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Original Research

Robotic versus conventional laparoscopic gastrectomy for gastric cancer: A retrospective cohort study

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ABSTRACT

Background: Robot-assisted gastrectomy (RAG), as an alternative minimally invasive surgical technique, is gradually being used for the treatment of gastric cancer (GC). This study aimed to assess the feasibility and safety of RAG over conventional Laparoscopy-assisted gastrectomy (LAG) for the treatment of GC.

Methods: We retrospectively analyzed all procedures (RAG and LAG) performed by one surgeon between 31 January 2017 and 1 December 2017. The short-term of surgical outcomes were compared between two groups and further subgroup analyses were performed.

Results: One hundred patients were enrolled in the RAG group and 135 in the LAG group. The demograghics and clinicopathologic characteristics are well matched between two groups. The RAG group had shorter post-operative hospital stay (11 (interquartile range 9–13) vs. 12 (10–14) day; $p < 0.0001$), earlier day of first flatus (2 (2–3) vs. 3 (2.3–3) day; $p < 0.0001$), and larger lymph nodes dissection (40.9 ± 13.1 vs. 35.4 ± 15.8; $p = 0.004$). Of interest, mean numbers of retrieved lymph nodes from station 6 ($p = 0.002$), 7 ($p = 0.032$), 10 ($p = 0.025$), 11p ($p = 0.036$), and 14v ($p = 0.038$) in RAG was significantly larger than LAG. However, no significant differences between two groups were observed in operative time ($p = 0.136$), operative blood loss ($p = 0.434$), days of eating liquid diet ($p = 0.889$), and postoperative complications ($p = 0.752$). In subgroup analyses, the similar results were observed.

Conclusions: RAG for the treatment of GC is a safe and feasible procedure and beneficial for postoperative recovery of GC patients. However, further studies are needed to evaluate long-term and oncologic outcomes of RAG.

1. Introduction

Gastric cancer (GC) is one of the most common malignancies in China, and its incidence and mortality are increasing in recent years [1,2]. Among Gansu Province of China, the morbidity and mortality for GC is higher than the rest area of China, and there were 142,400 new cases diagnosed as GC and 95,200 cases died from GC each year [3,4]. Surgical treatment has been the primary means of treating GC, and surgical techniques have made significant progress over the past few decades, the most important of which is the emergence and development of minimally invasive surgery (MIS).

Laparoscopy-assisted gastrectomy (LAG) is the earliest and most common application for treatment of GC. However, several technical limitations and drawbacks are associated traditional laparoscopic surgery including two-dimensional surgical field of view, limited freedom of operation, enlarged physiological tremors, and uncomfortable operation [5,6]. Da Vinci robot surgery system (Intuitive Surgical Inc., Sunnyvale, CA, USA) that provides a threedimensional high-definition, tenfold magnified view of the operating field and assists surgeons to overcome these limitations of traditional laparoscopic surgery [7]. These characteristics are particularly important when precise lymph node (LN) dissection is required for GC. In 2002, robot-assisted gastrectomy (RAG) was first reported by Hashizume team. Since then, clinical studies of RAG have been reported successively. Although these studies provide the basis for the safety and feasibility of RAG, RAG is still in the exploratory phase and its short-term and long-term efficacy remains to be further confirmed.

To date, there are a limited number of published literatures regarding RAG technique in the GC, and few studies have considered the impact of learning curve on RAG [8–10]. Studies have shown that

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robotic surgery has a short learning curve, that is, when the surgeon completes a certain number of cases, the operation time will suddenly shorten and then stabilize [11,12]. Therefore, this study aimed to determine the short-term surgical outcomes of RAG over LAG for the treatment of GC, based on a large sample of GC in our research team.

2. Materials and methods

2.1. Patient

All patients were enrolled from the database of Western China Gastric Cancer Collaboration (WCGCC) Group of the Lanzhou General Hospital of People's Liberation Army (Lanzhou, China). From 31 January 2017 to 1 December 2017, patients who underwent RAG and patients who recieved LAG were included using the same inclusion and exclusion criteria.

Inclusion criteria were as follows: (i) All patients with GC were diagnosed by pathological biopsy. (ii) All patients had no preoperative evidence of abdominal and distant metastasis on preoperative high-resolution helical CT, upper endoscopy, and endoscopic ultrasound. (iii) All gastrectomies were performed according to the standard of radical gastrectomy of the latest edition of Japanese gastric cancer treatment guidelines [13]. However, patients with benign gastric tumors, gastrointestinal stromal tumors, or combined with other organ malignancies, and residual GC were excluded in the current study.

