

# Jejunal Pouch Reconstruction After Total Gastrectomy for Cancer

## A Randomized Controlled Trial

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### Objective

The authors determined the optimum reconstruction procedure after total gastrectomy in terms of the quality of life of the patients.

### Summary Background Data

Gastric replacement with various enteric reservoirs has been used to improve the postprandial symptoms and nutrition of patients after total gastrectomy. However, the effect of each is uncertain because no prospective randomized studies have been conducted.

### Methods

A randomized controlled trial was conducted to compare the usefulness of the three reconstruction procedures of simple Roux-en-Y (RY; N = 10), pouch and Roux-en-Y (PR; N = 10), and pouch and interposition (PI; N = 10). In each subject, the postprandial symptoms, food intake in a single meal, body weight, serum nutritional parameters, and emptying time of the gastric substitute were evaluated.

### Results

The PR group showed significantly greater food intake in a single meal than the RY and PI groups, and greater weight recovery than the PI group. A gastric emptying test also revealed satisfactory retention capacity and emptying time of the gastric substitute in the PR group.

### Conclusions

Pouch and Roux-en-Y reconstruction is the most useful of the three procedures for improving the postoperative quality of life. In patients with pouch and interposition reconstruction, the clinical assessment was quite poor, even though it is a physiologic route.

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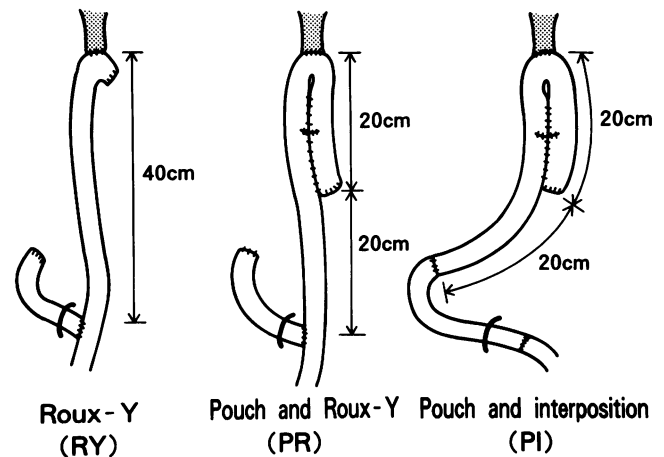
Many patients who undergo total gastrectomy experience dysphagia, pyrosis, lack of appetite, and reduced food intake, followed by loss of body weight. Therefore, attention has been focused on the relief of symptoms and improvement of the quality of life of these patients.

Since Schlatter<sup>1</sup> performed the first successful total gastrectomy, many types of gastric replacement with various enteric reservoirs have been applied in efforts to improve the symptoms or nutrition of patients after total gastrectomy.<sup>2-10</sup> However, the optimum reconstruction after total gastrectomy for malignant disease remains unsettled, and there have been few prospective clinical trials to examine this question. In Japan, as well as in many other countries, the Roux-en-Y esophagojejunostomy, although not a physiologic route, apparently is the preferred reconstruction because it is relatively simple to perform and prevents reflux esophagitis. We also have been applying this procedure as a standard reconstruction after total gastrectomy for cancer. We have observed, however, that with regard to dietary intake and nutrition, this procedure is not satisfactory. Published studies have indicated an obvious relationship between the postoperative change of body weight and the food intake.<sup>11-15</sup>

To determine the optimum reconstruction procedure after total gastrectomy in terms of the quality of life of the patients, we conducted a randomized controlled trial to compare the usefulness of the three reconstruction procedures of simple Roux-en-Y, pouch and Roux-en-Y, and pouch and interposition in patients who received the Hunt-Lawrence jejunal pouch<sup>7</sup> for improvement of dietary intake.

## PATIENTS AND METHODS

Thirty patients younger than 70 years of age who had undergone total gastrectomy with curative resection at our hospital between November 1988 and February 1993 were selected and randomly classified into the following three groups, according to the type of reconstruction: simple Roux-en-Y (RY; N = 10); pouch and Roux-en-Y (PR; N = 10); and pouch and interposition (PI; N = 10). For randomization, the type of reconstruction was written on a card and placed in an opaque, sealed envelope. The envelopes were thoroughly mixed and placed in a basket. Before operation, an envelope was selected at random from the basket and brought to the operating room. When total gastrectomy was performed cura-



**Figure 1.** Operative design of this randomized controlled trial for gastric cancer treatment.

tively, the envelope was opened, and we performed the type of reconstruction designated on the card.

