

Factors Affecting Conversion of Laparoscopic Cholecystectomy to Open Surgery in a Tertiary Healthcare Center in India

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ABSTRACT

Background: Laparoscopic cholecystectomy (LC) is the surgery of choice for patients suffering from gallstone diseases. Open cholecystectomy these days is performed after conversion from laparoscopic surgery due to various reasons. The aim of this study was to assess the factors responsible for conversion of LC to open surgery by identifying preoperative risk factors that could predict conversion and intraoperative technical/surgical difficulties and complications that cause conversion.

Methods: A total of 310 patients were included in this prospective observational study conducted between November 2018 and March 2020.

Results: Out of 310 cases, 38 were converted to open surgery with a conversion rate of 12.2%. Mean age was 10 years more in the converted group. Males had a higher chance of conversion than females (18.6 vs 7%). Conversion rate was significantly higher in patients with body mass index (BMI) >23 kg/m² (25%), with features of acute cholecystitis, who underwent interval cholecystectomy (25.8%), who underwent endoscopic retrograde cholangiopancreatography (ERCP) (>40%), with total white blood cell (WBC) counts $\geq 10,000/\text{mm}^3$ (25.6%), with serum albumin <3.5 g/dL (43.8%), with imaging findings of acute cholecystitis (25.6%), and with dilated common bile duct (CBD)/choledocholithiasis (33.3%). Conversion rate when LC was performed early after ERCP was 18% and when performed after 4–6 weeks was >50%. The most common causes for conversion were a frozen Calot's triangle due to dense inflammatory adhesions, leading to inadequate visualization of critical structures.

Conclusion: Identifying patients with significant risk factors for conversion could minimize adverse effects of prolonged surgery by limiting duration of trial of laparoscopic dissection. Surgical residents need to identify low-risk patients preoperatively and require proper training before handling difficult cases.

Clinical significance: Early LC should be considered in all patients who are able to withstand surgery, as delayed surgery increases the chances of conversion.

Registration of the study: This prospective study has been registered in the Clinical Trials Registry of India (CTRI). CTRI Registration Number CTRI/2018/11/016338.

Keywords: Acute cholecystitis, Calot's triangle, Complicated gallbladder, Delayed laparoscopic cholecystectomy, Endoscopic retrograde cholangiopancreatography, Laparoscopic cholecystectomy, Open surgery.

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INTRODUCTION

The first laparoscopic cholecystectomy (LC) was performed in 1985, and it is the current "gold standard" operation for patients with gallstone disease.¹ The most common indications include symptomatic gallstone disease, acute cholecystitis, and gallstone pancreatitis. Absolute contraindications include an inability to tolerate general anesthesia, patients with severe cardiovascular or pulmonary disease, and patients with gallbladder (GB) cancer. Many conditions previously thought to be contraindications for LC are no longer considered contraindications, e.g., gangrenous GB, empyema of the GB, obesity, pregnancy, previous upper abdominal procedures, and cirrhosis, as there has been a tremendous advancement in the technique and experience of laparoscopic surgeons.

Open cholecystectomy these days is generally performed after conversion from the laparoscopic approach. Factors affecting conversion of LC to open surgery include patient- and disease-related factors, as well as technical difficulties. The two most frequent indications for conversion currently are dense upper abdominal adhesions resulting in a frozen Calot's triangle or a necrotic GB wall that precludes grasping and elevation with a grasper.²

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MATERIALS AND METHODS

A prospective observational study was conducted in the Department of General Surgery, Kasturba Hospital, Manipal, India. A total of 310 patients above the age of 18 years who were planned for LC during the study period of November 2018 till March 2020 were included. Exclusion criteria were (i) gallbladder carcinoma; (ii) laparoscopy done, cholecystectomy not done/procedure abandoned; and (iii) other surgical procedures performed simultaneously.

