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A single center/single surgeon experience

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Short-term surgical outcomes of robotic gastrectomy: A single center/single surgeon experience

AIM: *Surgical resection is considered the optimum approach to the treatment of gastric cancer. The present study evaluates the efficacy of robotic surgery for the treatment of gastric cancer.*
METHOD: *Included in the study were 30 patients who underwent robotic surgery for gastric cancer at the General Surgery Clinic between July 2021 and 2022. The demographic and clinical properties of the patients,intraoperative and postoperative results, tumor* Characteristics, *and early morbidity and mortality values were evaluated.*
RESULTS: *The mean age of the 30 (F/M:8/22) patients was 63.9 (42-83) years, among which 20 (66.7%) had undergone neoadjuvant treatment. The mean surgery duration was 252.82 (110-380) minutes. A subtotal gastrectomy was performed in 10 patients (33%), while the remaining 20 patients (67%) underwent a total gastrectomy. The operation was converted to open surgery in four patients (13.2%). No intraoperative complications were seen, although one patient (3%) underwent re-anastomosis on postoperative day 3 due to an obstruction in the gastroenterostomy anastomosis. The mean largest diameter of the tumor was 4.6 (0-9) cm; the mean number of resected lymph nodes was 30.8 (11–58); and the mean duration of hospital stay was 5.9 (3-12) days. Early mortality within the first 30 days was seen in one patient with a cardiac cause. The rate of re-admission to hospital within the first 90 days was 11% (3 patients).*
CONCLUSION: *Robotic surgery in patients with gastric cancer can be applied efficiently considering the successful clinicopathological results, short hospital stay, and low morbidity and mortality rates.*

KEY WORDS: Cancer, Morbidity, Mortality, Robotic Surgery, Stomach

Introduction

Gastric cancer continues to be a significant public health issue worldwide and is one of the leading causes of cancer-related death. In 2020, gastric cancer was the sixth most commonly sen form of cancer and was the fourth leading cause of cancer-related death worldwide [1].

A treatment plan that is personalized and diversified for each patient will result in the best outcome, since gastric cancer can manifest in many different histological, anatomic and genetic ways. Gastrectomy performed with curative intent remains as the only promising strategy for long-term survival in patients with stomach cancer [2-5].

Minimally invasive surgery has witnessed increasing use for the treatment of gastric cancer in the last decade. Alongside the development of surgical techniques, the Da Vinci robotic surgery system has also been introduced to surgery, launching a new era in minimally invasive surgery. Minimally invasive surgery not only provides improved early postoperative results in selecte cases, but also long-term oncological outcomes that are comparable with open procedures [6-9].

Complex laparoscopic procedures, however, are associated with steep learning curves, while traditional laparo-

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scopic instruments have a limited range of motion as a two-dimensional platform. Robotic gastrectomy (RG) techniques have been developed based on laparoscopic gastrectomy (LG) techniques after the first report on RG was published by Hashizume et al [10]. Robotic surgery systems (RSS) have been developed to overcome the disadvantages of traditional laparoscopic surgery. The main benefits of RSS are the articulated movements of the robotic instruments, the elimination of shake and the availability of a 3-dimensional image [9].

Many basic observational studies have been published comparing RG and LG in patients with conventional gastrectomy (CG) over the last two decades [9,11,12]. RG has been [10-13] identified as an efficacious and safe approach in studies and meta-analyses published to date [10-13], and many experienced laparoscopic surgeons have adopted robotic surgery for the treatment of gastric cancer. Robotic gastrectomy has been identified as a safe and applicable alternative to traditional laparoscopic surgery [10] years after the publication of first reports on the use of robots in the treatment of early-stage gastric cancer [13,14]. That said, critical issues such as cost effectiveness and oncological safety have been awaiting a solution in cases of locally advanced cancer, and so whether RG can be suggested as the standard surgical treatment in gastric cancer is still controversial.

In the present study we describe our experience with robotic gastrectomy performed using the Da Vinci Surgical System and the short-term results in a consecutive case series.

