Totally Laparoscopic Total Gastrectomy for Gastric Cancer at a Single Institutional Experience and Changes in Technique of Esophagojejunostomy

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Abstract The totally laparoscopic total gastrectomy (TLTG) for gastric cancer has not gained widespread acceptance due to its technical difficulties, especially with the intracorporeal esophagojejunostomy (IEJS). Various modified procedures for the IEJS have been devised, but an optimal method has not yet been standardized. A total of 32 consecutive patients (23 men and 9 women) underwent TLTGs for gastric cancer, between December of 2009 and December of 2014 at the Iwate Medical University Hospital, and were enrolled in this study. Here, we report our institution's experience with TLTGs, with changes in the IEJS. The study participants had a mean age of 66.8 years and a body mass index of 22.8 kg/m². The mean operation time and blood loss were 356.1 min and 61.2 mL, respectively. According to the IEJS, there were 6 circular stapler (CS) (single and double stapling techniques) and 26 linear stapler (LS) (overlap technique and functional end-to-end anastomosis) procedures performed. Two patients, who had undergone IEJS by double stapling technique, developed anastomotic stenosis and required endoscopic balloon dilatations of the anastomotic sites. Therefore, we changed to LS to secure the abundant anastomotic diameter. In our institute, some problematic complications in the IEJS procedure occurred at the introduction of the TLTG. We have overcome these complications by changing and standardizing the IEJS techniques, and by cultivating the laparoscopic techniques.

Keywords Laparoscopic total gastrectomy · Gastric cancer · Intracorporeal esophagojejunostomy · Circular stapler · Linear stapler

Introduction

The totally laparoscopic total gastrectomy (TLTG) for gastric cancer has not gained widespread acceptance. This slow acceptance may be associated with a lower incidence of early gastric cancer requiring TLTG, because most early gastric cancers are treated using endoscopic procedures (endoscopic mucosal resection, endoscopic submucosal dissection). Additionally, the TLTG for advanced gastric cancer, requiring the combined resection of the adjacent organs and an extended lymphadenectomy, has not been established as a standard procedure. Furthermore, the TLTG exhibits several technical difficulties, especially the intracorporeal esophagojejunostomy (IEJS) technique [1]. Although the circular stapler (CS) method is the most commonly performed, as a standard procedure in conventional open total gastrectomy (OTG), new IEJS techniques, such as the linear stapler (LS) method, have been devised for the TLTG as its surgical techniques have advanced [2]. Here, we report our TLTG experiences, with changes in the IEJS, in our institute.

Patients and Methods

Enrolled Patients

A total of 32 consecutive patients underwent TLTGs for gastric cancer, between December of 2009 and December of 2014, at the Iwate Medical University Hospital. From the prospectively collected gastric cancer registry, the following

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clinical data from the patients was collated: age, sex, body mass index, preoperative complications, prior abdominal surgery, clinical staging, operation time, blood loss, degree of lymphadenectomy, total number of resected lymph nodes, IEJS technique, conversion to open surgery, tumor diameter, pathological staging, time to first flatus or defecation, time to diet resumption, postoperative complications, and mortality. All data are expressed as the mean $\pm$ standard deviation.

Operative Procedure

Under general anesthesia, the patients were placed in the supine position with their legs slightly apart. After a pneumoperitoneum was established through the umbilical trocar, four operating trocars were created in the upper abdomen.

A radical lymphadenectomy was performed, as described in the Japanese classification of gastric carcinoma. Then, the exposed esophagus and the duodenum were transected with a 45-mm LS (Endo GIA Tri-Staple; Covidien Japan, Tokyo, Japan). The umbilical trocar wound was extended, and the resected specimen, the stomach, and the en bloc dissected tissue were retrieved. A jejunal loop, approximately 20–30 cm distal to the ligament of Treitz, was marked with dye, pulled out through the small wound, and transected, after which a side-to-side jejunojejunostomy (Y-anastomosis) was performed, using a 45-mm LS to create a 50-cm Roux-en-Y limb. The Y-anastomosis was placed back into the abdominal cavity, and a pneumoperitoneum was reestablished.

We used four types of IEJS methods, including two CS methods and a single stapling technique (SST), which is a conventional CS method in OTG. After opening, the operating surgeon inserted an anvil head into the esophageal stump with an anvil holder, and an intracorporeal hand-sewn, purse-string suture was applied in preparation for the IEJS. A 25-mm CS (Proximate ILS CDH25A; Ethicon Japan, Tokyo, Japan) was introduced through the Roux limb, enabling the IEJS by firing the stapler. Finally, the entry hole was closed using a 45-mm LS.

The other CS method, the double stapling technique (DST), was performed using the efficient purse-string stapling technique (EST) [3]. First, an anvil set was established by securing a 2-0 nonabsorbable monofilament thread suture (Prolene; Ethicon Japan, Tokyo, Japan) at the tip of the trocar included in a 25-mm CS. Then, the central rod of the anvil was connected with the trocar to create the anvil set.

