

Comparison of the outcomes of robotic cholecystectomy and laparoscopic cholecystectomy

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Purpose: This study compared the effects of robotic single-port cholecystectomy (RC) and 3-port laparoscopic cholecystectomy (LC) on patients' surgical pain, postoperative complications, and satisfaction.

Methods: One hundred twenty patients with gallbladder disease scheduled for either LC or RC were recruited. Each patient was followed up for 1 week after hospital discharge.

Results: Time stayed in operating room was longer in patients with RC, however their hospital stay was shorter than those with LC ($t = 3.01$, $P = 0.003$). Since patients with RC received more analgesics during the surgery ($t = 3.98$, $P < 0.001$), all participants' surgical pain level were analyzed by using analysis of covariance. Patients who underwent RC reported less surgical pain consistently at 6 hours and first day after surgery and 2 days and 1 week later than patients in the LC. Repeated measure analysis of variance also demonstrated that the RC with single-port might cause less pain throughout the postoperative period ($F = 25.68$, $P < 0.001$). Participants' conditions appeared stable without complications such as infection or bleeding regardless of the surgical type however, overall satisfaction with RC showed significantly higher than those with LC except for one item, "the cost of surgery."

Conclusion: These results suggested that the RC might be a better choice for people who concern about surgical pain and early hospital discharge. Since there were no differences in postoperative health status between the 2 groups, health care providers as an advocate can provide more reliable information to their patients.

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Key Words: Laparoscopic cholecystectomy, Robotic surgical procedures, Postoperative pain, Postoperative complications, Personal satisfaction

INTRODUCTION

Recently, there has been an increase in the number of Koreans with gallbladder disease due to westernization and unhealthy eating habits associated with obesity. According to a report by the Health Insurance Review & Assessment Service, the number of Koreans with gallbladder disease rose from 140,000 in 2010 to 162,000 in 2012. In 2013, gallbladder surgery ranked seventh among common surgeries [1]. Cholelithiasis, cholecystitis, and gallbladder polyps are some common types of gallbladder disease. Cholecystectomy was performed as laparotomy before

the 1990s, but the use of laparoscopic cholecystectomy is more widespread these days. This procedure reduces postoperative pain, results in a smaller wound, and shortens length of hospital stay [2].

The recently introduced robotic single-port cholecystectomy (e.g., da Vinci Surgical System, Intuitive Surgical Inc., Sunnyvale, CA, USA) is a minimally invasive procedure performed through an incision at the navel, and surgeons are provided a 10 times magnified, high-definition 3-dimensional view. Some advantages of robotic single-port cholecystectomy (RC) are minimal scarring, less pain, less bleeding, early recovery, shorter

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hospital stay, and higher patient satisfaction [3]. However, RC is 4 to 5 times more expensive than laparoscopic cholecystectomy because it uses advanced equipment, requires regular replacement of the robotic arm, and is not covered by health insurance. Additionally, the procedure involves a longer docking time of the robotic equipment during surgery [4]. So far, RC's advantages and disadvantages have not been extensively studied in Korea, and patients considering the procedure do not have access to sufficient data. In reality, health care providers have relied on printed materials provided by robot manufacturers when explaining the RC to patients. Thus, not only the advantages and disadvantages of RC, but also patients' surgical experience and needs should be explored.

The main advantage of RC over 3-port laparoscopic cholecystectomy (LC), which is commonly used in clinical settings, is less surgical pain. Acute pain in the surgical site after surgery, besides causing patient discomfort, negatively affects various metabolic functions, which may interfere or delay recovery. As such, postoperative pain is an important issue since it is a cause of dissatisfaction among patients [5]. Providing accurate information on the level of pain involved in surgical procedures helps patients to make better decisions, and this is directly related to their satisfaction. The low occurrence of postoperative complications is considered another advantage of RC, but this has yet to be verified. Major complications arising after cholecystectomy include sepsis, hemoperitoneum, and dehiscence/infection of the surgical site [1].

Our society has high moral and ethical expectations for health care providers since hospitals are dedicated to the improvement of human life and health. In order to provide patients with high quality health services and enhance their satisfaction, health care providers must be able to objectively evaluate outcomes from the patients' perspective rather than that of robot manufacturers. They must serve as educators and advocates in assisting patients to select the best surgical procedure based on accurate, sufficient information. The purpose of this study is to compare and analyze the effects of different cholecystectomy surgical procedures on patients' surgical pain, postoperative complication and satisfaction.

