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ORIGINAL ARTICLE

Comparison of safety of loop ileostomy and loop transverse colostomy for low-lying rectal cancer patients undergoing anterior resection: A retrospective, single institute, propensity score-matched study

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Summary

Purpose: *To compare the prevalence of stoma-related complications and stoma reversal perioperative complications of patients with low-lying rectal cancer who received preventative loop ileostomy and those who underwent loop transverse colostomy.*

Methods: *This retrospective single-center study analyzed the clinicopathologic and surgical data of 288 patients with pathologically proven primary rectal cancer who underwent anterior resection of rectal cancer with preventative loop ileostomy or loop transverse colostomy between January 2012 and July 2017 at the Department of General Surgery, Peking Union College Hospital. The patients were allocated to the ileostomy group (n=82) and the loop transverse colostomy group (n=206). To achieve comparability of the ileostomy group and the loop transverse colostomy group with regard to potential confounding variables, a propensity score-matching method was used to match patients from each group in a 1:2 ratio. Determinants of stoma-related complications were analyzed by multivariate logistic regression analysis.*

Results: *The propensity score-matched loop ileostomy group (n=66) and the loop transverse colostomy group (n=111) were comparable in patient demographic and baseline characteristics. Forty-nine (74.3%) patients in the loop ileostomy group experienced stoma-related complications vs 48.7% in the loop transverse colostomy group (p<0.001). Irritant dermatitis was the most frequent complication in both groups. The loop ileostomy group had a significantly higher rate (24.24%) of stoma reversal perioperative complications than the loop transverse colostomy group (9.01%, p=0.008). Multivariate logistic regression analysis showed that ileostomy vs loop transverse colostomy was a significant independent risk for stoma-related complications (Odds ratio/OR 3.495; 95%CI 1.741, 7.018; p<0.001) and stoma reversal perioperative complications (OR 2.124; 95%CI 1.010, 4.512; p< 0.05).*

Conclusion: *This study has demonstrated that loop transverse colostomy is associated with significantly lower rates of stoma-related complications and stoma reversal perioperative complications compared to loop transverse colostomy. Prospective controlled studies with a larger patient population are warranted to examine the efficacy and safety of loop ileostomy and loop transverse colostomy.*

Key words: *complications, loop transverse colostomy, loop ileostomy, low anterior resection, propensity score matching, rectal cancer*

Introduction

Colorectal cancer (CRC) accounted for 10% of 14 million new cases globally in 2012 and currently is the 3rd most common cancer worldwide. Rectal cancer accounts for approximately one third of CRC cases [1]. Over the decade, the use of the 2-cm safety margin for rectal cancer resection,

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total mesorectal excision and double stapling device has greatly increased the likelihood of anal sphincter preservation in low-lying rectal cancer patients [2].

Currently, ultra-low lying anterior resection has become a mature sphincter-sparing operation [3]. Though progress has been made in rectal anastomotic fistula surgery, anastomotic leakage still remains one of the most severe complications of anterior resection [4]. Anastomotic fistula is not a negligible condition as it could lead to multiple complications, including pelvic abscess [5]. The prevalence of anastomotic fistula varies between 2.7 and >20% among different reports [5-11]. The height of rectal cancer from the anal verge is an important determinant of anastomotic fistula [10]. Permanent stoma [12,13] prolongs the length of hospital stay [14], increases healthcare cost [15] and predicts adverse long term prognosis [16]. Preventative diverting stoma is considered an effective surgical modality in lowering the risk of anastomotic fistula and second surgery [17]. Ileostomy and loop transverse colostomy are two common temporary diverting stomas and it still remains controversial which stoma is more effective in diverting feces and controlling infection.

In the current study, we retrospectively analyzed the clinicopathologic data of 288 patients with pathologically proven primary rectal cancer who underwent anterior resection of rectal cancer with preventative loop ileostomy or loop transverse colostomy and compared the prevalence of stoma-related complications and stoma reversal perioperative complications of patients who received preventative loop ileostomy and those who underwent loop transverse colostomy.

