

Short-Term Outcome Analysis of Temporary Ostomy in Low Anterior Resection for Rectal Cancer-A Retrospective Study

Chuanduo Zhao

Department of Colorectal Surgery, National Cancer Center/ National Clinical Research Center for Cancer/ Cancer Hospital, Chinese Academy of Medical Science and Peking Union Medical College, Beijing

Sicheng Zhou

Department of Colorectal Surgery, National Cancer Center/ National Clinical Research Center for Cancer/ Cancer Hospital, Chinese Academy of Medical Science and Peking Union Medical College, Beijing

Hao Su

Department of Colorectal Surgery, National Cancer Center/ National Clinical Research Center for Cancer/ Cancer Hospital, Chinese Academy of Medical Science and Peking Union Medical College, Beijing

Jianwei Liang

Department of Colorectal Surgery, National Cancer Center/ National Clinical Research Center for Cancer/ Cancer Hospital, Chinese Academy of Medical Science and Peking Union Medical College, Beijing

Zhixiang Zhou (✉ drzhixiangzhou@126.com)

Department of Colorectal Surgery, National Cancer Center/ National Clinical Research Center for Cancer/ Cancer Hospital, Chinese Academy of Medical Science and Peking Union Medical College, Beijing

Research Article

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Abstract

Background Temporary ostomy has proved to be an effective method to reduce anastomotic leakage in low anterior resection. However, the injury of additional reversal surgery and ostomy-related complications require more evaluation regarding its necessity and feasibility. In this study, we analyzed the outcomes of temporary ostomy in low anterior resection to provide more evidence for surgeons to make clinical decisions.

Methods A total of 279 consecutive patients with rectal cancer with temporary ostomy were matched 1:1 to contemporaneous 279 controls without temporary ostomy at our institution to compare the perioperative clinical situation. The matching criteria included age, body mass index (BMI), American Society of Anesthesiology (ASA) score, and tumor stage. The one-year follow-up data was collected to evaluate ostomy-related outcomes.

Results The non-ostomy group had a higher proportion of chemoradiotherapy (39.4% vs 10.0%, $P < 0.001$) and a lower site of anastomosis (6.0 cm vs. 9.0 cm, $P < 0.001$) than the ostomy group. The ostomy group had a lower rate of anastomotic leakage (0.4% vs 3.6%, $P = 0.039$), reduced reoperation rate (0.4% vs 2.9%, $P = 0.044$), longer operating time (214.9 min vs. 151.4 min, $P = 0.009$) and shorter time to first flatus (3.4 days vs. 4.1 days, $P = 0.005$) than the non-ostomy group. The safety of reversal surgery is acceptable; however, 21.1% of ostomates did not complete the reversal operation for various reasons within 1 year after the first operation. Age ($P = 0.029$) and AJCC stage ($P = 0.043$) may be important factors affecting the closure of ostomy.

Conclusions Although time-consuming, temporary ostomy is a good option for high-risk patients to reduce the rates of anastomotic leakage and reoperation in low anterior resection. Considering the ostomy-related inconveniences in daily living, other related complications and rather high proportion of non-reversal, the scope of application should be more for patients with low anastomosis and neoadjuvant treatment.

1. Background

As one of the five leading causes of cancer-related deaths in China (1), colorectal cancer is gaining increasing attention among doctors and the general public. With a special disease spectrum, China has a much higher proportion of rectal cancer, especially low rectal cancer, than that in western countries (2). Anastomotic leakage is a severe complication and can greatly prolong the hospitalization period and increase medical costs in low anterior resection (LAR). Several studies have confirmed that construction of a temporary ostomy will benefit patients who have undergone low-rectal anus preserving surgery and are at high risk of anastomotic leakage(3–7). A multivariate analysis (8) showed that gender and level of anastomosis were risk factors for anastomotic leakage, which suggests that temporary ostomy may be a good option to protect the anastomosis.

