




ORIGINAL ARTICLE

Effects of creating a jejunal pouch on postoperative quality of life after total gastrectomy: A cross-sectional study

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Abstract

Aim: Total gastrectomy results in the complete loss of gastric function and the development of severe postgastrectomy syndrome. During the jejunal pouch procedure following total gastrectomies, a substitute stomach is created to alleviate the effects of postgastrectomy syndrome. However, the procedure's effectiveness remains controversial. This study aimed to explore the effect of jejunal pouch creation after total gastrectomy on postoperative quality of life.

Methods: A nationwide multi-institutional cross-sectional study, the Postgastrectomy Syndrome Assessment study NEXT, used the Postgastrectomy Syndrome Assessment Scale-45 questionnaire to explore the optimal gastrectomy procedure for cancer located in the upper third of the stomach or around the esophagogastric junction. The questionnaire consists of 45 items consolidated into 19 main outcome measures relating to postgastrectomy symptoms, amount of food ingested, quality of ingestion, ability for working, level of satisfaction for daily life, and the physical and mental component summary of the 8-Item Short Form Health Survey. Eligible completed questionnaires were retrieved from 1909 patients. Of these, the data were analyzed for 1020 patients who underwent total gastrectomy and 93 patients who underwent jejunal pouch creation after total gastrectomy.

Results: Postoperative quality of life was compared between patients with and without pouches. The analysis revealed that patients with pouches, particularly oral pouches, experienced substantially improved postoperative quality of life than those without, even after adjusting for several clinical factors using multiple regression analyses.

Conclusion: The results suggest that total gastrectomy with jejunal pouch creation, particularly oral pouches, may significantly improve postoperative quality of life.

KEYWORDS

jejunal pouch, postgastrectomy syndrome, quality of life, total gastrectomy, upper-third gastric cancer

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1 | INTRODUCTION

The incidence of gastric cancer in the upper stomach and esophagogastric junction has recently increased worldwide, probably due to the decreased incidence of *Helicobacter pylori* infection and increased incidence of gastroesophageal reflux disease.¹⁻⁴ Current Western and Asian guidelines recommend total gastrectomy (TG) as the standard surgical procedure for treating proximal gastric cancer.⁵⁻⁷ Minimally invasive surgery and function-preserving surgery are actively performed to improve the quality of life (QOL) of patients with gastric cancer. However, the severity of postgastrectomy syndrome (PGS) experienced by patients increases with the extent of the gastric resection.⁸ Loss of reservoir capacity is considered one of the main reasons for increased PGS severity.⁹⁻¹¹ Therefore, TG leads to the most severe PGS and an inadequate QOL among all types of gastrectomies.

Creating a pouch that can simulate the reservoir function of the stomach could reduce the incidence of early and late dumping symptoms.^{12,13} Meta-analyses have revealed that pouch creation improves functional and nutritional outcomes after TG.¹⁴⁻¹⁶ However, in these meta-analyses the QOL was evaluated using different scales and presented inconsistently, precluding the pooling of data from studies in many cases. In addition, the QOL of patients after gastrectomy may not have been evaluated because no questionnaire was available to assess the symptoms of PGS adequately.

The Japan Postgastrectomy Syndrome Working Party (JPGSWP) was introduced to investigate the postoperative symptoms and lifestyle changes of gastrectomy patients. This working group collaboratively developed a novel questionnaire—the Postgastrectomy Syndrome Assessment Scale-45 (PGSAS-45)—to evaluate the symptoms, living status, and QOL of patients who had undergone gastrectomy.¹⁷ We aimed to evaluate the effect of pouch creation after TG on the postoperative QOL of patients through a nationwide multi-institutional collaborative study, the Postgastrectomy Syndrome Assessment study NEXT (PGSAS NEXT), using the PGSAS-45 questionnaire.

2 | PATIENTS AND METHODS

2.1 | Patients

This was a cross-sectional study involving 70 participating institutions. The PGSAS-45 questionnaire was distributed to 2364 patients between July 2018 and December 2019. Of the 1950 (82.5%) completed questionnaires retrieved from patients, 41 (1.7%) were deemed ineligible: 22 patients had received chemotherapy within the preceding 6 mo, six had a failed R0 resection, five an ineligible operative procedure, two an ineligible disease, two experienced cancer recurrence, two underwent a second gastrectomy, one was within the 6-mo period since surgery, and one withdrew consent.

After these exclusions, 1909 questionnaires (80.8%) were deemed eligible for inclusion in the analysis. Of these, 1685 patients

had gastric cancer affecting the upper third of the stomach, of which 1020 had undergone conventional TG and 93 TG with a jejunal pouch (TGJP) creation. These patients were selected for inclusion in this study (Figure 1). Reconstruction procedures were not regulated by the surgical protocol and depended on each surgeon's institutional principles or discretion.

