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A Prospective Study of Risk Factors to Predict Conversion of Laparoscopic Cholecystectomy to Open

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Abstract
Background: *Laparoscopic cholecystectomy (LC) is one of the most common laparoscopic procedures being performed by general surgeons all over the world. Preoperative prediction of the risk of conversion is an important aspect of planning laparoscopic surgery. The purpose of our prospective study was to analyze various risk factors based clinical history, laboratory investigations and imaging and their association with conversion to open. With the help of accurate prediction, high risk patient may be informed before hand regarding the probability of conversion and hence they may have a chance to make arrangements accordingly. On the other hand, surgeons also may have to schedule the time and team for the operation appropriately. Surgeons can also be aware about the possible complications that may arise in high risk patients.*
Aims and objectives:
1) *To study the risk factors associated with conversion of laparoscopic cholecystectomy to open.*
2) *To predict conversion of laparoscopic cholecystectomy to open preoperatively in future surgeries based on preoperative risk factors.*
Methods: *A prospective study was conducted in the Department of General Surgery at Government Rajaji Hospital, Madurai, a tertiary care centre. All patients whounderwent laparoscopic cholecystectomy (n=93) from August 2013 to September 2014 were enrolled as cases. The method for the study included screening of patients who presented with chronic calculous cholecystitis. A detailed proforma was developed to record data on clinical history, past history, laboratory investigations, ultrasound findings and post operative complications.Thirteen risk factors were evaluated and documented for each patient to analyse their association with conversion.*
Results : *Patients who underwent laparascopic cholecystectomy were categorised into two groups namely, successful or converted for univariate and multivariate analysis. Thirteen pre-operative variables associated with risk of conversion were analysed and compared with the outcome whether underwent successful LC or converted to open surgery. Univariate analysis was carried out by computing the odds ratio (OR) and 95% confidence interval (CI) to compare cases in successful and converted groups for each potential factor of interest. Among the preoperative variables, history of previous attacks of cholecystitis, presence of Murphy's sign, post ERCP, elevated leucocyte count, GB wall thickness > 3mm , pericholecystic fluid collection and multiple GB calculi were found to be significantly associated with conversion to open cholecystectomy on univariate analysis. Multivariate analysis was done to identify risk factors independently associated with conversion. Patients with gall bladder wall thickness > 3mm were 5.3 times more likely to get converted to open cholecystectomy compared to patients who underwent successful laparoscopic cholecystectomy (95% CI : 1.2, 24.6). The presence of pericholecystic fluid on USG (Odds ratio (OR) =9.6, 95% CI :2.5, 36.1) was also identified as a risk factor for conversion.*
Conclusion: *This study has identified certain preoperative variables as risk factors for conversion of laparoscopic cholecystectomy to open in our setting. Patient factors, laboratory investigations and preoperative USG findings are helpful in prediction of conversion. Identification of these factors preoperatively might help to psychologically prepare the patients for open surgery and for prolonged convalescence.*
Keywords: *Laparoscopic cholecystectomy, risk factors, conversion.*

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I. Introduction

Cholelithiasis is the most common biliary pathology. Gallstons are present in 10 to 15% of the general population and asymptomatic in the majority (>80%).The prevalence of gallstone varies widely in different parts of the world. In India it is estimated to be around 4%.An epidemiological study restricted to rail road workers showed that north Indians have 7 times higher occurrence of gallstones as compared to south Indians. Changing incidence in India is mainly attributed to westernization and availability of investigation that is ultrasound in both rural and urban areas and due to change in socioeconomic structure. Approximately 1-2% of asymptomatic patients will develop symptoms requiring cholecystectomy per year .Cholelithiasis is rare in the first two decades. Incidence gradually increases after 21 years and reaches its peak in 5th and 6th decade. Women are more affected than men in the ratio of 4:1. In 1992, The National Institute of Health (NIH) consensus development conference stated that laparoscopic cholecystectomy "provides a safe and effective treatment for most patients with symptomatic gallstones." The advantages of laparoscopic cholecystectomy over open cholecystectomy are quick recovery of bowel functions, minimal pain in postoperative period, minimal hospital stay, earlier return to normal activity, and decreased overall cost. Laparoscopic cholecystectomy has become the gold standard in the treatment of gallbladder pathology and is replacing open cholecystectomy. The rate of conversion from laparoscopic cholecystectomy to open cholecystectomy is 5 to 10%. Hence it is necessary to study the riskfactors to predict conversion of laparoscopic cholecystectomy to open preoperatively. Therefore this study was undertaken.

