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Research Article

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Preliminary study and short-term effect analysis of laparoscopic radical resection of rectal cancer with pre-transection of sigmoid colon in overweight/obese patients

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Abstract

Background Overweight/obesity narrows the pelvic space, increasing the difficulty of laparoscopic rectal cancer surgery. This study compared the clinical efficacy of sigmoid colon pre-transection versus conventional laparoscopic radical resection in overweight/obese patients to identify a safer and more efficient surgical approach.

Methods The clinical data of 91 overweight/obese patients in our department who underwent laparoscopic radical resection of rectal cancer from May 2021 to September 2023 were retrospectively analyzed. Patients were divided into the pre-transection group (laparoscopic radical resection of rectal cancer with pre-transection of sigmoid colon) and the traditional group (laparoscopic radical resection of rectal cancer). Differences in operative time, amount of bleeding during the operation, number of lymph node dissections, intestinal exhaust time, time to take fluids, drainage tube removal time, catheter removal time, postoperative hospital stay, surgical complications, and survival time were compared between the two groups.

Results Total operative duration [(136.88±35.91 vs. 151.14±26.00 min, $p = 0.038$)] was better in the pre-transection group than in the traditional group. There were no significant differences in the amount of bleeding, the intestinal exhaust time, time to take food, catheter removal time, drainage tube removal time, number of lymph node dissections, surgical complications, postoperative hospital stay, and survival time ($p > 0.05$).

Conclusion Compared with laparoscopic radical resection of rectal cancer, "sigmoid pre-transection" laparoscopic radical resection of rectal cancer has a better visual field, shorter operation time, and is safe, feasible, and particularly attractive when pelvic exposure is compromised by adiposity or other factors.

Key words Rectal cancer; Sigmoid colon; Radical resection of rectal cancer; Laparoscopes

Introduction

As one of the most common malignant tumors of the digestive tract, the incidence and mortality of colorectal cancer have been increasing annually. In 2022, colorectal cancer jumped to third place

in the world and in patients regardless of gender, and the mortality rate of colorectal cancer also ranked third worldwide [1]. According to the 2022 annual report of the Chinese Colorectal Cancer Surgery Registry Database, there were more than 590,000 new cases and approximately 310,000 deaths of colorectal cancer. The incidence and mortality of colorectal cancer ranked second and fourth, respectively, among all malignant tumors. Recent research indicates a correlation between obesity and an elevated risk of colorectal cancer. Specifically, a 1 cm increase in waist circumference correlates with a 2% - 3% rise in colorectal cancer risk. Current data reveal that rectal cancer surgeries constitute 57.6% of all colorectal cancer surgeries, with surgeries for middle and low rectal cancer comprising over 85% of rectal cancer surgeries [2-5]. Presently, total mesorectal excision (TME) is recognized as the standard surgical intervention for rectal cancer in clinical settings [6].

Hypertrophic mesenteric adipose tissue in overweight/obese patients further restricts the originally limited pelvic space, increasing the difficulty of surgery [7]. The visual field in pelvic surgery, operation time, and incidence of complications in overweight/obese patients have not been effectively improved. This study statistically analyzed 91 overweight/obese patients with colorectal cancer admitted to our hospital from May 2021 to September 2023 and compared the short-term clinical efficacy of laparoscopic radical resection of colorectal cancer and "pre-transection of sigmoid colon" laparoscopic radical resection of colorectal cancer. The results are reported as follows.

Materials and Methods

General information

From May 2021 to September 2023, 91 patients diagnosed with rectal cancer who underwent surgery at our hospital were retrospectively analyzed. According to the surgical method, the patients were divided into the pre-transection group (laparoscopic radical resection of rectal cancer with sigmoid colon pre-transection, $n = 40$) and the traditional group (traditional laparoscopic radical resection of rectal cancer, $n = 51$). In the pre-transection group, there were 26 males (65%) and 14 females (35%), with an actual age range of (43 - 77) years and an average age of (61.40 ± 8.23) years. In the traditional group, there were 33 males (64.7%) and 18 females (35.3%). The actual age range was (40 - 80) years, with an average age of (61.25 ± 8.52) years.

