Conversion from laparoscopic to open cholecystectomy: Multivariate analysis of preoperative risk factors

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ABSTRACT

Background: Laparoscopic cholecystectomy has become the gold standard in the treatment of symptomatic cholelithiasis. Some patients require conversion to open surgery and several preoperative variables have been identified as risk factors that are helpful in predicting the probability of conversion. However, there is a need to devise a risk-scoring system based on the identified risk factors to (a) predict the risk of conversion preoperatively for selected patients, (b) prepare the patient psychologically, (c) arrange operating schedules accordingly, and (d) minimize the procedure-related cost and help overcome financial constraints, which is a significant problem in developing countries.

Aim: This study was aimed to evaluate preoperative risk factors for conversion from laparoscopic to open cholecystectomy in our setting.

Settings and Designs: A case control study of patients who underwent laparoscopic surgery from January 1997 to December 2001 was conducted at the Aga Khan University Hospital, Karachi, Pakistan.

Materials and Methods: All those patients who were converted to open surgery (n = 73) were enrolled as cases. Two controls who had successful laparoscopic surgery (n = 146) were matched with each case for operating surgeon and closest date of surgery.

Statistical Analysis Used: Descriptive statistics were computed and, univariate and multivariate analysis was done through multiple logistic regression.

Results: The final multivariate model identified two risk factors for conversion: ultrasonographic signs of inflammation (adjusted odds ratio [aOR] = 8.5; 95% confidence interval [CI]: 3.3, 21.9) and age > 60 years (aOR = 8.1; 95% CI: 2.9, 22.2) after adjusting for physical signs, alkaline phosphatase and BMI levels.

Conclusion: Preoperative risk factors evaluated by the present study confirm the likelihood of conversion. Recognition of these factors is important for understanding the characteristics of patients at a higher risk of conversion.

KEY WORDS: Cholecystectomy, laparoscopic, risk factors, case control study

Laparoscopic Cholecystectomy (LC) has revolutionized minimally invasive procedures.[1-3] Decreased postop erative pain, earlier oral intake, shorter hospital stay, early resumption of normal activity, and improved cosmesis have been well recognized after LC.[4-6] A significant reduction in the incidence of wound complications and postoperative ileus has been documented in patients undergoing LC.[7,8] However, substantial proportions of patients in whom LC cannot be successfully performed are converted to Open Cholecystectomy (OC) because of technical difficulty or intraoperative complications.[9-11] The current study is aimed at evaluating the risk factors for conversion of LC to OC in our set-up. It was hoped that the prediction of a difficult procedure would allow the surgeon to discuss the likelihood of conversion with the patient and prepare him / her psychologically as well as plan their recovery. These risk factors would be able to predict the probability of conversion for those at a higher risk of conversion. Another benefit would be to allow more efficient scheduling of the operating lists and ensuring the availability of a more experienced laparoscopic surgeon for the procedure.

Materials and Methods

To identify the risk factors for conversion from LC to OC, a case control study was conducted at the Aga Khan University Hospital (AKUH) Karachi, an academic and tertiary care hospital. All patients who underwent LC (n =1,249) from January 1997 to December 2001 were identified from the medical records maintained in the Department of Health Information and Management Systems. All patients who were converted to OC (n = 73) were enrolled as cases. They were considered as 'converted' if LC was planned but due to difficult anatomy, presence of empyema, or perioperative complications, a conversion was necessitated. Cases with incomplete information with respect to anthropometry, laboratory investigations, and ultrasound findings were excluded. Two controls who underwent successful LC (n = 146) were matched with each case on operating surgeon to control for the effect of surgeon's skill; and closest date of surgery of case

(within 4 weeks) to minimize the possible variation due to the change of operating room team.

A detailed proforma was developed to record information on demographics, co-morbidities, past history, history of presenting illness, physical findings, laboratory investigations, ultrasound findings, and postoperative complications. Reasons for conversion such as difficult dissection or anatomy, perioperative cholangiographic findings of stones and perioperative complications were documented for each patient.