2.2 | Patient eligibility criteria

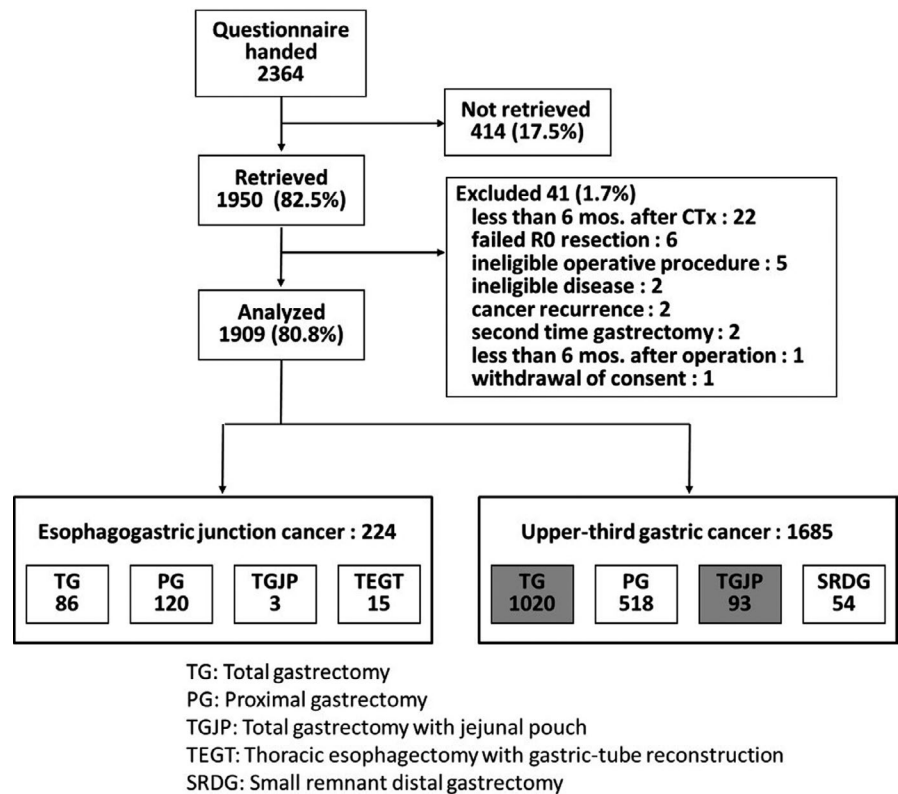
The patient inclusion criteria were: (a) females or males aged 20 y or older; (b) cancer located in the upper third of the stomach or around the esophagogastric junction (with any stage or histologic type); (c) R0 resection achieved; (d) no recurrence or metastasis; (e) more than 6 mo had passed since the gastrectomy; (f) previous chemotherapy was allowed, provided that more than 6 mo had passed since the termination of the treatment; (g) only undergone one gastrectomy; (h) a performance status of 0 or 1 on the Eastern Cooperative Group Scale; (i) capability of understanding the questionnaire; (j) no other disease present, or previous surgery, which could mask the effect of the gastrectomy results in the questionnaire; (k) no organ failure or mental disease; (l) and willingness to participate in this study.

The exclusion criteria included patients who had an active dual malignancy and had synchronously undergone another surgery (except for resection or extraction of the perigastric organs to achieve gastrectomy or lymph node dissection, and those who underwent cholecystectomies).

2.3 | Quality of life assessment

The PGSAS-45, a multidimensional QOL questionnaire based on the 8-Item Short Form Health Survey (SF-8) and Gastrointestinal Symptoms Rating Scale (GSRS), was used to assess PGS in this study.¹⁷⁻¹⁹ The questionnaire consists of 45 questions, with eight items from the SF-8, 15 from the GSRS, and 22 clinically important items, selected by the JPGSWP. The PGSAS-45 questionnaire includes 23 items pertaining to the postoperative symptoms (items 9-33), including 15 items from the GSRS and eight newly selected items. In addition, 12 items pertaining to the dietary intake, work, and level of satisfaction with daily life are included. Dietary intake items include five on the amount of food ingested (items 34-37 and 41) and three on the quality of ingestion (items 38-40). One questionnaire item pertains to work (item 42), while three address the level of satisfaction with daily life (items 43-45). For the 23 symptom items, a seven-grade Likert scale was used. A five-grade Likert scale was used for all other items, except for items 1, 4, 29, 32, and 34-37. For items 1-8, 34, 35, and 38-40, higher scores indicated better conditions. For items 9-28, 30, 31, 33, and 41-45, higher scores indicated worse conditions. The 19 main outcome measures were refined through consolidation and selection, and were classified into three domains: symptoms, living status, and QOL. Details of PGSAS-45 have been reported previously.¹⁷

FIGURE 1 Outline of the study



2.4 | Study methods

This study used continuous sampling from a central registration system for participant enrollment. The questionnaire was distributed to all eligible patients, who were instructed to return the completed forms to the data center. All QOL data from the questionnaires were matched with individual patient data collected via case report forms. This study was registered with the University Hospital Medical Information Network Clinical Trials Registry (registration number 000 032 221) and approved by the Ethics Committees of all participating institutions. Written informed consent was obtained from all enrolled patients.

2.5 | Statistical analysis

Patient characteristics and main outcome measures were compared using *t*-tests and Fisher's exact tests. Multigroup comparisons were conducted using analysis of variance (ANOVA) and Tukey's tests. All outcome measures were further analyzed using multiple regression analyses. Ten factors—type of gastrectomy, age, sex, postoperative period, operative approach, preservation of the celiac branch of the vagus, chemotherapy, clinical stage, extent of lymph node dissection, combined resection—were included in the multiple regression analysis as explanatory variables. These factors were selected according to their clinical importance and based on the results of previous Postgastrectomy Syndrome Assessment Studies. Statistical significance was set at $P < .05$. In the case of value $P < .1$ in univariate analyses, Cohen's *d* was calculated. Where multiple regression analysis yielded a *P*-value $< .1$, the standardization coefficient

of regression (β) and the *P*-value are shown in a table. Cohen's *d*, β , and R^2 were used to measure the effect sizes. Interpretation of effect sizes were ≥ 0.2 = small, ≥ 0.5 = medium, and ≥ 0.8 = large in Cohen's *d*; ≥ 0.1 = small, ≥ 0.3 = medium, and ≥ 0.5 = large in β ; and ≥ 0.02 = small, ≥ 0.13 = medium, and ≥ 0.26 = large in R^2 . Statistical analyses were performed using JMP 12.0.1 software (SAS Institute, Cary, NC) [Correction added on 23 October 2021, after first online publication: under section 2.5 Statistical analysis, 'vague' has been corrected to 'value' and symbol \leq has been changed to \geq].

