J Gastric Cancer. 2021 Sep;21(3):308-318
https://doi.org/10.5230/jgc.2021.21.e30
pISSN 2093-582X·eISSN 2093-5641

Journal of Gastric Cancer

Original Article

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Hybrid Robotic and Laparoscopic Gastrectomy for Gastric Cancer: Comparison with Conventional Laparoscopic Gastrectomy

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OPEN ACCESS

Received: Sep 4, 2021
Revised: Sep 28, 2021
Accepted: Sep 29, 2021

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ABSTRACT

Purpose: The benefits of robotic gastrectomy remain controversial. We designed this study to elucidate the advantages of a hybrid robot and laparoscopic gastrectomy over conventional laparoscopic surgery.
Materials and Methods: A total of 176 patients who underwent gastrectomy for gastric cancer were included in this study. We compared 88 patients treated with hybrid robotic and laparoscopic gastrectomy (HRLG) and 88 patients who underwent conventional laparoscopic gastrectomy (CLG). In HRLG, suprapancreatic lymph node (LN) dissection was performed in a robotic setting. Clinicopathological characteristics, operative details, and short-term outcomes were analyzed for the patients.
Results: The number of LNs retrieved from the suprapancreatic area was significantly greater in the HRLG group (11.27±5.46 vs. 9.17±5.19, P=0.010). C-reactive protein levels were greater in the CLG group on both postoperative day (POD) 1 (5.11±2.64 vs. 4.29±2.38, P=0.030) and POD 5 (9.86±6.51 vs. 7.75±5.17, P=0.019). In addition, the neutrophil-to-lymphocyte ratio was significantly greater in the CLG group on both POD 1 (7.44±4.72 vs. 6.16±2.91, P=0.031) and POD 5 (4.87±3.75 vs. 3.81±1.87, P=0.020). Pulmonary complications occurred only in the CLG group (4/88 [4.5%] vs. 0/88 [0%], P=0.043).
Conclusions: HRLG is superior to CLG in terms of suprapancreatic LN dissection and postoperative inflammatory response.

Keywords: Robotics; Laparoscopy; Gastrectomy; Postoperative complications; Neutrophils; Lymphocytes

INTRODUCTION

The standard treatment for patients with gastric cancer consists of gastrectomy and radical lymph node (LN) dissection [1]. Laparoscopic gastrectomy is widely performed, and various studies have proven that laparoscopic surgery has better short-term outcomes than conventional open surgery [2,3]. However, LN dissection along the suprapancreatic area

Funding
This research was supported by a grant from the National Research Foundation of Korea (grant No. 2020R1A2C1012007).

Author Contributions
Conceptualization: S.K.Y.; Data curation: K.S.J., S.K.Y.; Formal analysis: K.S.J., S.K.Y.; Funding acquisition: S.K.Y.; Investigation: K.S.J., S.K.Y.; Methodology: K.S.J., J.C.H., J.Y.J., S.H.S., L.H.H., S.K.Y.; Project administration: K.S.J., S.K.Y.; Resources: K.S.J., J.C.H., J.Y.J., S.H.S., L.H.H., S.K.Y.; Software: K.S.J.; Supervision: S.K.Y.; Validation: K.S.J., S.K.Y.; Visualization: K.S.J., S.K.Y.; Writing - original draft: K.S.J.; Writing - review & editing: K.S.J., S.K.Y., L.H.H.

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

during laparoscopic gastrectomy is still challenging and it can cause complications (e.g., bleeding or pancreatitis) during dissection of this area.

The main advantages of robotic surgery are its provision of a three-dimensional field of view, reduction of the operator's hand tremor, and diminished restriction of intra-abdominal movement due to wrist motion; therefore, it is comparatively easy to manipulate and reduce operator fatigue. In addition, robotic surgery provides the operator with a magnified surgical field of a more than 10-fold view. Owing to these advantages, robotic surgery has been introduced in many types of surgeries, including those for prostate cancer, gynecologic diseases, colorectal surgery, and biliary diseases respectively [4-7].

