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Original Article

Risk factors for nonclosure of defunctioning stoma and stoma-related complications among low rectal cancer patients after sphincter-preserving surgery

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Abstract

Background: Defunctioning stoma is widely used to reduce anastomotic complications in rectal cancer surgery. However, the complications of stoma and stoma reversal surgery should not be underestimated. Furthermore, in some patients, stoma reversal failed. Here, we investigated the complications of defunctioning stoma surgery and subsequent reversal surgery and identify risk factors associated with the failure of getting stoma reversed.
Methods: In total, 154 patients who simultaneously underwent low anterior resection and defunctioning stoma were reviewed. Patients were divided into two groups according to whether their stoma got reversed or not. The reasons that patients received defunctioning stoma and experienced stoma-related complications and the risk factors for failing to get stoma reversed were analysed.
Results: The mean follow-up time was 47.54 (range 4.0−164.0) months. During follow-up, 19.5% of the patients suffered stoma-related long-term complications. Only 79 (51.3%) patients had their stomas reversed. The morbidity of complications after reversal surgery was 45.6%, and these mainly consisted of incision-related complications. Multivariate analyses showed that pre-treatment comorbidity (HR = 3.17, 95% CI 1.27−7.96, $P = 0.014$), postoperative TNM stage (HR = 2.55, 95% CI 1.05−6.18, $P = 0.038$), neoadjuvant therapy (HR = 2.75, 95% CI 1.07−7.05, $P = 0.036$), anastomosis-related complications (HR = 4.52, 95% CI 1.81−11.29, $P = 0.001$), and disease recurrence (HR = 24.83, 95% CI 2.90−213.06, $P = 0.003$) were significant independent risk factors for a defunctioning stoma to be permanent.
Conclusions: Defunctioning stoma is an effective method to reduce symptomatic anastomotic leakage, but the stoma itself and its reversal procedure are associated with high morbidity of complications, and many defunctioning stomas eventually become

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permanent. Therefore, surgeons should carefully assess preoperatively and perform defunctioning stomas in very high risk patients. In addition, doctors should perform stoma reversal surgery more actively to prevent temporary stomas from becoming permanent.

Keywords: Rectal cancer; Low anterior resection; Anastomotic complications; Defunctioning stoma; Stoma reversal surgery

The development of mechanical stapler devices, laparoscopic techniques and total mesorectal excision with preoperative chemoradiation for the treatment of middle and low rectal cancer has allowed more and more patients to receive sphincter-saving surgeries and decreased the need for the patients to require a permanent stoma.[1–3] However, anastomotic leakage following low anterior resection (LAR) of rectal cancer still remains a major serious complication. Defunctioning stoma is thought to be the most effective method to reduce symptomatic anastomotic leakage[4] and is increasingly applied in patients who underwent LAR for rectal cancer. A defunctioning stoma is created in the initial surgery as a temporary diverting pathway and will be subsequently closed when the anastomosis is fully healed. However, defunctioning stomas can cause considerable complications and reduce quality of life.[5] Common stoma-related complications include skin problems, hernia, retraction and prolapse of the stoma, electrolyte imbalance, and dehydration because of high fluid output.[6–8] Although stoma reversal surgery is a much easier procedure to perform than LAR surgery, it can also cause significant postoperative complications. Furthermore, a number of published reports have suggested that 6–32%[9–11] of patients never had their stoma reversed because of disease recurrence, anastomotic stenosis or other reasons. Whether a stoma is constructed or not, it is usually dependent on the surgeon's experience, and there is currently no information available to surgeons to allow them to assess the risk factors associated with a non-reversed defunctioning stoma. The aim of this study was to summarize the results of defunctioning stoma surgery and subsequent stoma reversal surgery in our hospital and identify the risk factors associated with the failure of getting stoma reversed.

Methods

Ethical approval

This study complied with the principles of the *Declaration of Helsinki* and was approved by the Institutional Review Board of the Cancer Hospital, Chinese Academy of Medical Sciences (CHCAMS). Informed consent from patients was exempt due to it was a retrospective study.

