Predictive score for conversion in laparoscopic cholecystectomy - a prospective study

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ABSTRACT

Objective: 2-15% of laparoscopic cholecystectomy gets converted to an open procedure due to various factors.

The aim of this study was to identify pre-operative risk factors that could predict the conversion of laparoscopic cholecystectomy to open surgery. Pre-operative prediction would help in reducing the morbidity.

Material and Methods: Adult patients undergoing elective laparoscopic cholecystectomy at a tertiary institute were included in the study. The parameters analysed were age, gender, body mass index, total count, liver function test, gall bladder size and wall thickness, impacted stone in Hartmann's pouch and common bile duct (CBD) diameter on ultrasonography. Intra-operative findings and the total number of conversions to open surgery were documented. Statistical analysis was done using SPSS 16.0 Inc., IBM system. A univariate regression analysis was used to find the significant risk factors followed by multivariate linear regression.

Results: Twenty-one of the 222 (9.5%) patients who underwent laparoscopic cholecystectomy, were converted to open cholecystectomy. Six variables were found significant on univariate analysis: Age, sex, total count, gallbladder wall thickness and size and diameter of the CBD. On logistic regression analysis, gall bladder wall thickness and size were found to be significant, and were used in the scoring system, wherein 1 point was given to each variable. The predicted risk of conversion was 0.5%, 1.8% and 7.2% for a score of zero, one and two respectively.

Conclusion: The most significant factors predicting conversion of laparoscopic cholecystectomy to open surgery were gall bladder size and wall thickness. This prediction can be used to minimize the time to conversion and reduce the morbidity.

Keywords: Laparoscopic cholecystectomy, conversion, ultrasonography, gallbladder wall thickness, risk factors

INTRODUCTION

Cholelithiasis is an important disease in developed countries, affecting 10 to 15% of the adult population (1). In India, the prevalence of cholelithiasis varies from 3.1 to 6.12% with higher prevalence among women (2,3). The prevalence of gallstones increases with age and is a common cause of upper abdominal pain (4). Ultrasonography of the abdomen is the investigation of choice for diagnosis.

The gold standard treatment for cholelithiasis is laparoscopic cholecystectomy. On average, 2-15% of laparoscopic cholecystectomies have to be converted to an open surgery due to various reasons (5). Conversion is known to prolong the operative time and increase the complication rates, length of hospital stay and hospital charges (6).

The reasons for conversion could involve patient factors, surgeon factors, or rarely equipment failure. The need to convert should be considered an attempt to avoid complication and not as a failure. It would be useful if one could predict the need to convert pre-operatively, as these patients can be converted early, thus avoiding the morbidity associated with prolonged dissection and anesthesia.

This study was planned with the idea of formulating a pre-operative scoring system that could be used to predict the conversion of laparoscopic cholecystectomy to open. We aimed to examine the impact of the various pre-operative factors on the conversion rate and then we planned to devise a scoring system.

MATERIAL and METHODS

Aim of the Study

1. To identify the clinical as well as ultrasonic features that predict the conversion of laparoscopic cholecystectomy to open cholecystectomy.

2. To formulate a predictive score for conversion using regression analysis method.

After obtaining approval from Sri Ramachandra University Institutional Ethics Committee, patients undergoing elective laparoscopic cholecystectomy were included in the study (approval number: CSP-MED/14/OCT/19/195, date: 14.10.2014). The patients were enrolled in the study after obtaining written informed consent.

Inclusion Criteria

All patients above 18 years of age with an ultrasound diagnosis of cholelithiasis who were electively planned to undergo laparoscopic cholecystectomy were included in the study.

Exclusion Criteria

Patients with a history of previous upper abdominal surgeries, obstructive jaundice, acute cholecystitis, and recent endoscopic retrograde cholangio-pancreatography were excluded from the study.

The clinical and ultrasound features of the patients were taken into consideration in predicting the conversion of laparoscopic to open cholecystectomy.

The clinical factors were age, body mass index, and liver function tests. The demographic data of the patients were taken into account.

Ultrasonography of the abdomen was done using GE-Logiq P5, Probe-Convex 3.5CS (2-5 MHz) 128 elements, 38 mmR. The gallbladder was scanned with right subcostal oblique and intercostal section views.

The imaging features that were studied were:

- Gallbladder wall thickness,
- Size of the gallbladder,
- Presence of impacted stone in Hartmann's pouch,
- Common bile duct diameter.