3 | RESULTS

3.1 | Patient characteristics

The characteristics of the study participants are listed in Table 1. TG was performed in 1020 patients: Roux-en-Y in 1000 patients, a double tract in 13, jejunal interposition in two, and others in five. TGJP was performed in 93 patients: 49 patients underwent total gastrectomy with Roux-en-Y oral pouch (TGJPR), 28 underwent total gastrectomy with jejunal pouch interposition (TGJPI), and 16 underwent total gastrectomy with Roux-en-Y aboral pouch (TGJPY). In addition, TGJP was registered from 11 facilities. Each procedure is illustrated in Figure 2.

The TGJP group had a significantly longer mean postoperative period (69.8 ± 51.5 mo vs 52.9 ± 36.5 mo, $P < .001$), a significantly higher rate of use of the laparoscopic approach ($49/93$ [53%] vs $409/1020$ [40%], $P = .018$), and a significantly higher rate of combined resection ($61/93$ [66%] vs $284/1020$ [29%], $P < .001$) than the TG group. There were significant differences between

TABLE 1 Patient characteristics

	TG (n = 1020)	TGJP (n = 93)	P value
Age (y), mean (SD)	68.3 (10.4)	66.7 (11.2)	.154
Postoperative period (mo), mean (SD)	52.9 (36.5)	69.8 (51.5)	<.001
Gender			
Male/Female	743/277	74/19	.160
Preoperative BMI (kg/m ²), mean (SD)	23.1 (3.1)	23.2 (2.7)	.883
Postoperative BMI (kg/m ²), mean (SD)	19.7 (2.5)	19.7 (2.1)	.893
Abdominal approach			
Open/Laparoscopy	611/409	44/49	.018
Celiac branch of vagus			
Preserved/Divided	19/974	1/92	.843
Tumor location (JGCA 14th)			
UE (Siewert type III)/U/UM/MU	33/609/203/173	2/47/22/20	.371
Extent of esophageal resection			
Lower thoracic	28	1	.737
Abdominal	628	58	
None	358	34	
Level of esophago-GI anastomosis			
Tm	9	0	<.001
Ti	304	10	
D	444	37	
A	241	46	
cStage (JGCA 14th)			
I	547	42	.021
IIA/IIB	196	29	
III	240	16	
IVA/IVB	33	5	
Length of esophageal resection (mm), mean (SD)	7.4 (10.6)	7.2 (9.0)	.847
Distance from diaphragm to anastomosis (mm), mean (SD)	-6.2 (16.6)	3.9 (10.2)	<.001
Chemotherapy			
Preoperative	20	1	.990
Postoperative	271	26	
Both	64	5	
None	662	61	
Extent of lymph node dissection			
D0	1	0	.101
D1	10	3	
D1+	403	41	
D2	579	45	
D2+	23	4	

TABLE 1 (Continued)

	TG (n = 1020)	TGJP (n = 93)	P value
Combined resection			
None	736	32	<.001
Gallbladder	176	58	
Spleen	144	25	
Pancreas	16	7	
Others	17	2	

Abbreviations: A, abdomen; D, diaphragm; GI: gastrointestinal; SD, standard deviation; TG, total gastrectomy; TGJP, total gastrectomy with jejunal pouch; Ti, lower thoracic; Tm, middle thoracic; Ugca, upper-third gastric cancer.

the TG and TGJP groups in the level of esophago-gastrointestinal anastomosis and the distance from the diaphragm to anastomosis (-6.2 ± 16.6 mm vs 3.9 ± 10.2 mm, $P < .001$), indicating that the position of the anastomosis was higher in the TG group than in the TGJP group.

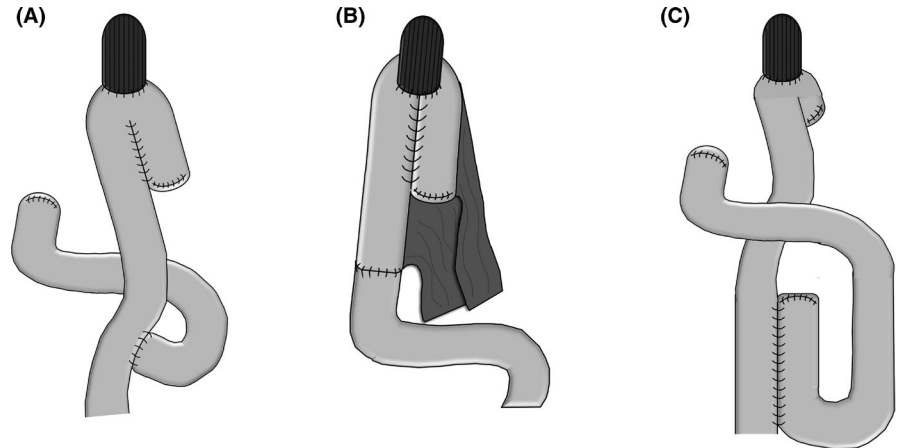
3.2 | Pouch size

The comparisons of the length of the jejunal pouch among the different types of TGJPs (TGJPR, TGJPI, and TGJPY) were as follows: TGJPR vs TGJPI, 14.0 ± 4.7 cm vs 13.5 ± 4.6 cm ($P = .840$); TGJPR vs TGJPY, 14.0 ± 4.7 cm vs 10.2 ± 1.9 cm ($P = .007$); and TGJPI vs TGJPY, 13.5 ± 4.6 cm vs 10.2 ± 1.9 cm ($P = .045$).

