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Preoperative risk factors for conversion from laparoscopic to open cholecystectomy

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Abstract. – BACKGROUND: Laparoscopic cholecystectomy has become the standard treatment for symptomatic gallstones. However, a conversion to open surgery is sometimes still required to complete the procedure safely. The aim of this study is to identify the predictive factors of conversion from laparoscopic to open cholecystectomy in both elective and emergency cases.

PATIENTS AND METHODS: A retrospective review of all patients underwent laparoscopic cholecystectomy for symptomatic gallstones from January 2011 to October 2013 was performed. Data considered for analysis were: demographic data, comorbidities, preoperative laboratory values, preoperative ERCP, indication for surgery, and the timing of the intervention in acute cholecystitis. Conversion to open cholecystectomy was chosen as the dependent variable for both, univariate and multivariate analysis.

RESULTS: 414 patients underwent laparoscopic cholecystectomy. 245 were female (59.1%) and 169 (40.8%) male, with a mean age of 51.7±16.4 years. The indication for surgery was acute cholecystitis in 91 cases (21.9%). Lithiasis of the bile duct was found in 40 patients (9.6%), and it was identified preoperatively in 37 patients, all treated with a preoperative ERCP. Conversion to open occurred in 33 cases (7.9%). Univariate analysis revealed as risk factor for conversion: increased age, acute cholecystitis, comorbidities, elevated white blood cell count, increased level of aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, gamma glutamyl transpeptidase, C-reactive protein, and fibrinogen. Multivariate logistic regression analysis showed that acute cholecystitis (OR 5.63) and age > 65 years (OR 3.025) were independent predictive factors for conversion.

CONCLUSIONS: These patients should be properly informed of their increased risk of conversion and should be operated by surgeons skilled in laparoscopic procedures to reduce this risk.

Key Words:
Laparoscopic cholecystectomy, Conversion, Risk factor.

Introduction

Laparoscopic cholecystectomy (LC) has become the gold standard for treatment of symptomatic gallstones, due to lower morbidity, shorter hospital stay, earlier return to regular daily activities, and less postoperative pain[1]. Although acute cholecystitis was considered a relative contraindications for laparoscopic cholecystectomy, the most recent literature shows that it can be performed safely even in these cases[2,3]. When consenting the patients for laparoscopic cholecystectomy is always important to mention the possibility of conversion to an open procedure (OC)[4,5]. The conversion rate reported in the literature ranges between 0% and 20%. Although the conversion of the procedure from laparoscopic to open is associated with an increase in the operating time, hospital stay, and morbidity, it shouldn't be regarded as a failure but rather as a necessary measure to prevent complications such as biliary or vascular injuries. The identification of the predictor factors for conversion is essential to obtain a proper informed consent prior to surgery. Several studies[6-13], performed with the intent to clarify this topic, have been carried out, but no agreement has been reached so far. The purpose of this study was to identify predictive factors for conversion in patients undergoing laparoscopic cholecystectomy in both elective and emergency cases in two tertiary hospitals.

Patients and Methods

A retrospective review of all patients undergoing laparoscopic cholecystectomy in the Unit of Laparoscopic Surgery at the Gaspare Rodolico Hospital of the A.O.U. "Policlinico - Vittorio Emanuele" of Catania, Italy, and in the Division

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of General Surgery of the Civil Hospital of Ragusa, Italy, from January 2011 to October 2013, was performed. The indications for cholecystectomy were: symptomatic gallstones, acute cholecystitis, chronic cholecystitis, recent biliary pancreatitis treated conservatively, recent lithiasis of the common bile duct (CBD) treated with ERCP. We excluded patients with preoperative suspicion of cancer of the gallbladder. Acute cholecystitis was defined clinically by the presence of fever (> 38° C), left upper quadrant abdominal pain with radiological signs of inflammation shown on ultrasound or computer tomography scan. The decision to operate in the acute phase or after conservative management was left to the surgical judgement of the attending physician.

