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# The comparison of post-proximal gastrectomy digestive tract reconstruction methods

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## Abstract

**Objective** Proximal gastrectomy (PG) is commonly used to remove proximal gastric cancer leading to gastroesophageal reflux and requires digestive tract reconstruction. This study is to compare the performance of esophagogastrostomy (EG), jejunal interposition (JI), and double tract reconstruction (DTR) on post-PG reconstruction effectiveness.

**Methods** A retrospective study was conducted using the clinical data of 94 PG patients who underwent digestive tract reconstruction by EG (37 patients), JI (29 patients) or DTR (28 patients). The safety of the reconstruction procedure and the incidence of surgical complications were evaluated using the Reflux Symptom Index (RSI), Gastroesophageal Reflux Disease Questionnaire (GERD-Q) scale score, gastroscopy, barium meal examination of digestive tract, and 24-h pH monitoring.

**Results** The DTR group showed significantly lower GERD-Q scores ($p < 0.05$) and RSI scores ($p < 0.05$) compared to the EG and JI groups. This indicates that DTR is more effective in preventing reflux esophagitis. The pre- and post-surgical GERD-Q scores assessed by esophageal 24-h pH acidity measurements and Los Angeles Grading were reduced in all patient groups, with the DTR group showing better results than the other two ($p < 0.05$). The results of the EORTC QLQ-STO22 questionnaire indicated that the DTR group had a higher overall health status score than the other two groups ($p < 0.001$).

**Conclusion** EG had a short surgical duration and less bleeding. JI reduced the prevalence of reflux esophagitis. DTR presented improved prevention of reflux esophagitis and enhanced quality of life.

**Keywords** Proximal gastrectomy (PG), Digestive tract reconstruction, Esophagogastrostomy, Jejunal interposition, Double track reconstruction

## Introduction

Adenocarcinoma of the esophagogastric junction (AEG) denotes adenocarcinoma arising within a five centimeter radius above and below the esophagogastric junction [1]. Surgical interventions including proximal gastrectomy (PG) and total gastrectomy (TG) remain the primary treatment for AEG type II and III. Siewert I lesions are typically treated with esophagectomy. According to various clinical trial outcomes, the transabdominal approach is predominantly utilized to treat types II and III AEG with effectiveness indicators such as surgical mortality, complication rates, postoperative survival duration, recurrence rates and postoperative quality of life (QOL) [2–6].

PG, in comparison with TG, offers advantages in treating proximal gastric cancer by preserving more gastric function and enhancing patients' QOL [7–9]. The

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Japanese Gastric Cancer Association (JGCG) recommends three different reconstruction options for PG, including esophagogastrostomy (EG) anastomosis, double-tract reconstruction (DTR) method, and jejunal interposition (JI) [10–12].

EG was the first choice for PG reconstruction before 2019 although it lacks an effective anti-reflux mechanism leading to a substantial risk of anastomotic complications [13, 14]. JI primarily connects esophagus with residual stomach using jejunum to preserve the remnant stomach which results in substantial increase of food intake and mitigate the occurrence of food reflux [15–17]. DTR is a transverse anastomosis executed on the jejuno-esophageal stump to facilitate enhanced bile mixing and food transportation into the jejunum and mitigate the delay in gastric emptying [18]. In contrast to EG, both JI and DTR prevent the direct reflux of gastric acid into the oesophagus [8, 16]. From 2019 to 2020, GT and DT were used for reconstruction after PG [19].

Reflux esophagitis remains unavoidable following PG reconstruction which significantly affects postoperative QOL [20]. post-PG gastroesophageal reflux emerges as a QOL-affecting complication, with a high incidence rate ranging from 60 to 70% [21–23]. Gastric acid is an important factor contributing to the pathogenesis of reflux esophagitis [18]. Although previous studies demonstrated the advantages and disadvantages of EG, JI and DTR regarding mitigating anti-esophageal reflux, no consensus exists on the optimal reconstruction technique after PG [24, 25].

The purpose of this study was to retrospectively compare and analyse the surgical outcomes among EG, JI, and DTR reconstruction in patients who underwent PG to clarify the superior reconstruction method.

## Materials and methods

### Patients

Ethical approval for this study (Approval no.2021–093) was provided by the Ethical Committee of the Shanghai Sixth People's Hospital and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained before the patient participated in the study. Clinical trial number: not applicable.

A retrospective study was conducted using 94 patients who were diagnosed with AEG and underwent PG from July 2017 to August 2022 at the Sixth People's Hospital Affiliated with Shanghai Jiao Tong University, located in Shanghai, China. 37 patients underwent direct anastomosis of the esophagus to the residual stomach following PG and were categorized as the EG group. 29 patients who underwent PG received JI reconstruction were enrolled in the JI group. 28 patients treated with the double tract method after PG were denoted as the DTR group (Fig. 1).

1. Inclusion criteria:

   (1) AEG (Siewert type II and III) was clearly identified through gastroscopy and biopsy pathology;
   (2) Preoperative CT examination of the abdomen revealed no significant enlarged and fused lymph nodes around the stomach and no distant metastasis;
   (3) The maximum diameter of the tumor is less than 4 cm;
   (4) The distance between the lower pole of the tumor and the gastric angle is greater than 5 cm.
   (5) Patients who preserved more than one-half of the remnant stomach underwent EG.

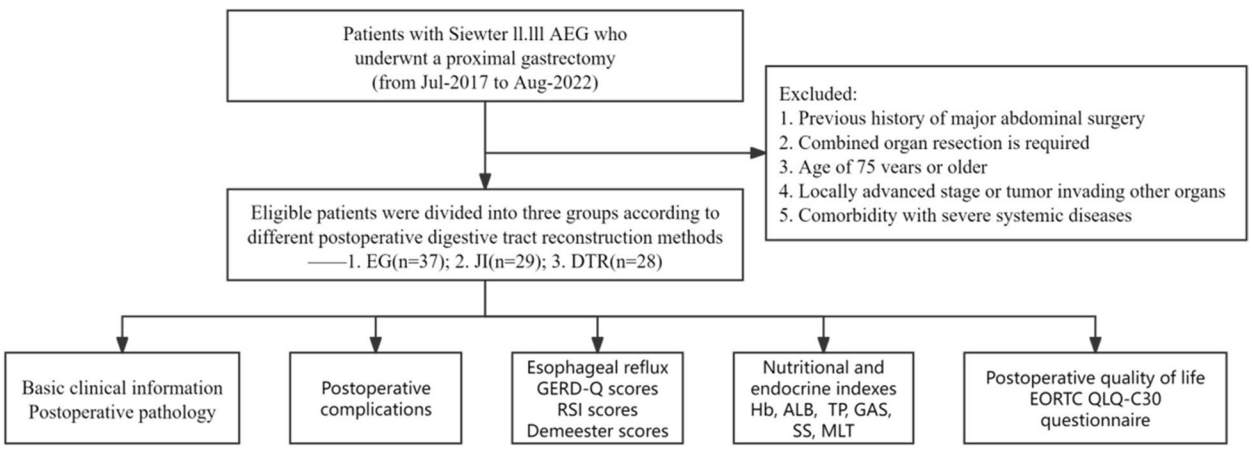


**Fig. 1** Flowchart of the study

(6) Patients who preserved less than one-half of the remnant stomach underwent DTR or JI according to medical condition assessment.

2. Exclusion criteria:

(1) Previous history of major abdominal surgery;
(2) Combined organ resection is required;
(3) Age of 75 years or older;
(4) Locally advanced stage or tumor invading other organs;
(5) Comorbidity with severe systemic diseases.

