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Original article

Analysis of factors for conversion of laparoscopic to open cholecystectomy: a prospective study of 703 patients with acute cholecystitis

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A B S T R A C T

Aims: Conversions to open surgery during laparoscopic cholecystectomy are performed in 20% of patients with acute cholecystitis, and are associated with increased morbidity and costs. The aim of this study was to identify predictive factors for conversion and to evaluate morbidity, mortality and hospital stay.

Methods: A prospective cohort of patients admitted to the emergency department with acute cholecystitis. We evaluated the statistical significance of the demographic, clinical, biochemical, imaging and surgical factors at admission, associated with conversion to open surgery using a univariate model. The associated factors evaluated during initial analysis were then included in a multivariate analysis. Finally a comparative analysis was made of the morbidity and mortality in both models.

Results: A total of 703 patients were included. Conversion rate was 13.8%. Univariate analysis identified as factors: male gender, previous ERCP, leucocytes >12,000 mm^3, age >70 years, hypertension, jaundice, cholangitis, total bilirubin >2 mg/dl, ASA III-IV, gallbladder wall enlargement and choledocholithiasis. Logistic regression identified as predictive factors: previous ERCP, leucocytes, age >70 years and male gender. Converted patients had a higher morbidity rate, further operations and longer hospital stays (P<.001). No difference was seen in mortality.

Discussion: It is important to recognise patients with a higher risk of conversion in order to optimise planning and performing of the surgical procedure, and to decrease the morbidity associated with laparotomy, given that the independent factors identified are not modifiable.

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Análisis de los factores de conversión durante colecistectomía laparoscópica a abierta en una cohorte prospectiva de 703 pacientes con colecistitis aguda

Palabras clave:
Colecistectomía laparoscópica
Factores de riesgo
Conversión
Morbilidad
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RESUMEN

Introducción: La conversión a cirugía abierta durante colecistectomía laparoscópica se presenta en el 20%. Este desenlace se relaciona con mayor morbilidad y costos. En este estudio se describen los factores predictivos de conversión, la estancia hospitalaria, morbimortalidad asociada.

Materiales y métodos: Cohorte prospectiva de pacientes sometidos a colecistectomía laparoscópica de urgencia con colecistitis aguda. Análisis uni- y multivariado de los factores predictivos de conversión a partir de variables socio-demográficas, clínicas, bioquímicas y de imágenes diagnósticas, identificación de la tasa de morbilidad, mortalidad y estancia hospitalaria en los dos grupos.

Resultados: 703 pacientes fueron incluidos en el análisis. La tasa de conversión fue 13,8%. Los factores identificados en el análisis univariado fueron: género masculino, edad > 70 años, hipertensión arterial, colangitis, CPRE previa, coledocolitiasis, bilirrubina total > 2 mg/dl, ictericia, recuento de leucocitos > 12.000 mm3, ASA III-IV y engrosamiento de la pared de la vesícula por ecografía. Los factores independientes fueron: género masculino ($p < 0,02$), edad > 70 años ($p < 0,02$), CPRE previa ($p < 0,05$) y recuento de leucocitos > 12.000 mm^3 ($p < 0,04$). Los pacientes convertidos presentaron mayor tasa de morbilidad, reoperación y estancia hospitalaria ($p < 0,001$). La mortalidad no mostró diferencias.

Conclusiones: Es importante reconocer al paciente con mayor riesgo de conversión para optimizar la planeación y ejecución del procedimiento quirúrgico y disminuir la morbilidad asociada a la laparotomía, dado que los factores independientes identificados no son modificables.

Introduction

Currently, between 10% and 15% of the adult population in developed countries has gallstones.[1] In these individuals, the annual risk of developing complications requiring surgery, such as acute cholecystitis, it is estimated at between 1%-2%.[2] Laparoscopic cholecystectomy (LC) is the treatment of choice for symptomatic gallstone disease and its complications.

As the prevalence of the disease has increased, the number of patients undergoing LC has increased proportionately,[3,4] and LC accounts for significant hospital expenditure.[5] LC is safe and effective in about 85% of patients with acute cholecystitis,[6] given the growing experience of surgeons worldwide, the improving learning curve and the rapid technological advancement of video-laparoscopic instrumentation. When compared to open cholecystectomy (OC), LC has a lower rate of morbidity and mortality (*morbidity*, OC: 18.7% *vs* LC: 4.8% *P*<.0001; *mortality*, OC: 4% *vs* LC: 2.8%, *P*<.0001).[7,8] Although the surgeon's clinical judgment indicates when a conversion to laparotomy is appropriate, the conversion rate is an indicator of quality and should be evaluated periodically in surgical departments.

