

# Reconstruction methods after radical proximal gastrectomy

## A systematic review

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### Abstract

**Background:** The incidence of tumors located in the upper third of the stomach is increasing, and the use of radical proximal gastrectomy is becoming prevalent. After a proximal gastrectomy, various reconstructions are performed, but surgical outcomes are controversial. This study was performed to review clinical outcomes of reconstructions after proximal gastrectomy.

**Methods:** Inclusion criteria focused on postoperative complications of patients who underwent a proximal gastrectomy for gastric cancer. Exclusion criteria were case reports; targeted data not investigated; a duplicate study reported in a larger cohort; esophageal sphincter preservation surgery; near-total gastrectomy; recurrence of tumor; and combined organ resection.

**Results:** In total, 22 retrospective and 2 prospective studies were included. The studies investigated surgical outcomes of esophagogastrectomy (n = 10), jejunal interposition (n = 12), jejunal pouch interposition (n = 7), double tract jejunal interposition (n = 1), and tube-like stomach esophagogastrectomy (n = 5). Pooled incidences of reflux esophagitis or reflux symptoms for these procedures were 28.6%, 4.5%, 12.9%, 4.7%, and 10.7%, respectively. Incidences of postoperative complications were 9.5%, 18.1%, 7.0%, 11.6%, and 9.3%, respectively.

**Conclusions:** Despite increasing operation complexity, which perhaps increased the risk of other postoperative complications, currently used reconstructions present excellent anti-reflux efficacy. However, the optimal reconstruction method remains to be determined.

**Keywords:** proximal gastrectomy, reconstructive surgical procedures, stomach neoplasms

## 1. Introduction

The morbidity rate of cancer located in the upper third of the stomach is increasing worldwide,<sup>[1,2]</sup> and radical gastrectomy remains the cornerstone in treating such a disease. When detected early, gastric cancer has an excellent long-term prognosis, and the 5-year survival rate is more than 90%.<sup>[3,4]</sup> Quality of life after a gastrectomy is very important for patients. A resection large enough to remove the cancer but preserve part of the stomach

contributes to improving the postoperative nutritional status, maintaining body weight, and improving postoperative quality of life.<sup>[5]</sup> However, compared with a total gastrectomy, a proximal gastrectomy is not as frequently performed for treating early gastric cancer in the upper third of the stomach. For instance, 1 report from 19 institutions in Japan demonstrated that 76.3% and 21.8% patients with early gastric cancer located in the upper third of the stomach underwent a total and proximal gastrectomy, respectively.<sup>[6]</sup>

A major concern for proximal gastrectomy is the high risk of postoperative complications, especially reflux esophagitis, which causes severe heart burn, chest pain, regurgitation of sourness, and anorexia, and significantly decreases the postoperative quality of life.<sup>[7]</sup> Accordingly, various types of reconstructions have been investigated. Japanese gastric cancer treatment guidelines propose 3 types of reconstructions for proximal gastrectomy: esophagogastrectomy, jejunal interposition, and double tract jejunal interposition.<sup>[8]</sup> In addition, jejunal pouch interposition and tube-like stomach esophagogastrectomy are also considered as promising methods.

Of the above reconstruction methods, the esophagogastrectomy is the most prevalent. A questionnaire from 145 Japanese institutions demonstrated that the most common reconstruction after proximal gastrectomy is esophagogastrectomy, which was adopted by approximately 50% of institutions.<sup>[9]</sup> Simplicity, shorter operation time, and less blood loss are advantages of an esophagogastrectomy. However, a major shortcoming of an esophagogastrectomy is the high incidence of esophageal reflux. As a result, anti-reflux reconstructions, such as jejunal interposition and tube-like stomach esophagogastrectomy, have been

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SW and LS contributed equally to this work.

Esophagogastrectomy has a high incidence of esophageal reflux.

Currently used anti-reflux methods present excellent anti-reflux efficacy.

Outcomes of different anti-reflux methods remain controversial.

The authors declare no conflicts of interest.

