The Impact of Complications on Short-Term Outcomes of Pelvic Peritoneum Reconstruction with Barbed Suture in Laparoscopic Rectal Resection for Rectal Cancer

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Abstract

Objective: This study aimed to evaluate the safety and short-term outcomes of pelvic peritoneum reconstruction with barbed sutures in laparoscopic rectal resection for rectal cancer.

Methods: This is a retrospective cohort study conducted in Chengdu second's people hospital. The clinicopathological data of 402 patients with rectal cancer admitted to our department hospital from January to December 2019 were collected. There was total of 402 patients, including 218 males and 174 females, with an average age of 68 years. Among them, 216 patients who underwent laparoscopic rectal resection with pelvic peritoneum reconstruction (PPR) were allocated into the PPR group, and 186 patients who underwent conventional laparoscopic rectal resection were allocated into a non-PPR group. All the patients received standard preoperative and postoperative treatments. Observational indicators (1) surgical and postoperative conditions; (2) postoperative pathological examination. (3) postoperative complications.

Results (1) Surgery condition: all patients in the two groups underwent successful surgery without conversion to open surgery. There were no differences between the two groups in terms of surgical approach, resection margin, tumor size, postoperative T-stage, postoperative N-stage, positive lymph nodes, harvest lymph nodes, perineal wound infection, perineal hernia, postoperative pneumonia, postoperative hemorrhage, presacral fluid, or abscess. The operative time, blood loss, the incidence of anastomotic leakage, and small-bowel obstruction showed a significant difference between the two groups.

Conclusion pelvic peritoneum reconstruction with barbed suture in laparoscopic rectal resection is safe and feasible for the treatment of rectal cancer, which can significantly reduce postoperative perineal-related complications.

Introduction

Rectal cancer is the most common malignant tumor of the digestive system [1]. Laparoscopic surgery has been applied to increasingly diseases with the development of laparoscopic surgery technology, which has been fully recognized from the perspective of surgical safety and radical cure of tumor. The incidence rate of low and middle rectal cancer is higher in China. To ensure the negative circumferential margin and minimize the local recurrence rate, Holm[2] proposed the extralevator abdominoperineal excision (ELAPE) for improving the prognosis of patients with T3 and T4 stage rectal cancer. However, laparoscopic surgery or open surgery in patients with rectal cancer after total mesorectal excision leaves a huge gap in the pelvic cavity. When the residual pelvic floor peritoneum is not suture, the small intestine will inevitably fall into the pelvic floor, causing the small intestine adhesion and increased the risk of intestinal obstruction [3]. Meanwhile, with increased intra-abdominal pressure and abdominal contents falling into the pelvic cavity, pelvic floor peritoneal hernia and delayed pelvic floor peritoneal healing will occur [4].

At present, most of the literatures reports three methods of closing the pelvic floor peritoneum, including biological patch repair, autologous tissue tamponade transplantation, and continuous suture. Laparoscopic continuous closure of the peritoneum is a separation and isolation technique. Suture closure of pelvic peritoneum reconstruction (PPR) has been proved to reduce postoperative intestinal obstruction, pelvic peritoneum hernia, and pelvic peritoneum healing-related complications [5]. In particular, neoadjuvant radiotherapy and chemotherapy can increase the fibrosis of the peritoneum, leading to increased difficulty in suture closure. However, effectively closing the pelvic floor peritoneum under laparoscopy has become a complex problem [6].

Materials And Methods

General information

Methods: The clinical data of 402 patients with rectal cancer who underwent laparoscopic radical resection from January 1, 2014, to December 31, 2019, were retrospectively analyzed. The patients were divided into two groups according to the pelvic floor peritoneum treatment methods: closed pelvic floor peritoneum (N = 216) group and without closed pelvic floor peritoneum (N = 186) group.

Inclusion criteria: Patients aged 18–75 years, diagnosed as rectal adenocarcinoma by preoperative pathological biopsy, ASA $\leq$ 3, no history of intestinal obstruction, gastrointestinal bleeding, etc. Before the operation, patients and corresponding family members fully understood and signed the informed consent form.

Exclusion criteria: Patients with benign rectal lesions who need emergency surgery, preoperative MRI, and CT found tumor invasion of surrounding tissues and organs, combined with diseases that seriously affect wound healing (liver cirrhosis, diabetes, autoimmune diseases, etc.). This study was approved by the ethics committee of our hospital (No.2021073) and informed consent of patients and their authorized family members. The general data of the two groups of patients were comparable.