3. Postoperative follow-up screening criteria:

(1) Patients who underwent palliative PG;
(2) Patients with postoperative complications such as anastomotic leakage, abdominal infection, and other serious complications;
(3) Patients with a postoperative survival time of less than 6 months;
(4) Patients with recurrence and metastasis diagnosed within 6 months after surgery;
(5) Patients who are evaluated after 6 months postoperatively and still require ongoing special treatments such as chemotherapy;
(6) Postoperative patients who missed their follow-up appointments.

The choice of the three surgical methods depends on several factors evaluated by the surgeon during the procedure. These factors include tumor diameter, the length of the small intestinal mesentery, the length of the abdominal esophagus, total stomach size, residual stomach volume, the number of vascular arches in the small intestinal mesentery, and vascular condition. Indications for EG: This surgical method is suitable for patients who can preserve a longer abdominal esophagus and a larger residual stomach (2/3 or more). Indications for DTR: This surgical method can be applied to the reconstruction of the digestive tract after proximal gastrectomy in the vast majority of cases, as it does not require a high size of residual stomach, especially for patients with small residual stomach that are not suitable for esophageal residual stomach anastomosis. Indications for JI: The use of this surgical method is similar to double-tract reconstruction, especially for patients with longer mesentery. In addition, the basic conditions of patients before surgery, such as anemia, hypoproteinemia, diabetes, abdominal CT scan, and the experience of surgeons are also important factors in the selection of surgical methods. The same surgery team performed all operation procedures, and all patients were managed with the same postoperative treatment when staying in the hospital.

**Fig. 2** Diagrammatic sketch of EG

## Surgical procedures

### *Laparoscopic proximal gastrectomy*

In the surgical procedure, a 10-mm port was inserted to the upper edge of the umbilicus using an open technique, followed by the injection of 12 mmHg of $CO_2$ into the peritoneal cavity. Four additional working ports were positioned under laparoscopic guidance: a 12-mm port on the left mid-clavicular line at the level of 1–2 cm above the umbilicus, a 5-mm port on the right mid-clavicular line situated 1–2 cm above the umbilicus, and two 5-mm ports were positioned on the left and right axillary lines respectively. Adhering to the guidelines stipulated by the JGCG [12], a D2 lymphadenectomy was performed to complete the PG. During the surgery, the right gastroepiploic and right gastric arteries were preserved to sustain adequate blood supply to the residual stomach. Furthermore, to conserve pyloric functionality, the hepatic branch of the vagus nerve was left intact. After confirming negative tumor resection margins with a frozen section examination, the reconstruction phase of the surgery began.

### *Reconstruction for PG with EG*

The proximal esophagus underwent precise resection via an endoscopic linear stapler. Subsequently, the specimen was removed with linear device closure along the line from the lower middle third of the lesser curvature to the junction of the right and left vascular arches of the greater curvature of the stomach. A meticulous small incision was made in the anterior wall of the remnant stomach. Then, end-to-side anastomosis was performed using a circular stapler between the esophagus and the anterior wall of the remnant stomach to complete the

reconstruction, and no anti-reflux procedure was implemented throughout the entire process (Fig. 2).

#### *Reconstruction for PG with JI*

Firstly, the jejunum was divided approximately 25–30 cm distal to the ligament of Treitz. Subsequently, a segment of at least 5 cm of the jejunum was resected to create a 10 to 13 cm jejunal limb via a retrocolic approach, ensuring that the distal arcade vessels of the distal mesentery remained intact. An end-to-side esophago-jejunal anastomosis was constructed utilizing a 25-mm circular stapler. The jejunal stump was then closed with a 55-mm linear stapler and reinforced with seromuscular sutures, resulting in a stump length of approximately 1–2 cm. An end-to-side jejunal-gastric anastomosis was fashioned on the anterior aspect of the residual stomach, approximately 10 cm inferior to the fundus, using Gambee stitches. Ultimately, an end-to-end jejunojejunostomy was executed by employing Gambee stitches (Fig. 3).

#### *Reconstruction for PG with DTR*

The jejunal mesentery was incised at a distance of 25 cm distal to the flexor ligament. Subsequently, the small intestinal mesenteric vessels were ligated. Utilizing a linear stapler, the jejunum was incised at a point 25 cm from the ligament of Treitz, and the proximal jejunal stump was closed properly. Subsequently, the distal intestinal canal was lifted, and an esophagojejunostomy (E-J anastomosis) was performed using a linear stapler. Following this, a side-to-side gastrojejunostomy (G-J anastomosis) was carried out, with one anastomotic hole created 15 cm caudal to the E-J anastomosis on the jejunum and another on the anterior wall of the remnant stomach, 2 cm from the incision edge. Facing cephalad, a linear anastomosis was inserted into the gastric and jejunal anastomoses to complete the anastomotic procedure. At a distance of 35 cm from the stump, a side-to-side jejunojejunostomy (J-J anastomosis) was created by anastomosing the anal-side jejunum with the oral-side jejunum. Finally, the gastric remnant and anastomoses were reinforced with sutures to prevent leakage (Fig. 4).

#### Observation indicators

Clinical data related to preoperative and postoperative follow-up were collected for patients in each group.

1. Patients' gender, age, operation time, operation duration, intraoperative blood loss, amount of bleeding, time to intestinal recovery, presence of diarrhea, time to ambulation, time to oral intake, time of drain removal, length of hospital stay, and other relevant factors were recorded.
2. Postoperative pathology included details such as lesion site/diameter, pathological type, depth of gastric wall infiltration, number of lymph node metastases, TNM stage, and incision margin. The variances in tumor pathology and staging after surgery were evaluated and compared among the groups.
3. Postoperative complications included anastomotic leakage, anastomotic stenosis, intestinal obstruction, abdominal hemorrhage (infection), and deep vein thrombosis of the lower extremities. The incidence of postoperative complications was evaluated and compared among the groups.
4. Postoperative esophageal reflux was compared among the groups.

    a. GERD-Q symptom scores were assessed before and after surgery in each group.