After routine investigations and assessment, all patients underwent standard laparoscopic cholecystectomy using four ports under general anesthesia. The critical view of safety was demonstrated in all cases. If the procedure was converted into an open cholecystectomy, then the reasons for conversion were noted. The post-operative course of the patient in the hospital was also documented, especially the duration of stay.

Statistical Analysis

All the data were entered in a Microsoft Excel sheet and analysed using statistical package for the social sciences 16.0, an international business machines statistical system. Descriptive statistics of quantitative data were presented as mean and standard deviation. A univariate regression analysis was used to find the significant risk factors. These significant factors were then analysed using a multivariate linear regression model.

We then developed a pre-operative predictive scoring system for conversion, based on independent factors derived from multivariate analysis, followed by logistic regression analysis.

RESULTS

Among the 222 patients who underwent elective laparoscopic cholecystectomy during the period 2014-2016, 21 patients were converted to open surgery. Therefore, 9.5% of the study population had conversion to open cholecystectomy.

On analysing the demographic details, most of the patients in our study were in the age group 51 to 60 years. The mean age of patients who underwent laparoscopic cholecystectomy was 48.2 years, whereas the mean age of patients converted to open cholecystectomy was 60.29 years. This was statistically significant at a p-value of 0.001.

43.2% of the study population was male. Among patients who underwent successful laparoscopic cholecystectomy, 39.8% were male and 60.2% were female. Among 21 patients who underwent conversion, 76.2% were male. This was statistically significant (p-value of 0.001).

When comparing body mass index (BMI) in laparoscopic and converted cases, the mean BMI was the same in both groups and was not statistically significant.

An elevation was observed in the total white blood count in patients who were converted, with a mean total count of 11,671.43, which was statistically significant (p-value of 0.014).

The most common reason for conversion was frozen Calot's triangle. The other causes were adhesions, mucocele of the gallbladder, hemorrhage and fibrosis of the gallbladder (Figure 1).

Analysis of the ultrasonographic findings in both group of patients yielded the following results: The mean gallbladder wall thickness in converted cases was 8.5 mm, which was statistically highly significant (p-value of 0.001).

The mean diameter of the common bile duct was 6.45 mm in the converted cases, and this was significant with a p-value of 0.001.

11.9% of patients who underwent laparoscopic cholecystectomy had a contracted gallbladder. On the contrary, 76.20% of patients
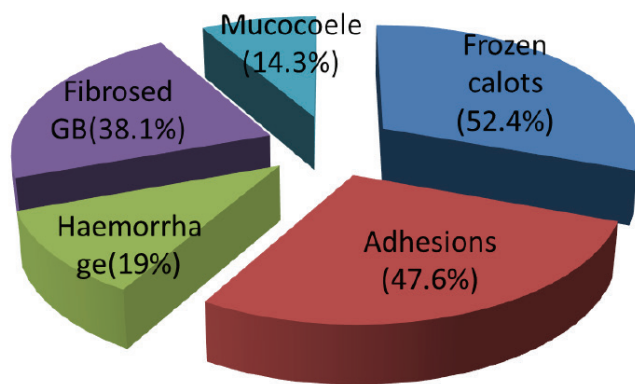
Figure 1. Reasons for conversion to open cholecystectomy.

who were converted to open cholecystectomy had contracted gallbladder, which was statistically significant (p-value=0.001).

13.4% of patients who underwent laparoscopic cholecystectomy had stone impaction in Hartmann's pouch. Impaction of stone in Hartmann's pouch was present in 23.8% of patients who underwent conversion to an open procedure, and this was not statistically significant.

The mean duration of hospital stay was 11.33 days for the converted cases and 3.44 days for the laparoscopic cases, which was statistically highly significant.

Univariate Analysis

The table below shows the six variables, which were found significant in univariate analysis, which were then subjected to logistic regression analysis for the scoring system (Table 1).

Logistic Regression Analysis

By logistic regression analysis, gallbladder wall thickness and size of the gallbladder was found to be significant factors associated with conversion to open cholecystectomy. These factors were therefore used to arrive at the pre-operative scoring system for conversion of laparoscopic cholecystectomy to open cholecystectomy. One point was given for each parameter. For example, if gallbladder thickness was more than 4 mm, then 1 point was given. If a contracted gallbladder was seen, then 1 point was given.

Statistical Analysis

Patients who scored zero have a risk of 0.5% for conversion to open cholecystectomy with a significant p-value of 0.001.

There is a 1.8% risk of conversion to an open procedure for patients who scored 1 with a p-value of 0.001, which is statistically significant.

Patients with a score of 2 have a likelihood of conversion to open by 7.2%, which is statistically highly significant with a p-value of 0.0001 (Table 2).