Operation methods

All patients underwent laparoscopic radical resection of rectal cancer according to the total mesorectal excision (TME) principle. The operation was performed by the same group of surgeons using the 5-hole method. In the study group, after laparoscopic radical resection of rectal cancer, 3 – 0 unidirectional barbed thread (20cm long, with a small round hole at the end) was used to close the pelvic floor peritoneum in a "U" shape. Suture from the right peritoneum to the seromuscular layer on the right side of colon. After the first suture, thread the needle tip through the small hole at the end of the suture and tighten it. Suture continuously to the direction of cystorectal depression or uterorctal depression, keeping the needle distance < 1cm and the needle edge 0.5cm. Part of the right peritoneum is sutured to the mesentery or intestinal fat sag. Pay attention not to damage the mesenteric vessels. Then, the anterior wall of the colon was sutured at the site of peritoneal refolding, and the anastomotic stoma was placed below the peritoneal refolding. Finally, the left peritoneum of the colon was sutured to the seromuscular

layer of colon. After suturing, the end of the suture was fixed with an absorbable clip. Ensure that the posterior wall of the colon adheres to the posterior abdominal wall and sacral front after suturing, and there is no gap between the needle distances. An absorbable suture can be used for additional suturing (Figs. 1 and 2).

Observation index

(1) Operation and postoperative conditions (2) postoperative pathology (3) postoperative complications: according to the clinical symptoms of patients, once atypical or typical symptoms related to anastomotic leakage are found, transanal abdominal CT angiography was performed as soon as possible to judge whether there is effusion around the anastomotic leakage, anastomotic leakage, and the location and severity of anastomotic leakage. According to Clavien-Dindo grading standard [7], based on the severity of anastomotic leakage, the corresponding treatment was carried out, ⅰ: only small fistula observed on oral contrast study or drainage imaging; ⅱ: Medical management or enteral/intravenous nutrition indicated; ⅲa: Imaging-guided drain placement/paracentesis, including wound opening or drain replacement indicated; ⅲb: Intervention under general anesthesia indicated (suture, re-anastomosis, bypass, drainage, colostomy); ⅳa: At least one organ failure; ⅳb: sepsis or multiple organ failure; ⅴ: Death. Perineal incision infection according to the Southampton wound score system, score $\geq$ IV was considered as complex perineal incision healing [8]. Pelvic floor peritoneal hernia (PH) is defined as the abdominal contents falling into the lower edge of the cauda and pubic symphysis on sagittal CT [9]. Pelvic floor peritoneal hernia is divided into symptomatic and asymptomatic. We observed the operation time, intraoperative blood loss, pulmonary infection, postoperative intestinal obstruction, Clavien-Dindo grading standard [7] of the two groups. The causes of postoperative intestinal obstruction were adhesion, tumor metastasis and recurrence, and fistula-related causes.

Follow-up after the operation

Follow-up was started 2 weeks after discharge. Follow-up was conducted once every 1 month. The patients were followed up by hospitalization, outpatient follow-up, and telephone follow-up. The incidence of intestinal obstruction and regular abdominal CT after operation were recorded. The follow-up deadline is February 31, 2020.

Statistical analysis

Spss19.0 software was used for statistical analysis. The data were represented by $\bar{X} \pm s$. t-test and χ^2 test were used for counting data. $P < 0.05$ was considered statistically significant.

Result:

Baseline Characteristics. There were 118 males (54.6%) and 98 females (45.4%) in PPR group, 110 males (59.1%) and 76 females (40.9%) in non-PPR group, 68.34 ± 10.93 vs 69.06 ± 10.51 in age PPR group, 22.8 ± 2.94 vs 22.87 ± 3.68 in BMI PPR group, 21 (9.7%) in upper rectum, 87 (40.3%) in middle rectum and 108 (50%) in lower rectum in PPR group. In the non-PPR group, the upper rectum was 26 (14%), the middle

rectum was 71 (38.2%), and the lower rectum was 89 (47.8%). There was no significant difference in the above data ($P > 0.05$).

Operation. All operations were completed in both groups without conversion to laparotomy. There was no significant difference between laparoscopic operation and radical resection. The operation time (PPR group 221.17 ± 59.56 , non-PPR group 194.76 ± 46.21 , $P < 0.05$) and blood loss (PPR group 91.89 ± 59.15 , non-PPR group 128.33 ± 80.61 , $P < 0.05$) were significantly different, as shown in Table 2.

