Evaluation of Pre- and Intra-operative Factors Predicting the Conversion of Laparoscopic Cholecystectomy to Open Cholecystectomy in Acute Cholecystitis

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Abstract

Introduction: Laparoscopic cholecystectomy has replaced open cholecystectomy for the treatment of gallbladder disease. However, certain cases still require conversion to open procedures. Identifying these patients at risk for conversion remains difficult. This study identifies risk factors that may predict conversion from a laparoscopic to an open procedure hence avoid the morbidity of unnecessary laparoscopic surgery, extra costs for equipment, and avoid prolonged hospitalization in acute cholecystitis.

Aims and Objectives: (1) To identify the pre-operative factors that may help to predict conversion of early laparoscopic cholecystectomy to open cholecystectomy in patients of acute cholecystitis. (2) To correlate the pre-operative predictive factors with intraoperative severity of acute cholecystitis. (3) To evaluate the value of these factors for predicting difficulty in laparoscopic cholecystectomy.

Materials and Methods: A prospective interventional study was conducted in the Department of Surgery. 163 patients of acute cholecystitis from August 2010 to September 2012 were included in the study.

Results: A total of 163 patients of acute cholecystitis underwent early laparoscopic cholecystectomy (within 1.5-3 days of onset of symptoms). Mean duration of symptoms before surgery was 2.8 days. 139 of these patients underwent successful completion of early laparoscopic cholecystectomy, 24 patients required conversion to open cholecystectomy. The main causes of conversion to open procedure were dense pericholecystic/omental/bowel adhesions, or difficult/obscure anatomy in Calot's triangle.

Conclusions: As per our study, male patients with acute cholecystitis who had raised serum alkaline phosphatase and raised total leukocyte count at admission had a significantly higher rate of conversion to open cholecystectomy. Furthermore, high intraoperative severity score predicts conversion. These patients are definitely poor candidates for early laparoscopic cholecystectomy and should be managed conservatively initially followed by laparoscopic cholecystectomy after 6-8 weeks.

Keywords: Acute disease, Cholecystectomy, Cholecystitis/surgery, Conversion to open cholecystectomy

INTRODUCTION

Laparoscopic cholecystectomy is considered the "gold standard" for the treatment of symptomatic gallstones presenting as chronic cholecystitis. With increasing experience in laparoscopic surgery, it was concluded by several investigators that the laparoscopic cholecystectomy is a safer, feasible, and valid alternative in patients with acute cholecystitis.[1,2] These patients had a shorter hospital stay. Limitations in laparoscopic surgery due to the two-dimensional view and lack of tactile sensation are amplified in the presence of acute inflammation. Thus, the conversion rate to open cholecystectomy is higher when compared to elective cases.[3] 2-15% of the cases require conversion to open cholecystectomy for various reason.[4-11]

It is imperative to preoperatively define the predictive factors that can reliably predict the chances of completing

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laparoscopic cholecystectomy in patients of acute cholecystitis as identifying these variables improves patient counseling, planning of convalescence, and post-operative expectations.

Aims and Objectives

1. To identify the pre-operative factors that may help to predict conversion of early laparoscopic cholecystectomy to open cholecystectomy in patients of acute cholecystitis
2. To correlate the pre-operative predictive factors with intraoperative severity of acute cholecystitis
3. To evaluate the value of these factors for predicting difficulty in laparoscopic cholecystectomy.

MATERIALS AND METHODS

Statistical Analysis

Estimates based on references[12,13] considering the conversion of laparoscopic cholecystectomy to open cholecystectomy in early operated cases of acute cholecystitis which was 21%. Here, alpha error was considered as 5% and relative precision of 30% (allowable error).

Descriptive statistic is analyzed, multivariate logistic preparation and Chi-square test is employed to compare various predictive factors leading to conversion of laparoscopic cholecystectomy to open cholecystectomy.

Inclusion Criteria

The patients of acute cholecystitis presenting at Tertiary Hospital between August 2010 and September 2012 satisfying case definition for acute cholecystitis and being operated within 3 days of onset of symptoms were included in the study. Age group between 18 and 80 years.

Case definition for acute cholecystitis

For the purpose of our study, diagnosis of acute cholecystitis was established in patients having following features:
1. Clinical - acute right upper abdomen-tenderness
   • Temperature at presentation >37.50 C and/or
   • White blood cell (WBC) count >10,000.
2. Ultrasonography (USG) - presence of gallstones in thickened and edematous gallbladder
   • Positive sonographic murphy sign
   • Pericholecystic fluid collection.