There have been several studies conducted on the advantages of robotic gastrectomy or comparison of robotic and laparoscopic gastrectomy [8-12]. However, controversy persists regarding whether the effectiveness of robotic gastric cancer surgery is superior to that of laparoscopic surgery. This is likely because gastric cancer surgery has distinct characteristics compared with other types of surgery, in which the advantages of robotic techniques have been clearly demonstrated. Gastric surgery is performed in a comparatively wide surgical field and it does not fully utilize the advantages of robotic systems. Therefore, portions of the surgical procedure (e.g., omentectomy or reconstruction after resection) may be more difficult when using such robotic techniques. This is particularly important for inexperienced surgeons and it can contribute to prolonged operation time for surgeons who lack familiarity with robotic systems. Our point is that we are not sure whether pure robotic gastrectomy is better than conventional laparoscopic surgery. We believe that hybrid robotic and laparoscopic surgery, which involves robotic surgery in only necessary areas, is better than conventional laparoscopic surgery. Therefore, we developed and implemented a hybrid surgical method to maximize the advantages of robotic surgery. As mentioned above, LN dissection along the suprapancreatic area is a challenging component of laparoscopic surgery. Since the use of robotic surgery can provide an enlarged and stable field of view, it is expected to improve short-term postoperative outcomes.

Therefore, this study was performed to compare clinical results between patients with gastric cancer who underwent pure laparoscopic gastrectomy and those who underwent hybrid robotic and laparoscopic gastrectomy (HRLG) during the same period.

MATERIALS AND METHODS

We reviewed a prospectively collected database of patients with gastric cancer who were treated at Seoul St. Mary's Hospital, The Catholic University of Korea, College of Medicine, Seoul, Korea. Between March 2019 and June 2020. A total of 200 patients underwent minimally invasive gastrectomy for gastric cancer by a single skilled surgeon (K. Y. Song). He had performed more than 1,500 cases of gastric cancer surgery in 2018. Until this study, he had performed more than 1,000 cases of laparoscopic gastrectomy and more than 150 cases of robotic gastrectomy. The surgeries included 94 consecutive patients who underwent HRLG and 106 patients who underwent conventional laparoscopic gastrectomy (CLG). The indications for both surgeries were early gastric cancer beyond the indications for endoscopic resection or serosa-negative advanced gastric cancer. Either HRLG or CLG was selected according to each patient's preference. Preoperative staging was assessed by endoscopy with or without endoscopic ultrasound and by abdominopelvic computed tomography

https://doi.org/10.5230/jgc.2021.21.e30

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(APCT). Twenty-four patients with other malignancies (n=6), history of previous abdominal surgery (n=13), neoadjuvant chemotherapy, stage IV disease (n=1), palliative surgery, and/or combined resection (n=4) were accordingly excluded. A total of 176 patients were hence, finally included in the study.

We clarified the definition and degree of complications according to the Clavien-Dindo classification method. The diagnosis of complications was confirmed by physical examination and interpretation of the imaging studies (e.g., chest radiography, abdominal radiography, APCT, and upper gastrointestinal series) by radiology specialists.

The study protocol was approved by the Institutional Review Board of Seoul St. Mary's Hospital (approval No. KC20RISI0593).

Operative technique

In HRLG, all robotic surgeries were performed using the da Vinci Xi system (Intuitive Surgical, Sunnyvale, CA, USA). The patient underwent induction of general anesthesia and was then placed in the lithotomy position with each leg abducted at an angle of 30°. Intraoperative endoscopy was performed in both the hybrid surgery and conventional surgery groups, and indocyanine green was injected submucosally at four sites surrounding the cancerous tissue. Fluorescent images were incorporated into the surgical view using infrared cameras installed on the robotic system (Firefly®; FLIR Systems, Wilsonville, OR, USA). In the CLG group, we used a laparoscopic camera (VISERA ELITE II system, Olympus, USA) to detect ICG. The surgeon was positioned on the right side of the patient, with the first assistant positioned on the left side. The camera operator was positioned between the patient's legs using a laparoscope. An 8-mm trocar for the camera port was inserted into the transumbilical incision, and a standard 5-port technique was used throughout the procedure. For robotic gastrectomy, an 8-mm port on the right upper area for Cadiere forceps and a 12-mm port for ultrasonic shear were used, while a 12-mm port for the assistant and an 8-mm port on the left upper area of the Maryland forceps were used on the left side (**Fig. 1**). The 12-mm port for an assistant was only used for surgical gauze, suctioning, or removal of the small resected tissue during operations. We do not think that this would have affected the surgical outcomes, especially in suprapancreatic LN dissection or postoperative inflammation. Moreover, some studies have demonstrated that reduced port surgery does not significantly differ from conventional surgery in terms of inflammatory markers or surgical outcomes [13,14]. Further, since there was no difference in the outcome according to the number of ports, we thought that it would be unlikely for the difference to arise due to the port size. The overall hybrid surgical procedure is shown in **Fig. 2**.

