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Effect of one-stitch method of temporary ileostomy on the surgical outcomes and complications after laparoscopic low anterior resection in rectal cancer patients: a propensity score matching analysis

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Abstract

Purpose The purpose of this current study was to explore whether one-stitch method (OM) of temporary ileostomy influenced the surgical outcomes after laparoscopic low anterior resection (LLAR).

Methods We retrospectively identified rectal cancer (RC) patients who underwent LLAR plus temporary ileostomy in a single teaching hospital from Jan 2011 to June 2023. According to the different methods of ileostomy, the patients were divided into the OM group and the traditional method (TM) group. A propensity score matching (PSM) analysis was performed to eliminate bias and compare the surgical outcomes.

Results A total of 469 RC patients were included in this study. There were 57 patients in the OM group and 412 patients in the TM group. After 1:1 PSM, there were 57 patients in each group, and no significant difference was found in baseline information ($P > 0.05$). In terms of surgical outcomes of primary RC surgery, we found that patients in the OM group had shorter operation time ($P < 0.01$), less blood loss ($P < 0.01$), and shorter postoperative hospital stay ($P < 0.01$) than in the TM group after PSM. Moreover, there was no significant difference in both overall complications and stoma-related complications. As for the outcomes of stoma reversal surgery, patients in the OM group had shorter postoperative hospital stay ($P = 0.002$) than in the TM group before PSM. However, no significant difference was found after PSM ($P > 0.05$).

Conclusion The OM of temporary ileostomy was easier, more effective and time-saving than the TM, which did not increase the incidence of both postoperative complications and stoma-related complications.

Keywords Rectal cancer, Laparoscopic low anterior resection, Ileostomy, One-stitch method, Surgical outcome

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Introduction

Colorectal cancer (CRC) ranked third in malignant tumors and second in cancer-related deaths in GLOBOCAN 2020 [1]. Among the kinds of treatment methods, radical surgery was still the most important one [2–4]. Over the past decades, with the steady development of laparoscopic technology, laparoscopic low anterior resection (LLAR) has been prevalently performed in rectal cancer (RC) patients, especially the low RC patients [5, 6].

Same as the open low anterior resection, anastomotic leakage was also one of the most common and severe complications after LLAR in RC patients [7, 8], which might delay the patients' recovery and affect the following treatment [9–11]. Studies demonstrated that temporary ileostomy after LLAR could decrease the occurrence of anastomotic leakage in RC patients [12–14]. However, stoma-related complications, including stoma bleeding, stoma stricture, stoma prolapse, stoma retraction, parastomal hernia, mucocutaneous separation et al. directly affected the patients' quality of life and increased the economic burden of stoma care [15–18]. Therefore, choosing the suitable surgical method of protective ileostomy was exceptionally important.

The traditional method (TM) of ileostomy was performed by suturing the peritoneum, anterior sheath and skin layer, respectively [19, 20], which cost both sutures and operation time. In addition, some studies reported that the one-stitch method (OM), which only used one stitch to finish the ileostomy procedure [21–23], could save the operation time and sutures. While few studies demonstrated whether the OM affected the surgical outcomes [21–23].

For this reason, the purpose of the current study was to compare the surgical outcomes between the OM and TM of protective ileostomy after LLAR in RC patients, using PSM analysis.

Materials and methods

Patients

Patients who were diagnosed with RC and underwent LLAR combining with temporary ileostomy from Jan 2011 to June 2023 were retrospectively enrolled in a single teaching hospital. This current study was conducted in accordance with the World Medical Association Declaration of Helsinki. Ethic approval was obtained from our committee, the First Affiliated Hospital of Chongqing Medical University (2021-519), and all participants signed the informed consents.

Inclusion and exclusion criteria

659 RC patients who underwent LLAR plus temporary ileostomy were initially enrolled ($n=659$). The exclusion criteria were as follows: (1) patients with incomplete records ($n=25$); (2) patients who combined with other organ resection ($n=37$); and (3) patients who underwent LLAR plus temporary ileostomy but did not undergo stoma closure surgery ($n=125$). Finally, a total of 469 patients were identified in this study (Fig. 1).