Inclusion criteria

1. Primary rectal adenocarcinoma diagnosed by clinical pathology, with a distance from the anal verge of (5 - 15) cm; 2. The clinical stage was T1-T2 and T3 (preoperative concurrent chemoradiotherapy), according to the Chinese Guidelines for Diagnosis and Treatment of Colorectal Cancer (2021 edition); 3. Age 40 - 80 years old; 4. All patients and their family members signed the informed consent before surgery. All patients' BMI ≥ 24; exclusion criteria: 1. The distance between the lower edge of the tumor and the anal verge was less than 5 cm; (2) patients with intestinal obstruction or perforation undergoing emergency surgery; 3. Patients with T4 stage before operation and distant organ metastasis during operation; 4. Those who were lost to follow-up or had incomplete data were excluded. There were no significant differences in the preoperative general data between the two groups ($p > 0.05$). Table 1

Study group

Patients in the pre-transection group underwent laparoscopic radical resection of rectal cancer with pre-transection sigmoid colon.

Specific surgical procedures of sigmoid colon pre-transection: (1) First, the right posterior peritoneum was opened along the surface of the iliac vessels and abdominal aorta to enter Toldt's space, and the root tissue of the inferior mesenteric artery was dissociated in an upward direction. Group 253 lymph nodes were dissected, the superior rectal artery was ligated and transected, and the left colonic artery was routinely preserved. (2) The left posterior peritoneum of the root of the sigmoid colon was cut up to the splenic flexure and down to the rectovesical pouch or rectouterine pouch, and Toldt's space was fully freed and expanded to penetrate the posterior space of the sigmoid colon while protecting the ureter and inferior celiac nerve plexus. The upper margin was determined at a distance of ≥ 10 cm from the upper edge of the tumor. The mesentery of the sigmoid colon was stripped free along the level of the pre-tangent line to the colon wall, and the sigmoid colon was closed and cut off along the pre-tangent line with a linear stapler (60 mm) to check for bleeding at the broken end of the colon and treat it in time. (3) The assistant's left hand grasping forceps lifted the distal intestinal canal up and out of the colon stump, and the right hand grasping forceps pulled the lateral and posterior wall of the rectum so that the space around the rectum became more simple and clear (Figs. 1).

Control group

Patients in the traditional group received standard laparoscopic radical resection of rectal cancer.

Outcome measures and evaluation criteria

Outcome measures

1. Clinical indicators included operation time, intraoperative blood loss, postoperative exhaustion time, number of lymph node dissections, time of first liquid diet, abdominal drainage tube removal time, catheter removal time, hospital stay, and surgical status of the patients, which were evaluated based on statistical results.

2. Complications included pulmonary infection, intra-abdominal infection, defecation disorder, urination disorder, incision infection, sexual dysfunction, intestinal obstruction, postoperative bleeding, anastomotic stenosis, anastomotic leakage, and chylous fistula. Defecation disorder is characterized by a decreased desire to defecate, increased frequency of defecation, and fecal incontinence after rectal cancer surgery due to partial or total resection of the rectum or damage to the pelvic floor nerve and anal sphincter that innervate the anal sphincter. Voiding dysfunction: This is a postoperative urinary dysfunction caused by damage to the pelvic floor nerve that innervates the bladder sphincter during surgery for rectal cancer.

3. Prognostic status, including the survival status of the patients.

Evaluation criteria

The clinical stage and tumor classification were based on the 8th edition of the American Joint Committeee on Cancer criteria. The evaluation criterion for incision infection, intra-abdominal infection and pulmonary infection. Intra-abdominal infection: fever (≥ 38 ℃), abdominal pain or

peritoneal irritation signs with elevated inflammatory markers (WBC, CRP, PCT), and evidence of abscess, anastomotic leakage or fluid collection confirmed by ultrasonography or CT, or purulent drainage confirmed by culture. Incisional infection: purulent discharge, local redness, swelling, or wound dehiscence at the incision site combined with positive bacterial culture within 30 days after surgery. Pulmonary infection: new-onset cough, purulent sputum or dyspnea with fever (≥ 38 °C) and/or leukocytosis, plus a new infiltrate on chest radiograph or chest CT, with or without a positive sputum culture.

