

Multivariable Analysis of Cholecystectomy after Gastrectomy: Laparoscopy is a Feasible Initial Approach even in the Presence of Common Bile Duct Stones or Acute Cholecystitis

Joo Hyun Kim · Jeong Nam Cho · Sun Hyung Joo ·
Bum Soo Kim · Sang Mok Lee

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Abstract

Background When performing cholecystectomy after gastrectomy, we often encounter problems, such as adhesions, nutritional insufficiency, and bowel reconstruction. The purpose of this study was to identify the factors related to surgical outcome of these associated procedures, with emphasis on the use of a laparoscopic approach.

Methods We retrospectively analyzed data from 58 patients who had a history of cholecystectomy after gastrectomy. Differences between subgroups with respect to operation time, length of postoperative hospital stay, and complications were analyzed. To identify the factors related with outcomes of cholecystectomy after gastrectomy, we performed multivariable analysis with the following variables: common bile duct (CBD) exploration, laparoscopic surgery, gender, acute cholecystitis, history of stomach cancer, age, body mass index, period of surgery, and interval between cholecystectomy and gastrectomy.

Results We found one case (2.9%) of open conversion. The CBD exploration was the most significant independent factor (adjusted odds ratio (OR), 45.15; 95% confidence interval (CI), 4.53–450.55) related to longer operation time. Acute cholecystitis also was a significant independent factor (adjusted OR, 14.66; 95% CI, 1.46–147.4). The laparoscopic approach was not related to operation time but was related to a shorter hospital stay (adjusted OR, 0.057; 95% CI, 0.004–0.74). Acute cholecystitis was independently related to the occurrence of complications (adjusted OR, 27.68; 95% CI, 1.15–666.24); however, CBD

exploration and laparoscopic surgery were not. A lower BMI also was an independent predictor of the occurrence of complications (adjusted OR, 0.41; 95% CI, 0.2–0.87).

Conclusions The laparoscopic approach is feasible for cholecystectomy after gastrectomy, even in cases with CBD stones or acute cholecystitis. This approach does not appear to increase operation time or complication rate and was shown to decrease the length of postoperative hospital stay.

Introduction

The incidence of cholelithiasis has been reported to be high in gastrectomy patients [1–3]. A vagotomized gallbladder or altered response to and secretion of cholecystokinin have been suggested as underlying pathophysiologies [4–6]. There is some debate about the appropriate management of these conditions, and some authors have suggested performing prophylactic cholecystectomy for these patients [7–9]. However, the incidence of a future need for cholecystectomy after upper gastrointestinal surgery has been reported to be as low as 1–7% in some prospective studies [2, 3, 10–12]. Moreover, laparoscopic cholecystectomy has been safely performed in patients with previous upper abdominal surgery [13–16]. For these reasons, prophylactic cholecystectomy during a gastrectomy procedure is generally not recommended [17, 18].

Although the need for cholecystectomy after gastrectomy is rare, the patient for whom it is indicated frequently suffers from unique problems. First, there may be significant adhesion around Calot's triangle, especially when lymph node dissection has been performed for stomach cancer. Second, chronic nutritional insufficiency induced by a previous gastrectomy decreases intra-abdominal fat, which may

J. Kim · J. N. Cho · S. H. Joo · B. S. Kim · S. M. Lee (✉)
Department of Surgery, School of Medicine, Kyung Hee
University, 26 Kyunghee-daero, Dongdaemun-gu,
Seoul 130-701, Korea
e-mail: hbplapa@khu.ac.kr

improve surgical accessibility but also may affect the recovery of a patient after the surgery [19]. Third, intestinal reconstruction after gastrectomy may interfere with access to the common bile duct (CBD) via endoscopic retrograde cholangiopancreatography (ERCP) [20]. A few groups have reported outcomes of laparoscopic cholecystectomy after gastrectomy [15, 16, 21, 22]. However, factors that may increase operation time, length of hospital stay, or complication rates of cholecystectomy after gastrectomy have not yet been reported. The purpose of this study was to identify factors related to surgical difficulties and outcome using multivariable analyses.