Methods

Patients

In this retrospective single-center study we analyzed the clinicopathologic and surgical data of 288 patients with pathologically proven primary rectal cancer who underwent anterior resection of rectal cancer with preventative loop ileostomy or loop transverse colostomy between January 2012 and July 2017 at the Department of General Surgery, Peking Union College Hospital. Eligibility requirements included 1) height from the anal verge ≤15 cm; 2) no metastasis at the time of surgical resection; and 3) preventative stoma was created at the time of anterior resection. Exclusion criteria were as follows: 1) patients who did not undergo stoma resection due to tumor metastasis or recurrence; 2) patients who did not undergo anastomotic stoma because of anastomotic stenosis or anastomotic fistula; 3) patients who were unable to tolerate stoma reversal surgery because of their advanced age or poor general conditions; and 4) patients with multiple primary colorectal carcinomas who had stage I resection of multiple lesions.

The study protocol was approved by the local ethics committee at the authors' affiliated institution and patient consent was not required because of the retrospective nature of the study. All patient data were anonymized in the current study.

Surgical procedure

All surgical procedures were performed by the same surgical team with more than 10 years of experience in ileostomy, loop transverse colostomy, stoma creation and reversal. The patients were allocated according to the position of stoma to the ileostomy group (n=82) and the loop transverse colostomy group (n=206). Preventative stoma was created. Before stoma reversal, conventional examinations including digital rectal examination, proctography, thoracic, abdominal and pelvic enhanced CT scan were performed to exclude anastomotic fistula, anastomotic stricture, local recurrence and distant metastasis. For ultra-low lying anastomosis, selective anorectal manometry was done to assist assessment of sphincter function and other factors that could influence stoma reversal surgery.

Patient evaluation

Demographic and baseline variables, American Society of Anesthesiology (ASA) physical classification grade [18], surgical modality, stoma complications, sto-

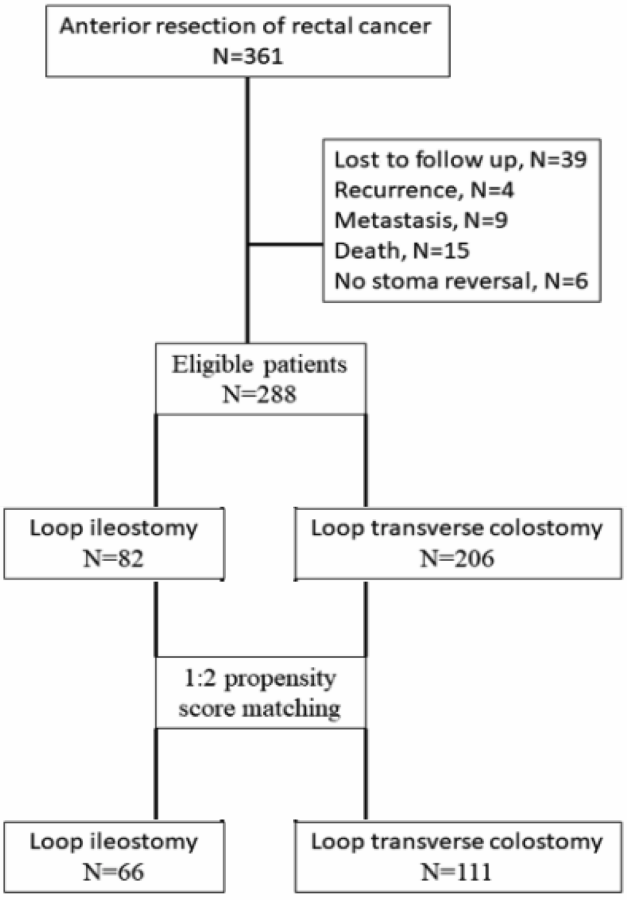

Figure 1. The study flowchart.

ma reversal perioperative complications and length of hospital stay post-stoma reversal were compared. Anastomotic fistula (anastomotic leakage) [19] was defined as abnormal communication between the outside and inside of the bowel due to breach of integrity of the intestinal wall as a result of colorectal anastomosis or coloanal anastomosis. Clinically, we defined anastomotic leakage as signs of peritonitis and radiological findings of extra luminal air, fistula, or intra-abdominal abscess. We excluded patients with radiologically demonstrated anastomotic leakage, but with no clinical evidence. Anastomotic stricture [20] was defined as the failure to advance a 12-mm colonoscope through stenosed anastomosis. Local recurrence was defined as tumor growth in the pelvic cavity [13] with radiological or histological evidence of tumor growth in the pelvic cavity, anastomosis, lateral lymph nodes or the perineal region.