Universally, the conversion rate of emergency LC varies between 5% and 40%,[9-12] and is related to difficulty in identifying the anatomy, severe inflammation, haemorrhage and adhesions, among others.[13-15] In Latin America, several studies indicate that the conversion rate varies between 0.8% and 11%.[16-19]. In Colombia, some studies report that conversion is between 0.8% and 12%,[20-23] however, no information is available regarding predictive factors.

The aim of this study was to identify clinical, biochemical and diagnostic imaging variables to predict conversion in patients undergoing emergency LC, and analyse the relationship between conversion and morbidity, mortality and hospital stay. This study was conducted in a reference university hospital with a high volume of patients treated annually for this condition. Although not considered a complication, conversion is an unfavourable outcome, and identification of related factors may lead to the development of strategies to reduce its frequency and the complications associated with open surgery.

Materials and methods

This study was approved by the ethics committee of the Hospital Universitario San Ignacio (Bogotá, Colombia). A prospective cohort analysis was performed of adult patients undergoing emergency LC between January 2007 and January 2010. Excluded were patients undergoing elective

LC for cholelithiasis, polyps, pregnancy, patients with malignancy of the gallbladder and/or the bile duct, those who underwent OC, as well as those whose information was incomplete.

On admission to the emergency department, patients were assessed by the surgeon and/or resident surgeon. Initial evaluation included clinical (jaundice, acute cholangitis, pancreatitis) and biochemical assessment (CBC, amylase, bilirubin, transaminases and alkaline phosphatase) and an ultrasound scan of the gallbladder and bile duct (common bile duct diameter). Using these parameters, patients were stratified into risk levels for choledocholithiasis: high (greater than 50% probability), medium (30% probability) and low (less than 5% probability). During the preoperative period, high risk patients were given an initial endoscopic retrograde cholangiopancreatography (ERCP); medium risk patients were given a magnetic resonance cholangiopancreatography (MRCP); and low risk patients were given a MRCP or put under observation. Those with documented choledocholithiasis underwent a sphincterotomy and stone extraction by endoscopic surgery during the ERCP or MRCP. After choledocholithiasis, patients underwent LC.

A number of different variables of interest were prospectively recorded for purposes of this study using an Excel database (Microsoft). Socio-demographic, clinical, biochemical and diagnostic imaging variables were included: gender; age; clinical development from the onset to admission to the emergency department; waiting time for surgery and total duration of symptoms until surgery; presence of hypertension (AHT); diabetes mellitus (DM); obesity; history of upper abdomen surgery; associated conditions such as jaundice; American Society for Anesthesiology (ASA) classification; cholangitis, pancreatitis and choledocholithiasis; total bilirubin (TB), alkaline phosphatase (ALP), alanine aminotransferase (ALT), aspartate aminotransferase (AST) and leukocyte count at admission; ultrasound findings, such as a >4 mm thickening of the gallbladder wall, bile duct diameter (mm), presence of perivesicular fluid and stones located in the neck of the gallbladder; and variables related to the use of preoperative diagnostic methods such as ERCP.

Age was classified into different groups. Obesity was defined as Body Mass Index (BMI) greater than 30 kg/m^2. Total bilirubin level >2 mg/dl, ALT and AST 1.5 times the normal value and alkaline phosphatase above normal were defined as positive. An abnormal ultrasound bile duct diameter was defined as ≥7 mm.

Cholecystectomies were performed by surgeons experienced in the standard four-port technique, who had performed at least four hundred laparoscopic cholecystectomies before the study. Conversions were performed by median or subcostal laparotomy according to each patient and the surgeon's decision. All patients were administered prophylactic antibiotic treatment as recommended by the Center for Disease Control (CDC).[24]

The main outcome evaluated was conversion to open surgery during LC. The parameters identified were the conversion rate and its causes; the complication rate, which included surgical site infection (SSI), bile leak, bile duct injury, haemorrhage and systemic complications, reoperation rate, hospital stay and death. These secondary outcomes were assessed until day 30 after the operation.

For statistical analysis, continuous variables were expressed as standard deviation and categorical variables as frequencies and percentages. A univariate analysis was performed comparing each factor with the main outcome. The chi-square test was used to determine differences between categorical variables and the Student's t-test to determine differences between continuous variables. Statistical significance was defined as $P<.05$. Subsequently, a multivariate analysis was performed with the factors previously evaluated to identify independent predictors. The odds ratio (OR) and confidence interval (CI 95%) were reported. The statistical analysis used Stata 9.0 programme (Stata Corporation, Texas, USA).