Patients and methods

Among the 2,401 patients who underwent a cholecystectomy at Kyung Hee University Medical Center between January 2000 and July 2010, 58 patients (2.4%) who had a history of a previous gastrectomy were included in this study. The median follow-up period time was 59 (range 2–180) months. Characteristics of our study group are summarized in Table 1. Twenty-four patients underwent open cholecystectomy (OC), and 34 patients underwent laparoscopic cholecystectomy (LC). The mean age of our study participants was 61.5 ± 10.2 years, and we had twice as many male patients ($n = 40$, 69%) as female patients ($n = 18$, 31%). As with other gastrectomy subjects, body mass index (BMI) was lower than normal (21.2 ± 2.7 kg/m²). The mean interval between gastrectomy and cholecystectomy was 11.2 ± 9.1 years. The most common indication of gastrectomy was stomach cancer (40 patients, 69%), whereas others included benign diseases, such as peptic ulcer disease. Total gastrectomy had been performed on 19 patients (32.8%), and the Billroth II operation was more common ($n = 27$, 46.6%) than was the Billroth I operation ($n = 11$, 19%) among partial gastrectomy patients.

The effects of various factors may be related to the period in which the operation was performed. To further analyze this relationship, we divided our study period into the period before 2006, and the period after 2006 based on the fact that laparoscopic cholecystectomies and laparoscopic common bile duct explorations were more frequently performed in the later period (15.4 vs. 93.8%; $P < 0.001$, and 22.2 vs. 87.5%; $P = 0.015$, respectively).

Overall, laparoscopic surgical procedures were performed for 34 patients (58.6%), 1 of whom underwent open conversion due to dense adhesions around Calot's triangle. Acute cholecystitis was present in 33 patients (56.9%) and acute cholangitis was present in 20 (34.5%). Previous percutaneous transhepatic biliary drainage (PTBD) had been performed in three patients (5.2%), and six (10.3%) had undergone previous percutaneous transhepatic gallbladder drainage (PTGBD). To

clear CBD stones, ERCP was attempted before cholecystectomy in eight patients (13.8%), but was successful in only one. We performed surgical CBD exploration in 17 patients (29.3%), including 9 cases (15.5%) of laparoscopic CBD exploration. When laparoscopic CBD exploration was indicated, choledochotomy and choledochoscopic investigation and stone removal followed by T-tube placement were performed. Duct clearance was successful in all patients who underwent surgical CBD exploration, and no residual or recurrent stones were identified after the procedure.

Mean operation time was 151.7 ± 79.8 min, and patients resumed a soft diet in 3.1 ± 2.5 days. Patients remained in the hospital for 7.6 ± 7.2 days. Complications were identified in 11 patients (19%), with the most common being intraoperative bowel injury during adhesiolysis. We postulated that operation time represented technical difficulty during the surgical procedure, duration of hospital stay represented patient comfort, and complication rate represented the risks associated with the operation. We designated these three variables as dependent variables, and we conducted analyses to identify factors that would predict technical difficulty, patient discomfort, and complications of the operation. For multivariable analyses, all clinically important variables were analyzed; however, apparently related variables were carefully merged to avoid multicollinearity. We performed multivariable analysis by using following variables: CBD exploration, laparoscopic surgery, gender, acute cholecystitis, history of stomach cancer, age, BMI, period in which the cholecystectomy was performed, and the interval between gastrectomy and cholecystectomy.

Continuous variables were summarized with means and standard deviations, for which frequencies and percentages were used for categorical variables. Student's *t* test and the χ^2 test were used to compare various demographic, clinical, and laboratory variables to the three dependent variables of operation time, hospital stay, and the presence of complications. Mean values of operation time (152 min) and hospital stay (7.6 days) were used to divide the patients into subgroups (Table 2). Multivariable logistic regression analysis was conducted to identify independent factors that would predict the three dependent variables. The results are presented as adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for each of the three dependent variables. All statistical analyses were conducted by using SPSS[®] 13.0 (SPSS, Inc., Chicago, IL), and $P < 0.05$ was considered statistically significant.