Methods

Patients who underwent robotic gastrectomy with curative intent between July 2021 and 2022 were included in the study after ethics board approval for the study was obtained from the local ethics board of Basaksehir Cam and Sakura City Hospital. Clinical data were collected from the medical files of the patients and histopathological data from the pathology reports in the digital patient archives.

Demographics, American Society of Anesthesiologists (ASA) score, preoperative hemoglobin and albumin levels, tumor markers, status of neoadjuvant treatment, tumor localization, surgical treatment approaches applied, intraoperative complications, duration of operation, tumor diameter, number of dissected lymph nodes, number of metastatic lymph nodes, postoperative complications, postoperative hospital stay, reoperation, postoperative 30-day mortality, 90-day unplanned re-admission to hospital and adjuvant treatment status of the patients were all included in the analysis.

A preoperative diagnosis was made based on an evaluation of the tumor characteristics and staging biopsy, esophagogastroduodenoscopy, computed tomography (CT), PET-CT and endoscopic ultrasonography (EUS). Decisions for neoadjuvant treatment in the clinic were made by the Oncology Council based on the current clinical guidelines. The histologic tumor type was identified based on the World Health Organization (WHO) classification, while the pthological disease stage was determined based on the 8th edition of the TNM Classification [15].

The selection of the patients for robotic surgery was decided on a case-by-case basis depending on the patient characteristics. None of the patients with distant organ metastasis, with previous or simultaneous cancers or history of medical cancer treatment, with inherited cancer syndromes and with emergent conditions underwent robotic surgery. The severity of surgical morbidity was graded based on the Clavien-Dindo classification [16]. Conversion to open surgery was defined as the completion of any part of the procedure using an open technique other than specimen extraction. The duration of surgery was defined as the time from the first skin incision to the closure of the abdominal wall. Discharge plans were based on meal toleration without nausea or vomiting, adequate pain control using oral medications and independent ambulation.

Surgical Technique

All operations were performed by the same surgeon (HB), and the Da Vinci Xi Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA, USA) was used for all robotic procedures. D2 lymph node dissection and distal subtotal or total gastrectomy were performed depending on the localization of the tumor and the preference of the surgeon.

Pneumoperitoneum was produced up to 10 mm Hg intraabdominal pressure in the patients via a puncture with a Veress needle placed 1 cm above the umbilicus. An 8-mm robotic port was placed 1 cm above the umbilicus and all quadrants of the abdomen were viewed through a 30-degree optic to exclude peritoneal metastasis. Three 8-mm robotic ports were placed in the midclavicular line in the right upper quadrant, in the midclavicular line in the left upper quadrant and in the anterior axillary line to ensure all ports were aligned horizontally, 6-10 cm distance from each other. A 12-mm laparoscopic port was placed in the anterior axillary line in the right upper quadrant to be used for the ingress and exit of devices for clipping and aspiration, the linear endostapler, gauzes and sutures by the assisting surgeon. The operating table was placed in a 15-30 degree Trendelenburg position after the ports were introduced. The Da Vinci Surgical System was advanced to the operating table from the left side of the patient.

Robotic subtotal/total gastrectomy was performed in line with the defined standard procedure. Total or subtotal gastrectomy was selected according to the localization of the tumor. All patients underwent D2 lymph node

metastasis. During the gastrectomy procedure, the greater omentum was sealed using a Vessel Sealer Extend (Intuitive da Vinci Robotic Surgical Systems) via the infrapyloric space, including lymph node station 6 through the left paracardiac lymph node station 2, including the splenic hilum and lesser omentum from the right paracardiac lymph node station 1 through the hepatic pedicle. The first portion of the duodenum was divided by an endostapler measuring 45 mm in length and appropriate for 3.5 mm tissue thickness. Lymph node stations [7-12] were excised using Monopolar Curved Scissors and Maryland Bipolar Forceps (Intuitive da Vinci Robotic Surgical Systems). A 5-10 cm long 1/0 polyplropylene curved needle suture knotted ancillary trocar attached to a 25 mm circular stapler anvil was introduced into the intraabdominal space from the 12 mm assisting port incision after being minimally enlarged by the assisting surgeon. The stapler anvil was inserted into the esophagus through an incision formed on the anterior side of the esophagogastric junction using Monopolar Curved Scissors (Intuitive da Vinci Robotic Surgical Systems) and the ancillary trocar was passed through the esophagus wall by using the needle. The esophagus was divided using an endostapler measuring 45 mm in length and appropriate for 4.8 mm tissue thickness. The ancillary trocar and the needle were detached from the anvil and removed.