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proposed. However, such methods are not generally adopted because of the increased complexity and lack of clinical evidence. Until recently, the efficacy and clinical outcomes of anti-reflux reconstructions have been unclear, and there is no consensus on the most appropriate reconstruction approach after a proximal gastrectomy.

This systematic review was performed to investigate the incidence of postoperative complications of currently used reconstruction methods after radical proximal gastrectomy.

## 2. Methods

### 2.1. Study selection

A literature search was performed in PubMed using the search terms “(Proximal gastrectomy) and ((esophagogastrostomy) or (jejunal interposition) or (gastric tube) or (tube-like stomach) or (jejunal pouch) or (double tract) or (reconstruction)).” All titles and abstracts of publications were screened to select articles describing reconstructions of proximal gastrectomy for gastric neoplasms located in the upper third of the stomach. Full-text articles of preliminarily included studies were screened. Literature searches and study selection were independently performed by 2 authors (Shiqi Wang & Lin Shang).

### 2.2. Inclusion criteria

Reported a group or subgroup of patients who underwent a proximal gastrectomy for gastric neoplasm.

Focused on postoperative complications, such as reflux esophagitis or reflux symptoms.

### 2.3. Exclusion criteria

Case reports

- Postoperative complications not reported
- Duplicated report in a larger cohort
- Esophageal sphincter preservation surgery
- Near-total gastrectomy

- Surgery for recurrent tumor
- Combined organ resection

### 2.4. Data extraction

General characteristics of included studies, such as the country, study design, groupings, and time interval, were extracted. According to the reconstruction types used, the studies were classified into 5 groups: esophagogastrostomy, jejunal interposition, jejunal pouch interposition, double tract jejunal interposition, and tube-like stomach esophagogastrostomy. Incidences of postoperative in-hospital morbidity, stenosis, reflux esophagitis or reflux syndromes, and residual food were extracted.

Early postoperative complications were considered “early complications,” “in-hospital complications,” “early morbidity,” or “early postoperative complications”; stenosis and reflux esophagitis were confirmed by an endoscopic examination; reflux symptoms were defined as “heart burn,” “reflux symptoms,” “regurgitation,” “nausea,” “vomiting,” or “symptoms from esophageal reflux.” Reflux esophagitis was classified by the Los Angeles classification; degree B or more severe degrees were considered.

In studies reporting incidences of reflux esophagitis during various periods, incidences during the 12th month were considered. In studies separately reporting each postoperative complication, the most frequently observed complication was considered. All analyses were based on previous published studies, thus no ethical approval and patient consent are required.

## 3. Results

Results of the literature searches are shown in Figure 1. The literature searches resulted in 209 studies. Of these studies, 126 obviously irrelevant reports, 35 case reports, 1 preserving esophageal sphincter, 3 performing a subtotal gastrectomy, 1 focusing on recurrent tumor, 1 with combined organ resection, 1