The laparoscopic cholecystectomies were performed by experienced surgeons in laparoscopy and surgical residents under supervision. The surgery was performed using a standardized technique with four ports and with the surgeon standing in between the patient's legs. Diathermy coagulation was used to dissect the Calot's triangle and obtain the critical view of safety (CVS). The method of dissection of the gallbladder off the liver bed with either hook or scissors was left to the surgeon's preference.

The data collected in our database that were considered for the study were: sex, age, indication for LC, American Society of Anesthesiologists (ASA) risk score, preoperative laboratory values, rate of conversion to open cholecystectomy, and reason for conversion. In acute cholecystitis it was also taken into account the time of the intervention, which was categorized as early (up to 72h from access to the hospital) and delayed (after at least 6 week from the onset of symptoms). Conversion laparotomy was chosen as the dependent variable. For the statistical analysis, continuous variables were transformed into categorical by the division of patients into subgroups. The subgroups were identified according to age (less than 50 years old, between 50 and 65 years old and older than 65), white blood cell (WBC) count (less than 11.000/ml, between 11.000/ml and 15.000/ml and above 15.000/ml), aspartate aminotransferase (AST) value (less than 40 IU/L, between 40 and 80 IU/L and above 80 IU/L), alanine aminotransferase (ALT) value (less than 40 IU/L, between 40 and 80 IU/L and above 80 IU/L), alkaline phosphatase (ALP) value (less than 110 IU/L, between 110 and 200 IU/L, above 200 IU/L), gamma glutamyl transpeptidase (GGT) value (less than 50 IU/L, between 50 and 80 IU/L and above 80 IU/L), C-reactive Protein (CRP) value (less than 10 mg/L, between 10 and 20 mg/L and above 20 mg/L), and fibrinogen value (less than 400 mg/L, between 400 and 550 mg/L and above 550 mg/L).

Statistical Analysis

All patients were divided into two groups, (laparoscopic group and conversion to laparotomy group) for both the univariate and the multivariate analysis. The univariate statistical analysis was performed using the Chi-square test with Yates correction. A p-value < 0.05 was considered statistically significant. The conversion to laparotomy was considered as the dependent variable in the multivariate statistical analysis. The variables found to be statistically significant on univariate analysis were evaluated by multivariate analysis using a multivariate logistic regression analysis. Statistical analyzes were performed with SPSS computer software (SPSS 21 for MacOS, SPSS Inc., Chicago, IL, USA).

Results

Four hundred and fourteen patients underwent laparoscopic cholecystectomy. Two hundred and forty-five were female (59.1%) and 169 (40.8%) were male, with a mean age of 51.7±16.4 years (range 14-88). The indication for surgery was acute cholecystitis in ninety-one cases (21.9%), and among these patients, fifty-three were female (58.2%) and thirty-eight were male (41.7%), with a statistically significant difference (p = 0.037). Conversion to open occurred in 33 cases, with an overall conversion rate of 7.9%. Conversion occurred in 23 patients were undergoing intervention for acute cholecystitis (25.2%) and in 10 patients were undergoing cholecystectomy for other indications (3%), with a difference that was statistically significant (p < 0.001).

The patients with acute cholecystitis who underwent early intervention were 32 (35%) and those treated with a delayed cholecystectomy were 59 (65%), with a conversion rate of 34.3% and 20.9%, respectively, which was not, however, statistically significant (p = 0.223). Lithiasis of the CBD was found in 40 patients (9.6%). It was identified preoperatively in 37 patients that were all treated with a preoperative ERCP. The 3 cases detected intraoperatively were treated with an endoscopic rendezvous procedure during the