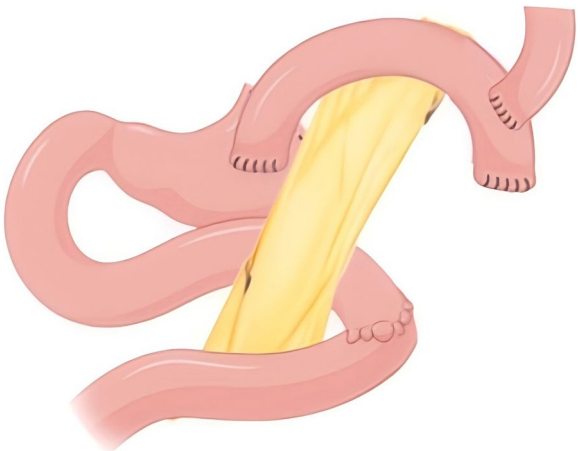

**Fig. 3** Diagrammatic sketch of JI

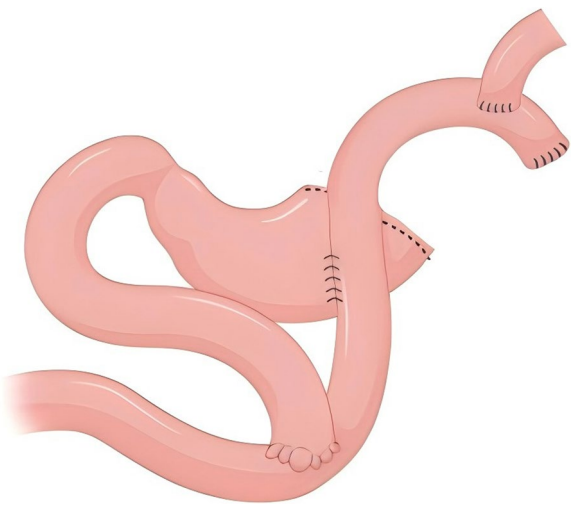

**Fig. 4** Diagrammatic sketch of DTR

b. The RSI of patients experiencing extraesophageal reflux symptoms was recorded during postoperative follow-up visits.
c. The degree of reflux esophagitis was evaluated and compared before and after surgery in each group. The 24-h pH monitoring index DeMeester score of the lower esophagus was collected before and after surgery in each group: patients in each group were subjected to 24-h pH monitoring of the lower esophagus (5 cm above the esophageal anastomosis) using the Digitrapper MKIII portable pH monitoring device from the CTD Company of Sweden before surgery and after resuming a semi-liquid diet in the postoperative period of 8–14 days. The pH composite score, the total number of refluxes in 24 h, the number of refluxes > 5 min, the percentage of total time with pH < 4.0, and the percentage of time with pH < 4.0 in the upright position and in the prone position were recorded.
d. The degree of reflux esophagitis before and after surgery was assessed and compared in each group. Gastroscopy was repeated 1 year after surgery to quantify the degree of reflux esophagitis. The gastroscopic diagnostic criteria for reflux esophagitis were based on the RE diagnostic criteria of the World Congress of Gastroenterology in Los Angeles and were divided into 4 grades: Grade A, one or several mucosal breaks in the esophageal mucosa, with a diameter of < 5 mm for a single break; Grade B, a diameter of mucosal breaks of > 5 mm, without fusion among the breaks; Grade C, more than 2 breaks with fusion of the mucosal breaks; Grade D, mucosal lesions fused with each other, with a cumulative extent of at least 75% of the esophageal circumference.
e. A gastrointestinal barium meal was performed one year after surgery to measure the volume of the residual stomach and the direction and passage of food flow.

5. Nutritional and endocrine indexes were evaluated and compared in each group: weight (Wt), hemoglobin (Hb), serum albumin (ALB), serum total protein (TP) levels; esophageal dynamics and gastrointestinal hormones: serum gastrin (GAS), gastric motility (MTL), and growth inhibitory hormone (SS) levels before and after the operation. The nutritional status and gastrointestinal hormone changes before and after surgery, including nutritional status and gastrointestinal hormone level changes, were evaluated and compared.
6. Postoperative QOL: The EORTC QLQ-C30 evaluation scale was utilized to assess the functional status and overall health status of the patients in each group one year post-operation. The aim was to evaluate and compare the postoperative quality of life in each group.

### Statistical processing

Esophageal pH monitoring data were presented as median (range: minimum to maximum). Statistical analysis was performed using SPSS 20.0 software. Categorical data were analyzed with the Chi-square test or Fisher's exact test, continuous data were assessed using F-test or one-way ANOVA, and non-normally distributed data were analyzed with the Mann–Whitney U test. Pairwise comparison of three groups was conducted by Chi-square test or Z-test. Statistical significance was defined as $p < 0.05$.

## Result

### Patient and reconstruction procedure information

This cohort comprised 79 males and 15 females with no significant difference in gender distribution (Table 1). The mean ages for the three groups were 63.2, 68.7, and 65.3 years, respectively ($p = 0.827$). Preoperative EORTC QLQ-scores were not significantly different among the three groups ($p = 0.942$). There were no significant differences in the number of days to start eating after surgery (6.50 vs. 6.70 vs. 6.80, $p = 0.245$), the number of days until drain removal (7.0 vs. 8.5 vs. 9.0, $p = 0.146$), and postoperative hospitalization duration (12.0 vs. 12.0 vs. 13.0, $p = 0.165$) (Table 1).

The EG group exhibited shorter operative times and less bleeding compared with JI and DTR groups with significant differences (190 vs. 200 vs. 240 min, $p < 0.05$) and intraoperative bleeding (50 vs. 75 vs. 100 mL, $p < 0.05$). DTR group experienced a significantly longer time to initial postoperative defecation ($p < 0.05$) and a longer duration before resuming peri-bed activities compared with JI and EG groups ($p < 0.05$) (Table 1).

Remove drainage tube criteria: According to the patient's good feeding tolerance, the abdominal drainage tube flow is less than 50 mL, the drainage fluid is tissue exudate, no obvious lymphatic fistula, no chyle leakage, no anastomotic fistula and other abnormal conditions. Peri-bed activities: Patients perform early voluntary physical activity including but not limited to bed turning and voluntary sitting. The number of days to start eating after surgery (6.50 vs. 6.70 vs. 6.80), the number of days to drain removal after surgery (7.0 vs. 8.5 vs. 9.0), and postoperative hospitalization time (12.0 vs. 12.0 vs. 13.0) are comparable with no significant difference. The

**Table 1** The comparison of EG, JI and DTR

| | EG($n=37$) | JI($n=29$) | DTR($n=28$) | *P*-value |
|---|---|---|---|---|
| Age(years) | 63.2 ± 10.3 | 68.7 ± 5.8 | 65.3 ± 9.0 | 0.827 |
| Male | 28(75.7) | 26(89.7) | 25(89.3) | 0.241 |
| Female | 9(24.3) | 3(10.3) | 3(10.7) | |
| Pre-operative EORTC QLQ E-30 | | | | |
| Quality of life | 64.3(56.7–68.1) | 61.5(58.4–62.7) | 63.6(57.3–65.4) | 0.942 |
| Physical function | 61.2(58.9–64.1) | 60.8(59.3–63.5) | 60.1(59.1–65.7) | |
| Emotional function | 43.7(30.8–48.4) | 45.1(31.7–49.1) | 43.9(30.8–47.1) | |
| Social function | 50.5(41.6–57.1) | 52.1(40.8–54.6) | 51.7(42.7–53.0) | |
| Operation time(min) | 190(165–240) | 200(190–220) | 240(200–275) | < 0.05 |
| Blood loss(mL) | 50(50–100) | 75(50–100) | 100(50–100) | < 0.05 |
| First flatus time(h) | 59.0(45.5–71.0) | 64.0(47.0–86.0) | 73.0(46.0–95.0) | < 0.05 |
| Diarrhea | 8 | 0 | 0 | 0.142 |
| Days to peri-bed activities post-operation(d) | 10(9–14) | 13(10–17) | 14(12–18) | < 0.05 |
| Days to start eating(d) | 6.50 ± 1.50 | 6.70 ± 1.75 | 6.80 ± 1.50 | 0.245 |
| Days to remove drainage tube (d) | 7.0(6.5–8.5) | 8.5(8.0–10.0) | 9.0(8.5–10.0) | 0.146 |
| Postoperative hospital stay (d) | 12.0(10.0–14.0) | 12.0(10.0–13.5) | 13.0(11.0–14.0) | 0.165 |

differences in operative time (190 vs. 200 vs. 240, $p < 0.05$) and bleeding (100 vs. 75 vs. 50, $p < 0.05$) among the three groups were statistically significant.

### Postoperative pathology

Postoperative pathological data revealed no significant differences in tumor site, tumor size, the number of dissected lymph nodes, and proximal and distal margin among the three groups (Table 2). There was a significant difference in the TNM staging ($p < 0.05$).

