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# *Roux-en-Y* Plus Distal Jejunal Pouch After Total Gastrectomy: A Prospective Study

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**Abstract.** *Background/Aim: We previously described the safety of distal jejunal pouch with Roux-en-Y reconstruction after total gastrectomy. The present prospective study evaluated its clinical benefit. Patients and Methods: Forty-five patients with gastric cancer were preoperatively assigned to groups who underwent Roux-en-Y reconstruction with jejunal pouch (PRY) (n=23) or without pouch (RY) (n=22). Age, sex, grade of lymph node dissection, splenectomy and mode of laparotomy were analyzed, and body mass index (BMI), volume of food intake at one sitting and blood chemistry (total protein, hemoglobin, iron and cholesterol) were periodically assessed in both groups. Results: Post-surgical mortality and severe morbidity did not occur. Three and four patients in the PRY and RY groups, respectively, died of gastric cancer recurrence during the study. BMI at six months after surgery was significantly higher in the PRY than in the RY group (p<0.05). The percentage of food intake at one year after the procedure was significantly higher in the PRY than in the RY group (p<0.05). Conclusion: The distal jejunal pouch ameliorated postoperative weight loss and increased food intake. A distal jejunal pouch with PRY reconstruction may confer significant clinical advantages after total gastrectomy. The long-term clinical benefit of this procedure should be evaluated.*

Total gastrectomy is indicated to treat gastric cancer of the upper part or the whole stomach (1). *Roux-en-Y* (RY) is a simple and safe reconstruction procedure after total gastrectomy (2) and has been performed worldwide especially after the introduction of suturing instruments, such as linear or circular staplers. Patients who undergo total gastrectomy have a dysfunctional gastric reservoir and impaired hormonal secretions from the stomach and thus, receive more daily meals of a small amount of food (3). Postoperative weight loss with malnutrition usually occurs (4, 5). A recent study has shown that total gastrectomy results in a 10% loss of skeletal muscle at about one year after surgery (6). Attempts have been made to improve postoperative nutritional status by reconstructing the maintenance of partial duodenal passage (7) or pouches using the transverse colon as a gastric substitute (8). The clinical benefit of pouch reconstruction has been addressed in randomized clinical trials (9-12). A recent meta-analysis found that a jejunal pouch confers a superior nutritional benefit compared to reconstruction that does not involve a pouch (13). *Roux-en-Y* reconstruction with a jejunal pouch at the esophagojejunostomy after total gastrectomy has become a standard procedure, but such pouches often become dilated and twisted, finally obstructing the passage of the food (14). These clinical findings indicated a need for an appropriate jejunal pouch after total gastrectomy. We previously reported the clinical benefit of *Roux-en-Y* reconstruction with jejunal pouch (PRY) (15). Postoperative clinical data derived from that pilot study indicated that patients with PRY recover body weight and nutritional status. Here, we prospectively compared the clinical benefit of PRY with conventional RY after total gastrectomy.

*Trial registration:* A clinical trial at Kagoshima University Hospital (IRB number 18-99).

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*Key Words:* Gastric cancer, total gastrectomy, *Roux-en-Y* reconstruction, distal jejunal pouch.

## Patients and Methods

*Patient selection and registration*. We registered 47 consecutive patients who underwent total gastrectomy for gastric cancer between April 2010 and December 2014 at Kagoshima University Hospital. Patients provided written, informed consent before undergoing surgical procedures associated with this study, which was registered as a clinical trial at Kagoshima University Hospital (IRB number 18-99). The eligibility criteria included histologically proven adenocarcinoma, no distant metastasis and a potentially resectable mass (R0) with lymph node dissection. Information about the

patients, such as age, sex, degree of nodal dissection and splenectomy, was preoperatively registered. The registration center informed us whether to perform RY or PRY reconstruction after total gastrectomy immediately before the procedure. Clinicopathological data were analyzed according to the Japanese Classification of Gastric Carcinoma (13th edition) (16).

