Prediction of Difficult Laparoscopic Cholecystectomy by Adoption of a Pre-Operative Scoring System

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ABSTRACT

BACKGROUND
Though Laparoscopic Cholecystectomy (LC), is considered as gold standard treatment for cholelithiasis, it is hard to predict whether it will be easy or a difficult one. At present no widely accepted scoring system can predict the difficulty and the level of difficulty in LC. Our study was done to formulate a scoring system for pre-operative prediction of difficult LC and identify those variables which contribute to difficult LC.

METHODS
Patients having symptomatic gall stone disease of both sexes of any age admitted under Department of Surgery in a tertiary level teaching hospital in Kolkata who subsequently underwent LC by a single experienced surgeon with > 5 years of experience in performing LC from June 2010 to May 2011 (1 year) were included in the study whereas cases of LC converted to open procedure for instrument failure were excluded from the study. We used eleven variables [age, sex, previous admission with biliary symptoms, BMI, abdominal surgical scar, palpable gall bladder, thick walled gall bladder, pericholecystic oedema, contracted / intrahepatic gall bladder, number of gall stones, stone impaction at GB neck] with relevant weightage of scoring to each.

RESULTS
The scoring system we used was a pre-validated one on Indian population with mild modification. Out of 108 patients, the scoring system predicted easy LC for 74, and difficult for 34. Per operatively, 68 patients had an easy and 40 a difficult LC. Univariate analysis showed h / o hospitalisation with biliary symptoms, GB wall thickness, pericholecystic oedema and stone impaction at GB neck were statistically significant predictors of difficult LC. Intra-hepatic and / or contracted GB had 100 % association with difficult LC. Multivariate analysis revealed h / o hospitalization with biliary symptoms, GB wall thickness and stone impaction at GB neck had significant contribution in difficult LC. Sensitivity of the scoring system was 95.59 % and 77.5 %, specificity 77.5 % and 95.59 %, positive predictive values 87.84 % and 91.12 % and negative predictive values 91.12 % and 87.84 % respectively for easy and difficult predictions. Discordance between pre-operative prediction and per-operative observations was statistically insignificant [McNemar χ^2 = 2.083 p = 0.01] which adds to strength of validity of the scoring system.

CONCLUSIONS
This scoring system successfully predicts difficult LC preoperatively. The study also identified the factors (h / o hospitalization with biliary symptoms, thick walled GB and stone impaction at GB neck) causing difficult LC.

KEYWORDS
Scoring, Prediction, Difficult Laparoscopic Cholecystectomy

BACKGROUND

LC nowadays is the gold standard treatment for cholelithiasis. The reasons behind its wide popularity are its less invasiveness, minimal pain and quick recovery and that is the reason that some centres now perform it even as a day care procedure. But at times LC becomes difficult and occasionally may require conversion. A pre-operative idea regarding the intra operative difficulty is thus very essential for preparedness of the operating team to prevent or minimise the complications and to have an uneventful surgical outcome. Often it becomes very difficult to identify the patient in whom LC will be difficult and more so to predict the degree of such difficulty. At present there are very few scoring systems for such prediction. So, the current study has been done to work-up one such system for predicting the same which will help a lot in selecting patients for elective LC. The study was aimed to assess pre-operative prediction of difficult LC as well as to identify the factors responsible for the difficulty.

Objectives
a. To assess the specificity, sensitivity, positive and negative predictive values of the scoring system.
b. To determine the factors responsible for difficult LC.

METHODS

Study Design
Institution based prospective observational study.

History					Max Score
1	Age	< 50 yrs. (0)	> 50 yrs. (1)		1
2	Sex	Female (0)	Male (1)		1
3	H / o hospitalisation With biliary symptoms	No (0)	Yes (4)		4
Clinical Features					
1	BMI	< 25 (0)	25 - 29.9 (1)	> 30 (2)	2
2	Abdominal scar (due to intra-abdominal surgery)	No (0)	Infra-umbilical (1)	Supra-umbilical (2)	2
3	Palpable gall bladder	No (0)	Yes (1)		1
USG					
1	Gb wall thickness	Thin,< 4 mm (0)	Thick, > 4 mm (2)		2
2	Pericholecystic collection	No (0)	Yes (1)		1
3	Contracted & / or intrahepatic GB	No (0)	Yes (3)		3
5	Number of gall stones	Single (0)	Multiple (1)		1
6	Stone impaction at GB neck	No (0)	Yes (2)		2
			Minimum score - 0	Maximum score -	20
Table 1. Scoring Factors					

