

Comparative Study on Three Types of Alimentary Reconstruction After Total Gastrectomy

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Abstract

Background More than 70 alimentary reconstruction procedures after total gastrectomy have been proposed to reduce the postoperative syndromes such as dumping syndrome, reflux esophagitis, and malnutrition. However, the optimal alimentary reconstruction method is still a matter of debate. The aim of the current study was to investigate the rationality of different alimentary tract reconstruction methods after total gastrectomy for gastric malignancy.

Methods Three types of digestive reconstruction methods were performed after total gastrectomy in 285 cases of gastric malignancy from May 1996 to December 2006, including Orr-type Roux-en-Y reconstruction (Orr-type), P-type Roux-en-Y reconstruction (P-type), and Moynihan-type reconstruction (Moynihan-type) methods. The operative time, early postoperative complications and mortality, food intake, alimentary symptoms, Visick scores, nutritional status at 1 and 3 years after surgery, and cumulative survival at 1, 3, and 5 years were comparatively analyzed.

Results There were no significant differences among the three methods in early postoperative complications and mortality, postoperative food intake and nutritional status (hemoglobin, total proteins and albumin), and incidence of diarrhea and dumping syndrome at 1 and 3 years ($p > 0.05$). The overall 1-, 3-, and 5-year cumulative survival rate were 75.30%, 39.86%, and 21.48%, respectively, without significant differences among the three groups ($p > 0.05$). However, the average operative time used in the Orr-type reconstruction method (2.9 ± 0.1 h) was comparatively shorter than that used in the P-type (3.4 ± 0.2 h) and the Moynihan-type (3.2 ± 0.1 h). The incidences of reflux esophagitis after the gastric reconstruction with the Moynihan-type method at 1 and 3 years (72% and 65%) were significantly higher than that with the Orr-type (3% and 0%) and P-type (5% and 0%; $p < 0.01$). Constituent ratio of Visick scores I–II of the Moynihan-type method at 1 and 3 years (54% and 73%) were smaller than that of the Orr-type (94% and 96%) and the P-type (93% and 96%) methods ($p < 0.01$).

Conclusion Orr-type Roux-en-Y reconstruction method can avoid reflux esophagitis, and the procedure is simpler than the other two methods. Therefore, Orr-type Roux-en-Y reconstruction can be recommended as an adoptable method of digestive reconstruction after total gastrectomy for gastric cancer.

Keywords Gastric cancer · Total gastrectomy · Alimentary reconstruction

Introduction

Gastric carcinoma is one of the most common malignant tumors in China, and the number of cases treated by total removal of the stomach (total gastrectomy) is increasing yearly.¹ However, total gastrectomy may result in early satiety, dumping syndrome, reflux esophagitis, malabsorption, malnutrition, and weight loss. The increase incidence of these postoperative syndromes thus leads to the continuous study of different alimentary reconstruction methods. During the past decades, over 70 alimentary reconstruction methods have been proposed.² However, the

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optimal digestive tract reconstruction procedure after total gastrectomy is still a matter of debate.

From May 1996 to December 2006, three types of alimentary reconstruction methods had been performed on 285 patients having gastric malignancy after total gastrectomy. The methods include Orr-type Roux-en-Y esophagojejunostomy (Orr-type), P-type Roux-en-Y esophagojejunostomy (P-type; the preference used before year 2000), and Moynihan-type reconstruction (Moynihan-type). A retrospective study was carried out to evaluate the operative time, postoperative complications, and food intake, digestive tract symptoms, and nutritional status at 1 and 3 years after surgery.

Materials and Methods

Patients

A total of 285 patients (150 male and 135 female, with a mean age of 57 years ranging from 26 to 75) who had undergone total gastrectomy with either one of the three types of reconstruction methods were studied (Orr-type, P-type, and Moynihan-type). All patients were diagnosed to have gastric cancer with clinical, barium meal, endoscopic, and histological examinations. Concerning tumor location, tumor diffused in three sections of stomach in 45 cases, mainly in cardia and body in 95 cases, mainly in body and antrum in 93 cases, and only in body of stomach in 52 cases. In the pathological examination, the tumors of 263 patients were diagnosed as adenocarcinoma, nine as malignant lymphoma, and 13 as leiomyosarcoma. The stage of the growing tumors in 27 patients was classified