The operative design in each procedure is shown in Figure 1. Stage IV patients were excluded from the study. The background of the patients in each group is summarized in Table 1.

The clinicopathologic data were evaluated on the basis of the General Rules for Gastric Cancer Study in Surgery and Pathology in Japan.<sup>16</sup> There were no significant differences among the three groups in age or sex distribution, stage classification, grade of lymph node dissection, or combined resection and postoperative morbidity rates, and there was no severe complication from jejunal pouch formation in any patients. The number of patients who were observed for follow-up for more than 12 months without recurrence was 8, 9, and 6 in the RY, PR, and PI groups, respectively. However, one patient in the RY group died of myocardial infarction 21 months after operation. The absence of recurrence was ascertained through regular follow-up examinations, which included analysis of serum tumor markers, endoscopy, computed tomography, and sonography. The follow-up period ranged from 12 to 64 months, with median duration of 43 months. The subjects were interviewed and examined periodically to assess symptoms, food intake (volume of a single meal), body weight, and serum nutritional parameters. The reservoir function of the gastric substitute also was examined 1 year after operation. Postoperative symptoms were evaluated as positive when the patients reported that they were experienced at least once a week during the month immediately preceding the interview. The volume of food intake in a single meal was expressed as a percent of the normal pre-illness level and classified into the following three grades; <50%; 50% to 80%; and >80%. Body weight change was expressed as a percent of normal weight by the formula

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**Table 1. PATIENTS UNDERGOING TOTAL GASTRECTOMY IN RANDOMIZED CLINICAL TRIAL**

Case	Reconstruction	Age (yrs)	Sex	Stage	Lymphnode Removal*	Combined Resection	Complication	Outcome and Period
T.U.	RY	49	F	1	R1	—	—	63 mos
K.Y.	RY	66	M	3	R3	Pancreas spleen	Pancreatic fistula	Recurrence and death (13 mos)
T.I.	RY	59	F	2	R2	Spleen	—	59 mos
M.I.	RY	38	M	2	R2	—	—	56 mos
Y.T.	RY	67	M	3	R3	Pancreas spleen	—	Recurrence and death (34 mos)
K.I.	RY	65	M	1	R2	—	—	53 mos
T.Y.	RY	67	F	2	R2	—	—	51 mos
I.F.	RY	47	M	1	R2	—	—	40 mos
M.W.	RY	66	M	2	R3	Spleen	Subphrenic abscess	37 mos
K.D.	RY	65	F	2	R3	Pancreas spleen	—	MI and death (21 mos)
M.T.	PR	44	M	3	R3	Spleen	Anastomotic stenosis	64 mos
H.N.	PR	56	M	2	R3	Spleen adrenal gland	—	63 mos
K.O.	PR	65	F	2	R3	Spleen	—	60 mos
M.N.	PR	37	F	1	R3	Spleen	Pancreatitis	59 mos
T.S.	PR	47	M	3	R3	Spleen	—	Recurrence and death (12 mos)
H.S.	PR	53	F	1	R2	—	—	49 mos
T.Y.	PR	53	M	3	R2	Spleen	—	42 mos
K.O.	PR	55	F	2	R2	Pancreas spleen	—	30 mos
A.N.	PR	65	M	1	R2	Pancreas spleen	—	24 mos
H.K.	PR	57	M	2	R3	Spleen	—	14 mos
N.O.	PI	59	M	3	R3	Spleen	—	Recurrence and death (15 mos)
C.T.	PI	63	M	2	R3	Spleen adrenal gland	Liver insufficiency	Death (2 mos)
K.T.	PI	48	F	3	R3	Spleen adrenal gland	Leakage	53 mos
S.M.	PI	63	M	3	R2	Spleen	—	Recurrence and death (9 mos)
S.F.	PI	61	M	2	R2	Spleen	—	43 mos
K.T.	PI	68	M	2	R3	Spleen	—	Recurrence and death (17 mos)
F.K.	PI	59	M	2	R3	Spleen	—	31 mos
S.S.	PI	62	F	3	R2	Spleen	—	26 mos
T.M.	PI	40	M	1	R2	—	—	26 mos
S.M.	PI	58	F	1	R2	Spleen	—	12 mos

RY = Roux-en-Y reconstruction; PR = pouch and Roux-en-Y reconstruction; PI = pouch and interposition.