After port placement, the patient was placed in the reverse Trendelenburg position. The abdominal cavity was examined to detect metastases. The same operative steps were performed for all the procedures. During the pre-console period, partial omentectomy with dissection of LN stations #4sb, 4d, and 6 was performed in the patient. Robot system docking was performed after laparoscopic transection of the duodenum. The da Vinci Xi was used to approach the patient from the right side. During the console period, the suprapancreatic LN stations (i.e., #5, 12a, 8a, 7, 9, and 11p) were dissected in accordance with the Korean Practice Guidelines for Gastric Cancer [15]. After dissection of the LNs along the lesser curvature, including nodes 1 and 3a, the robotic system was removed from the patient. Gastric transection was performed laparoscopically during the post-console period, and the resected tissue was extracted through the extended umbilical port site. Staplers were inserted

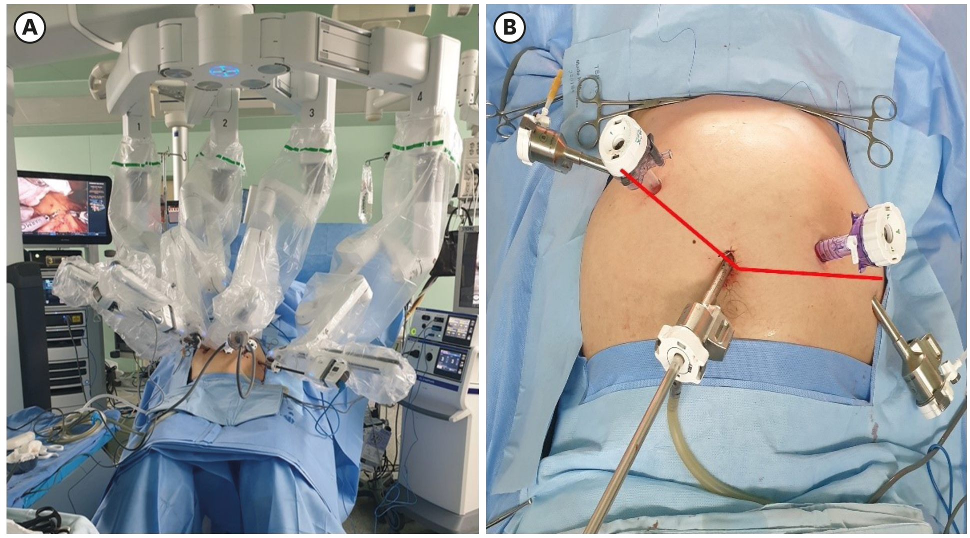

Fig. 1. Patient position and trocar location. (A) The da Vinci Xi model, (B) Trocar location on patient's abdomen.