Table 1
clinicopathological details and surgical results of rectal cancer

Baseline Characteristics	PPR	Non-PPR	P Value	
	216	186		
Sex			$\chi^2 = 0.363$	0.209
Male	118(54.6)	110(59.1)		
Female	98(45.4)	76(40.9)		
Age	68.34 ± 10.93	69.06 ± 10.51	$t = 0.672$	0.712
BMI	22.8 ± 2.94	22.87 ± 3.68	$t = 0.175$	0.862
Diabetes			$\chi^2 = 2.17$	0.171
yes	29	35		
no	187	151		
Smoke			$\chi^2 = 0.025$	0.899
yes	42	35		
no	174	151		
ASA			$\chi^2 = 1.44$	0.486
I	2	3		
II	194	160		
III	20	23		
Tumor location			$\chi^2 = 0.416$	0.35
Upper	21(9.7)	26(14.0)		
middle	87(40.3)	71(38.2)		
lower	108(50)	89(47.8)		

Table 2
surgical condition

	PPR	Non-PPR	P Value
Operative time	221.17 ± 59.56	194.76 ± 46.21	0.008
Blood loss in ml	91.89 ± 59.15	128.33 ± 80.61	0.001
Resection margin		$\chi^2 = 0.416$	0.258
R0	215(99.5)	183(98.4)	
R1	1(0.5)	3(1.6)	
Approach		$\chi^2 = 0.842$	0.49
DIXON	195(90.3)	169(90.8)	
ELAPE	21(9.7)	17(9.2)	

Table 3
different location rectal cancer Characteristics

Upper	PPR	Non-PPR	P Value
Operative time	207.16 ± 60.11	192.13 ± 46.77	0.397
Blood loss in ml	91.71 ± 63.60	121.68 ± 75.66	0.018
Tumor size(cm)	4.10 ± 1.17	4.65 ± 1.51	0.103
Middle	PPR	Non-PPR	P Value
Operative time	212.01 ± 45.22	192.35 ± 47.19	0.803
Blood loss in ml	80.15 ± 45.14	136.50 ± 87.05	0
Tumor size(cm)	4.30 ± 1.35	4.48 ± 1.26	0.896
Lower	PPR	Non-PPR	P Value
Operative time	246.90 ± 61.52	211.38 ± 41.32	0.04
Blood loss in ml	103.68 ± 64.13	152.38 ± 94.02	0.005
Tumor size(cm)	4.16 ± 1.18	4.26 ± 0.89	0.45

Table 4
pathological data

Tumor size(cm)	4.19 ± 1.23	4.19 ± 1.23	0.061
T stage			$\chi^2 = 0.343$ 0.29
early(T1)	5(2.3)	2(1.1)	
advanced(T2-T3-T4)	211(97.7)	184(98.9)	
N stage			$\chi^2 = 0.144$ 0.052
N0	138(63.9)	105(56.5)	
N1	69(31.9)	65(34.9)	
N2	9(4.2)	16(8.6)	
TNM			$\chi^2 = 4.788$ 0.091
I	7	3	
II	173	137	
III	36	46	
Positive lymph nodes	0.69 ± 1.49	0.887 ± 1.86	0.207
Harvest lymph nodes	13.91 ± 2.94	13.86 ± 2.95	0.875
Postoperative Chemotherapy			$\chi^2 = 2.101$ 0.19
yes	189	171	
no	27	15	

There was no significant difference in operation time between the upper and middle rectum, but operation time between the lower rectum showed a statistical difference ($P < 0.05$).

Postoperative pathology

There was no significant difference in tumor diameter, postoperative T stage, N stage, postoperative TNM stage, positive lymph node surgery, the total number of lymph nodes, and postoperative chemotherapy between the two groups ($P > 0.05$).

