Predictive Factors for Difficult Surgery in Laparoscopic Cholecystectomy for Chronic Cholecystitis

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Citation

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Abstract

Introduction: Conversion rate in laparoscopic cholecystectomy is still 1.5-19%. Our aim was to look for various factors and to make a predictive index which can predict the chances of conversion.

Methods: We included 536 patients with laparoscopic cholecystectomy during July 2002 to April 2006. A total of 64 patients needed conversion. Twenty four patients who underwent conversion because of non-surgical reasons were excluded. Criteria of exclusion were: history of jaundice, cholangitis, raised alkaline phosphatase, dilated common bile duct (CBD) and patients with CBD stones. Patients were evaluated in terms of clinical, hematological, biochemical and ultrasonographic parameters.
Results: Overall conversion rate was 7.81%. Univariate analysis showed that body mass index (BMI), fever at the time of attack, number of stones, number of attacks, previous history of acute cholecystitis, presence of tenderness, gall bladder wall thickness on ultrasonography (USG) and raised total leucocyte counts (TLC) were significant for conversion. Stepwise logistic regression showed that only number of attacks, TLC & wall thickness were significant. Probability of prediction: P = ey/(1+ey) and Y = -9.2015 + (0.3623 × Number of Attacks) + (0.0003 x TLC) + (0.8633 × Wall Thickness), where 'e' is the exponential constant -2.7182, number of attacks is '1' if > 5 and '0' for < 5, TLC = '1' if counts are > 11,000/cu.mm and '0' if within normal range, and wall thickness is '1' if > 4 mm and '0' for < 4 mm on USG.

Conclusion: Yes, it is possible to predict the risk of conversion and patients can be informed preoperatively.

INTRODUCTION

Since its advent in 1987, laparoscopic cholecystectomy (LC) has become the gold standard for symptomatic gall stones. In spite of increasing expertise and advances in technology conversion rate is still 1.5-19% in different centers [1]. The incidence of conversion is less in centers where LC is attempted in a selected group of patients. This conversion is neither a failure nor a complication, but an attempt to avoid complications. It would be useful to have some reliable predictive factors for conversion in LC so that patients may be informed appropriately and they have chance to make arrangements regarding their work and family. Similarly, the surgeon may schedule the time and team for surgery, because these high-risk patients are not candidates for routine resident training. Studies have shown that there are higher incidences of post-operative complications and longer hospital stays in converted patients when compared with both the laparoscopic and the open cholecystectomy group [2]. Scoring systems are designed in some studies for better understanding and for easy prediction of conversion [1,3]. The risk factors had been reviewed recently [4]. Our aim was to look for the various factors and to make a predictive index which can predict which patient may need to be converted, thus suitably opting for the operating procedure.

METHODS

We included 536 patients who underwent LC from July 2002 to April 2006 in our university hospital in North India. A total of 64 patients needed conversion. Twenty-four patients who underwent conversion because of anesthetic complications and presence of other co-morbidities were excluded from the study. Patients with history of jaundice, cholangitis, raised alkaline phosphatase or dilated common bile duct (CBD) were evaluated further by ERCP and patients with CBD stones were excluded. All cases were operated by a single experienced senior surgeon. All patients were evaluated in terms of clinical, hematological, biochemical and ultrasonographic parameters (Table 1). Conversion rate and reasons for conversions were also noted.

Figure 1

Table 1: List of various parameters assessed

Clinical	Hematological and Biochemical	Ultrasonography
Age	TLC	GB status (contracted, normal or distended)
Sex	Serum amylase	Wall thickness(mm)
BMI	Serum LDH	No. of stones (single or multiple)
Parity (in females)	Serum TG	Peri-cholecystitic edema (Y/N)
Duration from last attack	Serum LDL	CBD diameter(mm)
Total duration of symptoms		CBD stones (present or absent)
History of fever at time of attack		
Tenderness		
Previous history of acute attack		

GB – Gall Bladder, Y – Yes, N – No, TG – Triglycerides

RESULTS

We included 536 patients of chronic cholecystitis who underwent laparoscopic cholecystectomy and 64 required conversion. Twenty-four patients who underwent conversion because of technical difficulties were excluded from this study. So this study was effectively carried out on 512 patients with an overall conversion rate of 7.81%. The mean age of patients was 38.07 ± 10.16 years (range: 17-73). The maximum numbers of patients were in the age group of 31-40 years (46.5%). The mean age in non-converted cases was not statistically different from the conversion group ($p>0.05$). The conversion rate in males (10.41%) was also not significantly different from that in females (7.18%, $p = 0.456$).