Sample Size and Technique of Sampling
Sample size was 108. All cases of elective LC for symptomatic gall stone disease admitted under the Department of Surgery, Calcutta National Medical College & Hospital, Kolkata, and operated (after getting due consent)

by a single experienced surgeon (faculty member of the Department of General Surgery with > 5 years of experience in performing laparoscopic cholecystectomy) for the period from June 2010 - May 2011 were included in the study.

We used eleven variables [age, sex, previous admission with biliary symptoms, BMI, abdominal surgical scar, palpable gall bladder, thick walled gall bladder, pericholecystic oedema, contracted / intrahepatic gall bladder, number of gall stones, stone impaction at GB neck] with relevant weightage of scoring to each.

Based on history, clinical and ultrasonography (USG) findings, pre-operative scoring (Table 1) was made on individual patient included in the study on the day before operation.

A per operative score of 0 - 5 predicted as easy, 6 - 12 as difficult and 13 - 20 as very difficult was considered (Table 2).

A.	Easy	1. Time for surgery < 60 min 2. Spillage of bile 3. No operative trauma to bile duct or arterial system
B.	Difficult	1. Time for surgery 60 - 120 min 2. Spillage of bile / stone 3. Surgical trauma to bile duct 4. No conversion to open cholecystectomy
C.	Very Difficult	1. Time for surgery > 120 min 2. Conversion to open cholecystectomy
Table 2. Per-Operative Criteria for Assessment of Degree of Difficulty		

Surgery was performed with CO_2 pneumoperitoneum at 14 mm Hg pressure with two 5 mm and two 10 mm ports. Time needed of surgery was calculated from the first incision to last port closure. The surgery was recorded and all the patients received standardised post-operative care.

Statistical Analysis
Data analysis was done by SPSS (Statistical Package for the Social Sciences) version 20, Armonk, NY, USA. Sensitivity, specificity along with positive and negative predictive values of the scoring system were calculated. Discordance between the prediction and observation was tested by performing McNemar χ^2 test. Binomial logistic regression analysis was done to find out the factors responsible for difficult LC. ROC (Receiver Operating Characteristic) curve was performed for finding the cut-off score to classify easy and difficult prediction.

RESULTS

Out of the 108 patients included in this study, the scoring system predicted that 74 patients would be having an easy LC (LC) and 34 the difficult ones. There was no prediction for very difficult LC. As per operative observation revealed that 68 patients had an easy, 37 experienced difficult and in 3 patients it was of very difficult type of LC. As the very difficult LC were clubbed with difficult group to make it 40 (37 + 3) in number and all subsequent data analysis were made considering two groups, viz. easy and difficult. Patients with age ≥ 50 yrs. (65 %) were associated with

increase in difficult LC, but this association is not statistically significant [p = 0.387]. Male (46 %) or female (54 %) patients has no statistically significant association with difficult LC [p = 0.554]. It was revealed that history of hospitalisation due to biliary symptoms (16 %) has a statistically significant association with difficult LC [p = 0.010]

It was found that 60 % of the difficult LC belong to the overweight / obese group (BMI ≥ 25), but such association was not significant statistically [p = 0.780]. Although 56 % of the patients with a supra-umbilical scar and 43 % of patients with palpable GB had difficult LC, this association was also not statistically significant [p = 0.015, p = 0.629 respectively]. 81 % of the patients with thick GB wall had difficult LC and 75 % of the difficult LC patients had thick GB wall which were statistically significant [p < 0.001]

Patients with pericholecystic oedema (91 %) had difficult LC and 52 % of difficult LC patients had pericholecystic oedema and this association was statistically significant [p < 0.001]. It was observed that 100 % of patients with contracted and / or intrahepatic GB had difficult LC. 45 % of difficult LC cases had pre-operative USG prediction of contracted and / or intrahepatic GB.