Although the safety and advantages of temporary ostomy in LAR have been confirmed in previous studies, the necessity of ostomy was not strictly defined in LAR. In this study, we retrospectively analyzed the short-term postoperative recovery parameters of two groups—ostomy and non-ostomy—to evaluate the impact of this approach. The clinical parameters included hospitalization situation, surgical procedure, recovery of gastrointestinal function, postoperative pain, and short-term postoperative complications. To assess the impact of the ostomy, we collected one-year follow-up data of the ostomy group after surgery.

2. Patients And Methods

The study was approved by the ethics committee at the Cancer Hospital, Chinese Academy of Medical Sciences, and the protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki. We retrospectively analyzed 2321 consecutive patients from May 2014 to August 2018 who were diagnosed with rectal cancer and underwent laparoscopic LAR, with or without temporary ostomy. Patients ranged from American Joint Committee on Cancer (AJCC) stage I to IV. All included patients underwent colonoscopy and pathological biopsy before surgery to confirm the diagnosis.

All patients in this study underwent curative-intent or palliative (For AJCC stage IV) LAR. Based on whether the intraoperative temporary ostomy was performed, the patients were divided into two groups. Because the number of patients in the non-ostomy group was much higher than those in the temporary ostomy group, we randomly selected the same number of patients as in the temporary ostomy group for control statistics. Patients with temporary ostomy were matched in a 1:1 ratio with patients without ostomy. The matching criteria included age, body mass index (BMI), American Society of Anesthesiology (ASA) score, and tumor stage.

At our institution, the majority of LARs are performed laparoscopically. Normally four trocars are used for bowel mobilization, division, ligation of vessel, and lymphadenectomy. Transection of the bowel and anastomosis were performed either intracorporeally or extracorporeally according to the situation. When the situation permitted, the natural orifice specimen extraction surgery technique was also used in surgery. Regardless of the method used, the total mesorectal excision principle was strictly followed during surgery. If the patient required a protective stoma, loop ileostomy was the routine procedure. All patients underwent a preoperative colonoscopy, along with chest, abdominal, and pelvic enhanced computed tomography. However, for some patients, pelvic MRI and endoscopic ultrasonography were prescribed to further evaluate the local lesion to determine the surgical procedure.

We collected demographic and clinical data of the patients for this study, including age, gender, BMI, ASA score, and tumor location and size. Meanwhile, operative details including operating time and estimated blood loss were recorded. To comprehensively evaluate recovery, hospitalization days, postoperative hospitalization days, time to first flatus, time to first oral intake, and postoperative pain score were also recorded. To assess the impact of the temporary ostomy, we recorded ostomy-related complications and patients' reasons for not undergoing reversal surgery within one year

Quantitative variables are expressed as median and range, and comparisons were analyzed using the Student's *t*-test according to data distribution. Categorical variables are presented as number and percentage and were analyzed by chi-square test or Fisher's exact test. All tests were two-sided, and $P < 0.05$ was considered to indicate as statistical significance. The Statistical Package for the Social Sciences (SPSS, version 25.0; IBM Corp., Armonk, NY, USA) was used for all analyses.

3. Results

A total of 2321 consecutive patients with rectal cancer who underwent LAR at our institution from May 2014 to August 2018 were included. We selected laparoscopic surgery patients as the study subjects, among them, 279 patients underwent temporary ostomy. Patients with temporary ostomy were matched 1:1 with patients that did not undergo temporary ostomy (Fig. 1). Table 1 shows the demographic and clinical characteristics of the patients. The proportion of patients who received neoadjuvant chemoradiation in the ostomy group was significantly higher than that in the non-ostomy group (39.4% vs. 10.0%, $P < 0.001$). The tumor position in the ostomy group was lower than that in the non-ostomy group (6.0 cm vs. 9.0 cm, $P < 0.001$). In other aspects, gender, age, BMI, ASA score, tumor size, and tumor stage were essentially similar between both groups.