II. Objectives Of The Study

1) To study the risk factors associated with conversion of laparoscopic cholecystectomy to open.
2) To predict conversion of laparoscopic cholecystectomy to open preoperatively in future surgeries based on preoperative risk factors.

III. Study Criteria

Inclusion criteria:
Patients admitted in surgical ward at Government Rajaji Hospital , Madurai with chronic calculous cholecystitis who were confirmed by ultrasound and underwent laparoscopic cholecystectomy were included in the study.

Exclusion criteria :
1 . Absolute contraindication to laparoscopic cholecystectomy like cardiovascular diseases, pulmonary disorders and coagulopathies.
2 . Patients with calculous in common bile duct.
3 . Patients not consented for laparoscopic cholecystectomy.
4 . Laparoscopic cholecystectomy performed with any other laparascopic intervention in same sitting.
5 . Patients unfit for anaesthesia.
6 . Laparoscopic to open conversion due to equipment failure.

IV. Materials And Methods

A prospective study was conducted in the Department of General Surgery at Government Rajaji Hospital, Madurai, a tertiary care centre. All patients who underwent laparoscopic cholecystectomy (n=93) from August 2013 to September 2014 were enrolled as cases.The method for the study included screening of patients who presented with chronic calculous cholecystitis. A detailed proforma was developed to record data on clinical history, past history, laboratory investigations, ultrasound findings and post operative complications. The risk factors under study as shown in table were documented for each patient.All patients received symptomatic treatment for cholecystitis and injection vitamin K 10mg intramuscularly was given for 3 days preoperatively. After evaluation, patients were subjected to laparoscopic cholecystectomy and the outcome namely successful or converted were recorded as shown in table. All patients were operated by one surgical unit. Postoperatively cases were followed for any complications. Drain was removed between 2^{nd} to 5^{th} postoperative day depending on the drain output. Sutures were removed on 8^{th} postoperative day. All patients were followed up for any recurrent symptoms.

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V. Results

This study included 93 patients who were studied prospectively over a period of one year from August 2013 to September 2014. Data collected were analysed using Statistical Package for Social Sciences (SPSS version 11.0). Patients who underwent laparascopic cholecystectomy were categorised into two groups namely, successful or converted for univariate and multivariate analysis. Thirteen pre-operative variables associated with risk of conversion were analysed and compared with the outcome whether underwent successful LC or converted to open surgery.

Age distribution :

In the present series the youngest age was 15 years and the oldest being 75 years. Majority of patients were in the age group 45-60 years.

Age (years)	**No. of patients**
15 -30	22
31-45	25
45-60	31
61-75	15

Sex distribution :

Out of 93 patients , 32 were male and 61 were female patients. In this study, gallstones were more common in females than males.The male to female ratio in this study is 1: 1.9.

Gender	No. of patients
Male	32
Female	61
Total	93

Preoperative risk factors under study :

History of previous attacks of cholecystitis :

Out of 93 patients studied, 53 patients had history of previous attacks of cholecystitis. Patients with history of previous attacks had higher conversion rate (71.8%) in comparison to non converted group(46.3%).

History of previous attacks of cholecystitis	**No. of patients – n (%)**		**Total**
	Successful LC	**Converted**	
Absent	29 (53.7%)	11 (28.2%)	40 (43%)
Present	25 (46.3%)	28 (71.8%)	53 (57%)
Total	54 (100%)	39 (100%)	93 (100%)

Murphy's sign :

In this study, 36 patients had tenderness in right hypochondrium on deep inspiration i.e positive Murphy's sign. Out of 36 patients, 15 (27.8%) patients who had positive Murphy's sign underwent successful laparoscopic cholecystectomy but remaining 21 patients had conversion to open.

Positive Murphy's sign	**No. of patients – n (%)**		**Total**
	Successful LC	**Converted**	
Absent	39 (72.2%)	18 (46.2%)	57 (61.3%)
Present	15 (27.8%)	21 (53.8%)	36 (38.7%)
Total	54 (100%)	39 (100%)	93 (100%)

History of previous ERCP intervention :

In this study of 93 patients, there were 27 patients who had past history of previous ERCP intervention for gallstone disease. Out of these 27 patients, 17 patients had conversion from laparoscopic to open cholecystectomy and remaining had successful laparoscopic cholecystectomy.

