



Laparoscopic cholecystectomy in patients with previous upper midline abdominal surgery: comparison of laparoscopic cholecystectomy after gastric surgery and non-gastric surgery using propensity score matching

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Abstract

Background Previous upper midline abdominal surgery is a reported relative contraindication to laparoscopic cholecystectomy. We aimed to investigate the effects of previous upper abdominal surgery on the feasibility and safety of laparoscopic cholecystectomy; we evaluated the effects of the previous upper abdominal surgery type on laparoscopic cholecystectomy with respect to complications and conversion to open surgery.

Methods We prospectively evaluated 1,258 patients who underwent laparoscopic cholecystectomy, including those who underwent upper midline abdominal surgery previously, at a single tertiary referral center. The perioperative and postoperative outcomes—open conversion rate, operation time, intraoperative and postoperative complications, and length of hospital stay—were evaluated. Patients were grouped according to the previous surgical method into the gastric ($n=77$), non-gastric ($n=40$), and control ($n=1141$) groups. Patients in the gastric + non-gastric groups ($n=117$) were 1:1 matched with those in the control group ($n=117$) using propensity score matching (PSM).

Results Before PSM, age, sex, open conversion rate, gallbladder status, port number, overall morbidity, and postoperative hospital stay duration did not significantly differ between the gastric and non-gastric groups; the body mass index (22.3 ± 3.4 versus 24.1 ± 3.8 kg/m², $p=0.009$) and operation time (129.9 ± 63.6 versus 97.9 ± 51.1 min, $p=0.004$) significantly differed. After PSM, age, sex, body mass index, and American Society of Anesthesiology score did not significantly differ between gastric + non-gastric ($n=117$) and conventional groups ($n=117$; the operation time (118.9 ± 61.3 versus 75.8 ± 37.1 min, $p<0.001$), open conversion rate ($n=6$, 5.1% versus $n=0$, 0.0%, $p=0.013$), port number, overall morbidities ($n=26$, 22.2% versus $n=10$, 8.5%, $p=0.004$), and postoperative hospital stay duration (6.7 ± 4.3 versus 5.5 ± 3.2 days, $p=0.031$) significantly differed.

Conclusion Previous upper midline abdominal surgery was not contraindicated to safe laparoscopic cholecystectomy. Patients with previous upper midline abdominal surgery undergoing laparoscopic cholecystectomy should be informed preoperatively of the probability of conversion to open surgery, lengthened duration, and associated morbidities.

Keywords Cholecystectomy · Adhesion · Complication · Open conversion · Gastrectomy · Laparoscopic

Laparoscopic cholecystectomy (LC) is the most frequently performed type of biliary surgery. LC has become the standard treatment for symptomatic gallbladder stones, acute or chronic cholecystitis, and gallbladder polyps. Due to an

increase in the frequency of abdominal surgeries, the number of cases where LC is performed in patients with a history of abdominal surgery has correspondingly increased [1, 2]. Some patients undergoing LC require conversion to open surgery due to severe inflammation, bleeding, injury to other organs, or severe adhesion. Several studies have reported that previous surgery in the upper abdomen is an important risk factor for conversion to open cholecystectomy [2–4].

The upper midline incision can be categorized as operations related to the stomach and non-gastric operations. A

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previous study did not observe significant differences in blood loss, open conversion rate, and rate of intraoperative bile duct injury between groups with and without gastrectomy history [1]. On the other hand, Ercan et al. reported that the group with both upper abdominal incision and gastrectomy had more adhesions in the upper abdomen than the group with lower abdominal incisions. As a result, the former group had a much higher rate of conversion to open surgery [2]. In addition, previous diagnosis and patient demographics may differ among those undergoing LC without abdominal surgery, and few studies have compared conventional LC patients in terms of surgical outcomes of postoperative morbidity, operation time, length of hospital stay and open conversion rate by dividing the patients who underwent upper midline incision into two groups [2].

Although previous abdominal operations can cause increased morbidity and prolong hospital stay, the advantages of LC as compared to open cholecystectomy encourage most surgeons to try and complete the operation successfully [5, 6].

Therefore, this study aimed to investigate the effects of previous upper abdominal surgery on the feasibility and safety of laparoscopic cholecystectomy. We also aimed to investigate the effects of the type of previous upper abdominal surgery on laparoscopic cholecystectomy in terms of surgical outcomes, including surgery-related morbidities, operation time, length of hospital stay, and rate of open conversion.