Preoperatively, relevant history and clinical examination findings of the patients were noted. Laboratory data and radiological findings were accessed through the online database. Intraoperative findings of all cases (irrespective of whether converted or not) were taken from the operative notes. In cases converted to open surgery, the operating surgeon would fill a checklist regarding the reason for conversion.

Statistical Analysis

Chi-square test and unpaired *t*-test were applied. Analysis was done using IBM SPSS® software v 23.

RESULTS

A total of 310 patients planned for LC were included in the study out of which 38 patients underwent conversion to open (CO) surgery. Hence, the conversion rate in this study was 12.2%.

The mean age in the CO group was 58 years, almost 10 more than the mean age of 47 years in the LC group. This was found to be statistically significant with a *p*-value of 0.0001. Patients older than 50 years had a higher conversion rate. The study population had 170 female patients and 140 male patients. Males had a significantly higher conversion rate than females (18.6 vs 7%, *p* = 0.001). Patients who were overweight [body mass index (BMI) >23 kg/m²] according to the Asian BMI classification had a higher conversion rate, as compared to the patients with a BMI <23 kg/m² (25 vs 8.7%, *p* = 0.0001) (Table 1).

As shown in Table 2, patients who presented with symptoms suggestive of acute cholecystitis, i.e., right upper quadrant (RUQ) pain, vomiting, and fever, had a significantly higher rate of conversion. There was no significant difference observed in conversion rate between patients whose duration of symptoms was >1 week and <1 week (*p* = 0.120).

Patients, who had an episode of acute cholecystitis and were managed conservatively, underwent an elective interval cholecystectomy after 4–6 weeks. This also includes those patients who underwent a delayed LC post-endoscopic retrograde cholangiopancreatography (ERCP) with or without stenting. Conversion rate was higher (almost 25%) in patients who underwent an interval cholecystectomy (Table 2).

Comorbid conditions such as diabetes mellitus, cardiovascular disease (ischemic heart disease or hypertension), and respiratory disease (bronchial asthma or chronic obstructive pulmonary disease) had no significant impact on the rate of conversion. Also, a history of abdominal surgery was not found to be significant for conversion (Table 2).

Table 1: Patient characteristics

	Total cases	Converted cases	Conversion rate	Chi-square value	<i>p</i> value
Age					
<50	165	9	5.45%	11.816	<0.001
>50	145	29	20%		
Sex					
Male	140	26	18.6%	9.461	0.001
Female	170	12	7%		
BMI					
<23	242	21	8.7%	13.149	<0.001
>23	68	17	25%		

Conversion rate was significantly higher in patients who underwent ERCP with either papillotomy and common bile duct (CBD) stone extraction/clearance of sludge (41.9%) and ERCP with stenting (50%) as compared to those patients who had no ERCP done (2.5%) (*p* = 0.0001) (Table 3).

Patients who had clinical features suggestive of acute cholecystitis—tachycardia (pulse rate >100/m), fever (temperature >99 F), and positive Murphy's sign—had a higher conversion rate. The findings of leukocytosis [total white blood cell (WBC) count >10000/mm³], obstructive jaundice (total bilirubin >1.2 mg/dL; direct bilirubin >0.3 mg/dL; ALP >130 U/L), pancreatitis (amylase >100 U/L; lipase >60 U/L), and hypoalbuminemia (albumin <3.5 g/dL), preoperatively, had a significant association with conversion rate as shown in Table 2.

All patients (310) underwent ultrasonography (US) of the abdomen. Those who had a contrast-enhanced computed tomography (CT) abdomen (12 patients) or magnetic resonance cholangiopancreatography (5 patients) done were usually in addition to a US abdomen. The imaging findings that were assessed include presence of calculi; pericholecystic fluid collection or fat stranding; a distended GB; sludge; GB perforation; a dilated CBD; or presence of CBD calculi, polyp, or pancreatitis.