Data collection

The clinical characteristics were collected from the Electronic Medical System. Baseline information including age, sex, body mass index (BMI), smoking, drinking, hypertension, type 2 diabetes mellitus (T2DM), neoadjuvant therapy, tumor node metastasis stage (TNM), tumor size, and ileostomy methods were collected. The surgical outcomes including operation time, intraoperative blood loss, postoperative complications, postoperative hospital stay both the primary surgery and the second stoma closure surgery were collected, respectively. Moreover, we also collected the interval from the first surgery to the second closure surgery.

Definitions

The TNM stage was according to the 8th Edition of the AJCC [24]. The Clavien–Dindo classification was used to evaluate the complications [25], and the stoma-related complications included early complications and delayed complications. According to the consensus of Chinese experts on preventive stomy for middle and low rectal cancer, the early stoma-related complications included stoma retraction, stoma necrosis, stoma skin irritation and mucocutaneous separation, stoma edema, stoma bleeding, and stoma infection. The delayed complications included stoma stricture, stoma prolapse, and parastomal hernia. All stoma-related complications were diagnosed and managed by qualified wound continence nurses at our center.

Surgical procedure of protective ileostomy

The TM of ileostomy was performed while the LLAR procedure finished. Initially, we found and hold the terminal ileum with non-damaging gripper, which was about 30 cm from the ileocecal part with the laparoscopic scope. Then, the terminal ileum was extracted through a small incision, and we intermittently used 3/0 absorbable sutures to suture the serous-muscular layer of the bowl with the peritoneum, anterior sheath and skin layer, respectively.

The process for locating the terminal ileum in the ileostomy OM was the same as for the TM. Following the removal of the terminal ileum, we stitched into the anterior sheath and peritoneum layer from the middle of one side of the skin using a 2/0 absorbable suture. The peritoneum and anterior sheath layer would then be sewn out