Results

A total of 703 patients who met the inclusion criteria were analysed. The conversion rate was 13.8% (97 patients). The average age was 47.8 years, and 64.4% (453 patients) were women. The average time for progression of the symptoms to admission was 2.6 days, waiting for surgery was 1.5 days and the total time was 4.1 days. HTA (21.2%) and DM (5.2%) were the most common associated diseases.

The rate of choledocholithiasis documented and treated in the preoperative period was 10.9%. The demographic, biochemical, ultrasound and diagnostic imaging variables and univariate analysis results are shown in Table 1. The causes of conversion are described in Table 2.

The multivariate analysis identified the following as independent factors: male gender (OR: 1.7, 95% CI: 1.07-2.8), age over 70 years (OR: 2.7, 95% CI: 1.55-5.0), leukocyte count >12 000 mm^3 (OR: 1.6, 95% CI: 1.02-2.68) and a history of ERCP (OR: 2.0, 95% CI: 0.5-4.53), see Table 3.

For patients with converted LC, there was a higher rate of reoperation ($P<.0001$), complications ($P<.0009$), especially bile duct injury ($P<.0008$) and organ/space SSI ($P<.0008$), see Table 4. Bile leakage, haemorrhage and death showed no statistically significant differences. Hospital stay was higher in converted patients (4.3 days *vs* 1.3 days, $P<.00001$).

Discussion

In this cohort study, 97 patients (13.8%) underwent conversion. As in other studies, the highest proportion of conversions was related to severe inflammation and difficulty in identifying the anatomy of Calot's triangle, and less frequently to haemorrhage, bile duct injury and adhesions. Regarding this last factor, although several studies indicate that a history of abdominal surgery is associated with increased risk of conversion,[25,26] only 6.1% (6 cases) were converted due to this condition (present in 2.1% of the cohort study). In addition, this factor does not actually contraindicate the implementation of LC, as suggested by some authors.[27]

The literature identifies several factors for predicting the likelihood of converting a LC: demographic, clinical and

Table 1 – Demographic, clinical, biochemical and ultrasound parameters for 703 patients who underwent emergency laparoscopic cholecystectomy

Parameter	Not converted	Converted	Total	P
Number	606 (86.2%)	97 (13.8)	703	
Sex	606 (86.2%)	97 (13.8%)	703	
Female	405 (66.8%)	48 (49.5%)	453 (64.4%)	<.001
Male	201 (33.1%)	49 (50.5%)	250 (35.5%)	
Age, years	45.5 (15-92)	61.7 (22-96)	47.8 (15-96)	
<18	2 (0.3%)	0	2 (0.3%)	.5
18-44	306 (50.5%)	18 (18.5%)	324 (46.1%)	<.0001
45-49	76 (12.5%)	6 (6.1%)	82 (11.6%)	.07
50-54	49 (8.1%)	10 (10.3%)	59 (8.39%)	.4
55-59	44 (7.2%)	9 (9.2%)	53 (7.5%)	.4
60-64	36 (5.9%)	9 (9.2%)	45 (6.4%)	.2
65-69	28 (4.6%)	5 (5.1%)	33 (4.6%)	.4
>70	65 (10.73%)	40 (41.2%)	105 (14.9%)	<.0001
Symptoms duration				
<24 hours	417 (68.8%)	75 (77.3%)	492 (69.9%)	.09
24-72 hours	106 (17.4%)	10 (10.3%)	116 (16.5%)	.07
>72 hours	83 (13.7%)	12 (12.3%)	95 (13.5%)	.7
Time from admission to the emergency department to surgery				
<24 hours	238 (39.2%)	35 (36%)	273 (38.8%)	.5
24-72 hours	229 (37.7%)	39 (40.2%)	268 (38.1%)	.6
>72 hours	139 (22.9%)	23 (23.7%)	162 (23%)	.8
Total time (symptom duration and waiting)				
<7 days	546 (90.1%)	85 (87.6%)	631 (89.7)	
>7 days	60 (9.9%)	12 (12.3%)	72 (10.2%)	.4
AHT	117 (19.3%)	32 (32.9%)	149 (21.2%)	<.002
DM	30	6 (6.2%)	36 (5.2%)	.6
Jaundice	96 (15.8%)	23 (23.7%)	119 (16.9%)	<.05
Pancreatitis	76 (12.5%)	6 (6.1%)	82 (11.6%)	.07
Cholangitis	7 (1.2%)	5 (5.1%)	12 (1.7%)	<.005
Choledocholithiasis	60 (9.9%)	17 (17.5%)	77 (10.9%)	<.02
Previous supraumbilical surgery	15 (2.48%)	4 (4.12%)	19 (2.19%)	.3
BMI kg/m²				.5
BMI <30	531 (87.6%)	83 (85.5%)	614 (87.3%)	
BMI >30	75 (12.3%)	14 (14.4%)	89 (12.6%)	
ASA, class				<.0001
I/II	549 (90.5%)	74 (76.2%)	623 (88.6%)	
III/IV	57 (9.4%)	23 (23.7%)	80 (11.3%)	
Total bilirubin >2 mg/l	143 (23.6%)	32 (32.9%)	175 (24.9%)	<.04
Alkaline phosphatase	212 (34.9%)	35 (36%)	247 (35.1%)	.8
ALT>1.5 times	192 (31.6%)	22 (22.6%)	214 (30.4%)	.07
AST>1.5 times	195 (32.1%)	24 (24.7%)	219 (31.1%)	.1
Bile duct diameter >7 mm	128 (21.1%)	25 (25.7%)	153 (21.7%)	.3
WBC>12 000 mm³	210 (34.6%)	49 (50.5%)	259 (36.8%)	<.003
Gallbladder wall thickening by ultrasound	196 (42.2%)	43 (44.3%)	239 (34%)	<.02
Perivesicular fluid by ultrasound	21 (3.5%)	7 (7.2%)	28 (3.9%)	.07
Impacted stone in the Hartmann's pouch	134 (22.1%)	19 (19.5%)	153 (21.7%)	.5
Previous ERCP	118 (19.4%)	29 (29.9%)	147 (20.9%)	<.01