laparoscopic cholecystectomy. Conversion occurred in 10.8% of patients (4 patients) that had been subjected to an ERCP preoperatively, a difference not statistically significant compared with patients experiencing conversion and not subjected to this procedure ($p = 0.729$, OR = 1.45). The average age of patients in whom the laparoscopic procedure was completed successfully was 50.5 ± 16.1 years; while the average age of the patients converted to open was 65.9 ± 13.9 years, with a statistically significant difference between the 2 groups ($p < 0.0001$, 95% confidence interval [CI]: 9.71-21.09). Among the patients who needed a conversion, 19 were female (57.5%), and 14 were male (42.4%). This difference was not statistically significant ($p = 0.845$). A total of 33 patients were converted to an open procedure. Conversion to laparotomy was necessary in 12 patients because of acute inflammatory changes (gangrene, empyema, phlegmon) that made difficult to define the anatomy clearly, and in 8 patients because of extensive intra-abdominal adhesions. In six patients, the conversion was necessary because of chronic inflammation and fibrosis of the structures of the triangle of Calot, which did not allow to clearly identify the anatomy, in two cases because of bleeding from cystic artery, which couldn't be controlled laparoscopically, and in two patients because of the presence of gallbladder cancer, which hadn't been detected preoperatively. Two conversions were due to injuries to the CBD and one conversion was secondary to cholecystoduodenal fistula (Table I).

The univariate analysis of preoperative data to identify risk factors for conversion didn't find any statistically significant correlation with the following variables: gender, previous abdominal surgery, preoperative ERCP. Risk factors for conversion identified in the analysis were acute cholecystitis, increased age, high WBC count, increased serum levels of AST, ALT, ALP, GGT, CRP, and fibrinogen, and the presence of comorbidities (ASA risk score 2 and 3). (Table II) Multivariate analysis with a multiple logistic regression model showed that the significant independent predictive factors for conversions were acute cholecystisis ($p < 0.001$) and age > 65 yrs ($p = 0.036$). The risk for conversion was increased 5-fold in patients that underwent laparoscopic cholecystectomy in the setting of acute cholecystitis. Patients older than 65 years had a 3-fold risk for conversion (Table III).

Table I. Reasons for conversion from laparoscopic to open cholecystectomy.

	Conversion (33 patients)
Flogosis	12 (36.3%)
Intra-abdominal adhesions	8 (24.2%)
Fibrosis of Calot's triangle	6 (18.2%)
Cystic artery bleeding	2 (6%)
Cancer	2 (6%)
Lesion of CBD	2 (6%)
Cholecystoduodenal fistula	1 (3%)

Discussion

Conversion from laparoscopic to open cholecystectomy is required when a safe completion of the procedure can't be guaranteed[6]. The identification of parameters predicting conversion improves preoperative patient counselling, provides for better preoperative planning, optimizes operating room efficiency, and helps avoiding laparoscopic-associated complications by performing an open operation when considered appropriate. In our study, the total rate of conversion from laparoscopic to open cholecystectomy was 8%, making it comparable to that reported in the last 10 years[5-8,14]. The main causes for conversion reported in the literature are: unclear anatomy of the Calot's triangle, CBD stones, dense adhesions, arterial bleeding, shrunken gallbladder, impacted stone in the cystic duct, CBD injuries, bile leak, bleeding from the liver bed, cholecystoduodenal fistula, inability to create pneumoperitoneum, gallbladder cancer, Mirizzi syndrome, technical failure, and bowel injury[8-10]. In our series the most frequent cause of conversion was the inability to correctly identify the structures of the Calot's triangle and get the CVS, as reported in other studies too[8,11-13]. In twelve cases the reason for unclear visualization of the Calot's triangle was acute inflammation of the gallbladder and in six cases it was chronic inflammation and fibrosis. Acute cholecystitis has been mentioned by many authors as one of the factors, which is highly predictive of conversion[8,10,13,15-18]. In our series, the conversion rate in acute cholecystitis was 25% as opposed to 3% for other conditions. A preoperative diagnosis of acute cholecystitis proved to be a predictor of conversion in both univariate and multivariate analysis with a 5-fold risk. Van der Steeg et al.[13], reported in his multivariate analysis a risk of conversion increased by 12 times in case of acute cholecystitis

Table II. Univariate comparison of preoperative risk factors for conversion from laparoscopic (LC) to open cholecystectomy (OC).