Statistics

Continuous variables were expressed as mean ±SD and analyzed by Student's *t*-test. Binary variables were analyzed using chi square test or Fisher exact test and ordinal categorical variables were analyzed by rank sum test. Comparisons of the two groups were made using one way analysis of variance (ANOVA). To achieve comparability of the ileostomy group and the loop transverse colostomy group with regard to potential confounding variables, a propensity score matching method was used to match patients from each group in a 1:2 ratio. The propensity score was calculated by logistic regression analysis using the following covariates: age, sex, body mass index, smoking and drinking, past disease history (hypertension, diabetes and abdominal surgery), baseline hemoglobin and albumin, physical classification grade, tumor stage, tumor height from the anal verge, neoad-

Table 1. Patients' general characteristics

Variable	*Total set*				*Matched set*			
	Ileostomy	*Loop transverse colostomy*	*Statistical volume*	*p*	*Ileostomy*	*Loop transverse colostomy*	*Statistical volume*	*p*
n	82	206			66	111		
Age at surgery, years (mean ± SD)	60.5±10.87	61.2±11.54	t=-0.437	0.662	60.2±10.65	61.5±11.24	t=-0.763	0.447
Male sex, n(%)	50 (60.98)	136 (66.00)	x^2=0.652	0.419	44 (66.67)	68 (61.26)	x^2=520	0.521
Body mass index, kg/m2 (mean ± SD)	24.6±3.53	24.0±3.17	t=1.399	0.163	24.3±3.76	24.4±3.15	t=-0.069	0.945
Hemoglobin, g/L (mean ± SD)	131.4±19.00	132.3±17.17	t=-0.374	0.709	133.9±18.03	134.1±15.90	t=-0.062	0.951
Albumin,g/ (mean ± SD)	38.8±5.51	38.7±5.14	t=0.180	0.858	39.3±5.45	38.8±4.78	t=0.555	0.579
History of previous diseases, n(%)	50 (60.98)	119 (57.77)	x^2=0.249	0.618	54 (81.81)	84 (75.68)	x^2=0.909	0.453
Tumor height from anal verge, cm (mean ± SD)	7.91±3.25	8.1±5.80	t=-0.240	0.811	7.91±3.55	7.73±3.40	t=0.336	0.736
ASA PS classification grade, n(%)			Z=-1.771	0.076			Z=-0.294	0.769
I	15 (18.29)	53 (25.73)			14 (21.21)	22 (19.82)		
II	59 (71.95)	143 (69.42)			48 (74.24)	83 (74.77)		
III	8 (9.76)	10 (4.85)			3 (4.55)	6 (5.41)		
Tumor stage, n(%)			Z=-0.965	0.334			Z=-0.228	0.820
0	2 (2.44)	8 (3.88)			2 (3.03)	3 (2.70)		
I	20 (24.39)	47 (22.82)			19 (28.79)	26 (23.42)		
II	23 (28.05)	80 (38.83)			20 (30.30)	43 (38.74)		
III	36 (43.90)	69 (33.50)			25 (37.88)	38 (34.23)		
IV	1 (1.22)	2 (0.97)			0 (0.00)	1 (0.90)		
Neoadjuvant chemotherapy, n(%)	25 (30.49)	87 (42.23)	x^2=3.405	0.070	20 (30.30)	37 (33.33)	x^2=0.184	0.741
Anastomotic fistula, n(%)	5 (6.10)	8 (3.88)	x^2=0.667	0.414	5 (7.58)	4 (3.60)	x^2=1.353	0.296

SD: standard deviation, ASA PS: American Society of Anesthesiologists physical status

juvant therapy and anastomotic fistula using calipers of 0.05% width. Determinants of stoma-related complications were analyzed by multivariate logistic regression analysis. All statistical analyses were done using SPSS 23.0 (SPSS Inc., Chicago, IL, USA) and R version 3.3.3 (Bell Laboratory, Vienna, Austria).