### Postoperative complications

The DTR group showed lower intestinal obstruction compared with EG and JI (3.6% vs. 5.4% vs. 10.3%)

**Table 2** Postoperative pathology

| | | EG ($n=37$) | JI ($n=29$) | DTR ($n=28$) | *p*-value |
|---|---|---|---|---|---|
| **Tumor location** | AEG | 21(56.8) | 18(62.1) | 17(60.7) | 0.899 |
| | Upper third of the stomach | 16(43.2) | 11(37.9) | 11(39.3) | |
| **Tumor size (cm)** | | 3.0(2.0–4.0) | 1.7(1.3–3.1) | 1.5(1.1–3.0) | 0.279 |
| **Tumor differentiation** | Well | 5(13.5) | 6(20.7) | 5(17.8) | 0.948 |
| | Moderately | 17(45.9) | 12(41.4) | 11(39.3) | |
| | poorly | 15(40.5) | 11(37.9) | 12(42.9) | |
| **Depth of gastric wall infiltration (cm)** | | 1.51 ± 0.44 | 1.36 ± 0.67 | 1.56 ± 0.46 | 0.172 |
| **Number of lymph nodes cleared (pieces)** | | 18.7 ± 9.96 | 18.9 ± 9.88 | 19.3 ± 9.56 | 0.113 |
| **TNM stage** | IA | 18(48.7) | 19(65.5) | 16(57.1) | < 0.05 |
| | IB | 5(13.5) | 7(24.1) | 8(28.6) | |
| | IIA | 3(8.1) | 3(10.4) | 4(14.3) | |
| | IIB | 7(18.9) | 0 | 0 | |
| | IIIA | 3(8.1) | 0 | 0 | |
| | IIIB | 1(2.7) | 0 | 0 | |
| | IIIC | 0 | 0 | 0 | |
| **Proximal margin(mm)** | | 2.0(1.3–2.1) | 2.0(1.2–2.8) | 2.0(1.3–3.0) | 0.073 |
| **Distal margin(mm)** | | 5.0(2.2–6.0) | 5.0(2.8–7.6) | 5.0(2.6–7.4) | 0.243 |

The data demonstrated a significant difference in the TNM staging ($p < 0.05$). There was no significant difference in the proximal margin ($p < 0.05$) and distal margin among the three groups

**Table 3** Postoperative complications

| | | EG($n=37$) | JI($n=29$) | DTR($n=28$) | *p*-value |
|---|---|---|---|---|---|
| **Anastomotic leakage** | No | 34(91.9) | 25(86.2) | 26(92.9) | 0.744 |
| | yes | 3(8.1) | 4(13.8) | 2(7.1) | |
| **Anastomotic stenosis** | No | 27(73.0) | 24(82.8) | 25(89.3) | 0.590 |
| | Mild | 5(13.5) | 3(10.3) | 2(7.1) | |
| | Severe | 5(13.5) | 2(6.9) | 1(3.6) | |
| **Intestinal obstruction** | | 2(5.4) | 3(10.3) | 1(3.6) | 0.6 |
| **Surgical site infection** | | 3(8.1) | 4(13.8) | 3(10.7) | 0.913 |

(Table 3). There was no significant difference in the overall incidence of anastomotic leakage, anastomotic stenosis and surgical site infection. These results indicated that DTR led to a marginally better outcome of postoperative complications.

The location of anastomotic fistula is generally in the esophageal-remnant stomach and esophageal-jejunal stomosis. No jejuno-jejunal stomosis and jejunal gastric anastomotic fistula were found in this experiment. The JI group had a higher proportion of individuals with an intestinal obstruction compared to the other groups (10.3% vs. 5.4% vs. 3.6%). Patients diagnosed with intestinal obstruction have been effectively managed with conservative medical treatment.

### Esophageal reflux before and after surgery

RSI and GERD-Q scores and the Los Angeles grading were compared before and after PG up to 6 months. The patients showed similar score pattern before surgery in all three groups. After surgery, the DTR group showed lower GERD-Q and RSI scores and Los Angeles grading ($p<0.05$) compared with EG and JI, indicating higher efficacy of reflux esophagitis prevention by DTR (Table 4). Esophageal 24-h pH acidity was measured and the results showed the superior outcomes of the DTR group compared with EG and JI ($p<0.05$) (Table 4, Fig. 5).

The pairwise comparison by Chi-square test was performed among EG Group, JI Group and DTR Group (Table 5). The results showed that the outcomes of DTR group was significantly different compared with JI group ($\chi^2=6.79$, $p=0.043$) or EG group ($\chi^2=6.25$, $p=0.024$) respectively, suggesting a superior outcome of DTR procedure for post-PG digestive tract reconstruction.

The number of acid refluxes at pH-4 over a 24-h period is indicated (Fig. 5A).The DTR group showed a significant reduction in the number of refluxes lasting longer than 5 min (Fig. 5B), the percentage of total time with pH < 4.0 (Fig. 5C), and the percentage of time with pH < 4.0 in the upright position (Fig. 5D). Significant changes were seen in the percentage of time with pH < 4.0 in the tilted position (Fig. 5E) and Demeester scores (Fig. 5F) for EG, JI and DTR.

The DTR group showed the most significant decrease in the number of esophageal reflux episodes at 24 h postsurgery ($p<0.01$) (Fig. 5). The DTR group demonstrated post-PG recovery advantages regarding the number of reflux episodes lasting > 5 min (Fig. 5B), the percentage of total time with pH < 4.0 (Fig. 5C), as well as the percentage of time with pH < 4.0 in an upright position (Fig. 5D). These findings suggested that DTR has an optimal effect on anti-esophageal reflux.

**Table 4** Esophageal reflux before and after operation in each group

| | | Preoperative | | | *p*-value | Postoperative | | | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| | | EG | JI | DTR | | EG | JI | DTR | |
| **GERD-Q scores** | | 10(9–12) | 11(9–13) | 10(8–13) | 0.194 | 7(4–9) | 5(3–6) | 4(3–6) | < 0.05 |
| **RSI scores** | | 18(12–23) | 19(14–23) | 19(15–24) | 0.148 | 6(4–7) | 6(3–8) | 5(3–7) | < 0.05 |
| **Los Angeles rating** | **A** | 14 | 5 | 8 | 0.320 | 8 | 5 | 6 | < 0.05 |
| | **B** | 2 | 3 | 4 | | 2 | 1 | 2 | |
| | **C** | 3 | 1 | 3 | | 0 | 1 | 0 | |
| | **D** | 1 | 0 | 0 | | 0 | 0 | 0 | |

The DTR group showing superior outcomes compared to the other two groups ($p<0.05$)