The specific objectives of this study to compare three-port cholecystectomy performed with laparoscopic surgical tools and a single-port cholecystectomy performed using the robotic surgical system manufactured by Da Vinci were as follows:

(1) The participants' general characteristics and characteristics related to disease and surgery are identified according to surgical procedure.

(2) The level of surgical pain and postoperative complications and level of satisfaction experienced by participants are compared according to surgical procedure.

METHODS

Design

This was a descriptive and retrospective study that compared the effects of 3-port laparoscopic cholecystectomy and single-port robotic cholecystectomy on patients' surgical pain, postoperative complications and satisfaction.

Patients

Patients with gallbladder disease such as acute or chronic cholecystitis, cholelithiasis, or gallbladder polyp, who visited the department of gastrointestinal surgery at Kangbuk Samsung Medical Center were recruited. Of those patients who were scheduled to undergo either LC or RC, candidates were selected based on the American Society of Anesthesiologists physical status classification system, which is used to determine whether anesthesia can be used on patients during surgery. The participants selected for this study were classified as class I, defined as healthy patients without systemic disturbances, or as class II, defined as patients with moderate systemic disturbances caused by gallbladder disease or other existing pathological processes. Patients diagnosed with gallbladder cancer or at risk of bleeding were excluded. Both LC and RC used transumbilical approach with one 5-mm trocar for LC and two 12-mm trocars for RC.

G*POWER 3.1 was used to calculate the sample size according to Cohen formula. When a significance level (α) of 0.05 and statistical power of 0.8 were applied, the result was 2 groups of 51 subjects each, for a total of 102. In consideration of invalid responses, the questionnaire was distributed to 2 groups of 74, a total of 128. After subtracting the 8 subjects excluded from follow-up within 1 week of discharge, a total of 120 subjects remained in the final analysis.

Instrument

Data were obtained from participants using a structured questionnaire, including questions on their general characteristics, characteristics related to disease and surgery, surgical pain, postoperative complications, and satisfaction.

General characteristics

Sociodemographic information provided by patients included gender, age, education, job, marital status, bearer of surgical costs, health insurance coverage, and personal finances.

Characteristics related to disease and surgery

Characteristics related to disease and surgery, collected from medical records by the researcher, include body mass index (BMI), the length of hospital stay and time stayed in the operating room. The BMI, calculated by dividing weight (kg) over the square of height (m²) was interpreted by guidelines of

the Korean Society for the Study of Obesity [6]. Total length of hospital stay from the time of admission to discharge and the time in the operating room were retrieved from medical records.

Surgical pain

The pain level experienced by patients at the incision site was assessed according to a numeric rating scale over 5 sessions. Preoperative pain refers to pain during admission. Given that the average hospital stay after surgery is 2 days, postoperative pain was assessed over 4 sessions: within 6 hours of surgery, 9:00 AM on the following day, and 9:00 AM on the second day after surgery. Pain after being discharged was assessed during the follow-up 1 week after surgery. The pain was rated on a scale of 0 to 10. Type and frequency of analgesics taken were also investigated.

Postoperative complications

The questionnaire was revised and confirmed under the guidance of two surgeons and 2 head nurses with at least 15 years of clinical experience. Postoperative complications, which refer to complications occurring within one week after surgery, include bleeding, infection, respiratory problems, trouble in urination, and conversion to laparotomy. Specifically, the indications of complications were a decrease in hemoglobin level below 11 g/dL, an increase in WBC above 10,000/mm³ or neutrophils to greater than 70%, abnormal vital signs compared to readings obtained before surgery, chest X-rays, delayed time to urination, and conversion to laparotomy during surgery.

Satisfaction

Satisfaction after surgery was assessed with reference to the questionnaire developed by the American Pain Society [7] and modified versions by Kwon et al. [8] and Baek [9]. The questionnaire was revised for this study purpose. The Cronbach α measuring their reliability were 0.85 [8] and 0.88 [9]. Patients rated satisfaction on a 5-point Likert scale, where 1 is "not at all satisfied" and 5 is "extremely satisfied." A higher score indicates higher satisfaction.