Data source and study population

A surgical database was searched to identify data from patients who received initial treatment for rectal cancer and subsequently underwent an LAR surgery with total mesorectal excision principles and a defunctioning stoma from January 2003 to October 2014 in the department of abdominal surgery of the hospital. The exclusion criterion included: (1) hereditary colorectal cancer, including hereditary non-polyposis colorectal cancer (HNPCC) or familial adenomatous polyposis (FAP); (2) patients with inflammatory bowel disease, including ulcerative colitis and Crohn's disease; and (3) patients who underwent palliative operations. Medical records were reviewed, and demographic and clinicopathological information during treatment and follow-up were abstracted.

Data collection

The following clinicopathological characteristics were included in the analysis: age, gender, body mass index (BMI), preoperative comorbidities (such as hypertension, diabetes, and autoimmune disease), preoperative tumour-related complications (mainly including anaemia or obstruction caused by rectal cancer), the location of the tumour (e.g., the distance between the inferior edge of the tumour and the anal verge), clinical TNM stage and pathological TNM stage (according to the AJCC 8th TNM staging system; if the patient received neoadjuvant therapy, the clinical TNM stage was defined according to the patient's status before neoadjuvant therapy), the type of defunctioning stoma (ileostomy or colostomy), neoadjuvant therapy, postoperative adjuvant therapy, stoma-related complications (such as prolapse and hernia), disease recurrence, the duration between the initial operation and the stoma reversal procedure, the reasons for not reversing the stoma, and postoperative complications that occurred after the initial and stoma reversal surgeries.

Postoperative complications included short-term (≤4 weeks) and long-term (>4 weeks) after surgery. Short-term complications include anastomotic leakage, abdominal infection, wound complication, bowl obstruction, bleeding, rectovaginal fistula, and stoma-related complication. Long-term complications include urinary dysfunction, sexual dysfunction, incisional hernia.

Anastomotic-related complications include anastomotic leakage and anastomotic stenosis. Symptomatic anastomotic leakage was defined as a discharge of faecal material through the pelvic drainage tube. Anastomotic stenosis was diagnosed by colonoscopy.

Follow-up

Patients were followed up at 3-month intervals for the first 2 years after surgery, every 6 months for the next 3 years, and then every year after 5 years. Patient evaluations consisted of a physical examination, serum carcinoembryonic antigen (CEA) levels, CA199 levels, thoracic-abdominal-pelvic CT scans, colonoscopy, abdominal ultrasonography and pelvic MRI according to The National Comprehensive Cancer Network (NCCN) guidelines. If the patient did not come back for a routine re-examination, we attempted a telephone interview. The last follow-up date was December 31st, 2016, and the mean follow up time was 47.5 months (range: 4.0−164.0 months, one patient died of liver and lung metastasis 4 months after surgery).

Evaluation before stoma reversal surgery

When the patients completed all postoperative adjuvant therapy, the stoma was scheduled for closure. Thoracic-abdominal-pelvic CT scans, pelvic MRI and CEA levels were conducted to detect disease recurrence or metastasis. And colonoscopy and digital rectal examination were performed to evaluate the anastomoses. Patients were scheduled for stoma reversal only after examination to exclude diseases recurrence and anastomotic complications (leakage or stenosis).

If the stoma reversal surgery was not performed within the follow-up period or the reversal procedure has not been scheduled within 24 months after the LAR surgery, we considered the defunctioning stoma as a “non-reversal”. Among all of the patients enrolled in this study, 149 patients (149/154, 96.8%) were followed up for at least 2 years.

Statistical analysis

Categorical variables were analysed with the chi-square test. Continuous variables were analysed using student's *t*-test. To identify the risk factors associated with permanent stomas, a logistic multivariate analysis was conducted. All statistical tests were two-sided. Statistical significance was defined as a *P*-value <0.05. SPSS software version 19.0 (IBM Corp, Armonk, NY, USA) was used for all statistical analyses.

Results

Baseline characteristics between the reversal and non-reversal groups

We reviewed a total of 3477 consecutive primary rectal cancer patients who underwent radical anterior resection between January 1st, 2003 and October 31st, 2014 in our hospital. In total, 154 patients (101 male, 53 female) with a median age of 58 years old (range: 20−83 years old) underwent defunctioning stoma surgery; these patients accounted for 4.4% (154/3477) of all the patients. Additionally, the rate of defunctioning stoma substantially increased from 1.3% in 2003 to 7.7% in 2014, and the highest percentage of defunctioning stoma observed in rectal cancer patients was 8.6% (35/408) in 2013. Eighty-six patients (86/154, 55.8%) underwent laparoscopic surgery and 80 patients (80/86, 93.0%) underwent laparoscopic surgery since 2011.

