Acta Med. Okayama, 2017
Vol. 71, No. 5, pp. 419-425

Acta Medica Okayama
http://escholarship.lib.okayama-u.ac.jp/amo/

Original Article

Preoperative Risk Factors for Conversion of Laparoscopic Cholecystectomy to Open Cholecystectomy and the Usefulness of the 2013 Tokyo Guidelines

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To identify predictive factors for conversion from laparoscopic cholecystectomy (LC) to open cholecystectomy performed for mixed indications as an acute or elective procedure. We retrospectively analyzed the data of 236 consecutive cases of LC performed in our department between January 2012 and January 2015, and evaluated preoperative risk factors for conversion and the usefulness of the 2013 Tokyo guidelines (TG2013) for diagnosing acute cholecystitis. The conversion rate in our series was 8% (19/236 cases). The following independent predictive factors of conversion were identified ($p \leq 0.04$): previous upper abdominal surgery (odds ratio (OR), 14.6), pericholecystic fluid (OR, 10.04), acute cholecystitis (OR, 7.81), and emergent LC (OR, 15.8). Specifically for patients with acute cholecystitis defined using the 2013 Tokyo guidelines, use of an antiplatelet or anticoagulant drug for cardiovascular disease ($p = 0.043$), previous upper abdominal surgery ($p < 0.031$) and a resident as operator ($p = 0.041$) were predictive factors. The risk factors for conversion identified herein could help to predict the difficulty of the procedure and could be used by surgeons to better inform patients regarding the risks for conversion. The TG2013 can be an effective tool for diagnosing acute cholecystitis to make informed clinical decisions regarding the optimal procedure for a patient.

Key words: laparoscopic cholecystectomy, conversion, risk factors, acute cholecystitis, Tokyo guidelines 2013

Laparoscopic cholecystectomy (LC) has become the gold standard for treating symptomatic cholelithiasis [1-3], as it can shorten the hospital stay, decrease the pain and morbidity, and deliver better cosmetic results when compared to open cholecystectomy (CC). Although acute cholecystitis has generally been considered a relative contraindication for LC, recent research has provided evidence that LC can be safely performed in patients with acute cholecystitis [4,5]. In fact, the 2013 Tokyo guidelines (TG2013) for the diagnosis and management of acute cholecystitis [6,7] recommend LC for Grade I acute cholecystitis [8]. However, in some cases the technical difficulties of the LC procedure can make the conversion to CC inevitable. Because conversion from LC to CC lengthens the procedure and hospital stay and because it is associated with increased morbidity [2], there has been clinical interest in identifying preoperative risk factors for conversion. However, there is no current consensus regarding these preoperative risk factors.

Various risk factors for conversion from LC to CC

Received December 26, 2016; accepted May 25, 2017.
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Conflict of Interest Disclosures: No potential conflict of interest relevant to this article was reported.

have been inconsistently reported in the literature, including advanced age, acute cholecystitis, previous abdominal surgery, obesity, choledocholithiasis, pericholecystic fluid, pancreatitis, and the gallbladder wall thickness > 3 mm [2, 3, 9-12]. However, in order to accurately assess the risks of conversion and communicate them to patients preoperatively, predictive factors must be defined. Therefore, the aim of our study was to identify factors predictive of conversion in patients undergoing LC for mixed indications as either an acute or elective procedure. As a secondary aim, we evaluated the usefulness of the TG2013 for the diagnosis of acute cholecystitis.

Methods

The study was approved by the Ethics Committee at Iwakuni Clinical Center. We retrospectively analyzed the data of all consecutive patients who underwent LC between January 2012 and January 2015 in the Department of Surgery at Iwakuni Clinical Center. The hospital serves as an educational hospital for surgical residents in their third or fourth year of surgical training. Over our study period, the surgical staff included 7 surgeons and 3 residents.

The following variables were included in our analysis of possible risk factors for conversion from LC to CC: sex, age, history of acute cholecystitis or pancreatitis, pericholecystic fluid, a gallbladder wall thickness > 3 mm, previous abdominal surgery (above the umbilicus), concomitant disease (ischemic heart disease, diabetes mellitus or hypertension), and antiplatelet or anticoagulant drug therapy. These preoperative factors were compared between patients who required a conversion from LC to CC (the CC group) and those in whom the LC procedure was completed (the LC group). The intraoperative and postoperative records were reviewed to extract the following information: volume of bleeding, operating time, reason for conversion, status of performing surgeon (attending surgeon or resident), type of complication, and length of hospital stay. Indications for cholecystectomy were symptomatic cholecystolithiasis, acute cholecystitis, recent acute cholecystitis treated conservatively, recent biliary pancreatitis treated conservatively, and recent obstructive jaundice due to common bile duct stone (CBD) treated with endoscopic retrograde cholangiopancreaticography. In addition, we analyzed the relation between the major reason and risk factors for conversion from LC to CC.