\* Gastric resection was classified based on lymph node removal as follows: R1 = gastric resection including the complete removal of group 1 lymph nodes alone; R2 = gastric resection including the complete removal of group 1 and 2 lymph nodes; R3 = gastric resection including the complete removal of group 1, 2, and 3 lymph nodes.

body weight at the time of examination/pre-illness normal weight  $\times 100$ . Blood was withdrawn before and after total gastrectomy to measure the serum levels of total protein, albumin, and total cholesterol as nutritional indices. Onodera's Prognostic Nutritional Index (PNI)<sup>17</sup> also was examined to evaluate pre- and postoperative nutritional and immunologic status of the patients. The PNI was calculated by the formula  $10(\text{Alb}) + 0.005(\text{Lymph. C.})$ , where Alb is the serum albumin level (g/100 mL) and Lymph. C. is the total lymphocyte count (/mm<sup>3</sup>) of peripheral blood.

As a measure of the reservoir function, the emptying time of the gastric substitute was evaluated using technetium 99m diethylene-triaminepentacetic acid (<sup>99m</sup>Tc-DTPA; 1 mCi) labeled semisolid test meal (200 g of rice gruel including egg; 151 kcal) 1 year after operation. All the patients ate the test meal within 3 minutes. Immediately after the meal, the patient was placed in front of a

gamma camera in a standing position and the radioactivity was measured over the whole abdomen for 30 seconds at 0 (immediately after the meal), 5, 10, 20, 30, 40, 50, and 60 minutes after the meal. The patient remained in a sitting position at other times during the examination period. Data were stored on disks and processed in a digital computer. Areas of interest corresponding to the gastric substitute were outlined, and the radioactivity was counted on each image and expressed as the percentage of ingested activity.

For reconstruction, one of the three procedures described had been performed in each patient.

### Simple Roux-en-Y

After total gastrectomy with systematic lymphadenectomy, the jejunum was divided approximately 20 cm dis-

tal to Treitz's ligament. The distal limb of the jejunum was brought up posteriorly to the colon, and a circular stapler device (EEA 25, U.S. Surgical Corp., Norwalk, CT) was introduced through the end of the distal jejunum. After end-to-side esophagojejunostomy was performed using the EEA stapler, the distal end of the loop was closed with a linear stapler (TA 55, U.S. Surgical Corp.) 1 cm from the site of anastomosis. The proximal jejunal stump was anastomosed manually to the side of the distal jejunum, 40 cm below the esophagojejunostomy.

### Pouch and Roux-en-Y

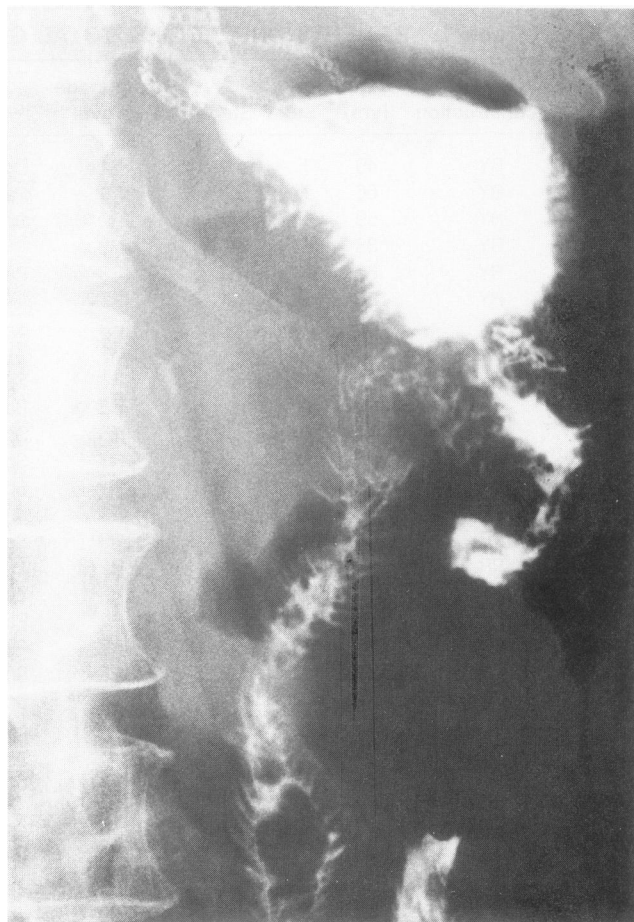
To construct the Hunt-Lawrence pouch, the distal portion of the divided afferent limb measuring 20 cm in length was brought up posteriorly to the colon, plicated to the proximal efferent limb, and held in place by traction sutures. At the midportion of each limb of plicated loops, a small stab wound was made. The linear autosuture stapler (GIA 90, U.S. Surgical Corp.) was introduced through this stab wound two times, upward and downward, and a side-to-side anastomosis was performed at the antimesenteric borders of the bowel.

