



Original article

Use of a segment of transverse colon as a gastric substitute after total gastrectomy: an audit of 18 patients

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Abstract

Background. Various types of reconstruction have been employed in attempts to improve the quality of life after total gastrectomy. The use of a jejunal pouch has been the most common approach, and preservation of the duodenal passage has been recommended in several related studies. The aim of the present study was to investigate the benefit of the use of a segment of transverse colon as a gastric substitute.

Methods. Isoperistaltic interposition with a segment of transverse colon was performed after total gastrectomy in 18 patients with gastric malignancies. To clarify the benefits and disadvantages of this technique, a comparison was made between these patients and another 17 patients who underwent jejunal interposition without a pouch. The parameters to be compared included operation time, amount of blood loss, incidence of postoperative complications, and changes in body weight.

Results. Postoperative complications were more frequent in the patients reconstructed with the transverse colon, despite a lower incidence of extended lymphadenectomies in this group of patients. No advantage over those treated by the jejunal interposition, in terms of postoperative body weight, was evident during 2 years of follow-up.

Conclusion. Although it may be too early to draw definite conclusions, there seems to be little benefit in the use of the transverse colon as a gastric substitute.

Key words Gastric malignancy · Reconstruction · Interposition · Total gastrectomy

Introduction

The quality of life (QOL) [1] and nutritional status [2] of patients is reported to be significantly better after distal subtotal gastrectomy than after total gastrectomy for gastric carcinoma. Nevertheless, total gastrectomy is likely to remain common because of the increasing inci-

dence of carcinoma of the proximal stomach [3]. Owing to improvements in survival after gastric cancer surgery, greater attention has recently been directed towards the issue of QOL after surgical treatments. Consequently, various reconstruction techniques have been invented and evaluated. Some authors postulate the importance of preserving duodenal passage [4,5], while others stress the need for reservoir function of the gastric substitute, which is often accomplished by the use of a jejunal pouch [5–8]. However, numerous randomized trials have, so far, failed to confirm beneficial effects of any one mode of reconstruction over any other, in terms of QOL or nutritional parameters [9,10].

The use of the transverse colon as a gastric reservoir was first reported in 1951, when State et al. [11] performed reconstruction with antiperistaltic interposition of the transverse colon in two patients who underwent total gastrectomies. No further attempts were reported until three decades later, when a modified version, with isoperistaltic interposition, performed extensively by Nagamachi [12] in Japan, was reported. The objective of this technique is to provide the patient with a gastric substitute with enhanced reservoir function while retaining the duodenal passage, and it is similar in concept to reconstruction with interposition of the jejunal pouch. One major difference is that the interposition of a colonic segment can be performed without the costly linear staplers that are often used in large numbers for a jejunal pouch reconstruction. Although the technique of the interposition of a colonic segment has been reported to result in improved nutritional status and has been recommended enthusiastically [13], its benefits have not been confirmed in a randomized trial. In the present study, we investigated the feasibility of this uncommonly used but interesting technique, in terms of short-term nutritional consequences and the incidence of surgical complications, in order to decide whether this technique deserves further evaluation by a randomized trial.

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Patients and methods

Between 1994 and 1999, jejunal interposition without a pouch was the standard mode of reconstruction used after total gastrectomies at Aichi Cancer Center. During this period, 18 patients with gastric malignancies (16 with gastric carcinoma and 2 with primary gastric lymphoma) underwent total gastrectomies, followed by reconstructions with interposition of the transverse colon (CI). All the patients underwent potentially curative R0 resection, performed by a surgeon with significant experience in gastric cancer surgery (Y. Kodera). Comparisons as regards operating time, blood loss, incidence of surgical complications, postoperative hospital stay, and changes in body weight were made between these patients and a group of 17 patients who were treated by jejunal interposition (JI) during the same period by the same surgeon. These patients (15 with gastric carcinoma and 2 with primary gastric lymphoma) had also been treated with R0 total gastrectomies. The patients underwent limited (D1 + α) lymphadenectomies (resection of the perigastric lymph nodes plus lymph nodes along the left gastric, splenic, and common hepatic arteries) without splenectomies when the disease had been diagnosed preoperatively as an early cancer (with invasion as far as the submucosa), and extended (D2) lymphadenectomies with splenectomies (resection of the perigastric lymph nodes plus lymph nodes along the left gastric, splenic, celiac, and common hepatic arteries and at the splenic hilus) when diagnosed otherwise. The clinical stages of the malignancies were classified according to the *Japanese classification of gastric carcinoma* [14]. The demographics of the 35 patients in-

involved in this study are summarized in Table 1. In this study, the patients were not randomly allocated to each reconstruction technique. CI had been selected and performed mostly for the patients with early-stage cancers who had greater life expectancies. Two patients in the CI group were treated with aggressive chemotherapy regimens immediately after surgery. These patients, and another patient who died on the twenty-first postoperative day, were excluded from the comparison of the postoperative hospital stay.