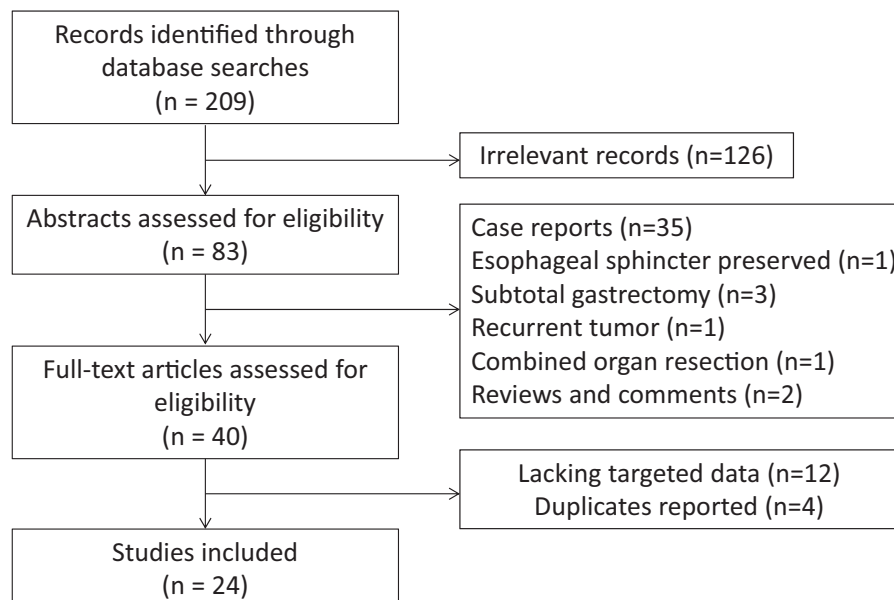


Figure 1. Flow chart of articles identified, included, and excluded.

**Table 1****Characteristics of included studies.**

Reference	Country	Study Interval	Design	Groups
Katai et al <sup>[5]</sup>	Japan	1993–2005	RS	Jl
Sakuramoto et al <sup>[10]</sup>	Japan	2005–2008	RS	EG
Seshimo et al <sup>[11]</sup>	Japan	2004–2012	RC	EG vs Jl
Ahn et al <sup>[12]</sup>	Korea	2003–2009	RS	EG
Masuzawa et al <sup>[13]</sup>	Japan	1998–2005	RC	EG vs Jl
Tokunaga et al <sup>[14]</sup>	Japan	1996–2005	RC	EG vs Jl
Chen et al <sup>[15]</sup>	China	2003–2011	RS	EG
Ichikawa et al <sup>[16]</sup>	Japan	1992–1999	RC	Jl vs EG
Chen et al <sup>[17]</sup>	China	2009–2010	RC	EG vs GT
Hoshikawa et al <sup>[18]</sup>	Japan	1993–1998	RC	JPl vs EG
Nakamura et al <sup>[19]</sup>	Japan	1999–2011	RC	EG vs Jl vs JPl
Shinohara et al <sup>[20]</sup>	Japan	1995–2000	RS	Jl
Yabusaki et al <sup>[21]</sup>	Japan	1996–2011	RC	JPl vs Jl
Kinoshita et al <sup>[22]</sup>	Japan	2008–2011	RS	Jl
Nozaki et al <sup>[23]</sup>	Japan	1999–2008	RS	Jl
Takagawa et al <sup>[24]</sup>	Japan	2000–2008	RCT	Jl vs JPl
Adachi et al <sup>[25]</sup>	Japan	1992–1998	RC	Jl vs GT
Namikawa et al <sup>[26]</sup>	Japan	2004–2010	RS	JPl
Takeshita et al <sup>[27]</sup>	Japan	1994–2003	RS	JPl
Yoo et al <sup>[28]</sup>	Korea	2000–2003	PS	JPl
Ahn et al <sup>[29]</sup>	Korea	2009–2012	RS	DT
Hosogi et al <sup>[31]</sup>	Japan	2010–2013	RS	GT
Aihara et al <sup>[32]</sup>	Japan	2007–2008	RS	GT
Mochiki et al <sup>[33]</sup>	Japan	2006–2011	RS	GT

DT=double tract jejunal interposition, EG=esophagogastrostomy, GT=tube-like stomach tube esophagogastrostomy, Jl=jejunal interposition, JPl=jejunal pouch interposition, PS=prospective case series, RC=retrospective comparative study, RCT=randomized controlled trial, RS=retrospective case series.

review, and 1 comment were excluded. Full-text articles of the other 40 reports were carefully studied, and 12 studies lacking targeted data and 4 duplicate reports were excluded. The remaining 24 reports, including 22 retrospective studies and 2 prospective studies, were included in the present study. Of the included studies, 10 were comparative studies and 14 were considered case series. Details of the included studies are shown in Table 1.

According to the reconstruction types used, the studies were divided into 5 groups: esophagogastrostomy, jejunal interposition, jejunal pouch interposition, double tract jejunal interposition, and tube-like stomach esophagogastrostomy. Results of the separated groups are summarized in Table 2.