Conversion rate was significantly higher in patients with features of acute cholecystitis—pericholecystic fluid or fat stranding (43.8 vs 10.5%; *p* = 0.0001), presence of sludge on imaging (32.3 vs 10.0%; *p* = 0.0001), perforated GB (66.7 vs 33.3%; *p* = 0.004), and dilated CBD/CBD calculi (33.3 vs 10.2%; *p* = 0.0001) (Table 2).

GB wall thickness was one of the preoperative imaging findings that the authors wanted to assess, but in the majority of the cases, it was not commented upon. A mention of a thickened GB wall or a wall thickness more than 4 mm was made in a total of 24 patients, out of which 6 were converted (25% conversion rate).

Patients with a preoperative diagnosis of acute cholecystitis, gallstone pancreatitis, and those who underwent a delayed LC after 6 weeks post-ERCP had higher conversion rates of 33, 20, and 52%, respectively.

Reasons for Conversion

Technical Difficulties

In all the 38 cases that were converted to open, the peritoneal cavity was entered, and adequate pneumoperitoneum was created. There were no instances of equipment failure and/or trocar injuries.

Surgical Difficulties Due to Intraoperative Findings

The reasons for conversion in 37 cases due to various surgical difficulties are mentioned in Table 4, with dense inflammatory adhesions leading to a frozen Calot's triangle and inadequate visualization of structures being the most common causes (Fig. 1). Aberrant anatomy was the cause for conversion in four cases (Fig. 2).

Surgical difficulties due to intraoperative complication: One patient had a visceral injury, a transverse colon injury that necessitated CO surgery. In this case, complete dissection of the GB was done laparoscopically.

Postoperative length of stay (LOS) was significantly longer in patients who had converted to open as compared to those patients who had the surgery completed by laparoscopy (8.8 ± 5.9 vs 2.7 ± 1.3; *p* = 0.0001). Most patients who had a prolonged LOS of more than 10–12 days were due to surgical site infection (Table 5).