Bowel preparation

Patients in the CI group received meticulous mechanical bowel preparation. They were given a low-residue diet for 3 days before surgery, were permitted to have only clear liquid on the day before surgery, were given 3000 ml of electrolyte solution to be taken orally in the afternoon of the day before surgery, and received an enema with 500 ml saline 2 h before surgery. They also received a single dose of parenteral second-generation cephalosporin at induction of anesthesia. Patients in the JI group received laxatives (sennoside and magnesium citrate solution) in the evening prior to the day of surgery, were permitted only clear liquid on that evening, and were treated with an enema (glycerin, 120 ml) 2 h before surgery, followed by a single dose of parenteral second-generation cephalosporin at induction of anesthesia.

CI reconstruction

After total gastrectomy with lymphadenectomy, a segment of colon, measuring 30 to 35 cm, was isolated from

Table 1. Demographics of patients in the present study

Variables	Colonic interposition; <i>n</i> = 18	Jejunal interposition; <i>n</i> = 17	<i>P</i> value
Mean age, in years	58.7	61.7	0.3975
Male:female ratio	13:5	11:6	0.6321
Mean height, in cm	162 (163)	160 (161)	0.4834
Mean body weight, in kg	57 (55)	57 (56)	0.9956
Type of malignancy			
Gastric carcinoma	16	15	NS
Primary gastric lymphoma	2	2	
Clinical stage			0.0022
I	13	2	
II	3	4	
III and IV	2	11	
Extent of lymphadenectomy			0.0201
D1 + α (limited)	7	1	
D2 (extended)	11	16	
Combined resection			0.0647
None	7	1	
Splenectomy	10	15	
Pancreaticosplenectomy	1	1	

Median values are shown in parentheses

NS, Not significant

the mid-portion of the transverse colon. The branches of the vascular arcade along the mesenteric border of the colon were transected, and the dissection was then continued in a relatively avascular plane of the mesocolon so that the segment could be mobilized and rotated in a clockwise direction without occlusion of the middle colic vessels. This clockwise rotation is mandatory in order that the segment be isoperistaltic. The proximal end of the segment to be interposed was closed with a linear stapler prior to the isolation. A circular stapling device was inserted from the distal end of the segment, and an end-to-side anastomosis was made between the esophagus and the colonic wall, approximately 5 cm from the proximal stump. Finally, an end-to-end anastomosis was made, with hand sutures, between the aboral end of the interposed segment and the duodenum.

JI reconstruction

For the patients who were treated by JI, esophagojejunostomy was performed with a circular stapler introduced from the proximal end of the jejunal segment. The proximal end of the jejunal segment was closed with a linear stapler after the circular stapler was withdrawn. The other anastomoses (between the interposed jejunum and the duodenum and between the two ends of the jejunum after the harvesting of the segment to be interposed) were made with hand sutures. The length of the jejunal segment was designed to be approximately 30 cm. No jejunal pouch was constructed in any of these patients.

Follow-up program

The patients were followed every 3 months at our outpatient clinic, with the exception of one patient whose data were obtained from her local physician. For the

remaining patients, clinical follow-up consisted of documenting the history of gastrointestinal function problems, physical examination, and evaluation of nutritional status by the measurement of body weight and serum biochemistry examinations. Endoscopy was performed at the discretion of the surgeons, mostly with intent to evaluate the extent of reflux esophagitis in symptomatic patients.

Statistical analyses

Differences in operating time, amount of blood loss, and length of postoperative hospital stay were evaluated with Student's *t*-test. The χ^2 test was performed to assess differences between the two groups in the distribution of clinical stages, extent of lymph node dissection, incidence of major surgical complications, and incidence of reflux esophagitis.

Results

Operating time

Mean (median) operating time was 289 (281) min for the CI group and 270 (265) min for the JI group, with no significant difference between the two groups. The mean (median) amount of blood loss was 481 (340) g for the CI group and 590 (600) g for the JI group; again, with no significant difference between the groups.