History of previous ERCP intervention	No. of patients – n (%)		Total
	Successful LC	Converted	
Absent	44 (81.5%)	22 (56.4%)	66 (71%)
Present	10 (18.5%)	17 (43.6%)	27 (29%)
Total	54 (100%)	39 (100%)	93 (100%)

History of previous surgery:

In this study of 93 patients, there were 41 patients who had past history of previous ERCP intervention for gallstone disease. Out of these 41 patients, 18 patients had conversion from laparoscopic to open cholecystectomy and remaining 23 patients had successful laparoscopic cholecystectomy.

History of previous surgery	No. of patients – n (%)		Total
	Successful LC	Converted	
Absent	31 (57.4%)	21 (53.8%)	52 (55.9%)
Present	23 (42.6%)	18 (46.2%)	41 (44.1%)
Total	54 (100%)	39 (100%)	93 (100%)

Body mass index (BMI)>25 kg/m^2 :

In patients with BMI> 25kg/ m^2, 22 patients were converted while 21 patients underwent successful LC. In patients with BMI< 25 kg/ m^2 , 33 patients had successful LC.

BMI > 25 kg/ m^2	No. of patients – n (%)		Total
	Successful LC	Converted	
Absent	33 (61.1%)	17 (43.6%)	50 (53.8%)
Present	21 (38.9%)	22 (56.4%)	43 (46.2%)
Total	54 (100%)	39 (100%)	93 (100%)

Laboratory findings:

Elevated white blood count (WBC) :

In patients with WBC>11,000 cells/mm^3, 16 patients were converted while 10 patients underwent successful LC. In patients with normal WBC count , 23 patients had conversion.

WBC count (cells/mm^3)	No. of patients – n (%)		Total
	Successful LC	Converted	
<11000 cells /mm^3	44 (81.5%)	23 (59%)	67 (72%)
>11000 cells/mm^3	10 (18.5%)	16 (41%)	26 (28%)
Total	54 (100%)	39 (100%)	93 (100%)

Liver function tests (LFT):

In patients with elevated liver function tests either of AST (aspartate transaminase) or ALT(alanine transaminase), alkaline phosphatase , 11 patients were converted while 11 patients underwent successful LC. In patients with normal LFT , 28 patients had conversion to open surgery.

Elevated LFT	No. of patients – n (%)		Total
	Successful LC	Converted	
Present	43 (79.6%)	28 (71.8%)	71 (76.3%)
Absent	11 (20.4%)	11 (28.2%)	22 (23.7%)
Total	54 (100%)	39 (100%)	93 (100%)

Increased serum amylase:

In this study of 93 patients, there were 27 patients who had increased serum amylase. Out of these 27 patients, 12 patients had conversion from laparoscopic to open cholecystectomy and remaining had successful laparoscopic cholecystectomy

Increased serum amylase	No. of patients – n (%)		Total
	Successful LC	Converted	
Absent	39 (72.2%)	27 (69.2%)	66 (71.0%)
Present	15 (27.8%)	12 (30.8%)	27 (29.0%)
Total	54 (100%)	39 (100%)	93 (100%)

Ultrasound findings

Gall bladder wall thickness:

With evaluation of patients with USG abdomen, a total of 50 patients had normal GB wall thickness. Of the remaining 43 patients with GB wall thickness > 3mm, 28 pateints had conversion to open cholecystectomy.

GB wall thickness	No. of patients – n (%)		Total
	Successful LC	Converted	
<3 mm	39 (72.2%)	11 (28.2%)	50 (53.8%)
>3mm	15 (27.8%)	28 (71.8%)	43 (46.2%)
Total	54 (100%)	39 (100%)	93 (100%)

Distended Gall bladder on USG:

In this study , 48 patients had a distended gall bladder on USG. Out of 48 patients, 25 patients with distended GB had a successful laparascopic cholecystectomy while 23 patients had conversion.

Distended GB on USG	No. of patients – n (%)		Total
	Successful LC	Converted	
Absent	29 (53.7%)	16 (41%)	45 (48.4%)
Present	25 (46.3%)	23 (59%)	48 (51.6%)
Total	54 (100%)	39 (100%)	93 (100%)

Pericholecystic fluid on USG :

In this study of 93 patients, 45 patients who had presence of pericholecystic fluid. Out of these 45 patients, 30 patients had conversion from laparoscopic to open cholecystectomy and remaining had successful laparoscopic cholecystectomy.