Of the 512 patients, 180 (35.15%) patients had history of acute cholecystitis attacks and the rest had history of dyspeptic symptoms. Patients with history of an acute attack had a significantly higher conversion rate (15.6% vs. 3.6%, $p <0.001$). Total duration of symptoms and duration between surgery and last attack was not significantly different in the conversion and the non-conversion group, but it was found that the conversion rate was higher in patients with >5 attacks and the number of attacks was a statistically significant factor (Table 2). Conversion rate was also significantly higher in patients with history of fever (17.46% vs. 4.66%) and tenderness in the right hypocondrium at presentation (36% vs. 4.8%).

Figure 2

Table 2: Change in frequency of conversion with number of attacks

No. of Attacks	Frequency No. (%)	Converted No. (%)	Non-converted No. (%)
0	332 (64.84)	12 (3.61)	320 (96.39)
1	46 (8.98)	2 (4.34)	44 (95.65)
2-5	114 (22.26)	6 (5.26)	108 (94.73)
6-10	36 (7.03)	20 (55.56)	16 (44.44)
>10	4 (0.78)	-	4 (100)
Total	512 (100.00)	40 (7.81)	472 (92.19)
Mean ± SD	1.16 ± 2.22	2.9 ± 3.22	0.81 ± 1.47
Range	0-15	0-8	0-15

$p = 0.001$; $\chi^2 = 5.37$

In this study of 512 patients, there were 50 (9.77%) patients with raised TLC. Twenty-two (4.76%) patients with normal values underwent conversion as compared to 18 (36%) patients with raised counts. The mean TLC in the conversion group was 10,195 ± 2,792.37, ranging from 6,400 to 16,000/cmm. The mean of the counts in the non-conversion group was 7,628.38 ± 1,846.00, ranging from 4,200 to 14,800. TLCs were found to be statistically significant for risk of conversion (Table 3).

Figure 3

Table 3: Change in frequency of conversion with change in Total Leukocyte Count

TLC (cells /cmm)	Frequency No. (%)	Converted No. (%)	Non-converted No. (%)
> 11,000	50 (9.76)	18 (36.00)	32 (64.00)
4,000 to 11,000	462 (90.23)	22 (4.76)	440 (94.01)
Total	512 (100.00)	40 (7.81)	472 (92.19)
Mean ± SD	7828.9 ± 2048.84	10195 ± 2792.37	7628.38 ± 1846.00
Range	4200-16000	6400-16000	4200-14800

$p = 0.005$; $\chi^2 = 5.7$

The patients were grouped into two groups, with BMI up to

30 kg/m ^{2} and above 30 kg/m ^{2} . In low BMI patients, 18 (4.81%) patients were converted while 22 (15.94%) obese patients with high BMI underwent conversion. Statistically, BMI was found to be significant for risk of conversion (p = 0.003). Serum LDH, serum amylase and serum triglycerides were also evaluated, but none of these was statistically significant.

With evaluation of patients by ultrasonographic parameters, 82 patients (16%) had contracted gall bladder, and 430 patients (84%) had non-contracted gall bladder. In the contracted gallbladder group, 12 patients (14.63%) underwent conversion while in the non-contracted gallbladder group 28 (6.51%) underwent conversion. The difference between the two groups was not statistically significant (p>0.05). A total of 336 patients had normal wall thickness with a conversion rate of 2.98% as compared to 29.4% with thick gall bladder wall (p<0.05). The minimum wall thickness beyond which the risk of conversion increased statistically was 4 mm (Table 4). A single stone was present in 150 patients (29.3%), while 362 patients (70.7%) had more than one stone. Conversion rate in each group was 13.33% and 5.52%, respectively, with a p-value of 0.0341. Patients who had at least one stone greater than 10mm in diameter were not having statistically significant difference in conversion rate as compared to those with stone sizes less than 10mm (p=0.531).