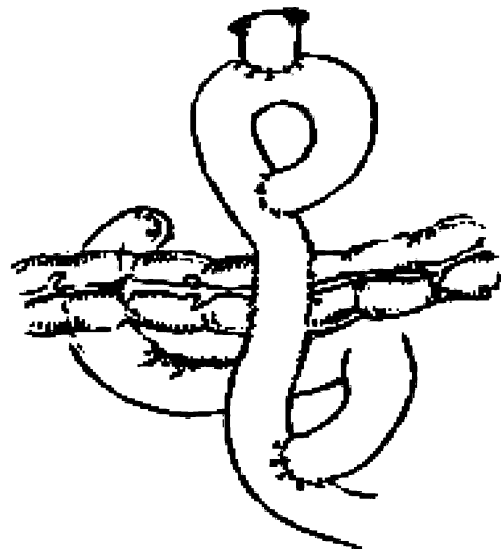


Figure 2 Illustration of P-type Roux-en-Y reconstruction.

as stage II, 143 patients as stage IIIa, 86 patients as stage IIIb, and 29 patients as stage IV. All subjects received a curative total gastrectomy.

Reconstruction After Total Gastrectomy

Three types of alimentary reconstruction methods were performed by the same operation team. Most of the reconstruction methods performed before year 2000 were P-type and Moynihan-type, and Orr-type has become the main procedure since 2000:

- (1) Orr-type Roux-en-Y esophagojejunostomy was performed in 155 cases. After total gastrectomy, the distal end of the duodenum was closed. The jejunum was separated 15–20 cm distal to the Treitz’s ligament, and an end-to-side esophagojejunostomy was done at the distal

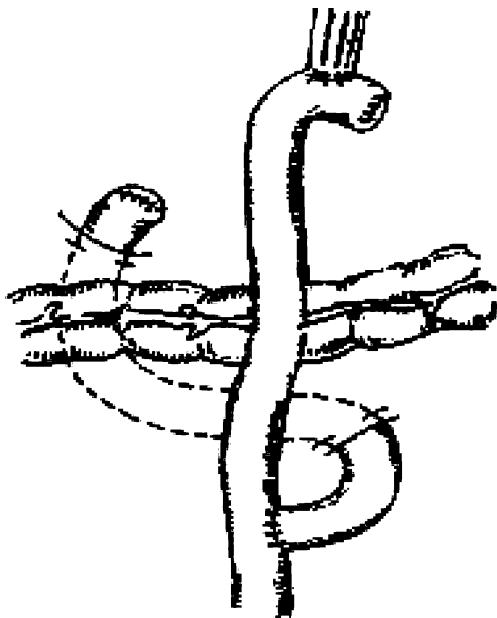


Figure 1 Illustration of Orr-type Roux-en-Y reconstruction.

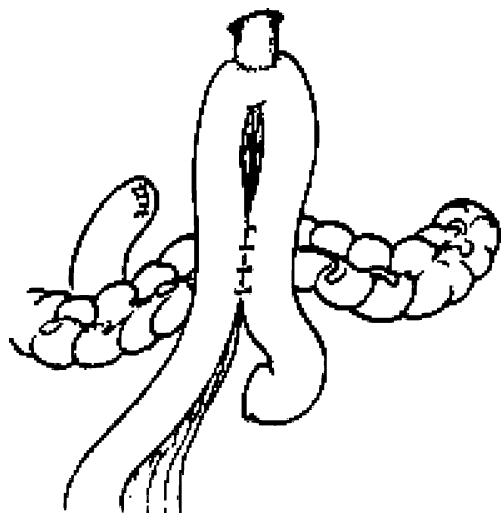


Figure 3 Illustration of Moynihan-type reconstruction.