Patients with multiple GB stone (41 %) had difficult LC and 65 % of difficult LC patients had multiple GB stones and this association was not significant statistically [p = 0.281]. Patients with stone impaction at GB neck (60 %) had difficult LC and this association has statistical significance [p = 0.002]. Validity of the scoring system concerned, it was found that sensitivity of the scoring system for easy and difficult predictions are shown in Table 3 - A, 3 - B.

Pre-Op Prediction	Per-Operative	Observation	Total
	Easy lc	Difficult lc	
Easy Prediction	65	9	**74**
Difficult Prediction	3	31	**34**
Total	**68**	**40**	**108**
Table 3A. Distribution of Patients According to Pre-Operative Prediction and Per-Operative Observation			

| Tests of Validity	For Easy Prediction	For Difficult Prediction
Sensitivity	95.59 %	77.50 %
Specificity	77.50 %	95.59 %
Positive Predictive Value	87.84 %	91.12 %
Negative Predictive Value	91.12 %	87.84 %
Table 3B. Validity of the Scoring System		

Per-Operative Degree of Difficulty	Mean	Std. Deviation
Difficult	8.45	2.490
Easy	3.94	.790
Total	**5.61**	**2.727**
Table 4. Mean Score According to Per-Operative Degree of Difficulty		

Furthermore, the discordance between the prediction and observation is not significant on performing McNemar χ^2 test [p = 0.10]. The multivariate analysis by binomial logistic regression method reveals that history of hospitalization with biliary symptoms, gall bladder wall thickness and stone impaction at gall bladder neck had significant contribution in difficulty of LC (Table 4). B - Coefficient for the constant (also called the "intercept") in the null model. Exp (B) - This is exponentiation of the B coefficient, which is an odds ratio.

Factors	B	Standard Error	Wald Chi-Square Test	Degree of Freedom	Significance	Exp (B)
Age	1.378	1.137	1.469	1	.226	3.967
Body mass index	.779	1.287	.366	1	.545	2.179
Sex	- .086	1.483	.003	1	.954	.918
Hospitalization with biliary symptoms	6.532	2.380	7.534	1	.006	.001
Abdominal scar	-1.167	6.481	.032	1	.857	.311
Palpable gall bladder	5.463	4.126	1.753	1	.186	235.826
Gall bladder wall thickness	5.195	1.859	7.809	1	.005	180.445
Pericholecystic collection	-3.947	2.002	3.888	1	.05	.019
Contracted and / or intra-hepatic gall bladder	14.467	46.442	.097	1	.755	.000
Number of gall stones	-2.190	1.215	3.249	1	.071	.112
Stone impaction at gall bladder neck	-4.513	1.516	8.859	1	.003	.011
Constant	16.388	47.176	.121	1	.728	13096621.742
Table 5. Binomial Logistic Regression Analysis for Factors Responsible for Difficult Laparoscopic Cholecystectomy						

Figure 1. ROC Curve
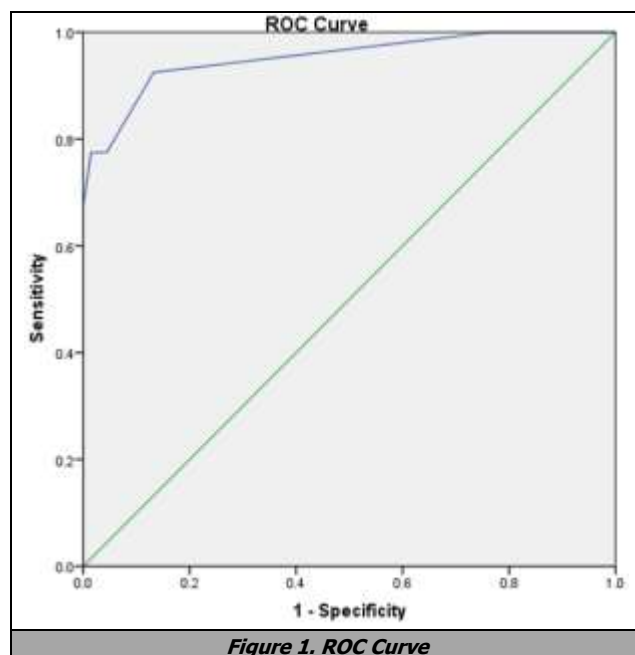
Test Result Variable(s): Score				
Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95 % Confidence Interval	
			Lower Bound	Upper Bound
.952	.022	.000	.910	.995
Table 6. Area Under the Curve				