Data collection

This study collected data over 6 months after approval from the Institutional Review Board of Kangbuk Samsung Medical Center (2015-09-010-004). The researcher explained the purpose of the study and procedures to the patients who already decided on a surgical procedure after consultation on cholecystectomy at the general surgery department. Before undergoing surgery, the patients voluntarily signed an informed consent form before participation. They were aware of their right to stop participating at any point and that such a decision would have no influence on treatment or nursing care. Only the researcher had access to the patients' medical records.

Statistical analysis

Collected data was analyzed using IBM SPSS Statistics ver. 22.0 (IBM Co., Armonk, NY, USA), and statistical tests used were as follows:

(1) The patients' general characteristics and characteristics related to disease and surgery were analyzed using descriptive statistics, chi-square tests and independent sample t-tests.

(2) The patients' surgical pain was analyzed using descriptive statistics, independent sample t-tests, Mann-Whitney test, repeated measure analysis of variance, and analysis of covariance (ANCOVA).

(3) The patients' postoperative complications and satisfaction were analyzed using descriptive statistics, chi-square tests and independent sample t-tests.

RESULTS

General characteristics

Out of the 120 subjects who received cholecystectomy, 51 (42.5%) were male and 69 (57.5%) were female subjects. RC was selected by 54.9% of male and 46.4% of female, indicating that the more cutting-edge surgical procedure was more favored by males. However, this difference was not statistically significant. The age of subjects who chose LC averaged 46.85 \pm 12.44 years, while that of RC averaged 42.53 \pm 9.92 years. Those who selected RC were on the younger side, but the difference was not significant. Majority age group (84.3%) was from thirties to fifties, and the largest age group, at 31.4%, was 30 to 39 years old. Participants in their 20s and 30s accounted for 45.1% of those who selected RC, which was higher than patients in the same age group who chose LC (28.3%). On the other hand, patients in the age range of 60 to 69 years only accounted for 3.3% of those who selected RC and 16.7% of those who selected LC. In other words, 66.7% of patients in their 20s and 60.5% of patients in their 30s selected RC, while 83.3% of patients in their 60s chose LC (Table 1).

More than half (55.8%) of them had completed college, and about 70% were employed. A high proportion of employed participants were office workers, amounting to a total of 45.8% from the 2 groups combined. Most of them were married (84.2%), and a vast majority considered their income to be middle-class (91.7%). The 2 groups showed no differences in terms of level of education, occupation, marital status, or finances. As for the bearer of surgical costs, 80% of those who chose RC paid for it themselves, compared to 63.3% among those who chose LC ($\chi^2 = 7.73$, $P = 0.052$). All of the RC group were covered by private insurance, but only 71.7% in the LC ($\chi^2 = 19.81$, $P < 0.001$).

Characteristics related to disease and surgery

The average BMI of participants with gallbladder disease fell under the overweight category for both the LC (24.67 \pm

Table 1. Study participants' general characteristics (n = 120)

Variable	Total	LC (n = 60)	RC (n = 60)	χ^2	P-value
Sex				0.85	0.356
Male	51 (42.5)	23 (38.3)	28 (46.7)		
Female	69 (57.5)	37 (61.7)	32 (53.3)		
Age (yr)		46.85 ± 12.44	42.53 ± 9.92	7.32	0.120
20–29	7 (5.7)	2 (3.3)	4 (6.7)		
30–39	38 (31.4)	15 (25.0)	23 (38.4)		
40–49	30 (24.8)	16 (26.7)	14 (23.3)		
50–59	34 (28.1)	17 (28.3)	17 (28.3)		
60–69	12 (10.0)	10 (16.7)	2 (3.3)		
Education level				2.13	0.832
≤Junior high school	6 (5.0)	4 (6.7)	2 (3.3)		
≤High school	17 (14.2)	7 (11.6)	10 (16.7)		
≥College	67 (55.8)	34 (56.7)	33 (55.0)		
Not answered	30 (25.0)	15 (25.0)	15 (25.0)		
Job				12.05	0.099
None	4 (3.3)	2 (3.3)	2 (3.3)		
Professional/service	10 (8.3)	5 (8.3)	5 (8.3)		
Office work	55 (45.8)	22 (36.7)	33 (55.0)		
Housewife	32 (26.7)	21 (35.0)	11 (18.4)		
Others (student etc.)	19 (15.9)	10 (16.7)	9 (15.0)		
Marital status				1.56	0.211
Not married	19 (15.8)	7 (11.7)	12 (20.0)		
Married	101 (84.2)	53 (88.3)	48 (80.0)		
Payer for surgery				7.73	0.052
Self	86 (71.7)	38 (63.3)	48 (80.0)		
Spouse	28 (23.3)	16 (26.7)	12 (20.0)		
Parents/children	6 (5.0)	6 (10.0)	0 (0)		
Private insurance				19.81	<0.001
Yes	103 (85.8)	43 (71.7)	60 (100.0)		
No	17 (14.2)	17 (28.3)	0 (0)		
Household economic status				4.04	0.133
Low	8 (6.6)	2 (3.3)	6 (10.0)		
Middle	110 (91.7)	56 (93.4)	54 (90.0)		
High	2 (1.7)	2 (3.3)	0 (0)		