Table 1
Demographic and clinical characteristics

Characteristics	Ostomy group (n = 279)	Non-ostomy group (n = 279)	P value
Female/male	88/191	110/169	0.052
Median age (y; range)	60 (21–97)	60 (31–89)	0.429
Median BMI (kg/m ² ; range)	24.2 (16.5–33.6)	24.2 (15.8–34.2)	0.426
ASA score (%)			0.536
1	13 (4.7)	19 (6.8)	
2	243 (87.1)	239 (85.7)	
3	23 (8.2)	21 (7.5)	
Neoadjuvant chemoradiotherapy (%)	110 (39.4)	28 (10.0)	< 0.001
Tumor size, cm, mean (range)	3.5 (0.2–10.5)	4.1 (0.5–9.0)	0.439
Tumor distance from the anal verge, cm, mean (range)	6.0 (1.0–15.0)	9.0 (2.0–20.0)	< 0.001
pT stage (%)			0.868
1	17 (6.1)	20 (7.2)	
2	46 (16.5)	42 (15.1)	
3	168 (60.2)	164 (58.8)	
4	48 (17.2)	53 (19.0)	
pN stage (%)			0.129
0	167 (59.9)	155 (55.6)	
1	79 (28.3)	74 (26.5)	
2	33 (11.8)	50 (17.9)	
AJCC stage (%)			0.144
1	87 (31.2)	69 (24.7)	
2	73 (26.2)	94 (33.7)	
3	103 (36.9)	96 (34.4)	
4	16 (5.7)	20 (7.2)	

Characteristics	Ostomy group (n = 279)	Non-ostomy group (n = 279)	P value
<i>BMI</i> body mass index, <i>ASA</i> American Society of Anesthesiologists, <i>AJCC</i> American Joint Committee on Cancer			

The operative outcomes are detailed in Table 2. The mean operating time in the ostomy group was significantly longer than that in the non-ostomy group (214.9 min vs. 151.4 min, $P = 0.009$). The estimated blood loss and open surgery rate were not statistically significant between the two groups. There was no statistically significant difference between the two groups in the number of regional lymph nodes harvested and the distal resection margin, which were used to evaluate the thoroughness of surgical resection. For postoperative recovery, the mean time to first flatus in the ostomy group was shorter than that in the non-ostomy group (3.4 days vs. 4.1 days, $P = 0.005$). The postoperative pain score in the two groups showed no difference in the first, second, and third day after surgery. The ostomy group showed a lower anastomotic leakage rate than the non-ostomy group (0.4% vs. 3.6%, $P = 0.039$). Therefore, the reoperation rate difference between the two groups was also statistically significant (0.4% vs. 2.9%, $P = 0.044$). Other postoperative complication rates including bleeding, intestinal obstruction, abdominal infection, wound infection, cardiopulmonary events, deep-vein thrombosis, and urinary infection were similar between the two groups.

Table 2
Operative outcomes

Variables	Ostomy group (n = 279)	Non-ostomy group (n = 279)	P value
Operating time, min, mean (range)	214.9 (70–481)	151.4 (68–344)	0.009
Estimated blood loss, mL, mean (range)	63.1 (10–600)	58.0 (5–650)	0.251
Open surgery (%)	7 (2.5)	13 (4.7)	0.172
Number of regional lymph nodes harvested, mean (range)	19.4 (2–51)	21.5 (4–61)	0.335
Distal resection margin, cm, mean (range)	1.5 (0.2–11.5)	2.1 (0.1–8.0)	0.189
Time to first flatus, days, mean (range)	3.4 (1–9)	4.1 (2–18)	0.005
Time to first oral take, days, mean (range)	4.7 (1–19)	6.0 (1–28)	0.135
Postoperative pain score (VAS score)			
First day, mean	2.74	2.59	0.078
Second day, mean	2.60	2.56	0.072
Third day, mean	2.52	2.49	0.068
Perioperative complications (%)			
Anastomotic leakage	1 (0.4)	10 (3.6)	0.039
Bleeding	4 (1.4)	0 (0)	0.124
Intestinal obstruction	5 (1.8)	4 (1.4)	1.000
Abdominal infection	3 (1.1)	2 (0.7)	1.000
Wound infection	6 (2.2)	2 (0.7)	0.285
Cardiopulmonary event	1 (0.4)	1 (0.4)	1.000
Deep-vein thrombosis	0 (0)	1 (0.4)	1.000
Urinary infection	5 (1.8)	2 (0.7)	0.447
Reoperation (%)	1 (0.4)	8 (2.9)	0.044