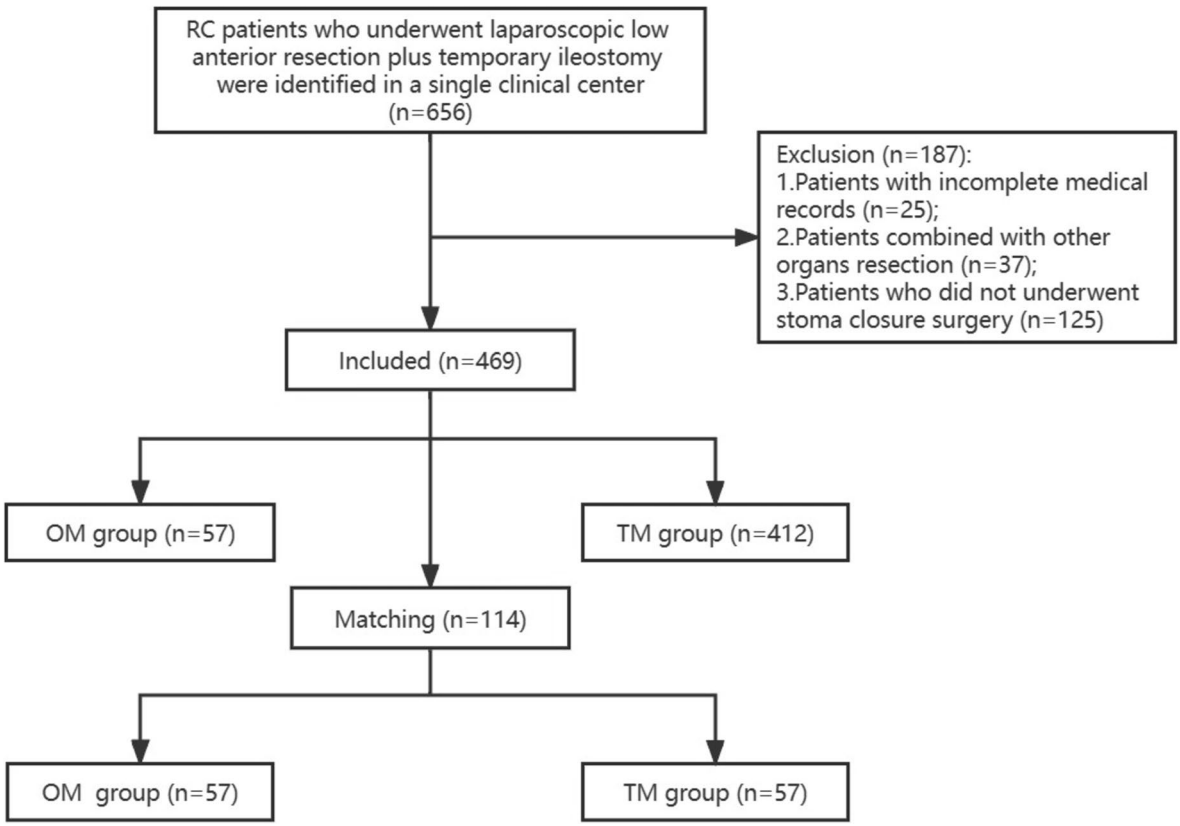

Fig. 1 Flowchart of patient selection

from the opposing skin after passing through the mesenteric mesangial avascular region. To complete the knotting and fastening, we went through the avascular region one more using the same stitch. Lastly, we intermittently sutured the skin layer with bowl using 3/0 absorbable sutures. (Figs. 2 and 3).

PSM

To minimize the baseline bias between the OM group and the TM group, we conducted PSM. Nearest neighbor matching was performed without replacement at a 1:1 ratio and a caliper width with a 0.01 standard deviation was specified. The baseline information including age, sex, BMI, smoking, drinking, hypertension, T2DM, neoadjuvant therapy, tumor size, and tumor stage were matched.

Statistics

Continuous variables were expressed as mean ± standard deviation (SD), and independent-sample *t* text was used to compare the difference. Categorical variables were expressed as *n* (%), and Chi-square or Fisher's exact text was adopted. A bilateral *P* value of < 0.05 indicated statistical difference. All data were analyzed using SPSS (version 22.0) software.

Results

Patients

According to the inclusion and exclusion criteria, a total of 469 RC patients who underwent LLAR plus temporary ileostomy were finally included. The average age was 61.8 ± 11.3 years old. There were 313 (66.7%) males and 156 (33.3%) females, and the average BMI was 23.2 ± 3.1 kg/m^2. More clinical characteristics of the cohort are shown in Table 1.

Baseline characteristics before and after PSM

According to the different methods of ileostomy, there were 412 patients in the TM group and 57 patients in the OM group. Baseline information including age, sex, BMI, smoking, drinking, hypertension, T2DM, neoadjuvant therapy, tumor size, and tumor stage were compared before and after PSM. The tumor stage was significantly different between the OM group and the TM group before PSM ($P < 0.05$). After 1:1 PSM, no significant difference ($P > 0.05$) was found in baseline information between the two groups (Table 2).