*Surgical methodology of distal jejunal pouch*. After total gastrectomy with lymphadenectomy, the alimentary tract was reconstructed using RY with or without a distal jejunal pouch. Side-to-end esophago-jejunostomy was performed using a PCEEA circular stapler with a 25-mm diameter (Tyco Healthcare, Tokyo, Japan). The jejunum was folded 30 cm distal to the Treitz' ligament, then an 8-cm long side-to-side distal jejunal pouch was prepared by stapling and cutting in a side-to-side manner. The pouch was then positioned 40 cm below the esophagojejunostomy using a linear Endo GIA Universal Straight 60-mm stapler (Tyco Healthcare) twice and then the entry hole was closed using the linear stapler as described (15) (Figure 1).

*Evaluation of postoperative body mass index (BMI) and nutritional status*. All patients were weighed and blood chemistry (hemoglobin, total protein, cholesterol, and iron) was analyzed at 3, 6, 12 and 24 months after surgery. BMI was calculated for each patient as weight (kg) divided by height2 (m). Postoperative food intake was compared between the PRY and RY groups after 12 months.

*Postoperative follow-up and chemotherapy in adjuvant and recurrent settings*. Blood chemistry (hemoglobin, total protein, serum Fe, cholesterol and tumor markers) and BMI were analyzed, and the pouch was assessed by abdominal CT every three months to detect gastric cancer relapse in all patients who underwent R0 surgery.

Patients who had over stage IIIA cancer at the final pathological evaluation received S-1 adjuvant therapy for one year after the procedure (14). Those with postoperative gastric cancer recurrence received cisplatin (CDDP) plus S-1 according to the guidelines for gastric cancer in Japan (17).

*Statistical analyses*. Differences between the two groups were calculated using the Student's t-test or the Chi squared test. A *p*-value <0.05 was considered significant.

## Results

*Allocation of patients with gastric cancer.* The 47 patients with gastric cancer were assigned to undergo PRY (n=23) or RY (n=24). Four and three patients were excluded from the PRY and RY groups, respectively, because peritoneal metastasis was detected or because perioperative staging laparoscopy revealed positive peritoneal cytology. Therefore, 20 patients per group were finally registered (Figure 2).

*Postoperative course of patients*. Among the 47 patients with advanced gastric cancer, 15 and 11 in the PRY and RY groups, respectively, received postoperative adjuvant chemotherapy.

Three and four in the PRY and RY groups, respectively, died of recurrent disease during the study (Figure 3).

Table I. *Patients' information*.

| | Pouch group (n=20) | | Non-Pouch group (n=20) | | *p*-Value |
|---|---|---|---|---|---|
| Gender | | | | | |
| Male/Female | 17 | 3 | 16 | 4 | N.S. |
| Age | 66,8 | | 63,1 | | N.S. |
| Curability | | | | | |
| R0 R2 | 20 | 0 | 20 | 0 | N.S. |
| Splenectomy | | | | | |
| Yes No | 2 | 18 | 4 | 16 | N.S. |
| LN dissection | | | | | |
| D1 D2 | 4 | 16 | 3 | 17 | N.S. |
| Tumor dept | | | | | |
| T1•2/T3•4 | 3 | 17 | 4 | 16 | N.S. |

*Comparison of blood chemistry data between PRY and RY groups*. We compared values for hemoglobin, total protein, iron, and total cholesterol between the two groups. Generally, the hemoglobin and total protein transiently decreased and then increased one year after surgery, whereas total cholesterol and iron tended to decrease postoperatively. The postoperative hemoglobin value at six months was significantly higher in the PRY than in the RY group ($p<0.05$) (Figure 4).

*Comparison of BMI between PRY and RY groups*. The postoperative average BMI was the lowest in 40 patients at six months, and then gradually increased. The postoperative BMI at six and 12 months was 19.7 and 19.9, respectively, in the PRY group and 18.8 and 18.9, respectively, in the RY group ($p<0.05$) (Figure 5).

*Comparison of food intake at postoperative 12 months between PRY and RY groups*. The average volume of food intake was significantly higher in the PRY than the RY group ($p<0.05$) (Figure 6).

## Discussion

We modified the Hunt-Lawrence reconstruction that consists of proximal and distal jejunal pouches, with RY reconstruction and this procedure is presently recognized as an aboral jejunal pouch (18). The present study found better food intake and a significantly better BMI at 12 months after surgery in the PRY group. These findings indicate that the jejunal pouch functioned as a reservoir and thus contributed to better postoperative nutritional status in the PRY than in the RY group.