The hospitalization and cost outcomes are detailed in Table 3. The mean postoperative hospital stay was 8.3 days in the ostomy group versus 9.3 days in the non-ostomy group, with no statistically significant difference (P = 0.498). The mean total hospitalization costs for the two groups were \$12087.2 and \$11783.3, respectively, and there was no statistical difference (P = 0.097).

Table 3
Hospitalization and cost

Variables	Ostomy group (n = 279)	Non-ostomy group (n = 279)	P value
Postoperative hospitalization, days, mean (range)	8.3 (3–23)	9.3 (5–33)	0.498
Total expense, USD, mean (range)	12087.2 (7492.4–27857.1)	11783.3 (7353.8–24981.8)	0.097

Table 4 describes the complications related to the stoma procedure after the first discharge. It should be noted that many of these complications disappeared with the reversal of the stoma. For patients whose ostomy was reversed, complications were mainly investigated between the two operations. For patients whose ostomy was not reversed, complications were those that occurred within one year of the first operation.

Table 4
Related complications of ostomy

Type of complication	Ostomy group (n = 279)	Percent
Ostomy obstruction	8	2.9
Ostomy retraction	41	14.7
Ostomy prolapse	6	2.2
Parastomal hernia	30	10.8
Cutaneous irritation	69	24.7
Dehydration	18	6.5

Table 5 summarizes the complications of reversal surgery. Of the 279 patients who received the prophylactic temporary ostomy, 59 (21.1%) had not yet received a reversal operation one year after the operation. The mean postoperative hospitalization duration was 4.8 days, and the mean interval between two operations was 127.5 days. The most common three complications for reversal surgery were wound infection (4.1%), cardiopulmonary disease (2.7%) and intestinal obstruction (1.4%).

Table 5
Reversal surgery complications

Type of complication	Reversal ostomy group (n = 220)	Percent
Anastomotic leakage	0	0
Bleeding	1	0.5
Intestinal obstruction	3	1.4
Abdominal infection	2	0.9
Wound infection	9	4.1
Cardiopulmonary	6	2.7
Deep-vein thrombosis	0	0
Urinary infection	1	0.5
Reoperation (%)	0	0

Table 6 presents the reasons for ostomates not undergoing reversal surgery within one year. The three most common reasons are tumor progression (50.8%), unable to tolerate surgery (28.8%) and anastomotic stricture (8.5%).

Table 6
Reasons for not undergoing reversal surgery within one year

Reasons	Non-reversal ostomy group (n = 59)	Percent
Tumor-related treatment not complete	3	5.1
Tumor progression	30	50.8
Anastomotic stricture	5	8.5
Unable to tolerate surgery	17	28.8
Unwilling to undergo surgery	4	6.8

Table 7 presents the factors that may influence whether the reversal surgery can be performed. Comparison of patients who did undergo reversal of temporary ostomy and those who did not yielded two factors effected the decision on closure, including age over 65 years old (P = 0.029) and advanced AJCC stage (III and IV) (P = 0.043).

Table 7
Factors associated with temporary ostomy reversal surgery

Variant	Reversal ostomy group (n = 220)	Non-reversal ostomy group (n = 59)	P value
Gender (F/M)	89/131	24/35	0.975
Age (y) (< 65 vs ≥ 65)	156/64	33/26	0.029
BMI (kg/m ²)	24.3	24.4	0.531
AJCC stage (I and II vs III and IV)	133/87	27/32	0.043
Postoperational chemoradiotherapy	127	35	0.826