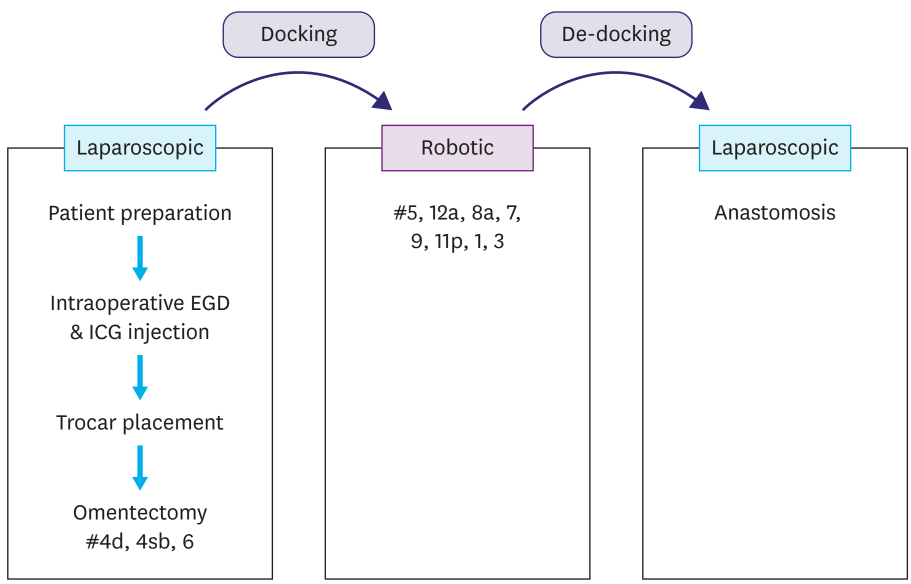

Fig. 2. Hybrid robotic and laparoscopic gastrectomy.
EGD = esophagogastroduodenoscopy; ICG = indocyanine green.

into the 12-mm ports on the right side for Billroth I, Billroth II, or Roux en Y reconstruction in the laparoscopic setting. Docking time was defined as the time necessary to move the robot into the surgical field and allow placement of all four robotic arms into their respective port sites. The console time was the actual time interval during which the operating surgeon was present at the robotic console.

In CLG, one 5-mm port on the right upper area for grasping forceps were used, along with one 12-mm port for the ultrasonic shear system on the right side. Two 5-mm ports on the left side were used for assistance.

https://doi.org/10.5230/jgc.2021.21.e30

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Postoperative management

Postoperative management plans followed the stomach cancer clinical pathway in both groups. Briefly, patients were allowed sips of water on postoperative day (POD) 2. A half-dose liquid diet and soft diet were provided for patients on POD 3 and 4, respectively. Routine laboratory tests to determine complete blood count, blood chemistry, and inflammatory markers (e.g., C-reactive protein [CRP]) were performed on PODs 1 and 4. We recommended discharge for patients with normal laboratory test results, who exhibited suitable adaptation to the soft diet on POD 6 or 7. Postoperative complications were documented and classified according to the Clavien-Dindo method. Readmission within 90 days of surgery in relation to surgical complications was also recorded in the database. The platelet/lymphocyte ratio was determined by dividing the absolute platelet count by the absolute lymphocyte count. The neutrophil-to-lymphocyte ratio (NLR) was determined by dividing the absolute neutrophil count by the absolute lymphocyte ratio. Both platelet/lymphocyte and neutrophil/lymphocyte ratios were used as acute inflammatory markers. Acute pancreatitis and postoperative pancreatic fistula (POPF) were defined by amylase or lipase levels, while drain amylase levels were defined as more than threefold above the upper limit of normal.

Statistical analysis

The χ^2 test or Fisher's exact test was used to compare categorical variables between the groups. Student's t-test or the Mann-Whitney U test was used to compare continuous variables. All statistical analyses were performed using SPSS Statistics version 24 (IBM Corp., Armonk, NY, USA). Statistical significance was set at P<0.05 for all the analyses.

RESULTS

Clinical characteristics

Patient characteristics are presented in **Table 1**. The mean (±standard deviation [SD]) age of patients was lower in the HRLG group than in the CLG group (57.15±10.51 vs. 66.23±11.55 years, P<0.001). The proportion of female patients was greater in the HRLG group than in the CLG group (56.8% vs. 37.5%, P=0.010). The proportion of patients with a worse American Society of Anesthesiologists score was greater in the CLG group than in the HRLG group (P<0.001). There were no differences in body mass index or tumor location between the groups.