Material and methods

Study design

In this retrospective study, we reviewed 1,258 patients who underwent LC for acute or chronic cholecystitis and/or gallbladder polyps at a single tertiary referral center between March 2012 and December 2019. Patients requiring open surgery due to suspected advanced gallbladder cancer or accompanying surgery in other organs were excluded. Of 1,258 patients, 117 had previously undergone upper midline abdominal surgery; 77 underwent gastric surgery with an upper midline incision (13 patients underwent total gastrectomy; 13 patients, distal gastrectomy Billroth-I; 34 patients, distal gastrectomy Billroth-II; and 17 patients, primary repair of gastric or duodenal ulcer perforation), 40 underwent non-gastric surgery with an upper midline incision (11 patients underwent right hemicolectomy; 15 patients, small bowel segmental resection; three patients, bleeding control of trauma; three patients, splenectomy; four patients, adhesiolysis of the small bowel; and four patients, nephrectomy), and 1141 had no previous surgical history.

The data regarding the perioperative and postoperative outcomes, including open conversion rate, operation time, intraoperative and postoperative complications, and hospital stay duration were prospectively collected and evaluated. The patients were categorized into the following three groups according to the previous surgical method: gastric group ($n=77$), non-gastric group ($n=40$), and control group ($n=1141$). Using propensity score matching (PSM), Patients in the gastric + non-gastric groups ($n=117$) were matched with those in the control group ($n=117$) in a 1:1 ratio with respect to the baseline characteristics, such as age, sex, body mass index (BMI), American Society of Anesthesiology (ASA) classification, and gallbladder status.

Patients were included if they satisfied the following criteria: age 20–85 years and diagnosis of acute or chronic cholecystitis and/or gallbladder polyp. Patients were excluded for the following reasons: diagnosis of malignant neoplasm of the gallbladder, diagnosis of common bile duct stones, history of low midline incision, and open cholecystectomy.

The study was approved by the Institutional Review Board (IRB) of Gachon University Gil Medical Center (IRB Number: GCIRB2020-320).

Procedural details of laparoscopic cholecystectomy

Most operations for acute cholecystitis were performed within 24 or 48 h. If cardiovascular or cerebrovascular evaluations such as echocardiography or coronary angiography were necessary before performing the operation due to comorbidities including angina or history of stroke, the LC was performed after the examinations. Percutaneous transhepatic gallbladder drainage (PTGBD) was performed as needed before cholecystectomy when surgery was postponed due to these tests or when the patients showed symptoms of severe inflammation including septic shock due to cholecystitis.

LC was performed by a single experienced surgeon with a first assistant and a laparoscopy assistant. Simple LC was performed using three ports (Fig. 1A). First, the skin was incised by creating a transverse semicircular incision under the umbilicus. The fascia and peritoneum were then opened using an open method, and pneumoperitoneum was created by inserting a 12-mm port. Under direct observation using a telescope inserted through the subumbilical port, a second 5-mm port was placed in the subxiphoid area and a third 5-mm port was placed on the midclavicular line of the right upper quadrant of the abdomen. Finally, LC was performed using the appropriate instrument.

If the patient had a history of upper midline abdominal operation (Fig. 1B), a pneumoperitoneum was provided by inserting a 12 mm port through the fascia and peritoneum using the open technique of vertical incision at an extended line, where the upper midline incision ends below the umbilicus (Fig. 2A). The severity of adhesion

