Original

Side-to-end vs. Colonic Pouch vs. End-to-end Anastomosis in Low Anterior Resection

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Abstract : Poor bowel function may occur after low anterior resection (LAR) with a straight anastomosis. The use of the colonic J-pouch is becoming increasingly popular in reconstruction to reduce these symptoms. An alternative method is to use a side-to-end anastomosis. The present study compared the functional results after LAR among patients receiving a side-to-end, colonic J-pouch, or end-to-end anastomosis. Seventeen patients underwent side-to-end anastomosis. Postoperative manometric and functional assessments of these patients were compared with a group of 19 patients who had a colonic J-pouch and low colorectal anastomosis and 13 patients who had an end-to-end anastomosis. There were no significant differences in maximum resting pressure and maximum squeeze pressure among the groups. Maximum tolerable volume was significantly favorable in the side-to-end group and colonic J-pouch group vs. the end-to-end group. Urgency of defecation was significantly greater in the end-to-end group than in the other two groups at three months postoperatively. There were no significant differences in functional and manometric results between the side-to-end and colonic J-pouch groups. Functional results of side-to-end anastomosis were comparable with colonic J-pouch and were superior to those of end-to-end anastomosis in the immediate postoperative period.

Key words : low anterior resection, anorectal function, side-to-end anastomosis, colonic J-pouch

Introduction

Bowel dysfunction after low anterior resection for rectal carcinoma is a well-described condition characterized by symptoms such as incontinence, increased frequency and fragmentation of bowel movements, and urgency; the latter is related to the anastomotic level^{1,2)}. The use of a colonic reservoir or pouch instead of a straight anastomosis can minimize these symptoms³⁻⁶⁾. The initially described reservoir was a J-pouch, approximately 8-12 cm long^{3-5,7)}. The recommended pouch size has been successively decreased to about 5-6 cm^{8,9)}. A new method of reconstruction called colooplasty seems to produce superior functional outcomes compared with straight anastomosis^{10,11)}. A second alternative to the J-pouch after

low anterior resection is a simple side-to-end (STE) anastomosis^{12,13}.

The present study compared the functional and surgical outcomes of an STE anastomosis, a colonic J-pouch (CJP) reconstruction, and end-to-end anastomosis (ETE) following low anterior resection.

Methods

This study comprised a consecutive series of 49 patients who underwent low anterior resection for carcinoma at the middle to lower third of the rectum (i.e., tumor level ≤ 10 cm from the anal verge as measured by colonoscopy) from 1999 to 2004. Informed consent was obtained from all the patients, and the Ethics Committee of Showa University School of Medicine approved the study protocol. During the first one-third of this period, the ETE was performed, followed by the CJP reconstruction, with the STE conducted during the latter one-third of this period. The level of the anastomosis from the anal verge was measured with a ruler following digital examination. No patients received preoperative or postoperative radiation. Patients with node-positive carcinoma received daily oral administration of 5-fluorouracil derivative postoperatively. One patient who received the STE had local recurrence and one treated by ETE showed distant metastasis. These patients were lost to follow-up (Table 1).

Each patient underwent laboratory studies of anal sphincter function before and at 3, 6, and 12 months after the surgery. When a diverting stoma was fashioned in the primary operation, the laboratory studies were performed at 3, 6, and 12 months after closure of the stoma. Examinations were performed with the patient in the left lateral position and no bowel preparation was used. Anal pressure was measured with a catheter-tip pressure transducer and the capacity of the neorectum was basically measured using a balloon placed with its lower extremity 10 cm from the anal verge. Depending on the configuration of the neorectum, the balloon was usually moved toward the anal verge. Rectal volumes including volume of perception of threshold for minimal sensation (V_{min}), urgency (V_{urg}), and maximum tolerable volume (MTV) were recorded. MTV was not measured preoperatively, due to the possible influence on volume of the tumor size. Each patient was questioned about bowel frequency, the presence of urgency, soiling, and the ability to differentiate between flatus and feces. Significant soiling was defined as that occurring at least once per week,

Table 1. Characteristics of patients

	Side-to-End	Colon Pouch	End-to-End
No. of patients	17 ^b	19	13 ^b
Median age (range) (yr)	62(29-89)	60(45-79)	63(48-78)
Male / Female ratio	11 / 6	11 / 8	9 / 4
Location of tumor (middle / low ^a)	5 / 12	3 / 16 *	8 / 5
Dukes stage			
A	6	11	2
B	5	5	5
C	6	3	6

Figures are number of patients unless otherwise specified

^aUnder the peritoneal reflexion; ^bOne patient with recurrence lost to follow-up;

* $P < 0.02$ vs. End-to-End (χ^2)

and urgency was defined as the inability to defer defecation for >15 min.

Statistical Analysis

Nominal data were analyzed by using the chi-square test or Fisher exact test as appropriate. Other group comparisons were tested by the Kruskal Wallis test, followed by the Mann Whitney U test when significantly different. Longitudinal changes in anal pressures and rectal volumes over time within groups were analyzed with Friedman's two-way analysis of variance test and Wilcoxon matched-pairs test. $P < 0.05$ was considered significant.