3.3 | Quality of life assessment

The results of the main outcome measures following TG and TGJP are presented in Table 2. The TGJP group showed a significantly lower need for additional meals (2.1 vs 2.4 , $P < .001$, Cohen's $d = 0.39$), ability for working (2.0 vs 2.2 , $P = .028$, Cohen's $d = 0.24$), dissatisfaction with the meal (2.4 vs 2.7 , $P = .045$, Cohen's $d = 0.22$), and dissatisfaction with the daily life subscale (SS) (2.1 vs 2.3 , $P = .032$, Cohen's $d = 0.23$) than the TG group. The TGJP group showed a better tendency in several main outcome measures, including meal-related distress SS ($P = .066$, Cohen's $d = 0.20$), ingested amount of food per meal ($P = .070$, Cohen's $d = 0.20$), and dissatisfaction at working ($P = .051$, Cohen's $d = 0.21$) than the TG group. Meanwhile, there were no significant adverse effects in any of the 19 main outcomes in the TGJP group compared with those in the TG group.

Multivariate analysis (MVA) was performed to eliminate confounding factors such as age, gender (ie, male or female), postoperative period, surgical approach (ie, laparoscopic, open), the celiac branch of the vagal nerve (ie, preserved or divided), chemotherapy (ie, yes or no), clinical stage (ie, I/II, III/IV), lymph node dissection (ie, D0/D1, D1+, D2/D2+), and combined resection (ie, yes, no) as explanatory variables (Table 3). Although the effect sizes of the

FIGURE 2 TGJP procedure. (A) TGJPR. (B) TGJPI. (C) TGJRY**TABLE 2** Comparison of main outcome measures between TG and TGJP (univariate analysis)

Domain	Main outcome measures	TG (n = 1020)		TGJP (n = 93)		P value	Cohen's d
		mean	SD	mean	SD		
Symptoms	Esophageal reflux SS	2.1	1.0	1.9	0.9	.106	
	Abdominal pain SS	1.7	0.8	1.6	0.7	.422	
	Meal-related distress SS	2.6	1.1	2.4	0.9	.066	0.20
	Indigestion SS	2.2	1.0	2.1	1.0	.210	
	Diarrhea SS	2.4	1.2	2.5	1.3	.502	
	Constipation SS	2.2	1.1	2.2	0.9	.770	
	Dumping SS	2.2	1.2	2.1	1.0	.228	
	Total symptom score	2.2	0.8	2.1	0.7	.310	
Living status	Change in Bw ^a	-0.1	0.1	-0.2	0.1	.286	
	Ingested amount of food per meal ^a	6.1	2.0	6.5	2.0	.070	0.20
	Necessity for additional meals	2.4	0.9	2.1	0.8	<.001	0.39
	Quality of ingestion SS ^a	3.6	1.0	3.6	1.0	.986	
	Ability for working	2.2	1.0	2.0	0.9	.028	0.24
QOL	Dissatisfaction with symptoms	2.0	1.0	1.9	1.0	.113	
	Dissatisfaction at the meal	2.7	1.2	2.4	1.1	.045	0.22
	Dissatisfaction at working	2.1	1.1	1.9	1.0	.051	0.21
	Dissatisfaction for daily life SS	2.3	1.0	2.1	0.9	.032	0.23
	PCS of SF-8 ^a	48.7	5.8	49.7	5.5	.104	
	MCS of SF-8 ^a	49.3	6.3	49.0	5.6	.655	

Abbreviations: BW, body weight; MCS, mental component summary; PCS, physical component summary; SS, subscale; TG, total gastrectomy; TGJP, total gastrectomy with jejunal pouch.

^aThe higher the score or value, the better the condition; otherwise (without letter a), the higher the score, the poorer the condition. The interpretation of effect size in Cohen's *d*: ≥ 0.2 as small, ≥ 0.5 as medium, ≥ 0.8 as large.

advantages in the two groups were relatively small, esophageal reflux SS ($\beta = -0.074$, $P = .022$), meal-related distress SS ($\beta = -0.064$, $P = .048$), ingested amount of food per meal ($\beta = 0.067$, $P = .039$), necessity for additional meals ($\beta = -0.108$, $P = .001$), ability for working ($\beta = -0.070$, $P = .026$), dissatisfaction with the meal ($\beta = -0.063$, $P = .049$), dissatisfaction at working ($\beta = -0.067$, $P = .039$),

and dissatisfaction for daily life SS ($\beta = -0.070$, $P = .029$) were significantly better in the TGJP than in the TG group. Dumping SS ($\beta = -0.055$, $P = .097$) showed a better tendency in the TGJP than in the TG group. All main outcome measures were better in the TGJP than in the TG group. Age, gender, postoperative period, and lymph node dissection had a significant effect on numerous main outcome

TABLE 3 Exploring independent factors affecting main outcome measures following TG and TGJP