Care was taken to leave a gap wide enough to admit the index finger between the proximal end of the anastomosis and the apex of the folded loop to avoid any possible compromise of the vascular supply of the jejunal wall at the site to be used for subsequent anastomosis to the esophagus.<sup>4,7</sup> After inspection of the anastomotic lines for hemostasis, the EEA device was introduced through the center hole of the pouch for esophagojejunostomy. The hole was closed transversely with two layer closures. The completed pouch measured approximately 20 cm in length. The leakage of the constructed pouch was checked by injecting 200 to 300 mL of warm saline through a nasogastric tube. The intestinal continuity was then reestablished manually in Roux-en-Y fashion, approximately 20 cm below the pouch.

### Pouch and Interposition

The construction of the pouch was performed with the same procedures as described above. Before esophagojejunostomy, an end-to-end jejunoduodenostomy approximately 20 cm below the pouch was made using the EEA instrument introduced through the center hole. Intestinal continuity was re-established with an end-to-end jejunojejunostomy approximately 20 cm distal to Treitz's ligament.

Postoperatively, all the patients had been maintained on hyperalimentation and were allowed nothing by mouth for 7 days. Before oral feeding was started, roent-



**Figure 2.** Roentgenogram 10 days after operation in a patient who underwent pouch and Roux-en-Y reconstruction. No evidence of leakage is seen, and reservoir capacity and progressive emptying are found.

genographic examination was performed to rule out any evidence of leak. Figure 2 shows the x-ray appearance 10 days after operation in a patient who underwent pouch and Roux-en-Y reconstruction showing reservoir function. Patients in stages II and III received fluorouracil or a derivative, given orally, for 6 to 12 months after operation. In stage III patients, an additional cytotoxic drug combination, such as mitomycin C or doxorubicin (Adriamycin, Adria Laboratories, Columbus, OH), was given intravenously once a month for 3 months if there were no severe side effects.

Statistical analysis was performed using the chi square and Student's *t* tests; *p* values of less than 0.05 were considered to be statistically significant.

## RESULTS

### Postoperative Symptoms

The highest frequency of postprandial symptoms (epigastric fullness, nausea, or vomiting) was found in the PI

**Table 2. POSTOPERATIVE SYMPTOMS OF PATIENTS WHO UNDERWENT TOTAL GASTRECTOMY**

	Epigastric Fullness Nausea, Vomiting				Heartburn, Bile Reflux				Early Dumping			
	MONTHS AFTER OPERATION				MONTHS AFTER OPERATION				MONTHS AFTER OPERATION			
	3	6	12	24	3	6	12	24	3	6	12	24
Roux-en-Y	3/8 (38)	2/8 (25)	2/8 (25)	1/7 (14)	3/8 (38)	2/8 (25)	1/8 (13)	1/7 (14)	1/8 (13)	0/8 (0)	0/8 (0)	0/7 (0)
Pouch and Roux-en-Y	1/9 (11)	1/9 (11)	0/9 (0)	0/8 (0)	3/9 (33)	0/9 (0)	0/9 (0)	0/8 (0)	0/9 (0)	0/9 (0)	0/9 (0)	0/8 (0)
Pouch and interposition	3/6 (50)	3/6 (50)	3/6 (50)	2/5 (40)	0/6 (0)	0/6 (0)	0/6 (0)	0/5 (0)	0/6 (0)	0/6 (0)	1/6 (17)	0/5 (0)

Numbers in parentheses are percentages.

group, followed by the RY group. The incidence was very low in the PR group. The RY group had the highest incidence of pyrosis and bile reflux, although the incidence was decreased 1 year after operation. In the PR and PI groups, heartburn and bile reflux was absent after the first 6 months. The incidence of dumping syndrome, which was diagnosed based on evidence of early post-prandial vasomotor disturbances such as dizziness, faintness, or weakness, and alimentary symptoms were very low in all three groups (Table 2).