Table 2: Clinical, laboratory, and imaging findings

		CO (n = 38)	LC (n = 272)	Total cases (N = 310)	Chi-square value	p value
Presenting symptoms						
RUQ pain	Present	26 (16.8%)	143 (83.2%)	155 (100%)	5.878	0.015
	Absent	12 (7.7%)	143 (92.3%)	155 (100%)		
Radiation to back	Present	3 (8.1%)	34 (91.9%)	37 (100%)	0.673	0.412
	Absent	35 (12.8%)	238 (87.2%)	273 (100%)		
Fever	Present	6 (27.3%)	16 (72.7%)	22 (100%)	4.964	0.026
	Absent	32 (11.1%)	256 (88.9%)	288 (100%)		
Vomiting	Present	12 (19.7%)	49 (80.3%)	61 (100%)	3.881	0.046
	Absent	26 (10.4%)	223 (89.6%)	249 (100%)		
Jaundice	Present	3 (23.1%)	10 (76.9%)	13 (100%)	1.447	0.224
	Absent	35 (11.8%)	262 (88.2%)	297 (100%)		
Interval cholecystectomy	Yes	35 (32.7%)	72 (67.3%)	107 (100%)	35.069	0.0001
	No	13 (6.4%)	190 (93.6%)	203 (100%)		
Past history						
Cardiovascular disease	Present	14 (17.5%)	66 (82.5%)	80 (100%)	2.755	0.097
	Absent	24 (10.4%)	206 (89.6%)	230 (100%)		
Diabetes	Present	12 (16%)	63 (84%)	75 (100%)	1.288	0.256
	Absent	26 (11.1%)	209 (88.9%)	235 (100%)		
0.825 Respiratory disease	Present	1 (10%)	9 (90%)	10 (100%)	0.049	0.825
	Absent	37 (12.3%)	263 (87.7%)	300 (100%)		
Previous abdominal surgery	Present	2 (4.8%)	40 (95.2%)	42 (100%)	2.538	0.111
	Absent	36 (13.4%)	232 (86.6%)	268 (100%)		
Clinical findings						
Tachycardia	Present	9 (34.6%)	17 (65.4%)	26 (100%)	13.189	<0.001
	Absent	29 (10.2%)	255 (89.8%)	284 (100%)		
Febrile	Present	3 (42.9%)	4 (57.1%)	7 (100%)	6.235	0.013
	Absent	35 (11.6%)	268 (88.4%)	303 (100%)		
RUQ tenderness	Present	22 (13.7%)	139 (86.3%)	161 (100%)	0.616	0.432
	Absent	16 (10.7%)	133 (89.3%)	149 (100%)		
Murphy's sign	Present	6 (40%)	9 (60%)	15 (100%)	11.279	0.001
	Absent	32 (10.8%)	263 (89.2%)	295 (100%)		
Icterus	Present	3 (33.3%)	6 (66.7%)	9 (100%)	3.828	0.043
	Absent	35 (11.6%)	266 (88.4%)	301 (100%)		
Laboratory investigations						
Leukocytosis	Present	10 (25.6%)	29 (74.4%)	39 (100%)	7.429	0.006
	Absent	28 (10.3%)	243 (89.7%)	271 (100%)		
Obstructive jaundice	Present	9 (33.3%)	18 (66.7%)	27 (100%)	12.214	<0.001
	Absent	29 (10.2%)	254 (89.8%)	283 (100%)		
Pancreatitis	Present	4 (57.1%)	3 (42.8%)	7 (100%)	13.415	<0.001
	Absent	34 (11.2%)	269 (88.8%)	303 (100%)		
Low serum albumin	Present	7 (43.8%)	9 (56.3%)	16 (100%)	15.556	<0.001
	Absent	31 (10.5%)	263 (89.5%)	294 (100%)		
Imaging						
Presence of calculi	Present	36 (12.2%)	258 (87.8%)	294 (100%)	0.001	0.976
	Absent	2 (12.5%)	14 (87.5%)	16 (100%)		
Pericholecystic fluid/fat stranding	Present	11 (25.6%)	32 (74.4%)	43 (100%)	8.240	0.004
	Absent	27 (10.1%)	240 (89.9%)	267 (100%)		
Distended GB	Present	23 (15.9%)	122 (84.1%)	145 (100%)	3.290	0.071
	Absent	15 (9.1%)	150 (90.9%)	165 (100%)		

(Contd...)

Table 2: (Contd...)

		CO (n = 38)	LC (n = 272)	Total cases (N = 310)	Chi-square value	p value
Sludge	Present	10 (32.3%)	21 (67.7%)	31 (100%)	12.810	<0.001
	Absent	28 (10%)	251 (90%)	279 (100%)		
Perforated GB	Present	2 (66.7%)	1 (33.3%)	3 (100%)	8.338	0.004
	Absent	36 (11.7%)	271 (88.3%)	307 (100%)		
Dilated CBD/CBD calculi	Present	9 (33.3%)	18 (66.7%)	27 (100%)	12.214	<0.001
	Absent	29 (10.2%)	254 (89.8%)	283 (100%)		

Table 3: Association with ERCP

	CO (n = 38)	LC (n = 272)	Total cases (N = 310)	p value
ERCP				
Not done	6 (2.5%)	233 (97.4%)	239 (100%)	0.0001
ERCP alone	18 (41.9%)	25 (58.1%)	43 (100%)	
ERCP + stenting	14 (50%)	14 (50%)	28 (100%)	
Duration post-ERCP				
Late (>6 weeks)	26 (53%)	23 (47%)	49 (100%)	0.0059
Early (within 48 hours)	4 (18%)	18 (82%)	22 (100%)	