	LC (n= 381)	Conversion to OC (n= 33)	*p*-value
Gender			
males	155 (40.6%)	14 (42.4%)	
females	226 (59.3%)	19 (57.5%)	0.845
Age (years)			
≤ 49.9	203 (53.2%)	4 (12.1%)	
50–64.9	93 (24.4%)	9 (27.2%)	
≥ 65	85 (22.3%)	20 (60.6%)	0.0001
ASA risk score			
1	155 (40.6%)	3 (9.1%)	
2	172 (45.1%)	14 (42.4%)	
3	54 (14.2%)	16 (48.4%)	0.0001
Previous abdominal surgery	45 (11.8%)	6 (18.1%)	0.420
Preoperative ERCP	33 (8.6%)	4 (14.1%)	0.729
Acute cholecystitis	68 (17.8%)	23 (69.7%)	0.0001
early LC	21 (5.5%)	11 (33.3%)	0.223
delayed LC	47 (12.3%)	12 (36.4%)	
WBC value (n × 1000/mL)			0.0001
≤ 10.8	345 (90.5%)	14 (42.4%)	
10.8–15	20 (5.2%)	9 (27.2%)	
≥15	16 (4.7%)	10 (30.3%)	
AST (IU/L)			0.0001
≤ 40	336 (88.2%)	1 (33.3%)	
40–80	38 (9.9%)	14 (42.4%)	
≥80	7 (1.8%)	8 (24.2%)	
1			
ALT (IU/L)			0.0001
≤ 40	297 (77.9%)	8 (24.2%)	
40–80	71 (18.6%)	12 (36.3%)	
≥80	13 (3.4%)	13 (39.4%)	
ALP (IU/L)			0.0001
≤ 110	330 (86.6%)	9 (27.2%)	
110–200	43 (11.2%)	13 (39.4%)	
≥200	8 (2.1%)	11 (33.3%)	
GGT (IU/L)			0.0001
≤ 55	295 (77.4%)	9 (27.2%)	
55–80	70 (18.3%)	21 (63.6%)	
≥80	16 (4.2%)	3 (9.1%)	
Fibrinogen (mg/L)			0.0001
≤400	342 (89.7%)	19 (57.5%)	
400–550	18 (4.7%)	7 (21.2%)	
≥550	21 (5.5%)	7 (21.2%)	
PCR (mg/L)			0.0001
≤ 10	319 (83.7%)	11 (33.3%)	
10–20	46 (12.0%)	11 (33.3%)	
≥20	16 (4.2%)	11 (33.3%)	

while Yajima et al.[17] reported a 9-fold risk for conversion. In a meta-analysis of Lau et al[19] the rate of conversion for the early LC was lower than in delayed-interval LC when treating patients for acute cholecystitis (16% vs 23%). A recent Cochrane meta-analysis[14] showed no statistically significant differences in terms of conversion rate, lesions of the biliary tract and other major complications of laparoscopic cholecystectomies when early cholecystectomies were compared to delayed cholecystectomies. In our study, the incidence of conversion was 34% for early

Table I. Multivariate analysis for independent predictive factors for conversion from laparoscopic to open cholecystectomy.

	Odds Ratio	95% confidence interval	*p*-value
Acute cholecystitis	5.630	2.091 – 15.157	0.001
Age ≥ 65 years	3.025	1.076 – 8.508	0.036

LC and 21% in the delayed LC, a difference that was not statistically significant. We believe that this difference is due to the fact that, in our institutions, surgeons prefer to delay the surgical treatment in favour of delayed LC (65%) and early LC are often reserved only for the most severe cholecystitis that don't respond to medical treatment. An increase in the WBC count, liver function test values (AST, ALT, ALP, GGT), and indices of inflammation (CRP, fibrinogen) reflect the severity of inflammation of the gallbladder and have been identified as risk factors for conversion in several studies[6,20-22]. In our series an increase in the levels of each one of these variables was found to be a risk factor for conversion.

The second cause of conversion in our study was represented by the presence of extensive intra-abdominal adhesions, peri- and sub-hepatic that made a safe dissection difficult to perform. The presence of adhesions is a known risk factor for conversion in elective LC[17,20]. Several studies have shown that previous surgery of the upper abdomen is a risk factor for conversion to open cholecystectomy[15,16,20,23]. However, our study, along with another paper[6], has not shown this to be a factor predisposing to conversion.

