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Research Article

Predicting operative difficulties during laparoscopic cholecystectomy using clinical and imaging criteria

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Abstract:

Introduction: Laparoscopic cholecystectomy has become the procedure of choice for the management of symptomatic gallstone disease. Difficulty in laparoscopic cholecystectomy is often encountered by surgeons and is associated with complications and a higher conversion rate. This study aims at identifying difficult laparoscopic cholecystectomies by clinical and imaging assessment and determining the utility of a pre-operative difficulty scoring system based on intra-operative findings.

Patients and Methods: A hospital based observational study was conducted including all patients above age 18 years undergoing laparoscopic cholecystectomy. Randhawa's preoperative score was calculated for every patient based on history, clinical and imaging parameters and the degree of operative difficulty was predicted. Another scoring was done using Sugrue's scoring system based on intra-operative findings. The outcome factors studied were degree of operative difficulty or need for conversion and intra-operative and post-operative complications. The statistical analysis was done by using EPI INFO software version 7.

Results: A total 84 patients with mean age 42.96 ±14.34 years with 58 females and 26 males were enrolled. Of them 28 (33.33%) had difficult laparoscopic cholecystectomies. The conversion rate to open cholecystectomy was 9.52%. Age above 50 years, prior history of acute cholecystitis, thickened gall bladder wall and stone impaction of Hartmann's pouch were statistically significant pre-operative risk factors. The sensitivity of the preoperative score in identifying difficult cases was 85.7% with the specificity of 96.43%; positive predictive value of 92.31% and the negative predictive value of 93.10% and the accuracy was 92.86%.

Conclusion: Pre-operative score and intra-operative findings are helpful in identifying difficult laparoscopic cholecystectomy.

Keywords: Difficult Laparoscopic cholecystectomy, Predictive factors for difficult cholecystectomy.

1. Introduction

Laparoscopic cholecystectomy has become the procedure of choice for the management of symptomatic gallstone disease. Advantages of laparoscopic cholecystectomy compared with open cholecystectomy are well described and usually include decreased postoperative pain, shorter ileus, earlier oral intake, and earlier return to normal activities with better cosmesis.[1] "Difficult gallbladder" (DGB) is a term coined to denote a procedure with an increased surgical risk compared to standard cholecystectomies and has been associated with difficult dissection, altered anatomy and increased risk of bleeding.[2,3] It is reported with an incidence of up to 26% in large series and a conversion rate of up to 26.5%.[4] There are many risk factors which make laparoscopic surgery difficult like old age, male gender, attacks of acute cholecystitis with fever and leukocytosis, obesity, previous abdominal surgery, clinical signs of acute cholecystitis, and some specific ultrasonographic findings i.e. thickened gall bladder wall, distended gall bladder, pericholecystic fluid collection, and impacted stone. [5]

Preoperative complexity estimation helps surgeons decide whether to proceed with a minimally invasive approach or perform an open procedure.[6] The use of a predictive score of operative difficulty is thus of primary interest to identify high-risk procedures and could be helpful to improve patient counselling, optimize surgical planning and operating room efficiency, detect patients at risk of complications and change, when necessary, the operative technique. This study aims at identifying difficult laparoscopic cholecystectomies by clinico-imaging assessment and also at assessing the utility of Randhawa's pre-operative scoring based on intra-operative findings and final outcome of conversion rate and complications.

2. Patients and Methods:

An observational study was carried out at a tertiary care hospital after obtaining ethical clearance from institutional ethics committee. All patients undergoing laparoscopic cholecystectomy for various indications such as cholelithiasis, acalculous cholecystitis, gall bladder polyps or porcelain gall bladder, were included in this study. Patients <18 years in age, unfit for anesthesia and those not consenting to join the study were excluded. 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.[7] **[Table 1]**

TABLE 1 - Preoperative (Randhawa) scoring system[7]

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

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

The degree of operative difficulty was assessed based on the laparoscopic intra-operative findings using the scoring system introduced by Sugrue et.al. [8] **[TABLE 2].**

TABLE 2 -Intra-operative Grading system for Difficult Laparoscopic Cholecystectomy (Sugrue et.al.)[8]

Scoring factors		Score	Maximum score
Gall bladder appearance	Adhesions < 50% of gall bladder	1	3
	Adhesions burying the gall bladder	3	
Distension/ Contraction	Distended or Contracted shriveled Gall Bladder	1	3
	Unable to grasp the gall bladder with atraumatic laparoscopic forceps	1	
	Stone of 1 cm or > 1 cm impacted in the Hartman's pouch	1	
Access	BMI > 30	1	
	Adhesions from previous surgery limiting access	1	2
Severe Sepsis/ Complication	Bile or Pus outside gall bladder	1	1
Time to identify cystic artery and cystic duct > 90 minutes		1	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. 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 studied were degree of operative difficulty or need for conversion and intra-operative and post-operative complications.