Results

Patient demographic and baseline characteristics

The study flowchart is shown in Figure 1. Totally 361 patients underwent anterior resection of rectal cancer with preventative loop ileostomy or loop transverse colostomy during the study period. Thirty-nine patients who were lost to follow up were excluded, and we also excluded 4 patients due to recurrence during follow up and 9 patients because of metastasis. Fifteen patients died during the review period and 6 patients who did not undergo stoma reversal were excluded. Finally, there were 288 patients who underwent anterior resection of rectal cancer with preventative loop ileostomy (n=82, 28.5%) or loop transverse colostomy (n=206, 71.5%). The patients were matched in a 1:2 ratio using the nearest neighbor matching method to the preventative loop ileostomy group (n=66) and the loop transverse colostomy group (n=111). The demographic and baseline characteristics of the study population and the propensity score-matched groups are shown in Table 1. The two propensity score-matched groups were comparable in patient demographic and baseline characteristics.

Stoma-related complications

Stoma-related complications are shown in Table 2. Forty-nine (74.3%) patients in the loop ileostomy group experienced stoma-related complications; among them, 17 patients had at least two stoma-related complications. Fifty-four (48.7%) patients in the loop transverse colostomy group developed stoma-related complications; among them, 12 patients had at least two stoma-related complications. The ileostomy group had a significantly higher rate of stoma-related complications than the loop transverse colostomy group (p<0.001). Irritant dermatitis was the most frequent complication (54.6%) in the loop ileostomy group, followed by stoma herniation (13.6%) and intestinal obstruction (13.6%). Irritant dermatitis was also the most

Table 2. Stoma-related complications in the two propensity score matched groups

Complications	*Ileostomy*	*Loop transverse colostomy*	*Statistical volume*	*p*
Patient No.	66	111		
Stoma-related complications n(%)	49 (74.24)	54 (48.65)	11.144	<0.001
Irritant dermatitis	36 (54.55)	25 (22.52)	18.792	<0.001
Herniation	9 (13.64)	13 (11.71)	0.141	0.814
Intestinal obstruction	9 (13.64)	9 (8.11)	1.385	0.305
Bleeding	4 (6.06)	6 (5.41)	0.033	1.000
Infections	2 (3.03)	3 (2.70)	0.016	1.000
Stricture	1 (1.52)	0 (0.00)	1.691	0.373
Retraction	0 (0.00)	2 (1.80)	1.203	0.530
Prolapse	2 (3.03)	5 (4.50)	0.237	1.000
Dehydration	1 (1.52)	0 (0.00)	1.691	0.373
Edema	1 (1.52)	0 (0.00)	1.691	0.373
Abscess	1 (1.52)	0 (0.00)	1.691	0.373

Table 3. Multivariate logistic regression analysis of risk factors for stoma-related complications

Variables	*B*	*S.E.*	*Wald*	*p*	*OR(95%CI)*
Ileostomy vs. loop transverse colostomy	1.251	0.356	12.378	<0.001	3.495 (1.741-7.018)
Sex	0.509	0.397	1.644	0.200	1.664 (0.764-3.623)
Age	0.013	0.016	0.641	0.423	1.013 (0.982-1.045)
Body mass index	0.148	0.059	6.236	<0.05	1.159 (1.032-1.302)
Hemoglobin	-0.001	0.012	0.013	0.910	0.999 (0.975-1.023)
Albumin	-0.036	0.038	0.885	0.347	0.965 (0.896-1.039)
Tumor height from anal verge	-0.052	0.048	1.140	0.286	0.950 (0.864-1.044)
Constant	-3.179	2.861	1.234	0.267	0.042 (0.000-0.000)

frequent complication (22.5%) in the loop transverse colostomy group, followed by stoma herniation (11.7%) and intestinal obstruction (8.1%). The loop ileostomy group had a significantly higher rate of irritant dermatitis than the loop transverse colostomy group (p<0.001).