4. Discussion

With increased life expectancy, the incidence and mortality of colorectal cancer is also increasing worldwide and especially in China (1, 9, 10). Unlike in western countries, rectal cancer is more common in China, and the majority of patients have lower rectal cancer (2). Because surgical resection is the main form of treatment for rectal cancer, the choice of surgical method is particularly important. Anastomotic leakage is the most serious complication after rectal resection and is associated with increased morbidity, mortality, and prolonged hospitalization (11–13). Mirnezami and McArdle reported that anastomotic leakage can lead to an increase in local recurrence of rectal cancer, reducing the overall survival (14, 15). Rullier(8) conducted a multivariate analysis and showed that the level of anastomosis was an independent factor for development of anastomotic leakage. It is worth noting that surgeons are more inclined to perform temporary ostomy in male patients to avoid anastomotic leakage; this is consistent with Rullier's (8) and Lipska's (16) conclusions that male sex is a risk factor of anastomotic leakage. This may be due to the combination of anatomical differences in the narrower male pelvis (16, 17) and the recently shown hormonal differences that influence the intestinal microcirculation (18). Low anterior resection with intraoperative temporary ostomy is a type of anus-preserving surgery that is used by surgeons to minimize the consequences of postoperative anastomotic dehiscence(4). Several studies(4–7) have confirmed that temporary ostomy is effective and beneficial for patients at high-risk of anastomotic leakage, such as those with previous irradiation of the pelvis, those who are hemodynamically unstable (e.g., trauma or sepsis), those undergoing chemotherapy or treatment with other biological agents that can impair wound healing, or those who have an intestinal anastomosis < 5 – 7 cm from the anal verge. A meta-analysis and systematic review showed that a temporary ostomy reduces the rate of clinically relevant anastomotic leakages and is thus recommended in surgery for low rectal cancers (19).

Normally, patients with a temporary ostomy reported difficulty in exercise, sleep, social activities, sexual activities, and wearing certain types of clothing. Additionally, some may suffer peristomal inflammation and dehydration resulting from high output. A systematic review (20) concluded that living with an ostomy negatively influences the overall quality of life. However, studies have identified ostomates' two major phases: stoma-related difficulties and perceived response shift. Patients' perception of quality of life with a temporary ostomy appears to have undergone a response shift through recalibration of their standards for measuring the quality of life and reconceptualization of what "good quality of life" is (21). In other words, patients' perceptions of the inconvenience of disease can be reshaped, in a positive direction. Florian investigated the impact of a diverting stoma on the quality of life in patients undergoing rectal cancer resection before and after stoma closure and found out that the negative impact on social functioning and GI symptoms had no clinically relevant influence on the global quality of life (22).

However, Taylor reported that some patients will experience altered bowel function after temporary ostomy reversal (23). A randomized multicenter trial showed that the severity of LAR syndrome was comparable in the ostomy and the non-ostomy groups, but incontinence for flatus and liquid stools were more commonly reported in the ostomy group(24). For the elderly(25), especially patients aged ≥ 70 years, they undergo proportionately more permanent fecal ostomy procedures than younger patients, with longer hospital stays, more postoperative complications, and higher mortality rates after undergoing the reversal operation.

In our study, we found that even with a higher proportion of neoadjuvant chemoradiotherapy and lower anastomosis, the ostomy group had a lower rate of grade C anastomotic leakage than the non-ostomy group. Cases of grade C anastomotic leakage are often fatal if operative reintervention with control of the septic source is delayed or not performed (26). Although the operation was more time-consuming, the first hospitalization expenses and postoperative recovery were similar between the two groups, which means that ostomy does not place too much extra burden on the patient or the health care system.