The statistical analysis was done by using EPI INFO software version 7. Univariate and multivariate regression analysis was carried out. Kaplan Maeir survivor analysis was also done to find out the cut off levels of pre-operative and intra-operative scoring.

3. Observations and Results

A total of 84 patients who underwent laparoscopic cholecystectomy were enrolled in present study. Their mean age was 42.96 ± 14.34 years with a range of 18 to 80 years. There was female preponderance with 58 (69.05%) females as compared to 26 (30.95%) males and a male: female ratio of 1:2.23. Difficult cholecystectomy was labelled in 28(33.33%) cases based on intra-operative criteria mentioned in methodology. Of these 28 patients, 8(28.57%) required conversion to open cholecystectomy. The overall conversion rate in this study was 9.52%.

With an aim to identify predictors of difficult laparoscopic cholecystectomy 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 16 (53.33%) out of the 30 patients above the age of 50 years undergoing a difficult laparoscopic cholecystectomy and the mean age of cases labelled as difficult was 50.29 ±12.298 years as compared to 39.3 ± 13.974 years in the cases labelled as easy. This was statistically significant with p value < 0.01.On evaluating gender as a risk factor, it was observed that 12 (46.15%) out of 26 males underwent a difficult laparoscopic cholecystectomy as compared to 16(27.59%) out of the 58 females. Although numerically it appears that male gender is a risk factor for difficult laparoscopic cholecystectomy, however statistical significance was not found [p value >0.05]. On assessing the role of BMI as a risk factor it was noted that 9 (34.62%) out of the 26 patients that had a BMI greater than 25, underwent a difficult laparoscopic cholecystectomy. Statistical significance of BMI as a risk factor was not found with [p value >0.05]. The history of hospitalization for prior attack of acute cholecystitis was inquired for and noted in 31(36.9%) patients. Of them, 21 (67.74%) underwent a difficult laparoscopic cholecystectomy. This factor was found to be statistically significant with p value < 0.01. History of undergoing abdominal surgery in past was inquired and presence of an abdominal scar was looked for and noted during examination and was found to be present in 27 patients; of which 12(44.45%) underwent difficult laparoscopic cholecystectomy. However, history of previous abdominal surgery was not found to be a predictor of difficult laparoscopic cholecystectomy [p value> 0.05]. None of the 84 subjects that underwent laparoscopic cholecystectomy had a palpable gall bladder which was supposed to be one of the predictors of difficult laparoscopic cholecystectomy.

On evaluating the patients using imaging modalities it was observed that thickened gall bladder which was suggestive of chronic cholecystitis was seen in 32(38.1%) patients. Of them 19 (59.38%) underwent a difficult laparoscopic cholecystectomy. Hence Thickened gall bladder wall was a statistically significant predictor of difficult laparoscopic cholecystectomy with p value < 0.01. Another imaging finding that is pericholecystic collection was seen in 15 (17.86%) patients. Of them 8(53.33%) underwent a difficult laparoscopic cholecystectomy. However, it was not a statistically significant predictor [p value > 0.05]. Stone impaction of Hartmann's pouch was noticed in 16(19.05%) cases out of which 14(87.5%) underwent a difficult laparoscopic cholecystectomy. This was statistically significant with p value < 0.01.

On evaluating the intra-operative findings based on which the difficulty of laparoscopic cholecystectomy was graded it was observed that; 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 were harbingers of difficult laparoscopic cholecystectomy with a p value < 0.01.[Table 3]. Intra-abdominal adhesions from previous surgeries and obesity which can limiting the access to gall bladder were not found to be associated with difficult laparoscopic cholecystectomy with statistical significance.