Results

To overview the basic data, we subdivided the patients into OC group and LC group (Table 1). The male patients were more dominant in OC group ($P = 0.002$). However, age,

Table 1 Baseline characteristics

	Total (n = 58)	Open (n = 24)	Laparoscopic (n = 34)	P value
Demographics				
Age (years)	61.5 ± 10.2	61.96 ± 9.54	61.15 ± 10.71	0.768
Gender				0.002
Male	40 (69.0)	22 (91.7)	18 (52.9)	
Female	18 (31.0)	2 (8.3)	16 (47.1)	
Body mass index (kg/m ²)	21.2 ± 2.7	21.39 ± 3.14	21.05 ± 2.38	0.644
ASA score	2.9 ± 1.3	3.20 ± 1.64	2.87 ± 1.31	0.617
Gastrectomy				
Interval between gastrectomy and cholecystectomy (years)	11.2 ± 9.1	11.45 ± 9.98	11.09 ± 8.52	0.884
Indication of gastrectomy				0.041
Stomach cancer	40 (69.0)	13 (54.2)	27 (79.4)	
Benign disease	18 (31.0)	11 (45.8)	7 (20.6)	
Type of gastrectomy and reconstruction				0.21
Total gastrectomy and Roux-en-Y esophagojejunostomy	19 (32.8)	5 (20.8)	14 (41.2)	
Billroth I	11 (19.0)	4 (16.7)	7 (20.6)	
Billroth II	27 (46.6)	14 (58.3)	13 (38.2)	
Esophagocolonogastrostomy	1 (1.7)	1 (4.2)	0 (0)	
Laboratory data				
Total bilirubin (mg/dL)	1.4 ± 1.3	1.26 ± 1.28	1.58 ± 1.33	0.373
Alkaline phosphatase (U/L)	126.6 ± 124.9	100.75 ± 50.92	144.85 ± 155.87	0.188
Alanine aminotransferase (U/L)	75.1 ± 139.2	32.88 ± 18.22	104.88 ± 176.08	0.024
Aspartate aminotransferase (U/L)	70.7 ± 126.8	37.04 ± 40.44	94.53 ± 158.78	0.05
Gamma-glutamyl transpeptidase (U/L)	116.2 ± 152.3	77.13 ± 95.16	142.59 ± 177.57	0.112
Cholecystectomy				
Operation time (min)	151.7 ± 79.8	157.92 ± 74.19	147.35 ± 84.28	0.624
Later period (2006–2010)	32 (55.2)	2 (8.3)	30 (88.2)	<0.001
Laparoscopic surgery	34 (58.6)	–	–	
Open conversion	–	–	1 (2.9%)	
Indication of cholecystectomy				
Acute cholecystitis	33 (56.9)	15 (62.5)	18 (52.9)	0.469
Acute cholangitis	20 (34.5)	8 (33.3)	12 (35.3)	0.877
Symptoms	49 (84.5)	19 (79.2)	30 (88.2)	0.467
PTBD before cholecystectomy	3 (5.2)	1 (4.2)	2 (5.9)	1
PTGBD before cholecystectomy	6 (10.3)	4 (16.7)	2 (5.9)	0.22
ERCP before cholecystectomy	8 (13.8)	3 (12.5)	5 (14.7)	1
CBD exploration	17 (29.3)	8 (33.3)	9 (26.5)	0.572
Outcome				
Diet resumption (soft diet, days)	3.1 ± 2.5	4.75 ± 1.65	1.91 ± 2.37	<0.001
Postoperation hospital stay (days)	7.6 ± 7.2	10.42 ± 5.60	5.53 ± 7.55	0.009
Complications	11 (19.0)	8 (33.3)	3 (8.8)	0.038
Intraoperative bowel injury	5 (8.6)	2(8.3)	3 (8.8) ^a	
Postoperative bile leak	1 (1.7)	1(4.2)	0 (0)	
Wound infection	3 (5.2)	3(12.5)	0 (0)	
Abscess formation	1 (1.7)	1(4.2)	0 (0)	
Pneumonia	1 (1.7)	1(4.2)	0 (0)	

Numbers are presented as means ± standard deviations or frequencies (percentages), as appropriate