### 3.1. Esophagogastrostomy

A total of 10 retrospective studies referred esophagogastrostomy.<sup>[10–19]</sup> Of these patients, early complications, stenosis, reflux esophagitis, and residual food were observed in 9.5%, 15.4%, 28.6%, and 21.8% of cases, respectively. Reflux esophagitis and residual food were the most frequently observed complications (Table 2).

### 3.2. Jejunal interposition

Twelve studies focused on results of the jejunal interposition.<sup>[3,11,13,14,16,19–25]</sup> In patients who underwent a jejunal interpositions, early complications, stenosis, reflux esophagitis, and residual food occurred in 18.1%, 9.6%, 4.5%, and 19.0%, respectively. Major problems of the simple jejunal interposition were high incidences of early complications and residual food (Table 2).

### 3.3. Jejunal pouch interposition

A total of 7 studies reported postoperative conditions of the jejunal pouch interposition. Incidences of postoperative complications were 7.0%, 11.9%, 12.9%, and 26.5% for early complications, stenosis, reflux esophagitis, and residual food, respectively.<sup>[18,19,21,24,26–28]</sup>

The most obvious disadvantage of the jejunal pouch interposition was the high incidence of residual food. In a study by Nakamura et al, the incidence of residual food was observed in more than 90% of patients, which was much higher than the 31.8% of patients who underwent a jejunal interposition and the 21.8% of patients who underwent an esophagogastrostomy (Table 2).<sup>[19]</sup>

### 3.4. Double tract jejunal interposition

Only 1 retrospective case series investigated the double tract method for proximal gastrectomy.<sup>[29]</sup> Early postoperative complications, stenosis, reflux syndromes, and residual food were reported in 11.6%, 4.7%, 4.7%, and 48.9% of patients, respectively. In addition, dumping syndromes were reported by 11.6% of patients. Two other studies with small sample sizes (n=10), of which the double tract subgroups were not included in the present study, investigated surgical outcomes of such an operation, and similar results were observed.<sup>[10,30]</sup> Despite the lack of clinical evidence, it seems that residual food is the main complication after a double tract jejunal interposition (Table 2).

### 3.5. Tube-like stomach esophagogastrostomy

A total of 5 studies concentrated on the postoperative condition of patients who underwent a tube-like esophagogastrostomy.<sup>[17,25,31–33]</sup> Incidences of patients who developed early complications, stenosis, and reflux esophagitis was 9.3%, 15.1%, and 10.7%, respectively. The incidence of residual food was not reported by any of the studies. Although not emphasized by the included studies, stenosis seemed to be the major concern of a tube-like stomach esophagogastrostomy (Table 2).

### 3.6. Comparative results

A total of 9 studies compared the surgical outcomes of the reconstruction methods: jejunal interposition versus esophagogastrostomy (n=4),<sup>[14,16,19,34]</sup> jejunal interposition versus jejunal pouch interposition (n=3),<sup>[19,21,24]</sup> jejunal interposition versus tube-like stomach esophagogastrostomy (n=1),<sup>[25]</sup> jejunal pouch interposition versus esophagogastrostomy (n=2),<sup>[18,19]</sup> and tube-like stomach esophagogastrostomy versus esophagogastrostomy (n=1).<sup>[17]</sup> Except for the 1 study that compared the jejunal pouch interposition and jejunal interposition in 2 randomized groups,<sup>[24]</sup> most of the comparative studies were retrospective cohort studies. Study comparisons are shown in Table 3.

Of the 4 retrospective studies comparing the outcomes of jejunal interposition and esophagogastrostomy, 1 study found increased early postoperative complications of jejunal interposition (20.0% vs 3.1%),<sup>[19]</sup> 2 studies found a decreased risk of developing reflux esophagitis (0% vs 21.8%) and (5.0% vs 32.4%),<sup>[14,19]</sup> and none of the studies found significant differences of stenosis or emptying dysfunction between the 2 different methods (Table 3).