As previously mentioned, one of the main purposes of conversion from laparoscopic to open cholecystectomy surgery is to avoid iatrogenic injuries, to the biliary tract. Injuries to the biliary tract occur in 0.3% to 0.6% of the cases after laparoscopic cholecystectomy[23,24], and when they are detected intraoperatively they represent the main cause for conversion. Several authors have proposed the use of routine or selective intraoperative cholangiography (IOC) to prevent injuries to the biliary tract; however, many centers perform laparoscopic cholecystectomy without the help of the IOC with comparable results[25,26]. The routine use of IOC, therefore, still remains a matter of debate. We had 2 injuries to the bile duct in our study: a type D and a type E1. They were both recognized intraoperatively and they were successfully treated after conversion to open.

In our study it has not been demonstrated a statistically significant difference between the incidence of conversion in males and females. This is in contrast with what has been described by other studies that show the male gender to be a risk factor for conversion, probably due to the more frequent association with severe disease, both acute and chronic, and to the higher percentage of intra-abdominal and visceral adipose tissue than women[6-8,13,15-18,20,23]. We hypothesize that our finding is most likely due to the higher number of female patients presenting with acute cholecystitis (58%) which therefore might be considered a confounding factor in this analysis.

Another matter of controversy is the influence of age on the conversion rate. Although several studies[8,16,23] have shown that older age is an independent risk factor for conversion, other works have not shown a clear correlation as well[6,12,15]. In our study the age of the patients that had a conversion to an open procedure was 65.9 ± 13.9 years old which was a difference statistically different from the laparoscopic group (50.5 ± 16.1). In the univariate analysis, the older age is a predictive factor for conversion. In multivariate analysis age > 65 years was found to be an independent risk factor for conversion to open surgery, with a three fold risk increase. There are several underlying causes that can explain the increase in the conversion rate in older subjects, such as a higher incidence of severe acute and gangrenous cholecystitis, lithiasis of CBD, previous abdominal surgery, cardio-pulmonary comorbidities, acute cholecystitis on unrecognized gallbladder cancer[11,23]. As a consequence of that, the surgeon may opt for an earlier decision to conversion, especially during the treatment of the very elderly patients (> 80 yrs), when dealing with difficult gallbladders.

Comorbidities are associated with an increased risk of complications and conversion[6,23,27], in particular diabetes mellitus[11,13,18]. In our study, patients were stratified by comorbidities using the ASA risk score, which was a predictor of conversion in univariate, but not in multivariate analysis; this finding is in line with the results obtained in other studies[6,20].

In our clinical practice we usually use a two-stage approach, with a preoperative ERCP for the treatment of choledocolithiasis. In several studies a preoperative ERCP has been identified as an independent predictor of conversion to open

surgery[20,28,29]. The presence of stones in the bile duct, as well as maneuvers performed during the ERCP, would lead to an inflammatory reaction in the bile duct and Calot's triangle. Furthermore, a sphincterotomy allows the retrograde passage of infected bile causing an aggravation of the inflammation. As a consequence of that, scarring and fibrosis ensue, with an increase in the difficulty of dissection Calot's triangle. The attention of several authors has been directed toward the effect of the timing of the approach in two stages, concluding that early laparoscopic cholecystectomy after ERCP was associated with a lower conversion rate than the delayed LC [30-32]. In our series lithiasis of the bile duct was found preoperatively in 37 cases, and they were all treated with ERCP before laparoscopic cholecystectomy. The conversion rate in these patients was higher (10.7%) than in the other patients (8.3%), however a preoperative ERCP was not a predictor of conversion in the univariate analysis.

Conclusions

In our study we found that a diagnosis of acute cholecystitis and age > 65 years are independent predictor factors for conversion from laparoscopic to open cholecystectomy. On univariate analysis, a high WBC count, an increase in liver function tests or inflammatory markers, and the presence of comorbidities, were identified as significant risk factors for conversion. These patients should be properly informed about their increased risk for conversion and should be operated by surgeons skilled in laparoscopic procedures to reduce the rate of conversion and operative complications.

Conflict of Interest

Goffredo Arena is a surgical consultant for Covidien, Canada. All authors declare that there are no conflicts of interest.

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