Table 4: Reasons for conversion

Reason for conversion	Number
Dense adhesions due to severe tissue inflammation/frozen Calot's triangle	27 (71%)
Aberrant anatomy	4 (10.5%)
• Aberrant vessel noted in posterior wall of GB (2)	
• Abnormal insertion of cystic duct (1)	
• Double GB (1)	
Inadequate visualization of structures	19 (50%)
Buried/intrahepatic GB	6 (15.7%)
Perforated GB	4 (10.5%)
Thickened GB wall	6 (15.7%)
Stones in CBD	1 (2.63%)
Pyocele/empyema/gangrenous GB	3 (7.89%)

DISCUSSION

LC is one of the most commonly performed surgical procedures. In a retrospective review by Livingston et al., it was found that 25% of all cholecystectomies were open cholecystectomies, and the remaining 75% were laparoscopic cholecystectomies, which had a 5–10% conversion rate. The major risk factors for conversion included male sex, obesity, and cholecystitis. Conditions such as concurrent choledocholithiasis, cholelithiasis, and cholecystitis had a higher conversion rate of 25%.²

The conversion rate varies from 5 to 20% in various studies as shown in Table 6. In a study by Jang et al., the conversion rate was found to be 19%, which is more than that found in this study.³ In a retrospective study of 1,802 patients by Simopoulos et al., the conversion rate was 5.2%.⁴

Causes for Conversion

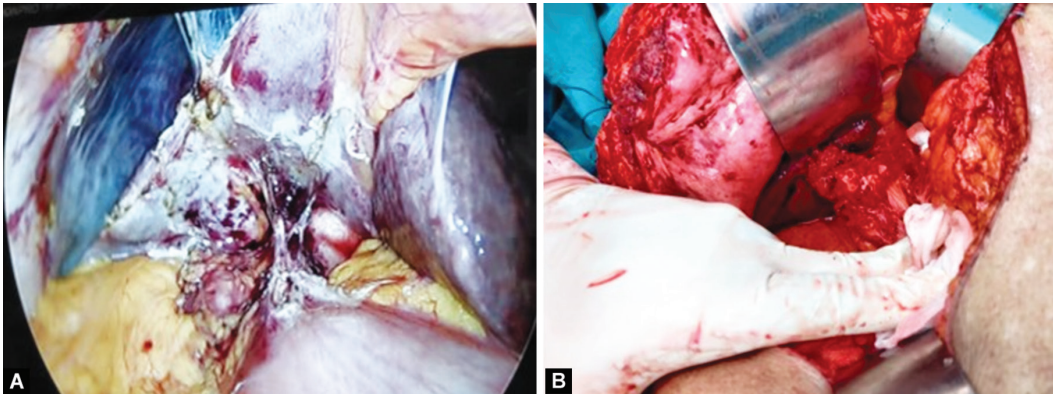
Obesity has been identified as a significant risk factor for conversion in various studies. Most studies have considered a BMI >30 kg/m²

as the cutoff for obesity.^{3,5} But considering this study population being only Indians, the cutoff for obesity is based on the Asian BMI criteria, with >23 kg/m² classified as overweight and >25 kg/m² considered obese.⁶ In this study, BMI of more than 23 kg/m², i.e., being overweight, was found to be a significant predisposing factor for conversion. This could be due to the higher prevalence of diabetes in these patients, leading to the possibility of recurrent and severe attacks of cholecystitis, causing dense inflammation and adhesions. However, diabetes alone was not found to be associated with a higher conversion rate in this study. Also, obese individuals have a higher visceral fat content obscuring vision during dissection, and the bulky omentum and transverse colon make manipulation tricky.