Values are presented as number (%) or mean ± standard deviation. LC, laparoscopic cholecystectomy; RC, robotic cholecystectomy.

4.01 kg/m²) and RC groups (24.45 ± 3.63 kg/m²). There was no significant difference in BMI between the 2 groups. The most common diagnosis was chronic cholecystitis, accounting for 46.3% of them. Among them, 52.4% selected RC. Three out of 4 subjects with gallbladder polyps favored RC, while most subjects with cholelithiasis (72.9%) and acute cholecystitis (100%) chose LC. The LC group had a significantly longer hospital stay (t = 3.01, P = 0.003), but a shorter time in the operating room (t = -15.72, P < 0.001) than the RC group. Specifically, the anesthesia (t = -15.64, P < 0.001) and operating times (t = -17.35, P < 0.001) were significantly shorter for the LC group (Table 2).

Surgical pain

There was no significant difference in the amount of analgesics administered before surgery between the LC and

RC groups (t = 1.00, P = 0.321). When surgery began, the RC group were found to receive more analgesics (t = -3.98, P < 0.001). According to data obtained from medical records, Pethidine and/or Fentanyl, opioid pain medications were given during the surgery. Diclofenac, one of NSAIDs was the analgesics administered routinely after surgery for patients in both LC and RC. For noncontrolled postoperative pain, opioid pain-killer such as Tramadol was given to both groups. Opioid analgesics were not included in the discharge medications. In the postoperative phase, the 2 groups again had no significant differences (Table 3). Pain level before surgery for the RC group was 3.46 ± 3.23, which was significantly higher than that of the LC group at 0.92 ± 2.21 (t = -4.92, P < 0.001). Differences in the average pain level 6 hours and the first day after surgery were not significant between the 2 groups. On the second day

Table 2. Illness and surgery related characteristics (n = 120)

Variable	Total	LC (n = 60)	RC (n = 60)	t/ χ^2	P-value
Body mass index (kg/m ²)				4.05	0.400
<18.5 (underweight)	1 (0.8)	1 (1.7)	24.7 ± 4.0	0 (0.0)	24.5 ± 3.6
18.5–22.9 (normal)	49 (40.8)	22 (36.6)		27 (45.0)	
23–24.9 (overweight)	25 (20.8)	16 (26.7)		9 (15.0)	
25–29.9 (obesity I)	32 (26.7)	14 (23.3)		18 (30.0)	
≥30 (obesity II)	13 (10.9)	7 (11.7)		6 (10.0)	
Diagnosis ^{a)}				8.61	0.035
Cholelithiasis	48 (27.1)	35 (38.5)		13 (15.1)	
Gall bladder polyp	40 (22.6)	10 (10.9)		30 (34.9)	
Acute cholecystitis	7 (4.0)	7 (7.7)		0 (0.0)	
Chronic cholecystitis	82 (46.3)	39 (42.9)		43 (50.0)	
Total	177 (100)	91 (100)		86 (100)	
ASA PS classification				0.00	10.000
I	74 (61.7)	37 (61.7)		37 (61.7)	
II	46 (38.3)	23 (38.3)		23 (38.3)	
History of abdominal surgery				0.64	0.426
None	84 (70.0)	44 (73.3)		40 (66.7)	
Yes	36 (30.0)	16 (26.7)		20 (33.3)	
Operating room stay					
Total time taken		71.9 ± 10.4		121.6 ± 22.2	-15.72 <0.001
Anesthesia (min)		65.9 ± 10.5		115.7 ± 22.3	-15.64 <0.001
Surgery (min)		34.0 ± 9.6		86.8 ± 21.7	-17.35 <0.001
Hospital stay (day)		4.7 ± 0.8		4.3 ± 0.5	3.01 0.003

Values are presented as mean ± standard deviation or number (%).