Surgical complications and mortality

The profiles of the observed surgical complications are summarized in Table 2. In the CI group, 8 patients had intraabdominal abscess, including 2 patients with anastomotic leakage. The sites of anastomotic leakage were

Table 2. Frequency and types of surgical complications

Variables	Colonic interposition; <i>n</i> = 18	Jejunal interposition; <i>n</i> = 17	<i>P</i> value
Endoscopic findings of reflux esophagitis/no. of patients examined	7/13	0/7	0.0160
Major surgical complications ^a	10	2	0.0172
Leakage	2	0	
Intraabdominal abscess	8	2	
Bowel obstruction	5	0	
Wound infection	3	0	
MRSA enteritis	1	0	
Operative death	1	0	
Mean length of hospitalization, in days	44 (42)	39 (37)	0.2075
Mean blood loss, in g	481 (340)	590 (600)	0.4106
Mean operating time, in min	289 (281)	270 (265)	0.1737

Median values are shown in parentheses

MRSA, Methicillin-resistant *Staphylococcus aureus*

^aThe number of patients with major surgical complications is shown. Three of the five patients treated with colonic interposition who had a bowel obstruction also had intraabdominal abscess or leakage

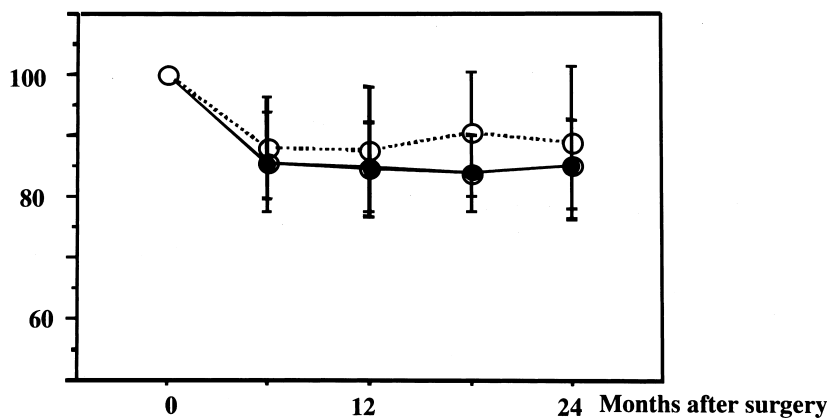
% body weight

Fig. 1. Postoperative changes in the body weight of patients treated by interposition with the transverse colon (*solid line*) and those treated by jejunum interposition without pouch (*dotted line*). The mean (\pm SD) values for body weights at 6, 12, 18, and 24 months after surgery are expressed as percentages in relation to the preoperative weight. No significant difference was observed between the two modes of reconstruction at any point during 2 years of follow up

the esophagojejunostomy in 1 patient and the stump of the interposed colon in the other patient. In the JI group, only 2 patients had intraabdominal abscess. Bowel obstruction in the early postoperative period was observed in 5 patients in the CI group; 1 of these patients eventually underwent surgery, and 1 died of sudden septic shock (with autopsy showing a strangulation ileus); this was the only death among the 35 patients in the study. In the 18 patients who were treated by JI, in contrast, no bowel obstruction has occurred to date. The incidence of these major surgical complications was significantly higher in the CI group ($n = 10$ for CI and $n = 2$ for JI; $P = 0.0172$). Other less serious complications, which were observed only in the CI group, included 3 patients with wound infection and 1 patient with enteritis caused by methicillin-resistant *Staphylococcus aureus*. The mean length of hospital stay after surgery was longer for the CI group (mean, 44 days; median, 42 days) than for the JI group (mean, 39 days; median, 37 days), but there was no significant difference between the two groups.

Incidence of reflux esophagitis

Heartburn, a common but irritating consequence of resection of the proximal stomach, occurred predominantly in those who were treated by CI, while it occurred seldom in those treated by JI. Endoscopic examination was performed for the patients with reflux symptoms, and there were endoscopic findings of reflux esophagitis in 7 of the 13 patients in the CI group who underwent endoscopy, while there were no such findings in any of the 7 JI patients evaluated endoscopically ($P = 0.0160$).

Changes in body weight after surgery

The percentages of the patients' body weights at 6, 12, 18, and 24 months after the gastrectomy, in relation to

their preoperative body weights, are summarized in Fig. 1. No significant difference in postoperative weight was observed between the two modes of reconstruction at any point during the postoperative period. A close look at each patient in the CI group revealed relative well-being in four patients, with more than 90% of their preoperative body weight after 24 months, while the body weight was around 80% of the preoperative body weight in the remaining patients in the group.