Exclusion Criteria

1. Choledocholithiasis - as on USG
2. Having comorbid conditions, e.g., uncontrolled hypertension, diabetes mellitus (DM), and hepatic/renal disease rendering them unfit for surgery on semi-emergency basis

3. Pregnancy/history of missed periods in premenopausal females
4. Primary liver pathology such as cirrhosis, hepatitis
5. Cholangitis.

Written informed consent of each patient included in the study was obtained.

Laparoscopic cholecystectomy was performed by an experienced laparoscopic surgeon (having done at least 200 laparoscopic cholecystectomies) within 3'days of onset of symptoms. Standard four-port technique was used for laparoscopic cholecystectomy. Dissection with electrocautery was done where required. Drain was inserted through the subcostal port into subhepatic space only when deemed necessary by operating surgeon. Conversion to open cholecystectomy was done as and when deemed necessary by the operating surgeon.

The following predictive factors, outcome variables, and desired outcome (i.e. successful laparoscopic cholecystectomy) were studied:

Predictive factors:
1. Age
2. Sex
3. Duration of symptoms before surgery
4. WBC counts
5. Serum alkaline phosphatase level
6. Total bilirubin (liver function test)
7. Duration of surgery
8. lntraoperative severity of acute cholecystitis
9. Successful laparoscopic cholecystectomy without conversion.

RESULTS

All patients underwent a trial of early laparoscopic cholecystectomy within 1.5-3 days of onset of symptoms. Mean duration of symptoms before surgery was 2.8 days. 139 of these patients underwent successful completion of early laparoscopic cholecystectomy, 24 patients required conversion to open cholecystectomy. The main causes of conversion to open procedure were dense pericholecystic/omental/bowel adhesions and difficult/obscure anatomy in Calot's triangle.

The outcome of laparoscopic cholecystectomy is successful laparoscopic cholecystectomy total no 139 that is 89.3%, failed laparoscopic cholecystectomy total no 24, that is, 14.7%. Mean age distribution in successful laparoscopic is 48.78 years (36-66) was as in failed laparoscopic mean age 51.08 years (38-66) $P = 0.234$. There were 58 male and 103 female patients with a mean age of 49.12 years (range 36-66 years)

most common age group was 36-45 years in both male and female (Table 1).

In this study gender distribution was as follows; males - 58 (35.6%) and females - 105 (64.4%). In this study, distribution of comorbidities as follows 3 patients with bronchial asthma and hypertension, 25 patient with DM, 8 patient with both diabetes and hypertension.

There was no significant difference in success versus failure rates of early laparoscopic cholecystectomy across the age distribution of patients in the study ($P = 0.536$). Even when the age distribution was categorized into <47 years and >47 years age groups, the differences in success/failure rates between the two age groups remained insignificant ($P = 0.682$).

Male patients had significantly higher failure rate of early laparoscopic cholecystectomy as compared to female patients ($P = 0.001$).

Distribution of Varying Intraoperative Severity of Acute Cholecystitis

The most common type of intraoperative severity was type 1a, and least was type 4b.

Age and sex distribution of patients of varying intraoperative severity of acute cholecystitis was compared.

The intraoperative severity grading of acute cholecystitis is as follows:[14,15]
I. Edematous
   a. Less severe
   b. Acutely severe
II. Mucocele
III. Gangrenous
   a. Fundal
   b. Infundibular
   c. Generalized
IV. Empyema
   a. Pyocholecystitis
   b. Frank empyema.

Distribution of patients as per various intraoperative severity score is given in Table 2. There was significant variation in intraoperative severity pattern of acute cholecystitis across the various age groups ($P \leq 0.001$). When the age distribution was categorized into <47 years and >47 years age groups, the variation in intraoperative severity pattern remained significant ($P = 0.002$). Males had significantly higher intraoperative 70 grades of acute cholecystitis as compared to females ($P = 0.003$) (Table 3).

The duration of symptoms before surgery and pre-operative laboratory variables (at admission) of patients undergoing successful versus failed early laparoscopic cholecystectomy was compared (Table 4) among patients with successful versus failed early laparoscopic cholecystectomy. There was no significant difference in mean values of duration of symptoms before surgery ($P \leq 0.382$), but significant difference was present in total leukocyte count at admission - ($P \leq 0.001$) serum alkaline phosphatase at admission ($P \leq 0.001$) and total bilirubin at admission ($P \leq 0.001$).