Statistical analysis

SPSS 26.0 software was used for analysis and processing. Measurement data were expressed as mean ± standard deviation (x±s), and the t-test was used to compare the two groups. Count data were expressed as, and the $\chi 2$ or Fisher's exact test was used to compare the two groups. If there were significant differences between groups, $p < 0.05$ was used. Kaplan-Meier curves and the log-rank test were used to compare the survival rates between the two groups.

Results

Surgical and postoperative conditions

The operation time and intraoperative blood loss in the sigmoid colon pre-transection group were significantly better than those in the traditional group ($p < 0.05$). There were no significant differences in postoperative exhaust time, number of lymph nodes dissected, time of first liquid diet, time of drainage tube removal, time of urinary catheter removal, and length of hospital stay between the two groups ($p > 0.05$).

There were 11 cases (21.6%) of postoperative complications in the traditional group, including 2 cases of postoperative anastomotic leakage, 1 case of incision infection, 1 case of pulmonary infection,1 case of intra-abdominal infection, 1 case of chylous leakage, 2 cases of postoperative bleeding, 1 case of anastomotic stenosis and 2 cases of intestinal obstruction, all of which were improved after conservative treatment. There were 6 cases (15.0%) of postoperative complications in the pre-transection group, including 1 case of incision infection, 1 case of intra-abdominal infection, 1 case of postoperative bleeding, 1 case of anastomotic leakage, 1 case of anastomotic stenosis and 1 cases of intestinal obstruction, which were improved and discharged after conservative treatment. There was no significant difference in the incidence of postoperative complications between the two groups ($p > 0.05$). See Table 2. The two groups were followed up for 6 - 36 months. Three patients in the traditional group were lost to follow-up, and one patient in the pre-transection group was lost to follow-up. There was no significant difference in overall survival time between the two groups (log-rank $p = 0.452$) ($p > 0.05$) (Figs. 2).

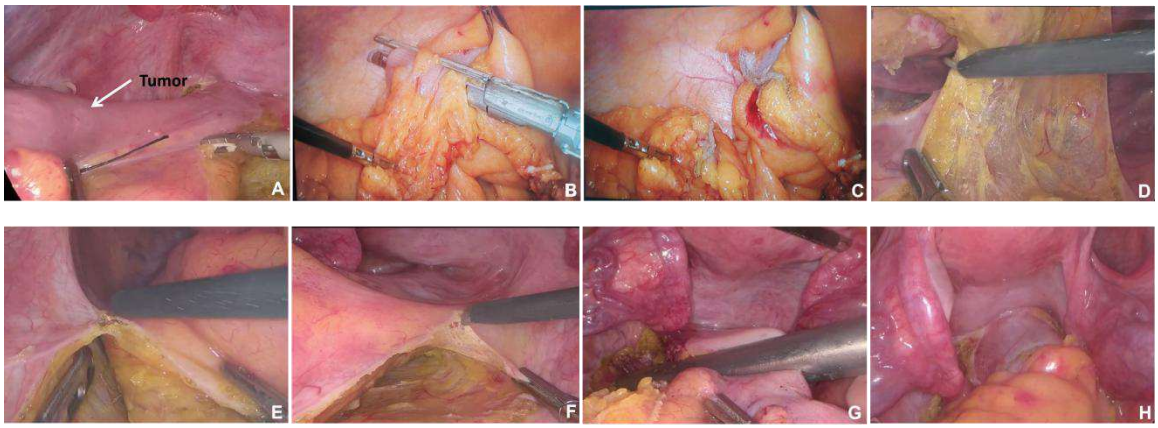

Fig. 1 The represntative images of laparoscopic radical resection of rectal cancer with "pre-transection of the sigmoid colon". **A.**The tumor was located in the upper part of the rectum. **B.**The sigmoid colon was transected≥5cm from the upper margin of the tumor. **C.**The distal rectum was lifted after transection of the colon. **D.**The rectum was pulled to expand the retrorectal space. **E.**The left rectal space was dissected. **F.**The right rectal space was dissected. **G.**The distal rectum was transected. **H.**End to end anastomosis of the sigmoid colon and rectum.

