



Comparison of overall survival and quality of life between patients undergoing anal reconstruction and patients undergoing traditional lower abdominal stoma after radical resection

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Abstract

Background Miles procedure is often necessary for patients with low rectal carcinoma. However, this operation often affects the quality of life of patients, to evaluate the advantages of improved operation (anal reconstruction), the quality of life and survival between patients undergoing anal reconstruction and patients undergoing traditional lower abdominal stoma after radical resection were analyzed.

Methods The clinical data of 43 patients with low situated rectal carcinoma were retrospectively analyzed. 23 patients with left lower abdominal stoma after radical resection (Miles procedure) were divided into group A, and 20 patients with reconstruction of the anus in situ after radical resection were in group B. All patients were investigated by the European Organization for Research and Treatment of Cancer (EORTC) QLQ-C30 and QLQ-CR38 questionnaire, the clinical data are recorded. Independent sample *T* test was used to analyze the difference in quality of life between group A and group B at 3, 6, and 12 months after surgery, and Kaplan–Meier was used to compare the difference in overall survival between group A and group B.

Results The results of *T* test showed that there were statistical significance in global health status and physical functioning between group A and group B at 3 and 6 months, but no statistical significance at 12 months ($P=0.024$, $P=0.019$, $P=0.115$ for global health status; $P=0.004$, $P=0.006$, $P=0.065$ for physical functioning, respectively). Emotional functioning and social functioning were also statistically significant between group A and group B at 3, 6, and 12 months ($P=0.041$, $P=0.040$, $P=0.034$ for Emotional functioning; $P=0.020$, $P=0.009$, $P=0.032$ for social functioning, respectively). This study also found that there was no statistical significance in body image and sexual functioning between group A and group B at 3 months, but there was statistical significance at 6 and 12 months ($P=0.098$, $P=0.035$, $P=0.045$ for body image; $P=0.110$, $P=0.048$, $P=0.047$ for sexual functioning, respectively). There were statistically significant about sexual enjoyment and defecation problems at 3, 6, and 12 months ($P=0.023$, $P=0.028$, $P=0.050$ for sexual enjoyment; $P=0.013$, $P=0.011$, $P=0.050$ for defecation problems, respectively). The results of Kaplan–Meier showed that the overall survival (OS) between group A and group B was not statistically significant ($\chi^2=0.600$, $P=0.439$).

Conclusions There was no difference in survival time between group A and group B, but compared with the patients with left lower abdominal stoma (group A), the quality of life was better in patients with reconstruction of the anus in situ (group B). It is significant to improve the traditional lower abdominal stoma operation.

Keywords EORTC QLQ-C30 · EORTC QLQ-C38 · Anal reconstruction · Ostomy · Rectal carcinoma

Introduction

Colorectal carcinoma is a health problem worldwide, and the morbidity and mortality are increased gradually in recent years, which was also becoming the leading cause of death in the population [1–5]. Patients with low situated rectal carcinoma often need lower abdominal stoma after surgical resection (Miles procedure). Surgical resection of early

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low rectal carcinoma can improve the survival of patients. However, lower abdominal stoma has a significant impact on the quality of life (QOL) of patients [6, 7]. Therefore, the quality of life is considered to be an important factor in evaluating the efficacy of surgery, and together with 5-year survival rate and progression-free survival rate [8–12]. The European Organization for Research and Treatment of Cancer (EORTC) QLQ-C30 and QLQ-CR38, two standardized EORTC questionnaires, were used: EORTC QLQ-C30 scale is often used to assess the quality of life of patients with carcinoma, as well as the specific EORTC QLQCR38 scale for patients with colorectal carcinoma, and QLQCR38 is a supplement to QLQCR30 [13–15].

In this study, 43 patients with low situated rectal carcinoma were enrolled. Among them, 23 patients underwent left lower abdominal stoma (Miles procedure), and other 20 patients underwent orthotopic anal reconstruction. The quality of life and overall survival of the patients treated with two different surgical methods were compared to assess whether there were statistical differences, and explore a more proper surgical method for these patients with low situated rectal carcinoma.