The diagnosis of acute cholecystitis was made according to the TG2013 when all of the following criteria were present: (1) local inflammatory signs; (2) systemic inflammatory findings; and (3) characteristic findings on imaging. The severity of acute cholecystitis was classified according to the following 3 categories: mild (Grade I), moderate (Grade II) and severe (Grade III) [8]. According to TG2013, early LC is indicated for patients with Grade I acute cholecystitis, with LC or CC indicated for patients with a Grade II acute cholecystitis, presenting > 72 h after onset [13]. An acute procedure was defined as surgery performed on an emergency basis within 72 h from the onset of symptoms.

The LC was performed by experienced surgeons and surgical residents under supervision. The LC was performed using a standard 4 port technique, with Calot's triangle dissected using low voltage hook diathermy. The gallbladder was dissected off the liver bed. Prevention of injury to the bile duct is considered to be ultimate standard of patient safety during the LC procedure [13]. No clipping was performed until all anatomical structures had been clearly identified. We did not perform routine intraoperative cholangiography. Resected specimens were routinely delivered into a bag through the laparoscope port.

Statistical analysis. Because of their non-normal distribution, age and length of hospital stay were reported as a median and range (min-max). Other continuous variables were reported as a mean ± standard deviation (SD), with categorical variables reported as frequencies (and percentage). Between-group differences for continuous variables were evaluated using a Mann−Whitney *U*-test, with a chi-squared test for categorical variables. Multiple logistic regression analysis, using stepwise options, was used to identify independent risk factors for CC. All analyses were performed using JMP version 11 (SAS Institute Inc., Cary, NC, USA), with values of $p < 0.05$ considered as significant.

Results

Over our study period, 236 patients underwent an LC procedure, 116 females (49.2%) and 120 males (50.8%), with a median age of 65 (18-93) years. The indications for LC among our study group were as follows: gallstone colic in 204 cases, gallstone pancreatitis in 91 cases, acute cholecystitis in 53 cases, and gallbladder polyp (or adenomyomatosis) in 21 cases. There was some overlap among the indications.

A conversion to CC was necessary in 19 patients (8.0%), and the indications for conversion in these patients are shown in Table 1 and summarized as follows: inability to clearly define the anatomy in Calot's triangle due to local inflammation (n = 11); adhesions around the gallbladder (n = 5); bleeding from the cystic artery or liver bed (n = 2); and an inadequately created pneumoperitoneum (n = 1). There was no incidence of injury to major vessels or death in our case series.

Table 1 Reasons for conversion to open cholecystectomy

Reason	Number (n = 19)	%
Inflammation obscuring the relevant anatomy	11	58.0
Adhesion around the gallbladder	5	26.3
Bleeding	2	10.5
Inability to create a pneumoperitoneum	1	5.2

Significant predictors of conversion, based on the univariate analyses, are shown in Table 2 and summarized as follows: male sex ($p = 0.038$), use of an antiplatelet or anticoagulant drug for cardiovascular disease ($p = 0.013$), previous upper abdominal surgery ($p < 0.001$), pericholecystic fluid ($p < 0.001$), a gallbladder wall thickness > 3 mm ($p = 0.006$), LC performed as an emergent procedure ($p = 0.005$), and a history of gallstone pancreatitis or acute cholecystitis ($p < 0.001$). On multivariate analysis using a multiple logistic regression model, the following independent factors for CC were retained (Table 3): previous upper abdominal surgery (odds ratio (OR), 14.6; 95% CI, 2.83-83.4;

Table 2 Comparison of patients (n = 236) treated by laparoscopic cholecystectomy with those who required conversion to open cholecystectomy