AHT indicates hypertension; ALT, alanine aminotransferase; ASA, American Society of Anesthesiology, AST, aspartate aminotransferase; BMI, body mass index; DM, diabetes mellitus; ERCP, endoscopic retrograde cholangiopancreatography; WBC, leukocyte count.

biochemical factors, ultrasound and invasion of the biliary tree during the preoperative period, such as the use of ERCP.

With regard to demographic factors, gender, age and symptom duration are factors that are highlighted in several studies.[26-28] This study independently identified anyone older than 70 years, and men in particular as having a higher probability of conversion. These findings have been confirmed by other authors.[26,28] Some agree that men consult emergency services late and therefore have greater inflammation and fibrosis.[27] In this context, the elderly had a higher probability, due to a hypothetical association with greater progression of symptoms and previous episodes of cholecystitis.[27] Such an

Table 2 – Causes of conversion for emergency laparoscopic cholecystectomy

Causes	No.	%
Severe inflammation	56	57.7
Difficulty identifying anatomy	28	28.8
Adhesions	6	6.1
Haemorrhage	4	4.1
Suspected biliary tract injury	3	3
Total		**97**

association could not be demonstrated after analysis of this cohort study. One of the most important factors leading to possible conversion is symptom duration and/or waiting time to surgery. While several studies emphasise the need for early LC to prevent conversion and reduce morbidity,[29,30] other studies do not show this association. A recent meta-analysis confirmed that the conversion rate between early and late LC was 20% *vs* 23%.[31] However, other authors suggest that the optimal time for LC is within 72 hours of admission to the emergency department or within the first 7 days of onset of the symptoms.[29] Looking at the Colombian health system, it is possible to infer that longer symptom duration and waiting time TO surgery were factors associated with an increased likelihood of conversion. However, this study showed a greater number of conversions were performed in patients having symptoms for less than 24 hours (77.3%), within 24-72 hours after admission (40.2%) and within seven days, taking into consideration the total time for evolution and waiting time to surgery (87.6%). This might represent a measure of quality of care (more conversions after longer evolution or waiting for an operation), but this study confirmed that this association could not be demonstrated for patients treated at the Hospital Universitario San Ignacio (Bogotá, Colombia), as most of them were affiliated to the health system via subsidy on demand.