Table 1 Clinicopathologic Characteristics of the Patients

Operation procedures	Number of patients	Mean age (years)	Sex (M/F)	Clinicopathologic stage [n (%)]			
				II	IIIa	IIIb	IV
Orr-type	155	56.8 (26–73)	82:73	15 (10)	76 (49)	49 (31)	15 (10)
P-type	63	58 (30–75)	33:30	6 (10)	32 (51)	18 (28)	7 (11)
Moynihan-type	67	57.4 (29–72)	35:32	6 (9)	35 (52)	19 (28)	7 (11)

No significant differences among the procedures ($p > 0.05$)

side of the jejunum. Then, the continuity of the jejunum was reconstructed with side-to-end jejunojejunostomy at 40–45cm distal to esophagojejunostomy. The operative design in this procedure is shown in Fig. 1 (Orr-type group, $n = 155$).

- (2) P-type Roux-en-Y esophagojejunostomy was performed in 63 cases. This type of reconstruction method was done in a way similar to the Orr-type except that a “P” type jejunum loop was made in the proximal jejunum before doing the end-to-side esophagojejunostomy, as shown in Fig. 2 (P-type group, $n = 63$).
- (3) Moynihan-type reconstruction was performed in 67 cases. After the distal end of the duodenum was closed, an end-to-side esophagojejunostomy was made at 40–45cm distal to the Treitz’s ligament, and then a 10-cm side-to-side jejunojejunostomy was made between the afferent jejunal loop and the transposed jejunal loop, which was also called Braun anastomosis. See Fig. 3 (Moynihan-type, $n = 67$).

All the esophagojejunal end-to-side anastomoses were performed using a circular stapler, and other types of anastomoses were sutured by hand. There were no significant differences among the three groups of patients in age, sex, and clinicopathologic stage classification, as summarized in Table 1.

Postoperative Following Up

For the purpose of this comparative study, the case files were reviewed by two of our staff members to obtain the following data: the operative time, the early postoperative complications, and the mortality. The patients were followed up regularly by one of our experienced staff through out-patient visit, telephone interview, and letter contact.

A standardized questionnaire concerning the postgastrectomy symptoms was distributed to the patients and was collected 1 and 3years, respectively, after surgery. The questions included several items relating to eating habits and alimentary symptoms. The patients needed to estimate their craving for eating in each meal and the number of

meals they had each day. The items of alimentary symptoms included heartburn, diarrhea, and dumping syndrome, and Visick scores were calculated. Postgastrectomy symptoms were classified into either good/fair (I–II) or poor (III–IV) based on the Visick scores.

These evaluations of nutritional status also had comprised various nutritional parameters on laboratory examinations (serum albumin, hemoglobin, and serum proteins) at 1 and 3years after surgery. Endoscopy was performed with interval of 6 to 12months.

Statistic Analysis

All values were expressed as mean \pm SE. The data were analyzed by chi-square test, Student’s t test, and the analysis of variance; postoperative survival was analyzed by Kaplan–Meier. The statistical calculations were carried out using Statistical Package for the Social Sciences (SPSS) 11.0 statistical software package. The level of significance was defined at $p < 0.05$.

Results

Operative Time and Postoperative Complications

Early postoperative complications occurred in 27 cases, including pulmonary infection in 14 cases, anastomotic straightness in five cases, anastomotic bleeding in seven cases, and anastomotic leakage in one case. Six patients died, one because of anastomotic leakage, four because of adult

Table 2 Operative Time, Early Postoperative Complications, and Mortality of the Three Procedures

Operation procedures	Number of patients	Operative time (h)	Complications [n (%)]	Mortality [n (%)]
Orr-type	155	2.9 \pm 0.1	12 (8)	3 (2)
P-type	63	3.4 \pm 0.2	7 (11)	1 (2)
Moynihan-type	67	3.2 \pm 0.1	8 (12)	2 (3)
p value		<0.01	>0.05	>0.05