### Dietary Intake in a Single Meal

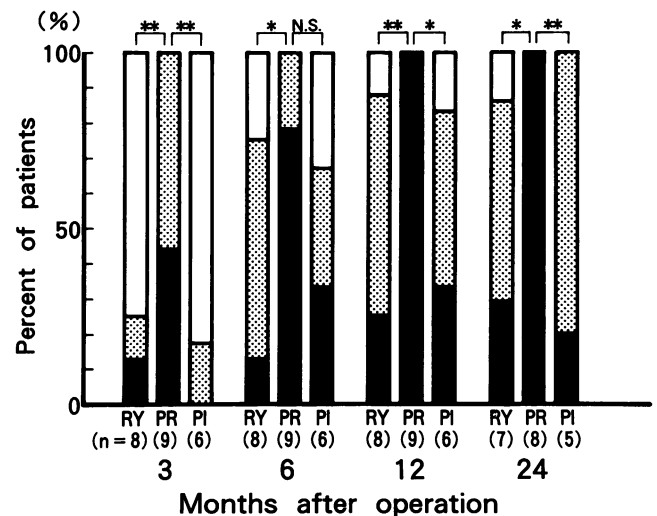
The percent change of food intake after total gastrectomy in all patients in the PR group was at least 50% of the pre-illness food intake as early as 3 months after operation and more than 80% of the pre-illness level 12 months after operation. However, only approximately 30% of the patients in the RY and PI groups had an intake of more than 80%, even as late as 12 or 24 months after operation. The percent food intake in the PR group was significantly higher than in the other 2 groups at almost all times examined (Fig. 3).

### Development of Body Weight

The PR group showed the highest body weight as a percent of the pre-illness body weight. The percent body weight in the PI group remained very low; it was 80% or less of the pre-illness weight throughout the follow-up period. A significant difference was found between the percent body weight in the PR and RY groups at 12 months after operation, and between the PR and PI groups throughout the follow-up period (Fig. 4).

### Serum Nutritional Parameters Before and After Total Gastrectomy

The total protein level in the PR group showed gradual increase after gastrectomy and was significantly higher than that in the RY group 12 months ( $p < 0.05$ ) and 24 months ( $p < 0.01$ ) after operation. In some patients in the RY group, the total protein level remained below the minimum level of the normal range throughout the follow-up period. The albumin level in the PR group also increased gradually, but there were no significant differences among the three groups in albumin level. The total cholesterol level decreased after operation in all three groups, but the variations remained within the normal limits (Fig. 5).



**Figure 3.** Percent change of food intake in a single meal of patients who underwent total gastrectomy. (□) <50% food intake compared with pre-illness normal level; (▨) 50–80%; (■) >80%. \* $p < 0.05$ , \*\* $p < 0.01$ ; NS = not significant.

### Prognostic Nutritional Index Before and After Total Gastrectomy

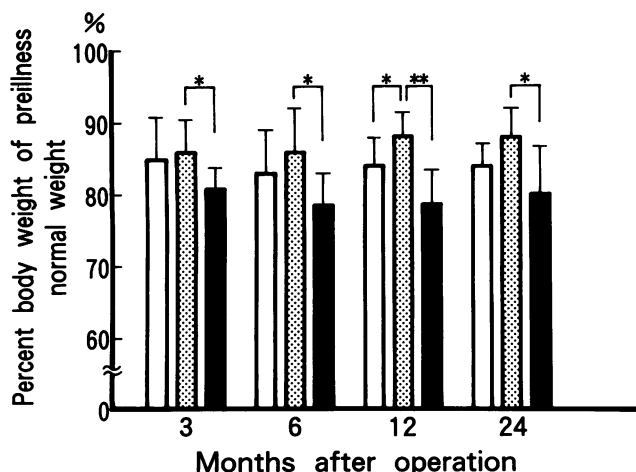
As a possible measure of the pre- and postoperative nutritional and immunologic status of the patients, Onodera's PNI<sup>17</sup> was calculated.