Risk factor	LC n = 217 (%)	CC n = 19 (%)	*P* value
Age, years, median [range]	64.5 [18–93]	69 [41–79]	0.242
Sex			**0.038**
Men	106 (48.8)	14 (73.8)	
Women	111 (51.5)	5 (26.3)	
Comorbidity			
Hypertension	81 (37.2)	9 (47.4)	0.379
Diabetes mellitus	30 (13.8)	3 (15.8)	0.806
Use of an antiplatelet or anticoagulant drug for cardiovascular disease	32 (14.9)	7 (36.8)	**0.013**
Previous upper abdominal surgery	6 (2.7)	6 (31.6)	**<0.001**
Pericholecystic fluid	22 (10.1)	11 (57.8)	**<0.001**
Gallbladder wall thickness	112 (51.4)	16 (84.2)	**0.006**
Emergency surgery	35 (16.1)	8 (42.1)	**0.005**
Indication			
Gallstone colic	186 (85.3)	18 (94.7)	0.255
Pancreatitis or obstructive jaundice by CBD stone	78 (35.8)	13 (68.4)	**0.005**
Gallbladder polyp (or adenomyomatosis)	21 (9.6)	0 (0)	0.055
Acute cholecystitis	41 (18.8)	12 (63.2)	**<0.001**
Grade I	25 (11.5)	7 (21.8)	
Grade II	15 (6.9)	4 (21.0)	
Grade III	1	1	
Cholangitis due to CBD stone	56 (25.7)	5 (26.3)	0.952
Operator			0.310
Resident	123 (56.2)	13 (68.4)	
Attending surgeon	94 (43.6)	6 (31.6)	
Operating time, min	114 ± 49	207 ± 83	**<0.001**
Bleeding, ml	29 ± 6	503 ± 151	**<0.001**
Hospital stay days, median [range]	5 [3–12]	11 [5–30]	**<0.001**

LC, laparoscopic cholecystectomy; CC, conversion to open cholecystectomy; CBD, common bile duct.
Because of their non-normal distribution, age and the length of hospital stay were reported as the median and range [min-max]. Other continuous variables were reported as a mean ± standard deviation, with categorical variables reported as frequencies (and percentage).

$p = 0.0014$), pericholecystic fluid (OR, 10.0; 95% CI, 1.95-59.1; $p = 0.0054$), acute cholecystitis (OR, 7.81; 95% CI, 1.26-47.2; $p = 0.028$), and LC performed as an emergent procedure (OR, 15.8; 95% CI, 2.13-138.8; $p = 0.0071$). By further restricting our analysis to patients with acute cholecystitis, as defined by the TG2013, the following predictive factors of conversion were identified on univariate analysis (Table 4): use of an antiplatelet or anticoagulant drug for cardiovascular disease ($p = 0.043$), previous upper abdominal surgery ($p < 0.031$), and a resident as the operator ($p = 0.041$). However, none of these factors were retained as independent predictors on multivariate analysis.

The mean duration of operation for the LC group was 114 ± 49 min, compared to 207 ± 83 min for the CC group ($p < 0.001$). The volume of bleeding for the LC group was 29 ± 6 ml, compared to 503 ± 151 ml for the CC group ($p < 0.001$). The mean length of hospital stay was 5 (3-12) days for the LC group and 11 (5-30) days for the CC group ($p < 0.05$).

The major reason for conversion from LC to CC was inability to clearly define the anatomy in Calot's triangle due to local inflammation (n = 11). In analysis of the relationship between the major reason for conversion and the risk factors for conversion, pericholecystic fluid ($p < 0.001$), a gallbladder wall thickness > 3 mm ($p = 0.004$), LC performed as an emergent procedure ($p = 0.012$), and acute cholecystitis ($p < 0.001$) were significant factors (Table 5). On multivariate analysis using a multiple logistic regression model, the following

Table 3 Multivariate logistic regression of conversion risk factors for all patients who underwent laparoscopic cholecystectomy

Risk factor	Odds ratio (95% CI)	*P* value
Previous upper abdominal surgery	14.6 (2.83–83.4)	0.001
Acute cholecystitis	7.81 (1.26–47.2)	0.028
Pericholecystic fluid	10.0 (1.95–59.1)	0.005
Emergency surgery	15.8 (2.13–138.8)	0.007

Table 4 Comparison of patients (n = 53) with acute cholecystitis treated by laparoscopic cholecystectomy with those who required conversion to open cholecystectomy