Orit Kaidar-Person summarized a series of complications of construction and closure of temporary loop ileostomy and reported a complication rate between 5% and 100% and incidence of non-closure rates between 0% and 19% (27). In our study, the complications associated with the stoma were mild, did not cause the patient great pain, and were completely curable with the reversal operation. Den Dulk's(28) study showed that 97% of patients chose to have a reversal operation within 1 year after prophylactic ostomy, while most of the remaining ostomy tend to be permanent. Studies have shown that postoperative metastasis(29) and local recurrence(30) of rectal cancer are risk factors for stoma to turn permanent, which was also consistent with the conclusion that advanced AJCC stage affected the rate of reversal in this study. It should be noted that anastomotic stenosis has often been neglected in the past, and its incidence has been reported as high as 30% in the previous research(31). Although endoscopic dilatation(32) is effective in the treatment of anastomotic stenosis, there are still many patients who cannot close their ostomies for this reason. Considering the high percentage of patients who can not reverse their ostomies in our study, preoperative consent for surgical patients is extremely important, especially given the possibility of the ostomy becoming permanent.

Even so, temporary stomas have a good preventive effect on grade C anastomotic leakage and they should be considered as an important means to avoid serious postoperative complications, especially in patients who cannot tolerate severe infection and have other risk factors and complications such as older age, primary underlying diseases, and immunocompromised status. To improve the quality of life of patients, reduce medical costs, and avoid permanent ostomy some studies have suggested temporary percutaneous ileostomy as a safe, efficient, and cost-effective option (11, 33). However, because this method of fecal diversion may not be sufficient, it has not yet been used on a large scale.

Our study has some limitations. First, the study is retrospective in nature and hence, biases may exist. Second, because the patients were not randomized, the surgeons decided which surgical approach was used, leading to a likely selection bias. Third, the end point of our study was the one-year follow-up after first discharge from hospital, which means that long-term survival data and complications could not be completely observed and assessed. The lack of above-mentioned data may affect the objectivity and comprehensiveness of the conclusion. Last, we did not evaluate other techniques involved in reducing anastomotic leakage and the corresponding reoperation rates. Despite these limitations, a large number of patients were included from multiple aspects in our study and relevant clinical data were complete, detailed, and reliable. Prospective randomized controlled trials and more observation time are needed to further validate our findings.

5. Conclusion

At the expense of everyday inconvenience, but reasonable operating time, temporary ostomy should be considered in low anterior resection as it reduces the rate of anastomotic leakage and reoperation rate in patients with a higher proportion of chemoradiotherapy and lower site of anastomosis. Overall, a significant proportion of patients' prophylactic ostomies become permanent, and the risk factors are age over 65 and advanced AJCC stage. Considering the possibility of the inconvenience associated with permanent ostomy, the application scope should be applied more to patients with low anastomosis and neoadjuvant treatment.

Abbreviations

LAR: Low anterior resection; BMI: Body mass index; ASA: American Society of Anesthesiology; AJCC: American Joint Committee on Cancer

Declarations

Ethics approval and consent to participate

The study was examined and approved by the local ethics committee and the protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki and its later amendments and regarding the

involvement of human subjects for research. Written informed consent was obtained from individual or guardian participants.

Consent for publication

Not applicable

Availability of data and material

The datasets generated during and analysed during the current study are not publicly available due to patients' private information need to be protected but are available from the corresponding author on reasonable request

Competing interests

The authors declare that they have no competing interests.

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Authors contributions

Affiliations

Department of Colorectal Surgery, National Cancer Center/ National Clinical Research Center for Cancer/ Cancer Hospital, Chinese Academy of Medical Science and Peking Union Medical College, Beijing, People's Republic of China

Chuanduo Zhao, Sicheng Zhou, Hao Su, Jianwei Liang and Zhixiang Zhou

Contributions

CZ collected the data, made the statistics and was the major contributor in writing the manuscript. SZ and HS were in part of data collection and analysis. JL was in part of revising the manuscript. ZZ were the main organizer for the study and made major contributor in designing the study and analyzing the data. All authors read and approved the final manuscript.