Technique

The sigmoid colon was used for reconstruction. The ETE was performed transanally using the PCEEATM (Autosuture, Norwalk, CT) circular stapling device. The CJP was constructed with the EndopathTM Endo Cutter EZ 45B (Ethicon, Cincinnati, OH) introduced through the apex. The anastomosis was performed by placing a purse-string suture in the colostomy at the curved end of the J-pouch. The anvil of the circular stapler was placed in the colostomy and the purse string tied. When the STE was performed, the anvil of the circular stapler was placed 3–6 cm from the end of the divided bowel. For both the STE and the CJP, the ProximateTM ILS CDH 33 stapler (Ethicon) inserted through the anus was used to anastomose the colon to the short rectal remnant. In contrast, anastomosis of the colon to the anal canal was performed transanally.

Results

There was no significant difference in the median age at operation or in gender distribution among the patient groups (Table 1). The number of patients with Dukes C in the ETE group was significantly larger than in the STE or CJP groups. Table 2 lists the operative results. The median level of anastomosis in the ETE group was significantly higher than measured in the other two groups. The incidence of transanal anastomosis was significantly higher in the STE group than in the ETE group. In addition, the STE group showed significantly more protective stoma than either the CJP or ETE group, possibly reflecting either our recent attitude toward creating protective stoma for safe reconstruction or the lower anastomotic level in the STE group compared to the ETE group. Stoma were reversed 2–3 months later. There were four colorectal or coloanal anastomotic leaks (three in the CJP group, one in the ETE group) and three colonic end leaks (two in the STE group and one in the CJP group). Fig. 1 shows barium enema imaging of a STE anastomosis 6 months after closure of the ileostomy.

Manometry revealed no significant differences among the groups with respect to length of pressure zone, maximum resting pressure, and maximum squeeze pressure before and at each postoperative time. A decreased resting pressure at 3 months was found in the ETE group, with gradual recovery after 6 months. The manometric analysis therefore showed no significant longitudinal changes in either the STE group or CJP group. Vmin and Vurg also did not differ significantly among the groups at each postoperative time, nor longitudinally (Fig. 2, 3). There was a significant increase in MTV in the CJP and ETE groups after 6 months, whereas the STE group showed no significant longitudinal change. MTV in the CJP group was significantly higher than that in the ETE group at each postoperative period. Similarly, MTV in the STE group was significantly higher than that in the ETE group 3

Table 2. Operative results

	Side-to-End	Colon Pouch	End-to-End
Median length of side limb/pouch (range) (cm)	4.5(3-6)	7(5-10)	
Median level of anastomosis (range) (cm)	4(2.5-6) *	4(3-6) *	5.7(4-8)
Transanal anastomosis	6(35.5) †	3(15.8)	0(0)
Protective stoma	15(88.2) **	6(31.6)	0(0)
Anastomotic leak	2	4	1

Figures are number of patients and (percentage) unless otherwise specified

* $P < 0.01$ vs. End-to-End (Mann-Whitney U test); † $P = 0.025$ vs. End-to-End;

** $P < 0.01$ vs. Colon Pouch, End-to-End (χ^2)

Fig. 1. Barium enema view of side-to-end anastomosis. The so-called, "side pouch" was disclosed.

and 12 months after surgery. There was no significant difference in MTV between the STE and CJP groups at each postoperative examination period (Fig. 4).

Bowel movement frequencies per 24 hours and the presence of soiling did not differ significantly among the groups at each postoperative time. Urgency of defecation 3-month postoperatively was greater in the ETE group than in the other two groups, but was only significantly increased in the ETE group compared to the CJP group at the 6-month postoperative examination. There was no significant difference in urgency of defecation between the STE and CJP groups at each postoperative examination period. The CJP group showed a greater ability to differentiate between flatus and feces 3months postoperatively than the ETE group. There was no significant difference in the same ability between the STE and CJP groups at each postoperative examination period (Table 3).

Fig. 2. Maximum resting pressure. Column, median. * $P < 0.05$ vs. preoperative data

Fig. 3. Maximum squeeze pressure. Column, median.

Fig. 4. Maximum tolerable volume. Column, median. * $P < 0.05$ vs. Side-to-end, Colonic J-pouch; † $P < 0.05$ vs. Colonic J-pouch; ** $P < 0.05$ vs. 6 or 12 months after operation in respective groups.

Table 3. Clinical results comparing Side-to-end, Colonic J-pouch and End-to-end

	Side-to-end (n = 16)	Colonic J-pouch (n = 19)	End-to-end (n = 13)
Bowel frequency(per day)			
3 months	3.3(3-8)	3.4(5-7)	4.2(1-11)
6 months	2.1(0.3-5)	2.5(0.3-6)	3.5(0.3-10)
12 months	2.7(0.2-7)	2.2(0.3-5)	2.8(0.3-8) ^a
Urgency of defecation			
3 months	4(25)	5(26)	9(69) [*]
6 months	2(13)	0(0)	4(31) [†]
12 months	0(0)	0(0)	2(17) ^a
Differentiation between flatus and feces			
3 months	11(69)	15(79)	5(38) [†]
6 months	12(75)	17(89)	11(85)
12 months	14(88)	18(95)	11(92) ^a
Soiling			
3 months	8(50)	7(37)	4(31)
6 months	5(31)	6(32)	1(8)
12 months	3(19)	4(21)	0(0) ^a

Data are numbers with percentages in parenthesis, except for bowel frequency(range).