Pericholecystic fluid on USG	No. of patients – n (%)		Total
	Successful LC	Converted	
Absent	39 (72.2%)	9 (23.1%)	48 (51.6%)
Present	15 (27.8%)	30 (76.9%)	45 (48.4%)
Total	54 (100%)	39 (100%)	93 (100%)

Multiple GB calculi on USG:

Out of 93 patients, 42 patients had multiple GB calculi on USG. 24 patients with multiple GB calculi were converted to open surgery while 18 patients had successful laparoscopic cholecystectomy.

Multiple GB calculi on USG	No. of patients – n (%)		Total
	Successful LC	Converted	
Absent	36(66.7%)	15 (38.5%)	51 (54.8%)
Present	18 (33.3%)	24 (61.5%)	42 (45.2%)
Total	54 (100%)	39 (100%)	93 (100%)

Impacted GB calculi on USG:

In this study, a total of 22 patients had impacted GB calculi. 12 patients with impacted GB calculi had successful laparascopic surgery while 10 patients had conversion to open.

Impacted GB calculi on USG	No. of patients – n (%)		Total
	Successful LC	Converted	
Absent	42 (77.8%)	29 (74.4%)	71 (76.3%)
Present	12 (22.2%)	10 (25.6%)	22 (23.7%)
Total	54 (100%)	39 (100%)	93 (100%)

Univariate analysis :

Univariate analysis was carried out by computing the odds ratio (OR) and 95% confidence interval (CI) to compare cases in successful and converted groups fo each potential factor of interest.Table-6 shows univariate analysis in which the preoperative risk factors based on physical examination, laboratory investigations and ultrasonographic findings are recorded. Among the preoperative variables, history of previous attacks of cholecystitis, presence of Murphy's sign, post ERCP, elevated leucocyte count, GB wall thickness > 3mm , pericholecystic fluid collection and multiple GB calculi were found to be significantly associated with conversion to open cholecystectomy.

Table-6. Univariate analysis showing association of physical examination, laboratory and ultrasonographic findings with conversion by their ORs, 95% CI, and P values

Variable	Converted	Successful	OR	95% CI for OR	P value
	N=39	N=54			
	n (%)	n (%)			
History of previous attacks	28 (71.8)	25 (46.3)	2.9	1.2, 7.1	0.014
Murphy's sign	21 (53.8)	15 (27.8)	3.0	1.3, 7.2	0.011
Previous surgery	18 (46.2)	23 (42.6)	1.1	0.5, 2.6	0.733
Post ERCP	17(43.6)	10 (18.5)	3.4	1.3,8.6	0.009
BMI > 25	22 (56.4)	21 (38.9)	2.0	0.9, 4.7	0.094

LFT deranged	11 (28.2)	11 (20.4)	1.5	0.6, 4.0	0.380
Increased serum amylase	12 (30.8)	15 (27.8)	1.1	0.5, 2.8	0.754
WBC > 10000	16 (41.0)	10 (18.5)	3.1	1.2, 7.8	0.017
Distended gall bladder on USG	23 (59.0)	25 (46.3)	1.7	0.7, 3.8	0.227
GB wall thickness > 3mm	28 (71.8)	15 (27.8)	6.6	2.6, 16.5	<0.001
Pericholecystic fluid collection	30 (76.9)	15 (27.8)	8.7	3.3, 22.5	<0.001
Multiple GB stone	24 (61.5)	18 (33.3)	3.2	1.3, 7.5	0.007
Impacted GB stone	10(25.6)	12(22.2)	1.2	0.5,3.2	0.702

N-total no. of cases, n-percentage of cases, OR- odds ratio. CI- confidence interval

Multivariate Analysis

Multivariate analysis was done to identify risk factors independently associated with conversion. The criterion for selection for the selection of factors for the final multivariate logistic regression model was a 'P' value< 0.05 in the univariate analysis. Table-7 shows the multivariate model of risk factors independently associated with conversion. Patients with gall bladder wall thickness > 3mm were 5.3 times more likely to get converted to open cholecystectomy compared to patients who underwent successful laparoscopic cholecystectomy (95% CI : 1.2, 24.6) after adjusting all the other variables in the model. The presence of pericholecystic fluid on USG (Odds ratio (OR) =9.6, 95% CI :2.5, 36.1) was also identified as a risk factor for conversion. The final model of multivariate analysis was calculated after adjusting for the confounding risk factors history of previous attacks, Murphy's sign, multiple GB calculi, post ERCP and BMI > 25 kg/ m^2.