DISCUSSION

Prevalence rates of gallstone disease in Asian populations vary from 5-20% and among Black Americans it ranges from 5.3% of men to 13.9% of women (1). In India, the prevalence of gallstone disease varies from 3.1-6.12% with a higher prevalence among women.

Ultrasonography of the abdomen is the gold standard investigation for the diagnosis of cholelithiasis. Since the advent of minimally invasive surgery, laparoscopic cholecystectomy has become the gold standard treatment for symptomatic and asymptomatic cholelithiasis.

Laparoscopy is minimally invasive and is associated with less morbidity, shorter hospital stay, reduced postoperative pain and wound complications, decreased incidence of postoperative ileus, earlier oral intake, early ambulation, quicker return to normal activity, and improved cosmesis (7).

Despite these advantages, conversion to open surgery is necessary in some cases. Approximately 2-15% of attempted laparoscopic cholecystectomies have to be converted to open cholecystectomies due to different reasons (8,9). There are numerous factors responsible for conversion to an open procedure: Aberrant or altered anatomy, ductal or vascular anomalies, and/or acute or chronic inflammation (10). Excessive bleeding, accidental injuries of the biliary tract, inability to perform lateral traction of the gallbladder due to thickened gallbladder wall, presence of dense adhesions, frozen Calot's triangle, and mucocele of the gallbladder are the patient-related factors responsible for conversion (11,12).

Concise knowledge about these preoperative variables for conversion helps the operating team to plan for the surgery appropriately (13). This conversion should not be taken as

Table 1. Univariate analysis of patient factors

	Score	Df	Sig. (p-value <0.5)
Age	10.712	1	0.001
Sex	10.258	1	0.001
TC	5.991	1	0.014
Gallbladder wall thickness	103.613	1	0.000
Size of gallbladder	53.136	1	0.000
Diameter of CBD	47.281	1	0.000
CBD: Common bile duct			

Table 2. Statistical analysis of the scoring system

Score	Conversion	Relative risk (95% CI)	p-value
0	0.5%	0.84 (0.11-0.612)	0.001
1	1.8%	0.215 (0.075-0.619)	0.001
2	7.2%	27.687 (11.182-68.555)	0.0001
CI: Confidence interval			

a failure of surgery or inexperience of the surgeon; rather, it is a wise decision to avoid intraoperative injuries to the vital structures and associated morbidity and mortality. The ability to accurately identify an individual patient's risk for conversion based on preoperative information can result in accurate preoperative counselling, improved operating room scheduling, grading of risk for technical difficulty appropriate assignment of surgical assistance, and may improve patient care by reducing the time to conversion (14).

In our study, out of the 222 patients who underwent elective laparoscopic cholecystectomy, 21 patients (9.5%) were converted to open cholecystectomy.

On reviewing the world literature, the conversion rate of laparoscopic cholecystectomy to open varies from 2% to 15% (15). A study conducted by Al-Mulhim (16) stated that the conversion rate of lap cholecystectomy was 1.8%. In our study, we found the incidence of conversion to be 9.5%. This is in accordance with literature, which states that the average conversion rate of laparoscopic to open surgery is in the range of 1.8-27.7% (8).

In a study by Chauhan et al. (17), seven hundred and sixtyfour patients (539 females and 225 males) were taken-up for laparoscopic cholecystectomy; 33 (4.31%) of them were converted to open cholecystectomy. The most common reason for conversion was dense pericholecystic adhesion (51.5%), leading to either non-progression of surgery or inability to reach the Calot's triangle safely. Frozen Calot's triangle was the second most common reason (18.8%) for conversion.

Saber et al. (18) reported a conversion rate of 7.35%. The most common reasons for conversion were acutely inflamed gallbladder, frozen Calot's, aberrant anatomy, and bleeding. This was similar to our experience, where the most common reason for conversion was a frozen Calot's triangle.

Predictive Factors

Age

In our study, the mean age of patients who underwent laparoscopic cholecystectomy was 48.2 years, and the mean age of patients converted to open cholecystectomy was 60.29 years. This variable is statistically highly significant with p-value of 0.001. Philip Rothman et al. (8) found age to be a significant risk factor in the conversion of laparoscopic cholecystectomy to open, with an age range of 60 to 65 years. Another study by Reddy and Balamaddaiah (7) also showed age more than 60 as a significant compounding factor for conversion of laparoscopic cholecystectomy to open cholecystectomy.