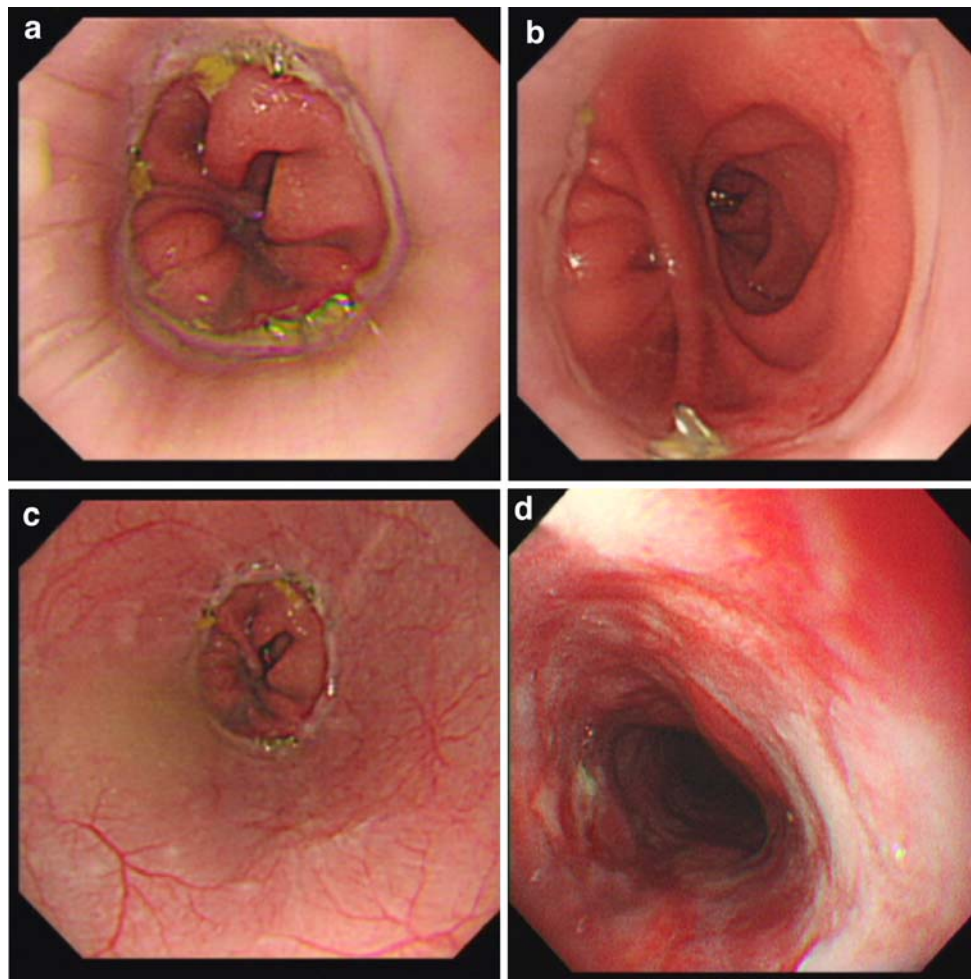


Figure 4 Illustration of endoscopic manifestations. **a** The representative endoscopic image of the Orr-type group. **b** A patient’s endoscopic image of the P-type group. **c, d** The representative endoscopic images of the Moynihan-type group.

respiratory distress syndrome, and one because of myocardial infarction. No significant ($p > 0.05$) intergroup differences of early postoperative complications and mortality were found. The average operative time required for the Orr-type

reconstruction method (2.9 ± 0.1 h) was shorter than that required for the P-type (3.4 ± 0.2 h) and the Moynihan-type (3.2 ± 0.1 h) reconstruction methods. The differences were significant ($p < 0.01$; Table 2)

Table 3 Alimentary Symptoms of the Three Procedures [n (%)]

Operation procedures	Number of patients	Eating capacity (per meal)		Eating frequency (per day)		Diarrhea	Dumping syndrome	Reflux esophagitis	Visick scores	
		>300 ml	<300 ml	3–5	>5				I–II	III–IV
Orr-type										
1 year	154	140 (91)	14 (9)	150 (97)	4 (3)	15 (10)	8 (5)	5 (3)	145 (94)	9 (6)
3 years	56	53(95)	3 (5)	55 (98)	1 (2)	0	0	0	54 (96)	2 (4)
P-type										
1 year	54	50 (93)	4 (7)	51 (95)	3 (5)	5 (9)	3 (6)	3 (5)	50 (93)	4 (7)
3 years	23	22 (96)	1 (4)	23 (100)	0	0	0	0	22 (96)	1 (4)
Moynihan-type										
1 year	52	47 (91)	5 (9)	50 (96)	2 (4)	5 (10)	4 (8)	37 (72)	28 (54)	24 (46)
3 years	26	24 (95)	2 (5)	26 (100)	0	0	0	17 (65)	19 (73)	7 (27)
<i>p</i> value		>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	<0.01	<0.01	<0.01