Distal jejunal pouches after total gastrectomy have been investigated in two prospective clinical studies (19, 20). Horváth *et al*. were the first to prospectively compare patients after surgery with and without a distal jejunal pouch

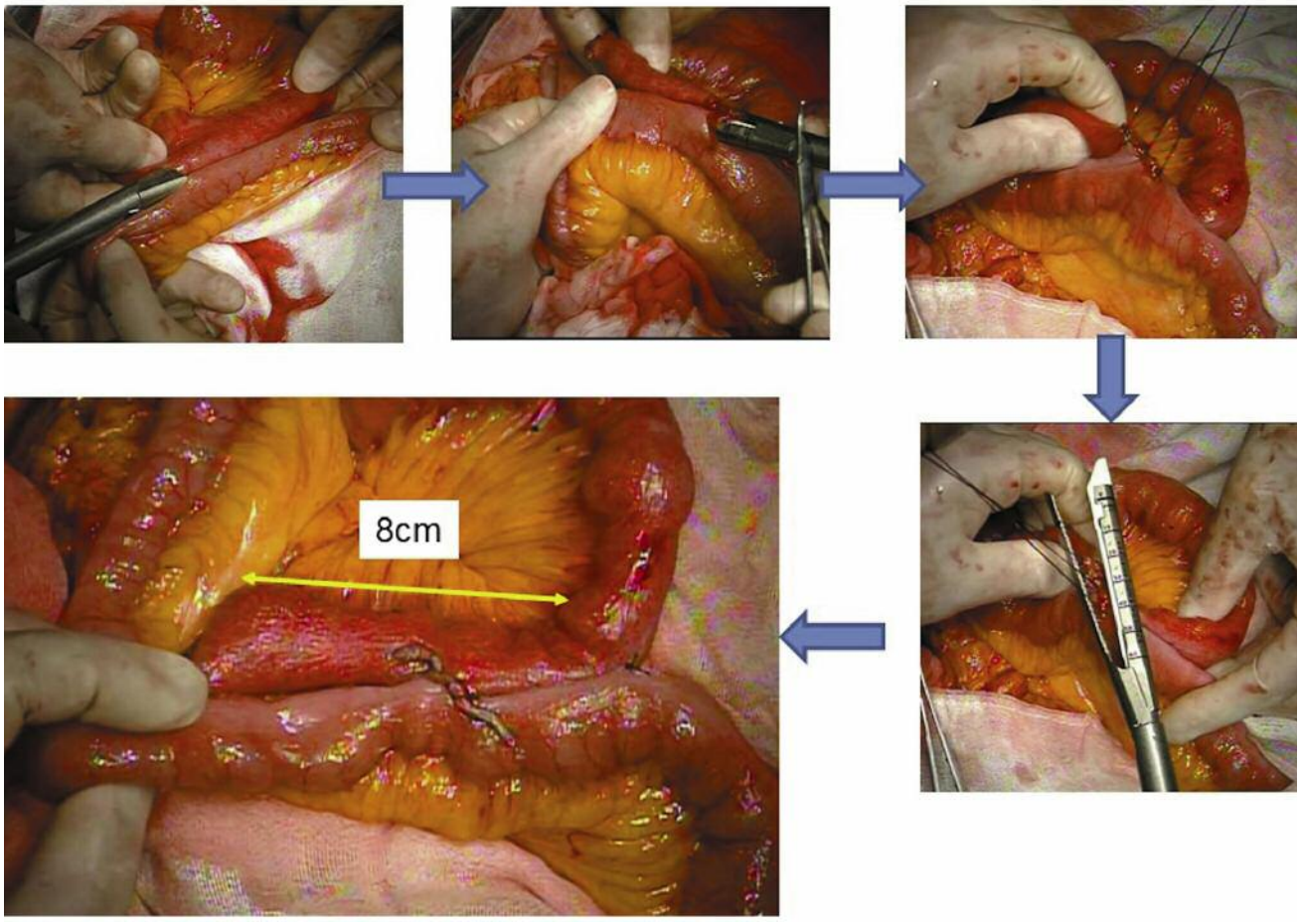


Figure 1. *Procedure of distal jejunal pouch after Roux-en-Y reconstruction. The pouch was then positioned 40 cm below the esophagojejunostomy using a linear Endo GIA Universal Straight 60-mm stapler (Tyco Healthcare) twice and then the entry hole was closed using the linear stapler.*