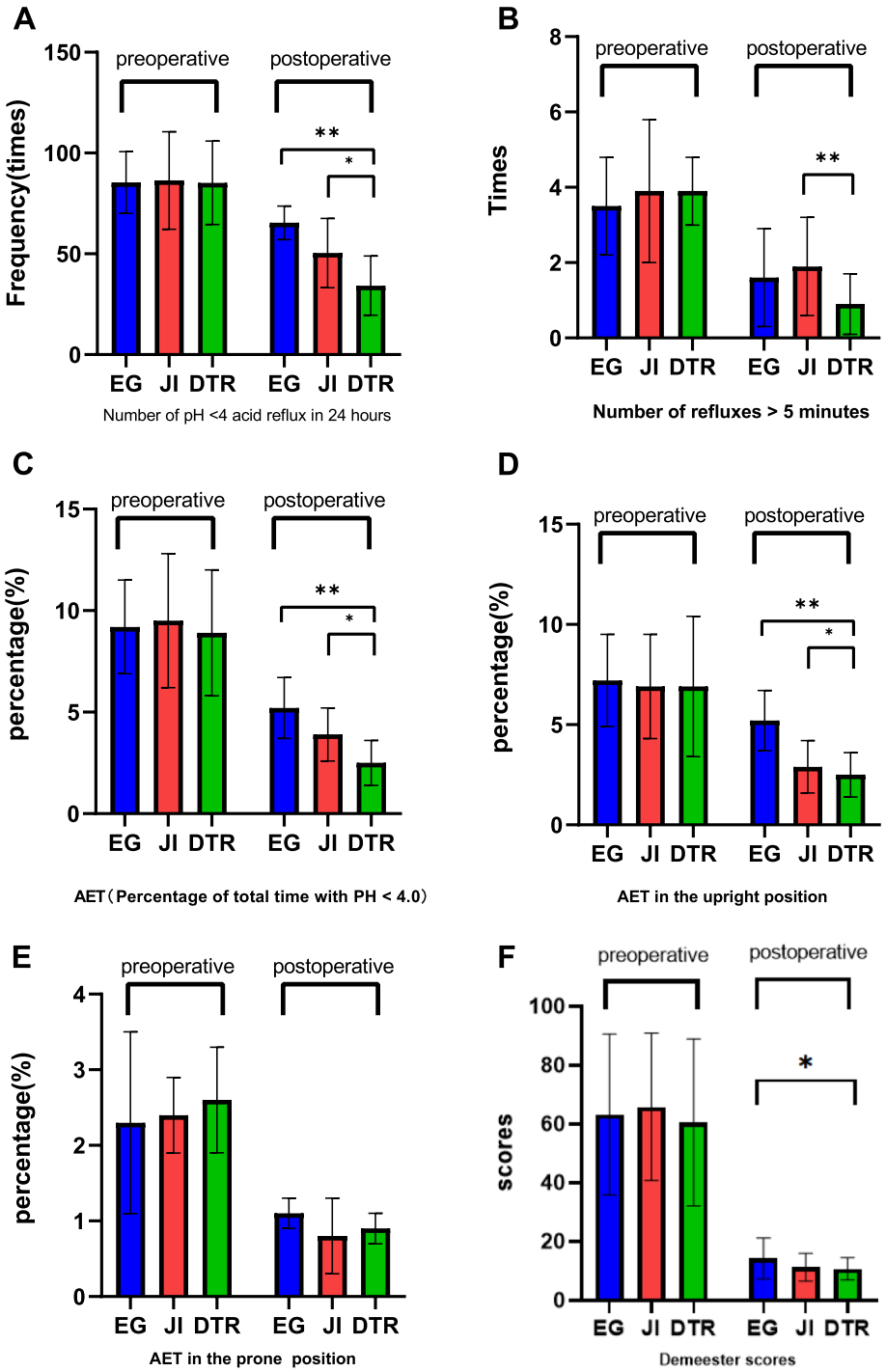


**Fig. 5** Esophageal reflux before and after operation in each group (**A**-**F**)

### Changes in nutritional and endocrine indexes before and after surgery

There was no significant change of BMI, hemoglobin, serum albumin, total protein, serum gastrin, motilin and somatostatin in the DTR group compared with EG and JI despite of similar preoperative level among all groups ($p > 0.05$) (Table 6). Gastric motility, as reflected by endocrine indexes, showed relatively high levels of GAS and SS in the JI group post-surgery, with

**Table 5** Pairwise comparison of three groups was conducted by Chi-square test

| Variable | $\chi^2$ value | *p* value |
|---|---|---|
| JI vs DTR | 6.79 | 0.043 |
| JI vs EG | 5.17 | 0.165 |
| DTR vs EG | 6.25 | 0.024 |

significant differences compared with the other two groups (Fig. 6A-C).

A graph of GAS preoperative and postoperative level indicators (Fig. 6A); A graph of preoperative and postoperative level indicators (Fig. 6B). A graph of SS preoperative and postoperative level indicators (Fig. 6C). The levels of GAS and SS in the JI group were relatively high after surgery, showing significant differences compared to the other two groups.

#### Postoperative quality of life

EORTC QLQ-C30 questionnaire scores were assessed among the EG, JI, and DTR groups (Table 7). Overall health status scores were significantly higher in the DTR group than that of the EG and JI groups (84.5 vs. 79.3 vs. 50.1, $p<0.001$). Patients in the DTR group reported superior emotional functioning ($p<0.001$) and experienced fewer symptoms of nausea and vomiting ($p<0.001$), pain ($p=0.063$), insomnia ($p<0.001$), and constipation ($p=0.025$) compared with EG and JI groups.

Overall health status scores were higher in the DRT group than in the EG and JI groups (84.5 vs. 79.3 vs. 50.1, $p<0.001$).

The pairwise comparison by Z-test was performed among EG Group, JI Group and DTR Group (Table 8). The results showed that the outcomes of DTR group was significantly different compared with JI group ($Z=2.016$, $p=0.039$) or EG group ($Z=3.271$, $p<0.001$) respectively, suggesting a superior outcome of DTR procedure for post surgery patient health status.

## Discussion

EG, JI and DTR are the main surgical options for PG despite of different pathophysiologic consequences. JI, first reported by Adachi et al. [26, 27], extends the reflux distance and reduces gastric acid secretion, thereby alleviating reflux symptoms. It also decreases anastomotic tension to enhance the safety of the anastomosis [28]. However, research indicates that anastomotic stenosis and reflux esophagitis rates remain high following JI. Several studies report postoperative complications in JI patients, with stenosis rates ranging from 7.1% to 20% and reflux esophagitis rates from 5.7% to 31.8% [28]. Regarding DTR, a study found no significant correlation between the number of anastomoses and the incidence of anastomotic leakage or stenosis [29]. Additionally, several retrospective studies have reported surgical outcomes following DTR use for PG [30–33]. Reflux esophagitis, reflux syndromes, and residual food were reported in 1.1–10.5%, 4.7–10.5%, and 0–48.9% of patients, respectively. EG is the most classical reconstruction technique after PG and has been widely used by surgeons for years, exhibiting greater changes in post-discharge nutritional parameters, with Skeletal Muscle Index also demonstrating significant superiority (0.83 vs. 0.89; $p=0.045$) [34].

In our study, the DTR demonstrated a better anti-reflux effect comparable with the EG and JI group in terms of reducing esophageal reflux episodes at 24 h post-surgery. The number of reflux episodes lasting > 5 min, the percentage of total time with pH < 4.0, as well as the percentage of time with pH < 4.0 in an upright position were significantly reduced in the DTR group suggesting that DTR holds advantage of mitigating anti-esophageal reflux within a short period of post surgery. Although DTR procedures is more complicated with three anastomoses (esophagojejunostomy, gastrojejunostomy, and jejunojejunostomy) and takes longer operational time, there was no obvious difference in the overall incidence of anastomotic leakage, anastomotic stenosis and surgical site infection among the three groups. The DTR group showed lower intestinal obstruction compared with the EG and JI groups (3.6% vs 5.4% vs. 10.3%, $p<0.05$). In our study, outcomes in terms of postoperative complications in DTR had a marginally better outcome.

Differences were observed for overall health status and emotional functioning including dysphagia, pain, reflux, feeding difficulties, anxiety, dry mouth, and taste disturbances. The DTR group was marginally better in the outcome of overall health status compared with the EG and JI groups. The DTR group exhibited stable intestinal absorption and hormone secretion kinetics, indicating its potential superiority over JI in function-preserving gastrectomy [11]. DTR was associated with a longer operative time, increased blood loss, and greater surgical complexity compared to the other two groups. Therefore, the selection of the gastrointestinal reconstruction should be carefully considered based on individual patient circumstances [35–40].

EG resembles the physiological structure to allow food to pass through the stomach and duodenum and to facilitate nutrient absorption. Our results indicated that the EG group did not outperform in terms of nutrition absorption parameters. Instead it had a higher incidence of postoperative reflux. This reconstructive approach resulted in technical simplicity and less intraoperative blood loss, shorter operative time, and hospital stay compared with the other two groups.