Figure 4

Table 4: Change in frequency of conversion with change in gall bladder wall thickeness on USG

Wall thickness (mm)	Frequency No. (%)	Converted No. (%)	Non-converted No. (%)
Up to 3.00	336 (65.6)	10 (2.98)	326 (97.02)
3.1-4.00	102 (19.9)	14 (13.73)	88 (86.27)
4.1-5.00	48 (9.4)	2 (4.17)	46 (95.83)
5.1 – 6.0	16 (3.1)	10 (62.50)	6 (37.5)
> 6.00	10 (2.0)	4 (40.00)	6 (60.0)
Total	512 (100.00)	40 (7.81)	472 (92.19)
Mean ± SD	3.40 ± 0.82	4.59 ± 1.79	3.30 ± 0.68
Range	3.00-8.20	3.00-7.40	3.00-8.20

$p = 4.482 \times 10^{-7}$ (<0.001); $\chi^2 = 7.34$.

STATISTICAL ANALYSIS

Univariate analysis showed that BMI, fever at the time of attack, number of stones, number of attacks, previous history of acute cholecystitis, presence of tenderness in the right hypochondrium, gall bladder wall thickness on USG and raised TLCs were statistically significant for risk of conversion (Table 5).

Figure 5

Table 5: Logistic regression of univariate significant variables

Variables	β coefficient	S.E.	P	Odd's ratio	95% CI	
					Lower	Upper
BMI	0.9409	1.30901	0.4723	2.5623	0.197	33.3316
Fever	-0.6165	1.4191	0.6640	0.5398	0.0334	8.7133
No. of attacks	0.4520	0.3580	0.2067	1.5715	0.7791	3.1698
No. of stones	1.4347	1.4078	0.3081	4.1982	0.2659	66.2748
Tenderness	3.6120	2.4619	0.1423	37.0387	0.2972	4615.3397
TLC	0.0004	0.0003	0.2168	1.0004	0.9998	1.0010
Wall thickness	2.4116	1.0891	0.0268	11.1520	1.3191	94.2806
Ac. cholecystitis	-2.6125	1.9697	0.1847	0.0734	0.0015	3.4839
Constant	-17.0824	6.6476	0.0102			

SE – Standard error

Stepwise logistic regression to find the independent risk factors showed only wall thickness (p=0.02) to be statistically significant, then stepwise logistic regression was performed deleting one non-significant variable at a time and final logistic regression matrix showed that only number of attacks, TLC counts & wall thickness were statistically significant (Table 6).

Figure 6

Table 6: Final matrix showing significant variables on logistic regression

Variables	β-Co-efficient	S.E.	p-value	Odds ratio	95% CI	
					Lower	Upper
Number of attacks	0.3623	0.0988	0.0002	1.4366	1.1836	1.7437
Total leukocyte counts	0.0003	0.0001	0.0239	1.0003	1.0000	1.0006
GB wall thickness on USG	0.8633	0.2358	0.0003	2.3709	1.4935	3.7636
Constant	-9.2015	1.5579	0.0000	-		

PREDICTIVE INDEX

Probability of prediction in a particular patient can be calculated by the following formula. $P = e^{y} / (1+e^{y})$ and y = -9.2015 + (0.3623 × Number of attacks) + (0.0003 × TLC) + (0.8633 × Wall thickness), where 'e' is the exponential constant -2.7182, Number of attacks is '1' if > 5 and '0' for < 5, TLC = '1' if the counts are >11,000/cu.mm and '0' if the counts are within normal range, wall thickness is '1' if > 4 mm and '0' if < 4 mm on USG.