LC, laparoscopic cholecystectomy; RC, robotic single port cholecystectomy; ASA PS, American Society of Anesthesiologists physical status.

^{a)}Multiple answers possible.

Table 3. Analgesics administration and surgical pain over time

Variable	LC (n = 60)	RC (n = 60)	t	P-value
No. of analgesics given				
Preop phase	0 (0–4)	0 (0–0)	1.00	0.317
During surgery	1 (0–3)	1 (0–3)	-3.98	<0.001
In recovery room	0 (0–0)	0 (0–1)	-1.43	0.156
Postop phase	1 (0–6)	1 (0–9)	0.29	0.531
Pain level				
Preop phase	0 (0–8)	4 (0–8)	-4.92	<0.001
6 Hours postop	2 (0–5)	2 (0–5)	0.89	0.256
First day postop	2 (0–6)	2 (0–4)	1.33	0.540
Second day postop	2 (0–5)	0 (0–4)	5.90	<0.001
One week postop	2 (0–3)	0 (0–2)	11.32	<0.001

Values are presented as median (range).

LC, laparoscopic cholecystectomy; RC, robotic cholecystectomy; Preop, preoperative; Postop, postoperative.

after surgery, the RC group reported a significantly lower level of pain at 0.72 ± 1.24 than the LC group at 2.08 ± 1.03 ($t = 5.90$, $P < 0.001$). A similar trend was observed again one week after surgery ($t = 11.32$, $P < 0.001$) (Table 3). Since the patients in the RC group were given more analgesics, this was taken into consideration in ANCOVA. The analysis found that the patients

with RC experienced a significantly lower pain level than those who chose LC in all four sessions after surgery: 6 hours after ($t = 2.00$, $P = 0.048$), first day after ($t = 2.28$, $P = 0.015$), second day after ($t = 6.40$, $P < 0.001$) and 1 week after surgery ($t = 9.06$, $P < 0.001$).

Postoperative complications

More than half of the patients from both groups had red blood cell counts and hemoglobin levels in the normal range before surgery, one hour after surgery and one day after surgery. The number of patients who experienced an increase in WBC count to beyond the normal range 1 hour after surgery was 22 (36.7%) among those who chose LC and a significantly higher 33 (55.0%) among those who chose RC ($\chi^2 = 4.06$, $P = 0.044$). The number of patients who experienced an increase in neutrophils to beyond the normal range 1 hour after surgery was 31 (51.7%) among those who chose LC and a significantly higher 46 (76.6%) among those who chose RC ($\chi^2 = 8.16$, $P = 0.004$). On the first day after surgery, the number of patients who experienced an increase in neutrophils to beyond the normal range was 25 (41.7%) among those who chose LC and a significantly higher 41 (68.3%) among those who chose RC ($\chi^2 = 8.62$, $P = 0.003$) (Table 4). Both the LC and RC groups reported normal chest X-ray results before surgery. On the first day after surgery, there

Table 4. Comparisons of postoperative complete blood cell count and complications