Duration of symptoms before surgery and pre-operative laboratory variables - (at admission) in patients with varying intraoperative severity of acute cholecystitis compared (Table 5).

Among patients with varying intraoperative severity of acute cholecystitis, there was no significant difference in mean values of duration of symptoms before surgery ($P = 0.382$), significant difference in total leukocyte count at admission ($P \leq 0.001$), alkaline phosphate at admission ($P \leq 0.001$), and serum total bilirubin at admission ($P \leq 0.001$).

The difference in mean duration of symptoms at admission was insignificant ($P = 0.382$) across the various intraoperative severity grades of acute cholecystitis.

Table 1: Age and gender distribution of patients undergoing successful verus failed early laparoscopic cholecystectomy

Age/gender	Laparoscopic cholecystectomy		Total (%)	*P* value
	Successful (%)	Failed (%)		
36-45 years	64 (88.9)	8 (11.1)	72 (100.0)	0.536
46-55 years	46 (85.2)	8 (14.8)	54 (100.0)	
56-65 years	21 (77.8)	6 (22.2)	27 (100.0)	
>65 years	8 (80.0)	2 (20.0)	10 (100.0)	
Total	139 (85.3)	24 (14.7)	163 (100.0)	
Age				
≤47 years	75 (90.4)	8 (9.6)	83 (100.0)	0.062
>47 years	64 (80.0)	16 (20.0)	80 (100.0)	
Total	139 (85.3)	24 (14.7)	163 (100.0)	
Gender				
Male	42 (72.4)	16 (27.6)	58 (100.0)	0.001
Female	97 (92.4)	8 (7.6)	105 (100.0)	
Total	139 (85.3)	24 (14.7)	163 (100.0)	

Table 2: Distribution of varying intraopertive severity of acute cholecystitis

Intraoperative severity grades	Frequency (%)
Edematous less severe (1a)	53 (32.5)
Edematous acutely severe (1b)	37 (22.7)
Mucocele (2)	38 (23.3)
Gangrenous fundal (IIIa)	19 (11.7)
Empyema pyocholecystits (IVa)	12 (7.4)
Empyema frank empygema (IVb)	4 (2.5)
Total	163 (100.0)

Table 3: Age and gender distribution of patients of varying intraopertive severity of acute cholecystitis

Age/gender	Intraoperative severity grades						Total	P value
	Ia	Ib	II	IIIa	IVa	IVb		
36-45 years	21 (29.2)	18 (25.0)	15 (20.8)	13 (18.1)	5 (6.9)	0 (0.0)	72 (100.0)	<0.001
46-55 years	20 (37.0)	16 (29.6)	8 (14.8)	4 (7.4)	2 (3.7)	4 (7.4)	54 (100.0)	
56-65 years	4 (14.8)	3 (11.1)	15 (55.6)	1 (3.7)	4 (14.8)	0 (0.0)	27 (100.0)	
>65 years	8 (80.0)	0 (0.0)	0 (0.0)	1 (10.0)	1 (10.0)	0 (0.0)	10 (100.0)	
Total	53 (32.5)	37 (22.7)	38 (23.3)	19 (11.7)	12 (7.4)	4 (2.5)	163 (100.0)	
Age								
≤47 years	25 (30.1)	21 (25.3)	15 (18.1)	17 (20.5)	5 (6.0)	0 (0.0)	83 (100.0)	0.002
>47 years	28 (35.0)	16 (20.0)	23 (28.8)	2 (2.5)	7 (8.8)	4 (5.0)	80 (100.0)	
Gender								
Male	17 (29.3)	10 (17.2)	16 (27.6)	3 (5.2)	8 (13.8)	4 (6.9)	58 (100.0)	0.003
Female	36 (34.3)	27 (25.7)	22 (21.0)	16 (15.2)	4 (3.8)	0 (0.0)	105 (100.0)	

Table 4: Comparison of mean duration of symptoms before surgery and mean values of preoperative laboratory variables (at admission) of patients undergoing successful versus failed early laparoscopic cholecystectomy