^an = 12; ^{*}P < 0.05 vs. Side-to-end, Colonic J-pouch; [†]P < 0.05 vs. Colonic J-pouch

Discussion

Three prospective randomized trials have compared STE with CJP thus far¹³⁻¹⁵⁾. Machado *et al*¹⁴⁾ and Jiang *et al*¹⁵⁾ reported comparable functional results for STE and CJP, while Huber *et al*¹³⁾ recommended STE over CJP for functional reasons, concluding that the major advantage of CJP is seen in the immediate postoperative phase. However, no study has compared anorectal function with STE and ETE in the same institute. Although the present study was not a randomized trial, functional results with either the STE or CJP were superior to those with the ETE in the immediate postoperative time period. We found that 20% of the STE and CJP groups experienced soiling, while none was reported by the ETE group up to 12 months after the operation. This may be because the level of anastomosis in these groups was significantly low compared with the ETE group. The physiological examinations indicated an increase in neorectum capacity following surgery in the STE group compared with the ETE group, despite the significantly higher level of the anastomosis constructed in the ETE group compared with the STE group. However, it was not possible to detect any significant difference in clinical or physiological parameters between the STE and CJP groups. The resting pressure was also significantly decreased in the ETE group at 3 months. The reason for this was unclear, but intraoperative mechanical injury to the internal sphincter due to the circular stapler or hand-sewn anastomosis might be more likely to recover in the STE group than in the ETE group, as the manometric assessment was made 3 months after closure of stoma in most patients of the STE group. This delay significantly decreased the mean interval between the first and second manometric measurements in the ETE group compared to the STE group.

The STE was developed originally to overcome the problem of luminal discrepancy¹²⁾.

However, additional benefits are applicable for colorectal anastomosis: 1) prevention of anastomotic stricture, 2) possible construction from the abdomen by a single practitioner and without the necessity for a lithotomy position¹⁶⁾. Jiang *et al*¹⁵⁾ reported good continence preservation and minimized sphincter injury using STE from the abdomen. The present study found no significant longitudinal change assessed manometrically in the STE or CJP group. The STE either with the circular stapler or by hand was performed transanally in the present study, indicating that if performed carefully, transanal anastomosis does not impair sphincter function. However, our results should be interpreted carefully because the period between the first operation and manometric assessment was not uniform among the groups, and the decrease in resting pressure at 3 months was noticed in the ETE group in the present study.

The role of the neorectal reservoir principle of the CJP has been questioned as the determinant functional factor¹⁷⁾. The alternative functional principle proposed involves delayed propulsive motility and not an effect of increased neorectal capacity¹⁷⁾. The transverse coloplasty pouch is a small-volume reservoir¹⁰⁾ and the functional results of the coloplasty pouch and the CJP are similar¹¹⁾, also supporting this alternative hypothesis. We found similar results in volumetric and functional results between the STE and CJP groups, indicating that the side limb of the STE might actually act as a “side pouch” and/or the altered motility created by the reversed segments has a significant effect on the functional outcome. Nevertheless, further analysis of our data revealed a minor significant difference in the postoperative change in MTV. The CJP group showed an increased MTV with time compared with the STE group, for whom the MTV was stable postoperatively. On the other hand, there was no significant difference in postoperative functional outcome at each postoperative examination between the two groups. The discrepancy between functional and volumetric results suggested that altered motility has a more important influence than increased reservoir volume on the functional outcome. It should also be noted in this context that the side-limb or colonic J-pouch length was not uniform within the STE group in the present study. Further study will be required to determine the optimal size of the STE side limb.

Overall leak rates in rectal cancer surgery range from 12–19% and the risk is higher in low anastomosis^{18,19)}. Optimal colonic perfusion is the decisive factor in the healing of colorectal anastomosis and argues in favor of the CJP^{21,22)}. The frequency of anastomotic leakage in the present study with low anastomosis was 8–21% with there was no significant difference in the rate of anastomotic leakage among groups. However, perfusion of the colonic ending of either the CJP or the STE should be monitored carefully; three patients developed a leak at this site. Reduced blood flow reduction at the colonic ending has been associated with an increased risk of anastomotic leaking^{23,24)}. In the same way, ischemic necrosis at the colonic ending secondary to reduced colonic perfusion could affect the healing. Furthermore, the sigmoid colon is an established area of high pressure and this may contribute to the perceived poor function. The descending colon may therefore be a preferable site for reconstruction^{13,14)}.

We conclude that the STE anastomosis results in comparable functional outcomes to a colonic J-pouch and superior outcomes to the ETE anastomosis in the immediate postoperative period. STE anastomosis provides an easier alternative reconstruction technique after low anterior resection.

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