.9% (80-97)	91.6% (86-96)	80.6% (69-90)	96.3% (92-99)	91.4% (87-95)
Pericholecystic Fluid	47.3% (34-61)	100.0% (97-100)	100.0% (87-100)	83.1% (77-88)	85.4% (80-90)
Stone In Hartaman's Pouch	40.0% (27-54)	98.6% (95-100)	91.7% (73-99)	81.0% (74-87)	82.3% (76-87)
Preoperative Score (Cutoff: 4 by ROC)	98.2% (90-100)	95.8% (91-98)	90.0% (79-96)	99.3% (96-100)	96.5% (93-99)
Predicted Difficulty	94.5% (85-99)	97.9% (94-100)	94.5% (85-99)	97.9% (94-100)	97.0% (94-99)
Adhesions	70.9% (57-82)	97.9% (94-100)	92.9% (81-99)	89.7% (84-94)	90.4% (85-94)
Thick Gall Bladder	34.5% (22-49)	100.0% (97-100)	100.0% (82-100)	79.9% (73-85)	81.8% (76-87)
Gallbladder Distension	53.2% (38-68)	100.0% (16-100)	100.0% (86-100)	8.3% (1-27)	55.1% (40-69)
Adhesions Due To Previous Suergery	80.0% (67-90)	100.0% (97-100)	100.0% (92-100)	92.9% (88-96)	94.4% (90-97)
Duration For Identification Of Cystic Duct And Artery	89.1% (78-96)	93.0% (88-97)	83.1% (71-92)	95.7% (91-98)	91.9% (87-95)
Impacted Stone In Hartaman's Pouch	49.1% (35-63)	99.3% (96-100)	96.4% (82-100)	83.5% (77-89)	85.4% (80-90)
Ruptured Gallbladder	7.3% (2-18)	100.0% (97-100)	100.0% (40-100)	73.7% (67-80)	74.2% (68-80)
Lap Converted to Open	21.8% (12-35)	99.3% (96-100)	92.3% (64-100)	76.8% (70-83)	77.8% (71-83)

Table 6: Comparison of the Diagnostic Performance of Various Predictors in Predicting Surgery Difficulty: Difficult vs Surgery Difficulty: Easy (Full Sample)

Predictor	AUROC	95% CI	P	Sn	Sp	PPV	NPV	DA
Age (Years)	0.820	0.754-0.885	<0.001	87%	73%	55%	94%	77%
Preoperative Score	0.992	0.983-1	<0.001	98%	96%	90%	99%	96%

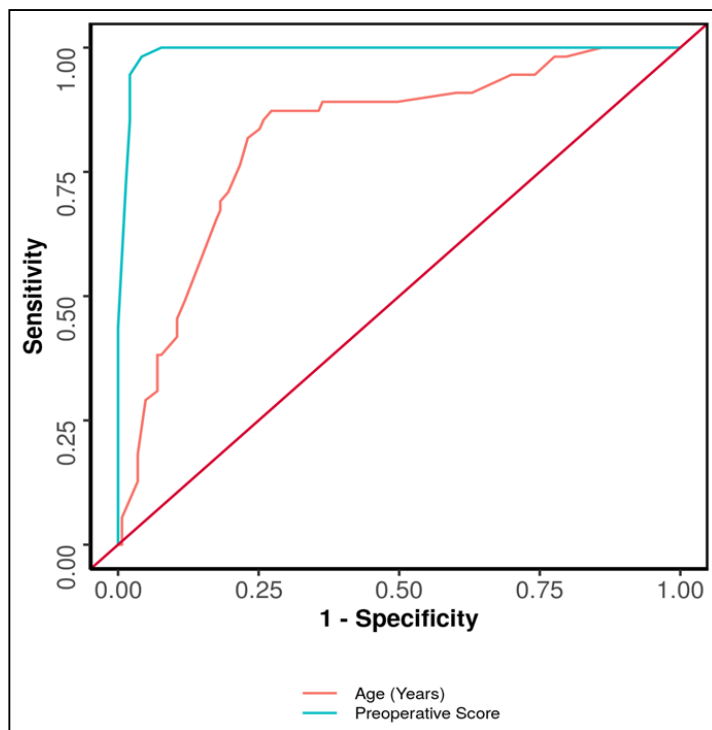


Fig 1: ROC curve (AUROC) for Age predicting Surgery Difficulty

The area under the ROC curve (AUROC) for Age (Years) predicting Surgery Difficulty: Difficult vs Surgery Difficulty: Easy was 0.82 (95% CI: 0.754 - 0.885), thus demonstrating good diagnostic performance. It was statistically significant ($p < 0.001$).

Table 7: Age of patient predicting difficult laparoscopic cholecystectomy

Parameter	Value (95% CI)
Cut off (p value)	≥ 48 (<0.001)
AUROC	0.82 (0.754 - 0.885)
Sensitivity	87.3% (76-95)
Specificity	72.7% (65-80)
Positive Predictive Value	55.2% (44-66)
Negative Predictive Value	93.7% (87-97)
Diagnostic Accuracy	76.8% (70-82)
Positive Likelihood Ratio	3.2 (2.4-4.26)
Negative Likelihood Ratio	0.18 (0.09-0.35)
Diagnostic Odds Ratio	18.29 (7.63-43.83)

At a cutoff of Age (Years) ≥ 48 , it predicts Surgery Difficulty: Difficult with a sensitivity of 87%, and a specificity of 73%.