The robotic port incision in the left upper quadrant midclavicular line was enlarged vertically according to the tumor dimensions. The specimen was extracted from the abdomen by placing an Alexis Wound protector-retractor (Applied Medical) into the incision. Using the same incision, the jejunum was divided using a linear stapler measuring 45 mm in length and appropriate for 2.5 mm tissue thickness at the 30 cm point of the jejunum. An intracorporeal antecolic end-to-side esophagojejunostomy was performed using a 25 mm circular stapler, and an extracorporeal side-to-side jejunojejunostomy was performed at 40 cm distal to the esophagojejunostomy anastomosis using a linear stapler measuring 45 mm in length and appropriate for 2.5 mm tissue thickness.

Statistical Analysis

IBM SPSS Statistics for Windows (Version 24.0. Armonk, NY: IBM Corp.) Was used for the statistical analysis of the data. Categorical data was expressed as numbers and percentages, and continuous data was expressed as mean and standard deviation (with median and minimum-maximum values, where required).

Results

Included in the study were 30 patients with a mean age of 63.9 years. The sample was predominantly male (73.6%) and most were ASA 2 patients. Two-thirds of the patients had undergone neoadjuvant treatment. The patient characteristics are presented in (Table I).

The mean duration of the operation was 252 minutes, with a mean blood loss of 100 ml. No intraoperative complications were noted in the patients. Most patients underwent a total gastrectomy (66.7%), and four procedures were converted to open surgery, due mostly to difficulties experienced in dissection. The mean postoperative duration of hospital stay was 5.9 days, although one patient who had sub-ileus was kept for 12 days, one patient died due to myocardial infarct on day 10 following surgery, and one patient underwent a reoperation due to anastomotic stenosis and was treated with a laparoscopic revision. Serious complications occurred in two patients postoperatively, and re-admission was necessary in 10% of the patients, mostly due to a deterioration in oral intake. The intraoperative and postoperative period records are presented in (Table II).

The most common location of the tumors was the antrum (37.2%). The mean diameter of the tumor was 46 mm and the largest tumor diameter was measured at 90 mm. The mean number of dissected lymph nodes was 30.8, with 11 lymph nodes dissected in a single patient. The mean number of positive lymph nodes was 4.8; the most common tumors were T4a (37.3%); the most common N stage was 0; the rate of lymphovascular invasion was 56.1%+ with a perineural invasion rate of 43.9% and 20% of the patients had a mixed-type pathology. The tumor characteristics are presented in (Table III).

Discussion

Acceptable oncological dissection findings and postoperative morbidity and mortality rates were attained in the present study in which we report on the results of patients who underwent robotic curative gastrectomy for gastric cancer. The only recent curative treatment approach to stomach cancer is surgical resection. Laparoscopy has been used increasingly in cases of stomach cancer in the developing world. Robotic surgery tech-

Table I - *Characteristics of patients*

Age mean +std (min-max)		63.9+10.1(42-83)
Gender	Male	22 (73.36)
	Female	8 (26.6)
ASA score	1	1 (3.3)
	2	19 (63,4)
	3	10 (33,3)
Neoadjuvant CT	Not received	10 (33.3)
	Received	20 (66.7)
Hemoglobin g/dl mean±std (min-max)		10.61±1.75 (5.2-13.9)
Albumin g/l mean±std (min-max)		40±3.92 (31-47)
Cea mean±std (min-max)		3.30±1.57 (1.09-8.38)
CA19.9 median (min-max)		26.8 (2-703)