Of the 3 studies comparing the outcomes of jejunal interposition and jejunal pouch interposition, 1 retrospective study found an increased risk of reflux esophagitis in the jejunal interposition

**Table 2****Surgical outcomes of reconstructions.**

Authors	In-hospital complications	Stenosis	Reflux esophagitis	Residual food
<b>Esophagogastrostomy</b>				
Sakuramoto et al <sup>[10],*</sup>	2/26 (7.7%)	0/26 (0%)	4/20 (20%)	–
Seshimo et al <sup>[11]</sup>	4/46 (8.7%)	5/46 (11%)	10/46 (22%)	–
Masuzawa et al <sup>[13]</sup>	4/49 (8.2%)	2/49 (4.1%)	–	–
Tokunaga et al <sup>[14]</sup>	3/36 (8.0%)	–	11/34 (32.4%)	–
Chen et al <sup>[15]</sup>	–	6/34 (17.6%)	12/34 (35.3%)	–
Ichikawa et al <sup>[16]</sup>	0/13 (0%)	0/13 (0%)	3/13 (23.1%)	–
Chen et al <sup>[17]</sup>	–	9/41 (22.0%)	9/41 (22.0%)	–
Hoshikawa et al <sup>[18]</sup>	–	12/23 (52.2%) <sup>†</sup>	15/23 (65.2%) <sup>†</sup>	–
Nakamura et al <sup>[19],*</sup>	2/64 (3.1%)	12/55 (21.8%)	12/55 (21.8%)	12/55 (21.8%)
Ahn et al <sup>[29]</sup>	12/50 (24%)	6/50 (12.0%)	–	–
	<b>27/284 (9.5%)</b>	<b>52/337 (15.4%)</b>	<b>76/266 (28.6%)</b>	<b>12/55 (21.8%)</b>
<b>Jejunal interposition</b>				
Katai et al <sup>[5]</sup>	20/128 (15.6%)	13/128 (10.2%)	2/118 (1.7%)	10/118 (8.5%)
Seshimo et al <sup>[11]</sup>	4/18 (22.2%)	1/18 (6%)	2/18 (11%)	–
Masuzawa et al <sup>[13]</sup>	3/32 (9.4%)	1/32 (3.1%)	–	–
Tokunaga et al <sup>[14]</sup>	6/40 (15%)	–	2/40 (5.0%)	–
Ichikawa et al <sup>[16]</sup>	1/13 (7.7%)	2/13 (15.4%)	2/13 (15.4%)	–
Nakamura et al <sup>[19]</sup>	5/25 (20.0%)	7/22 (31.8%)	0/22 (0%)	7/22 (31.8%)
Takagawa et al <sup>[20]</sup>	6/19 (31.6%)	4/19 (21.1%)	3/19 (15.8%)	2/19 (10.5%)
Shinohara et al <sup>[21]</sup>	1/18 (5.6%)	–	1/18 (5.6%)	–
Yabusaki et al <sup>[22]</sup>	2/20 (10%)	3/19 (18.0%)	6/18 (33.3%)	3/19 (17%)
Kinoshita et al <sup>[23]</sup>	28/90 (31.1%)	6/90 (6.7%)	1/81 (1.2%)	–
Nozaki et al <sup>[24]</sup>	–	6/102 (6.0%)	2/102 (2.0%)	30/95 (31.6%)
Adachi et al <sup>[25]</sup>	0/16 (0%)	1/16 (6.3%)	0/16 (0%)	–
	<b>76/419 (18.1%)</b>	<b>44/459 (9.6%)</b>	<b>21/465 (4.5%)</b>	<b>52/273 (19.0%)</b>
<b>Jejunal pouch interposition</b>				
Hoshikawa et al <sup>[18]</sup>	–	5/18 (27.8%) <sup>†</sup>	5/18 (27.8%) <sup>†</sup>	–
Nakamura et al <sup>[19]</sup>	3/12 (25.0%)	1/12 (8.3%)	1/12 (8.3%)	11/12 (91.7%)
Yabusaki et al <sup>[21]</sup>	5/139 (3.6%)	18/131 (14.0%)	15/131 (11.3%)	28/131 (21%)
Takagawa et al <sup>[24]</sup>	1/19 (5.3%)	2/19 (10.6%)	3/19 (15.8%)	4/19 (21.1%)
Namikawa et al <sup>[26]</sup>	2/22 (9.1%)	0/22 (0%)	–	–
Takeshita et al <sup>[27]</sup>	–	–	4/20 (20%) <sup>†</sup>	–
Yoo et al <sup>[28]</sup>	5/25 (20%)	1/25 (4%)	1/25 (4%)	–
	<b>16/217 (7.0%)</b>	<b>27/227 (11.9%)</b>	<b>29/225 (12.9%)</b>	<b>43/162 (26.5%)</b>
<b>Double tract jejunal interposition</b>				
Ahn et al <sup>[29]</sup>	5/43 (11.6%)	2/43 (4.7%)	2/43 (4.7%) <sup>†</sup>	21/43 (48.9%)
<b>Tube-like stomach esophagogastrostomy</b>				
Chen et al <sup>[17]</sup>	–	4/35 (11.4%)	2/35 (5.7%)	–
Adachi et al <sup>[25]</sup>	0/14 (0%)	1/14 (7.1%)	1/14 (7.1%)	–
Hosogi et al <sup>[31]</sup>	3/15 (20%)	3/15 (20%)	4/13 (30.8%)	–
Aihara et al <sup>[32]</sup>	1/14 (7.1%)	4/14 (28.6%)	–	–
Mochiki et al <sup>[33]</sup>	–	6/41 (14.6%)	4/41 (9.8%)	–
	<b>4/43 (9.3%)</b>	<b>18/119 (15.1%)</b>	<b>12/103 (10.7%)</b>	