Thirty-one patients (31/154, 20.1%) underwent ileostomy, and the other 123 patients (123/154, 79.9%) underwent colostomy. Fifty-four patients (54/154, 35.1%) received neoadjuvant therapy, and 99 patients (99/154, 64.3%) received postoperative adjuvant therapy. In total, 100 patients (100/154, 64.9%) were diagnosed as clinical stage III−IV before they received any therapy. Sixty-three (63/154, 40.9%) patients had preoperative comorbidities, including diabetes mellitus and autoimmune disease. According to whether the stoma was reversed at the end of follow up, the patients were divided into a reversal group (79/154, 51.3%) and a non-reversal group (75/154, 48.7%). The clinical characteristics of the patients with or without stoma reversal are listed in Table 1.

Table 1
Differences in baseline characteristics between the reversal and non-reversal groups ($N = 154$).

Variables	Reversal, *n* (%)	Non-reversal, *n* (%)	Univariate analysis	Multivariate analysis
			P values	HR (95% CI)
Age			0.310	1.17 (0.37−3.63)
<70 years	68 (53.1)	60 (46.9)		
≥70 years	11 (42.3)	15 (57.7)		
BMI			0.650	2.60 (0.30−22.80)
<30 kg/m^2	76 (51.7)	71 (48.3)		
≥30 kg/m^2	3 (42.9)	4 (57.1)		
Gender			0.460	0.69 (0.28−1.70)
Male	54 (53.5)	47 (46.5)		
Female	25 (47.2)	28 (52.8)		
Tumour-related complications[a]			0.030	2.12 (0.71−6.30)
Yes	10 (33.3)	20 (66.7)		
No	69 (55.6)	55 (44.4)		
Pre-operative co-morbidity			0.160	3.17 (1.27−7.96)
Yes	28 (44.4)	35 (55.6)		
No	51 (56.0)	40 (44.0)		
Tumour location[b]			0.320	1.31 (0.54−3.20)
≤5 cm	39 (47.6)	43 (52.4)		
>5 cm	40 (55.6)	32 (44.4)		
Pre-treatment cTNM stage[c]			0.002	2.16 (0.74−6.30)
I−II	37 (68.5)	17 (31.5)		
III−IV	42 (42.0)	58 (58.0)		
Post-operative TNM stage			0.001	2.55 (1.05−6.18)
I−II	55 (62.5)	33 (37.5)		
III−IV	24 (36.4)	42 (63.6)		
Neoadjuvant therapy[d]			0.009	2.75 (1.07−7.05)
Yes	20 (37.0)	34 (63.0)		
No	59 (59.0)	41 (41.0)		
Method of fistulation			0.100	0.62 (0.22−1.75)
Ileostomy	20 (64.5)	11 (35.5)		
Colostomy	59 (48.0)	64 (52.0)		
Anastomosis-related complication			<0.001	4.52 (1.81−11.29)
Yes	15 (39.5)	34 (23.5)		
No	64 (84.9)	41 (76.5)		
Postoperative complications			0.190	1.17 (0.44−3.10)
Yes	16 (42.1)	22 (57.9)		
No	63 (54.3)	53 (45.7)		
Stoma-related complications			0.570	1.37 (0.50−3.81)
Yes	14 (46.7)	16 (53.3)		
No	65 (52.4)	59 (47.6)		
Adjuvant therapy			0.050	1.08 (0.41−2.86)
Yes	45 (45.5)	54 (54.5)		
No	34 (61.8)	21 (38.2)		
Disease recurrence[e]			<0.001	24.83 (2.89−213.06)
Yes	1 (4.8)	20 (95.2)		
No	78 (58.6)	55 (41.4)		

[a] Including preoperative anaemia or obstruction.
[b] If a patient had received neoadjuvant therapy, the location was measured after neoadjuvant therapy.
[c] If a patient had received neoadjuvant therapy, the TNM stage was evaluated before neoadjuvant therapy.
[d] Including neoadjuvant chemoradiotherapy (NCRT) and neoadjuvant chemotherapy.
[e] Including local recurrence and metastasis.