Operative outcomes

Table 2 shows operative and pathological outcomes of our study. There were no open or laparoscopic conversions throughout the study population. The mean (±SD) operation time was longer in the HRLG group than in the CLG group (183.23±38.46 vs. 145.34±33.43 minutes, P<0.001). In the HRLG group, the mean docking time was 3.41±1.55 minutes and mean robot surgery console time was 59.01±21.13 minutes. There were no significant differences in the extent of gastric resection or type of reconstruction between groups. The proportion of D2 LN dissection was greater in the HRLG group than in the CLG group, although this difference was not statistically significant (62.5% vs. 51.1%, P=0.128). Although the total number of retrieved LNs did not differ between groups (48.05 vs. 44.19, respectively, P=0.170), the number of retrieved LNs from the suprapancreatic area was greater in the HRLG group than in the CLG group (11.27±5.46 vs. 9.17±5.19, P=0.010). Estimated blood loss and postoperative hospital stay did not differ between groups.

Table 1. Patient clinical characteristics

Variable	HRLG (n=88)	CLG (n=88)	P-value
Age (yrs)	57.15±10.51	66.23±11.55	0.000
Sex			0.010
Male	38 (43.2)	55 (62.5)	
Female	50 (56.8)	33 (37.5)	
BMI (kg/m^2)	23.93±3.33	24.72±3.50	0.124
ASA score			0.000
1	34 (38.6)	11 (12.5)	
2	53 (60.2)	71 (80.7)	
3	1 (1.1)	6 (6.8)	
Tumor location			0.105
Upper third	17 (19.3)	20 (22.7)	
Middle	34 (38.6)	21 (23.9)	
Lower third	37 (42.0)	47 (53.4)	
cT stage			0.023
T1	60 (68.2)	42 (48.3)	
T2	21 (23.9)	26 (23.4)	
T3	6 (6.8)	14 (16.1)	
T4	1 (1.1)	5 (5.7)	
cN stage			0.062
N0	83 (94.3)	71 (81.6)	
N1	5 (5.7)	13 (14.9)	
N2	0 (0)	2 (2.3)	
N3	0 (0)	1 (1.1)	

Data are presented as mean±standard deviation or number (%). The χ^2 test was used to evaluate between-group differences in categorical variables, and a P-value <0.05, was deemed to indicate statistical significance.
HRLG = hybrid robotic and laparoscopic gastrectomy; CLG = conventional laparoscopic gastrectomy; BMI = body mass index; ASA = American Society of Anesthesiologists.

Postoperative inflammatory markers

Table 3 shows the specific inflammatory markers in the HRLG and CLG groups. Although postoperative white blood cell count did not differ between groups, the levels of serum amylase and Jackson-Pratt (JP) drain amylase were significantly greater in the CLG group than in the HRLG group on POD 1 (83.33±34.86 U/L vs. 74.01±32.43 U/L, P=0.046; 1,954.16±3,102.38 U/L vs. 1,158.80±1,207.93 U/L, P=0.028). CRP levels were significantly greater in the CLG group than in the HRLG group on both POD 1 (5.11±2.64 vs. 4.29±2.38, P=0.030) and POD 5 (9.86±6.51 vs. 7.75±5.17, P=0.019). The NLR, which reflects postoperative inflammation, was significantly greater in the CLG group than in the HRLG group on both POD 1 (7.44±4.72 vs. 6.16±2.91, P=0.031) and POD 5 (4.87±3.75 vs. 3.81±1.87, P=0.020).

Early postoperative complications

There were no instances of mortality throughout the study population during the follow-up period (**Table 4**). There were no significant differences in the postoperative complication rate (Clavien-Dindo grade ≥2) or length of postoperative hospital stay between the groups. However, pulmonary complications (e.g., pleural effusion, atelectasis, pneumonia, and bronchiectasis) occurred only in the CLG group; this difference was statistically significant (4/88 [4.5%] vs. 0/88 [0%], P=0.043).