The odds ratio (95% CI) for Surgery Difficulty: Difficult when Age (Years) is ≥ 48 was 16.83 (7.28-38.9). The relative risk (95% CI) for Surgery Difficulty: Difficult when Age (Years) is ≥ 48 was 7.97 (4.1-15.92).

The area under the ROC curve (AUROC) for Preoperative Score predicting Surgery Difficulty: Difficult vs Surgery Difficulty: Easy was 0.992 (95% CI: 0.983 - 1), thus demonstrating excellent diagnostic performance. ($p < 0.001$).

At a cutoff of Preoperative Score ≥ 4 , it predicts Surgery Difficulty: Difficult with a sensitivity of 98%, and a specificity of 96%.

The odds ratio (95% CI) for Surgery Difficulty: Difficult when Preoperative Score is ≥ 4 was 808.89 (158.22-4135.29). The relative risk (95% CI) for Surgery Difficulty: Difficult when Preoperative Score is ≥ 4 was 45.07 (15.76-132.24).

Table 8: Preoperative Score predicting laparoscopic cholecystectomy

Parameter	Value (95% CI)
Cutoff (p value)	≥ 4 (<0.001)
AUROC	0.992 (0.983 - 1)
Sensitivity	98.2% (90-100)
Specificity	95.8% (91-98)
Positive Predictive Value	90.0% (79-96)
Negative Predictive Value	99.3% (96-100)
Diagnostic Accuracy	96.5% (93-99)
Positive Likelihood Ratio	23.4 (10.68-51.25)
Negative Likelihood Ratio	0.02 (0-0.13)
Diagnostic Odds Ratio	1233 (145.03-10482.94)

Preoperative Score, Age (Years) significantly predicted Surgery Difficulty: Difficult. Trends:

Best parameter in terms of AUROC: Preoperative Score.

Best parameter in terms of sensitivity: Preoperative Score.

Best parameter in terms of specificity: Preoperative Score.

Best parameter in terms of positive predictive value: Preoperative Score.

Best parameter in terms of negative predictive value: Preoperative Score.

Best parameter in terms of diagnostic accuracy: Preoperative Score.

The diagnostic performance of Preoperative Score (AUC = 0.992) was significantly better than that of Age (Years) (AUC = 0.820) (DeLong's Test $p < 0.001$).

There was a significant difference between the various groups in terms of distribution of Palpable Gallbladder ($X^2 = 18.867$, $p < 0.001$).

Chi-squared test was used to explore the association between 'Surgery Difficulty' and 'Predicted Difficulty'.

There was a significant difference between the various groups in terms of distribution of Predicted Difficulty ($X^2 = 169.222$, $p < 0.001$).

Discussion

Laparoscopic cholecystectomy is a common operation which may vary in operative difficulty. Current literature however, suggests that the rate of intra-operative conversion from laparoscopic cholecystectomy to open cholecystectomy is 1%-15%^[10].

Conversion to open cholecystectomy is still high with difficult laparoscopic cholecystectomies^[11]. In patients with difficult laparoscopic cholecystectomies various other procedures are done like subtotal cholecystectomy, cholecystostomy, fundus first approach to reduce complications^[12].

Age more than 50 years have a significant risk factor for difficult laparoscopic cholecystectomy in this study. It is consistent with results in literature^[13]. The reason for older age being at risk of difficult laparoscopic cholecystectomy is due to a longer history of gallstones and increased number of acute attacks of cholecystitis. In literature, Elderly patients have a higher likelihood of complicated biliary pathology^[14].

Males are at a higher risk of difficult gall bladder^[15]. In our study a greater number of male patients had difficult laparoscopic cholecystectomy but it is not statistically significant but is consistent with literature^[16].

In our study history of prior attacks of acute cholecystitis was considered as a risk factor for difficult laparoscopic cholecystectomy which is quite consistent with literature^[17]. Patient, who require hospitalization for repeated attacks of acute cholecystitis, carry more chances of difficult laparoscopic cholecystectomy and conversion, probably due to dense adhesions at calot's triangle and gall bladder fossa.

History of previous upper or lower abdominal surgery was not associated with difficult laparoscopic cholecystectomy in our study. In our study BMI of 25-30 has greater chances of difficult laparoscopic cholecystectomy and is statistically significant.^[18] Stone impaction at the neck or Hartman's pouch results hindrance in holding of the gallbladder during dissection^[19].

Based on intra-operative findings of the operating surgeon, gall bladder adhesions were noted to be associated with difficult laparoscopic cholecystectomy which is quite consistent with the literature^[20].

Predictive score should be able to stratify intra-operative difficulty with a simple scale of operative difficulty would have the advantages of assisting in intra-operative strategy and planning, allowing comparison across different research studies, facilitating risk adjustment for surgical outcomes and providing an aid in training surgeons and monitoring of training progression

Conclusion

Preoperative score has high sensitivity, specificity, and accuracy in predicting difficult cases and can be used for identifying difficult laparoscopic cholecystectomies.

The risk of difficult laparoscopic cholecystectomy increases with age. Also, prior hospitalization for acute cholecystitis is clinical risk factor associated with difficult laparoscopic cholecystectomy. On imaging studies, thick gall bladder wall and impacted stone in the Hartmann's pouch are risk factors for difficult laparoscopic cholecystectomy.

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