Materials and methods

Patients

We enrolled 43 patients with low situated rectal carcinoma who underwent open abdomen tumor resection at the Second Hospital of Lanzhou University (Gansu Province, China) between 2013 and 2014, these patients were treated by Folfex chemotherapy after surgery. The study was approved by the Ethics Committee of the Second Hospital of Lanzhou University, and the data were anonymously obtained and retrospectively analyzed. Informed consents from participants were also waived due to the complete anonymity of the patients. The clinical data of all patients were collected from the electronic medical records of the Second Hospital of Lanzhou University. This study was performed in accordance with the relevant guidelines and regulations, and conformed to the Declaration of Helsinki [16]. The inclusion criteria of patients included complete pathological and follow-up data, Assessment of preoperative CT and other modalities: T staging is between T1 and T3, without long distance metastasis, no other chronic diseases, and without any treatments before the surgery, the distance of the tumor from the anal verge less than 4 cm. The patients were not treated with radiotherapy before surgery. The exclusion criteria: patients who suffered from other tumor or other chronic diseases, or died from accidental death or other diseases, lack of pathological and follow-up data, long distance metastasis before the surgery. Ultimately, a total of 43 cases

were eventually enrolled in this study, including 24 males and 19 females, aged 36–78 years, median age of 57 years.

Grouping and follow-up

All patients underwent surgery due to low situated rectal carcinoma, and because the distance of the tumor from the anal verge is less than 4 cm, the anus can not be preserved. It is necessary that all patients are treated by Miles procedure. Abdominoperineal Radical Operation of Rectal Cancer (Miles procedure): it is applicable to the patients with low situated rectal carcinoma which is under the peritoneal reflection, these patients must undergo lower abdominal stoma after radical resection. Anal reconstruction is similar to Dixon procedure, but different from Dixon. The operation is to reconstruct the anus in situ after resection of the tumor. Transabdominal resection of rectal carcinoma and presacral anastomosis (Dixon procedure): it is suitable for rectal carcinoma which is above peritoneal reflection, it is also known as anterior resection of the rectum and presacral anastomosis, which is suitable for the lower margin of the tumor which is above the dentate line 5 cm. Patients were randomly divided into group A or group B before the surgery, and then treated according to Miles operation or anal reconstruction. 23 patients with lower abdominal stoma after radical resection (Miles procedure) were as group A, 20 patients with orthotopic anal reconstruction after radical resection were as group B. The quality of life related indicators were assessed by EORTC QLQ-C30 and EORTC QLQ-C38 scale, and the survival data of patient was recorded by follow-up. The follow-up period was from the surgical date to the death date, and no patients died during follow-up, the follow-up dates from the surgical date to the end of 5 years.

Surgical details of anal reconstruction

To dissociate Intestinal tract according to TME

The dissociation of rectum and its mesentery are required to reach the pelvic floor. The retained sigmoid colon must be relaxed so that it can be pulled down and anastomosed. If it is necessary, the gastrointestinal ligaments should be cut off to free the splenic flexure and the descending colon. The rectal canal is exposed at the pelvic floor, and the distal segment is the internal sphincter. It is bluntly separated downward along the gap between the internal and external sphincters with scissors or fingers. Ring incision along the INTERSPHINCTER sulcus into the gap between the internal and external sphincters. The internal sphincter was separated from the external sphincter and the puborectal muscle according to the guidance of the abdominal surgeon, and the external anal sphincter, the puborectal muscle and the levator ani muscle were preserved. After the rectum and anal

canal were completely free, the rectum was pulled down to the outside body, and the rectum was incised. The staging of the tumors was evaluated again by intraoperative observation of tumor infiltration and intraoperative rapid frozen pathological examination. Anal reconstruction was performed in eligible patients.

Intestinal dung bag, anal canal and anus plasty

After determining the position of the incision margin, the intestinal dung bag was reconstructed, and the intestinal tube at the position of the pelvic dung bag was longitudinally cut. The incision was about 2 cm long. After transverse suture, the intestinal tube was formed into an enlarged dung bag. The intestinal tube was pulled to the left and fixed on the left pelvic wall to form an enlarged dung bag with an arc. The intestinal tube in the position of the anal canal is sutured (purse string suture) with absorbable suture from the serosa layer of the intestinal wall, then the suture is tightened to form a narrow intestinal tube. It can be easily passed through two fingers. The intestinal tube is fixed from the pelvic cavity to the pelvic floor so that the narrow segment of the intestinal tube is in the position of the original anal canal. The intestinal tube is sutured and fixed from the perineum, and the intestinal tube of the tumor segment is resected, and the end of anal plasty is performed, as shown in Fig. 2. Notes for this operation: 1. To reduce the recurrence rate of tumors, the stage of tumors must be less than T3. 2. The external anal sphincter, puborectal, levator ani muscles must be preserved to ensure self-control of defecation and avoid anal incontinence, levator ani exercises should be performed after 3 weeks of surgery.