Multivariate logistic regression analysis showed that ileostomy vs loop transverse colostomy was a significant independent risk factor for stoma-related complications (OR 3.495; 95%CI 1.741, 7.018; p<0.001). In addition, body mass index (BMI) was a significant independent risk factor for stoma-related complications (OR 1.159; 95% CI 1.032, 1.302; p< 0.05) (Table 3).

Stoma reversal perioperative complications

Stoma reversal perioperative complications are shown in Table 4. The loop ileostomy group had a significantly higher rate (24.24%) of stoma reversal perioperative complications than the loop transverse colostomy group (9.01%, p=0.008). The loop ileostomy group had a significantly higher rate of diarrhea (18.18%) than the loop transverse colostomy group (5.41%, p=0.009). Multivariate logistic regression analysis revealed that loop ileostomy vs loop transverse colostomy was a significant independent risk factor for stoma reversal perioperative complications (OR 2.124; 95% CI 1.010, 4.512; p<0.05) (Table 5).

Discussion

This retrospective case-matched study of 288 patients with pathologically proven primary rectal cancer who underwent anterior resection showed that loop ileostomy was associated with a significantly higher rate of stoma complications (74.3% vs 48.7, p<0.001) and stoma reversal perioperative complications than loop transverse colostomy (24.2% vs 9.0, p=0.008). Ileostomy vs loop transverse colostomy was a significant independent risk for stoma-related complications (OR 3.495; 95%CI 1.741, 7.018; p<0.001) and stoma reversal perioperative complications (OR 2.124; 95%CI 1.010, 4.512; p<0.05). Diverting stoma is a common surgical method to lower the risk of anastomotic fistula [17,21,22], and loop ileostomy and loop transverse colostomy are two common temporary diverting stomas for rectal cancer patients undergoing anterior resection. Some authors showed that loop

Table 4. Stoma reversal perioperative complications of the two propensity score matched groups

Variables	*Ileostomy*	*Loop transverse colostomy*	*Statistical volume*	*p*
Patients, n	66	111		
Tumor height from anal verge, cm (mean ± SD)	4.9±1.29	4.9±1.45	t=-0.317	0.751
Length of hospital stay, days (mean ± SD)	7.3±3.30	6.8±0.97	t=1.499	0.136
Stoma reversal perioperative complications, n (%)	16 (24.24)	10 (9.01)	x^2=7.665	0.008
Diarrhea	12 (18.18)	6 (5.41)	x^2=7.396	0.009
Intestinal obstruction	4 (6.06)	3 (2.70)	x^2=1.229	0.427
Anastomotic fistula	0 (0.00)	1 (0.90)	x^2=0.598	1.000
Hematochesia	0	0	-	-
Wound infection	0	0	-	-
Wound hernia	4 (6.06)	8 (7.21)	x^2=0.086	1.000

Table 5. Multivariate logistic regression analysis of risk factors for stoma reversal complications

Variables	*B*	*S.E.*	*Wald*	*p*	*OR(95%CI)*
Ileostomy vs. loop transverse colostomy	0.753	0.384	3.838	<0.05	2.124 (1.010-4.512)
Sex	-0.284	0.454	0.392	0.531	0.753 (0.309-1.832)
Age	0.016	0.019	0.682	0.409	1.016 (0.979-1.054)
Body mass index	0.046	0.057	0.646	0.421	1.047 (0.936-1.170)
Hemoglobin	-0.014	0.014	1.038	0.308	0.986 (0.959-1.013)
Albumin	-0.004	0.043	0.010	0.922	0.996 (0.915-1.084)
Tumor height from anal verge	0.058	0.050	1.315	0.251	1.060 (0.960-1.170)
Constant	-1.749	3.137	0.311	0.577	0.174 (0.000-0.000)

ileostomy had fewer stoma-related complications and fewer stoma reversal associated infections and incisional hernia than loop transverse colostomy [25-27]. Some others found that, compared to loop ileostomy, loop transverse colostomy patients were more readily predisposed to develop stoma-related complications such as irritant dermatitis and electrolyte disorders [23-25]. Our findings indicate that loop transverse colostomy is a significantly safer option compared to ileostomy.