Domain	Main outcome measures	TGJP		Age (y)		Gender (male)		Postoperative period (mo)		Approach (laparoscopic)	
		β	P value	β	P value	β	P value	β	P value	β	P value
Symptoms	Esophageal reflux SS	-0.074	.022	-0.072	.020					0.086	.021
	Abdominal pain SS					-0.096	.002	-0.066	.040		
	Meal-related distress SS	-0.064	.048	-0.104	.001	-0.057	.065	-0.072	.022		
	Indigestion SS			-0.085	.007			-0.114	<.001		
	Diarrhea SS			-0.103	.001	0.092	.003				
	Constipation SS			0.087	.006						
	Dumping SS	-0.055	.097	-0.195	<.001	-0.121	<.001				
	Total symptom score			-0.125	<.001			-0.087	.009		
Living status	Change in BW ^a			-0.122	<.001						
	Ingested amount of food per meal ^a	0.067	.039	-0.083	.009						
	Necessity for additional meals	-0.108	.001	0.092	.003	-0.069	.026	-0.063	.043		
	Quality of ingestion SS ^a					-0.065	.038				
	Ability for working	-0.070	.026	0.254	<.001						
QOL	Dissatisfaction with symptoms			-0.102	.001	-0.091	.003	-0.090	.004		
	Dissatisfaction at the meal	-0.063	.049	-0.107	.001			-0.096	.002		
	Dissatisfaction at working	-0.067	.039					-0.063	.047	0.085	.022
	Dissatisfaction for daily life SS	-0.070	.029	-0.087	.005			-0.096	.002	0.080	.030
	PCS of SF-8 ^a			-0.098	.002						
	MCS of SF-8 ^a										

Abbreviations: [Y], yes; BW, body weight; CTx, chemotherapy; LN, lymph node; MCS, mental component summary; PCS, physical component summary; SS, subscale; TG, total gastrectomy; TGJP, total gastrectomy with jejunal pouch.

^aThe higher the score or value, the better the condition; otherwise (without letter a), the higher the score, the poorer the condition. If β is positive, the score of the outcome measure of the patients belonging to the category in [brackets] is higher in cases when the factor is a nominal scale, and the score of outcome measure of the patients with larger values is higher in cases when the factor is a numeral scale. The interpretation of effect size in β : ≥ 0.1 as small, ≥ 0.3 as medium, ≥ 0.5 as large. The interpretation of effect size in R^2 : ≥ 0.02 as small, ≥ 0.13 as medium, ≥ 0.26 as large.

measures, while the surgical approach, celiac branch preservation, clinical stage, and combined resection of other organs had limited effect on the main outcome measures. There was no association between chemotherapy and outcome measures.

The results of multiple comparisons of the main outcome measures among TGJPR, TGJPI, and TGJPY are shown in Table 4. The quality of ingestion SS ($P = .020$, Cohen's $d = 0.59$) was significantly better with TGJPI than with TGJPR. Dissatisfaction with the symptoms ($P = .001$, Cohen's $d = 1.19$), dissatisfaction at working ($P = .003$, Cohen's $d = 0.89$), and dissatisfaction for daily life SS ($P = .002$, Cohen's $d = 0.97$) were all significantly better with TGJPR than with TGJPY. Dissatisfaction with symptoms ($P = .001$, Cohen's $d = 1.07$), dissatisfaction at working ($P = .002$, Cohen's $d = 1.00$), and dissatisfaction with daily life SS ($P = .001$, Cohen's $d = 0.94$) were significantly better with TGJPI than with TGJPY. The physical component summary ($P = .064$, Cohen's $d = 0.72$) showed a better tendency for TGJPI than for TGJPY. TGJPR and TGJPI were equal and, therefore, showed a certain superiority to TGJPY in terms of several main outcome measures.

We further compared the postgastrectomy QOL between TG with an oral pouch (ie, TGJPR and TGJPI, except for TGJPY) and TG. In univariate analysis (UVA), the TG with oral pouch group showed a significantly better meal-related distress SS (2.4 vs 2.6, $P = .01$, Cohen's $d = 0.26$), ingested amount of food per meal (6.6 vs 6.1, $P = .03$, Cohen's $d = 0.26$), necessity for additional meals (2.1 vs 2.4, $P = .001$, Cohen's $d = 0.26$), ability for working (2.0 vs 2.2, $P = .033$, Cohen's $d = 0.26$), dissatisfaction with symptoms (1.7 vs 2.0, $P = .003$, Cohen's $d = 0.36$), dissatisfaction with the meal (2.4 vs 2.7, $P = .013$, Cohen's $d = 0.30$), dissatisfaction at working (1.7 vs 2.1, $P = .002$, Cohen's $d = 0.37$), dissatisfaction with daily life SS (1.9 vs 2.3, $P = .001$, Cohen's $d = 0.39$), and physical component summary (PCS) of SF-8 (50.1 vs 48.7, $P = .039$, Cohen's $d = 0.25$) than the TG group (Table 5).

In MVA, esophageal reflux SS ($\beta = -0.075$, $P = .022$), meal-related distress SS ($\beta = -0.076$, $P = .021$), dumping SS ($\beta = -0.069$, $P = .039$), ingested amount of food per meal ($\beta = 0.089$, $P = .008$), necessity for additional meals ($\beta = -0.106$, $P = .001$), ability to work ($\beta = -0.079$, $P = .015$), dissatisfaction with symptoms ($\beta = -0.102$, $P = .002$),