\* Fundoplication was performed.

† Reflux syndromes.

group (33.3% vs 11.3%),<sup>[21]</sup> and another study found an increased incidence of residual food in the jejunal pouch interposition group (31.8% vs 91.7%).<sup>[19]</sup> The only prospective, randomized study found an increased risk of early postoperative complications in the jejunal interposition group (31.6% vs 5.3%) (Table 3).<sup>[24]</sup>

One retrospective study reported the outcomes of jejunal interposition and tube-like stomach esophagogastrostomy.<sup>[25]</sup> No significant differences in early complications, stenosis, or reflux esophagitis was found between the 2 groups (Table 3).

Jejunal pouch interposition, compared with esophagogastrostomy, has been shown to decrease the incidence of reflux esophagitis (27.8% and 8.3% vs 65.2% and 21.8%) but increased the risk of early complications (25.0% vs 3.1%) and residual food (91.7% vs 21.8%) in 2 retrospective studies (Table 3).<sup>[18,19]</sup>

In the 1 retrospective study that compared the outcomes of tube-like stomach esophagogastrostomy and esophagogastrostomy, the tube-like stomach procedure showed a decreased incidence of reflux esophagitis (5.7% vs 22.0%) and similar incidence of stenosis and emptying dysfunction (Table 3).<sup>[17]</sup>

#### 4. Discussion

The present study reviewed the surgical outcomes of classical esophagogastrostomy and 4 anti-reflux methods for proximal gastrectomy in 24 studies. All the anti-reflux reconstruction methods demonstrated excellent efficacy in preventing reflux. However, most of the studies had a small sample size, were retrospective case series, and presented weak clinical evidence. In addition, the anti-reflux methods in several reports, increased the