SCORING SYSTEM FOR CONVERSION PREDICTION

The β-coefficients of the variables found significant on logistic regression were considered for a scoring system: The coefficients were rounded and multiplied by 10 for easy calculation. These coefficients and a constant formed the risk score for conversion from laparoscopic to open cholecystectomy (Table 7).

Figure 7

Table 7: Risk Score For Conversion From Laparoscopic To Open Cholecystectomy

Parameters	Frequency	Coefficients
No. of attacks	≥ 5	0
	> 5	4
TLCs	≤ 11,000	0
	> 11,000	1
GB wall thickness	≤ 4 mm	0
	> 4 mm	9
Constant		-10

The sum of the coefficients and the constant gives the final score of the patient and can take a value between -10 and 4. Increasing scores are associated with significantly increased conversions rate. The mean risk score in non-converted patients was about -9.0, while in the converted patients it was about -2.0. The range of scores in converted patients was from -10 to 4 and in the non-conversion group the range was from -10 to 0. Evaluating the significance of this scoring system with prediction of conversion, it was noticed that the test was highly significant for prediction of conversion (Table 8).

Figure 8

Table 8: Comparison of risk scores in conversion and non-conversion group

Score	Total (512)	Converted (40)	Non-converted (472)
Mean ± SD	8.9942 ± 3.46	2.00 ± 4.74	8.9958 ± 2.71
Range	-10 to 4	-10 to 4	-10 to 0

$\chi^2 = 129.515$, p = <0.005

The most important reason for conversion was adhesions at Calot's triangle (35%), followed by contracted gall bladder (20%). The other reasons of conversion were empyema of the gall bladder (10%), stone at Hartmann's pouch (10%), bleeding during dissection (10%), dilated cystic duct with stone (5%), short cystic duct (5%), injury to the stomach (5%) and injury to the CBD (5%).

DISCUSSION

In view of laparoscopic cholecystectomy being the gold

standard treatment of symptomatic cholelithiasis, preoperative prediction of the risk of conversion is an important aspect of planning laparoscopic surgery. The “risk scoring for conversion from laparoscopic to open cholecystectomy” (RSCLO) was developed by Kama et al. [1] The successful efficacy of this system has been proved [5] .

In most of the studies on patients with advanced age (>65 years), an increase in complication and conversion rate is reported and age is recognized as a risk factor for conversion [1,2,6,7,8,9,10,11] . We and some other authors did not notice age to be associated with conversion rate [12,13] . This varied opinion could be attributed probably to surgeons' experience and expertise.

Male sex was considered an independent risk in many series [1,6,7,12,14,15,16,17,18] . However, Liu et al. [2] did not notice sex to be associated with conversion. In our series, male sex and parity was not a risk factor for conversion. In the literature, we found no study assessing parity as a risk factor for conversion.

In our study, there was significantly more risk of conversion in patients with previous history of acute cholecystitis ($p<0.001$). The same has been observed in other studies as well [1,2,6,16,17,19] . Association of total duration of symptoms with conversion has also been evaluated. Alponat et al. [19] did not notice association of conversion with duration of symptoms in both univariate and multivariate analysis. Duration of symptoms is also not found to be associated with risk of conversion in our series ($p=0.446$). Sanabria et al. [7] found in their study of 628 patients that patients with multiple attacks (ten or more) were significantly associated with conversion, but in our study we found significance with a number of attacks more than five. Schrenk et al. [3] reported in a study of 300 patients assessing 24 variables for conversion that patients with history of acute cholecystitis within the last 3 weeks were at increased risk of conversion. Brodsky et al. [9] reported that patients undergoing laparoscopic cholecystectomy after 96 hours after an attack of acute cholecystitis were more likely to undergo conversion. In this series, we took a longer period (before or after 90 days) for assessment of this risk factor and we found it insignificant.

Morbid obesity is known to be associated with difficult surgery and increased risk for conversion [2,6,16,17,20,21] . Hutchinson et al. [12] reported a two-time increase in conversion rate when BMI is >27.2 kg/m^2 . We also found obesity as a significant risk factor for conversion. Some workers did not associate obesity with conversion in their study [1,22] .