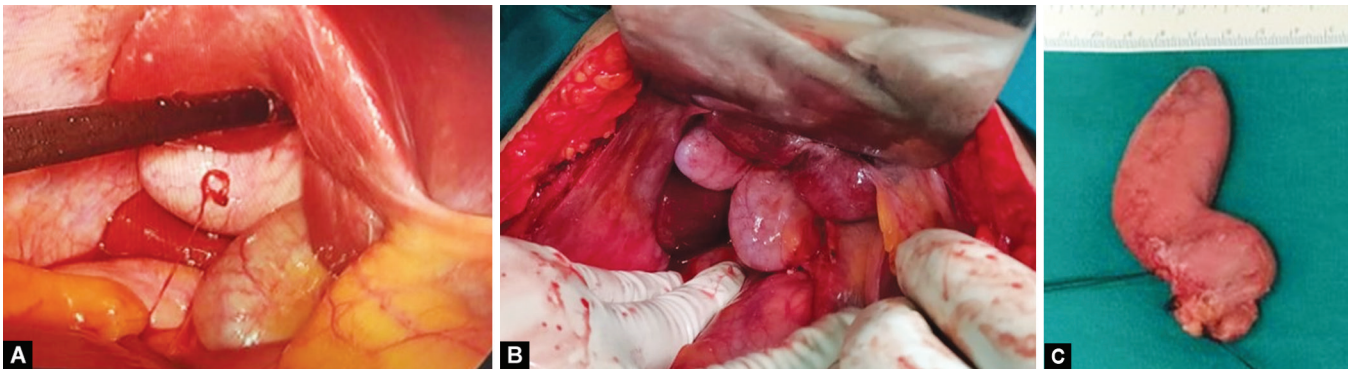
Various studies have shown that the conversion rate is higher in male patients, compared to female patients.^{4,7,8} Several series have reported that advanced age is associated with a higher conversion rate. In the study by Livingston et al., very little correlation was found between age and the need for conversion.² Both male sex and advanced age having been identified as significant risk factors for conversion in this study, the authors emphasized the fact that a laparoscopic procedure should be offered to these patients with a high likelihood of conversion explained clearly. Male patients tend to ignore initial mild symptoms of upper abdominal pain, leading to a delayed presentation or presentation after recurrent episodes of cholecystitis, which could lead to chronic cholecystitis and a fibrotic GB, making the procedure difficult.

In this study, the conversion rates in patients with features of cholecystitis were significantly higher. Clinical findings of a positive Murphy's sign and a fever (temperature >37.5) were found to be significant in this study. This is similar to the results from studies by Simopoulos et al., Rosen et al., and Chauhan et al.^{4,5,7} Preoperative laboratory investigations and radiological findings suggestive of acute cholecystitis include elevated total WBC count of more than 10,000/mm³, and features of pericholecystic fluid collection and fat stranding were found to be significant factors that could predict CO surgery. Simopoulos et al. found that a WBC count >9,000/mL and total bilirubin >1.2 mg/dL doubled the likelihood of conversion.⁴ Jang et al. found that CT findings of the absence of GB wall enhancement, presence of a gallstone in the infundibulum, and inflammation of the hepatic pedicle were significantly associated with conversion.³

Patients with acute cholecystitis have varying degrees of inflammatory changes involving Calot's triangle, and it is of utmost importance that the critical view of safety is visualized, and the safety steps as recommended by the Tokyo Guidelines 2018 are followed.⁹ The severity of cholecystitis must be gauged promptly preoperatively, and there should be no delay in performing a LC in a patient who can withstand surgery, as there is a higher chance of a difficult surgery and CO if there is a delay in the surgery, or if performed as an interval surgery, as shown in this study as well.



Figs 1A and B: (A) Pyocele of GB with dense adhesions between omentum, colon, and GB—seen laparoscopically; (B) On conversion to open



Figs 2A to C: (A) Bilobed GB visualized laparoscopically; (B) On conversion to open; (C) Cholecystectomy was done, infundibulum of GB was found to be enlarged and folded over the body of the GB giving an impression of a bilobed GB

Table 5: Length of stay

	CO (n = 38) (Mean ± SD)	LC (n = 272) (Mean ± SD)	Total (N = 310) (Mean ± SD)
LOS (days)	8.8 ± 5.9	2.7 ± 1.3	3.5 ± 3.1