Table-7. Multivariate Logistic Regression Model Of Risk Factors Associated With Conversion To Open Cholecystectomy With Adjusted Odds Ratio And 95% Confidence Interval.

Variable	**aOR***	**95% CI for aOR**
GB wall thickness > 3mm		
≤ 3mm	Reference	
>3 mm	5.3	1.2, 24.6
Pericholecystic fluid collection		
No	Reference	
Yes	9.6	2.5, 36.1

* Adjusted for History of previous attacks, Murphy's sign, Multiple GB Stone, Post ERCP and BMI > 25 kg/m^2

Post Operative complications :

Table: showing no. of patients with postoperative complications:

Complications	**Successful LC**	**Converted**
Wound infection	**0**	**3**
Hemorrhage	**0**	**0**
Bile leak	**1**	**0**
Prolonged ileus	**0**	**1**

VI. Discussion

The advantages and safety of laparascopic cholecystectomy have been well documented and made it a standard of care for management of patients with gall stone disease. Inspite of these advantages , conversion to open may be needed in few patients which ranges from 2- 15 % as shown in various studies[2,3,6,7,8]. Hence it is important that the surgeon realise the need for conversion is neither a failure nor a complication but done only for the best interest of the patient. The important factors predisposing to conversion from laparoscopic cholecystectomy to open has been extensively evaluated in several studies. In this study, patients who required hospitalisation for repeated attacks of acute cholecystitis and presence of Murphy's sign on clinical examination had higher chance of conversion due to formation of dense adhesions at Calot's triangle and gall bladder fossa due to chronic inflammation and fibrosis.

Obesity[4] has been considered as a risk factor for difficult laproscopic cholecystectomy and conversion as observed by. In our study , body mass index > 25 did not significantly affect the outcome.Any previous abdominal surgery may cause adhesions between bowel and viscera of abdominal wall. There is a high risk of injury to these structures during insertion of first port and hence risk of conversion is high. In our study, 41 patients had undergone previous surgeries like tubectomy, appendectomy and caesarean section. These patients had an infraumblical scar and previous abdominal surgery was not found to be significant risk factor for conversion.Post ERCP (endoscopic retrograde cholangiopancreaticography) is associated with dense adhesions in Calot's triangle and difficulty in adhesiolysis. Our study has also shown a significant association as a risk factor for conversion.The present study did not identify deranged liver function test (LFT) as a significant risk

factor for conversion. Abnormal LFT signify ongoing hepatitis, cholangitis and cause difficulty in dissection due to edema[5]. Alphonsa et al and Kama et al [2] have shown a similar association in their study. They have also shown increased total leucocyte count more than 11,000 as a risk factor for conversion and our study has also shown a significant association.

Gall bladder wall thickness[9] > 3mm and and presence of pericholecystic fluid collection are associated with difficult laparoscopic cholecystectomy and conversion due to dense adhesions in Calot's triangle.Multiple gall bladder stones and large stone in neck of gall bladder[9] causes distension of gall bladder and is associated with difficulty in grasping and rupture of gall bladder with spillage of bile and calculi intraperitoneally. It is associated with conversion to open as demonstrated in few studies.In the postoperative period, patients were kept nil per oral and Ryle's tube aspiration was until patient had passed flatus and presence of bowel sounds. Oral diet was started on 3rd postoperative day and intravenous antibiotics were given for five days. Analgesics were given as and when required. Intraabdominal drain was removed on 5th postoperative day. None of the patients had postoperative complications. The gall bladder specimen was sent for histopathological examination and 90 patients had features of chronic cholecystitis and 3 patients had features of acute cholecystitis. There was no evidence of malignancy in the specimens studied. All the patients were followed up for one month and none of them had any complications due to surgery.

VII. Conclusion

This study has identified certain preoperative variables as risk factors for conversion of laparoscopic cholecystectomy to open in our setting. Patient factors, laboratory investigations and preoperative USG findings are helpful in prediction of conversion. Our study has shown the following conclusions :

- History of previous attacks of cholecystitis and presence of Murphy's sign are associated with high risk of conversion.
- Obesity , history of previous abdominal surgeries have not been found to be associated with conversion.
- Previous ERCP intervention, elevated WBC count has a significant risk of conversion from laparoscopic cholecystectomy to open.
- Gall bladder wall thickness> 3mm, presence of pericholecystic fluid are associated with higher risk of conversion.
- Identification of these factors preoperatively might help to psychologically prepare the patients for open surgery and for prolonged convalescence

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