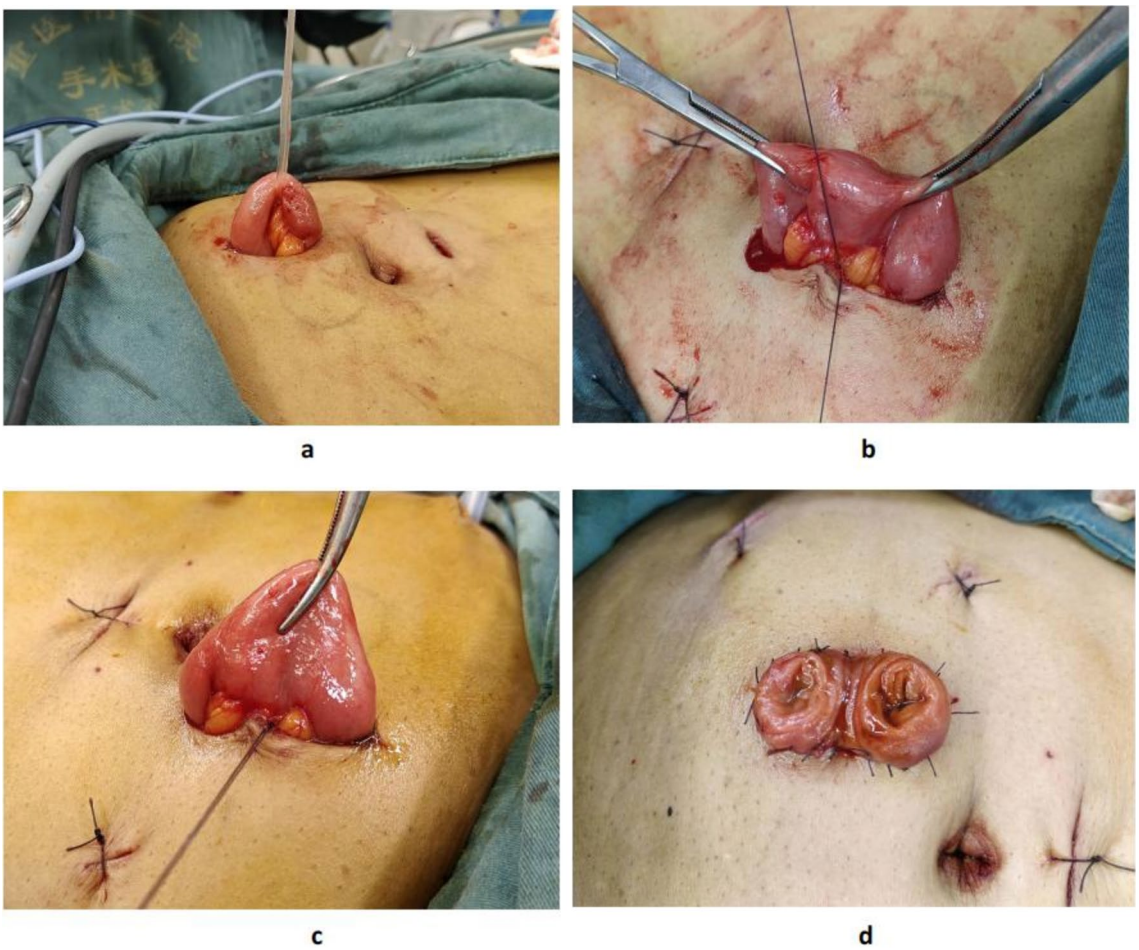

Fig. 2 Surgical procedure of one-stitch method of ileostomy

Surgical outcomes of the primary RC surgery

Surgical outcomes of the primary LLAR, including operation time, intro-operative blood loss, postoperative hospital stay, overall complications, and stoma-related complications were compared before and after PSM. Before PSM, patients in the OM group had shorter operation time ($P<0.01$), less blood loss ($P=0.017$), and shorter postoperative hospital stay ($P<0.01$) than in the TM group. After 1:1 PSM, patients in the OM group also had shorter operation time (192.1 ± 51.7 min versus 252.1 ± 83.0 min, $P<0.01$), less blood loss (39.1 ± 37.7 ml versus 86.1 ± 73.7 ml, $P<0.01$), and shorter postoperative hospital stay (5.6 ± 2.5 days versus 8.1 ± 4.3 days, $P<0.01$) than in the TM group. Regarding overall complications and stoma-related complications, no obvious significant difference was found ($P>0.05$) (Table 3).

Outcomes of the stoma reversal surgery

As for the outcomes of second stoma reversal surgery, we compared the interval time from ileostomy to stoma reversal, operation time, blood loss, postoperative hospital stay, and overall complications between the OM group and the TM group. However, there was no significant difference ($P>0.05$) (Table 4).

Discussion

In this retrospective study, we included 469 RC patients who underwent LLAR plus temporary ileostomy. After 1:1 ratio PSM, there were 57 patients in each group. Patients in the OM group had shorter operation, less intraoperative blood loss, and shorter postoperative hospital stay than in the TM group. Moreover, there was no significant difference in overall complications and stoma-related complications. However, as for the second stoma reversal surgery, no obvious significant difference was found in surgical outcomes.