A 3-cm incision was made through the anterior wall of the abdominal esophagus, and the anvil set was introduced into the abdominal cavity through the small wound, subsequently into the esophageal cavity through the esophageal incision. The 2-0 nonabsorbable monofilament thread suture was inserted at the anterior abdominal esophagus, 2–3 cm above the esophageal incision. The suture and the anvil rod were pulled out of the esophageal wall, and the anal end of the

abdominal esophagus was transected near where the central rod was exposed using a 45-mm LS. The shaft of a 25-mm CS was introduced through the Roux limb, enabling the IEJS by firing the stapler. Finally, the entry hole was closed using a 45-mm LS.

There are two LS methods, one of which is the overlap technique [2], which we usually employ for the IEJS. A small enterotomy was made, 7 cm distal to the staple line on the antimesenteric side of the jejunal limb. Another small enterotomy was made on the left wall of the esophageal stump. After one fork of the 45-mm LS was inserted into the opening made in the jejunal limb toward the oral side of the lumen, the jejunal limb was drawn up and positioned at the left side of the abdominal esophagus to create an IEJS in an antecolic fashion. Another fork of the 45-mm LS was inserted carefully into the hole of the esophagus, guided by a nasogastric tube. After each fork was completely inserted into each lumen, the 45-mm LS was fired, and an end-to-side IEJS was created.

The entry hole was closed using an absorbable closure device (V-Loc; Covidien Japan, Tokyo, Japan), using the hand-sewn Albert-Lembert method. The other LS method is a functional end-to-end anastomosis (FETEA), which is the most well-known stapled anastomotic technique used in colorectal surgery. The IEJS using the FETEA is similar to that of the colorectal surgery; however, we closed the entry hole using an absorbable closure device: the hand-sewn Albert-Lembert method. The schemas of these four types of IEJS are shown in Fig 1.

A suction drain (J-VAC; Ethicon Japan, Tokyo, Japan) was inserted from the upper right trocar and placed behind the anastomotic site, through the supra-pancreatic body. The operation was finished by closing the skin of the trocar wounds.

Postoperative Care

The preoperatively inserted nasogastric tube for air decompression was removed at the end of the operation, and all patients received broad-spectrum antibiotics just before and after the TLTG. On postoperative day 3, a gastrografen study was performed to evaluate the anastomotic leakage and reflux, then oral feeding was begun. Without further complications, the patients were discharged between postoperative days 10 and 14, after the tolerance of a normal diet for 2 additional days.

A postoperative complication was defined as any condition that required conservative or surgical treatment. Especially in anastomotic complications, they were defined as conditions that required an endoscopic or interventional procedure or reoperation. Mortality was defined as a hospital death after TLTG, due to postoperative complications.

Fig. 1 The schemas of four techniques for IEJS. **a** SST. **b** DST. **c** Overlap method. **d** FETEA

Results

Patient Characteristics

The characteristics of the enrolled patients (23 males and 9 females) are shown in Table 1. These patients had a mean age

Table 1 Characteristics of patients undergoing TLTG

	TLTG (<i>n</i> = 32)
Sex	
Male	23
Female	9
Age (years)	66.8 ± 10.5
Body mass index (kg/m ²)	22.8 ± 3.3
Preoperative complication (<i>n</i>)	
Diabetes mellitus	8
Hypertension	2
Cardiac disease	4
History of abdominal operation (<i>n</i>)	5
Clinical staging	
IA	22
IB	6
II or III	4

TLTG totally laparoscopic total gastrectomy

of 66.8 years, and a body mass index of 22.8 kg/m². Five patients had histories of prior abdominal operations.

Surgical Details

Table 2 summarizes the surgical details and postoperative data, including the postoperative complications. The mean operation time was 356.1 min, and the mean volume of blood loss was 61.2 mL. All of the patients underwent radical lymphadenectomy, with the mean number of resected lymph nodes being 46.6. According to the IEJS, the total numbers of

Table 2 Operative data from patients undergoing TLTG

	TLTG (<i>n</i> = 32)
Operation time (min)	356.1 ± 82.7
Blood loss (mL)	61.2 ± 56.6
Lymphadenectomy	
D1	2
D1+	22
D2-No.10	8
Total number of resected lymph nodes (<i>n</i>)	46.6 ± 13.8
Technique of IEJS (<i>n</i>)	
CS method	6
SST	1
DST	5
LS method	26
Overlap	21
FETEA	5
Conversion to open surgery (<i>n</i>)	1
Tumor diameter (mm)	45.1 ± 23.9
Pathological staging	
IA	20
IB	4
IIA	2
IIB	1
IIIA	3
IIIB	1
IIIC	1
Time to first flatus or defecation (days)	2.8 ± 1.0
Time to diet resumption (days)	3.6 ± 1.9
Postoperative complications (<i>n</i> , %)	5, 15.6
Anastomotic leakage	0
Anastomotic bleeding	0
Anastomotic stenosis	2
Pancreatic fistula	2
Pneumonia	1
Mortality (<i>n</i> , %)	0, 0
Postoperative hospital stay (days)	15.5 ± 11.5