Table 1 Comparison of General Information of the two groups of patients

		Traditional group (n = 51)	Pre-transection group (n = 40)	t/χ^2 *value*	*p value*
Sex	Male	33	26	0.212	0.645
	Female	18	14		
Age（years）		61.25±8.52	61.40±8.23	-0.082	0.935
BMI(kg/m^2)		26.63±1.80	27.26±2.27	-0.148	0.142
TNM stage	I	6	5	-	0.591
	II	27	25		
	III	18	10		
Hypertension		12	10	0.026	0.871
diabetes mellitus		13	9	0.109	0.741
Preoperative hypoproteinemia		8	6	0.008	0.928
History of abdominal operation		7	6	0.030	0.863
ASA score (≤ II)		30	25	0.127	0.722
ASA score (> II)		21	15		
Neoadjuvant chemoradiotherapy		3	4	0.186	0.666
Tumour location/cm (0-5)	lower	7	10	-	0.226
Tumour location/cm (5-10)	middle	30	24		
Tumour location/cm (10 -	higher	14	6		

Table 2 Comparison of various perioperative indicators between two groups of patients with different surgical methods (x±s)

Perioperative indicators	Traditional group (*n* = 51)	Pre-transection group (*n* = 40)	t/χ^2 *value*	*p value*
Operative time/min	151.14±26.00	136.88±35.91	2.115	0.038
Amount of bleeding during the operation/ml	77.17±12.18	73.13±11.80	1.589	0.116
Intestinal exhaust time	3.51±0.54	3.37±0.59	1.189	0.238
Number of lymph node dissections	16.80±3.42	16.93±2.77	-0.182	0.856
Time to take fluids	3.97±0.43	4.09±0.44	-1.280	0.204
Drainage tube removal time	5.67±0.50	5.75±0.47	-0.816	0.417
Catheter removal time	4.35±0.54	4.30±0.44	0.504	0.616
Postoperative hospital stay	8.51±1.22	8.35±1.19	0.626	0.533
surgical complications	11	6	0.637	0.425

Table 3 Comparison of postoperative complications between two groups of patients with different surgical methods (%)

Complication indicators	Traditional group (*n* = 51)	Pre-transection group (*n* = 40)	χ^2 *value*	*p value*
Pulmonary infection	1(2.0)	0(0.0)	-	1.000
Intra-abdominal infection	1(2.0)	1(2.5)	-	1.000
Incision infection	1(2.0)	1(2.5)	-	1.000
Postoperative bleeding	2(3.9)	1(2.5)	-	1.000
Anastomotic leakage	2(3.9)	1(2.5)	-	1.000
Chylous fistula	1(2.0)	0(0.0)	-	1.000
Anastomotic stenosis	1(2.0)	1(2.5)	-	1.000
Intestinal obstruction	2(3.9)	1(2.5)	-	1.000
Defecation disorder	0(0.0)	0(0.0)	-	-
Urination disorder	0(0.0)	0(0.0)	-	-
Sexual dysfunction	0(0.0)	0(0.0)	-	-
Total Complications	11(21.6)	6(15.0)	0.637	0.425

"—"： Fisher's exact test does not produce a test statistic (not applicable).