Questionnaires

Qlq-c30

QLQ-C30 is a core scale developed by EORTC for measuring the quality of life of cancer patients. There are 30 items in QLQ-C30: items 29 and 30 are in seven grades, and they are scored from 1 to 7 according to their answers. Other items are divided into 4 grades: none, a little, more, a lot, and 1–4 points in grading. Thirty items can be divided into 15 areas, including five functional areas (physiological, role, cognitive, emotional and social functions), three symptom areas (fatigue, pain, nausea and vomiting), one overall health condition, five functional areas and six single items [13, 17].

Qlq-cr38

QLQ-CR38 is a special quality of life questionnaire for patients with colorectal carcinoma developed by EORTC. It consists of 38 questions: 19 questions must be answered

by all patients, and the remaining 19 questions are answered according to the male or female patients, with or without stoma. EORTC QLQ-CR38 can be divided into four functional scales (body image, sexual function, sexual feelings and prognostic expectations), eight symptom scales (voiding problems, gastrointestinal symptoms, respiratory symptoms, adverse reactions to chemotherapy, defecation problems, stoma-related problems, sexual problems in men and women, weight loss) [14].

Statistical analysis

SPSS 22.0 statistical software was used to analyze all data. Independent sample *T* test was used to compare the difference of quality of life between group A and group B. The results were expressed as mean (M) ± standard deviation (SD). Kaplan–Meier survival estimates model were used to assess the correlation of clinical factors with the overall survival (OS). $P < 0.05$ was considered statistically significant.

Results

Surgical figures of anus reconstruction from typical cases

Most of patients come to the hospital for bloody stool. For instance, a female patient was detected by colonoscopy for hematochezia. The lesion was about 2 cm in diameter and 2.5 cm away from the anal margin. During preoperative conversation, the patient and his family refused to have a lower abdominal stoma and asked for in situ anal reconstruction (Fig. 1a, b). A male patient was detected by colonoscopy for hematochezia. The lesion was about 2 cm in diameter and 2.5 cm away from the anal margin. During preoperative conversation, the patient and his family also refused to have a lower abdominal stoma and asked for in situ anal reconstruction (Fig. 1c, d).

Statistical results

Statistical results of QLQ-C30 questionnaire

The results of *T* test showed that there were statistical significance in global health status between group A and group B at 3 and 6 months ($P = 0.024$, $P = 0.019$, respectively), but no statistical significance at 12 months ($P = 0.115$); There were statistical significance in physical functioning between group A and group B at 3 and 6 months ($P = 0.004$, $P = 0.006$, respectively), but no statistical significance at 12 months ($P = 0.065$). There were statistical significance in emotional functioning between group A and group B at 3, 6, and 12 months ($P = 0.041$,