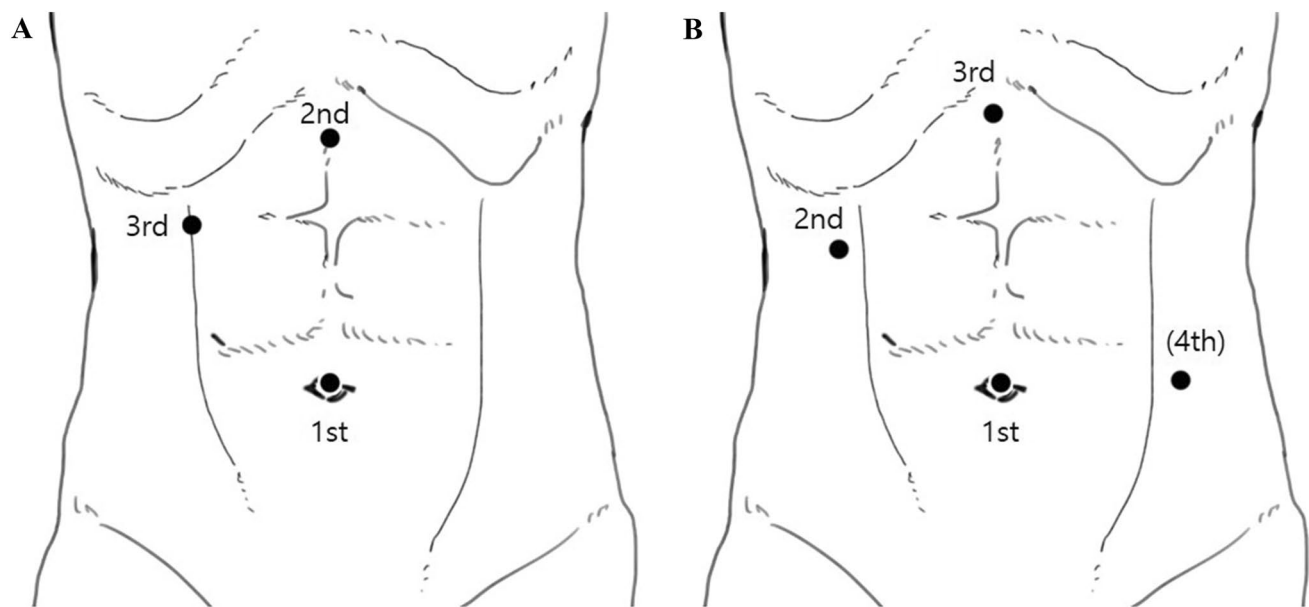


Fig. 1 Laparoscopic working port locations for laparoscopic cholecystectomy. **A** Laparoscopic working port location for conventional laparoscopic cholecystectomy. **B** Modified laparoscopic working port

location for laparoscopic cholecystectomy in patients with a history of upper midline abdominal incision

in the peritoneal cavity was evaluated by inserting a telescope, (Fig. 2B). If there was no free space in the subxiphoid area due to the previous operation (most common adhesion site was beneath the midline wound), we inserted a second 5-mm port in any free space of the abdominal cavity to perform adhesiolysis (Fig. 2C). Adhesiolysis was attempted using endoscissors or other energy device instruments through the second 5-mm port (Fig. 2D). The omentum and/or small intestine, which usually adheres to the abdominal wall along the upper abdominal incisional scar, can be removed and thus, we were able to create space for the third 12-mm port in the subxiphoid area by dissecting at the site of adhesion (Fig. 2E, F).

If adhesions of the transverse colon and/or small intestine was observed throughout the right upper abdominal cavity and gallbladder, we additionally inserted 5-mm or 12-mm ports for the first assistant in the left lower abdomen or central site. Following this, the colon and small intestine were dissected using the endograsp and endoscissors with both hands. Using the procedure described above, existing cholecystectomy was performed for a subsequent operation for a subsequent operation. After completing the surgery, a closed suction drain was implanted in all the patients using a 5-mm port. The drain was inserted with the aim to diagnose potential organ injuries that may have occurred after adhesiolysis early on. If the drain content was not turbid, did not have bilious or bloody content, and measured less than 50 cc after at least one postoperative day, then the drain was removed.

Main outcomes

The main outcomes of this study were overall morbidity rate and open conversion rate. The secondary outcomes were length of postoperative hospital stay, operation time, morbidity of Clavien-Dindo grade IIIa or worse, and re-admission within 30 days.

Data extraction

The data on the following parameters were collected from each patient: demographic characteristics, including age, sex, preoperative BMI, ASA score, gallbladder status, adhesion status, laparoscopic port number, operation time, open conversion rate, duration of hospitalization, postoperative morbidities, and re-admission within 30 days. To assess the postoperative morbidity rate, all events that occurred during the same hospital stay and within 30 days of operation were analyzed. Postoperative morbidities were recorded as per the Clavien-Dindo classification system [7]. All patients were assessed preoperatively by anesthesiologists using the ASA classification [8]. Conversion to open surgery was counted during the operation, depending on the surgeon.

Gallbladder status was assessed during the operation by the surgeon using three categories: symptomatic gallbladder stone or gallbladder polyp (no inflammatory changes), acute or chronic cholecystitis (inflammatory changes localized to the gallbladder, wall thickening, distention), and gangrenous gallbladder (distended gallbladder with pus or