**Table 6** Nutritional and endocrine indicators

| | Preoperative | | | *p*-value | Postoperative (1 month) | | | *p*-value |
|---|---|---|---|---|---|---|---|---|
| | EG | JI | DTR | | EG | JI | DTR | |
| **Body Mass Index(BMI)(kg/m$^2$)** | 24.0 ± 4.0 | 23.6 ± 3.9 | 23.5 ± 3.5 | 0.294 | 22.4 ± 4.3 | 21.6 ± 2.9 | 22.7 ± 3.5 | 0.314 |
| **hemoglobin(Hb) (g/dl)** | 12.8 ± 2.0 | 13.0 ± 1.8 | 13.2 ± 1.9 | 0.148 | 12.5 ± 2.3 | 12.8 ± 1.8 | 12.2 ± 1.7 | > 0.05 |
| **serum albumin(ALB) (g/dl)** | 4.0 ± 0.5 | 4.2 ± 0.4 | 3.9 ± 0.4 | 0.562 | 3.9 ± 0.6 | 4.5 ± 0.4 | 3.9 ± 0.4 | > 0.05 |
| **total serum protein(TP) (g/dl)** | 7.0 ± 0.6 | 7.2 ± 0.5 | 7.1 ± 0.5 | 0.274 | 6.4 ± 0.6 | 6.6 ± 0.5 | 6.1 ± 0.5 | > 0.05 |
| **serum gastrin(GAS) (pg/ml)** | 167.56 ± 49.32 | 156.56 ± 47.52 | 162.56 ± 39.77 | 0.197 | 91.7 ± 26.52 | 114.32 ± 44.32 | 103.32 ± 49.29 | 0.293 |
| **motilin(MLT) (pg/ml)** | 244.32 ± 59.23 | 264.32 ± 61.27 | 253.32 ± 69.18 | 0.241 | 203.7 ± 26.52 | 223.56 ± 44.62 | 212.56 ± 29.57 | 0.112 |
| **somatostatin(SS) (pg/ml)** | 69.62 ± 22.13 | 72.62 ± 28.35 | 71.60 ± 19.56 | 0.662 | 53.62 ± 12.43 | 63.19 ± 19.37 | 51.60 ± 15.22 | > 0.05 |

The differences in BMI, hemoglobin, serum albumin, total protein, serum gastrin, motilin and somatostatin among the three groups were not statistically significant

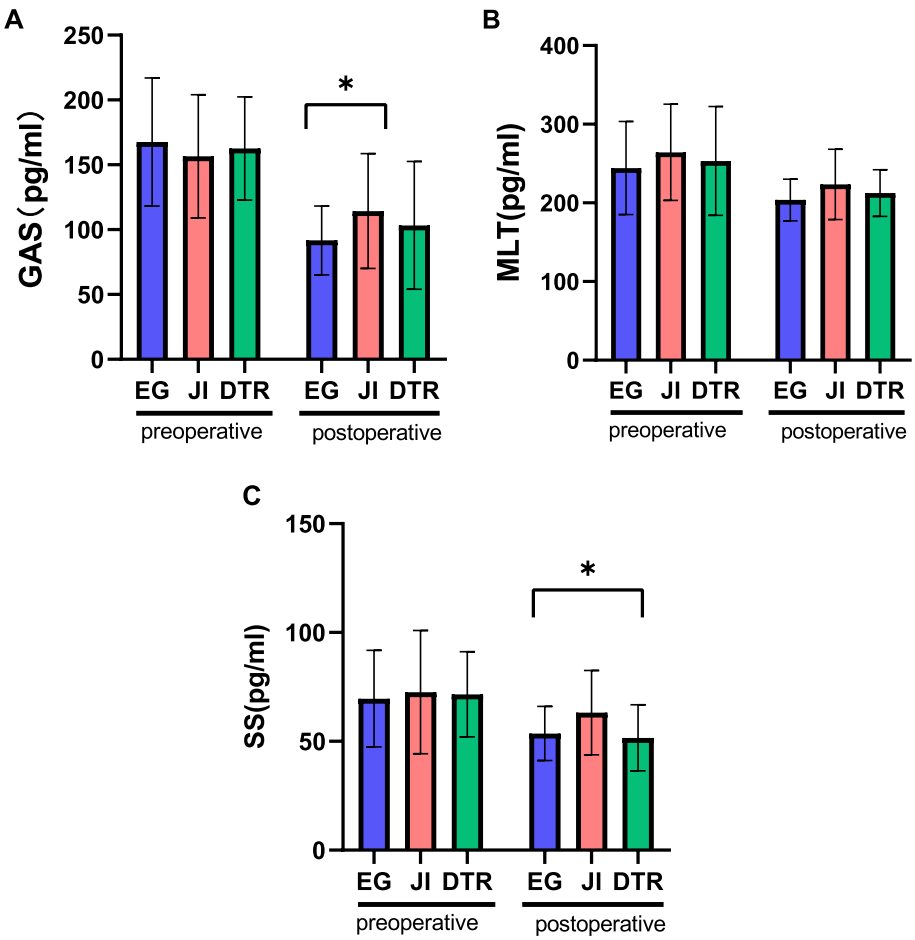


**Fig. 6** Nutritional and endocrine indicators (**A**-**C**)

**Table 7** EORTC QLQ-C30 evaluation scale (one year after surgery)

| | EG | JI | DTR | *p*-value |
|---|---|---|---|---|
| **Global health status** | 50.1(30.3–50.6) | 79.3(58.6–82.7) | 84.5(65.7–87.9) | < 0.001 |
| **Functional scales** | | | | |
| Physical functioning | 81.0(64.9–86.5) | 79.3(65.5–86.5) | 82.1(66.5–85.7) | 0.667 |
| Role functioning | 65.7(64.9–65.7) | 69.0(69.0–73.1) | 68.5(65.9–78.6) | 0.126 |
| Emotional functioning | 51.4(40.5–59.5) | 62.1(41.4–62.1) | 67.9(65.9–78.6) | < 0.001 |
| Cognitive functioning | 100.0(66.5–100.0) | 100.0(69.0–100.0) | 100.0(71.4–100.0) | 0.241 |
| Social functioning | 65.7(65.7–67.5) | 65.5(65.5–69.0) | 67.9(65.9–82.1) | 0.087 |
| **Symptom scales** | | | | |
| Fatigue | 37.8(35.1–37.8) | 34.5(0–34.5) | 35.7(0–35.7) | 0.372 |
| Nausea and vomiting | 51.3(51.3–86.5) | 13.8(10.3–17.2) | 14.3(10.7–17.9) | < 0.001 |
| Pain | 16.2(13.5–29.7) | 13.8(0–13.8) | 10.7(0–14.3) | 0.063 |
| Dyspnea | 0.0(0.0–24.3) | 0.0(0.0–0.0) | 0.0(0.0–0.0) | < 0.001 |
| Insomnia | 32.4(0.0–32.4) | 0.0(0.0–0.0) | 0.0(0.0–0.0) | < 0.001 |
| Appetite loss | 32.4(0.0–32.4) | 34.5(0.0–34.5) | 0.0(0.0–32.1) | 0.072 |
| Constipation | 0.0(0.0–0.0) | 34.5(0.0–34.5) | 0.0(0.0–0.0) | < 0.05 |
| Diarrhea | 0.0(0.0–32.4) | 0.0(0.0–0.0) | 0.0(0.0–0.0) | 0.632 |
| **Financial difficulties** | 32.4(0.0–32.4) | 34.5(0.0–34.5) | 32.1(0.0–32.1) | 0.329 |

**Table 8** Pairwise comparison of three groups was conducted by Z-test

| Variable | *Z* value | *P* value |
|---|---|---|
| EG vs. JI | 2.184 | 0.037 |
| EG vs. DTR | 3.271 | < 0.001 |
| DTR vs. JI | 2.016 | 0.039 |

JI is a function-preserving gastrectomy that almost completely maintains preoperative intestinal absorption and achieves a better postoperative quality of life than EG. JI shows the highest plasma gastrin levels and better anti-reflux effects compared with EG [11]. Our results showed that JI had a higher risk of intestinal obstruction and anastomotic stenosis than the other two groups. Previous studies reported that JI patients often experience problems with emptying dysfunction and residual food, leading to postprandial abdominal discomfort, persistent abdominal fullness, and hiccups between meals [39, 40]. Our results also showed that the incidence of reflux esophagitis was lower in PG patients with JI than those with EG.