In cases of conventional laparoscopic cholecystectomy, the mean operative time of those which were graded as easy was 64.02 ± 10.38 minutes and range was between 40 to 95 minutes whereas in cases found to be difficult the operative time ranged between 75 to 150 minutes with a mean of 110 ± 19.003 minutes. This was statistically significant with p value < 0.01 suggesting difficult procedure obviously needed longer duration for completion of procedure. On evaluating the Randhawa's pre-operative score based on the intra-operative findings, it was found that easy cholecystectomies scored 2.52 ±1.81 as compared to 7.25 ±2.22 in the difficult group. The sensitivity of the preoperative score in predicting difficult cases was 85.7% with the specificity of 96.43%; positive predictive value of 92.31% and the negative predictive value of 93.10%. The accuracy of the pre-operative scoring system was 92.86%. It was observed that the subjects that were labelled to have undergone easy laparoscopic cholecystectomy the mean intra-operative score (Sugrue et. al.) was 1.32 ± 0.956 and all the subjects that were labelled to have undergone difficult laparoscopic cholecystectomy the mean score was 5.79 ± 1.067

A multivariate analysis was carried out of the factors found to be significant by univariate analysis and it was observed that no singular factor was independently identifiable with difficult laparoscopic cholecystectomy.

Table 3 showing univariate analysis of intra-operative parameters

Serial number	Patient charecteristics (N=84)		Intra-operative outcome based on grading		Univariate analysis P value
			Difficult	Easy	
1.	Amount of gall bladder adhesions	≥ 50%	13(100%)	0	<0.01
		< 50%	14(50%)	14(50%)	
		No adhesions	1(2.33%)	42(97.67%)	
2.	Distended/Contracted gall bladder	Yes	20(47.62%)	22(52.38%)	<0.005
		No	8(19.05%)	34(80.95%)	
3.	Inability to grasp the gall bladder with atraumatic laparoscopic forceps	Yes	22(68.75%)	13(37.14%)	<0.01
		No	6(11.54%)	43(87.75%)	
4.	Intra-operative spillage of gall bladder contents	Yes	22(81.48%)	5(18.52%)	<0.01
		No	6(10.53%)	51(89.47%)	
5.	Time taken to identify cystic artery	≥ 90 minutes	19(86.36%)	3(13.64%)	<0.01
		< 90 minutes	9(13.85%)	53(85.48%)	

On carrying out Kaplan-Maeir survival analysis and plotting a receiver operating curve of pre-operative score and intra-operative score; the pre-operative cut off score for difficult laparoscopic cholecystectomy was found to be 6 or more [Figure 1] and the intra-operative cut off score was 5 or more, [Figure 2] suggesting that any pre-operative score of 6 or more was associated with difficult laparoscopic cholecystectomy while intra-operative score of 5 or more was suggestive of difficult laparoscopic cholecystcetomy.

Figure 1. ROC of pre-operative score

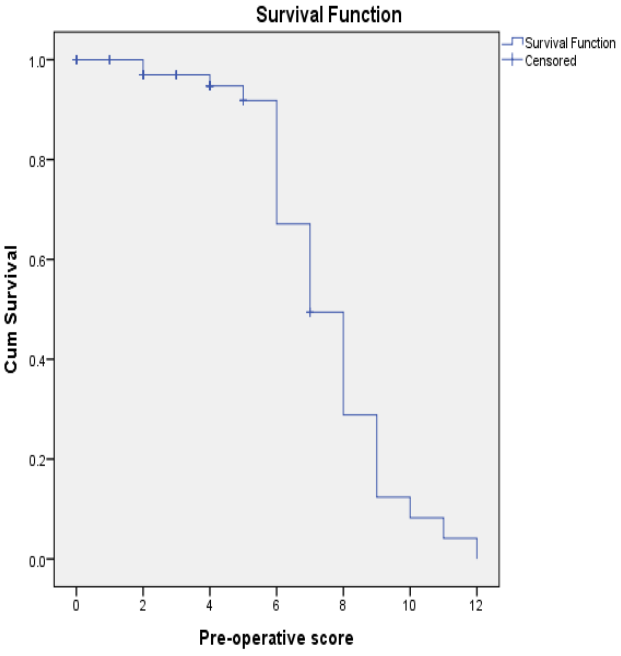
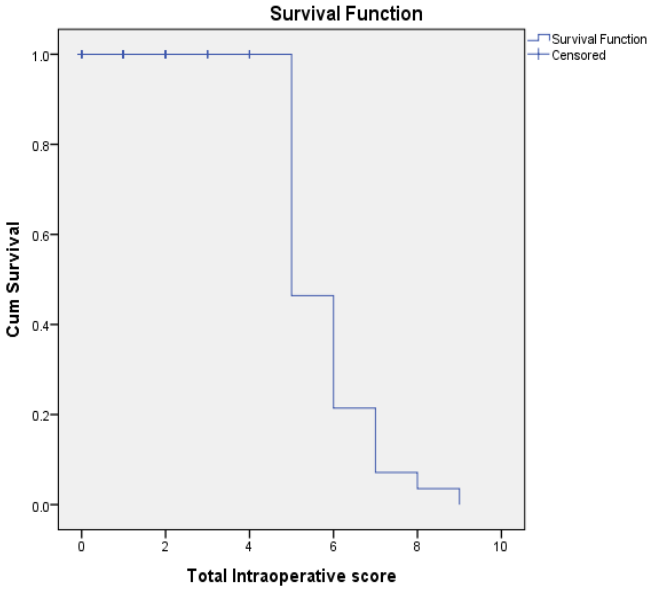