Risk factor	LC n = 41 (%)	CC n = 12 (%)	*P* value
Age, years, median [range]	77 [25–93]	69.5 [41–79]	0.552
Sex			0.100
Men	20 (69.0)	9 (31.3)	
Women	21 (87.5)	3 (12.5)	
Comorbidity			
Hypertension	21 (51.2)	5 (41.6)	0.560
Diabetes mellitus	13 (31.7)	3 (25.0)	0.652
Use of antiplatelet or anticoagulant drug for cardiovascular disease	8 (19.5)	6 (50.0)	**0.043**
Previous upper abdominal surgery	3 (7.3)	4 (33.3)	**0.031**
Pericholecystic fluid	19 (46.3)	9 (75.0)	0.076
Gallbladder wall thickness	32 (78.1)	11 (91.7)	0.255
Emergency surgery	35 (85.3)	8 (66.7)	0.166
Pancreatitis or obstructive jaundice due to CBD stone	15 (36.6)	7 (58.3)	0.179
Cholangitis due to CBD stone	4 (9.76)	2 (16.7)	0.523
Operator			**0.041**
Resident	17 (41.6)	9 (75.0)	
Attending Surgeon	24 (58.5)	3 (25.0)	
Operating time, min	140 ± 50	225 ± 86	**<0.001**
Bleeding, ml	87 ± 24	634 ± 227	**<0.001**
Hospital stay days, median [range]	6 [3–17]	12 [5–29]	**0.002**

LC, laparoscopic cholecystectomy; CC, conversion to open cholecystectomy; CBD, common bile duct.
Because of their non-normal distribution, age and length of hospital stay were reported as a median and range [min-max]. Other continuous variables were reported as a mean ± standard deviation, with categorical variables reported as frequencies (and percentage).

independent risk factors for CC were retained because local inflammation prevented a clear definition of the anatomy in Calot's triangle (Table 6): pericholecystic fluid (OR, 33.2; 95% CI, 3.57-798.5; $p=0.001$), acute cholecystitis (OR, 11.4; 95% CI, 1.09-103.1; $p=0.042$), and LC performed as an emergent procedure (OR, 12.1; 95% CI, 1.36-148.7; $p=0.025$).

Table 6 Multivariate logistic regression of conversion risk factors because of inability to clearly define the anatomy in Calot's triangle due to local inflammation

Risk factor	Odds ratio (95% CI)	*P* value
Acute cholecystitis	11.4 (1.09−103.1)	0.042
Pericholecystic fluid	33.2 (3.57−798.5)	0.001
Emergency surgery	12.1 (1.36−148.7)	0.025

Discussion

Overall LC-to-CC conversion rates of 2-15% have previously been reported [1,14,15], with a rate of 6-35% specifically in patients with acute cholecystitis [3,16,17]. For our case series, we identified an overall conversion rate of 8.0% and a rate of 22.6% in patients with acute cholecystitis. Our analysis further indicated that conversion to CC was not based on failure of the LC procedure but rather on a prudent approach to surgical planning, with the decision for conversion made to avoid complications due to difficulty in differentiating the local anatomy because of inflammation and adhesions.

We identified several significant preoperative risk factors for conversion to CC: previous upper abdominal surgery, a diagnosis of acute cholecystitis, pericholecystic fluid, and an LC procedure on an emergent basis. These risk factors were significantly associated

Table 5 Univariate analysis of relation between risk factor and major reason for conversion to open cholecystectomy

Risk factor	Display anatomy safely		*P* value
	Able (n=217)	Unable (n=11)	
Age, years, median [range]	64.5 [18−93]	68 [41−77]	0.597
Sex			0.338
Men	106 (48.5)	7 (63.6)	
Women	111 (51.5)	4 (36.4)	
Comorbidity			
Hypertension	81 (37.2)	6 (54.6)	0.246
Diabetes mellitus	30 (13.8)	3 (27.3)	0.213
Use of antiplatelet or anticoagulant drug for cardiovascular disease	32 (14.9)	3 (27.3)	0.257
Previous upper abdominal surgery	6 (2.7)	1 (9.1)	0.233
Pericholecystic fluid	22 (10.1)	8 (72.3)	**<0.001**
Gallbladder wall thickness	112 (51.4)	9 (81.8)	**0.004**
Emergency surgery	35 (16.1)	6 (54.6)	**0.012**
Indication			
Gallstone colic	186 (85.3)	11 (100)	0.234
Pancreatitis or obstructive jaundice by CBD stone	78 (35.8)	7 (63.6)	0.062
Gallbladder polyp (or adenomyomatosis)	21 (9.6)	0 (0)	0.055
Acute cholecystitis	41 (18.8)	8 (73.2)	**<0.001**
Grade I	25 (11.5)	4 (36.6)	
Grade II	15 (6.9)	4 (36.6)	
Grade III	1	0	
Cholangitis due to CBD stone	56 (25.7)	2 (18.8)	0.577
Operator			0.475
Resident	123 (56.2)	5 (45.5)	
Attending surgeon	94 (43.6)	6 (54.5)	

LC, laparoscopic cholecystectomy; CC, conversion to open cholecystectomy; CBD, common bile duct.
Because of their non-normal distribution, age and length of hospital stay were reported as a median and range [min-max]. Other continuous variables were reported as a mean ± standard deviation, with categorical variables reported as frequencies (and percentage).

with the major reason for conversion to CC. Patients in the CC group had significantly higher volume of bleeding, longer operative time and longer hospital stay than patients in the LC group. Therefore, for patients who present with all of these risk factors, we recommend starting with a CC to avoid unnecessary conversion from LC. Upper abdominal surgery has previously been reported as a risk factor for conversion, with adhesions due to the prior injury typically making the LC procedure more difficult to perform. In our study, the operation in all cases with previous upper abdominal surgery was distal gastrectomy. We recommend simultaneous cholecystectomy during gastrectomy.