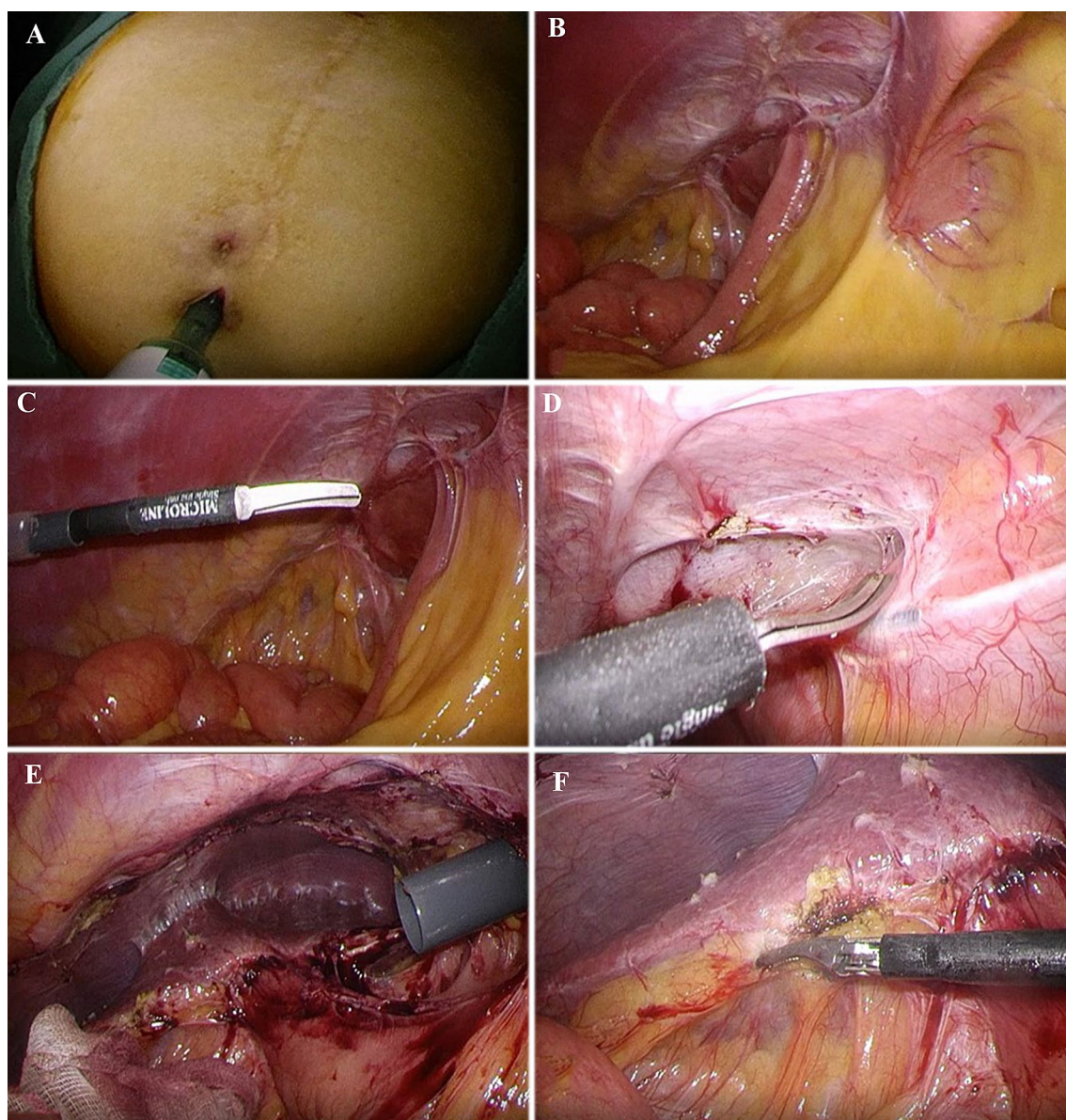


Fig. 2 Procedure details of laparoscopic cholecystectomy in a patient with upper midline incision. **A** A 12-mm port is inserted below the umbilicus using an open technique. **B** By inserting a telescope, the severity of adhesion in the peritoneal cavity is evaluated. **C** The second 5-mm port is inserted in any free space in the abdominal cavity to perform adhesiolysis. **D** Adhesiolysis is attempted using endoscis-

sors or other energy device instruments inserted through the second 5-mm port. **E** The omentum and/or small intestine, which usually adheres to the abdominal wall along the upper abdominal incisional scar, can be removed and space can be made for the third 12-mm port in the subxiphoid area by dissecting the adhered site. **F** Operating adhesiolysis around the gallbladder via the third 12-mm port

hydrops, necrosis or gangrene of wall, and/or perforation of gallbladder wall), based on the American Association for the Surgery of Trauma (AAST) cholecystitis severity scale [9]. Adhesion status was also assessed during the operation by the surgeon using three categories as per the Parkland grading scale for cholecystitis: normal or mild (no adhesion present or adhesions restricted to the neck or lower on the gallbladder), moderate (adhesions to the body, partial visualization of the gallbladder), and severe (inability to

visualize the gallbladder due to adhesions) [10]. One to five laparoscopic ports were used, depending on the operation.

Statistical analysis

Propensity scores were generated using baseline characteristics, including sex, age, ASA Score, BMI, and gallbladder status. For PSM, the Student's *t*-tests and χ^2 test were used for continuous variables and categorical

variables, respectively, to analyze and compare the baseline characteristics. After PSM, preoperative, intraoperative, and postoperative outcomes, such as open conversion rate, surgery-related morbidity, and length of postoperative hospital stay were compared using the paired *t*-test or Wilcoxon signed-rank test for continuous variables and the McNemar's test for categorical variables. PSM was performed using SAS v9.3 (SAS Institute Inc., Cary, NC, USA). Other statistical analyses after PSM were performed using SPSS v22.0 (SPSS Inc., IBM Company, Chicago, IL, USA). All *p* values were two-sided, and $p < 0.05$ was considered statistically significant.

Results

Patient demographics before propensity score matching

The demographic and clinical characteristics of the patients before PSM are listed in Table 1. The mean age was 55.9 ± 16.2 years, and 650 (51.7%) patients were men. Significant differences were observed with respect to the age, sex ratio, preoperative BMI, and ASA physical status between the gastric and control groups and the non-gastric and conventional groups. No significant difference was observed with respect to the age, sex ratio, and ASA physical status between the gastric and non-gastric groups. Significant differences were observed with respect to the preoperative BMI (22.3 ± 3.4 versus 24.1 ± 3.8 kg/m², $p = 0.009$) between the gastric and non-gastric groups.