We found that the loop ileostomy group had a significantly higher rate of irritant dermatitis than the loop transverse colostomy group (54.6 vs 22.5%, p<0.001). The watery discharge in the ileum readily adheres and covers the skin surrounding the stoma. The ileum content contains abundant digestive enzymes and could cause further erosion of the surrounding skin [26]. Different from the loop ileostomy group, in the loop transverse colostomy group water was partially absorbed in the ascending colon, forming paste-like discharge, which does not readily contact the surrounding skin. Moreover, with lengthened transit of the intestinal content in the intestinal tract, the enzymes may become degraded or lose activity, lessening erosive action on the skin surrounding the stoma and suppressing the occurrence of irritant dermatitis. The open position of the preventative loop stoma should be close to the distal bowel end so that the ileum stoma is 2.5 cm higher than the skin and the transverse colon stoma is 1 cm higher than the skin and the stoma discharge can directly enter the stoma bag. This will avoid contact of intestinal content with the surrounding skin and reduce the occurrence of irritant dermatitis [27]. Irritant dermatitis may also be associated with mechanical trauma, allergic reaction in the skin surrounding the stoma, fungal infection and antibiotics therapy [28]. Therefore, appropriate vertical distance from the stoma to the skin should be kept and the sitting disc of the stoma appliance plate should completely cover the skin surrounding the stoma, which helps avoid contact of discharge with the skin and prevent disc-induced allergy. Intermittent exposure of the stoma will reduce the moist environment of the surrounding skin and may prevent irritant dermatitis.

Parastomal hernia is a common stoma-related complication [29], and occurs in 39% of patients with rectal stoma based on clinical symptoms and signs alone, and in 6% of loop ileostomy patients. The rate of rectal parastomal hernia may be as high as 76% by CT scan [27]. Parastomal hernia often occurs within 2 years of stoma creation but may occur 20 to 30 years after stoma creation [29]. The wide variation in parastomal hernia prevalence may be attributed to differences in definition and diagnosis of parastomal hernia, time of follow up visit and stoma type. In the current study, the rate of parastomal hernia in loop ileostomy and loop transverse colostomy was 13.6 and 11.7%, respectively (p=0.0.814). Carne et al. reported a rate of 0-6.2% for loop ileostomy patients and 0-30.8% for loop transverse colostomy patients [30]. Our stoma reversal surgery is simple, and we introduce 4 sutures at each layer of the bowel wall and the abdominal wall for stoma creation, which may contribute to the lower rate of parastomal hernia in our patients.

We found that loop ileostomy was associated with significantly higher rate of stoma reversal perioperative complications than loop transverse colostomy (24.2 vs 9.0%, p=0.008), particularly in the rate of perioperative diarrhea (18.2 vs 5.4%, p=0.009). Diverting stoma reduces pelvic infections due to anastomotic fistula in low-lying rectal cancer, but due to diversion of feces, the absorption ability of the colon mucosa decreases and cannot absorb water and diarrhea ensues after stoma reversal. Diversion colitis leads to deficiency of short chain fatty acids, which are involved in maintaining the integriy of the intestinal wall and provide nutritional support for mucosal cells [31]. The intestinal mucosa, especially in the proximal colon where absorption mainly occurs, could not effectively absorb and transport water and vitamins as a result of deficiency of short chain fatty acids [32]. Loop ileostomy and loop transverse colostomy differ in anatomic position and the difference in the extent of diverted colon may explain the higher rate of diarrhea in loop ileostomy patients during the stoma reversal perioperative period. Low anterior resection syndrome is another possible contributory cause to diarrhea [33], but it has no clear correlation with stoma position.

The current study has several limitations. The study was retrospective and cannot provide causal relationships. The study was carried out at a single tertiary care institute and the findings may not be applicable to primary care settings. Furthermore, the sample size was small. Prospective controlled studies with larger patient populations are warranted to examine the efficacy and safety of loop ileostomy and loop transverse colostomy.

In conclusion, this study has demonstrated that loop transverse colostomy is associated with significantly lower rates of stoma-related complications and stoma reversal perioperative complications compared to loop transverse colostomy.

Conflict of interests

The authors declare no conflict of interests.

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