**Table 3**  
**Comparison of different reconstructions after proximal gastrectomy.**

Authors	Early complications	Stenosis	Reflux esophagitis	Emptying dysfunction	Residual food
Jejunal interposition vs esophagogastrostomy					
Seshimo et al <sup>[11]</sup>	22.2% vs 8.7%	6.0% vs 11%	11% vs 22%	–	–
Tokunaga et al <sup>[14]</sup>	15.0% vs 8.0%	–	5.0% vs 32.4%	–	–
Ichikawa et al <sup>[16]</sup>	7.7% vs 0%	15.4% vs 0%	15.4% vs 23.1%	–	–
Nakamura et al <sup>[19]</sup>	20.0% vs 3.1%	31.8% vs 21.8%	0% vs 21.8%	31.8% vs 21.8%	–
Jejunal interposition vs jejunal pouch interposition					
Nakamura et al <sup>[19]</sup>	20.0% vs 14.0%	31.8% vs 8.3%	0% vs 8.3%	–	31.8% vs 91.7%
Yabusaki et al <sup>[21]</sup>	10% vs 3.6%	18.0% vs 14.0%	33.3% vs 11.3%	10% vs 7.9%	17% vs 21%
Takagawa et al <sup>[24]</sup>	31.6% vs 5.3%	21.1% vs 10.6%	15.8% vs 15.8%	0% vs 5.3%	10.5% vs 21.1%
Jejunal interposition vs tube-like stomach esophagogastrostomy					
Adachi et al <sup>[25]</sup>	0% vs 0%	6.3% vs 7.1%	0% vs 7.1%	–	–
Jejunal pouch interposition vs esophagogastrostomy					
Hoshikawa et al <sup>[18]</sup>	–	27.8%* vs 52.2%*	27.8%* vs 65.2%*	–	–
Nakamura et al <sup>[19]</sup>	25.0% vs 3.1%	8.3% vs 21.8%	8.3% vs 21.8%	–	91.7% vs 21.8%
Tube-like stomach esophagogastrostomy vs esophagogastrostomy					
Chen et al <sup>[17]</sup>	–	11.4% vs 22.0%	5.7% vs 22.0%	2.9% vs 4.9%	–

\* Reflux symptoms.

incidence of early postoperative complications, stenosis, and residual food.

With the development of clinical research, proximal gastrectomy has gradually replaced total gastrectomy in treating early gastric cancer located in the upper third of the stomach. Proximal gastrectomy has maintained comparable oncological radicality to the total gastrectomy and the reservoir capacity of the stomach.<sup>[35,36]</sup> pT1-2 gastric cancer located in the upper third of the stomach has rarely shown any pathological lymph node metastasis at stations #4d, #5, and #6.<sup>[37-39]</sup> Although no difference in the long-term survival has been detected between the total and the proximal gastrectomy,<sup>[35]</sup> cardio-esophageal resection and the reserved stomach were shown to significantly increase the risk of gastroesophageal reflux and significantly decrease the postoperative quality of life.

Esophagogastrostomy is a classical reconstruction method conducted after proximal gastrectomy and is superior in operative simplicity and safety. The pooled incidence of early postoperative complications was 9.5% and seemed to be lower than that in the jejunal interposition and jejunal pouch interposition groups.<sup>[19]</sup> However, direct esophagogastrostomy was shown to frequently cause serious gastroesophageal reflux and leads to varying degrees of esophagitis.<sup>[7]</sup> The pooled data in this study demonstrated that more than one-fourth of patients who underwent an esophagogastrostomy developed a varied degree of reflux esophagitis (Table 2). This proportion decreased little even after a modified esophagogastrostomy, such as side-to-side esophagogastrostomy and fundoplication, was performed.<sup>[10,12]</sup>

Some researchers demonstrated a 4% incidence of reflux esophagitis if a fundoplication was adequately performed (with a >180° wrap).<sup>[19]</sup> However, in our experience, such a wrap is difficult to perform unless the remnant stomach is large. A large remnant stomach may influence the radicality and is unsuitable for the general population. Moreover, more than 20% of anastomotic stricture was observed in patients who underwent fundoplication (Table 2).<sup>[19]</sup>

To avoid erosion to the esophagus from the refluxed gastric juice and to improve the postoperative quality of life, various types of anti-reflux methods have been proposed. Compared with esophagogastrostomy, jejunal interposition,<sup>[14,19]</sup> jejunal pouch

interposition, and tube-like stomach esophagogastrostomy have shown excellent anti-reflux efficacy.<sup>[17,18]</sup> The pooled incidence of reflux esophagitis after such approaches was 4.5–12.9% and was much lower than the 28.6% of the esophagogastrostomy (Table 2).