Early vs Delayed Surgery Following ERCP

In a systematic review of 14 studies including 1,930 patients, it was found that early LC post-ERCP was associated with a lower conversion rate.¹⁰

The indications for ERCP in most studies including this study are choledocholithiasis or dilated CBD on imaging and clinical and laboratory evidence of obstructive jaundice or cholangitis. In this study, the conversion rate when LC was performed early after ERCP was 18% and when performed after 4–6 weeks was 53%. The higher conversion rate in delayed LC after ERCP can be attributed to the fact that ERCP creates an inflammation of the hepatoduodenal ligament, leading to difficulty in delineating the anatomy and dissection of Calot’s triangle in the following LC; in addition, it can lead to the formation of additional stones in the CBD, thereby increasing the risk of conversion.^{11,12}

The current study has shown that patients with preoperative low-serum albumin value (<3.5 g/dL) had a higher conversion rate, compared to the patients with a normal serum albumin value (43.8 vs 10.5%; *p* = 0.0001). A similar association was found in a study by Ishizuka et al., in which they have stated that serum albumin of <3.8 g/dL was an independent risk factor for conversion from LC to open surgery.¹³

Limitations of the Study

The surgeons’ experience could not be studied as a factor for conversion as all difficult surgeries were performed by experienced surgeons only, or they had taken over as the operating surgeon during the surgery.

CONCLUSION

The preoperative factors that were found to be significantly associated with a higher conversion rate in this study are male gender, BMI >23 kg/m², clinical, laboratory, and imaging findings suggestive of acute cholecystitis, interval surgery after 4–6 weeks, and surgery post-ERCP. The intraoperative findings that were commonly found prior to conversion are dense adhesions or severe tissue inflammation leading to a frozen Calot’s triangle with inadequate visualization of structures.

The decision to convert to open surgery must be made before a complication occurs. This reflects sound surgical judgment and should not be viewed as a failure or complication of the laparoscopic approach. There are quite a few advantages of open surgery over laparoscopy, especially in trying situations, as manual pressure can be applied, tactile feedback is better experienced, exposure and movements are better, and there is less restriction on the number of instruments.

If we can identify patients with these significant risk factors for conversion, we could refine preoperative counseling in such selected patients and emphasize the higher conversion rate of around 12% as found in this study. We can also reduce the adverse effects of prolonged surgery by limiting the duration of the trial

Table 6: Comparing other studies

Study	Type of study	Sample size	Conversion rate	Most significant factors
Jang et al. ² (2020)	Retrospective	581	19%	Obesity Previous abdominal surgery Prolonged PT Absence of GB wall enhancement on CT Gallstone at infundibulum
Chauhan et al. ⁶ (2019)	Retrospective	764	4.3%	Age >60 Male gender Prior ERCP Dense adhesions Frozen Calot's triangle
Thyagarajan et al. ⁷ (2017)	Prospective	500	10%	Male gender Diabetes Previous upper abdominal surgery Obesity Acute cholecystitis
Simopoulos et al. ³ (2005)	Retrospective	1,804	5.2%	Male gender Age >60 years Previous upper abdominal surgery Diabetes Severity of inflammation
Rosen et al. ⁴ (2002)	Retrospective	1,347	5.3%	BMI >30 ASA >2 WBC count >9,000 GB wall thickness >4 mm
Current study	Prospective	310	12.2%	Male gender, BMI >23, Age >50, WBC >10,000/mm ³ , post-ERCP Imaging features of acute cholecystitis Dense adhesions, frozen Calot's triangle, and perforated GB

of laparoscopic dissection and can consider operating low-risk patients safely in day care surgery facilities.

Identifying low-risk patients is crucial when surgical residents are operating and appropriate training under supervision can also be planned for residents requiring training in high-risk cases or in open surgery.

COMPLIANCE WITH ETHICAL STANDARDS

Ethics Approval

This study has been approved by the institutional ethics committee.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

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