in 2001 (19) and found better lipid absorption and a better quality of life among those who had a pouch. Our results were similar to these. Ito *et al*. published a multi-institutional prospective study of postoperative quality of life and nutrition (20) but could not confirm the superiority of PRY reconstruction. These conflicting results may have been due to the size of the jejunal pouches because Ito *et al*. and Horváth *et al*., respectively, created 12- and 15-cm jejunal pouches. Ito *et al*. suggested that a shorter jejunal pouch was responsible for the unequivocal findings. However, an excessively long jejunal pouch could become dilated. The appropriate length of a jejunal pouch requires further discussion. Here, we focused on postoperative BMI as well as the volume of food intake, both of which directly reflect nutrition status, and identified a significantly higher BMI and significantly more food intake after PRY than RY. The jejunal pouch may function well as an alimentary reservoir.

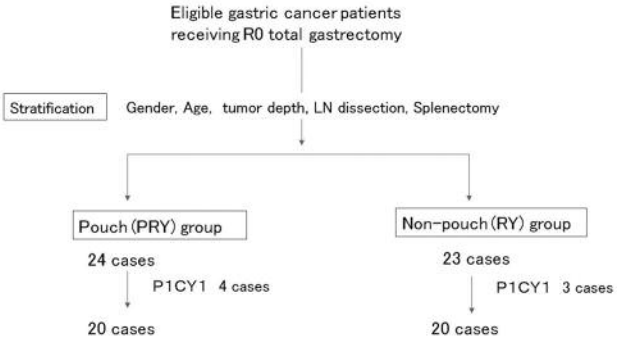


Figure 2. *Allocation of patients with gastric cancer. The 47 patients with gastric cancer were assigned to undergo PRY (n=23) or RY (n=24). Four and three patients were excluded from the PRY and RY groups, respectively, because peritoneal metastasis was detected or because perioperative staging laparoscopy revealed positive peritoneal cytology. Therefore, 20 patients per group were finally registered.*

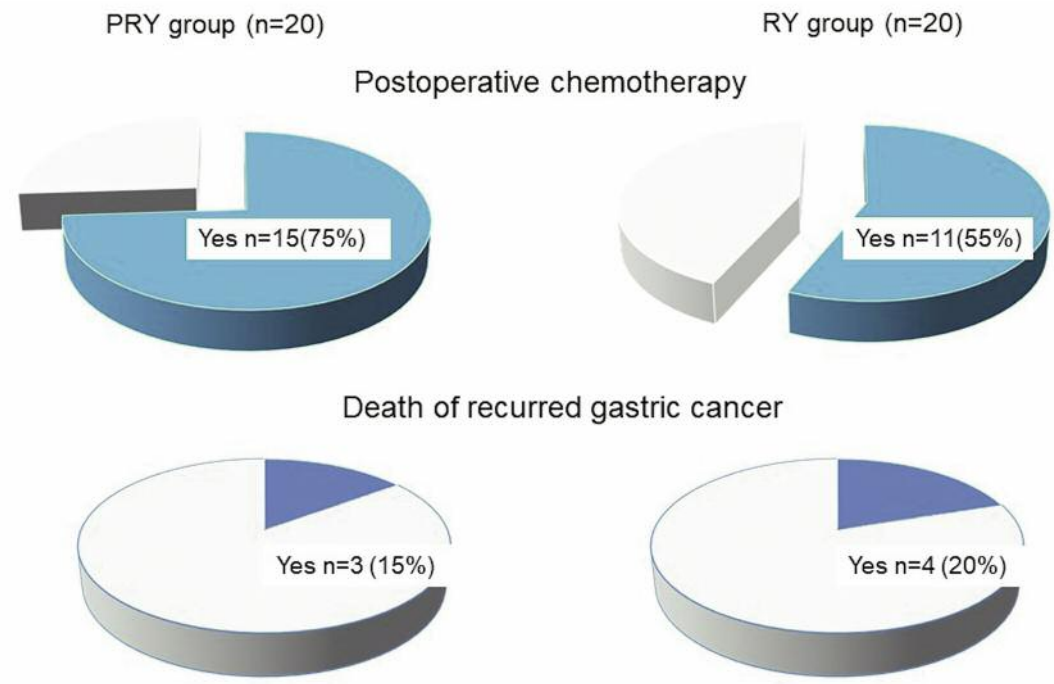


Figure 3. *Postoperative chemotherapy and outcome of the 40 patients. Among the 47 patients with advanced gastric cancer, 15 and 11 in the PRY and RY groups, respectively, received postoperative adjuvant chemotherapy. Three and four in the PRY and RY groups, respectively, died of recurrent disease during the study.*