Table 4 Serum Protein of the Three Procedures (Mean±SE)

Operation procedure	Hemoglobin (g/l)		Total protein (g/l)		Albumin (g/l)	
	1 year	3 year	1 year	3 year	1 year	3 year
Orr-type	110.20 ± 11.80	111.30 ± 10.15	69.58 ± 4.96	67.08 ± 5.20	39.32 ± 3.30	37.75 ± 4.86
P-type	111.45 ± 11.33	110.10 ± 11.98	68.32 ± 5.45	66.21 ± 6.24	38.76 ± 3.41	36.66 ± 5.37
Moynihan-type	109.87 ± 10.92	107.63 ± 12.14	67.94 ± 4.86	65.86 ± 6.78	38.56 ± 3.50	36.12 ± 5.74

No significant differences among the procedures ($p > 0.05$)

Nutritional Status and Alimentary Symptoms

The patients were followed up over 12 months; the data were collected 1 year after total gastrectomy. The following up rate was 91.6%, with 24 dropped-out cases because of the lost of contact with the patients.

There were no significant differences among the three methods in postoperative food intake and nutritional status (hemoglobin, total protein, and albumin), and the incidence of diarrhea and dumping syndrome at 1 and 3 years ($p > 0.05$). However, the incidence of reflux esophagitis of the Moynihan-type group at 1 and 3 years (72% and 65%) was higher than that of the Orr-type (3% and 0) and P-type (5% and 0) groups. The endoscopic manifestations of the three groups were shown in Fig. 4. The differences were significant ($p < 0.01$). Constituent ratio of Visick scores I–II of the Moynihan-type group at 1 and 3 years (54% and 73%) were less than that of the Orr-type (94% and 96%) and P-type (93% and 96%) groups ($p < 0.01$). Otherwise, the ratio of Visick scores III–IV was larger than the other two, as shown in Tables 3 and 4.

Postoperative Survival

The mass postoperative cumulative survival at 1, 3, 5 years was 75.30%, 39.86%, and 21.48% respectively, and no significant ($p > 0.05$) differences were discovered among the three procedures, as shown in Fig. 5.

Discussion

Total gastrectomy is indicated when a radical subtotal gastrectomy cannot widely encompass a malignant gastric lesion. It is estimated that 20% to 40% of gastric cancers necessitate a total gastrectomy. Since Schlatter performed the first successful total gastrectomy in 1897, more than 70 different kinds of digestive tract reconstruction methods after total gastrectomy have been described, and the number is continuously increasing.³

It has been generally accepted that the optimum procedure of alimentary reconstruction after total gastrectomy must

fulfill the following requirements: (1) maintain the fluency of duodenal food; (2) a good digestive and absorptive function of the gastric substitute; (3) minimal or no “non-gastric syndromes” (e.g., reflux esophagitis, dumping syndrome, lack of appetite, feeling of gull and being bloated, and indigestion); (4) keep the patients in good postoperative nutritional status and have better quality of life; and (5) safe, simple, and less postoperative complications and mortality. However, no reconstruction procedures have been reported to meet all the above requirements.^{2,4–8}

It is well known that food chyme moving along the duodenal passage can promote the secretion of cholecystikinin and secretin, and this also has an advantage for maintaining the normal digestion and absorption functions of the digestive tract.^{3,6,9,10} Although the importance of keeping the duodenal passage was widely investigated, very few studies had successfully reported the practical value of this procedure. Many investigations indicated that preservation of the duodenal passage was difficult and the operation procedures were complex, as there were more anastomoses needed to be reconnected. Moreover, there were more