There was no significant postoperative change in the index in the RY group. The index in the PR group showed a progressive increase postoperatively, and reached a plateau 12 months after operation; there was a significant difference between the PNI in the PR and RY groups 12 months ( $p < 0.01$ ) and 24 months ( $p < 0.05$ ) postoperatively. In the PI group, the index increased slightly, but no significant difference was found between the PNI in the PI and RY groups (Fig. 6).

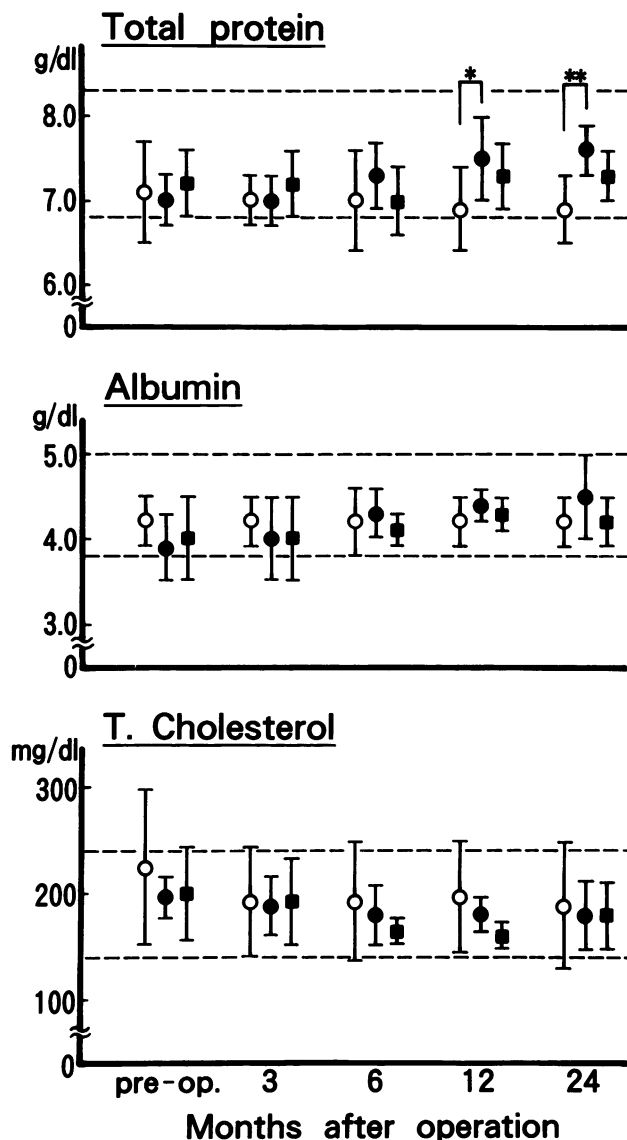
### Reservoir Function of the Gastric Substitute

Figure 7 shows gamma camera images 5, 30, and 60 minutes after test meal ingestion in a patient with pouch who underwent Roux-en-Y reconstruction. The images show retention of the test meal in the pouch, which seems to have some reservoir function as a gastric substitute.

The mean isotope retention rate of the test meal in the gastric substitute in each group is shown in Figure 8. In the RY group, the emptying time was very rapid and there was no reservoir function. In the PR and PI groups, the initial emptying curve was satisfactory, but from 30 to 60 minutes after ingestion, the curve in the PI group was flat and almost no emptying was found. There was a significant difference between the PR and PI groups in



**Figure 4.** Change of body weight in patients who underwent total gastrectomy. (□) Roux-en-Y (RY); (▨) pouch and Roux-en-Y (PR); (■) pouch and interposition (PI). \* $p < 0.05$ . \*\* $p < 0.01$ .



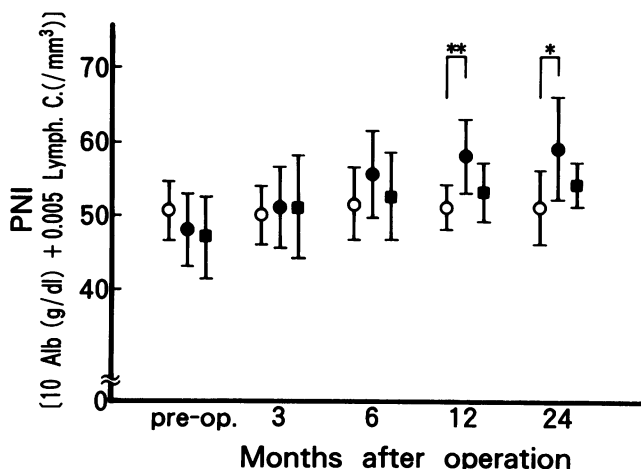
**Figure 5.** Change of serum nutritional parameters in each group before and after total gastrectomy. (○) RY; (●) PR; (■) PI. \* $p < 0.05$ , \*\* $p < 0.01$

the isotope retention rate 60 minutes after ingestion ( $p < 0.05$ ).