Intraoperative outcomes before propensity score matching

The intraoperative outcomes of patients before PSM are listed in Table 2. Significant differences were observed with respect to the operation time, rate of open conversion, gallbladder status, and port number between the gastric and control groups, and the non-gastric and control groups. A significant difference was observed in operation time between the gastric and non-gastric groups (129.9 ± 63.6 versus 97.9 ± 51.1 min, $p = 0.004$). No significant difference was observed in the open conversion rate ($n = 4$, 5.2% versus $n = 2$, 5.0%, $p = 0.964$), gallbladder status, adhesion status, adhesiolysis level, rate of PTGBD before LC, and port number between the gastric and non-gastric groups.

Postoperative morbidity before propensity score matching

Postoperative outcomes of the patient before PSM are listed in Table 3. Significant differences were observed in overall morbidity, morbidity of Clavien-Dindo grade IIIa or worse, bile leak, complicated intra-abdominal fluid collection, wound dehiscence, length of postoperative hospital stay, and re-admission within 30 days between the gastric and control groups. Significant differences were observed in overall morbidity, morbidity of Clavien-Dindo grade IIIa or worse, adhesive ileus, wound dehiscence, length of postoperative hospital stay, and re-admission within 30 days between the non-gastric and control groups. No significant difference was observed in overall morbidity ($n = 17$, 22.1% versus $n = 9$, 22.5%, $p = 0.522$), morbidity of Clavien-Dindo grade IIIa or worse ($n = 10$, 13.0% versus

Table 1 Demographic and clinical characteristics of the patients who underwent laparoscopic cholecystectomy

	All (<i>n</i> = 1,258)	Control (<i>n</i> = 1141)	Gastric (<i>n</i> = 77)	Non-gastric (<i>n</i> = 40)	P value		
					Control vs Gastric	Control vs Non-gastric	Gastric vs Non-gastric
Age, years	55.9 ± 16.2	55.1 ± 16.3	65.9 ± 11.3	61.8 ± 15.2	< 0.001	0.011	0.135
Sex					< 0.001	0.003	0.243
Male	650 (51.7)	558 (48.9)	63 (81.8)	29 (72.5)			
Female	608 (48.3)	583 (51.1)	14 (18.2)	11 (27.5)			
Preoperative BMI, kg/m ²	24.6 ± 4.1	24.8 ± 4.1	22.3 ± 3.4	24.1 ± 3.8	< 0.001	0.322	0.009
ASA physical status					< 0.001	0.005	0.844
I	411 (32.7)	398 (34.9)	9 (11.7)	4 (10.0)			
II	753 (59.9)	663 (58.1)	58 (75.3)	32 (80.0)			
III	94 (7.5)	80 (7.0)	10 (13.0)	4 (10.0)			

BMI body mass index, ASA American Society of Anesthesiologists

Values are expressed as *n* (%) or mean $\pm$ standard deviation unless otherwise indicated

Table 2 Intraoperative data of the patients who underwent laparoscopic cholecystectomy

	All (<i>n</i> = 1258)	Control (<i>n</i> = 1141)	Gastric (<i>n</i> = 77)	Non-gastric (<i>n</i> = 40)	<i>P</i> value		
					Control vs Gastric	Control vs Non-gastric	Gastric vs Non-gastric
Operation time, min	74.6 ± 46.5	70.0 ± 42.2	129.9 ± 63.6	97.9 ± 51.1	< 0.001	0.001	0.004
Open conversion	13 (1.0)	7 (0.6)	4 (5.2)	2 (5.0)	< 0.001	0.002	0.964
Gallbladder status					0.003	0.029	0.883
Symptomatic gallbladder stone or gallbladder polyp	327 (26.0)	311 (27.3)	10 (13.0)	6 (15.0)			
Acute or chronic cholecystitis	719 (57.2)	651 (57.1)	46 (59.7)	22 (55.0)			
Gangrenous gallbladder	212 (16.9)	179 (15.6)	21 (27.3)	12 (30.0)			
Adhesion status							0.418
Normal or mild			9 (11.7)	8 (20.0)			
Moderate			28 (36.4)	15 (37.5)			
Severe			40 (51.9)	17 (42.5)			
Adhesiolysis level							0.642
None			24 (31.2)	10 (25.0)			
Omentum			21 (27.3)	14 (35.0)			
Gastrointestinal organ			32 (41.6)	16 (40.0)			
PTGBD	183 (14.5)	161 (14.1)	16 (20.8)	6 (15.0)	0.110	0.879	0.448
Port number					< 0.001	< 0.001	0.413
One	74 (5.9)	74 (6.5)	0 (0.0)	0 (0.0)			
Three	1091 (86.7)	1028 (90.1)	42 (54.5)	21 (52.5)			
Four	84 (6.7)	37 (3.2)	32 (41.6)	15 (37.5)			
Five	9 (0.7)	2 (0.2)	3 (3.9)	4 (10.0)			