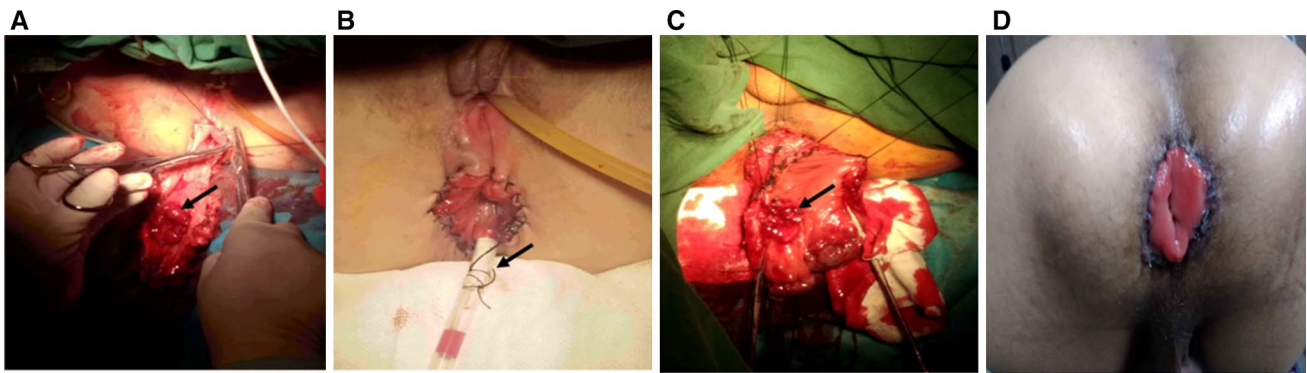


Fig. 1 Surgical Figures of anus reconstruction from typical cases. **a** Resection of lesion and reconstruction of anus in situ during surgery, tumor lesion is in the direction of arrow; **b** the operation is finished, drainage tube is in the direction of arrow. **c** Resection of lesion and reconstruction of anus in situ during surgery, tumor lesion is in the direction of arrow. **d** Figure at 2 weeks after anus reconstruction

drainage tube is in the direction of arrow. **c** Resection of lesion and reconstruction of anus in situ during surgery, tumor lesion is in the direction of arrow. **d** Figure at 2 weeks after anus reconstruction

Table 1 Statistical results of *T* test for QLQ-C30 questionnaire

Category	3 months			6 months			12 months		
	A group (M±S)	B group (M±S)	<i>P</i>	A group (M±S)	B group (M±S)	<i>P</i>	A group (M±S)	B group (M±S)	<i>P</i>
Global health status	69.09±6.3	74.25±7.9	0.024	69.43±6.4	75.35±8.9	0.019	70.75±10.9	75.85±8.9	0.115
Functional scales									
Physical functioning	68.52±7.5	76.55±9.6	0.004	71.91±7.9	79.80±7.6	0.006	73.70±12.3	79.90±7.8	0.065
Role functioning	73.74±8.7	76.10±5.7	0.293	74.0±6.7	75.70±5.4	0.370	75.70±6.2	76.05±4.8	0.822
Emotional functioning	70.83±9.6	77.10±9.8	0.041	73.70±10.9	80.15±9.0	0.040	76.47±8.4	83.10±10.3	0.034
Cognitive functioning	78.57±9.5	77.45±9.3	0.701	78.30±10.2	77.50±8.9	0.787	78.20±10.0	77.40±9.6	0.786
Social functioning	69.96±13.5	77.90±7.26	0.020	71.30±10.6	78.95±6.9	0.009	75.16±8.8	80.80±7.0	0.032
Symptom scales									
Fatigue	22.83±10.4	21.25±8.7	0.534	25.96±14.3	19.40±8.4	0.071	24.95±12.5	17.80±8.7	0.045
Nausea and vomiting	7.74±5.6	6.15±5.4	0.351	7.78±5.5	6.05±4.4	0.265	5.84±5.9	4.95±5.6	0.616
Pain	10.26±4.3	10.05±4.7	0.875	10.04±4.0	10.60±4.5	0.672	9.10±4.7	9.75±5.8	0.705
Dyspnoea	13.04±9.7	10.50±8.3	0.284	13.26±11.8	11.25±7.8	0.509	10.53±13.7	10.75±10.4	0.954
Insomnia	17.61±10.4	17.10±8.1	0.861	15.86±11.0	14.50±8.7	0.658	13.16±8.9	12.55±8.0	0.823
Appetite loss	17.39±10.5	15.25±6.6	0.423	16.96±11.4	13.75±6.9	0.278	14.21±8.2	13.25±7.9	0.713
Constipation	13.91±9.0	15.75±8.9	0.580	13.69±7.1	14.50±6.5	0.702	12.10±4.8	13.00±5.2	0.582
Diarrhoea	9.78±8.0	12.25±9.4	0.395	8.90±7.8	11.75±7.3	0.228	8.68±7.8	9.25±6.5	0.807
Financial problems	13.48±7.0	11.50±5.2	0.303	16.52±7.6	14.00±6.4	0.250	20.26±7.1	17.50±5.3	0.176

Group A Stoma group, Group B Orthotopic anus reconstruction group

P = 0.040, *P* = 0.034, respectively), and were statistical significance in Social functioning between group A and group B at 3, 6, and 12 months (*P* = 0.020, *P* = 0.009,

P = 0.032, respectively). It was also found that there was statistical difference between group A and group B at 12 months for fatigue (*P* = 0.045) (Table 1).