Characteristic	LC (n = 60)	RC (n = 60)	t/ χ^2	P-value
One-hour postop				
WBC (1,000 cells/mm ³)				
Normal (5–10/mm ³)	38 (63.3)	27 (45.0)	4.06	0.044
Elevated	22 (36.7)	33 (55.0)		
RBC (million/mm ³)				
Normal (3.5–5 mm ³)	50 (83.3)	44 (73.3)	1.77	0.184
Decreased	10 (16.7)	16 (26.7)		
Hemoglobin (g/dL)				
Normal (11–16 g/dL)	51 (85.0)	48 (80.0)	0.52	0.471
Decreased	9 (15.0)	12 (20.0)		
Neutrophil segmentation (%)				
Normal (38%–70%)	29 (48.3)	14 (23.3)	8.16	0.004
Elevated	31 (51.7)	46 (76.7)		
Next day postop				
WBC (1,000/mm ³)				
Normal (5–10/mm ³)	37 (61.7)	41 (68.3)	0.59	0.444
Elevated	23 (38.3)	19 (31.7)		
RBC (1,000,000/mm ³)				
Normal (3,5–5 mm ³)	48 (80.0)	44 (73.3)	0.75	0.388
Decreased	12 (20.0)	16 (26.7)		
Hemoglobin (g/dL)				
Normal (11–16 g/dL)	52 (86.7)	52 (86.7)	0.00	>0.999
Decreased	8 (13.3)	8 (13.3)		
Neutrophil segmentation (%)				
Normal (38%–70%)	35 (58.3)	19 (31.7)	8.62	0.003
Elevated	25 (41.7)	41 (68.3)		
Chest X-ray				
Normal	20 (33.3)	17 (28.4)	0.35	0.830
Pneumoperitoneum	37 (61.7)	41 (68.3)		
Atelectasis	2 (3.3)	2 (3.3)		
Pleural effusion	1 (1.7)	0 (0.0)		
Time taken to the first urination (hr)	5.1 ± 3.8	5.1 ± 4.8	0.05	0.960
Change to abdominal surgery	0 (0)	0 (0)	0.00	>0.999

Values are presented as number (%) or mean ± standard deviation.

LC, laparoscopic cholecystectomy; RC, robotic cholecystectomy; Postop, postoperative.

Table 5. Comparison of postoperative satisfaction (n = 120)

Item	Characteristic	LC	RC	t	P-value
1	Consistency of preoperative information with surgical experience	3.1 ± 0.7	3.7 ± 0.5	-5.63	<0.001
2	Overall satisfaction with surgery	3.2 ± 0.7	3.9 ± 0.4	-6.34	<0.001
3	Postoperative pain control	2.7 ± 0.9	4.2 ± 0.6	-11.35	<0.001
4	Size of postoperative wound(s) or scar(s)	2.5 ± 0.6	4.7 ± 0.5	-21.08	<0.001
5	Postoperative recovery phase (in hospital)	3.2 ± 0.7	4.0 ± 0.5	-7.14	<0.001
6	Current health status after surgery	3.2 ± 0.7	4.1 ± 0.6	-7.62	<0.001
7	Postoperative discomfort in daily activities	3.3 ± 0.7	4.1 ± 0.5	-7.06	<0.001
8	Costs of surgery	3.3 ± 0.6	2.2 ± 0.6	10.05	<0.001

Values are presented as mean ± standard deviation.

LC, laparoscopic cholecystectomy; RC, robotic cholecystectomy.

was no significant difference between the 2 groups in terms of abnormal chest X-rays such as pneumoperitoneum, atelectasis, and pleural effusion ($\chi^2 = 0.35$, $P = 0.830$). The time taken to

urination after surgery averaged 5.1 hours for both groups ($t = 0.05$, $P = 0.960$), and none of them had to convert to laparotomy during surgery.

Postoperative satisfaction

Of the total eight items, satisfaction with the RC was significantly higher in the 7 items than those with the LC: 'consistency of the surgical experience as it has been told in the preoperative explanation' ($t = -5.63, P < 0.001$), 'overall satisfaction' ($t = -6.34, P < 0.001$), 'pain control' ($t = -11.35, P < 0.001$), 'postoperative scar' ($t = -21.08, P < 0.001$), 'recovery period' ($t = -7.14, P < 0.001$), 'postoperative health status' ($t = -7.62, P < 0.001$), 'postoperative discomfort in activities of daily living' ($t = -7.06, P < 0.001$). However, regarding satisfaction with the item of "surgical cost" was lower in the RC group than the LC group ($t = 10.05, P < 0.001$) (Table 5). Regarding the incision size, carmeraport size of LC was 12 mm and single port size of RC was 25 mm.