In present study, the pathological stages were classified according to the eighth edition of the American Joint Committee on Cancer TNM Staging System for GC [14,15]. In addition, the work of this study has been reported in line with the STROCSS criteria of the International Journal of Surgery [16].

2.2. Surgeon background

All the procedures in the present study were performed by the same surgeon (H-B Liu), who had completed more than 3000 cases of LAG since April 2007, and had undergone a long period of robotic surgery training.

2.3. Surgical procedures

The surgical procedures of two MIS were similar except for the locations of the trocars and the surgical instruments. The detailed surgical procedures of LAG have been described in detail elsewhere [17]. The robotic operative procedures were similar to that previously reported [11,18]. The extent of gastrectomy and LN dissection was accomplished according to the guidelines of Japanese Research Society for Gastric [19,20]. In the present study, most of the reconstructions were performed intracorporeally under the assistance of the da Vinci surgical system and then necessary extracorporeal hand-assisted suture was accomplished. In simple terms, according to the resection extent of gastrectomy, Roux-en-Y esophagojejunostomy was performed to reconstruct the alimentary tract for total gastrectomy, and Billroth II gastrojejunostomy or Roux-en-Y anastomosis was applied for distal gastrectomy.

2.4. Perioperative management

The perioperative management followed standardized perioperative clinical pathways of diet, rehydration, ambulation, and treatment. Postoperative care, diet build-up, and discharge were applied to both surgery groups, following the same protocols, at the surgeon's discretion. Patients were given sips of water after first flatus, a liquid diet on postoperative day 3 or day 4, and a soft diet on postoperative day 5 to day 7. Once soft diet was tolerated for 3 day or 4 day, patients without complications were recommended to be discharged. All discharged patients were followed up within six months after gastrectomy.

Table 1
Demograghics and clinicopathologic characteristics of patients with GC.

Demographic or Characteristic	RAG (n = 100)		LAG (n = 135)	
	No. of Patients	%	No. of Patients	%
Gender				
Male	79	79.0	101	74.8
Female	21	20.0	34	25.2
Age (years)				
Median	58.0		58.0	
Range	49.0–66.8		50.0–65.0	
BMI (kg/m^2)				
Median	21.2		22.0	
Range	19.7–23.6		20.1–24.3	
Tumor location				
Upper third	15	15.0	25	18.5
Middle third	31	31.0	45	33.3
Lower third	54	54.0	65	48.2
Tumor size (cm)				
Median	4.5		4.5	
Range	3.0–5.5		2.5–6.5	
Resection extent				
Distal gastrectomy	58	58.0	67	49.6
Total gastrectomy	42	42.0	68	50.4
Previous abdominal operation				
Yes	19	19.0	14	10.4
No	81	81.0	121	89.6
Pathological T category[a]				
T1	16	16.0	22	16.3
T2	14	14.0	23	17.0
T3	48	48.0	79	58.5
T4a	21	21.0	8	5.9
T4b	1	1.0	3	2.2
Pathological N category[a]				
N0	41	41.0	47	34.8
N1	12	12.0	16	11.9
N2	15	15.0	25	18.5
N3a	19	19.0	25	18.5
N3b	13	13.0	22	16.3
Stage[a]				
IA	15	15.0	19	14.1
IB	12	12.0	13	9.6
IIA	9	9.0	18	13.3
IIB	14	14.0	13	9.6
IIIA	14	14.0	21	15.6
IIIB	18	18.0	21	15.6
IIIC	10	10.0	15	11.1
IV	8	8.0	15	11.1
Lymph node metastasis				
Yes	59	59.0	89	65.9
No	41	41.0	46	34.1

Abbreviations: RAG, robot-assisted gastrectomy; LAG, laparoscopy-assisted gastrectomy BMI, body mass index; LN, lymph node.
[a] Based on the Eighth American Joint Committee on Cancer classification.

2.5. Statistical analysis

All statistical analyses were performed using the SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). Continuous variables are presented as means ± standard deviations (SD) and median with inter quartile range (IQR). Continuous variables were analyzed using Student's t-test or the Mann-Whitney *U* test and Categorical variables using the Pearson's χ^2 test or Fisher's exact test. Statistical tests were two-sided and p values less than 0.05 were considered statistically significant.

3. Results

3.1. Clinicopathologic characteristics of patients

A total of 100 RAG (79 males and 21 females) and 135 LAG (101 males and 34 females) were enrolled (Table 1) and a flowchart of the study was presented in Fig. 1. Two groups had similar demograghics and clinicopathologic characteristics, namely gender, age, body mass