DISCUSSION

Minimally invasive approaches, such as laparoscopic surgeries, are widely used in various areas on account of their many advantages (e.g., reduced postoperative pain, early bowel recovery, and better postoperative quality of life) [16]. Robotic systems have been introduced

https://doi.org/10.5230/jgc.2021.21.e30

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Table 2. Operative and pathological outcomes

Variable	HRLG (n=88)	CLG (n=88)	P-value
Open or laparoscopic conversion case	0 (0.0)	0 (0.0)	NA
Extent of resection			0.096
TG	6 (6.8)	15 (17.0)	
DG	77 (87.5)	69 (78.4)	
PG	5 (5.7)	4 (4.5)	
Extent of LN dissection			0.128
<D1+	33 (37.5)	43 (48.9)	
≥D2	55 (62.5)	45 (51.1)	
Types of reconstruction			0.292
B-I	9 (10.2)	4 (4.5)	
B-II	42 (47.7)	53 (60.2)	
R-Y	32 (36.4)	27 (30.7)	
Double tract	5 (5.7)	4 (4.5)	
Tumor margin (cm)			
Proximal	3.36±1.73	3.27±2.01	0.755
Distal	7.81±3.79	7.42±4.46	0.536
Differentiation			0.355
Differentiated	32 (36.4)	38 (43.2)	
Undifferentiated	56 (63.6)	50 (56.8)	
pTNM stage			0.683
I	72 (81.8)	68 (77.3)	
II	10 (11.4)	11 (12.5)	
III	6 (6.8)	9 (10.2)	
Total number of retrieved LNs	48.05±17.20	44.19±19.83	0.170
Number of supra-pancreatic LN retrieval*	11.27±5.46	9.17±5.19	0.010
EBL (mL)	28.64±25.95	37.73±47.94	0.120
Postop. HD (day)	7.42±3.27	8.56±4.41	0.054
Op time (min)	183.23±38.46	145.34±33.43	0.000
Docking time (min)	3.41±1.55		
Console time (min)	59.01±21.13		

Data are presented as mean±standard deviation or number (%). The χ^2 test was used to evaluate between-group differences in categorical variables, and a P-value <0.05, was deemed to indicate statistical significance.
HRLG = hybrid robotic and laparoscopic gastrectomy; CLG = conventional laparoscopic gastrectomy; TG = total gastrectomy; DG = distal gastrectomy; PG = proximal gastrectomy; LN = lymph node; B-I = Billroth-I; B-II = Billroth-II; R-Y = Roux-en-y; EBL = estimated blood loss; HD = hospital day; NA = not available.
*Supra-pancreatic LN: LN#7 (LN along the left gastric artery), 8a (LN along the common hepatic artery), 9 (LN along the celiac artery), 11p (LN along the splenic artery), 12a (LN along the hepatoduodenal ligament).

to minimize the limitations of laparoscopic surgery via multiple technical advantages, including a high-resolution 3D surgical view, instrumentation with greater freedom of movement, and a more ergonomic posture for the surgeon. Since the introduction of robotic surgery to gastrectomy, many reports have presented its advantages; however, controversies still remain [9].

The long operating time and steep learning curve involved in robotic gastrectomy can be resolved with the accumulation of experience. However, the use of robots can hinder surgeons in some instances. For example, omentectomy or anastomosis procedures using a linear stapler are less convenient in the robotic surgical field since the robot's field of view is enlarged by more than 10-fold, which impedes the acquisition of a higher-level view of the surgical field. Robotic systems are superior to laparoscopic surgery in the event of prostatectomy [17] (which requires a very narrow surgical field of view), proximity surgery, and a highly challenging suture technique.

To address these issues, we divided the overall gastrectomy process into two subprocesses (laparoscopic surgery and robotic surgery) using the concept of hybrid surgery. Laparoscopic

https://doi.org/10.5230/jgc.2021.21.e30

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Table 3. Comparison of specific inflammatory markers between HRLG group and CLG group