Celiac branch of vagus (preserved)		CTx [Y]		cStage (III/IV)		LN dissection (D1+)		LN dissection (D2/D2+)		Combined resection [Y]		R ²	P value		
β	P value	β	P value	β	P value	β	P value	β	P value	β	P value				
												0.028	.002		
												0.022	.022		
												0.030	.001		
							-0.054	.082				0.029	.001		
							-0.075	.016		0.062	.070	0.028	.002		
										0.058	.090	0.015	.148		
							-0.088	.006				0.073	<.001		
											0.063	.087	0.043	<.001	
							-0.069	.088							
							0.110	.003		-0.057	.064	0.096	.013	0.057	<.001
							0.098	.010				-0.074	.032	0.022	.017
0.064	.038						-0.062	.097						0.040	<.001
														0.009	.628
							0.064	.083		-0.054	.078	0.057	.092	0.083	<.001
														0.036	<.001
														0.031	.001
							-0.056	.073						0.019	.050
														0.030	.001
														0.022	.018
							0.062	.049						0.012	.330

dissatisfaction with the meal ($\beta = -0.080$, $P = .015$), dissatisfaction at working ($\beta = -0.111$, $P = .001$), dissatisfaction for daily life SS ($\beta = -0.113$, $P = .001$), and PCS of SF-8 ($\beta = -0.070$, $P = .036$) were significantly better in the TG with oral pouch group than in the TG group (Table 6). The main outcome measures of the TG with oral pouch group were all higher than those of the TG group.

4 | DISCUSSION

The TGJP procedure was developed to improve the QOL of patients after TG, which develops the most severe PGS of all gastrectomies. While some studies reported that creating a pouch improves the QOL of patients after TG, the postoperative QOL has not been adequately evaluated because of limitations such as a small sample size and the lack of a questionnaire to accurately assess the symptoms of PGS. Various clinical factors affect the QOL after gastrectomy²⁰; however, no study has shown the usefulness of pouch creation after adjustment for these factors using MVA. Furthermore, there are no

studies evaluating the effect of the jejunal pouch position on postoperative QOL. In the present study the usefulness of jejunal pouch creation after TG was investigated using the PGSAS-45 questionnaire developed to evaluate QOL after gastrectomy after adjusting for multiple clinical factors that affect QOL after gastrectomy using MVA. In addition, our sample size was sufficient compared to that in previous studies. Our results showed that patients in the TGJP group, especially those in whom oral pouches had been created, had more significantly superior main outcome measures than those in the TG group. Therefore, this study provided more reliable evidence for the effectiveness of jejunal pouch creation after TG than previous studies.

PGS results in various disturbances in the living status, functional disorders, and deterioration of QOL.¹⁷ TG causes the most severe form of PGS, as the entire stomach is removed. Several studies have reported that pouch creation after TG allows increased food intake, thereby alleviating symptoms associated with the dumping syndrome and reflux disease, and improving QOL.^{15,21} Nevertheless, our findings (1020 cases of TG vs 93 cases of TGJP) show that the

TABLE 4 Comparison of main outcome measures among TGJPR, TGJPI, and TGJPY (multiple comparison)

Domain	Main outcome measures	TGJPR (n = 49)			TGJPI (n = 28)			TGJPY (n = 16)			ANOVA				Tukey-test				
		Mean	SD		Mean	SD		Mean	SD		P value	Cohen's d	P value	Cohen's d	P value	Cohen's d	P value	Cohen's d	
Symptoms	Esophageal reflux SS	1.8	0.8		2.1	1.1		2.0	0.9		.372								
	Abdominal pain SS	1.6	0.7		1.6	0.8		1.7	0.8		.904								
	Meal-related distress SS	2.3	0.7		2.4	1.0		2.7	1.3		.351								
	Indigestion SS	2.1	1.0		2.0	1.0		2.3	1.1		.526								
	Diarrhea SS	2.4	1.2		2.7	1.5		2.3	1.0		.565								
	Constipation SS	2.1	0.9		2.2	0.8		2.5	1.2		.322								
	Dumping SS	2.0	1.0		2.1	0.9		2.4	1.3		.362								
Living status	Total symptom score	2.1	0.6		2.1	0.8		2.2	0.8		.785								
	Change in BW ^a	-14.7%	7.3%		-17.6%	8.5%		-13.5%	7.9%		.195								
	Ingested amount of food per meal ^a	6.6	2.0		6.6	2.2		5.9	1.6		.441								
	Necessity for additional meals	2.0	0.8		2.2	0.8		2.1	0.7		.391								
	Quality of ingestion SS ^a	3.5	1.0		4.0	0.9		3.5	0.9		.041		.020	0.59					
	Ability for working	2.1	1.0		1.8	0.8		2.1	0.9		.505								
	QOL	Dissatisfaction with symptoms	1.7	0.8		1.6	1.0		2.8	1.2		.000				.001	1.19	.001	1.07
Dissatisfaction at the meal	2.4	1.0		2.3	1.1		2.9	1.4		.222									
Dissatisfaction at working	1.8	0.9		1.6	0.9		2.7	1.3		.003				.003	0.89	.002	1.00		
Dissatisfaction for daily life SS	2.0	0.7		1.9	0.8		2.8	1.2		.002				.002	0.97	.001	0.94		
PCS of SF-8 ^a	49.2	5.5		51.6	4.6		47.8	6.4		.067							.064	0.72	
MCS of SF-8 ^a	49.1	5.4		50.0	4.9		47.0	6.8		.215									

Abbreviations: MCS, mental component summary; PCS, physical component summary; SS, subscale; TGJPI, total gastrectomy with jejunal pouch interposition; TGJPR, total gastrectomy with Roux-en-Y oral pouch; TGJPY, total gastrectomy with Roux-en-Y aboral pouch.

^aThe higher the score or value, the better the condition; otherwise (without letter a), the higher the score, the poorer the condition. The interpretation of effect size in Cohen's *d*: ≥ 0.2 as small, ≥ 0.5 as medium, ≥ 0.8 as large.