Statistical analysis

Data were analysed using Statistical Package for Social Sciences (SPSS version 11.0). Descriptive statistics were computed for characteristics of patients, laboratory and ultrasonographic findings. Patients who underwent LC were categorized into 'converted' and 'successful' for univariate and multivariate analysis. Univariate analysis was carried out by computing odds ratios (OR) and their 95% confidence intervals (CI) to compare 'converted' and 'successful' patients for each potential risk factor of interest. Multivariate analysis was carried out to identify risk factors independently associated with conversion to OC. The criterion for the selection of factors for the final multivariate logistic regression model was a *P* value of 0.25 in the univariate analysis. The final model included age, palpable gall bladder and tenderness in the right hypochondrium on physical examination and ultrasonographic signs of inflammation.

Results

A total of 1,249 LCs were attempted during the study period, out of which 94 were converted to open cholecystectomy; thus the conversion rate in our study was 7.5%. Twenty-one patients were excluded from the study due to incomplete data while 73 patients with complete medical records were selected as cases. Among these cases 23.3% patients were males and the reasons for conversion in both genders were dense adhesions in 41 (56.2%), identification of an empyema of the gall bladder in 9 (12.2%), obscure anatomy in 14 (19.2%), perioperative finding of common bile duct stone in 5 (6.9%), and suspicion of common bile duct injury in 2 cases (2.7%); while the reason for conversion was not documented in the remaining 2 cases.

Patient characteristics, laboratory and ultrasonographic findings

Table 1 shows patient characteristics recorded in the 73 converted and 146 successful LC patients with means and standard deviations (SD). Conversion to OC compared with successful LC was significantly associated with higher age, longer duration of surgery and hospital stay, higher white blood cell count and alkaline phosphatase levels, and thicker gall bladder wall.

Univariate analysis

Among the perioperative variables recorded (Tables 2 and 3), patient's age >60 years, previous upper abdominal surgery, clinical and ultrasonographic signs of acute cholecystitis at admission, and white blood cell count > 10 x 109/L were found significantly associated with conversion to OC.

Multivariate analysis

Table 4 presents the multivariate model of risk factors independently associated with conversion. Patients with ultrasonographic signs of inflammation (gall bladder wall thickness > 3 mm, oedematous wall, pericholecystic fluid, and ultrasonographic Murphy's sign) were 8.5 times more likely to be converted to OC compared to the patients who underwent successful LC (95% CI: 3.3, 21.9) after adjusting all other variables in the model. Age > 60 years (OR = 8.1, 95% CI: 2.9, 22.2) was also identified as a risk factor for conversion. The final model also adjusted simultaneously for other factors such as alkaline phosphatase level > 130 IU/L, and body mass index of > 25 kg/m^2. 'Hosmer and Leme show goodness of fit test' showed a good fit of the model (χ^2 = 10.1, *P* value = 0.11).

Table 1: Distribution of patient demographics, anthropometrics, laboratory and physical findings in converted and successful laparoscopic cholecystectomy patients

Variable	Converted n = 73	Successful n = 146
Age (years)	44. 2 (12.4)	52.7 (12.6)*
Weight (kg)	68. 8 (17.5)	67.4 (14.5)
Height (cm)	153.9 (11.5)	156.6 (9.6)
Body mass Index	28.8 (5.8)	27.4 (5.2)
Duration of surgery (hrs)	2.4 (0.9)	1.3 (0.4)*
Length of hospital stay (days)	3.4 (2.5)	2.5 (1.9)*
WBC (109/L)	10.1 (3.8)	8.6 (2.7)*
Total bilirubin (direct) (mg/dL)	0.4 (0.8)	0.3 (0.7)
Total bilirubin (indirect)(mg/dL)	0.8 (0.6)	0.7 (0.6)
Alkaline phosphatase (IU/L)	131.8 (89.4)	96.6 (49.1)*
SGOT (IU/L)		32.9 (25.0)
SGPT (IU/L)	48.4 (53.3)	33.7 (33.4)
GB wall thickness (mm)	3.5 (1.6)	2.5 (0.9)*
Stone size (mm)	11.5 (6.2)	11.2 (6.2)
CBD size (mm)	4.9 (2.0)	4.4 (1.4)

Values in Mean (Standard deviation), * *P* value significant at 0.05

Discussion

The well-documented advantages and safety of LC have made it standard of care for the management of patients with symptomatic gallstones. Despite these advantages, conversion to open procedure is required in a varying proportion of patients which ranges from 2% to 15% in different studies.[4,12,13] Recent reports also indicate that LC could be a safe and effective treatment option for patients with acute cholecystitis, although the procedure tends to be more difficult with a higher risk of conversion.[14,15] It is important to realize that the need for conversion to laparotomy is neither a failure nor a complication, but an attempt to avoid complication and ensure patient safety.