The reasons for patients received defunctioning stomas

The main reasons that the patients received defunctioning stomas were classified into five categories, as follows: (1) "low tumour location (the distance between the inferior edge of the tumour and the anal verge ≤5 cm)" (61/154, 39.6%), (2) "serious oedema of the rectum after neoadjuvant chemoradiotherapy with/without a low tumour location" (44/154, 28.6%), (3) "unsatisfied surgery procedure and/or inappropriate anastomosis" (22/154, 14.3%), (4) "poor general medical condition, such as agedness, malnutrition, or diabetes" (15/154, 9.7%), and (5) "preoperative obstruction or extensive and complex surgical procedure, such as multiple organ resection" (12/154, 7.8%). Three stage IV patients accompanied liver metastasis, and all of these patients received simultaneous liver resection. If patient had more than one reason, the most serious reason was selected.

Postoperative complications and stoma-related complications

Among all the patients, thirty-two (32/154, 20.8%) suffered postoperative short-term (≤4 weeks after surgery) complications, not including stoma-related complications. Anastomotic leakage occurred in 13 patients (8.4%), although they received defunctioning stoma operation. Thirteen patients (13/154, 8.4%) suffered incision-related complications, including fat liquefaction, incision infection and incision necrosis. The other postoperative short-term complications included postoperative bowl obstruction, postoperative bleeding, abdominal infection, pneumonia and rectovaginal fistula, which occurred in 7 (4.6%), 4 (2.6%), 2 (1.3%), 1 (0.7%), and 1 (0.7%) patients, respectively. In all, 6 patients (3.9%) suffered long-term (>4 weeks after surgery) complications, such as urinary dysfunction and incisional hernia. No patient died within 30 days after surgery (Table 2).

Table 2
Complications of low anterior resection surgery in patients with defunctioning stoma ($N = 154$).

Complications	Number	Percentage (%)
Short-term (≤4 weeks after surgery)[a]	32	20.8
Anastomotic leakage	13	8.4
Incision liquefaction/infection	13	8.4
Bowl obstruction	7	4.6
Abdominal bleeding	4	2.6
Abdominal infection	2	1.3
Pneumonia	1	0.7
Rectovaginal fistula	1	0.7
Long-term (>4 weeks after surgery)	6	3.9
Urinary dysfunction	4	2.6
Incisional hernia	2	1.3

[a] Patients may have multiple complications after surgery.

Table 3
Complications of defunctioning stoma ($N = 76$).

Complications	Number	Percentage (%)
Short-term (<4 weeks after surgery)		
Dermatitis around stoma	34	44.7
Intestine separate from skin	26	34.2
Long-term (>4 weeks after surgery)		
Parastomal hernia	16	21.1
Stoma prolapse	11	14.5
Hernia and prolapse	3	3.9

In total, 76 patients (76/154, 49.4%) suffered stoma-related complications. The most common stoma-related short-term (≤4 weeks after surgery) complications were dermatitis around the stoma (34/76, 44.7%) and separation of the intestine from the skin (26/76, 34.2%). All of these cases recovered with conservative treatment. Thirty patients (30/76, 39.5%) suffered from stoma-related long-term (over 4 weeks after surgery) complications. Of these, 16 (16/76, 21.1%) had parastomal hernia, 11 patients (11/76, 14.5%) had accompanying stoma prolapse, and 3 (3/76, 3.9%) suffered from both stoma prolapse and parastomal hernia (Table 3). Patients with preoperative comorbidities (such as diabetes) were more likely to have stoma-related long-term complications (30.2 vs. 12.1%; $P = 0.005$). There was no remarkable correlation between stoma-related long-term complications and patient age (<70 years old, 19.2% vs. ≥70 years old, 19.5%; $P = 0.97$).

The reasons for patients failed to get stoma reversed

Only 79 (79/154, 51.3%) patients had their defunctioning stomas reversed by the end of December 2016. The median interval from the initial creation of the defunctioning stoma to stoma reversal was 12 months (rang: 2−39 months). The other 75 patients did not receive stoma reversal. There were 4 main reasons why the patients failed to get their stoma reversed. The most common reasons were tumour-related (22/75, 29.3%), including disease local recurrence and distant metastasis (15/22,68.2%), advanced disease with a very high risk of recurrence (5/22, 22.7%), and

Table 4
Comparison within the stoma reversal group of patients with or without reversal-related complications ($N = 79$).