Fever has been identified as a risk factor for conversion in our series and by many workers in their studies [3,9,10,13,19] , but some found it insignificant [1,2] . Tenderness has also been reported as a risk factor for conversion by some authors [1,3,19] , as in our study. Many authors have identified raised WBC as a risk factor for predicting conversion [1,3,9,10,17,20,23] . In our study, there was significantly more risk of conversion in patients having TLC >11000/cmm. This can be probably attributed to persisting acute inflammation with edema of the gall bladder making surgery difficult. Moreover, patients with raised counts in cases of acute cholecystitis are likely to have a complicated gall bladder.

Many others have identified a contracted gall bladder as a potential factor for conversion [1,3,8,15] . Schrenk et al. [3] identified shrunken gall bladder as an independent risk factor for conversion along with other variables. In a study of 738 patients, Jansen et al. [8] found contracted gall bladder to be statistically significant for risk of conversion. Gall bladder wall thickness has been identified as a risk factor for conversion in almost all the studies. The critical thickness of gall bladder associated with conversion varies from study to study. It was 3mm [6,16] , 4mm [1,8] , and 6mm [24] in different studies. In present series, it was 4mm.

Most of the authors did not find any statistical significance with number of stones and risk of conversion [8,12] . But we found that patients with a single stone had more chance of conversion. Many authors found no statistical significance between size of stones and conversion [1,6] . We also found the same, but Jansen et al. [8] found that stone size >20mm was associated with increased risk of conversion explaining that large stones are likely to get impacted at Hartmann's pouch, thereby making dissection difficult.

A predictive index has been equated in various studies. In a study of 1,676 patients, Fried et al. [6] calculated the predictive index for conversion. The probability of conversion was predicted by ‘P', where $P = e^y / (1+e^y)$ and $y = -5.7924 + (0.0248 \times Age) + (0.8935 \times Sex) + (1.7764 \times Acute) + (0.5294 \times Thick)$. “Age” is the actual age, “Sex” = 1 if the patient is male and 0 if female, “Acute” = 1 if acute cholecystitis is present or ‘0' if absent, “Obesity” = 1 if the patient is obese and ‘0' if not obese, “Thick” = 1 if USG demonstrates thickness of gall bladder wall or ‘0' if the wall is not thickened. Nachnani et al. [16] also proposed a predictive index as the following equation: $P=e^y / (1+e^y)$, where P

indicates the predicted probability of conversion of LC to open cholecystectomy (OC), 'e' is the exponential constant 2.7182, and y = -1.4198 – 1.0218 (Gender) – 2.7588 (Acute Cholecystitis/Acute Pancreatitis) + 1.7550 (Obesity) + 1.8303 (GB Thickness) – 1.4604 (Surgery). A higher value of P indicates a higher likelihood of conversion, with a value of 1.0 indicating certainty of conversion to OC.

We also equated the predictive index showing $P = e^{y} / (1+e^{y})$, in which 'e' is the exponential constant -2.7182 and y = -9.2015 + (0.3623 x Number of Attacks) + (0.0003 x TLC) + (0.8633 x Wall thickness). "Number of Attacks" is '1' if attacks are more than 5 and '0'if the number of attacks is less than or equal to 5, "TLC" = '1' if the counts are more than 11,000/cu.mm and '0' if the counts are within normal range, "wall thickness" is '1' if more than 4 mm and '0' if up to 4 mm on USG.

Tayeb et al. [25] presents the multivariate model of risk factors independently associated with conversion. Patients with ultrasonographic signs of inflammation (gall bladder wall thickness >3mm, edematous wall, peri-cholecystic 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 after adjusting all other variables in the model. Age >60 years was also identified as a risk factor for conversion.

Recent series [26] state that presence of previous upper abdominal surgery with AC and obesity had a substantial effect on conversion, compared with the reference group. LC is safe in patients with AC, previous abdominal surgery, or obesity. However, the presence of inflammation alone or in combination with obesity and/or previous (especially upper) abdominal surgery is the main factor that influences the adverse outcomes of LC.

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