The importance of factors predisposing to conversion from laparoscopic to open cholecystectomy has been emphasized in several studies reported from the developed countries.[15-18] In our study, the final multivariate model demonstrated that ultrasonographic signs of inflammation and age > 60 years were independently associated with conversion after controlling for the confounding effect of other factors in the model. The finding that ultrasonographic signs of inflammation are risk factors for conversion is consistent with previously dem-

Table 2: Univariate analysis showing association of gender, age, co-morbidities and past history findings with conversion by their odds ratios (OR), 95% confidence intervals (95% CI), and *P* values.

Variable	Converted N =73 n (%)	Successful N =146 n (%)	OR	95% CI for OR	*P* value
Male gender	17 (23.3)	42 (28.8)	0.7	0.4, 1.4	0.390
Age > 60 years	19 (26.0)	13 (8.9)	3.6	1.7, 7.8	0.001
BMI > 30kg/m²	28 (38.4)	42 (28.8)	1.5	0.9, 2.8	0.153
Diabetes mellitus	16 (21.9)	26 (17.8)	1.3	0.6, 2.6	0.467
Hypertension	20 (27.4)	29 (19.9)	1.5	0.8, 2.9	0.209
Past history of recurrent biliary pain	58 (79.5)	138 (94.5)	0.2	0.1, 0.6	0.001
Past history of acute cholecystitis	6 (8.2)	6 (4.1)	2.1	0.6, 6.7	0.216
Past history of acute cholangitis	1 (1.4)	2 (1.4)	1.0	0.1, 11.2	0.900
Past history of acute pancreatitis	2 (2.7)	6 (4.1)	0.6	0.1, 3.3	0.613
Past history of obstructive jaundice	5 (6.8)	3 (2.1)	3.5	0.8, 15.1	0.092
Past history of upper abdominal surgery	6 (8.2)	2 (1.4)	6.4	1.3, 32.8	0.025
Diagnosis at admissionAcute cholecystitis	28 (38.4)	10 (6.8)	8.9	4.1, 19.9	< 0.005
Acute cholangitis	2 (2.7)	1 (0.7)	6.4	0.6, 72.3	0.134
Acute pancreatitis	1 (1.4)	4 (2.7)	0.8	0.1, 7.3	0.843

Table 3. Univariate analysis showing association of physical examination, laboratory, and ultrasonographic findings with conversion by their ORs, 95% CI, and *P* values

Variable	Converted N =73 n (%)	Successful N =146 n (%)	OR	95% CI for OR	*P* value
Jaundice	5 (6.8)	6 (4.1)	1.7	0.5, 5.8	0.386
Tenderness in *RHC	58 (79.5)	60 (41.1)	5.5	2.9, 10.7	<0.005
Palpable gall bladder	16 (21.9)	2 (1.4)	20.2	4.5, 90.3	<0.005
†WBC (10^9/L) > 10	36 (49.3)	47 (32.2)	2.1	1.2, 3.6	0.02
Bilirubin (direct) >0.15 mg/dL	41 (56.2)	78 (53.2)	1.1	0.6, 1.9	0.702
Bilirubin (indirect) > 1.2 mg/dL	16 (21.9)	27 (18.5)	1.2	0.6, 2.5	0.55
Alkaline phosphatase > 130 IU/L	25 (34.2)	41 (21.1)	1.3	0.7, 2.4	0.349
‡GB wall thickness >3 mm	35 (47.9)	25 (17.1)	4.5	2.4, 8.4	<0.005
Oedematous wall of GB	28 (40.6)	4 (2.8)	23.4	7.8, 70.4	<0.005
Pericholecystic fluid	20 (29.0)	2 (1.4)	28.4	6.4, 125. 8	<0.005
Ultrasonographic Murphy's sign	23 (33.3)	6 (4.3)	11.3	4.31, 29.4	<0.005
Multiple gall bladder stones	61 (89.7)	116 (84.7)	1.6	0.6, 3.9	0.326
Size of stone > 10mm	39 (53.4)	64 (43.8)	1.5	0.8, 2.6	0.181
§CBD size > 8 mm	9 (12.3)	9 (6.2)	2.1	0.8, 5.6	0.124
Presence of CBD stones	4 (5.8)	1 (0.7)	0.1	0.01, 1.1	0.057