TABLE II - *Intraoperative and postoperative outcomes*

Duration of operation (min)		252.6 ± 61.8 (110–380)
Mean blood loss (ml)		103.7 ± 114.7 (50–400)
Intraoperative complications		0
Postoperative mortality		1 (3.3)
Type of operation	Total	20 (66.7)
	Subtotal	10 (33.3)
Conversion		4 (13.2)
Length of postoperative hospital stay (days)		5.9 ± 2.4 (3–12)
Reoperation		1 (3.3)
Clavien-Dindo degree of complication	1	25 (83.4)
	2	3 (10)
	3b	1 (3.3)
	5	1 (3.3)
90-day readmission to the hospital	None	27 (90)
	Impaired oral intake	2 (6.6)
	Acute renal failure	1 (3.3)

TABLE III - *Characteristics of tumor*

Tumor localization	Antrum	11 (37.2)
	Cardia	8 (26.4)
	Corpus	8 (26.4)
	OGJ	3 (10)
Tumor Diameter mm		46.6 ± 26.7(0–90)
Total number of lymph nodes extracted (mean) (min-max)		30.8 ± 13.7 (11–58)
Number of positive lymph nodes (mean) (min-max)		4.8 ± 8.0 (0–36)
pT	0	6 (19.8)
	1	5 (16.5)
	2	2 (6.6)
	3	5 (16.5)
	4a	11 (37.3)
	4b	1 (3.3)
pN	0	13 (43.9)
	1	6 (19.8)
	2	2 (6.6)
	3a	6 (19.8)
	3b	3(10)
Presence of Lymphovascular invasion		17 (56.1)
Presence of Perineural invasion		13 (43.9)
Mixt type adenocarcinoma		6 (20)

niques have been developed to overcome the practical limitations associated with laparoscopic surgery, although advances in robotic surgical resection techniques are slow due to the technical problems, complications and inefficacious procedures [13].

Chen et al. compared robotic and open gastrectomy approaches in their analysis of 11 studies in their extensive meta-analysis, and provided clear data on postoperative complications. The results of the analysis revealed postoperative complications in the RG group to be 0.57 lower than in the open gastrectomy group and the difference was statistically significant OR =0.57, 95% CI, 0.35-0.93, P=0.025. The nine studies also provided clear data on the duration of surgery, with a significant heterogeneity observed between the studies I2=98.9%, P=0.000. The analysis revealed the duration of surgery in the OG group to be 83.126 minutes shorter than in the RG group, with a statistically significant difference between the groups WMD = 83.21, 95 % CI, 19.88e146.55, P = 0.010. The duration of hospital stay was 2.21 days shorter in the RG group than in the OG group, and the blood loss was 144 ml lower in the RG lesser than in the OG group.

This meta-analysis provided a clear understanding the effects of minimal invasive surgery [17]. Postoperative complications were seen in two patients in the present study, and the hospital stay and operation durations were at acceptable levels.

Anastomotic leak is one of the main complications of gastric surgery, with a rate of 1-10% reported in previously published studies [18]. Kostakis et al reported no significant difference in anastomotic leak figures between the groups of patients who underwent minimal invasive surgery and open surgery in their meta-analysis [19]. In the present study, no anastomotic leak was seen in any of the patients, although one patient underwent reoperation due to an anastomotic stricture in the early postoperative period.