Bold values indicate statistical significance ($P < 0.05$)

PTBD percutaneous transhepatic biliary drainage; PTGBD percutaneous transhepatic gallbladder drainage; ERCP endoscopic retrograde cholangiopancreatography; CBD common bile duct

^a Including one patient of enterocutaneous fistula developed after laparoscopic surgery (See text)

Table 2 Differences between subgroups according to operation time, the length of postoperative hospital stay, and the presence of complications

	Operation time ^a		Hospital stay ^a		Complications	
	Short (<i>n</i> = 34)	Long (<i>n</i> = 24)	Short (<i>n</i> = 39)	Long (<i>n</i> = 19)	None (<i>n</i> = 47)	Present (<i>n</i> = 11)
Operation time (min)	NA	NA	140.0 ± 77.8	175.8 ± 80.4	145.6 ± 82.4	177.7 ± 64.3
Diet resumption (days)	2.3 ± 2.2	4.2 ± 2.5[‡]	2 ± 1.7	5.3 ± 2.5[‡]	2.5 ± 2	5.8 ± 2.8[‡]
Hospital stay (days)	5.2 ± 4.5	10.8 ± 8.9[‡]	NA	NA	5.4 ± 3.4	16.7 ± 11.2[‡]
Age (years)	60.2 ± 10.3	63.3 ± 9.8	60.6 ± 10	63.3 ± 10.5	60.9 ± 9.9	64 ± 11.6
Body mass index (kg/m ²)	21.4 ± 2.5	20.9 ± 3.0	21.4 ± 2.7	20.8 ± 2.8	21.5 ± 2.7[‡]	19.7 ± 2.1
Interval (years) ^b	11.4 ± 9.6	11.0 ± 8.5	11.9 ± 8.9	9.9 ± 9.4	12.5 ± 9.3[‡]	5.8 ± 5.7
ASA score	2.7 ± 1.2	3.2 ± 1.6	2.9 ± 1.3	3 ± 1.5	3 ± 1.4	2.3 ± 0.6
Bilirubin (mg/dL)	1.1 ± 0.7	2 ± 1.7[‡]	1.6 ± 1.4	1.2 ± 1	1.5 ± 1.4	1.1 ± 0.9
ALP (U/L)	90.8 ± 35.3	177.4 ± 179.6[‡]	132.7 ± 138.9	114.1 ± 91.5	133.9 ± 136.6	95.4 ± 42.1
AST (U/L)	56.7 ± 72.8	101.1 ± 197.9	80 ± 139.7	65 ± 141.3	83.8 ± 153	37.8 ± 27.5
ALT (U/L)	56.1 ± 86.2	91.5 ± 168.5	83.6 ± 145.4	44.4 ± 71.7	83.0 ± 138.1[‡]	18.4 ± 12.5
GGT (U/L)	72.2 ± 92.6	176.6 ± 194.8[‡]	134.6 ± 169.7	79.4 ± 103.8	133.2 ± 163.2[‡]	45.2 ± 56.4
Complications	4 (11.8)	7 (29.2)	2 (5.1)	9 (47.4)[‡]	NA	NA
Gender (male)	20 (58.8)	20 (83.3)	24 (61.5)	16 (84.2)	30 (63.8)	10 (90.9)
Later period	22 (64.7)	10 (41.7)	27 (69.2)[‡]	5 (26.3) [‡]	28 (59.6)	4 (36.4)
History of stomach cancer	23 (67.6)	17 (70.8)	27 (69.2)	13 (68.4)	30 (63.8)	10 (90.9)
Previous total gastrectomy	9 (26.5)	10 (41.7)	15 (38.5)	4 (21.1)	16 (34)	3 (27.3)
PTBD	0 (0)	3 (12.5)	2 (5.1)	1 (5.3)	3 (6.4)	0 (0)
PTGBD	3 (8.8)	3 (12.5)	3 (7.7)	3 (15.8)	4 (8.5)	2 (18.2)
ERCP	3 (8.8)	5 (20.8)	5 (12.8)	3 (15.8)	6 (12.8)	2 (18.2)
Acute cholecystitis	14 (41.2)	19 (79.2)[‡]	20 (51.3)	13 (68.4)	23 (48.9)	10 (90.9)[‡]
Acute cholangitis	7 (20.6)	13 (54.2)[‡]	14 (35.9)	6 (31.6)	17 (36.2)	3 (27.3)
Presence of symptoms	26 (76.5)	23 (95.8)	33 (84.6)	16 (84.2)	38 (80.9)	11 (100)
CBD exploration	2 (5.9)	15 (62.5)[‡]	11 (28.2)	6 (31.6)	15 (31.9)	2 (18.2)
Laparoscopic surgery	22 (64.7)	12 (50)	30 (76.9)[‡]	4 (21.1)	31 (66)[‡]	3 (27.3)