TLTG totally laparoscopic total gastrectomy, CS circular stapler, SST single stapling technique, DST double stapling technique, LS linear stapler, FETEA functional end-to-end anastomosis

SSTs, DSTs, overlaps, and FETEAs were 1, 5, 21, and 5, respectively. However, we experienced only one case that needed a conversion to OTG, due to unforeseen trouble during the IEJS procedure. On that occasion, we had planned to perform the IEJS employing an overlap technique. The jejunal limb was lifted up to the esophageal stump after an anvil fork of the LS was inserted into the oral side of the jejunum; then, when we tried to insert another fork into the hole of the esophageal stump, the anvil fork penetrated the tip of the jejunal limb (Fig. 2). Reluctantly, we converted to the OTG and securely performed an esophagojejunostomy.

Clinical Outcomes and Postoperative Complications

Table 2 summarizes the postoperative data, including the postoperative complications. The mean time to diet resumption was 3.6 days, while the mean postoperative stay was 15.5 days, with no mortality. Although we experienced neither anastomotic leakage nor anastomotic bleeding, anastomotic stenosis and pancreatic fistula occurred in two cases each. Both patients who developed anastomotic stenosis had undergone IEJS by DST and required an endoscopic balloon dilatation of the anastomotic site.

Discussion

With improvements in laparoscopic surgical devices and surgeon skills, laparoscopic procedures are becoming established for adequate lymph node dissection in cases of gastric cancer [2, 3]. As is the trend of laparoscopic surgery for various organs, laparoscopy-assisted surgery has been switched to totally laparoscopic surgery in laparoscopic gastrectomy to allow greater magnification, a wider view, and the practical use of more refined surgical techniques. However, the critical aspect of the TLTG is the IEJS technique, due to its different varieties and technical difficulties.

There are two methods for mechanical IEJS in TLTG: CS and LS methods. The merit of the former is the accumulated

experience in OTGs for most surgeons, and the CS method has been discussed in previous reports [4]. We successfully performed an SST in a laparoscopy-assisted total gastrectomy, thus employing an SST in TLTG. However, the intracorporeal technique of purse-string suturing at the esophageal stump is relatively cumbersome; therefore, we began to employ the DST using the EST. Although the DST by EST method is conceptually quite sophisticated, we experienced two cases with anastomotic stenosis of the IEJS. When the CS methods were used in esophageal cancer and colorectal surgery, the anastomotic stenosis was considered to be a relatively frequent complication, occurring often. Therefore, we changed to LS methods to secure the abundant anastomotic diameter. We have never experienced postoperative anastomotic complications in patients who underwent IEJS employing the LS methods.

Since the IEJS is performed using longitudinally long devices in LS methods, a wider diameter of anastomosis can be secured, in principle. However, there are concerns about the possible onset of gastroesophageal reflux disease, due to the disruption of the esophageal hiatus, slippage of the IEJS site into the mediastinum, and the severe consequences of leakage [4]. The current IEJS techniques of TLTG are obviously the CS and LS methods; however, the superiority of one over the other remains to be determined. Therefore, further clinical trials are warranted.

Regarding the long-term oncological prognosis, the TLTG produced extremely satisfying results in the patients with early gastric cancer, without metastases to the lymph nodes [4, 5]. However, the global effectiveness of the TLTG has not been clearly demonstrated by well-designed randomized clinical trials, thus far. Additionally, one of the major concerns regarding the application of the laparoscopic approach for tumors with bulky and serosal invasion has been the possibility of the peritoneal seeding of the malignant tumor cells during the operation. Therefore, preoperatively diagnosed advanced gastric cancers, such as bulky and serosa-positive tumors, have been excluded from indication for the TLTG, in principle. In view of this, the long-term oncological effectiveness or non-inferiority of the TLTG for early gastric cancer should be demonstrated first, then it can be considered for advanced gastric cancers.

In conclusion, although the surgical procedures of the TLTG for gastric cancer have not yet been widely established and standardized, the TLTG can be a safe and feasible procedure, when performed by an experienced laparoscopic gastric surgeon [5]. In our institute, some problematic complications in the IEJS procedure occurred at the introduction of the TLTG. We have overcome these complications by changing and standardizing the IEJS technique, and by cultivating the laparoscopic techniques. In the future, further research is necessary to establish the advantages of the TLTG for short-term and long-term oncological prognoses, as well as the most reliable IEJS technique.

Fig. 2 Penetration of an anvil fork during overlap method (arrow)

Compliance with Ethical Standards

Conflict of Interest Akira Umemura and all the co-authors have no conflict of interest.

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