Patient symptoms and lab values	n	Mean±SD	P value
Mean duration of symptoms (days)			
Successful	139	2.21±0.681	0.382
Failed	24	2.33±0.654	
WBC			
Successful	139	12.92±1.422	<0.001
Failed	24	16.73±1.701	
Total bilirubin			
Successful	139	0.69±0.276	<0.001
Failed	24	0.91±0.219	
Alkaline phosphatase (Ka/ml)			
Successful	139	76.11±24.328	<0.001
Failed	24	137.38±47.548	

WBC: White blood cell

Table 5: Comparison of mean values of preoperative laboratory variables (at admission) in patients with varying intraoperative severity of acute cholecystitis

Laboratory variables	Severity	n	Mean±SD	P value
WBC	Ia	53	13.023±2.1223	<0.001
	Ib	37	12.646±1.3641	
	II	38	13.453±0.9386	
	IIIa	19	14.253±2.4679	
	IVa	12	16.308±1.9266	
	IVb	4	15.400±0.0000	
Total bilirubin	Ia	53	0.670±0.2250	<0.001
	Ib	37	0.708±0.2431	
	II	38	0.832±0.3129	
	IIIa	19	0.605±0.2877	
	IVa	12	1.008±0.1165	
	IVb	4	0.300±0.0000	
Alkaline phosphatase (Ka/ml)	Ia	53	89.62±43.073	<0.001
	Ib	37	73.03±30.189	
	II	38	80.63±23.063	
	IIIa	19	77.89±29.265	
	IVa	12	126.67±39.389	
	IVb	4	90.00±0.000	

WBC: White blood cell, SD: Standard deviation

lntraoperative severity grades of acute cholecystitis among patients with successful versus failed early laparoscopic cholecystectomy (Table 6): The intraoperative severity of acute cholecystitis was significantly less in patients with successful early laparoscopic cholecystectomy than in those with a failed procedure. Distribution of comorbidity among patients with successful versus failed early laparoscopic cholecystectomy (Table 7): There was no significant correlation between patient having comorbidity in successful versus failed early laparoscopic cholecystectomy ($P = 0.032$).

DISCUSSION

Early laparoscopic cholecystectomy has become the treatment of choice for acute cholecystitis. However, the rate of conversion to open operation in laparoscopic cholecystectomy for acute cholecystitis is 15-25% (5 times the conversion rate for chronic cholecystitis).[14,16] A converted cholecystectomy diminishes - the potential medical, cosmetic, and economic advantages of an early minimal invasive intervention.

Table 6: Distribution of various intraoperative severity grades of acute cholecystitis among patients with successful versus failed early laparoscopic cholecystectomy

Intraoperative severity grades	Laparoscopic cholecystectomy		Total (%)	P value
	Successful (%)	Failed (%)		
Ia	46 (86.8)	7 (13.2)	53 (100.0)	<0.001
Ib	36 (97.3)	1 (2.7)	37 (100.0)	
II	37 (97.4)	1 (2.6)	38 (100.0)	
IIIa	16 (84.2)	3 (15.8)	19 (100.0)	
IVa	0 (0.0)	12 (100.0)	12 (100.0)	
IVb	4 (100.0)	0 (0.0)	4 (100.0)	
Total	139 (85.3)	24 (14.7)	163 (100.0)	

This study is a comparative evaluation of the patient groups undergoing successful versus failed early

Table 7: Distribution of comorbidty among patients with successful versus failed early laparoscopic cholecystectomy

Laparoscopic cholecystectomy	Comorbidity				Total	*P* value
	Br/Htn (%)	DM (%)	DM+HTN (%)	No (%)		
Successful	3 (2.2)	22 (15.8)	4 (2.9)	110 (79.1)	139 (100.0)	0.032
Failed	0 (0.0)	3 (12.5)	4 (16.7)	17 (70.8)	24 (100.0)	
Total	3 (1.8)	25 (15.3)	8 (4.9)	127 (77.9)	163 (100.0)	

DM: Diabetes mellitus

laparoscopic cholecystectomy for acute cholecystitis. The study has been designed to identify the predictive factors for successful laparoscopic cholecystectomy for acute cholecystitis. An attempt has also been made to identify the predictive factors for pre-operative and intraoperative severity for acute cholecystitis and to establish whether the success of early laparoscopic cholecystectomy is influenced by the latter.