Test Result Variable(s): Score		
Positive if Greater Than or Equal To[a]	Sensitivity	1 - Specificity
1.00	1.000	1.000
2.50	1.000	.985
3.50	1.000	.765
4.50	.925	.132
5.50	.775	.044
6.50	.775	.015
7.50	.675	.000
8.50	.575	.000
9.50	.375	.000
10.50	.275	.000
11.50	.075	.000
13.00	.000	.000
Table 7. Coordinates of the Curve		

The ROC curve showed that the best cut off value to distinguish between the per-operative degrees of difficulty was 4.50, with a sensitivity of 92.5 %.

The area under curve (AUC) was 952 which meant that there would be 95 % chance that the scoring system will be able to correctly distinguish between the degrees of difficulty per-operatively and this finding was found to be statistically significant (p = 0.000).

DISCUSSION

Conversion to open procedure is often required when safety of the laparoscopic procedure cannot be ensured. If the predicting parameters can be identified, the surgeon can predict difficulties preoperatively. The patient can be counselled, the operation planning is better with lesser perioperative and post-operative complications.

Various available literatures suggest that male gender is as a risk factor of difficult cholecystectomy[1,2,3,4] In our study male gender was not detected as a statistically significant predicting factor of difficult LC (p = 0.554). This finding has similarity with that of P Schrenk R. Woiserschlager et al[5] and Michael Rosen, Fred Brody, Jeffrey Ponsky et al.[6]

Elderly patients probably have a longer history of gallbladder disease with more episodes of acute attacks causing fibrotic adhesions. Several series had reported that advanced age was associated with the need to convert.[3,7,8,9] No positive correlation was detected between patient's age and difficult LC (p = 0.387). Same were the findings of Edward H. Livingston, Robert V, Rege et al.[10] and one Indian study by S S Sikora, Ashok Kumar, R Saxena et al.[11]

No significant correlation [χ^2 = 8.406 (df = 2) p = 0.015] between past abdominal surgeries (indicated by abdominal scar) and difficulties encountered during LC. This observation is consistent with previous published works.[12,13,14]

Conversion rate is high in upper abdominal surgery, about 37.5 %[15] and most probably it is due to dense adhesion. The conversion rate has become less with more experience in adhesiolysis and advanced laparoscopy.[16]

Here overweight / obesity (BMI ≥ 25) was not a statistically significant predictor [p = 0.856] of difficulty in LC. Although obesity has been considered a risk factor for increased conversion,[8,14] several investigations have reported conversion rates similar to those in non-obese patients. [9,11,12-16] Liu et al[14] in 1996 and in 1994 Fried et al have found obesity as a risk factor for conversions. Micheal Rosen, Fred Brody, Jeffrey Ponsky[6] in their study found obesity an independent predictive factor for conversion to open cholecystectomy in patients with acute cholecystitis. This result was in conformity with that of S S Sikora, Ashok Kumar R Saxena, V, K Kapoor, S P Kaushik et al.[11] In their series they failed to identify statistical significance of BMI in predicting conversion. Other studies[17,18] also stated that BMI has no association with surgical outcomes in patients with uncomplicated gallstone disease.

S.S. Daradkeh et al.[19] used multiple regression analysis to predict that only of GB wall thickness and diameter of CBD (Common Bile Duct) were found to have significant effects on the variation in the overall difficulty score (ODS).

In our study we did not find any statistically significant association [p = 0.629] between palpable gall bladder and difficult LC but thick GB wall [χ^2 = 46.8 p = 0.000] and pericholecystic oedema [χ2 = 36.905 p = 0.000] both were found to have statistical significance as a predictor of difficult LC. We observed 65 % of difficult LC patients had multiple GB stones but this association was not statistically significant [p = 0.281] whereas stone impaction at GB neck had a statistically significant association [p = 0.002] with difficult LC. Pervez Iqbal et al[20] showed contracted gall bladder to be one of the important factors for conversion of LC. According to Ajay Anand et al[21] cirrhotic liver with shrunken gallbladder was one of the important causes of conversion of LC. In conformation with the above findings we also observed contracted / intrahepatic gall bladder to have 100 % association with difficult LC.