Statistical results of QLQ-CR38 questionnaire

The results of *T* test also showed that there was no statistical significance in body image between group A and group B at 3 months ($P=0.098$), but there were statistical significance at 6 and 12 months ($P=0.035$, $P=0.045$, respectively); There were statistically significant about sexual functioning between group A and group B at 6 and 12 months ($P=0.048$, $P=0.047$, respectively), but there was no statistical difference between group A and group B at 3 months ($P=0.11$); There were statistically significant for sexual enjoyment between group A and group B at 3, 6, and 12 months ($P=0.023$, $P=0.028$, $P=0.050$, and were statistically significant for defecation problem between two groups at 3, 6, and 12 months ($P=0.013$, $P=0.011$, $P=0.050$, respectively) (Table 2).

The correlation between clinical factors and overall survival of patients with colorectal carcinoma were analyzed by Kaplan–Meier

The results of Kaplan–Meier showed that the progression free survival (PFS) of group A and group B was not

statistically significant, The Median PFS was 1298 days in the patients of group A, and the Median PFS was 1464 days in the patients of group B ($\chi^2=0.189$, $P=0.664$); However, the PFS of patients with rectal carcinoma is associated with lymph node metastasis. The median PFS of patients with lymph node-positive was 1201 days, and the PFS of patients with lymph node-negative was 1735 days ($\chi^2=4.229$, $P=0.040$). The study did also not show that PFS was related to other clinical factors. And found that the overall survival (OS) of group A and group B was not statistically significant, The Median OS was 1522 days in the patients of group A, and the Median OS was 1276 days in the patients of group B ($\chi^2=0.600$, $P=0.439$); However, the OS of patients with rectal carcinoma is associated with lymph node metastasis. The median OS of patients with lymph node-positive was 1185 days, and the OS of patients with lymph node-negative was 1819 days ($\chi^2=6.333$, $P=0.012$). The study did also not show that OS was related to other clinical factors (Table 3, Figs. 2, 3).

Table 2 Statistical results of *T* test for QLQ-CR38 questionnaire

Category	3 months			6 months			12 months		
	A group (M±S)	B group (M±S)	<i>P</i>	A group (M±S)	B group (M±S)	<i>P</i>	A group (M±S)	B group (M±S)	<i>P</i>
Functional scales									
Body image	75.13±11.4	81.05±11.5	0.098	77.39±11.6	84.35±8.9	0.035	79.85±9.4	86.45±10.6	0.045
Sexual functioning	38.78±17.2	46.55±13.3	0.110	42.09±17.9	51.95±13.1	0.048	46.63±14.5	56.05±14.2	0.047
Sexual enjoyment	41.69±16.0	52.10±12.3	0.023	46.70±16.0	56.65±12.1	0.028	51.68±14.2	60.05±11.6	0.050
Future perspective	68.13±9.6	72.05±9.2	0.178	70.43±11.9	73.80±8.7	0.301	76.16±8.9	76.95±8.5	0.778
Symptom scales									
Micturition problems	21.52±8.0	19.10±7.5	0.313	24.95±8.6	20.75±7.0	0.081	23.53±6.0	20.30±6.9	0.132
Chemotherapy side-effects	21.26±8.1	18.05±4.5	0.111	22.69±7.9	19.20±4.4	0.076	20.79±8.3	19.40±5.1	0.530
Symptoms of GI tract	20.09±8.4	15.85±4.0	0.040	18.30±7.4	15.45±3.6	0.112	15.05±5.5	14.20±3.5	0.565
Male sexual problems	25.23±11.6	17.18±6.3	0.045	23.61±11.4	15.82±5.9	0.046	22.30±11.2	14.28±3.9	0.050
Female sexual problems	27.44±8.5	18.33±8.6	0.038	26.22±7.2	17.44±8.2	0.028	24.50±6.7	16.89±7.2	0.039
Defecation problems	19.26±7.4	14.60±3.8	0.013	18.56±7.4	13.85±3.6	0.011	17.26±6.9	13.65±3.4	0.050
Weight loss	18.96±7.6	15.70±4.1	0.085	17.30±7.4	14.05±3.7	0.073	13.42±6.2	12.15±3.2	0.434