Several limitations must be acknowledged in this study. Firstly, the study design is retrospective and based on a case series, with a relatively small sample size. Secondly, comprehensive functional outcomes were not investigated through clinical evaluations, anthropometric tests and laboratory assessments. Nutrition status was solely evaluated using blood indicators and BMI. Thirdly, the study only presents postoperative data for one year. Fourth, the impact of PPIs on gastric acid secretion was not evaluated as patient PPI intake could not be recorded after hospital discharge. Fourthly, this study did not elucidate whether the remnant stomach size influences the QOL and nutrition status of postoperative patients. Last, in this study PG was completed with D2 lymphadenectomy while multiple factors may affect the number of lymph nodes obtained after gastric cancer surgery. 1, BMI can affect the number of lymph nodes obtained from gastric cancer radical surgery specimens due to the difficulty of lymph node dissection and sorting caused by the different degrees of abdominal fat. 2, specimens fixed in formalin increase the difficulty of finding lymph nodes, especially for smaller diameter lymph nodes, which further increases the difficulty of effective detection. 3, the familiarity of different pathologists with the anatomy of gastric lymph nodes is also an important factor affecting the number of lymph nodes detected. Experienced pathologists often detect more lymph nodes. 4, the number of detected gastric lymph nodes in each patient is also related to the factors such as the differentiation type of the tumor and the depth of infiltration into the gastric wall. Therefore, according to the guidelines for obtaining the required number of lymph nodes after radical gastrectomy for gastric cancer, the average number of lymph nodes obtained in each group in this study should be considered as meeting the requirements and exceeding the number of lymph nodes cleared in the study.

In conclusion, this study compared EG, JI and DTR for PG in term of effectiveness of anti-reflex. EG had high incidence of reflux esophagitis which reduced patients' QOL while exhibiting shorter operative times and less bleeding. JI reduced the prevalence of reflux esophagitis although the rate of reflux symptoms and reflux esophagitis remained high in the JI group. DTR presented a better prevention of reflux esophagitis and enhancement of quality of life than JI and EG.

**Abbreviations**

| | |
|---|---|
| AEG | Adenocarcinoma of the esophagogastric junction |
| PG | Proximal gastrectomy |
| TG | Total gastrectomy |
| JGCG | The Japanese Gastric Cancer Association |
| EG | Esophagogastrostomy |
| JI | Jejunal interposition |
| DTR | Double tract reconstruction |
| RSI | Reflux Symptom Index |
| GERD-Q | Gastroesophageal Reflux Disease Questionnaire |
| QOL | Postoperative quality of life |
| CT | Computed Tomography |
| E-J anastomosis | Esophagojejunostomy |
| G-J anastomosis | Gastrojejunostomy |
| J-J anastomosis | Jejunojejunostomy |
| TNM stage | Tumor node metastasis classification |
| Wt | Weight |
| Hb | Hemoglobin |
| ALB | Serum albumin |
| TP | Serum total protein |
| GAS | Serum gastrin |
| MTL | Gastric motility |
| SS | Growth inhibitory hormone |
| BMI | Body Mass Index |
| PPIs | Proton pump inhibitors |

## Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Not applicable.

**Clinical trial number**
Not applicable.

**Authors' contributions**
Y. X were responsible for designing and running the experiments and writing the manuscript. N.Q. S and Z.G. W were responsible for experiments and data analysis. Q.C. Z were responsible for the conception, design, and coordination

of the study, acquisition and interpretation of the statistical data, and revision of the manuscript.

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**Data availability**
Data is provided within the manuscript or supplementary information files.

## Declarations

**Ethics approval and consent to participate**
The study was approved by the Medical Ethics Committee of Shanghai Sixth People's Hospital (2021–093) and conducted in accordance with the Declaration of Helsinki.
All patients provided informed consent by signing an informed consent form.

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare no competing interests.