Our case series analysis provides evidence that LC is a safe and feasible procedure for patients with acute cholecystitis, confirming the findings of prior studies [14, 18, 19]. Our conversion rate was 22.6% in patients with acute cholecystitis, and acute cholecystitis was identified as an independent predictor of conversion. We did not identify a difference in the conversion rate between Grade I (21.8%) ad Grade II (21.0%) acute cholecystitis cases. The high rates of conversion from LC to CC for acute cholecystitis result from the technical difficulty of managing severe inflammatory adhesions around the acutely inflamed gallbladder, which makes the dissection of Calot's triangle and clear differentiation of the anatomy more difficult. These cases require troubleshooting and a more careful surgical procedure than cases without cholecystitis. Finally, sufficient preoperative assessment and inoperative communication between operation staffs are required.

Based on the TG2013, an LC is recommended for Grades I and II acute cholecystitis, and these guidelines are generally adhered to in experienced centers. For patients with severe local inflammation, early cholecystectomy may be difficult, and thus early medical treatment, including gallbladder drainage, and delayed cholecystectomy may be necessary [13]. The TG2013 guidelines further recommend that cholecystectomy should be performed as soon as possible after admission, typically within 72 h of the onset of symptoms. The superiority of LC over CC as a surgical technique for acute cholecystitis has been reported previously [20, 21]. However, in our case series, we identified LC performed as an emergency surgery as a significant risk factor for conversion to CC. Therefore, although LC is recommended as the preferred treatment for acute cholecystitis in the TG2013, patient safety should be a priority and CC can be considered to be as effective as LC for patients with acute cholecystitis.

Pericholecystic fluid is one of the local signs of inflammation and a characteristic finding of acute cholecystitis on imaging; it is also one of the criteria for a diagnosis of Grade II acute cholecystitis [13]. The absence of a difference in the conversion rate among patients with Grade I and II acute cholecystitis in our case series could be explained, in part, by the overall low rate of conversion among patients in our study group. However, a more severe grade of cholecystitis, with greater local inflammation, is generally considered to carry a higher risk of conversion to CC. Therefore, the medical status of each patient must be comprehensively assessed, and the diagnosis confirmed by ultrasound or computed tomography. Then, based on the results of these analyses, the timing of surgical management of acute cholecystitis must be carefully determined by experienced surgeons. In our univariate analysis, we did identify a single risk factor for conversion—namely, a resident being the operator ($p = 0.041$). Therefore, for cases which are foreseen to be difficult, an experienced surgeon should perform the LC procedure. Nevertheless, surgeons should never hesitate to convert to a CC to prevent injuries when a difficulty with the LC procedure is encountered. For residents, simulator training provides a more rapid acquisition of both technical skills and non-technical skills, such as communication and teamwork [22, 23]. To exploit this approach, our hospital must implement a simulation device and surgical simulation curriculum. In addition, preoperative image evaluation by drip infusion cholecystocholangiography-CT or magnetic resonance cholangiopanceatography is important for elucidating the anatomy in individual cases. Such training outside the operating room is clearly beneficial and may even reduce surgical complications.

In conclusion, significant risk factors for conversion from LC to CC included previous upper abdominal surgery, diagnosis of acute cholecystitis, pericholecystic fluid, and emergency surgery. In patients who have all of these risk factors, we recommend starting with a CC. The TG2013 guidelines provide an effective tool not only to diagnose acute cholecystitis but to inform clinical decisions regarding the optimal procedure in an educational hospital. The risk factors for conversion that we identified with TG2013 could help to predict the difficulty of the procedure and could be used by surgeons to better inform patients regarding the risks of conversion from LC to CC. Nonetheless, independent of their level of experience, attending surgeons should first prioritize patient safety, making the decision to convert to a CC during the course of an LC procedure as needed.

Acknowledgments. The authors wish to thank Rie Yamasaki for assistance with the pathological diagnosis.

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