Variable	HRLG (n=88)	CLG (n=88)	P-value
WBC count (μL)			
POD1	12,269.00±2,958.10	11,318.30±3,672.73	0.060
POD5	6,732.21±2,084.283	7,984.53±6,716.93	0.101
CRP (mg/dL)			
POD1	4.29±2.38	5.11±2.64	0.030
POD5	7.75±5.17	9.86±6.51	0.019
Serum amylase (U/L)			
POD1	74.01±32.43	83.33±34.86	0.046
POD5	78.01±75.69	63.05±43.56	0.135
JP amylase (U/L)			
POD1	1,158.80±1,207.93	1,954.16±3,102.38	0.028
POD3	189.82±232.03	284.36±584.59	0.166
D-dimer (mg/L)			
POD1	3.91±3.79	4.26±3.10	0.513
POD5	3.89±2.49	5.09±4.15	0.030
Platelet count (10^9/L)			
POD1	231.92±215.96	201.24±65.78	0.204
POD5	229.61±58.67	213.19±75.01	0.110
Neutrophil count (%)			
POD1	81.57±5.67	80.99±5.69	0.502
POD5	66.80±7.59	68.09±9.01	0.308
Lymphocyte count (%)			
POD1	11.74±7.95	11.70±4.42	0.966
POD5	20.36±7.27	18.45±7.87	0.099
PLR			
POD1	26.23±42.46	21.06±16.79	0.289
POD5	12.41±4.72	13.93±10.04	0.202
NLR			
POD1	6.16±2.91	7.44±4.72	0.031
POD5	3.81±1.87	4.87±3.75	0.020

Data are presented as mean±standard deviation. The χ^2 test was used to evaluate between-group differences in categorical variables, and a P-value <0.05, was deemed to indicate statistical significance.
HRLG = hybrid robotic and laparoscopic gastrectomy; CLG = conventional laparoscopic gastrectomy; WBC = white blood cell; POD = postoperative day; CRP = C-reactive protein; JP = Jackson Pratt drain; PLR = platelet-to-lymphocyte ratio; NLR = neutrophil-to-lymphocyte ratio.

Table 4. Morbidity and mortality

Variables	HRLG (n=88)	CLG (n=88)	P-value
Complication (CD grade≥2)	8 (9.1)	16 (18.2)	0.079
Pulmonary	0 (0)	4 (4.5)	0.043
Anastomotic bleeding	0 (0)	0 (0)	NA
Anastomotic leakage	0 (0)	1 (1.1)	0.316
Anastomotic stenosis	1 (1.1)	0 (0)	0.316
Duodenal leakage	0 (0)	0 (0)	NA
Intra-abdominal bleeding	0 (0)	0 (0)	NA
Ileus	2 (2.3)	2 (2.3)	1.000
Pancreatitis*	6 (6.8)	9 (10.2)	0.418
POPF†	11 (12.6)	14 (16.3)	0.497
Intra-abdominal inflammation	0 (0)	0 (0)	NA
Wound infection	0 (0)	0 (0)	NA
A-loop syndrome	1 (1.1)	0 (0)	0.316
Delayed gastric emptying	1 (1.1)	2 (2.3)	0.560
Others‡	6 (6.8)	9 (10.2)	0.418
Operative mortality (within 30 days)	0 (0)	0 (0)	NA

Data are presented as number (%). The χ^2 test was used to evaluate between-group differences in categorical variables, and a P-value <0.05, was deemed to indicate statistical significance.
CD grade = Clavien-Dindo grade; HRLG = hybrid robotic and laparoscopic gastrectomy; CLG = conventional laparoscopic gastrectomy; POPF = postoperative pancreatic fistula; NA = not available.
*Serum amylase or lipase greater than three times the upper normal serum value; †Drain amylase content of drain greater than three times the upper normal serum value; ‡Fluid collection, bacteremia, omental infarction.

https://doi.org/10.5230/jgc.2021.21.e30

surgery was performed from the start of surgery to omentectomy and division of the duodenum. After docking, suprapancreatic and lesser curvature dissections were performed in the robotic environment. We then returned to laparoscopic surgery, divided the stomach, and performed anastomosis. Therefore, the sole distinction of robotic surgery from CLG is the suprapancreatic and lesser curvature dissection procedures.