### DISCUSSION

An alimentary tract reconstruction operative technique that prevents reflux esophagitis and provides an adequate reservoir for food probably will lead to improved nutritional status after total gastrectomy.

Therefore, we chose the following three reconstructions: Roux-en-Y esophagojejunostomy, which is the most common reconstruction because of its relative simplicity and effective prevention of reflux esophagitis;



**Figure 6.** Change of PNI in patients before and after total gastrectomy. The PNI was calculated by the following formula; 10 Alb (g/dL) + 0.005 Lymphocyte count (/mm<sup>3</sup>). (○) RY; (●) PR; (■) PI. \*p < 0.05, \*\*p < 0.01.

Hunt-Lawrence pouch and Roux-en-Y reconstruction, which has been reported to provide a reservoir function and nutritional advantage; and Hunt-Lawrence pouch and interposition, which seems to be more physiologic than PR reconstruction. Furthermore, the jejunal pouch using GIA staplers can be constructed rapidly and safely.<sup>18,19</sup>

In the present study, only 30% of the patients with Roux-en-Y reconstruction, however, showed dietary intake more than 80% of the pre-illness level 1 or 2 years

postoperatively, which is not satisfactory. In the patients with pouch and Roux-en-Y reconstruction, the frequency of postprandial syndromes was found to be very low and the food intake was increased immediately after operation, as several other authors have reported.<sup>7-9,18</sup>

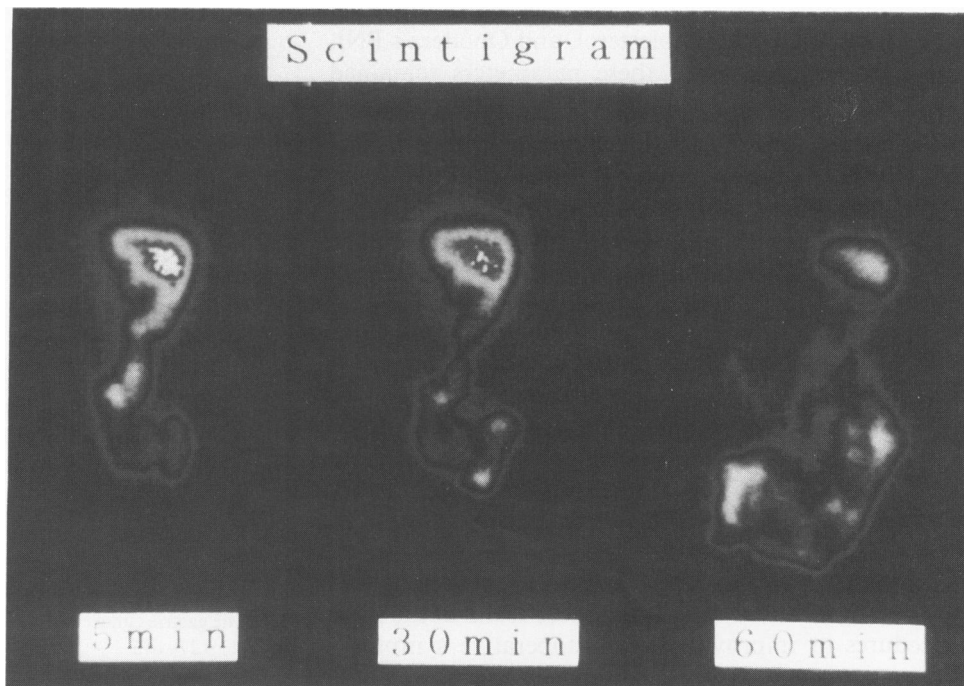
On the other hand, the patients with pouch and interposition showed poor food intake mainly because of sensation of epigastric fullness or nausea, which did not improve markedly with time. No impact of the preservation of the duodenal passage on symptoms could be recognized in our study.