PTGBD percutaneous transhepatic gallbladder drainage

Values are expressed as *n* (%) or mean ± standard deviation, unless otherwise indicated

n = 3, 7.5%, *p* = 0.370), length of postoperative hospital stay (6.7 ± 4.4 versus 6.6 ± 4.1 days, *p* = 0.893), and re-admission within 30 days (*n* = 3, 3.9% versus *n* = 2, 5.0%, *p* = 0.779) between the gastric and non-gastric groups.

Preoperative and perioperative outcomes after propensity score matching

Preoperative and perioperative outcomes after propensity score matching are listed in Table 4. Significant differences were observed in operation time (118.9 ± 61.3 versus 75.8 ± 37.1 min, *p* < 0.001), open conversion rate (*n* = 6, 5.1% versus *n* = 0, 0.0%, *p* = 0.013), port number, overall morbidity (*n* = 26, 22.2% versus *n* = 10, 8.5%, *p* = 0.004), and length of postoperative hospital stay (6.7 ± 4.3 versus 5.5 ± 3.2 days, *p* = 0.031) between the gastric + non-gastric and control groups. No significant differences were observed in age, sex ratio, preoperative BMI, ASA physical status, gallbladder status, morbidity of Clavien-Dindo grade IIIa or worse, and re-admission within 30 days between the gastric + non-gastric and control groups.

Discussion

This retrospective and PSM study revealed that patients with an upper midline incision, including gastric and non-gastric groups, have different characteristics as compared to conventional LC patients. In addition, patients with an upper midline incision have more morbidity-related operations, a higher rate of open conversion, longer length of postoperative hospital stay, and longer operation time both before and after PSM matching when compared to conventional LC patients. There was no significant difference in demographics, except for preoperative BMI, between the gastric and non-gastric groups. In addition, there were no significant differences in the perioperative and postoperative outcomes of morbidity, length of postoperative hospital stay, rate of open conversion, and re-admission within 30 days between the gastric and non-gastric groups. Patients in the gastric group required longer operation times than those in the non-gastric group.

Several previous studies have reported that patients with a low midline incision who underwent LC had

Table 3 Postoperative morbidities among the patients who underwent laparoscopic cholecystectomy

	All (<i>n</i> = 1258)	Control (<i>n</i> = 1141)	Gastric (<i>n</i> = 77)	Non-gastric (<i>n</i> = 40)	<i>P</i> value		
					Control vs Gastric	Control vs Non-gastric	Gastric vs Non-gastric
Overall morbidity	83 (6.6)	57 (5.0)	17 (22.1)	9 (22.5)	<0.001	<0.001	<0.552 <
Grade II	34 (2.7)	21 (1.8)	7 (9.1)	6 (15.0)			
Grade IIIa	39 (3.1)	28 (2.5)	8 (10.4)	3 (7.5)			
Grade IIIb	4 (0.3)	2 (0.2)	2 (2.6)	0 (0.0)			
Grade IVa	6 (0.5)	6 (0.5)	0 (0.0)	0 (0.0)			
Clavien-Dindo grade IIIa or worse	49 (3.9)	36 (3.2)	10 (13.0)	3 (7.5)	<0.001	<0.001	0.370
Postoperative bleeding	5 (0.4)	4 (0.4)	1 (1.3)	0 (0.0)	0.208	0.708	0.469
Bile leak	8 (0.6)	3 (0.3)	4 (5.2)	1 (2.5)	<0.001	0.129	0.659
Cholangitis	11 (0.9)	8 (0.7)	2 (2.6)	1 (2.5)	0.128	0.267	0.975
Complicated intra-abdominal fluid collection	18 (1.4)	11 (1.0)	7 (9.1)	0 (0.0)	<0.001	0.533	0.094
Adhesive ileus	9 (0.7)	5 (0.4)	1 (1.3)	3 (7.5)	0.325	0.002	0.115
Wound dehiscence	17 (1.4)	7 (0.6)	5 (6.5)	5 (12.5)	<0.001	<0.001	0.307
Pulmonary complication	12 (1.0)	10 (0.9)	2 (2.6)	0 (0.0)	0.173	0.708	0.546
Postoperative hospital stay duration, days	5.0 ± 2.9	4.8 ± 2.7	6.7 ± 4.4	6.6 ± 4.1	0.001	0.012	0.893
Re-admission within 30 days	8 (0.6)	3 (0.3)	3 (3.9)	2 (5.0)	0.004	0.010	0.779