Figure 2. ROC of intra-operative score.



4. Discussion :

Cholecystectomy is currently one of the commonest reasons for admission to hospital with an associated mortality of 0.45 to 6% depending on severity of gallbladder disease.[9] With technological advancement and increase in the expertise, the complication rate has reached a remarkably low level at 2.0-6.0%.[10] Current literature however, suggests that the rate of intra-operative conversion from laparoscopic cholecystectomy to open cholecystectomy is 1%-15%.[11-13] Difficult laparoscopic cholecystectomy still, is associated with serious operative and postoperative complications and a relatively high conversion rate.[14] Various "damage control" procedures, such as cholecystostomy (percutaneous or trocar site), fundus first approach, subtotal cholecystectomy and more recently, an "inside approach" have been proposed to reduce the risk of intra-operative complication in cases of difficult laparoscopic cholecystectomy. [15]

Age above 50 years proved to be a significant risk factor for difficult laparoscopic cholecystectomy in this study. It is consistent with results in literature.[16] 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. Besides, elderly patients have a higher likelihood of complicated biliary pathology.[17-19] Males are at a higher risk of difficult gall bladder.[1,20] Men with symptomatic gall bladder are more prone to inflammation and fibrosis with the same disease intensity thus leading to difficulty in dissection. They obtained higher levels of collagen, hydroxyproline, macrophages, mast cells and eosinophils in gallbladder wall and pericholecystic tissue which might explain the male fibrogenic propensity.[21] Also, men tend to present late as they pay less attention to subtle symptoms, therefore, may have more advanced disease.[22] However, in present study no statistical significance was found to co-relate male gender with difficult laparoscopic cholecystectomy; and these results are quite consistent with literature.[8,23] BMI >30 to be significantly associated with difficulty in umbilical port entry and creating pneumoperitoneum.[24,25] Present study did not identify raised BMI as a risk factor for difficult laparoscopic cholecystectomy. These results are consistent with some studies.[23] However, other studies did recognize raised BMI as a risk factor.[26]

In present study history of prior attacks of acute cholecystitis was identified as a risk factor for difficult laparoscopic cholecystectomy which is quite consistent with literature.[27-29] 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.[30,31] History of previous upper or lower abdominal surgery was not associated with difficult laparoscopic cholecystectomy in present study, which is consistent with some of the available literature[8,23]. However, some studies reported prior history of abdominal surgery as a risk factor.[32] Previous abdominal surgery may lead to adhesions between viscera or omentum and abdominal wall. There may be chances of injury to these structures during insertion of first port and risk of conversion.[14,24] Thickened gall bladder wall as a predictor of difficult laparoscopic cholecystectomy in this study and these results are consistent with the literature.[16,33]. Gallbladder wall thickness greater than 3mm is suggestive of cholecystitis.[33] Presence of pericholecystic collection signifies acute cholecystitis and also makes visualization of the gall bladder difficult. Presence of pericholecystic collection was not identified as a risk factor for difficult laparoscopic cholecystectomy in this study. However, in literature pericholecystic collection was identified as a significant risk factor for difficult laparoscopic cholecystectomy. Stone impaction of Hartmann's pouch was identified as a risk factor for difficult gall bladder in this study and these results are consistent with literature. Stone impaction at the neck or Hartman's pouch results hindrance in holding of the gallbladder during dissection. [23,32]

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.[26]

Difficulty in gall bladder grasping was associated significantly with contracted gall bladder, distended gall bladder. A distended gall bladder or a gall bladder filled with stones is not easily grasped because it tends to slip away. Presence of inflammation around the gall bladder makes the wall friable and oedematous, thus posing problems to grasping.

5. Conclusion

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. The preoperative score (Randhawa) has high sensitivity, specificity, and accuracy in predicting difficult cases and can be used as a benchmark for identifying difficult laparoscopic cholecystectomies.

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