LLAR was one of the most important treatments for RC patients, especially the low distance from the anus [26, 27]. Anastomotic leakage, as one of the most severe complications occurring after LLAR, could cause acute

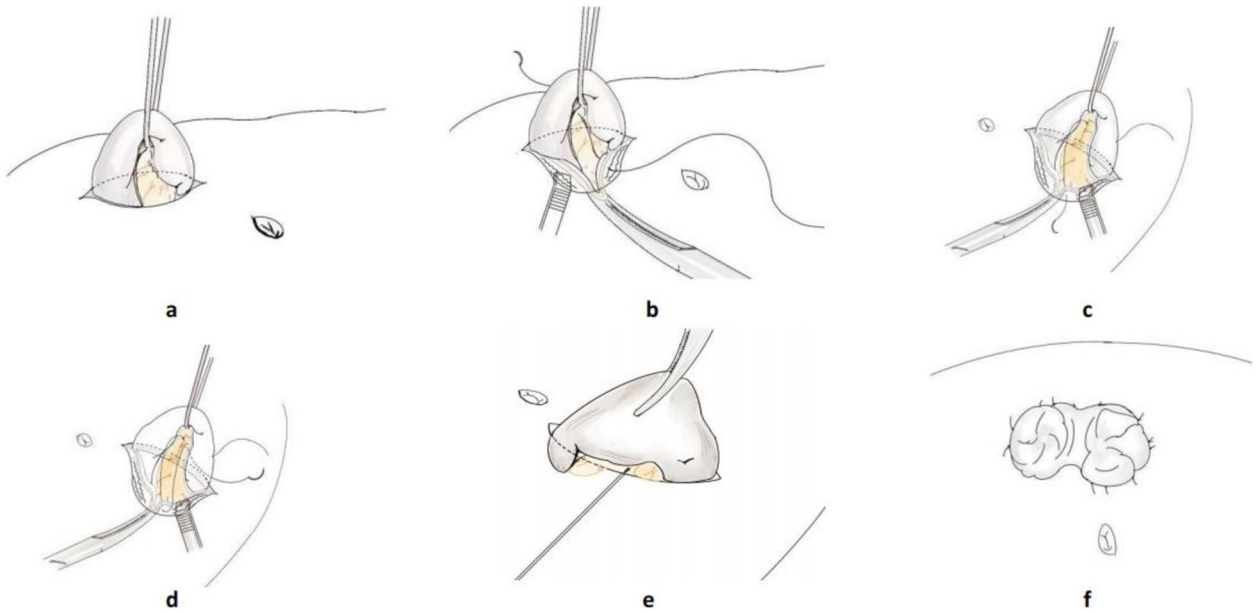

Fig. 3 Schematic picture of one-stitch method of ileostomy

Table 1 Clinical characteristics of the total cohort

Characteristics	No. 469
Age, year	61.8 ± 11.3
Sex	
Male	313 (66.7%)
Female	156 (33.3%)
BMI, kg/m^2	23.2 ± 3.1
Smoking	187 (39.9%)
Drinking	162 (34.5%)
Hypertension	124 (26.4%)
T2DM	46 (9.8%)
Neoadjuvant therapy	99 (21.1%)
Tumor size	
<5 cm	393 (83.8%)
≥5 cm	76 (16.2%)
TNM stage	
I	155 (33.1%)
II	130 (27.7%)
III	159 (33.9%)
IV	25 (5.3%)
Ileostomy method	
OM	57 (12.2%)
TM	412 (87.8%)

Variables are expressed as the mean ± SD, *n* (%)

BMI body mass index, *T2DM* type 2 diabetes mellitus, *OM* one-stitch method, *TM* traditional method

secondary peritonitis and even septic shock [28]. Previous studies have reported that temporary ileostomy after LLAR could reduce the incidence of anastomotic leakage [29, 30]. In current clinical work, loop ileostomy has been widely used, and the selection of different support modes in loop ileostomy has different influences on the occurrence of postoperative complications, the postoperative comfort level of patients, and the ease of self-care [31]. At present, the commonly used ostomy methods mainly included traditional support rod loop ileostomy, skin bridge loop ileostomy, self-closing ileostomy, one-stitch ileostomy, ghost ileostomy, etc. [32]. The TM of ileostomy needed dozens of stitches and caused a relatively higher incidence of stoma-related complications [15, 33]. Comparing with the TM, the OM of ileostomy was a novel surgery, which we summarized the correlated studies in Table 5. Chen et al. [21] included 54 patients in the TM group and 41 patients in the OM group and reported that the operation time of both RC surgery and stoma closure surgery were shorter in the OM group. Pei et al. [22] did a subgroup analysis for BMI obese patients. They demonstrated that this novel surgical way was more beneficial for BMI obese patients. In addition, Li et al. [23] found RC patients who underwent natural orifice specimen extraction surgery (NOSES) plus the OM of ileostomy could achieve more rapid recovery after surgery.