Hussain A. in Aug 2011[22] concluded that risk factors for difficult LC were male gender, increasing age, acute and thick walled GB, broad and short cystic duct, cholecystoenteric fistula, earlier supra umbilical abdominal surgery, obese patients, cirrhosis of liver, anatomical anomalies, cholangiocarcinoma, and less surgeon's caseload. Fred GM et al[23] showed that statistically significant predictive factors of conversion were acute calculus cholecystitis, advancing age, male gender, obesity, and thick walled gallbladder in ultrasound. As per SAGES (Society of American Gastrointestinal and Endoscopic Surgeons) guidelines[24] factors responsible for bile duct injury are less experienced surgeon, advancing age of patient, male gender and acute cholecystitis. Rosen M et al showed that BMI > 40 kg / m² (33.1 OR, p = 0.01) and GB wall > 0.4 cm (24.7 OR, p < 0.004) as predicting factors for conversion.

In our study we also observed that past h / o hospitalisation due to biliary symptoms had a statistically significant association with difficult LC [χ^2 = 6.624 p = 0.010]. There are reports of excessive bleeding, bile duct injury and subsequent conversion in patients with h / o acute cholecystitis.[25] Kyung Soo Cho et al[26] in their original paper published in Journal of Clinical Ultrasound in 2004 established that the overall difficulty score (for laparoscopic cholecystectomy) was significantly associated with a GB size ≥ 50 ml, GB wall thickness ≥ 3 mm and colour Doppler signals in GB wall.

On analysing data, we found five statistically significant predictors on univariate analysis, viz. past h / o hospitalisation due to biliary symptoms, past intra-abdominal surgeries, palpable gall bladder, pericholecystic oedema and stone impaction at GB neck. Intra-hepatic and / or contracted GB had 100 % association with difficult LC.

However, multivariate analysis by binomial logistic regression method reveals three variables, viz. history of hospitalization with biliary symptoms, gall bladder wall thickness and stone impaction at gall bladder neck had significant contribution in difficulty of LC.

The possible explanation is that sample size of our study being small the result is not reflective of the population. This study has the potential to get improved in future by increasing the sample size reflecting the reference

population. According to a preoperative scoring method formulated by J. S. Randhawa and A.K. Pujahari[27] for predicting difficult LC, prediction was true in 88.8 % for easy and 92 % for difficult LC.

In our study the sensitivity of the scoring system for easy and difficult prediction were respectively 95.59 % and 77.5 % and the specificity of the same for easy and difficult prediction were respectively 77.5 % and 95.59 % (Table 5). The positive predictive values for easy and difficult prediction were 87.84 % and 91.12 % and the negative predictive values were 91.12 % and 87.84 % respectively.

Furthermore, the discordance between the pre-operative prediction and per-operative observation noted in our study was found to be statistically insignificant [McNemar χ^2 = 2.083 p = 0.10] which further adds to the strength of the validity of our scoring system.

CONCLUSIONS

In our study, the sensitivity of the scoring system for easy and difficult prediction were respectively 95.59 % and 77.5 % and the specificity of the same for easy and difficult prediction were respectively 77.5 % and 95.59 %. The positive predictive values for easy and difficult prediction were 87.84 % and 91.12 % and the negative predictive values were 91.12 % and 87.84 % respectively.

Univariate analysis showed that out of the eleven variables h / o hospitalisation with biliary symptoms, gall bladder wall thickness, peri-cholecystic oedema, and stone impaction at GB neck were statistically significant predictors of difficult LC and intra-hepatic and / or contracted GB had 100 % association with difficult LC.

However, multivariate analysis by binomial logistic regression method reveals three variables, viz. history of hospitalization with biliary symptoms, gall bladder wall thickness, and stone impaction at gall bladder neck, had significant contribution in difficulty of LC.

Furthermore, discordance between the pre-operative prediction and per-operative observation noted in our study was found to be statistically insignificant [McNemar χ^2 = 2.083 p = 0.01] which further adds to the strength of the validity of the scoring system.

It can be concluded from this study that this scoring system can successfully predict difficult LC preoperatively. This can help the operating surgeon to provide better surgical care to the patient.

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