DISCUSSION

Overall, men rather than women, younger participants in their 20s and 30s rather than those in their 60s appeared to prefer RC, the new surgical technology although these differences were not significant. However, a significant number of participants in the RC tend to pay surgical cost on their own and all of them had private health insurance as well. This can be explained by the younger mean age of the RC group, early 40s indicating active economic activities. Mean BMI of the participants with gallbladder diseases indicated overweight. Participants with chronic cholecystitis and gallbladder polyp appeared to prefer RC. In contrast, patients with gall stone or acute cholecystitis preferred LC to RC. In the cases of RC, surgical preparation can be started after patients entered the operating room which makes waiting time till initiation of RC much longer than that of LC. It was also observed from this study that patients in RC stayed about 50 minutes longer in the operating room than the LC group (Table 2) due to docking time required for robotic equipment. Thus, it is assumed that the nature of acute disorder makes people to choose LC over RC since delay in surgery may not be easy for them under acute circumstances.

This study finding was consistent with previous studies reporting that time for minimally invasive robotic surgery takes longer than operations leaving bigger surgical incision [10] and that total operation time taken in the RC was significantly longer than the LC [11]. Therefore, health care providers should pay attention to the patients who are undergone RC since their stay in operating room from initiation of general anesthesia to awakening takes longer than patients who chose LC [12]. That is, lengthy time under anesthesia has risk of delay in postanesthetic awakening [13] which might cause more nausea and vomiting leading to delay in awakening and requiring longer stay in the recovery room [14]. Thus, patients after RC need careful assessment for possible delay in awakening.

Regarding surgical pain, patients in RC group received

significantly more analgesics under anesthesia than LC group. Although there is no protocol available that identifies amounts or classes of analgesics to be used during RC, considering that pain increases in the case of lengthy surgery [15], it is assumed that more analgesics were administered to the patients during the RC. Thus, RC patients might be at risk of respiratory distress due to the influence of opioid analgesics given under anesthesia which increases carbon dioxide within their body system [16]. Nurses who take care of RC patients need to be aware of decrease in sensitivity of respiratory center and to evaluate their patients' respiratory status carefully. In general, postoperative pain which starts at awakening is known to decrease over one or two days after surgery [17]. Likewise, this study results showed similar pattern of pain reduction over time in both groups. With ANCOVA controlling the analgesics administered, postoperative pain level at 4 different sessions such as 6 hour after, 1 day after, 2 days after, and 1 week after, showed significantly lower in the RC group than LC group. This can be explained by difference in the number of port in each procedure. That is, patients who chose the RC with single-port could experience relatively less pain and this result supported previous study reporting that pain decreases as incision site decreases from three to one [18]. Considering this finding that the less pain with the RC might be related to its single-port, more minimally invasive, future study to compare the RC and LC needs to use single-port for both surgical procedures. However, a recent study [19] recommended LC using multiport for patients with acute cholecystitis to ensure better adequate visualization and less bleeding risk than single incision LC.

Bleeding, infection or other complications was not found in both groups indicating safety of minimally invasive surgery. Although significant elevation in the WBC count and neutrophils was found in the RC group at one hour after surgery, they decreased over time without developing signs of infection. This can be explained by previous study result [20] reporting that minimally invasive surgical incision site in cholecystectomy can reduce risk of complications such as infection. In addition to less pain and less scar in the RC group, they were more satisfied with their surgical experience except for the surgical cost. This is also consistent with this study finding that shorter hospital stay in the RC group than that of the LC group. This is also supported by previous studies suggesting high cosmetic satisfaction with single-port cholecystectomy [21] and showing shorter recovery period after single-port cholecystectomy [22].

In summary, the participants' postoperative status was stable regardless of the surgical procedures. Since the patients in the RC reported less pain and higher satisfaction than patients in LC group, the RC can be recommended for those patients who are more concerned about postoperative surgical pain, surgical incision, and hospital stay than surgical cost. However, health

care providers should be aware of risk of delay in awakening and associated changes in the postoperative health status in the patients with the RC due to longer time under general anesthesia than the LC. Since this study was performed at one hospital, generalization of this study finding is limited. The results are expected to serve as a valuable reference for health care providers assigned to patients with cholecystectomy.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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REFERENCES