In this current study, we found that patients in the OM group had shorter operation time, shorter postoperative hospital stays, and less intraoperative blood loss in the primary RC surgery. Moreover, patients in the OM group

Table 2 Baseline characteristics before and after PSM

Characteristics	Before PSM			After PSM		
	OM (57)	TM (412)	*P* value	OM (57)	TM (57)	*P* value
Age (year)	63.1 ± 10.7	61.6 ± 11.4	0.373	63.1 ± 10.7	61.2 ± 9.6	0.334
Sex			0.774			1.000
Male	39 (68.4%)	274 (66.5%)		39 (68.4%)	39 (68.4%)	
Female	18 (31.6%)	138 (33.5%)		18 (31.6%)	18 (31.6%)	
BMI (kg/m^2)	23.6 ± 2.9	23.1 ± 3.1	0.309	23.6 ± 2.9	23.4 ± 3.1	0.771
Smoking	25 (43.9%)	162 (39.3%)	0.512	25 (43.9%)	31 (54.4%)	0.261
Drinking	24 (42.1%)	138 (33.5%)	0.200	24 (42.1%)	28 (49.1%)	0.452
Hypertension	16 (28.1%)	108 (26.2%)	0.766	16 (28.1%)	11 (19.3%)	0.271
T2DM	4 (7.0%)	42 (10.2%)	0.450	4 (7.0%)	2 (3.5%)	0.679
Neoadjuvant therapy	15 (26.3%)	84 (20.4%)	0.304	15 (26.3%)	18 (31.6%)	0.536
Tumor size			0.635			0.325
<5 cm	49 (86.0%)	344 (83.5%)		49 (86.0%)	45 (78.9%)	
≥5 cm	8 (14.0%)	68 (16.5%)		8 (14.0%)	12 (21.1%)	
Tumor stage			0.005*			0.171
I	19 (33.3%)	136 (33.0%)		19 (33.3%)	17 (29.8%)	
II	18 (31.6%)	112 (27.2%)		18 (31.6%)	20 (35.1%)	
III	12 (21.1%)	147 (35.7%)		12 (21.1%)	18 (31.6%)	
IV	8 (14.0%)	17 (4.1%)		8 (14.0%)	2 (3.5%)	

Variables are expressed as the mean ± SD, *n* (%)

BMI body mass index, *T2DM* type 2 diabetes mellitus, *PSM* propensity score matching, *OM* one-stitch method, *TM* traditional method

**P*-value < 0.05

Table 3 Surgical outcomes of the primary RC surgery before and after PSM

Characteristics	Before PSM			After PSM		
	OM (57)	TM (412)	*P* value	OM (57)	TM (57)	*P* value
Operation time (min)	192.1 ± 51.7	235.8 ± 85.2	< 0.01*	192.1 ± 51.7	252.1 ± 83.0	< 0.01*
Blood loss (mL)	39.1 ± 37.7	80.9 ± 130.9	0.017*	39.1 ± 37.7	86.1 ± 73.7	< 0.01*
Hospital stay (day)	5.6 ± 2.5	8.0 ± 3.9	< 0.01*	5.6 ± 2.5	8.1 ± 4.3	< 0.01*
Overall complications	6 (10.5%)	76 (18.4%)	0.215	6 (10.5%)	10 (17.5%)	0.281
Stoma-related complications	2 (3.5%)	10 (2.4%)	0.647	2 (3.5%)	1 (1.8%)	1.000

Variables are expressed as the mean ± SD, *n* (%)