Numbers are presented as means ± standard deviations or frequencies (percentages), as appropriate

Bold values indicate statistical significance ($P < 0.05$)

NA not applicable; ASA American Society of Anesthesiologists; ALP alkaline phosphatase; AST aspartate aminotransferase; ALT alanine aminotransferase; GGT gamma-glutamyl transpeptidase; PTBD percutaneous transhepatic biliary drainage; PTGBD percutaneous transhepatic gallbladder drainage; ERCP endoscopic retrograde cholangiopancreatography; CBD common bile duct

^a Shorter or longer than mean values (operation time, 152 minutes; hospital stay, 7.6 days)

^b Interval between gastrectomy and cholecystectomy

[‡] A significantly higher value after statistical analysis

body mass index, ASA score, indications of gastrectomy, and type of gastrectomy procedures were not significantly different between OC patients and LC patients. Among the laboratory data, alanine aminotransferase (ALT) was significantly higher in LC patients. Indications of cholecystectomy were not significantly different, and preoperative and intraoperative management of gallstones, namely PTBD, PTGBD, ERCP, and CBD exploration were not significantly different between groups. LC patients showed earlier diet resumption ($P < 0.001$) and shorter hospital stay ($P = 0.009$) and lower incidence of complications ($P = 0.038$).

Subgroup analyses were performed according to operation time, length of postoperative hospital stay, and the

presence of complications (Table 2). We first divided the patients into two groups according to the operation time of cholecystectomy: those with a “short” operation time (mean operation time ≤ 152 min; $n = 34$) and those with a “long” operation time (> 152 min; $n = 24$). We found that diet resumption and discharge from the hospital were delayed in the long operation time group (4.2 vs. 2.3 days and 10.8 vs. 5.2 days, respectively; $P < 0.05$), whereas gender, BMI, and the interval between gastrectomy and cholecystectomy were not significantly related to operation time. Acute cholecystitis and acute cholangitis were more frequently combined in the long operation time group (79.2 vs. 41.2% and 54.2 vs. 20.6%, respectively; $P < 0.05$). CBD exploration was more frequently performed in the

Table 3 Multivariable analyses according to operation time, length of postoperative hospital stay, and the presence of complications

	Operation time ^a			Hospital stay ^a			Complications		
	Adjusted OR	95% CI	<i>P</i> value	Adjusted OR	95% CI	<i>P</i> value	Adjusted OR	95% CI	<i>P</i> value
CBD exploration	45.15	(4.53–450.55)	0	0.937	(0.2–4.32)	0.93	0.13	(0.01–3.03)	0.2
Laparoscopic surgery	11.6	(0.42–320.53)	0.15	0.057	(0.004–0.74)	0.03	0.03	(0.001–1.85)	0.1
Gender (male)	5.47	(0.45–66.97)	0.18	1.256	(0.17–9.09)	0.82	16.37	(0.32–827.66)	0.16
Acute cholecystitis	14.66	(1.46–147.4)	0.02	1.864	(0.44–7.92)	0.4	27.68	(1.15–666.24)	0.04
History of stomach cancer	0.67	(0.04–10.69)	0.77	1.122	(0.11–11.48)	0.92	0.29	(0.003–30.43)	0.6
Age	1.01	(0.92–1.1)	0.92	1.03	(0.96–1.11)	0.43	1.03	(0.92–1.15)	0.66
BMI	0.83	(0.56–1.14)	0.25	0.854	(0.65–1.13)	0.27	0.41	(0.20–0.87)	0.02
Later period	0.08	(0.002–2.82)	0.16	1.241	(0.1–15.49)	0.87	10.24	(0.23–461.52)	0.23
Interval ^b	0.98	(0.87–1.11)	0.77	0.969	(0.87–1.08)	0.57	0.75	(0.53–1.05)	0.1