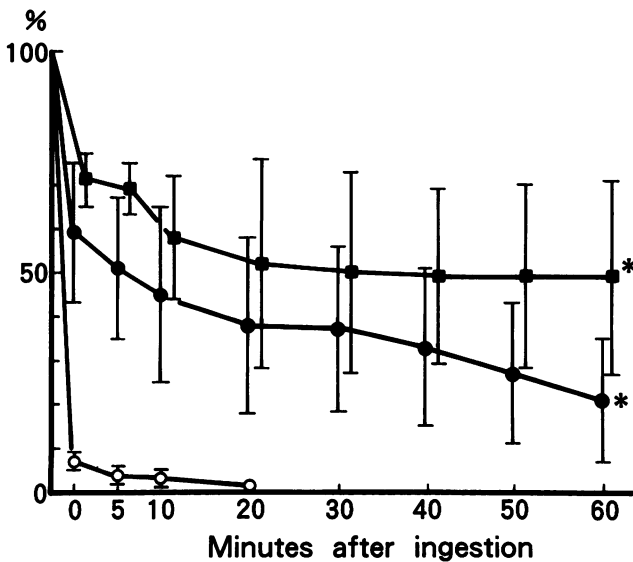
Malnutrition after total gastrectomy was formerly attributed to malabsorption caused by bacterial overgrowth, mucosal lesions of the small intestine, relative pancreatic enzyme insufficiency, and shortened small intestinal transit time. However, in 1975, Bradly<sup>12</sup> suggested that the malnutrition observed after total gastrectomy was the result of inadequate calorie intake rather than maldigestion or malabsorption. Some other authors<sup>11,13-15</sup> also have suggested that the major cause of weight loss might be inadequate calorie intake.

In the present study, the PR group showed the most marked increase of body weight, and a possible relationship between dietary intake and development of body weight was observed.

In 1980, Buzby et al.<sup>20</sup> first reported the PNI for assessing the relationship between preoperative nutritional assessment and postoperative complications in patients undergoing major gastrointestinal surgery. Onodera et

**Figure 7.** Gamma camera images 5, 30, and 60 minutes after ingestion of test meal in a patient who underwent pouch and Roux-en-Y reconstruction. Some reservoir function and emptying of the gastric substitute was found.





**Figure 8.** Retention rate of isotope ( $^{99m}\text{Tc}$ -DTPA) labeled semisolid meal in gastric substitute. Immediately after the test meal, the patient was placed in front of a gamma camera in a standing position and radioactivity was measured over the whole abdomen. Areas of interest corresponding to the gastric substitute were outlined, and the radioactivity was counted and expressed as a percentage of ingested activity. (O) RY; (●) PR; (■) PI.  $p < 0.05$  (\* vs. \*)

al.<sup>17</sup> also reported their own PNI, which is simpler and more clinically based than that of Buzby et al., and which is easily calculated using the aforementioned formula. They reported that resection and anastomosis of gastrointestinal tract could be safely applied when the calculated index value was more than 45.

As nutritional parameters, we selected serum total protein, albumin, total cholesterol, and Onodera's PNI. Although the changes of these parameters remained close to normal limits, high levels of total protein and high PNI, consistent with the change in body weight, were found in patients with pouch and Roux-en-Y reconstruction 1 year postoperatively.

We evaluated the reservoir function of the pouch by isotopic method using a  $^{99m}\text{Tc}$ -labeled semisolid test meal (rice gruel), although the application of this method is still controversial.<sup>21,22</sup> The test revealed satisfactory retention of nutrition in both the PR and PI groups. However, in the PI group, despite the physiologic route, the transmission from the pouch to the small intestine was delayed and most of the patients complained of sensation of epigastric fullness or nausea. On the other hand, reasonable gastric emptying performance was found in the PR group.

The results of this study indicate that pouch and Roux-en-Y reconstruction is the most useful of the three procedures in improving the postoperative symptoms

and the quality of life. In the patients with pouch and interposition reconstruction, even though it is a physiologic route, the clinical assessment was quite poor, in contrast to the findings presented in other reports.<sup>23,24</sup>

In most of our patients, the x-ray video film revealed apparent folding and twisting of the jejunal conduit between the pouch and duodenum, which disturbed the transmission of nutrition from the pouch to the duodenum and the motility of the jejunal conduit. These phenomena might partially be the result of the operative procedures.

Currently, we are conducting another randomized clinical trial to compare the modified pouch interposition procedure with the pouch and Roux-en-Y reconstruction procedure.

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