In this study, the number of LNs retrieved after suprapancreatic area dissection was greater in the HRLG group than in the CLG group. The robotic arm has multiple joints, allowing for comparatively free movement in the abdominal cavity. The upper part of the pancreas is curved, which limits the use of laparoscopic instruments that can only move in a straight line. In addition, the left arm can be controlled in accordance with the operator's intentions; therefore, it can be used to pull the LNs upward or to compress the pancreas. If arm 1 compresses the pancreas, the field of view is much more advantageous than if compression is performed by the assistant. Moreover, the scope can be controlled as required by the operator, providing a more beneficial and efficient procedure from the operator's point of view, compared with laparoscopic surgery. These differences have been associated with differences in postoperative amylase levels and POPFs [12,18].

Notably, postoperative inflammatory changes were greater in the HRLG group than in the CLG group. We examined changes in various inflammatory markers (e.g., white blood cell count, CRP level, D-dimer level, NLR, and platelet-to-lymphocyte ratio) to determine postoperative patient status. As expected, the postoperative inflammation level was lower in the HRLG group than in the CLG group. In the CLG group, four patients had postoperative pulmonary complications, which might have affected the inflammatory markers. Therefore, we performed an additional comparative analysis of the markers, except for those four patients. CRP levels were significantly different between the CLG group and the HRLG group on both POD1 (5.02±2.63, $P=0.049$) and POD5 (9.52±6.36, $P=0.048$). Besides, although statistical significance disappeared, NLR on POD1 (6.97±3.84, $P=0.118$) and POD5 (4.37±2.57, $P=0.108$) still showed a higher trend in the CLG group. Regardless of pulmonary complications, the markers related to postoperative pancreatitis or POPF, the serum amylase level (121.30±169.44 U/L, $P=0.199$) and JP drain amylase level (1,999.49±3,166.01 U/L, $P=0.025$) on POD1 were also higher in the CLG group. Since the only difference between the groups was in the suprapancreatic node dissection procedure, the difference in the degree of injury to the pancreas during surgery seemed to reflect the difference in postoperative inflammatory response.

With regard to surgical outcomes, blood loss and length of hospital stay were similar between the groups. Furthermore, the operation time was longer for hybrid gastrectomy than for laparoscopic surgery, as reported previously [19]. The longer operation time in the hybrid operation was presumably related to the transition from laparoscopic surgery to robotic surgery and then back to laparoscopic surgery. Despite this difference in operation time, there were no differences in postoperative complications, and the HRLG group exhibited superior outcomes in terms of pulmonary complications.

The issue of cost-effectiveness cannot be addressed for robotic surgery. Since the cost of robotic surgery is not covered by the National Health Insurance in Korea, the cost is very high [6,7]. This could be a major drawback of robotic surgery. Nevertheless, the reason why we considered hybrid surgery was because in our opinion, pure robot surgery was inferior in some aspects. We thought it would be good to compensate for those parts by laparoscopic

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surgery, even if it costed higher. In other words, the important point in our study was the "technical issue," and not the cost-effectiveness. Therefore, we did not discuss this topic in depth. In addition, in Korea, there is no difference in price between pure robot surgery and hybrid surgery with laparoscopy.

The present study had some limitations. First, this was a retrospective, single-center study with a limited number of patients. Second, the choice of surgery was made by the patients without randomization; therefore, a selection bias might be present. To overcome the nature of this study, we performed propensity score matching with several variables (age, sex, tumor location, extent of resection, and extent of LN dissection); however, the outcomes of additional analysis did not differ from the present results. We also performed subgroup analysis by selecting only the DG group. Although the difference was not significant, the trend of the number of retrieved suprapancreatic LN of HRLG group was still higher than CLG group (10.97±5.46 vs. 9.51±5.27, P=0.102). Third, as mentioned above, one of the most important and realistic issues in robotic surgery was cost-effectiveness, and our report did not investigate this topic.

In conclusion, HRLG is superior to CLG in terms of the yield of LNs and postoperative inflammation following the dissection of suprapancreatic LNs. To our knowledge, this is the first report showing the potential benefit of gastrectomy with "hybrid" robotic and laparoscopic surgery in terms of suprapancreatic LN dissection, in comparison to conventional laparoscopic surgery. However, additional studies with large sample sizes are needed to investigate the advantages of this hybrid surgery model.

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