Bold values indicate statistical significance ($P < 0.05$)

CBD common bile duct; BMI body mass index

^a Shorter or longer than mean values (operation time, 152 minutes; hospital stay, 7.6 days)

^b Interval between gastrectomy and cholecystectomy

long operation time group (62.5 vs. 5.9%; $P < 0.05$); however, laparoscopic surgery was not significantly related to a long operation time.

We also divided the patients into two groups according to the length of postoperative hospital stay: those with a “short” stay (\leq mean value of 7.6 days; $n = 39$) and those with a “long” stay (>7.6 days, $n = 19$). We found that operation time, BMI, and the interval between gastrectomy and cholecystectomy were not significantly related to length of postoperative hospital stay. Diet resumption occurred earlier in the short hospital stay group and the complication rate was higher in the long hospital stay group (2.0 vs. 5.3 days and 5.1% vs. 47.4%, respectively; $P < 0.05$). Patients who underwent surgery during the later period (post-2006) were more commonly in the short hospital stay group (29.2 vs. 26.3%; $P < 0.05$). The presence of acute inflammatory pathology, namely acute cholecystitis or acute cholangitis, was not significantly related to the duration of hospital stay. Likewise, CBD exploration, a factor that significantly increased operation time, was not an important factor in predicting the duration of hospital stay. Patients who underwent laparoscopic surgery, however, were more frequently in the short hospital stay group (76.9 vs. 21.1%; $P < 0.05$).

Eleven patients experienced intraoperative or postoperative complications (19%). We found that diet resumption and discharge from the hospital were delayed in this complications group (2.5 vs. 5.8 days and 5.4 vs. 16.7 days, respectively; $P < 0.05$), and patients who experienced complications had a lower BMI (21.5 vs. 19.7 kg/m²; $P < 0.05$). In addition, the interval between gastrectomy and cholecystectomy was shorter in the complications group (12.5 vs. 5.8 years;

$P < 0.05$), which also included a greater number of acute cholecystitis patients (48.9 vs. 90.9%; $P < 0.05$), although the occurrence of acute cholangitis was not affected. CBD exploration did not increase the likelihood of complications, and laparoscopic surgery was performed less frequently on members of the complications group (66 vs. 27.3%; $P < 0.05$).

We conducted multivariable analyses to identify independent predictors of longer operation time, longer hospital stay, and increased complications (Table 3). For operation time, the need for CBD exploration was the most significant factor (adjusted OR, 45.15; 95% CI, 4.53–450.55), followed by the presence of acute cholecystitis (adjusted OR, 14.66; 95% CI, 1.46–147.4). A laparoscopic approach, however, was not a significant factor related to operation time. Moreover, a laparoscopic approach was the only factor related to the duration of hospital stay, significantly decreasing the duration of hospital stay (adjusted OR, 0.057; 95% CI, 0.004–0.74). Acute cholecystitis was independently related to the occurrence of complications (adjusted OR, 27.68; 95% CI, 1.15–666.24), and a lower BMI also was an independent predictor of complications (adjusted OR, 0.41; 95% CI, 0.2–0.87). Neither the period during which the cholecystectomy was performed nor the interval between gastrectomy and cholecystectomy was shown to be independently associated with any of the above variables.

Discussion

In 2008, 16,448 gastrectomies were performed in the Republic of Korea, compared with 38,039 cholecystectomies [23]. When cholecystectomy is indicated for a patient

with a history of gastrectomy, we can perform either an open or laparoscopic approach; if there are CBD stones, they can be treated by preoperative ERCP or intraoperative CBD explorations. We tried to find the better approach for these patients.