Variables	Reversal-related complications group, *n* (%)	No reversal-related complications group, *n* (%)	Univariate analysis	Multivariate analysis
			P Values	HR (95% CI)
Age			0.990	1.15 (0.27−4.91)
<70 years	31 (45.6)	37 (54.4)		
≥70 years	5 (45.5)	6 (54.5)		
BMI			0.450	2.06 (0.13−33.40)
<30 kg/m^2	34 (44.7)	42 (55.3)		
≥30 kg/m^2	2 (66.7)	1 (33.3)		
Gender			0.850	1.01 (0.30−3.32)
Male	25 (46.3)	29 (53.7)		
Female	11 (44.0)	14 (56.0)		
Tumour-related complications[a]			0.330	2.07 (0.38−11.20)
Yes	6 (60.0)	4 (40.0)		
No	30 (56.5)	39 (43.5)		
Pre-operative co-morbidity			0.130	2.14 (0.69−6.60)
Yes	16 (57.1)	12 (42.9)		
No	20 (39.2)	31 (60.8)		
Tumour location[b]			0.920	1.38 (0.44−4.38)
≤5 cm	18 (46.2)	21 (53.8)		
>5 cm	18 (45.0)	22 (55.0)		
Pre-treatment cTNM stage[c]			0.330	0.49 (0.13−1.75)
I−II	19 (51.4)	18 (48.6)		
III−IV	17 (40.5)	25 (59.5)		
Post-operative TNM stage			0.980	1.85 (0.51−6.76)
I−II	25 (45.5)	30 (54.5)		
III−IV	11 (45.8)	13 (54.2)		
Neoadjuvant therapy[d]			0.130	2.75 (0.68−11.24)
Yes	12 (60.0)	8 (40.0)		
No	24 (40.7)	35 (59.3)		
Method of fistulation			0.560	0.56 (0.14−2.31)
Ileostomy	8 (40.0)	12 (60.0)		
Colostomy	28 (47.5)	31 (52.5)		
Anastomosis-related complication			0.500	1.70 (0.42−6.91)
Yes	8 (53.3)	7 (46.7)		
No	28 (45.9)	33 (54.1)		
Postoperative complications			0.870	0.89 (0.23−3.36)
Yes	7 (43.8)	9 (56.3)		
No	29 (46.0)	34 (54.0)		
Stoma-related complications			0.001	9.63 (1.77−52.45)
Yes	12 (85.7)	2 (14.3)		
No	24 (36.9)	41 (63.1)		
Adjuvant therapy			0.250	0.54 (0.15−1.87)
Yes	18 (40.0)	27 (60.0)		
No	18 (52.9)	16 (47.1)		

[a] Including preoperative anaemia or obstruction.
[b] If a patient had received neoadjuvant therapy, the location was measured after neoadjuvant therapy.
[c] If a patient had received neoadjuvant therapy, the TNM stage was evaluated before neoadjuvant therapy.
[d] Including neoadjuvant chemoradiotherapy (NCRT) and neoadjuvant chemotherapy.

other metachronous malignant tumour (lung cancer and lymphoma, respectively) (2/22, 9.1%). The second most common reasons were anastomosis-related (19/75, 25.3%), such as anastomotic stricture, serious radiation proctitis, or uncured anastomotic leakage. The third most common reasons were patient-related (18/75, 24.0%), including a number of patients who were reluctant to undergo an additional operation and who refused to get their stoma reversed. The last common reasons doctor-related (16/75, 21.3%), including doctors who decided it was inappropriate for the patient to have their stoma reversed because of the patient's poor general medical condition or who had a poor expectation that defecation control would be achieved after stoma reversal. Among the 75 patients who failed to have their stomas reversed, 26 (26/75, 34.7%) indicated that they could not change the stoma bag themselves, and this caused serious inconvenience in their daily lives.