The failure rate of laparoscopic procedure in this study was 14.7% (as 24 out of 163 patients failed to undergo laparoscopic completion of early cholecystectomy. This is comparable with the 15-25% conversion rate reported in the literature.[14,17]

Acute cholecystitis was found to be much more common in females than males (Table 1), which is in agreement with the literature.[17-20]

Age was not found to be a significant predictive factor for successful laparoscopic cholecystectomy in acute cholecystitis (Table 1). Furthermore, there was a significant relationship of age and gender with intraoperative severity of acute cholecystitis (Table 3). This is in contrast with the study by Eldar *et al.*[21] which found age >65 years, a significant independent factor associated with conversion. Schaefer *et al.*[22] also identified age as a significant independent predictor of conversion. The observed disparity may be due to younger age of patients in this study. The mean age of patients in this study was 37:74 years, and there was no patient with age >65 years. In Schafer's series, mean age was 61.4 years with age range of 23-95 years.

Male sex significantly predicted the conversion of early laparoscopic cholecystectomy (Table 1) and was also found to be associated with significantly higher intraoperative severity grades of acute cholecystitis (Table 6). Eldar *et al.* and Schafer *et al.*[22] also found male sex to be a significant predictor of severity of inflammation and conversion of laparoscopic cholecystectomy in acute cholecystitis. Mean duration of symptoms before surgery was not found to have any significant difference on success/failure of early laparoscopic cholecystectomy. Total leukocyte count, alkaline phosphatase, and total bilirubin were found to significantly predict successful laparoscopic completion of early cholecystectomy (Table 4). Rattner *et al.*[23] found degree of leukocytosis to be significantly associated with

severity of inflammation and failure of laparoscopic procedure. Similar observation was also made by Eldar *et al.*[21] and Schafer *et al.*[22]

Serum alkaline phosphatase, total leukocyte count levels showed significant association with success/failure of laparoscopic procedure (Table 4) or with intraoperative severity of acute cholëcystitis (Table 5). Degree of alkaline phosphatase elevation was found to be significant predictor of failure of laparoscopic cholecystectomy by Rattner *et al.*[23]

Degree of intraoperative severity of acute cholecystitis had good association with conversion rate of early laparoscopic cholecystectomy (Table 6). Similar association between severity of inflammation and failure rate of laparoscopic procedure was also reported by Eldar *et al.*,[21] Schafer *et al.*,[22] Rattner *et al.*,[23] and Bickel *et al.*[24]

Logistic regression for multivariate discriminant analysis of pre-operative factors identified male sex and serum alkaline phosphatase, total leukocyte count, total bilirubin at admission to be strongly related to failure of early laparoscopic cholecystectomy in acute cholecystitis (*P* < 0.001). Logistic regression analysis in study by Schafer *et al.*[22] identified total leukocyte counts at admission, American Society of Anesthesiologists (ASA) classification, duration of symptoms before surgery and age as significant predictive factors for failure of early laparoscopic cholecystectomy. The predictive value of ASA classification was not investigated in this study.

SUMMARY AND CONCLUSIONS

The following conclusions have been drawn:
1. Male patients have significantly higher intraoperative severity grades of acute cholecystitis and are at significantly, higher risk of failure of early laparoscopic cholecystectomy than female patients.
2. Total leukocyte' counts and serum alkaline phosphtase levels were found to be strong predictors of preoperative and intraoperative severity of acute cholecystitis. Serum alkaline phosphatase proved to be a good predictor of intraoperative severity of acute cholecystitis. These laboratory variables showed significant association with failure\ conversion of early laparoscopic cholecystectomy.
3. The severity of inflammation (i.e., a high grade

of intraoperative severity) in acute cholecystitis is associated with higher failure\conversion rates of early laparoscopic cholecystectomy.

4. Age, at least up to 68 years, (range of age in the study was 36-68 years) does not affect the success of laparoscopic cholecystectomy and the severity of inflammation in acute cholecystitis.

5. Mean duration of symptoms before surgery does not affect the success of early laparoscopic cholecystectomy, at least, if the surgery is done within 1.5-3 days of onset of symptoms. However, intraoperative severity of acute cholecystitis is found to increase with increasing duration of symptoms.

6. Acute cholecystitis is much more common in females than males.

Hence as per our study, we may conclude that male patients with acute cholecystitis who had raised serum alkaline phosphatase and raised total leukocyte count at admission had a significantly higher rate of conversion to open cholecystectomy.

These patients, thus, are definitely poor candidates for early laparoscopic cholecystectomy and should be managed preferably conservatively initially followed by laparoscopic cholecystectomy after 6-8 weeks.

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