Group A Stoma group, Group B Orthotopic anus reconstruction group

Table 3 Kaplan-Meier was used to analyze the correlation between clinical data and overall survival

Clinical parameters	Case	Median OS (days)	χ^2	<i>P</i>
Gender				
Male	24	1410	0.043	0.836
Female	19	1382		
Age				
<57	19	1372	0.014	0.905
≥57	24	1410		
HGB				
<110	5	1521	0.104	0.747
≥111	38	1396		
<i>N</i> %				
<70	23	1472	2.413	0.12
≥70	20	1274		
<i>L</i> %				
<20	14	1292	0.886	0.346
≥20	29	1427		
T staging				
T1–2	13	1588	2.368	0.124
T3	30	1256		
Pathology grade				
I–II	15	1443	0.258	0.611
III–IV	28	1325		
Surgical method				
A group	23	1276	0.600	0.439
B group	20	1522		
Lymphatic metastasis				
Negative	17	1819	6.333	0.012
Positive	26	1185		

Group A Stoma group, Group B Orthotopic anus reconstruction group

Discussion

Rectal carcinoma is a common malignant tumor of the digestive tract, and more common in middle and low rectal carcinoma [18]. At present, the treatment of rectal carcinoma is a combination of surgical treatment and multidisciplinary treatment, and both emphasizing tumor radical treatment and ensuring the quality of life after surgery, stoma is a common surgical procedure for low rectal cancer, but it often affects the quality of life of patients [19–21]. Compared with Miles operation, Dixon operation has less damage to human physiological structure, and the quality of life of patients is better. The EORTC QLQ-C30 questionnaire consists of 30 questions which assess the quality of life in five functional scales (functional, physical, cognitive, emotional, social) as well as 6 symptoms (nausea and vomiting, pain, dyspnoea, insomnia, loss of appetite, constipation or diarrhoea); EORTC QLQ-CR38 consists of 2 functional scales (body image, sexual functioning) and symptom scales (gastrointestinal symptoms, problems related to having a stoma and sexual symptoms). EORTC QLQ-C30 and QLQ-CR38 are two effective scales to assess the quality of life of patients with colorectal carcinoma [6, 7, 22].

In previous clinical work, most of patients with stoma complained about the impact of stoma on their quality of life. To improve this situation, and because some patients do not accept Miles operation, the surgical procedure is improved by the surgeons in this group and reconstructed the anus in situ in some patients. In this study, 23 patients underwent left lower abdominal stoma (Miles procedure), and 20 patients underwent orthotopic anus reconstruction. The quality of life of these patients was investigated by EORTC QLQ-C30 scale and QLQ-CR38 scale, and overall survival of the patients also was compared. The results of this study showed that the OS of these patients is was no statistical difference, but left lower abdominal stoma can impact on the quality of life of patients with rectal carcinoma, the quality

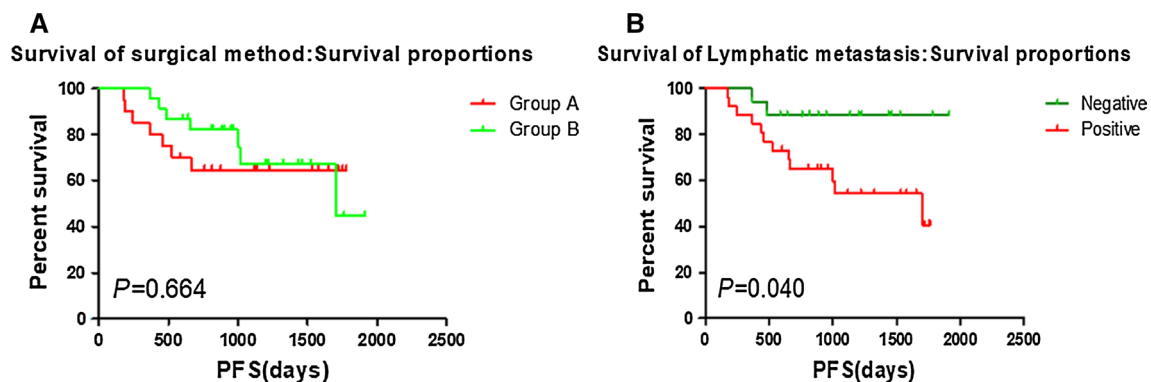


Fig. 2 Clinical factors related to PFS: **a** PFS comparison between group A and group B; **b** PFS comparison between patients with lymphatic negative and patients with lymphatic positive