Values are expressed as *n* (%) or mean ± standard deviation, unless otherwise indicated

acceptable perioperative and postoperative outcomes, including the rates of open conversion and morbidities [4, 11, 12]. In keeping with recent reports on patients with an upper midline incision who underwent LC [1, 2, 6], Ercan et al. showed that patients with previous lower abdominal incisions had fewer adhesions in the upper abdomen than those with upper or combined upper and lower incisions; consequently, the former group had a markedly lower rate of conversion to open cholecystectomy [3]. However, in these studies, the analysis was not performed based on the surgical procedure used for patients with upper midline incisions [2]. There are several studies on LC in patients who underwent gastrectomy, but only a few studies have reported on LC in patients with non-gastric operations using an upper midline incision, such as small bowel resection, splenectomy, and nephrectomy. The current study evaluated the LC outcomes between patients with non-gastric operation using an upper midline incision and those with gastric surgery.

Prior to applying PSM analysis, demographics including age, BMI, sex ratio, and ASA physical status differed between the three groups. Since selection bias, one of the limitations of retrospective studies, can affect the results of this study, the research team conducted PSM analysis using demographic data. In particular, patients in the gastric group showed characteristics of old age, low BMI, and high male

ratio when compared to other groups. Therefore, if there are different demographics for each group among patients with upper midline incision, it is necessary to perform PSM analysis to overcome selection bias, which has not been done in previous studies [1, 2, 12].

The current study reported significant differences in operation time (118.9 ± 61.3 versus 75.8 ± 37.1 , $p < 0.001$), open conversion rate ($n = 6$, 5.1% versus $n = 0$, 0.0%, $p = 0.013$), overall morbidity ($n = 26$, 22.2% versus $n = 10$, 8.5%, $p = 0.004$), and length of postoperative hospital stay (6.7 ± 4.3 versus 5.5 ± 3.2 days, $p = 0.031$) between the gastric + non-gastric and control groups. If a patient had an open conversion event or complications after surgery, the hospitalization period was lengthened and hospital costs were increased. Therefore, in the case of LC in patients with previous upper abdominal surgery, it is necessary to explain the above risks. Nevertheless, in the case of cholecystectomy in patients with previous upper abdominal surgery, the laparoscopic approach is more beneficial to patients than open surgery [6, 13–15].

When LC was performed in patients with a history of abdominal surgery, the rate of postoperative complications, including morbidities of Clavien-Dindo grade IIIa or worse, may increase as compared to patients without a history of abdominal surgery [1–3, 6, 14, 16]. In this study, among 1,258 patients, 49 patients experienced morbidities

Table 4 Preoperative and perioperative outcomes after propensity score matching among the patients who underwent laparoscopic cholecystectomy

	Gastric plus Non-gastric (<i>n</i> = 117)	Control (<i>n</i> = 117)	<i>P</i> value
Age, years	64.5 ± 12.9	64.4 ± 12.8	0.939
Sex			1.000
Male	92 (78.6)	92 (78.6)	
Female	25 (21.4)	25 (21.4)	
Preoperative BMI, kg/m ²	22.9 ± 3.6	23.5 ± 4.0	0.263
ASA physical status			0.098
I	13 (11.1)	25 (21.4)	
II	90 (76.9)	78 (66.7)	
III	14 (12.0)	14 (12.0)	
Gallbladder status			0.298
Symptomatic gallbladder stone or gallbladder polyp	16 (13.7)	25 (21.4)	
Acute cholecystitis	68 (58.1)	63 (53.8)	
Gangrenous gallbladder	33 (28.2)	29 (24.8)	
Operation time, min	118.9 ± 61.3	75.8 ± 37.1	< 0.001
Open conversion	6 (5.1)	0 (0.0)	0.013
Port number			< 0.001
One	0 (0.0)	1 (0.9)	
Three	63 (53.8)	107 (91.5)	
Four	47 (40.2)	9 (7.7)	
Five	7 (6.0)	0 (0.0)	
Overall morbidity	26 (22.2)	10 (8.5)	0.004
Grade II	13 (11.1)	4 (3.4)	
Grade IIIa	11 (9.4)	4 (3.4)	
Grade IIIb	2 (1.7)	1 (0.9)	
Grade IVa	0 (0.0)	1 (0.9)	
Clavien-Dindo grade IIIa or worse	13 (11.1)	6 (5.1)	0.094
Postoperative hospital stay duration, days	6.7 ± 4.3	5.5 ± 3.2	0.031
Re-admission within 30 days	5 (4.3)	1 (0.9)	0.098

BMI body mass index, ASA American Society of Anesthesiologists

Values are expressed as *n* (%) or mean ± standard deviation, unless otherwise indicated

of Clavien-Dindo grade IIIa or worse after LC; 36 of these patients (3.2%) were in the control group, 10 (13.0%) were in the gastric group, and 3 (7.5%) were in the non-gastric group. The complications included postoperative bleeding, bile leak, cholangitis, complicated intra-abdominal fluid collection, and wound dehiscence. After PSM, patients in the gastric and non-gastric groups had a higher postoperative complication rate than those in the control group. To date, no studies with PSM analysis have been conducted on LC in patients undergoing abdominal surgery.