The usefulness of laparoscopic CBD exploration in general patients without history of gastrectomy has been reported, with success rates in the range of 93.3–100% [24–26]. As a result, a single-stage approach without attempting ERCP has been suggested [27, 28]. Moreover, previous gastrectomy has been reported as a reason for failed endoscopic extraction using ERCP [20]. Among the 20 patients diagnosed as combined CBD stones, two spontaneously passed the CBD stones. ERCP was attempted in eight subjects, but successful CBD clearance was achieved in only one patient. Among the eight patients, the previous stomach surgeries were total gastrectomy in three cases and Billroth-II operation in four cases. This higher incidence of complex bowel reconstruction may explain the low success rate of duct clearance by ERCP. Meanwhile, ERCP is not a benign procedure; complications, such as bleeding, pancreatitis, duodenal perforation, and papillotomy stenosis, are not uncommon [28, 29]. One of our patients also experienced small-bowel perforation during the ERCP procedure. One report states that laparoscopic CBD exploration is a feasible approach for post-gastrectomy patients [30]. In our series, no recurrent stones were identified after operative CBD exploration during the follow-up period; however, two subjects showed CBD stricture and underwent ballooning and stent insertion, respectively. Our results also suggest the advantage of a single-stage approach for the management of CBD stones after gastrectomy, and we now believe that laparoscopic exploration should be the initial approach for gastrectomy patients with CBD stones.

Laparoscopic cholecystectomy has been suggested as a feasible approach for acute cholecystitis [31, 32], and it was our preferred method, especially during the later period of our study. Combined acute cholecystitis may increase the incidence of complications [33] and may worsen the anatomical orientation that has already been disturbed by previous gastrectomy. The proportion of patients with acute cholecystitis (56.9%) was higher than normal in our study population. We postulated that cholelithiasis patients with a history of gastrectomy were managed more conservatively, and the proportion of more critical patients who could not avoid cholecystectomy, such as subjects with CBD stones or acute cholecystitis, might have been increased in this group. As we expected, two factors—CBD exploration and acute cholecystitis—resulted in increased operation time, which represented technical difficulties. Preoperative ALT level was higher in the noncomplication group than in the complication group

(Table 2). Meanwhile, preoperative ALT level was significantly higher in the laparoscopic surgery group than in the open surgery group (Table 1). As the complication rate was lower in laparoscopic surgery group than in open surgery group, ALT level in patients without complication might be paradoxically higher.

Acute cholecystitis was an independent predictor of complications, but CBD exploration was not. The results of this study showed that a laparoscopic approach did not increase operation time and significantly decreased the length of hospital stay. We also found that lower BMI was an independent predictor of complications. This may be a unique feature in this population, and more data are necessary to reveal the underlying mechanisms, such as chronic nutritional insufficiency. The most common complication was the bowel injury, which occurred both in open (2 cases) and laparoscopic (3 cases) approaches. Among three laparoscopic cases, one patient underwent open conversion, and two were managed by laparoscopic repair of the injury. Of note, one patient who underwent laparoscopic repair of the bowel injury developed enterocutaneous fistula, which was cured by conservative management. It has been reported that the type of incision used in previous abdominal surgery is related to the outcome of laparoscopic cholecystectomy [21]. We infer that gastrectomy via minimally invasive surgery may improve outcomes in future reoperations for cholecystectomies. The mean interval between gastrectomy and cholecystectomy was 11.2 years in our series. In Korea, the laparoscopic gastrectomy was not widely accepted until a few years ago. Although only one of our study subjects underwent laparoscopy-assisted distal gastrectomy, we think that the role of minimal invasive surgery in gastrectomy will increase in the near future as laparoscopy-assisted distal gastrectomy gains popularity for the treatment of early gastric cancer [34].

In summary, cholecystectomy after gastrectomy requires a longer operation time in patients who need CBD exploration and in patients with acute cholecystitis. The presence of acute cholecystitis and a lower BMI may increase the rate of complications. A laparoscopic approach is feasible and does not increase operation time or complication rates and decreases the length of hospital stay after surgery. Laparoscopy is a feasible initial approach for cholecystectomy after gastrectomy even in the presence of common bile duct stones or acute cholecystitis.

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