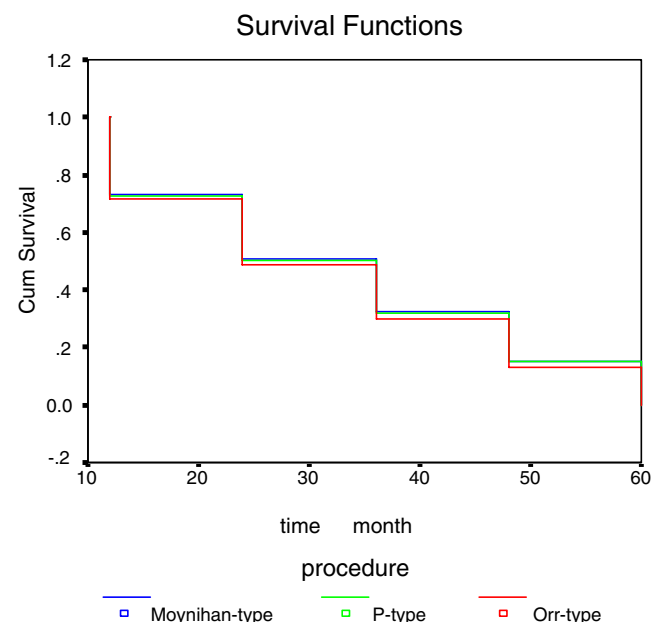


Figure 5 Survival curve of the three procedures.

postoperative complications and higher mortality rate and no significant difference in body weight and nutritional status from the Roux-en-Y esophagojejunostomy.^{11,12}

The optimal procedure of forming a substitute stomach is also a matter of debate.^{2,13–17} Some scholars even questioned on the functions of the gastric substitute, arguing that this procedure not only contributes very little to the long-term food intake and the recovering of nutritional status but also increases the operation's complexity, operative time, and postoperative complications.^{18,19} For example, Hunt–Lawrence pouch construction has been widely accepted in western countries because it can restore a large food reservoir and consequently improve the nutritional status of the patients. However, there is a potential hazard as ischemia may occur at the upper acute angle while suturing the 180-degree rotated jejunum to form a pouch, not to mention the three anastomoses in the procedure. Additionally, if the length of the jejunum or the mesentery is insufficient for pouch construction, it may cause undue tension or difficulty in forming a Hunt–Lawrence pouch.²⁰ In this point, Orr-type Roux-en-Y reconstruction is safer and technically less demanding.

The current comparative study indicates no significance in postoperative complications, mortality and food intake, nutritional status, and cumulative survival rate among the three procedures. However, both the Orr-type Roux-en-Y reconstruction and the P-type Roux-en-Y reconstruction were superior to Moynihan-type anastomosis in the Visick scores because both of them can play a role in anti-esophageal reflux. The original purpose of Moynihan-type procedure was to reduce the incidence of reflux esophagitis by means of Braun anastomosis. However, in fact, the side-to-side jejunojejunostomy between the afferent and transposed jejunal loop failed to transfer bile and pancreatic secretions, so the incidence of reflux esophagitis in Moynihan-type anastomosis still reached up to 33–70%. As the lower esophageal sphincter is resected at total gastrectomy, the synperistaltic function of the afferent jejunal loop can transport the alkaline digestive juice to the distal part of the esophagus in Moynihan-type reconstruction. Alkaline reflux esophagitis occurs because the chronic reflux of bile and pancreatic secretions into the esophagus may cause serious injury to its mucosa. Sometimes, the food chyme or alkaline digestive juice can circulate through the Braun anastomosis, thus causing lesions to the esophagus mucosa. However, in the Orr- or P-type reconstruction, with a 40- to 50-cm distance between the esophagus and the Roux-en-Y anastomosis, the interposed jejunal “Y” limb with can restrain the esophagus from damaging by the alkaline juice. Thus, both the Orr- and P-type reconstruction methods can decrease reflux esophagitis and improve the long-term quality of life. Furthermore, when compared the Orr-type with the P-type esophagojejunostomy, the operation procedures of the

Orr-type esophagojejunostomy was simpler and shorter operative time was needed (2.9 ± 0.1 h vs. 3.4 ± 0.2 h).

In conclusion, the data of our study suggest that the Orr-type Roux-en-Y esophagojejunostomy is safe and technically less demanding and can contribute to the avoidance of reflux esophagitis effectively. Therefore, Orr-type Roux-en-Y reconstruction can be recommended as an adoptable method of alimentary reconstruction after total gastrectomy for gastric cancer.

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