Postoperative complications

Table 5 shows the postoperative complications. There were significant differences in anastomotic leakage and intestinal obstruction ($P < 0.05$). According to Clavien-Dindo classification, 13 cases (6%) had anastomotic leakage in PPR group, one was grade III anastomotic leakage and underwent sigmoidostomy. Six cases (3.2%) had anastomotic leakage in the non-PPR group, including 3 cases of

grade II anastomotic leakage and 3 cases of grade III anastomotic leakage. Among the 3 cases, 1 case underwent a transverse colostomy, and 2 cases underwent sigmoidostomy. Postoperative intestinal obstruction (9 (4.2%) in the PPR group and 18 (9.6%) in the non-PPR group) occurred. One patient in the non-PPR group underwent reoperation, and adhesion between the terminal ileum and pelvic floor was found during the operation. There was no significant difference in perineal incision infection rate, pelvic floor hernia, pulmonary infection, presacral effusion or infection, and postoperative bleeding (Table 5).

Table 5
postoperative complications

	PPR	Non-PPR	P Value
Anastomotic leakage	13(6)	6(3.2)	0.008
Reoperation	1(7.6)	3(50)	0.016
Perineal wound infection	2(0.9)	3(1.6)	0.319
Perineal hernia	0	1(0.5)	0.319
Small-bowel obstruction	9(4.2)	18(9.6)	0.002
Reoperation	0	1(5.6)	0.319
postoperative pneumonia	5(2.3)	6(3.2)	0.319
postoperative hemorrhage	3(1.38)	5(0.054)	0.158
Presacral fluid or abscess	1(0.046)	5(2.69)	0.054

Postoperative follow-up

The follow-up rate was 94.5% (22 / 380). There were 42 deaths in the PPR group and 45 deaths in the non-PPR group. The cumulative survival curve is shown in Fig. 3.

Discussion

The incidence rate of rectal cancer is high. The most common cases are middle and low rectal cancer. The early symptoms are mostly atypical. For patients with middle and low rectal cancer, laparoscopic radical resection is more frequently used, especially for low rectal cancer (distance from anus less than 5cm), ELAPE operation is adopted. After the surgery, peritoneal pelvic hernia, intestinal obstruction, perineal incision infection, and other complications may occur. Although laparoscopic surgery can reduce the infection of the abdominal incision, the perineum is associated with postoperative complications. The disease still faces a significant challenge [10].

TME operation, especially the side lymph node operation can damage the pelvic floor structure, large perineum incision, suture under high tension, neoadjuvant radiotherapy and chemotherapy, and pelvic cavity residuals[11, 12]. At present, the pelvic floor peritoneal reconstruction is divided into isolation

technology and filling technology. Previous reports showed that biological patches could be used to strengthen the peritoneum structure of the pelvic floor[13]. However, it increased the cost of operation, and the probability of infection and internal hernia may occur in the patch. Therefore, it also limits the clinical use of the patch. There are also reports that omental plasty is often used to eliminate the invalid cavity of the pelvic cavity after operation. However, it cannot improve the healing of the perineal incision and increase the incidence of pelvic floor peritoneal hernia [14].

Laparoscopic pelvic floor peritoneal reconstruction is challenging. Improper pelvic floor peritoneal sutures may lead to residual suture space, improving the risk of postoperative internal hernia. Wang[15] reconstructs the pelvic floor peritoneum with a Hem-o-lok clip; however, it still has the risk of intestinal obstruction due to the small intestine herniation. The results showed no significant difference between the patients in PPR group and non-PPR group, but the obstruction of the PPR group was significantly lower than non-PPR group. One patient in the non-PPR group was ineffective after conservative treatment due to mechanical intestinal obstruction. After an operation, the end of the operation was found, ileum fell into the right pelvic floor and formed adhesion with the pelvic floor. The reconstruction of the pelvic floor peritoneum and the restoration of the continuity of the pelvic floor peritoneum can effectively prevent the intestinal obstruction caused by the adhesion of the pelvic floor tissue due to the intestinal tract decline. The fibrosis of pelvic floor tissue after neoadjuvant radiotherapy and chemotherapy was prominent [5]. There was no extra peritoneum in reconstructing the pelvic floor peritoneum, leading to continuous suture and reconstruction of the peritoneum. Shen et al. proposed that the free bladder back wall flap supplement the pelvic floor isolation technique[16]. We found statistical differences in the operation time between the two groups, but the stratified analysis of the two groups found no difference in the operation time of the upper and middle rectal cancer. However, there was a statistical difference in the time of low rectal cancer, which was related to the size of the tumor and the tumor location. However, we found that the prolonged operation time did not increase the postoperative pulmonary infection and other perioperative complications.