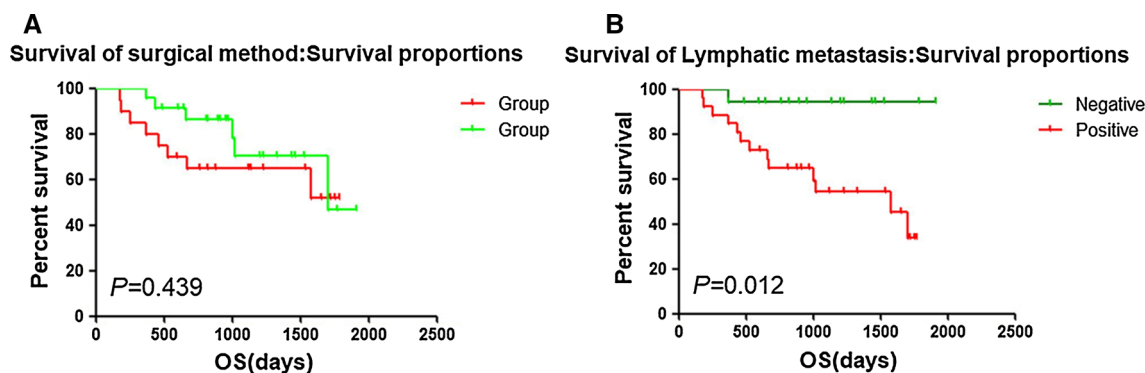


Fig. 3 Clinical factors related to OS: **a** OS comparison between group A and group B; **b** OS comparison between patients with lymphatic negative and patients with lymphatic positive

of life of patients underwent orthotopic anus reconstruction is better than the patients underwent left lower abdominal stoma. Some studies have also found that stoma has a negative impact on quality of life among patients with a stoma following surgery for colorectal carcinoma [7, 20, 23–26]. It is indeed a problem that patients with a stoma also deal with daily stoma-related practical management issues. Therefore, it is necessary to improve clinical practice and achieve better outcomes for these patients with low situated rectal carcinoma.

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Compliances with ethical standards

Conflict of interest The authors declare that they have no conflict of interest concerning this article.

Ethical approval The study was approved by the Ethics Committee of the Second Hospital of Lanzhou University, and the data were anonymously obtained and retrospectively analyzed. The clinical data of all patients were collected from the electronic medical records of the Second Hospital of Lanzhou University. This study was performed in accordance with the relevant guidelines and regulations, and conformed to the Declaration of Helsinki.

Informed consent Informed consents from participants were also waived due to the complete anonymity of the patients.