Corresponding author

References

1. Chen W, Zheng R, Baade PD, Zhang S, Zeng H, Bray F, et al. Cancer statistics in China, 2015. *CA Cancer J Clin.* 2016;66(2):115–32.
2. Gu J, Chen N. Current status of rectal cancer treatment in China. *Colorectal Dis.* 2013;15(11):1345–50.
3. Peeters KC, Tollenaar RA, Marijnen CA, Klein Kranenbarg E, Steup WH, Wiggers T, et al. Risk factors for anastomotic failure after total mesorectal excision of rectal cancer. *Br J Surg.* 2005;92(2):211–6.
4. Tan WS, Tang CL, Shi L, Eu KW. Meta-analysis of defunctioning stomas in low anterior resection for rectal cancer. *Br J Surg.* 2009;96(5):462–72.
5. Bax TW, McNevin MS. The value of diverting loop ileostomy on the high-risk colon and rectal anastomosis. *Am J Surg.* 2007;193(5):585–7; discussion 7–8.
6. den Dulk M, Marijnen CA, Collette L, Putter H, Pahlman L, Folkesson J, et al. Multicentre analysis of oncological and survival outcomes following anastomotic leakage after rectal cancer surgery. *Br J Surg.* 2009;96(9):1066–75.
7. Andrea Vignali M, Victor W. Fazio, MB, F ~ CS, FACS, Ian C. Laver/, MB, FRACS, FACS,, Jeffrey W. Milsom M, VACS, James M. Church, MD, FACS, Tracy L. Hull, MD,, Scott A. Strong M, and John R. Oakley, MB, FRACS, FACS. Factors associated with the occurrence of leaks in stapled rectal anastomoses- a review of 1014 patients. *JOURNAL OF THE AMERICAN COLLEGE OF SURGEONS.* 1997.
8. E. RULLIER CL, J. L. GARRELON, P. MICHEL*, J. SARIC and M. PARNEIX Risk factors for anastomotic leakage after resection of rectal cancer. *British Journal of Surgery* 1998.
9. Chen W, Sun K, Zheng R, Zeng H, Zhang S, Xia C, et al. Cancer incidence and mortality in China, 2014. *Chin J Cancer Res.* 2018;30(1):1–12.
10. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin.* 2018;68(6):394–424.
11. Bugiantella W, Rondelli F, Mariani L, Polistena A, Sanguinetti A, Avenia N, et al. Cost-effectiveness analysis of the temporary percutaneous ileostomy for faecal diversion after colorectal resection in elderly. *Aging Clin Exp Res.* 2017;29(Suppl 1):47–53.
12. W.L.Law KWCaHKC. Randomized clinical trial comparing loop ileostomy and loop transverse colostomy for faecal diversion following total mesorectal excision. *British Journal of Surgery.* 2002.
13. Rondelli F, Reboldi P, Rulli A, Barberini F, Guerrisi A, Izzo L, et al. Loop ileostomy versus loop colostomy for fecal diversion after colorectal or coloanal anastomosis: a meta-analysis. *Int J Colorectal Dis.* 2009;24(5):479–88.