The strengths and limitations of our study warrant discussion. First, the results are subject to the bias and limitations inherent to a retrospective study. However, it is almost impossible to implement randomized controlled trials in such studies, and none have used prospective cohorts. Second, although the PSM method was used to minimize selection bias, not all factors that could influence

complications and open conversion events could be controlled. Nevertheless, PSM analysis was performed by evaluating the demographics of each group and level of gallbladder inflammation objectively using the AAST cholecystitis severity scale.

In conclusion, previous upper midline abdominal operations, including gastric and duodenal operations, are not contraindications to safe laparoscopic cholecystectomy. However, patients with previous upper midline abdominal incisions who are scheduled to undergo LC should be informed preoperatively of the chance of conversion to open surgery, lengthened the hospitalization period, and morbidities associated with surgery compared to these of LC in patients without previous abdominal surgery.

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Declarations

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References

1. Zhang MJ, Yan Q, Zhang GL, Zhou SY, Yuan WB, Shen HP (2016) Laparoscopic Cholecystectomy in Patients With History of Gastrectomy. *JSLs*. <https://doi.org/10.4293/JSLs.2016.00075>
2. Ercan M, Bostanci EB, Ulas M, Ozer I, Ozogul Y, Seven C, Atalay F, Akoglu M (2009) Effects of previous abdominal surgery incision type on complications and conversion rate in laparoscopic cholecystectomy. *Surg Laparosc Endosc Percutan Tech* 19:373–378
3. Zhang WJ, Li JM, Wu GZ, Luo KL, Dong ZT (2008) Risk factors affecting conversion in patients undergoing laparoscopic cholecystectomy. *ANZ J Surg* 78:973–976
4. Ibrahim S, Hean TK, Ho LS, Ravintharan T, Chye TN, Chee CH (2006) Risk factors for conversion to open surgery in patients undergoing laparoscopic cholecystectomy. *World J Surg* 30:1698–1704
5. Yu SC, Chen SC, Wang SM, Wei TC (1994) Is previous abdominal-surgery a contraindication to laparoscopic cholecystectomy? *J Laparoendosc Surg* 4:31–35
6. Yamamoto H, Hayakawa N, Yamamoto T, Momiyama M, Nagino M (2013) Laparoscopic cholecystectomy in patients with a previous history of gastrectomy. *Hepatogastroenterology* 60:443–446
7. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, Santibanes E, Pekolj J, Slankamenac K, Bassi C, Graf R, Vonlanthen R, Padbury R, Cameron JL, Makuuchi M (2009) The Clavien-Dindo classification of surgical complications: five-year experience. *Ann Surg* 250:187–196
8. Doyle DJ, Goyal A, Bansal P, Garmon EH (2020) American Society of Anesthesiologists Classification (ASA Class). StatPearls, Treasure Island, Florida
9. Madni TD, Nakonezny PA, Imran JB, Taveras L, Cunningham HB, Vela R, Clark AT, Minshall CT, Eastman AL, Luk S, Phelan HA, Cripps MW (2019) A comparison of cholecystitis grading scales. *J Trauma Acute Care Surg* 86:471–478
10. Madni TD, Leshikar DE, Minshall CT, Nakonezny PA, Cornelius CC, Imran JB, Clark AT, Williams BH, Eastman AL, Minei JP, Phelan HA, Cripps MW (2018) The Parkland grading scale for cholecystitis. *Am J Surg* 215:625–630
11. Wongworawat MD, Aitken DR, Robles AE, Garberoglio C (1994) The impact of prior intra-abdominal surgery on laparoscopic cholecystectomy. *Am Surg* 60:763–766
12. Karayiannakis AJ, Polychronidis A, Perente S, Botaitis S, Simopoulos C (2004) Laparoscopic cholecystectomy in patients with previous upper or lower abdominal surgery. *Surg Endosc* 18:97–101
13. Jun KH, Kim JH, Kim JJ, Chin HM, Park SM (2015) Retrospective analysis on the gallstone disease after gastrectomy for gastric cancer. *Gastroenterol Res Pract* 2015:827864
14. Sasaki A, Nakajima J, Nitta H, Obuchi T, Baba S, Wakabayashi G (2008) Laparoscopic cholecystectomy in patients with a history of gastrectomy. *Surg Today* 38:790–794
15. Kim J, Cho JN, Joo SH, Kim BS, Lee SM (2012) Multivariable analysis of cholecystectomy after gastrectomy: laparoscopy is a feasible initial approach even in the presence of common bile duct stones or acute cholecystitis. *World J Surg* 36:638–644
16. Wang M, Zhang T, Peng C (2013) Laparoscopic cholecystectomy with previous gastrectomy. *J Invest Surg* 26:96–98

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