RC rectal cancer, *PSM* propensity score matching, *OM* one-stitch method, *TM* traditional method

**P*-value < 0.05

did not increase the incidence of overall complications and stoma-related complications. However, in terms of outcomes of the stoma reversal surgery, we did not find the statistical difference. The interval time to stoma reversal in our center was relatively longer. The perhaps reason might be that we included RC patients who were diagnosed with stage IV. The postoperative treatment for metastasis might influence the time to stoma closure [34, 35]. After PSM, the overall incidence of stoma-related complications in the OM and TM groups were 3.5 and 1.8%, respectively, which were lower than other studies. The perhaps reason might be that we used a 3/0 stitch to suture the bowl with the skin layer intermittently, which could decrease the incidence of stoma-related complications, especially the stoma skin irritation and mucocutaneous separation [36, 37]. On the other hand, this operation might increase the adhesion around the stoma, which influences the outcomes of reversal surgery [38, 39].

To our knowledge, this current study was the first one using a PSM analysis to compare the surgical outcomes between the OM group and TM group. We conducted

Table 4 Outcomes of the stoma reversal before and after PSM

Characteristics	Before PSM			After PSM		
	OM (57)	TM (412)	*P* value	OM (57)	TM (57)	*P* value
Time to stoma reversal after ileostomy (day)	138.1 ± 66.9	137.0 ± 86.4	0.930	138.1 ± 66.9	148.9 ± 113.6	0.535
Operation time (min)	100.4 ± 42.5	93.4 ± 41.3	0.227	100.4 ± 42.5	87.0 ± 32.4	0.060
Blood loss (mL)	27.2 ± 24.6	31.2 ± 44.8	0.513	27.2 ± 24.6	32.2 ± 66.2	0.594
Hospital stay (day)	4.6 ± 4.0	5.9 ± 2.9	0.002*	4.6 ± 4.0	5.1 ± 1.6	0.370
Overall complications	7 (12.3%)	45 (10.9%)	0.759	7 (12.3%)	7 (12.3%)	1.000

Variables are expressed as the mean ± SD, *n* (%)

PSM propensity score matching, *OM* one-stitch method, *TM* traditional method

**P*-value < 0.05

Table 5 Previous studies reporting the difference between the OM group and the TM group

Author	Year	Country	Sample size	OM/TM	Outcomes
Chen YZ	2020	China	95	41/54	The OM group had a shorter operation time both in the RC resection and stoma closure surgery than the TM group. The postoperative complications were similar in two groups
Pei WT	2021	China	242	106/136	The OM group showed a shorter operation time both in the loop ileostomy and stoma closure surgery than the TM group. The BMI obese patients had more postoperative complications
Li XM	2023	China	70	30/40	The OM group exhibited a shorter operation time both in the ileostomy and stoma closure surgery. The OM group had less stoma-related complications than the TM group

OM one-stitch method, *TM* traditional method, *RC* rectal cancer, *BMI* body mass index

a PSM analysis to eliminate the baseline bias. However, some limitations were inevitably existed. First, this was a retrospective study in a single clinical center, and the sample size was relatively small, which might lead to selection bias. Second, the information on degree of intraoperative adhesion, the time and amount of blood loss during stoma creation was lacking. And third, we did not identify the oncological outcomes in our study. Therefore, more multi-center prospective randomized controlled studies are needed for further exploration.

Conclusion

In conclusion, the OM of temporary ileostomy was easier, more effective, and time-saving than the TM. Moreover, this novel surgical method did not increase the incidence of both overall complications and stoma-related complications.

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Author contributions
Dong Peng contributed to conception and design of the study. Xin-Peng Shu and Jia-Liang Wang collected the data, Dong Peng finished the statistical analysis. Xin-Peng Shu and Jia-Liang Wang wrote the first-draft manuscript. All authors contributed to revise the manuscript, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

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Availability of data and materials
The data are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethic approval was obtained from our committee, the First Affiliated Hospital of Chongqing Medical University (2021-519), and the informed consent forms were acquired from all participants.

Consent for publication
All patients signed the informed consent to participate in this study.

Competing interests
The authors declare no competing interests.

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