TABLE 5 Comparison of main outcome measures between TG and TG with oral pouch (univariate analysis)

Domain	Main outcome measures	TG (n = 1020)		TG with oral pouch (n = 77)		P value	Cohen's d
		Mean	SD	Mean	SD		
Symptoms	Esophageal reflux SS	2.1	1.0	1.9	0.9	.117	0.26
	Abdominal pain SS	1.7	0.8	1.6	0.7	.384	
	Meal-related distress SS	2.6	1.1	2.4	0.8	.031	
	Indigestion SS	2.2	1.0	2.1	1.0	.131	
	Diarrhea SS	2.4	1.2	2.5	1.3	.398	
	Constipation SS	2.2	1.1	2.1	0.9	.430	
	Dumping SS	2.2	1.2	2.0	1.0	.113	
	Total symptom score	2.2	0.8	2.1	0.7	.255	
Living status	Change in BW ^a	-0.1	0.1	-0.2	0.1	.194	0.26
	Ingested amount of food per meal ^a	6.1	2.0	6.6	2.0	.030	
	Necessity for additional meals	2.4	0.9	2.1	0.8	.001	
	Quality of ingestion SS ^a	3.6	1.0	3.7	1.0	.798	
	Ability for working	2.2	1.0	2.0	1.0	.033	
QOL	Dissatisfaction with symptoms	2.0	1.0	1.7	0.8	.003	0.36
	Dissatisfaction at the meal	2.7	1.2	2.4	1.0	.013	0.30
	Dissatisfaction at working	2.1	1.1	1.7	0.9	.002	0.37
	Dissatisfaction for daily life SS	2.3	1.0	1.9	0.7	.001	0.39
	PCS of SF-8 ^a	48.7	5.8	50.1	5.3	.039	0.25
	MCS of SF-8 ^a	49.3	6.3	49.4	5.2	.866	

Abbreviation: TG, total gastrectomy.

^aThe higher the score or value, the better the condition; otherwise (without letter a), the higher the score, the poorer the condition. The interpretation of effect size in Cohen's *d*: ≥ 0.2 as small, ≥ 0.5 as medium, ≥ 0.8 as large. [Correction added on 23 October 2021, after first online publication: in table heading TG with oral pouch '(n = 93)' has been changed to '(n = 77)'].

pouch creation procedure is still uncommon. Surgeons are reluctant to create pouches because of possible complications related to the pouch, such as delayed emptying of an ingested meal from the substitute stomach and excessive dilatation of the jejunal pouch,²²⁻²⁴ and the complexity of the surgery. A nationwide questionnaire administered at the 44th Annual Meeting of the Japanese Society for Gastro-surgical Pathophysiology, held in 2014 and involving 117 institutions, showed that only 53 of 1375 (3.9%) patients experienced pouch-related complications, delayed emptying being the most common. This indicates a low frequency of such complications (unpublished data). Recently, surgical techniques and device functionality have improved; thus, pouch creation is no longer technically difficult. However, pouch creation is more expensive and time-consuming. Therefore, it is considered that evidence is needed to encourage surgeons to perform pouch creation. This study provides reliable evidence for improved postoperative QOL among patients who have pouches and could encourage surgeons to select this procedure.

Patient-reported outcome measures are often used to compare QOL between various gastrectomy procedures. A combination of the 36-Item Short Form Health Survey (SF-36) and GRS is one such questionnaire,^{25,26} but the latter tends to overlook certain important

symptoms, such as meal-related distress and dumping that are specific to patients who have undergone gastrectomies. Questionnaires such as the EORTC QLQ-C30²⁷ and STO-22²⁸ have been developed to assess the QOL of cancer patients undergoing treatment; however, these scales cannot adequately assess several important symptoms of PGS. The PGSAS-45 is a self-reported questionnaire that provides a comprehensive assessment of the outcomes of patients who have undergone surgery for gastric cancer. This questionnaire contains questions on well-known symptoms that considerably affect the QOL of these patients and are adequate for clinical evaluation.²⁹ Since our study used the PGSAS-45, it can be considered to have adequately evaluated the postgastrectomy syndrome and the QOL in gastrectomy patients.

The results of the MVA showed that the TGJP group was superior to the TG group in terms of 9 of the 19 main outcome measures of the PGSAS-45. Furthermore, when the TG with oral pouch group and TG group were compared, the TG with oral pouch group was superior to the TG group, with a larger effect size (β) in 11 main outcome measures, compared with TGJP. Nakada et al reported that meal-related distress and dumping symptoms most severely impaired postgastrectomy QOL in seven postgastrectomy symptom

TABLE 6 Exploring independent factors affecting main outcome measures following TG and TG with oral pouch (TGJPR and TGJPI) (multivariate analysis)

Domain	Main outcome measures	TG with oral pouch		Age (y)		Gender (male)		Postoperative period (mo)		Approach (laparoscopic)	
		β	P value	β	P value	β	P value	β	P value	β	P value
Symptoms	Esophageal reflux SS	-0.075	.022	-0.070	.026					0.092	.013
	Abdominal pain SS					-0.100	.002	-0.061	.057		
	Meal-related distress SS	-0.076	.021	-0.106	.001	-0.057	.069	-0.067	.036		
	Indigestion SS			-0.084	.008			-0.116	<.001		
	Diarrhea SS			-0.102	.001	0.091	.003				
	Constipation SS			0.097	.002						
	Dumping SS	-0.069	.039	-0.197	<.001	-0.121	<.001				
	Total symptom score			-0.124	<.001			-0.085	.012		
Living status	Change in BW ^a			-0.125	<.001						
	Ingested amount of food per meal ^a	0.089	.008	-0.085	.007						
	Necessity for additional meals	-0.106	.001	0.096	.002	-0.072	.021	-0.063	.046		
	Quality of ingestion SS ^a					-0.065	.039				
	Ability for working	-0.079	.015	0.254	<.001						
QOL	Dissatisfaction with symptoms	-0.102	.002	-0.098	.002	-0.091	.003	-0.078	.014		
	Dissatisfaction at the meal	-0.080	.015	-0.112	<.001			-0.087	.006		
	Dissatisfaction at working	-0.111	.001							0.082	.027
	Dissatisfaction for daily life SS	-0.113	.001	-0.088	.005			-0.083	.008	0.078	.035
	PCS of SF-8 ^a	0.070	.036	-0.100	.002						
	MCS of SF-8 ^a										