Discussion

The nature of the optimum reconstruction after total gastrectomy for malignant disease remains unsettled. Theoretically, procedures that preserve duodenal passage and provide an adequate reservoir are considered ideal, and a small number of randomized trials, such as Roux-en-Y reconstruction versus interposition [4,7,9] and jejunum pouch versus no pouch [6,10,17,18] have been performed to prove these points. Conclusions regarding the value of duodenal passage are rather mixed, possibly because of variations in the timing and methods of functional evaluation and quality-of-life assessment.

We considered interposition of the transverse colon, a classic but infrequently investigated mode of reconstruction after total gastrectomy, for reevaluation, because this method preserves duodenal passage and provides reservoir function at the same time. Although the patients in our two groups were not randomly allocated to each procedure, the physical features, sex ratio, and mean age of the patients were almost identical in the two groups of patients. However, a greater proportion of early-stage cancers was treated by the CI procedure, leading to a significantly lower incidence of extended lymphadenectomies and splenectomies in this group of patients. This explains the lower blood loss in the CI group. Despite this advantage, the operating

time for the CI group was slightly longer. Time was consumed for selecting the optimal segment of the transverse colon to be used as a reservoir, because the distribution of the middle colic arteries and veins was sometimes anomalous. Meticulous observation was needed to ensure that the blood supplies to all four stumps of the colon were intact. Additional resection of the transverse colon was performed in one patient, when pulsation of the vasa recta was found to be absent at one of the stumps, possibly because of inadequate ligation of the marginal artery.

Serious postoperative complications, such as anastomotic leakage, intraabdominal abscess, and bowel obstruction were more common in the patients who underwent the CI procedure ($P = 0.0172$). This is an unexpected result, given that a greater number of patients allocated to the JI group underwent extended lymphadenectomies and splenectomies; procedures that are generally reported to have a high risk of surgical complications [15,16]. Of the six cases of intraabdominal abscess in the CI group that were not related to anastomotic dehiscence, one was attributable to a pancreatic fistula. The etiology in the other five cases was unknown, and may have reflected endogenous infection by bacterial colonization of the intestinal lumen. At the time the operations were performed, the standard preparation of the bowel for elective colorectal operations at Aichi Cancer Center consisted of thorough mechanical preparation, plus preoperative parenteral cephalosporin. The results of some clinical trials in the West indicate that mechanical preparation may be irrelevant, and suggest that the additional use of oral antibiotics may have helped reduce the incidence of abdominal abscess [19,20]. The high rate of bowel obstruction in our CI group may be attributable to the shortening of the transverse colon after the removal of the segment that was to be used as a gastric substitute. This shortening may have allowed jejunal loops to slide freely over the transverse colon into the subphrenic cavity, resulting in adhesion and jejunal obstruction.

During the 2 years of postoperative follow up, we noted no apparent benefit of the CI procedure, in terms of changes in body weight, that would compensate for the higher rate of surgical complications. Unfortunately, CI resulted in a more profound loss of body weight during the short-term follow-up. This may have been caused, in part, by the greater incidence of heartburn, a common consequence of reflux esophagitis that may produce feeding problems. Endoscopic evidence of the reflux esophagitis was observed in 54% of the CI patients examined, as opposed to none of the JI patients. The prevalence of esophagitis may have reflected the insufficient length and reduced motility of the transverse colon segment. It was found that the colon segment was reduced to approximately 70% of the original

length after resection. In addition, postoperative barium meal studies showed that peristalsis was absent in some of the gastric substitutes. This finding may be explained in terms of the destruction of motor nerves caused by incision of the mesocolon. Because the segment has to be rotated clockwise for isoperistaltic reconstruction, and to avoid excessive torsion of the middle colic vessels, the incision to mobilize the segment is mandatory. However, we now feel that this incision should be kept to as small an incision as possible. Finally, in this study, we used a circular stapler for the esophagocolostomy, which apparently did not prevent the reflux, as did the hand-sewn valvular anastomosis described in the original report [12].

To conclude, despite its theoretical advantage, CI was found to provide little nutritional benefit over JI at or before 2 years postoperatively. Furthermore, CI was associated with a significantly higher incidence of major surgical complications. Utilization of oral antimicrobial prophylaxis may be indicated for future attempts with the CI procedure.

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