- Health Insurance Review and Assessment Service. Health insurance major surgery statistics 2013 [Internet]. Wonju: Health Insurance Review and Assessment Service; 2013 [cited 2016 July 7]. Available from: <http://www.hira.or.kr>
- McCloy R, Randall D, Schug SA, Kehlet H, Simanski C, Bonnet F, et al. Is smaller necessarily better? A systematic review comparing the effects of minilaparoscopic and conventional laparoscopic cholecystectomy on patient outcomes. *Surg Endosc* 2008;22:2541-53.
- Kroh M, El-Hayek K, Rosenblatt S, Chand B, Escobar P, Kaouk J, et al. First human surgery with a novel single-port robotic system: cholecystectomy using the da Vinci Single-Site platform. *Surg Endosc* 2011;25:3566-73.
- Lee SE. Current status of single-port laparoscopic cholecystectomy. *J Minim Invasive Surg* 2016;19:5-8.
- Huh YJ, Jung CW, Joh JY, Kim YL. The effect of the initiating time of patient controlled analgesia on the onset of postoperative analgesic effect. *Korean J Anesthesiol* 2004;47:101-5.
- Korean Society for the Study of Obesity. Guideline of obesity therapy 2012 [Internet]. Seoul: Korean Society for the Study of Obesity; 2012 [cited 2016 Sept 5]. Available from <http://www.kosso.or.kr/general/>
- Quality improvement guidelines for the treatment of acute pain and cancer pain. American Pain Society Quality of Care Committee. *JAMA* 1995;274:1874-80.
- Kwon IG, Whang MS, Kim JH. Effects of pain management education on pain of the terminal cancer patients at home. *Asian Oncol Nurs* 2002;2:36-49.
- Baek HJ. Changes in postoperative pain and patient satisfaction with pain management with laparoscopic cholecystectomy [dissertation]. Seoul: Seoul University; 2015. p. 1-73.
- Choi YM. The present and future of surgery. *J Korean Surg Soc* 2006;70:87-90.
- Lee GI, Baek NH, Yoo KS, Kim JH, Kim WH. Robotic cholecystectomy versus laparoscopic cholecystectomy: single institution experience in Korea. In: The 38th Congress of the Korean Association of Hepato-Biliary-Pancreatic Surgery; 2013 Apr 26-27. Jeju, Korea. Seoul: Korean Association of Hepato-Biliary-Pancreatic Surgery; 2013;4:182-3.
- The Korean Society of Anesthesiologists. *Anesthesiology*. Seoul: Elsevier Korea; 2009. p. 152-60.
- Frost EA. Differential diagnosis of delayed awakening from general anesthesia: a review. *Middle East J Anaesthesiol* 2014; 22:537-48.
- Kim MK, Bai SJ, Han JM, Lee YK, Kim JS, Shin YS. The incidence of nausea and vomiting in immediate postanesthetic period. *Korean J Anesthesiol* 2004;47:472-6.
- Peters ML, Sommer M, de Rijke JM, Kessels F, Heineman E, Patijn J, et al. Somatic and psychologic predictors of long-term unfavorable outcome after surgical intervention. *Ann Surg* 2007;245:487-94.
- Lee HS. Hypnotics and analgesics. In: The Korean Society for Anesthetic Pharmacology. *Anesthetic pharmacology*. Seoul: Koonja Publisher; 2011. p. 304-10.
- The Korean Pain Society. *Pain medicine*. 3rd ed. Seoul: Koonja Publisher; 2007. p. 252-60.
- Chow A, Purkayastha S, Aziz O, Pefanis D, Paraskeva P. Single-incision laparoscopic surgery for cholecystectomy: a retrospective comparison with 4-port laparoscopic cholecystectomy. *Arch Surg* 2010;145: 1187-91.
- Kim SG, Moon JI, Choi IS, Lee SE, Sung NS, Chun KW, et al. Risk factors for conversion to conventional laparoscopic cholecystectomy in single incision laparoscopic cholecystectomy. *Ann Surg Treat Res* 2016;90:303-8.
- Johansson M, Thune A, Nelvin L, Stiernstam M, Westman B, Lundell L. Randomized clinical trial of open versus laparoscopic cholecystectomy in the treatment of acute cholecystitis. *Br J Surg* 2005; 92:44-9.
- Kim KH, Roh YH, Kim YH, Jung GJ, Choi HJ. Comparing the results between single port and three port at laparoscopic cholecystectomy. *J Korean Surg Soc* 2010;11:173.
- Desai MM, Rao PP, Aron M, Pascal-Haber G, Desai MR, Mishra S, et al. Scarless single port transumbilical nephrectomy and pyeloplasty: first clinical report. *BJU Int* 2008;101:83-8.