In the study by Saber et al. (18) regarding preoperative prediction of difficult laparoscopic cholecystectomy with 204 patients, they found that age over 50 years, was an independent risk factor for the conversion of the procedure to the open technique.

Gender

In our study, 43.2% of the participants were male and 56.8% were female. 76% of the cases that were converted from laparoscopic to open surgery were male. Analysis of these data showed a p-value of 0.001, which was statistically significant.

Philip Rothman et al. (8), in their meta-analysis, found that out of 31 studies, male gender was a significant risk factor in 21 studies. The study by Yol et al. (19) found that in patients with symptomatic gallbladder stones, inflammation and fibrosis were more severe in men than in women. These findings are likely to explain the higher rates of conversion in men. O'Leary et al. (20), Agrawal et al. (9), and other studies conducted worldwide showed male sex as a significantly associated factor for conversion of laparoscopic cholecystectomy to open, which is similar to our study.

Size and Wall Thickness of the Gallbladder

Ultrasonography of the abdomen is the preoperative investigation of choice for the diagnosis of cholelithiasis (21,22). In our study population, 76.2% of the converted cases had a contracted gallbladder, which was statistically significant, and the mean gallbladder wall thickness in converted cases was 8.5 mm, which was statistically significant.

This is in accordance with the meta-analysis by Philip Rothman et al. (8), who found a gallbladder wall thickness of more than 4 mm and contracted gallbladder that is less than 2 cm as a contributory factor in the conversion of laparoscopic cholecystectomy to open.

The theory postulated for conversion in these patients is that the thickened and contracted gallbladder makes it difficult to hold the gallbladder neck to allow adequate retraction, which is very essential to perform safe dissection in the Calot's triangle. It also reduces the extent of the anatomical definition leading to more injuries of the anatomical structures and uncontrollable bleeding thereby acting as a risk for conversion to open surgery to manage the complication. Studies done by Saber et al. (18), Gupta et al. (11), Agrawal et al. (9), Nidoni et al. (10), Chandio et al. (23) have also identified thickened gallbladder wall, and contracted gallbladder as significant factors responsible for the conversion.

Scoring System

There are several pre-operative risk scoring systems formulated, to calculate the risk of conversion from laparoscopic to open cholecystectomy. On analysing the various factors that are predictive of conversion to an open cholecystectomy, we have formulated a scoring system including the two significant predictors, namely, gallbladder wall thickness greater than 4 mm, and contracted gallbladder.

In comparison to other scoring systems, which include factors such as previous hospital admission, palpable gallbladder, impacted gall-stone, pericholecystic fluid, previous surgery, male sex, gallbladder thickness, obesity, contracted gallbladder, and the presence of an abdominal scar, our scoring system proves to be easier, as the only investigation needed for the scoring is an ultrasound (24,25). As other biochemical and clinical parameters were insignificant, it is therefore not necessary to analyse these to determine the conversion rate.

A similar scoring system to ours predicts the likelihood of conversion using a scale of 0 to 3 points, with 1 point given for each of the following: Male gender, gallbladder wall thickness more than 4 mm, and the presence of a contracted gallbladder on ultrasound. A score is defined as significant if it has two or more points (significant p-value), but a score of less than 2 showed no statistical significance in relation to the percentage of conversion (20). However, in our study, there were only two ultrasonic variables that were significant and a score of 1 had a 1.8% chance of conversion (p-value of 0.001) and a score of 2 had a 7.2% chance of conversion (p-value of 0.001). If both these ultrasonic features were absent, a score of 0 was given, which had a 0.5% chance of conversion (p-value of 0.0001), meaning that these patients still had a small chance of conversion.

The variables in our scoring system are readily available, as ultrasound is the primary modality of investigation in the diagnosis of gallbladder disease, thus eliminating the need for additional imaging . This predictive score has to be validated in a future study.

Study Limitations

One limitation of our study was that not all cases were operated on by the same surgeon. Cases were taken from four surgical units which had surgeons of varying experience in laparoscopic surgery. The other limitation was that only elective cases were included. These limitations can be overcome by including patients undergoing both elective and emergency laparoscopic cholecystectomy, performed by a single surgeon.

CONCLUSION

Conversion to an open cholecystectomy shows a strong association with gallbladder characteristics on ultrasound, which are available preoperatively. The need to convert should be considered as an attempt to avoid complication and not as a failure. Our scoring system is simple and will help the surgeon to be better prepared for technical difficulties that are expected to be encountered on the table. As this scoring system is both easy to follow and inexpensive, it can be used as pre-operative tool to predict accurately, the need for conversion during laparoscopic cholecystectomy.

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