Abbreviations: [Y], yes; CTx, chemotherapy; LN, lymph node; SS, subscale; TG, total gastrectomy; TGJPI, total gastrectomy with jejunal pouch interposition; TGJPR, total gastrectomy with Roux-en-Y oral pouch.

^aThe higher the score or value, the better the condition; otherwise (without letter a), the higher the score, the poorer the condition. If β is positive, the score of the outcome measure of the patients belonging to the category in [brackets] is higher in cases when the factor is a nominal scale, and the score of outcome measure of the patients with larger values is higher in cases when the factor is a numeral scale. The interpretation of effect size in β : ≥ 0.1 as small, ≥ 0.3 as medium, ≥ 0.5 as large. The interpretation of effect size in R^2 : ≥ 0.02 as small, ≥ 0.13 as medium, ≥ 0.26 as large.

subscales.²⁹ Since the results of the present study revealed that creating a pouch diminished both meal-related distress and dumping symptoms, this procedure may improve postoperative QOL.

Furthermore, we compared the postgastrectomy QOL among three variations of the pouch-creation procedure: TGJPR, TGJPI, and TGJPY. In the present study, TGJPR and TGJPI patients expressed equally better QOL than TGJPY patients. As a result, the postoperative QOL in the TG with oral pouch group improved more broadly and more effectively than that in the TGJP group, including TGJPY, in multiple main outcome measures with larger effect sizes. The usefulness of TG in the distal pouch remains controversial. Some studies have reported its usefulness,^{30,31} while Tanaka et al reported that the long-term benefits of this procedure are limited.³² As only a few studies have reported on the usefulness and shortcomings of the different types of pouches, our study provides valuable insights into the difference in postgastrectomy QOL between patients with oral and distal pouches.

In addition, in the present study the length of the jejunal pouch was significantly shorter in TGJPY patients (10.2 ± 1.9 cm) than in TGJPR (14.0 ± 4.7 cm) and TGJPI (13.5 ± 4.6 cm) patients. Nanthakumarang et al reported that in vivo experiments using a porcine model indicated that, for a 10 cm pouch, a volume of 350–400 mL was only achieved after a pressure of 45 cm H₂O was applied; for a 15 cm pouch, this volume was easily achieved at a pressure of 15 cm H₂O.³³ Therefore, our results may indicate that, not only the position of the pouch, but also the size of the pouch affected QOL of TG patients. Further studies are required to determine the optimal pouch sites and sizes.

Multiple regression analysis showed that, in addition to pouch creation, several background factors such as age, gender, postoperative period, and lymph node dissection significantly affected PGS severity. These results were generally consistent with those of a previous study that examined the influence of background factors on the main outcome measures of the PGSAS-45.²⁰

Celiac branch of vagus (Preserved)		CTx [Y]		cStage (III/IV)		LN dissection (D1+)		LN dissection (D2/D2+)		Combined resection [Y]		R ²	P-value
β	P value	β	P value	β	p value	β	p value	β	p value	β	p value		
												0.030	.001
												0.023	.014
												0.033	<.001
						-0.055	.078					0.030	.001
						-0.075	.016			0.059	.096	0.028	.002
										0.074	.035	0.019	.046
						-0.090	.005					0.076	<.001
				-0.074	.068	-0.100	.003			0.070	.065	0.045	<.001
				0.109	.004	-0.058	.064	0.095	.015			0.058	<.001
				0.101	.009					-0.087	.014	0.026	.006
0.065	.038			-0.069	.069							0.040	<.001
												0.009	.592
						-0.055	.073			0.064	.061	0.083	<.001
										0.071	.043	0.041	<.001
												0.035	<.001
						-0.061	.050			0.066	.060	0.025	.007
										0.077	.029	0.036	<.001
						0.064	.041					0.024	.009
												0.013	.288

This study has several limitations. First, there was an uneven match between the number of patients in the TG and TGJP groups because of the retrospective nature of the study. However, our study still included a much larger number of patients than any other previous study analyzing the effect of postgastrectomy pouch creation on QOL. Second, there may have been selection bias concerning the type of reconstruction technique used. Since surgeons or institutions are likely to use their preferred techniques, a randomized controlled trial is required to eliminate potential biases.

In conclusion, the results of our study indicate that creating a pouch, particularly an oral pouch, for patients who undergo TG may be beneficial for improving their postoperative QOL and reducing the symptoms of PGS.

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DISCLOSURE

Approval of the Research Protocol: The protocol for this study was approved by a suitably constituted Ethics Committee of all participating institutions.

Informed Consent: Written informed consent was obtained from all enrolled patients.

Registry and the Registration No. of the Study/Trial: The University Hospital Medical Information Network Clinical Trials Registry (registration number 000 032 221).

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