References

- Schreckenbach T, Zeller MV, El Youzouri H, et al. Identification of factors predictive of postoperative morbidity and short-term mortality in older patients after colorectal carcinoma resection: a single-center retrospective study[J]. *J Geriatr Oncol*. 2018;9:649–58.
- Simon K. Colorectal cancer development and advances in screening[J]. *Clin Interv Aging*. 2016;11:967–76.
- Guo H, Zhou X, Lu Y, et al. Translational progress on tumor biomarkers[J]. *Thorac Cancer*. 2015;6(6):665–71.
- Mouchli MA, Ouk L, Scheitel MR, et al. Colonoscopy surveillance for high risk polyps does not always prevent colorectal cancer[J]. *World J Gastroenterol*. 2018;24(8):905–16.
- Iwamoto M, Kawada K, Hida K, et al. Delayed anastomotic leakage following laparoscopic intersphincteric resection for lower rectal cancer: report of four cases and literature review[J]. *World J Surg Oncol*. 2017;15(1):143.
- Zajac O, Spychala A, Murawa D, et al. Quality of life assessment in patients with a stoma due to rectal cancer[J]. *Rep Pract Oncol Radiother*. 2008;13(3):130–4.
- Elfeki H, Thyo A, Nepogodiev D, et al. Patient and healthcare professional perceptions of colostomy-related problems and their impact on quality of life following rectal cancer surgery[J]. *BJS Open*. 2018;2(5):336–44.
- Jo S, Choi Y, Park SK, et al. Efficacy of dose-escalated radiotherapy for recurrent colorectal cancer[J]. *Ann Coloproctol*. 2016;32(2):66–72.
- Methy N, Bedenne L, Bonnetain F. Surrogate endpoints for overall survival in digestive oncology trials: which candidates? A questionnaires survey among clinicians and methodologists[J]. *BMC Cancer*. 2010;10:277.
- Du P, Xu B, Zhang D, et al. Hierarchical investigating the predictive value of p53, COX2, EGFR, nm23 in the post-operative patients with colorectal carcinoma[J]. *Oncotarget*. 2017;8(1):954–66.
- Kim JW. The quality of life after rectal cancer surgery[J]. *Korean J Gastroenterol*. 2006;47(4):295–9.
- Souza J, Nahas CSR, Nahas SC, et al. Health-related quality of life assessment in patients with rectal cancer treated with curative intent[J]. *Arq Gastroenterol*. 2018;55(2):154–9.
- Aaronson NK, Ahmedzai S, Bergman B, et al. The European Organization for Research and Treatment of Cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology[J]. *J Natl Cancer Inst*. 1993;85(5):365–76.
- Sprangers MA, te Velde A, Aaronson NK. The construction and testing of the EORTC colorectal cancer-specific quality of life questionnaire module (QLQ-CR14). European Organization for Research and Treatment of Cancer Study Group on Quality of Life[J]. *Eur J Cancer*. 1999;35(2):238–47.
- Lin JK, Tan EC, Yang MC. Comparing the effectiveness of capecitabine versus 5-fluorouracil/leucovorin therapy for elderly Taiwanese stage III colorectal cancer patients based on quality-of-life measures (QLQ-C30 and QLQ-CR1) and a new cost assessment tool[J]. *Health Qual Life Outcomes*. 2015;13:61.

16. World Medical A. World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects[J]. *Bull World Health Organ*. 2001;79(4):373–4.
17. Kopp I, Bauhofer A, Koller M. Understanding quality of life in patients with colorectal cancer: comparison of data from a randomised controlled trial, a population based cohort study and the norm reference population[J]. *Inflamm Res*. 2004;53(Suppl 2):S130–5.
18. The World Cancer. Report—the major findings[J]. *Cent. Eur J Public Health*. 2003;11(3):177–9.
19. Reinwalds M, Blixter A, Carlsson E. A descriptive, qualitative study to assess patient experiences following stoma reversal after rectal cancer surgery[J]. *Ostomy Wound Manag*. 2017;63(12):29–37.
20. Nasvall P, Dahlstrand U, Lowenmark T, et al. Quality of life in patients with a permanent stoma after rectal cancer surgery[J]. *Qual Life Res*. 2017;26(1):55–64.
21. Herrle F, Sandra-Petrescu F, Weiss C, et al. Quality of life and timing of stoma closure in patients with rectal cancer undergoing low anterior resection with diverting stoma: a multicenter longitudinal observational study[J]. *Dis Colon Rectum*. 2016;59(4):281–90.
22. Segalla JG, Van Eyll B, Federico MH, et al. Evaluation of quality of life in patients with metastatic colorectal cancer treated with capecitabine[J]. *Clin Colorectal Cancer*. 2008;7(2):126–33.
23. Pachler J, Wille-Jorgensen P. Quality of life after rectal resection for cancer, with or without permanent colostomy[J]. *Cochrane Database Syst Rev*. 2012;12:CD004323.
24. Neuman HB, Park J, Fuzesi S, et al. Rectal cancer patients' quality of life with a temporary stoma: shifting perspectives[J]. *Dis Colon Rectum*. 2012;55(11):1117–24.
25. Cakmak A, Aylaz G, Kuzu MA. Permanent stoma not only affects patients' quality of life but also that of their spouses[J]. *World J Surg*. 2010;34(12):2872–6.
26. Sideris L, Zenasni F, Vernerey D, et al. Quality of life of patients operated on for low rectal cancer: impact of the type of surgery and patients' characteristics[J]. *Dis Colon Rectum*. 2005;48(12):2180–91.

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