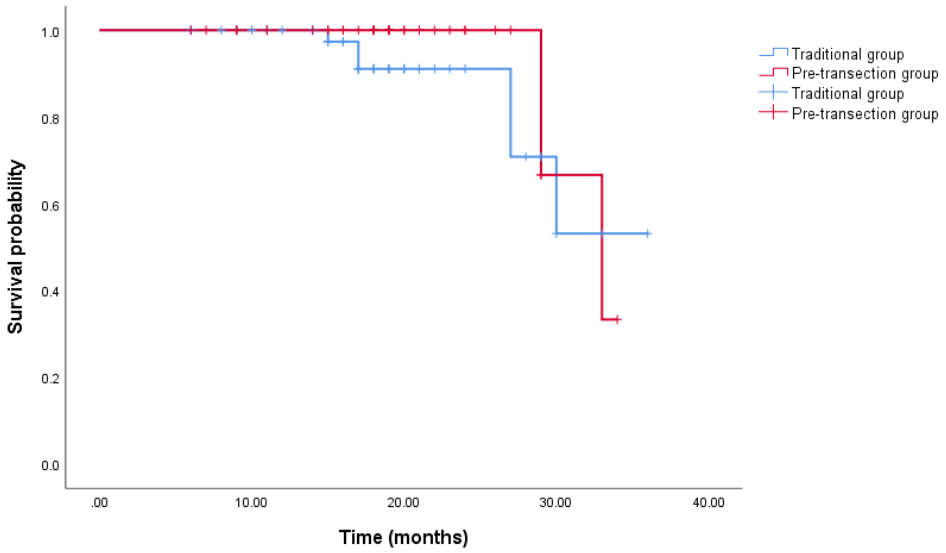

Fig. 2 Comparison of survival curves between the pre-transection group and the traditional group

Discussion

With improvements in living standards, the proportion of patients who are overweight or obese has increased significantly, and the number of obese people in more than 70 countries has doubled in the past 30 years. Leitzmann [8] showed that obese individuals have an increased risk of colorectal cancer (HR=1.12, 95% CI: 1.03-1.21), and visceral fat accumulation is the main reason for the increased incidence of CRC [9,10]. Unlike Westerners with general obesity, Chinese people are mainly abdominally obese [11], and excessive adipose tissue accumulates in the subcutaneous and visceral surfaces of the middle and lower abdomen.

Randomized evidence from CLASICC, COLOR II, COREAN, ACOSOG Z6051, and ALaCaRT has confirmed that the laparoscopic approach can reproduce the quality of open TME while offering faster recovery [12-17]. Nevertheless, laparoscopic pelvic dissection is technically challenging, and this difficulty is amplified in overweight and obese patients, in whom hypertrophic mesenteric and pelvic fat narrows an already confined workspace[18,19].Excessive fat also causes poor blood supply and unsatisfactory anastomosis due to the filling of small lipid granules at the anastomotic site or poor anastomotic sealing[20], which is also a risk factor for postoperative complications of colorectal cancer [21,22]. Obese patients undergoing laparoscopic colorectal surgery have a higher conversion rate to open surgery, longer operation time [23-25], and lower number of lymph nodes dissected during the operation [26].

Before the pelvic phase, the modification shortened the total operative time by approximately 14 min (136.88 ± 35.91 vs. 151.14 ± 26.00 min, p = 0.038) without compromising hemostasis, lymphadenectomy, recovery, morbidity, or short-term survival. The reduction in operative time was the central finding of this study and deserves mechanistic scrutiny rather than being dismissed as a marginal difference. First, pre-transection re-sequences the operation into a strictly

cranial-to-caudal, medial-to-lateral flow. Vascular control at the root of the inferior mesenteric artery, dissection of Toldt's space, and No. 253 lymphadenectomy are completed while the specimen is still in situ, so that the surgeon enters the pelvis along an already defined plane instead of alternating repeatedly between the abdomen and the pelvis. Pooled data indicate that medial-to-lateral mobilization shortens the procedure time by more than 30 min and lowers the conversion rate, an effect attributed precisely to this avoidance of repetitive re-orientation [27].

In overweight/obese patients, the sigmoid colon and its hypertrophic, fat-laden mesentery behave as a mobile lid that repeatedly falls over the sacral promontory and the pelvic inlet, obscuring the retrorectal space and forcing continuous re-traction. Once the bowel is divided at least 10 cm from the upper tumor margin, that mass is eliminated; the assistant can lift the closed distal stump ventrally and cranially while counter-traction is applied to the posterolateral rectal wall, so that the pararectal and retrorectal spaces are displayed frontally rather than at the bottom of a deep, fatty well (Figs 1C, D). This directly counteracts the mechanism by which adiposity prolongs surgery: visceral fat area rather than body mass index predicts incomplete mesorectal excision and longer operative time [28], and a BMI of 24 kg/m2 or more is an independent predictor of prolonged operative time for laparoscopic anterior resection [29]. Better exposure translates into less bleeding and fewer corrections. Early ligation of the superior rectal artery with routine preservation of the left colic artery devascularises the specimen before the pelvic phase, which plausibly underlies the lower, although statistically similar, blood loss in the pre-transection group (73.13 ± 11.80 vs 77.17 ± 12.18 mL, $p = 0.116$); sustained coaxial traction along the rectum also makes it easier to remain within the holy plane and to recognize the hypogastric nerve plexus, thereby reducing the time spent re-entering the correct plane.The technique decomposes a long operation into three reproducible modules: vascular control and No. 253 dissection, sigmoid transection, and pelvic TME — which facilitates standardization and training.