* Right Hypochondria, † White Blood Cells, ‡ Gall Bladder, § Common Bile Duct

Table 4: Multivariate logistic regression model of risk factors associated with conversion to open cholecystectomy with adjusted odds ratios (aOR) and 95% CI

Variable	aOR*	95% CI for aOR
Sonographic signs of inflammation		
No	Reference	
Yes	8.5	3.3, 21.9
Age		
≤ 60	Reference	
> 60	8.1	2.9, 22.2

* adjusted for palpable gall bladder, tenderness in right hypochondrium, alkaline phosphatase level > 130 IU/L, and BMI > 30 kg/m²

onstrated studies that radiographic findings of inflammation increases the risk of conversion to OC.[3,14,17-19] Ultrasonographic signs analysed in our study were: gall bladder wall thickness, oedematous wall, pericholecystic fluid and ultrasonographic Murphy's sign. Of these, gall bladder wall thickness was strongly associated with conversion on univariate analysis. Our data shows that 58% of patients with a thickness >3 mm had to be converted, contradicting the belief that this is a weak predictor.[12,20] However, these categories were merged for simplicity of analysis in the final model, which facilitated identification of ultrasonographic signs of inflammation as an independent risk factor. The presence of these predictive factors allows the operating surgeon to anticipate the likelihood of encountering a difficult anatomy and / or adhesions before performing LC. He then proceeds with the LC cautiously based on his or her experience.

The logistic regression model also shows that patients older than 60 years of age have an increased likelihood of conversion probably because of the chronicity of gall bladder disease and more fibrotic adhesions. The increased risk of conversion in elderly patients because of recurrent attacks of cholecystitis and complicated biliary tract disease has previously been demonstrated by several studies.[3,10,12,13,21,23] Older patients are probably at a greater risk of conversion due to complications of metabolic decompensation. Therefore preliminary diagnostic

laparoscopy should help identify patients who, due to the presence of dense adhesions or unclear anatomy, warrant early conversion. The surgeon and the patient, however, should be aware of the increased risk of conversion in the older age group and open surgery should be scheduled especially in the presence of other contributing risk factors. This judicious approach will help in avoiding prolonged surgery as well as the risk of complications like injury to the biliary tree.

The present study however did not identify alkaline phosphatase level of > 130 IU/L as an independent risk factor for conversion. Increased levels of alkaline phosphatase are of little value since most of them are within the normal range in patients who actually require conversion. Previously obesity (BMI > 30 kg/m^2) had been identified as a major factor predicting conversion and had ranged from a moderate to highly significant risk factor; [4,12,19,24] however it was not identified as an independent risk factor in our logistic regression model even though obesity was checked for its possible association with conversion on univariate analysis and was identified as marginally significant with an odds ratio of 1.5 (Table 2). The probable explanation is a fewer number of patients with a BMI > 30 kg/m^2 (38.4% among converted). However the risk factors in the final model were adjusted for obesity and other factors due to their plausibility and significance on univariate analysis (Table 4).

The review of risk factors from this study has propositions for surgeons while encountering difficulty during LC. Patients who require conversion based on a suspicion of identified preoperative findings are the ones who are likely to be prone to postoperative complications as well. Also, conversion to OC should be regarded as a prudent and conscious attempt to avoid complications. As anticipated, apart from the loss of all the potential advantages of a minimally invasive procedure, conversion also results in increased morbidity, prolonged hospital stay, and increased cost. If a prediction model based on the risk factors evaluated from our logistic regression model can be applied in a clinical setting, it can prevent the surgeon from persisting with a difficult operation. With patients > 60 years of age and in those with signs of inflammation on ultrasonography, the surgeon should maintain a low threshold for conversion.

Conclusions

This study identifies the preoperative risk factors for conversion from laparoscopic to open cholecystectomy in our setting. Patient factors, presentation, and preoperative ultrasonographic findings can all contribute to the prediction of conversion. Recognition of these factors is important for understanding the characteristics of patients at a higher risk of conversion since they require longer hospital stay and place more demands on the health care facilities. The knowledge of these risk factors might help in better psychological preparation of the patient for open surgery and for prolonged convalescence. It will also allow for better organization of the operating room schedule ultimately leading to reduction in procedure-related costs.

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