For clinical factors, several studies describe an increased risk of conversion for patients with jaundice, cholangitis, choledocholithiasis, or pancreatitis.[32-35] This study identified jaundice and cholangitis as factors in the univariate analysis, but not a history of gallstone pancreatitis. Similarly, the association between diabetes and conversion is arguable, with some studies supporting it.[28,36] In this study DM did not correlate with the outcome, however, some authors have reported this association.[26,27] Nevertheless, other conditions such as hypertension, present in one third of patients converted in this study, was established as a univariate predictor. This is found in other studies, although the pathological mechanism associated with it is not clear.[17,36] Other factors, such as obesity, also demonstrate an association in the literature,[15,25,27,29,37] especially when related with complications such as haemorrhage and hollow organ and bile duct injuries.[36] Obesity was not identified as a predictor in this cohort study. Lastly, for this group of factors, ASA III

Table 3 – Multivariate analysis of factors associated with conversion

Factor	OR	SD	P	CI 95%	
Jaundice	1.241	0.482	.577	0.580	2.657
Cholangitis	1.612	1.153	.504	0.397	6.549
TB>2 mg/dl	0.758	0.271	.44	0.376	1.528
AHT	1.324	0.361	.302	0.776	2.259
ERCP	2.022	0.833	.05	0.501	4.536
ASA III/IV	1.422	0.464	.28	0.750	2.697
WBC>12 000 mm^3	1.658	0.408	.04	1.023	2.686
Gallbladder wall thickening	1.556	0.383	.072	0.960	2.522
Choledocholithiasis	1.016	0.488	.973	0.396	2.607
Male	1.743	0.427	.023	1.078	2.817
Age (18-44 years)	0.4	0.123	.3	0.218	0.734
Age (>70 years)	2.793	0.833	.001	1.556	5.011

AHT indicates hypertension; ASA, American Society of Anesthesiology; CI, confidence interval; ERCP, endoscopic retrograde cholangiopancreatography; OR, odds ratio; SD, standard deviation; TB, total bilirubin; WBC, leukocyte count.

Table 4 – Morbidity, mortality and hospital stay in 703 patients undergoing converted and unconverted laparoscopic cholecystectomy

	Not converted	Converted	Total	P
Reoperation	7 (1.16%)	6 (6.1%)	13 (1.8%)	<.001
Complications	8 (1.3%)	5 (5.1%)	13 (1.8%)	<.009
Bile duct injury	1 (0.2%)	2 (2.1%)	3 (0.4%)	<.008
Bile leak	1 (0.2%)	1 (1%)	2 (0.3%)	.1
Haemorrhage	0	5 (5.1%)	5 (0.7%)	.3
Surgical site infection	1 (0.2%)	2 (2.1%)	3 (0.4%)	<.008
Death	2 (0.3%)	1 (1%)	3 (0.4%)	.3
Hospital stay, days	1.6	4.3	2.95	<.0001

and IV levels were identified in the univariate analysis, which has also been reported in other studies.[36]

For biochemical variables, factors such as a leukocyte count >9000/mm^3, TB value >1.2 mg/dl, transaminase levels >60 U/L and a high value for C-reactive protein have been reported.[10,11,14,15] A TB value >2 mg/dl and leukocyte count >12 000 mm^3 were identified in this cohort study as associated factors. The rest of the biochemical tests showed no statistical significance.

Several studies indicate that certain findings during the initial ultrasound assessment can predict conversion to open surgery, such as the presence of a stone impacted in the Hartmann's pouch, a thickened gallbladder wall, perivesicular fluid, scleroatrophy of the gallbladder and dilatation of the intrahepatic bile duct.[31,38-43] In this study, a thickening of the wall was the only factor having statistical significance, in fact, several authors note that this finding is the main predictor.[38,40,42]

Some authors have linked conversion with a history of endoscopic removal of bile duct stones prior to surgery.[7,39,42] This factor has been related to the severity of the underlying biliary disease and may be a covariate of interest. In this study, a history of ERCP is a statistically independently associated with a higher risk of conversion. However, the main indication in our cohort study for performing this procedure was the suspicion or presence of choledocholithiasis in the preoperative period, which would demonstrate an intrinsic relationship between the two variables analysed, which are statistically significant.

Lastly, several studies indicate that conversion to open surgery carries a greater risk of morbidity and mortality.[7,8,25,36,38,39,44] Conversion to open cholecystectomy in this study was associated with an increased incidence of haemorrhage, reoperation, biliary tract lesion and SSI. Consequently, it leads to an increase in hospital stay.

In conclusion, being a man older than 70 years, with a WBC>12 000 mm^3 during hospitalisation and having been subjected to an ERCP before cholecystectomy are factors increasing the risk of conversion to open surgery in a cohort study of Colombian patients with acute cholecystitis. Since all identified independent factors are not modifiable and conversion involves an increased risk of morbidity, this rate can be reduced, despite already being within acceptable limits. Information from this study should be used to incorporate improvement strategies via innovation, new technologies, changes in surgical technique and education in surgery. All these aspects show gaps in academic knowledge that need to be analysed in further studies.

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Conflict of interest

The authors affirm that they have no conflict of interest.

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