Univariate and multivariate analysis between reversal and non-reversal group

When parameters were compared between the reversal and non-reversal groups, the incidences of pre-treatment tumour-related complications (such as anaemia or obstruction) ($P = 0.03$), pre-treatment clinical TNM stage ($P = 0.002$), postoperative pTNM stage ($P = 0.001$), neoadjuvant therapy ($P = 0.009$), anastomosis-related complications ($P < 0.001$), and disease recurrence ($P < 0.001$) were significantly different between the groups. Other parameters, such as age, BMI, sex, and the type of defunctioning stoma, were comparable between the two groups. Multivariate logistic regression analysis showed that pre-treatment comorbidity (mainly including diabetes and autoimmune disease) (HR = 3.17, 95% CI 1.27−7.96, $P = 0.014$), post-operative TNM stage (HR = 2.55, 95% CI 1.05−6.18, $P = 0.038$), neoadjuvant therapy (HR = 2.75, 95% CI 1.07−7.05, $P = 0.036$), anastomosis-related complications (HR = 4.52, 95% CI 1.81−11.29, $P = 0.001$), and disease recurrence (HR = 24.83, 95% CI 2.90−213.06, $P = 0.003$) were independent risk factors for the failure of getting stoma reversed (Table 1).

In total, 79 patients had their defunctioning stomas reversed. And the incidence of complications caused by the reversal surgery itself was 45.6% (36/79); the complications included incision infection or fat liquefaction (16/36, 44.4%), incisional hernia (14/36, 38.9%), anastomotic leakage (4/36, 11.1%) and post-operative bowel obstruction (2/36, 5.6%). Of these, incision-related complications accounted for the highest proportion (30/36, 83.3%) and included incision infection, incision fat liquefaction and incisional hernia. Multivariate analysis showed that stoma-related complications were independent risk factors for reversal complications (HR = 9.63, 95% CI 1.77−52.45, $P = 0.009$, Table 4).

Discussion

Anastomotic leakage following LAR for rectal cancer still remains a major serious complication. Defunctioning stoma is thought to be the most effective method to reduce symptomatic anastomotic leakage[4] and is increasingly applied in patients who underwent LAR for rectal cancer; it is even routinely used in some hospitals. Snijders et al[12] reported that over 70% of patients had a defunctioning stoma after LAR surgery. In our hospital, defunctioning stoma is only used for highly selective rectal cancer patients with high-risk of anastomotic leakage, such as patients with a very low tumour location and receiving preoperative chemoradiotherapy. However, the rate of defunctioning stoma still increased from 1.33% in 2003 to 7.65% in 2014 in our centre.

However, everything, including defunctioning stoma, has two sides. Although defunctioning stoma can reduce anastomotic leakage, it can also cause considerable complications and reduce patient quality of life. For example, patients who undergo LAR with a temporary diverting stoma can experience seriously compromised physical and psychological well-being which may then improve after stoma closure.[5] Second, patients suffer many types of complications, such as skin problems, electrolyte imbalance, dehydration, parastomal hernia, retraction, and prolapse of the stoma during the stoma period. Akesson et al[8] reported that 59% of these patients had problems related to the loop ileostomy, such as skin irritation or leakage from the stoma dressing and wound-related problems during the stoma period, and that over 40% of these patients lived with stoma-related long-term complications, such as parastomal hernia and dehydration. The rate of stoma-related complications is very high, ranging from 23.5% to 68% according to previous publications.[5,7,8,11] In this study, 76 patients (49.4%) suffered stoma-related complications. Nearly 20% of the patients suffered stoma-related long-term complications, mainly including stoma prolapse and parastomal hernia. These complications made it more difficult to care for the stoma and consequently had a significantly bad effect on their quality of life. Previous studies suggested that reversing the stoma earlier could avoid stoma-associated complications.[8,13] Lertsithichai[13] proposed that stoma-related complications were more frequent in colostomies than ileostomies and that ileostomy tended to cause more post-closure surgical complications. However, in our study, there was no significant difference between the ileostomy and colostomy group with regard to stoma-related complications.

Theoretically, a diverting stoma is considered as a protective procedure that is commonly performed after LAR surgery in rectal cancer patients. However, in our study, 8.4% of the patients suffered anastomotic leakage after defunctioning stoma surgery. This is consistent with other studies in which the rate of anastomotic leakage varied from 6.3% to 14%.[4,12,14−16] The main reason is that over 60% of the patients enrolled in this study had a very low tumour location (the distance between inferior edge of tumour and the anal verge were ≤5 cm) or received neoadjuvant chemoradiotherapy. Therefore, these patients might have a higher risk of anastomotic leakage without defunctioning stoma, and it is necessary to perform a diverting stoma procedure in these high-risk patients.