Despite the excellent anti-reflux effects, the interposed jejunum between the remnant stomach and esophagus presented other complications. Because of the increased anastomosis numbers and technique complexity, postoperative complications, such as intestinal obstruction and anastomosis stricture, were shown to increase accordingly.<sup>[11,16,19]</sup> Stenosis, emptying dysfunction, and residual food were frequently observed in the jejunal interposition group.<sup>[5,19]</sup> Abdominal discomfort after meals, continuous abdominal fullness, and hiccups between meals also presented in the jejunal interposed group.<sup>[40]</sup> In addition to the jejunal interposition, the jejunum is also interposed as a pouch to increase the reservoir capacity of the remnant stomach. Theoretically, such a procedure may cause further emptying dysfunction and residual food. Some studies did observe a significantly higher incidence of residual food (91.7%) in the jejunal pouch interposition group than in the jejunal interposition group,<sup>[19]</sup> but others found no difference.<sup>[21,24]</sup>

The influence of the interposed jejunal pouch on reflux also remains controversial. One study reported a stronger anti-reflux efficacy,<sup>[21]</sup> whereas others demonstrated negative results.<sup>[19,24]</sup> To avoid problems caused by the interposed jejunum, other types of reconstruction have been attempted. One approach is the double tract jejunal interposition, which makes an end-to-side anastomosis between the esophagus and proximal jejunum and a side-to-side anastomosis between the jejunum and remnant stomach. This method is to add an additional outlet in the stomach and to avoid the emptying dysfunction accordingly. Of the included studies, only 1 retrospective case series investigated the efficacy of this approach. With similar anti-reflux efficacy, such methods had little impact on the residual food or other complications. Moreover, 11.6% of patients reported dumping syndromes after the operation.<sup>[19]</sup> Another approach is the tube-like stomach esophagogastrostomy, which makes an anastomosis between the esophagus and a tube-like remnant stomach.<sup>[25,41]</sup> Gastric tube reconstruction showed comparable anti-reflux efficacy with jejunal interposition. Some researchers even found

no evidence of reflux esophagitis by endoscopy or 24-hour pH monitoring.<sup>[25]</sup> Tube-like stomach esophagogastronomy showed significantly reduced surgical complexity and controlled reflux and residual food, as well as the jejunal interposition, but the incidence of stenosis after this procedure was shown to reach 17.1%.<sup>[34]</sup> Other limitations of the method were shown to be the incurability of tumors located in the greater curvature and the decreased volume of the stomach, which may influence food intake and nutrition status.<sup>[25]</sup> In addition, only a few retrospective studies with small sample sizes investigated the surgical outcomes of this method. The actual treatment efficacy remains to be determined.

There are 2 major limitations in the present study. First, most of the studies on the outcomes of reconstructions for proximal gastrectomy were retrospective case series and non-randomized comparative studies. Comparisons between the reconstructions were unavailable. Second, in the included studies, various types of complications and various diagnostic criteria of postoperative reflux esophagitis were adopted. As a result, postoperative complications, including esophageal reflux, were described in general; each type of complication was not described in detail. Given the preliminary stage of this study on the reconstruction following a proximal gastrectomy, it was difficult to estimate the incidence of each complication and to summarize the incidence of reflux esophagitis by each diagnostic criterion. We must first investigate general data of the reconstructions.

In summary, anti-reflux reconstruction methods involve increased surgical complexity, higher incidence of early postoperative complications, anastomosis stenosis, and residual food. Nevertheless, such methods, except for esophagogastronomy, effectively decrease the risk of reflux esophagitis after proximal gastrectomy. Due to the lack of large randomized studies, optimal anti-reflux methods remain to be determined.

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