Oncological and pathological outcomes are evaluated based on an analysis of the status of the proximal and distal margins of the resection and the number of dissected lymph nodes. No significant differences have been reported in literature between Robotic and laparoscopic gastrectomy in terms of the proximal or distal margin, and also involvement [20]. Lymph node dissection is an important step in radical gastrectomy. Previous studies have shown no statistically significant difference between the number of lymph nodes dissected between RG and open gastrectomy surgeries [21-23]. Laparoscopic lymph node dissection in the peripancreatic area, such as for suprapancreatic or infrapyloric lymph nodes, remains challenging, and RG has been proposed as a possible approach to improve lymph node dissections in this anatomical area due to the large movement spectrum of the device [23]. The mean number of dissected lymph nodes was above the average accepted as adequate for oncological assessment. Postoperative mortality still is an unresolved problem in gastric cancer. Greenleaf et al. conducted an extensive, multi-center retrospective analysis and reported 30- or 90- day mortality not to be significantly higher in patients who underwent RG than in those who underwent open gastrectomy. The odds ratio for mortality following RG and open surgery was reported by the same authors to be 1.07, 0.42-2.75, p=0.883 and 1.02, 0.52-2.01 p=0,949, respectively [24]. Mortality after RG has been reported at rates of 0-0.9% in other retrospective studies, with no significant differences between RG and LG or OG being reported. Similarly, three prospective and two retrospective studies from Japan reported low rates of mortality in the range of 0-1.1% with no significant difference between RG and LG [25-28]. One patient dies due to myocardial infarction. No early mortality was seen due to surgical complications.
Recently, evidence regarding the oncological safety of laparoscopic gastrectomy for gastric cancer has been produced by many randomized clinical studies [21,29,30]. Studies reporting the long-term survival outcomes related to robotic gastrectomy are scarce, unlike those analyzing laparoscopic gastrectomy. No difference was found in the 5-year relapse-free survival and general survival of the robotic and laparoscopic gastrectomy groups in a single center, large scale retrospective study in Korea [31]. Caruso et al reported no significant difference in general survival in their comparative study of RG and conventional gastrectomy groups [32]. In contrast, Pernazza et al reported a significantly higher rate of survival in RG when compared to conventional surgery, especially in patients with advanced stage stomach cancer [33]. No survival analysis was performed in the present series since the duration of follow-up was one year.
The present study has some limitations that should be considered, first of which is the single-center, retrospective and non-randomized study design. Furthermore, the operations were performed by surgeons who had just completed their learning curve.

Conclusion

The minimal invasive techniques that are currently available are considered preferable for selected patients for the treatment of stomach cancer. Laparoscopic and robot assisted gastrectomy has provided similar oncological results to open surgical approaches in many studies. Robotic surgery can have an important impact on the treatment of stomach cancer in carefully selected patients, if performed by surgeons trained in advanced level minimally invasive interventions.
Furthermore, with the advances in robotic technologies and efforts to improve the quality of lymph node dissection, the scope of treatment can be enlarged to include advanced stage gastric cancer. More evidence is needed, however, to determine the actual benefits and cost-effectivity. In addition, robot technologies should be continuously developed so as to provide greater opportunities for advanced surgery.

Riassunto

La resezione chirurgica è considerata l'approccio ottimale al trattamento del cancro gastrico. Il presente studio valuta l'efficacia della chirurgia robotica per il trattamento del cancro gastrico.
Sono stati inclusi nello studio 30 pazienti sottoposti a chirurgia robotica per cancro gastrico presso la Clinica di chirurgia generale tra luglio 2021 e 2022. Le proprietà demografiche e cliniche dei pazienti, i risultati intraoperatori e postoperatori, le caratteristiche del tumore e i valori di morbilità e mortalità precoci sono stati valutati.
Risultati: L'età media dei 30 pazienti (F/M:8/22) era di 63,9 (42–83) anni, di cui 20 (66,7%) erano stati sottoposti a trattamento neoadiuvante. La durata media dell'intervento è stata di 252,82 (110-380) minuti. Una gastrectomia subtotale è stata eseguita in 10 pazienti (33%), mentre i restanti 20 pazienti (67%) sono stati sottoposti a gastrectomia totale. L'operazione è stata convertita in chirurgia aperta in quattro pazienti (13,2%). Non sono state osservate complicanze intraoperatorie, sebbene un paziente (3%) sia stato sottoposto a re-anastomosi in terza giornata postoperatoria a causa di un'ostruzione nell'anastomosi gastroenterostomica. Il diametro medio maggiore del tumore era di 4,6 (0-9) cm; il numero medio di linfonodi resecati era 30,8 (11-58); e la durata media della degenza ospedaliera è stata di 5,9 (3-12) giorni. La mortalità precoce entro i primi 30 giorni è stata osservata in un paziente con una causa cardiaca. Il tasso di riammissione in ospedale entro i primi 90 giorni è stato dell'11% (3 pazienti).
Conclusione: la chirurgia robotica nei pazienti con carcinoma gastrico può essere applicata in modo efficiente considerando i risultati clinicopatologici positivi, la breve degenza ospedaliera e i bassi tassi di morbilità e mortalità.

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