Although stoma closure is not a complex surgery, it has risks and can have several postoperative complications. The morbidity rate of complications after stoma reversal surgery varies from 9.3% to 33.3%.[7,17−19] The most common complications reported in previous studies were incision infection and bowel obstruction. In the present study, 45.6% (36/79) of the patients suffered postoperative complications after stoma reversal surgery; these included incision-related complications, which had an especially high rate (30/36, 83.3%). Stoma-related complications were considered as independent risk factors for reversal surgery complications. Therefore, surgeons should try to decrease stoma-related complications in the initial surgery and pay more attention on how to reduce incision-related complications in reversal surgery. Another problem is symptomatic anastomotic leakage following stoma reversal. In our study, four patients re-experienced anastomotic leakage after the reversal operation, and all of them received conservative treatment. Unfortunately, two of them were not cured during their long follow-up of 30 months and 19 months.

Defunctioning stoma is created in the initial surgery as a temporarily diverting pathway and is subsequently closed when the anastomosis is fully healed. However, 3.0%−23.2%[20−22] patients never have their defunctioning stoma reversed, causing a permanent stoma to eventually form. Therefore, Lindgren et al[23] proposed that a temporary stoma should be deemed "permanent" if a reversal procedure has not been scheduled within 12.5 months after the LAR surgery for the rectal cancer. There are many reasons that contribute to non-reversal stoma.[21,22,24,25] Chiu et al[24] analysed data from a nationwide multicentre trial and found that the risk for permanent stomas in patients with and without symptomatic anastomotic leakage were 56% and 11% respectively, and half of those patients with a permanent stoma had a previous symptomatic anastomotic leakage. It has also been reported that patients' general condition, which is affected by chronic diseases such as diabetes mellitus, was an independent risk factor for non-reversal stoma.[22]

In this study, 48.7% patients did not close their stomas, and this rate was much higher than those reported in most previous publications. This might be due to the fact that the majority of the patients (64.9%) in this study were clinical stage III−IV and had a very high risk of anastomotic leakage after LAR. Therefore, temporary digestive tract diverting surgery was performed only under highly selective conditions in our hospital, and this might be different from the procedures used in other medical centres that regard defunctioning stoma as a routine surgery after LAR. Over 54.6% of the patients (41/75) failed to have the stoma reversed because of tumour-related reasons or anastomosis-related reasons. For the patients who suffered tumour recurrence, stoma reversal surgery was not scheduled because it could interrupt sequential treatment for the tumour. Approximately 24.0% of the patients failed to have their stoma reversed because of fear about undergoing an additional operation. Additionally, 21.3% of the patients who failed to have their stoma reversed were due to doctor-related reasons. This indicates that some doctors paid more attention to tumour treatment rather than to the patients' quality of life. To relieve those patients' pain and improve their quality of life, it is necessary for surgeons to perform reversal surgery more actively.

Our results showed that preoperative comorbidity, neoadjuvant therapy, pathological TNM stage, anastomosis-related complications and disease recurrence were independent risk factors for failure to close a defunctioning stomas. While it is widely accepted that neoadjuvant chemoradiotherapy enhances the possibility of tumour R0 resection and sphincter preservation,[3,26] it is also an important risk factor that impacts anastomosis healing, increases the risk of anastomosis-related complications, and prolongs stoma closure time.[27] According to our data, in patients who received preoperative neoadjuvant therapy, the median closure time was 20.5 months, whereas it was 10 months in patients without neoadjuvant therapy ($P = 0.003$).

Therefore, we suggest that if a temporary stoma procedure is determined to perform and will get reversed definitely, ileostomy may be a favourable choice because its procedure is easier to perform. In patients with more than one risk factor (such as severe tumour-related complications and comorbidity before operation, advanced disease, neoadjuvant therapy or a high risk of recurrence) who might therefore not have their stoma reversed for a long period, transverse colostomy may be a better choice because it has a low incidence of dehydration and is more convenient to care for. Furthermore, we consider that the high incidence of prolapse in transverse colostomy. So if patients were unlikely to undergo reversal surgery because of poor general medical condition or elderly age, permanent sigmoid colostomy may be a better choice.

One major limitation should be considered. These data were collected retrospectively using available medical record information collected in a single centre over a 10-year period. However, this large study population allowed detailed sociodemographic and clinical characteristics to be analysed. This study provides suggestive evidence for sphincter-preserving surgery with diverting stomas in rectal cancer.

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Conflicts of interest

None.

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