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**References**

1. Rice TW, Ishwaran H, Ferguson MK, Blackstone EH, Goldstraw P. Cancer of the esophagus and esophagogastric junction: an Eighth Edition staging primer. J Thorac Oncol. 2017;12(1):36–42 Epub 2016 Oct 31.
2. Xu Y, Tan Y, Wang Y, et al. Proximal versus total gastrectomy for proximal early gastric cancer: a systematic review and meta-analysis. Medicine (Baltimore). 2019;98(19):e15663.
3. Yang X, Zeng Z, Liao Z, Zhu C, Wang H, Wu H, Cao S, Liang W, Li X. Comparison of proximal gastrectomy and total gastrectomy in proximal gastric cancer: a meta-analysis of postoperative health condition using the PGSAS-45. BMC Cancer. 2024;24(1):1282.
4. Blank S, Schmidt T, Heger P, Strowitzki MJ, Sisic L, Heger U, Nienhueser H, Haag GM, Bruckner T, Mihaljevic AL, Ott K, Büchler MW, Ulrich A. Surgical strategies in true adenocarcinoma of the esophagogastric junction (AEG II): thoracoabdominal or abdominal approach? Gastric Cancer. 2018;21(2):303–14.
5. Kamarajah SK, Markar SR. Esophagectomy or Total Gastrectomy for Siewert 2 Gastroesophageal Junction (GEJ) Adenocarcinoma: An Ongoing Debate. Ann Surg Oncol. 2022;29(1):750.
6. Yamashita H, Toyota K, Kunisaki C, Seshimo A, Etoh T, Ogawa R, Baba H, Demura K, Kaida S, Oshio A, Nakada K. Current status of gastrectomy and reconstruction types for patients with proximal gastric cancer in Japan. Asian J Surg. 2023;46(10):4344–51.
7. Association J G C. Japanese gastric cancer treatment guidelines 2014 (ver. 4). Gastric Cancer. 2017;20(1):1–19.
8. Wang S, Lin S, Wang H, et al. Reconstruction methods after radical proximal, gastrectomy: a systematic review. Medicine (Baltimore). 2018;97(11):e121.
9. Jeon TY, Lee S, Kim HH, Kim YJ, Son HC, Kim DH, Sim MS. Changes in plasma ghrelin concentration immediately after gastrectomy in patients with early gastric cancer. J Clin Endocrinol Metab. 2004;89(11):5392–6.
10. Nomura E, Lee SW, Kawai M, et al. Functional outcomes by reconstruction technique following laparoscopic proximal gastrectomy for gastric cancer: double tract versus jejunal interposition. World J Surg Oncol. 2014;12:20.
11. Nomura E, Kayano H, Lee SW, et al. Functional evaluations comparing the double-tract method and the jejunal interposition method following laparoscopic proximal gastrectomy for gastric cancer: an investigation including laparoscopic total gastrectomy. Surg Today. 2019;49(1):38–48.
12. Japanese Gastric Cancer A. Japanese gastric cancer treatment guidelines 2021 (6th edition). Gastric Cancer. 2023;26(1):1–25.
13. Ichikawa D, Ueshima Y, Shirono K, Kan K, Shioaki Y, Lee CJ, et al. Esophagogastrostomy reconstruction after limited proximal gastrectomy. Hepatogastroenterology. 2001;48:1797–801.
14. Nakamura M, Nakamori M, Ojima T, Katsuda M, Iida T, Hayata K, et al. Reconstruction after proximal gastrectomy for early gastric cancer in the upper third of the stomach: an analysis of our 13-year experience. Surgery. 2014;156:57–63.
15. Hsu CP, Chen CY, Hsieh YH, Hsia JY, Shai SE, Kao CH. Esophageal reflux after total or proximal gastrectomy in patients with adenocarcinoma of the gastric cardia. Am J Gastroenterol. 1997;92(8):1347–50.
16. Katai H, Sano T, Fukagawa T, Shinohara H, Sasako M. Prospective study of proximal gastrectomy for early gastric cancer in the upper third of the stomach. Br J Surg. 2003;90(7):850–3.
17. Katai H, Morita S, Saka M, Taniguchi H, Fukagawa T. Long-term outcome after proximal gastrectomy with jejunal interposition for suspected early cancer in the upper third of the stomach. Br J Surg. 2010;97(4):558–62.
18. Ahn SH, Jung DH, Son SY, Lee CM, Park DJ, Kim HH. Laparoscopic double-tract proximal gastrectomy for proximal early gastric cancer. Gastric Cancer. 2014;17(3):562–70 Epub 2013 Sep 20.
19. Chen J, Wang F, Gao S, Yang Y, Zhao Z, Shi J, Wang L, Ren J. Surgical outcomes of laparoscopic proximal gastrectomy for upper-third gastric cancer: esophagogastrostomy, gastric tube reconstruction, and double-tract reconstruction. BMC Surg. 2023;23(1):309.
20. Takiguchi N, Takahashi M, Ikeda M, et al. Long-term quality-of-life comparison of total gastrectomy and proximal gastrectomy by post-gastrectomy syndrome assessment scale (PGSAS-45): a nationwide multi-institutional study. Gastric Cancer. 2015;18(2):407–16.
21. Ohashi M, Morita S, Fukagawa T, Oda I, Kushima R, Katai H. Functional advantages of proximal gastrectomy with jejunal interposition over total gastrectomy with Roux-en-Y esophagojejunostomy for early gastric cancer. World J Surg. 2015;39(11):2726–33.
22. Zhang D, Liu S, Li Z, Wang R. Global, regional and national burden of gastroesophageal reflux disease, 1990–2019: update from the GBD 2019 study. Ann Med. 2022;54(1):1372–84.
23. Zheng Z, Shang Y, Wang N, Liu X, Xin C, Yan X, Zhai Y, Yin J, Zhang J, Zhang Z. Current advancement on the dynamic mechanism of gastroesophageal reflux disease. Int J Biol Sci. 2021;17(15):4154–64.
24. Jung DH, Lee Y, Kim DW, et al. Laparoscopic proximal gastrectomy with double tract reconstruction is superior to laparoscopic total gastrectomy for proximal early gastric cancer. Surg Endosc. 2017;31(10):3961–9.
25. Ma JJ, He ZR, Zang L. Digestive tract reconstruction after laparoscopic proximal gastrectomy for adenocarcinoma of esophagogastric junction. Zhonghua Wei Chang Wai Ke Za Zhi. 2022;25(2):124–30 Chinese.
26. Bolton JS, Conway WC. 2nd postgastrectomy syndromes. Surg Clin North Am. 2011;91(5):1105–22.
27. Sun KK, Wu YY. Current status of laparoscopic proximal gastrectomy in proximal gastric cancer: technical details and oncologic outcomes. Asian J Surg. 2021;44(1):54–8.
28. Chen XF, Zhang B, Chen ZX, et al. Gastric tube reconstruction reduces postoperative gastroesophageal reflux in adenocarcinoma of esophagogastric junction. Dig Dis Sci. 2012;57(3):738–45.
29. Adachi Y, Inoue T, Hagino Y, Shiraishi N, Shimoda K, Kitano S. Surgical results of proximal gastrectomy for early-stage gastric cancer: jejunal interposition and gastric tube reconstruction. Gastric Cancer. 1999;2(1):40–5.
30. Hosogi H, Yoshimura F, Yamaura T, Satoh S, Uyama I, Kanaya S. Esophagogastric tube reconstruction with stapled pseudo-fornix in laparoscopic proximal gastrectomy: a novel technique proposed for Siewert type II tumors. Langenbecks Arch Surg. 2014;399(4):517–23.
31. Mochiki E, Fukuchi M, Ogata K, Ohno T, Ishida H, Kuwano H. Postoperative functional evaluation of gastric tube after laparoscopic proximal gastrectomy for gastric cancer. Anticancer Res. 2014;34(8):4293–8.
32. Toyomasu Y, Mochiki E, Ishiguro T, et al. Clinical outcomes of gastric tube reconstruction following laparoscopic proximal gastrectomy for early gastric cancer in the upper third of the stomach: experience with 100 consecutive cases. Langenbecks Arch Surg. 2021;406(3):659–66.

33. Li Z, Ma Y, Liu G, Fang M, Xue Y. Proximal gastrectomy with gastric tube reconstruction or jejunal interposition reconstruction in upper-third gastric cancer: which offers better short-term surgical outcomes? BMC Surg. 2021;21(1):249.
34. Morino K, Kitano T, Kadokawa Y, Nakanishi N, Yamamoto M, Machimoto T. Esophagogastrostomy versus double tract reconstruction for laparoscopic proximal gastrectomy: short-term outcomes based on nutritional parameters and skeletal muscle index. In Vivo. 2024;38(3):1325–31.
35. Kawaguchi Y, Akaike H, Ichikawa D. Proximal gastrectomy for gastric cancer. Nihon Shokakibyo Gakkai Zasshi. 2023;120(6):468–74.
36. Shaibu Z, Chen Z, Mzee SAS, Theophilus A, Danbala IA. Effects of reconstruction techniques after proximal gastrectomy: a systematic review and meta-analysis. World J Surg Oncol. 2020;18(1):171.
37. Hipp J, Hillebrecht HC, Kalkum E, Klotz R, Kuvendjiska J, Martini V, Fichtner-Feigl S, Diener MK. Systematic review and meta-analysis comparing proximal gastrectomy with double-tract-reconstruction and total gastrectomy in gastric and gastroesophageal junction cancer patients: Still no sufficient evidence for clinical decision-making. Surgery. 2023;173(4):957–67.
38. Shoda K, Kubota T, Kawaguchi Y, Akaike H, Maruyama S, Higuchi Y, Nakayama T, Saito R, Takiguchi K, Furuya S, Shiraishi K, Amemiya H, Kawaida H, Ichikawa D. Differences in glycemic trends due to reconstruction methods after proximal gastrectomy from the perspective of continuous glucose-monitoring. Surg Today. 2024;54(9):1104–11.
39. Gentilli S, Portigliotti L, Davoli F, Roncon A, Rena O, Oldani A. Novel double-stapling technique for distal oesophageal resection and oesophagojejunal anastomosis. Ann Ital Chir. 2016;87:79–82.
40. Yasuda A, Yasuda T, Imamoto H, Kato H, Nishiki K, et al. A newly modified esophagogastrostomy with a reliable angle of His by placing a gastric tube in the lower mediastinum in laparoscopy-assisted proximal gastrectomy. Gastric Cancer. 2015;18(4):850–8.


## Publisher's Note