These gains are clinically relevant because operative time is not a neutral metric: in a cohort of 23,098 patients, prolonged operative time was independently associated with longer hospital stay and higher complication rates [30]. With respect to safety, the overall complication rate was numerically halved in the pre-transection group (15.0% vs 21.6%), but the difference did not reach statistical significance ($p = 0.425$), and every event in both groups resolved with conservative management. This study was designed to compare continuous perioperative variables, not to detect a halving of a binary event; the result should therefore be read as an absence of evidence of harm rather than evidence of equivalence, and the possibility of a type II error must be acknowledged. Anastomotic leakage is the most informative single endpoint: it occurred in two patients (3.9%) after conventional laparoscopic TME and in one after pre-transection (2.5%) ($p = 1.000$). Three mechanisms may account for this. Preserving the left colic artery maintains perfusion of the proximal conduit, and although meta-analyses have not shown a consistent leakage advantage for either ligation level [31], the combination of a well-perfused proximal limb and a tension-free anastomosis is biologically protective. In addition, dividing the sigmoid early allows the staple line to be inspected directly and any bleeding to be controlled immediately, and it removes redundant, poorly vascularized sigmoid that might otherwise be incorporated into the anastomosis. Finally, the shortened operative time may itself reduce leakage risk, given the recognized risk factors of male sex, low anastomosis, neoadjuvant therapy, and prolonged operating time [32-35,36].

Notably, the shorter operative time did not translate into earlier exhaustion, earlier oral intake, or shorter hospital stay. This is not unexpected: both groups were managed within a standardized enhanced recovery pathway in which discharge is governed by defined functional milestones [37], an absolute difference of approximately 14 min is small relative to the biological determinants of postoperative ileus, and the saving of operating time was not related to the anastomosis-related factors that dominated recovery.

Oncological adequacy was preserved. The lymph node yield was comparable (16.93 ± 2.77 vs 16.80 ± 3.42, $p = 0.856$) and exceeded the minimum of 12 nodes required for reliable staging [40], and 253 lymphadenectomy was performed routinely, and overall survival was superimposable (log-rank $p = 0.452$). These data indicate that the modification does not trade radicality for speed.

Limitations

Several limitations should be acknowledged. This was a retrospective, single-center, non-randomized study with a modest sample ($n = 91$) and short follow-up (6 - 36 months); allocation according to surgical method and time period may have introduced selection and learning-curve bias, and the absence of randomization precludes causal inference. Visceral fat area, which predicts surgical difficulty better than body mass index [19,28], was not measured. Complications were recorded but not graded with the Clavien-Dindo classification [38], specimen quality was not assessed using the mesorectal grading system proposed with complete mesocolic excision [39], and functional outcomes, such as low anterior resection syndrome, were not evaluated. Multicenter randomized controlled trials with standardized quality grading and long-term functional endpoints are required to confirm whether the ergonomic advantage of sigmoid pre-transection translates into lower morbidity in overweight/obese patients.

Conclusion

In summary, in overweight/obese patients undergoing laparoscopic radical resection of rectal cancer, pre-transection of the sigmoid colon shortens operative time by decompressing the pelvic workspace and improving retraction while maintaining oncological radicality and a complication profile at least equivalent to that of conventional laparoscopic TME. This technique is safe, feasible, and particularly attractive when pelvic exposure is compromised by adiposity or other factors.

Author contributions ZYP, ZX and BWM conceived the idea and conceptualized the study.

WC, MW, CJL and LPP collected and assembled the clinic data. MW, LPP and LM analyzed the data. ZYP and WC drafted the initial manuscript and then ZX and BWM reviewed the manuscript. All authors read and approved the final draft.

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Data availability The data referred to in this study is available on request from the corresponding author upon reasonable reasons.

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