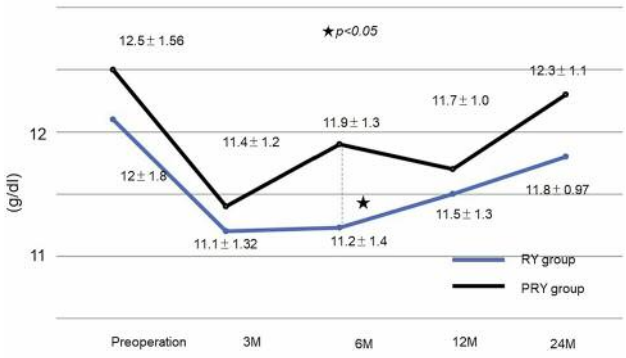


Figure 4. *Changes in the hemoglobin ratio. The postoperative hemoglobin value at six months was significantly higher in the PRY than in the RY group (p<0.05).*

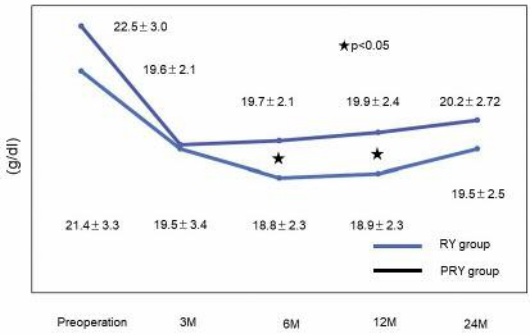


Figure 5. *Changes in the BMI ratio. The postoperative BMI at six and 12 months was 19.7 and 19.9, respectively, in the PRY group and 18.8 and 18.9, respectively, in the RY group (p<0.05).*

Twenty-three of the 40 patients in this study had advanced cancer and the percentage of patients receiving adjuvant chemotherapy or who had recurrent disease was > 40%. This rather high rate may not be appropriate for evaluation of the two types of reconstruction. The influence of adverse effects of anticancer therapy or recurrent gastric cancer should be considered. Nonetheless, the results of PRY were favorable, indicating a clear clinical benefit of PRY.

The present study showed a short-term clinical benefit of PRY. However, changes in pouch shape or nutritional status over the long term have not yet been predicted. Nakada *et al.* (21) indicated that living status and quality of life should be assessed for over two years. We have regularly monitored jejunal pouches by follow-up CT and have not yet identified any dilation. However, we plan to monitor the incidence of dilation among the aboral pouches described herein and postoperative status over time.

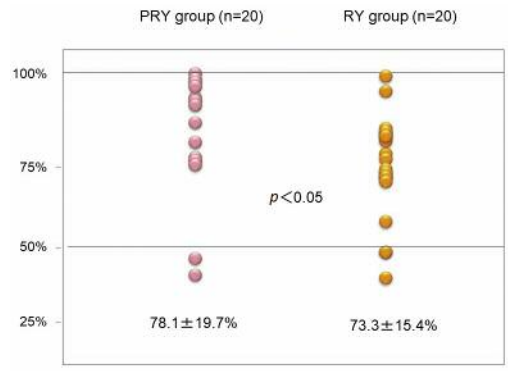


Figure 6. *Comparison of food intake at postoperative 12 months between PRY and RY groups. The average volume of food intake was significantly higher in the PRY than the RY group (p<0.05).*

In conclusion, this prospective study identified a clinical benefit of PRY after total gastrectomy. A distal jejunal pouch can be simply and safely constructed using suturing instruments. The PRY can be performed via the laparoscopic approach after laparoscopic total gastrectomy. An extracorporeal jejuno-jejunostomy can be prepared because a distal jejunal pouch can be constructed twice using a linear stapler at the navel (19). The long-term outcomes of these procedures remain to be evaluated.

## Conflicts of Interest

The Authors declare that they have no conflicts of interest.

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