The incidence of anastomotic leakage was statistically different between the two groups. The reason of leakage was related to the tumor site. There were more patients with middle and low rectal in the group of closing the pelvic floor peritoneum. However, the reoperation rate of patients in PPR group was significantly lower than non-PPR group, and the reoperation rate was statistically significant. Therefore, we believe that reconstruction of the pelvic floor peritoneum can effectively seal the dead cavity of the pelvic floor. Even if the anastomotic leakage occurs, the contaminated liquid will not pollute the whole abdominal cavity and even cause severe abdominal infection, even infectious shock. Meanwhile, if the abdominal cavity drainage is smooth, most patients can be cured by conservative treatment, and the hospitalization time is not increased significantly. There was one case of presacral effusion in PPR group, 5 cases in the non-PPR group, but there was no statistical significance between the two groups. However, presacral effusion may cause presacral infection and lead to the laceration of incision of the pubic part and the risk of delayed healing. The reconstruction of the pelvic floor peritoneum can isolate the dead cavity of the pelvic floor, limit the further expansion of the effusion. Moreover, drainage through the perineum incision can also reduce the presacral effusion to the greatest extent.

Pelvic floor peritoneal hernia is a rare and complex complication after elape. The incidence of perineal hernia after laparoscopic radical resection of rectal cancer is 2.15% – 13%[17]. Surgery is only treatment option for a symptomatic perineal hernia. However, the recurrence rate of perineal hernia is still high after operation repair. It has been reported that the recurrence rate of perineal hernia is more than 50%[18]. Therefore, the prevention of peritoneal pelvic hernia is particularly important in elape. The results showed no pelvic floor hernia in the PPR group, while one case in the non-PPR group had a postoperative pelvic floor hernia. This patient had anorectal distension and was cleared by abdominal CT, but no operation was performed, there was no statistical difference between the two groups. Most of the pelvic floor peritoneal hernia has no clinical symptoms and has delayed characteristics. Only a short-term effect is observed in this study and the follow-up time is short; thus the long-term incidence of pelvic floor peritoneal hernia may be different [17]. Therefore, we believed that the reconstruction of the pelvic floor peritoneum could prevent the postoperative pelvic floor peritoneal hernia.

The open position of the pelvic peritoneum is close to the mesentery when laparoscopic operation, aiming to keep as much peritoneum as possible to facilitate the closure of the pelvic floor peritoneum. However, there is still a high tension in the peritoneum of the pelvic floor, leading to suture cracking or secondary hernia. The needle angle needs to be adjusted several times to meet the master knife and assistant proficiency requirements. The barb thread is embedded in the suture due to tiny barbs on the suture. The surrounding tissue can form self-fixation without knots, and it is easy to operate and save time. It has the following advantages: (1). It is a rapid and simple pelvic floor peritoneal reconstruction method, which is cheaper than patch repair. (2). The reinforcement of the perineal incision can reduce the incidence of perineal hernia. (3). It can prevent intestinal adhesion and obstruction caused by intestinal tract slide. 4. It can reduce drainage between the pelvis and the abdomen to reduce infection risk in abdominal and perineal incisions.

Conclusion

It is a feasible and safe method to reconstruct the pelvic floor peritoneum by continuous suture with a barb line under a laparoscope, which can effectively reduce pelvic peritoneal complications after elape. However, this study is a retrospective study, and its safety and feasibility need to be verified by a larger prospective research.

Abbreviations

PPR

pelvic peritoneum reconstruction

TME

total mesorectal excision

ELAPE

extralevator abdominoperineal excision

PH

peritoneal hernia

Declarations

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Author contribution

Jing Wen: study concept or design, data collection, data analysis or interpretation, writing the paper.

Qiushi Huang: data collection, data analysis or interpretation, writing the paper.

Jian Shen: study concept or design, data collection, data analysis or interpretation, writing the paper.

Shen He: data collection, data analysis, or interpretation.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was based on the information gathered from the database of Chengdu Second People's Hospital. The establishment of this database was approved by the Research Ethics Committee of the hospital. Informed consent individual patients were waived because of the retrospective nature of the analysis.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

Figure 1

reconstruction of preperitoneal pelvic floor

Figure 2

reconstruction of retroperitoneal pelvic floor

Figure 3

the Kaplan Meier curve of the PPR and non-PPR groups showed no obvious abnormality, with $\chi^2 = 2.493$, $P < 0.05$. There was no significant difference in the survival rate between the two groups.