14. Mirnezami A, Mirnezami R, Chandrakumaran K, Sasapu K, Sagar P, Finan P. Increased local recurrence and reduced survival from colorectal cancer following anastomotic leak: systematic review and meta-analysis. *Ann Surg.* 2011;253(5):890–9.
15. McArdle CS, McMillan DC, Hole DJ. Impact of anastomotic leakage on long-term survival of patients undergoing curative resection for colorectal cancer. *Br J Surg.* 2005;92(9):1150–4.
16. Lipska MA, Bissett IP, Parry BR, Merrie AE. Anastomotic leakage after lower gastrointestinal anastomosis: men are at a higher risk. *ANZ J Surg.* 2006;76(7):579–85.
17. Wai-lun Law M, FRCS, Kin-Wah Chu, MBBS, FRCS, Judy W. C. Ho, MBBS, FRCS, Cheung-Wah Chan, MBBS, FRCS. Risk factors for anastomotic leakage after low anterior resection with total mesorectal excision. *THE AMERICAN JOURNAL OF SURGERY.* 2000;VOLUME 179
18. Zheng F, Ba YY, Balazs Toth, Loring W. Rue III, Kirby I. Bland, and Irshad H. Chaudry. Gender differences in small intestinal endothelial function: inhibitory role of androgens. *Am J Physiol Gastrointest Liver Physiol.* 2004;286.
19. Huser N, Michalski CW, Erkan M, Schuster T, Rosenberg R, Kleeff J, et al. Systematic review and meta-analysis of the role of defunctioning stoma in low rectal cancer surgery. *Ann Surg.* 2008;248(1):52–60.
20. Vonk-Klaassen SM, de Vocht HM, den Ouden MEM, Eddes EH, Schuurmans MJ. Ostomy-related problems and their impact on quality of life of colorectal cancer ostomates: a systematic review. *Qual Life Res.* 2016;25(1):125–33.
21. Neuman HB, Park J, Fuzesi S, Temple LK. Rectal cancer patients' quality of life with a temporary stoma: shifting perspectives. *Dis Colon Rectum.* 2012;55(11):1117–24.
22. Herrle F, Sandra-Petrescu F, Weiss C, Post S, Runkel N, Kienle P. 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. *Diseases of the Colon & Rectum.* 2016;59(4):281–90.
23. Taylor C, Bradshaw E. Tied to the toilet: lived experiences of altered bowel function (anterior resection syndrome) after temporary stoma reversal. *J Wound Ostomy Continence Nurs.* 2013;40(4):415–21.
24. Gadan S, Floodeen H, Lindgren R, Matthiessen P. Does a Defunctioning Stoma Impair Anorectal Function After Low Anterior Resection of the Rectum for Cancer? A 12-Year Follow-up of a Randomized Multicenter Trial. *Dis Colon Rectum.* 2017;60(8):800–6.
25. Bosshardt TL. Outcomes of ostomy procedures in patients aged 70 years and older. *Arch Surg.* 2003;138(10):1077–82.
26. Rahbari NN, Weitz J, Hohenberger W, Heald RJ, Moran B, Ulrich A, et al. Definition and grading of anastomotic leakage following anterior resection of the rectum: A proposal by the International Study Group of Rectal Cancer. *Surgery.* 2010;147(3):339–51.
27. Kaidar-Person O, Person B, Wexner SD. Complications of construction and closure of temporary loop ileostomy. *J Am Coll Surg.* 2005;201(5):759–73.
28. den Dulk M, Smit M, Peeters KCMJ, Kranenburg EM-K, Rutten HJT, Wiggers T, et al. A multivariate analysis of limiting factors for stoma reversal in patients with rectal cancer entered into the total

- mesorectal excision (TME) trial: a retrospective study. *Lancet Oncology*. 2007;8(4):297–303.
29. Lindgren R, Hallbook O, Rutegard J, Sjudahl R, Matthiessen P. What Is the Risk for a Permanent Stoma After Low Anterior Resection of the Rectum for Cancer? A Six-Year Follow-Up of a Multicenter Trial. *Diseases of the Colon & Rectum*. 2011;54(1):41–7.
 30. Mak JCK, Foo DCC, Wei R, Law WL. Sphincter-Preserving Surgery for Low Rectal Cancers: Incidence and Risk Factors for Permanent Stoma. *World Journal of Surgery*. 2017;41(11):2912–22.
 31. Hiranyakas A, Da Silva G, Denoya P, Shawki S, Wexner SD. Colorectal anastomotic stricture: Is it associated with inadequate colonic mobilization? *Tech Coloproctology*. 2013;17(4):371–5.
 32. Nguyen-Tang T, Huber O, Gervaz P, Dumonceau JM. Long-term quality of life after endoscopic dilation of strictured colorectal or colocolonic anastomoses. *Surgical Endoscopy and Other Interventional Techniques*. 2008;22(7):1660–6.
 33. Rondelli F, Balzarotti R, Bugiantella W, Mariani L, Pugliese R, Mariani E. Temporary percutaneous ileostomy versus conventional loop ileostomy in mechanical extraperitoneal colorectal anastomosis: a retrospective study. *Eur J Surg Oncol*. 2012;38(11):1065–70.

Figures

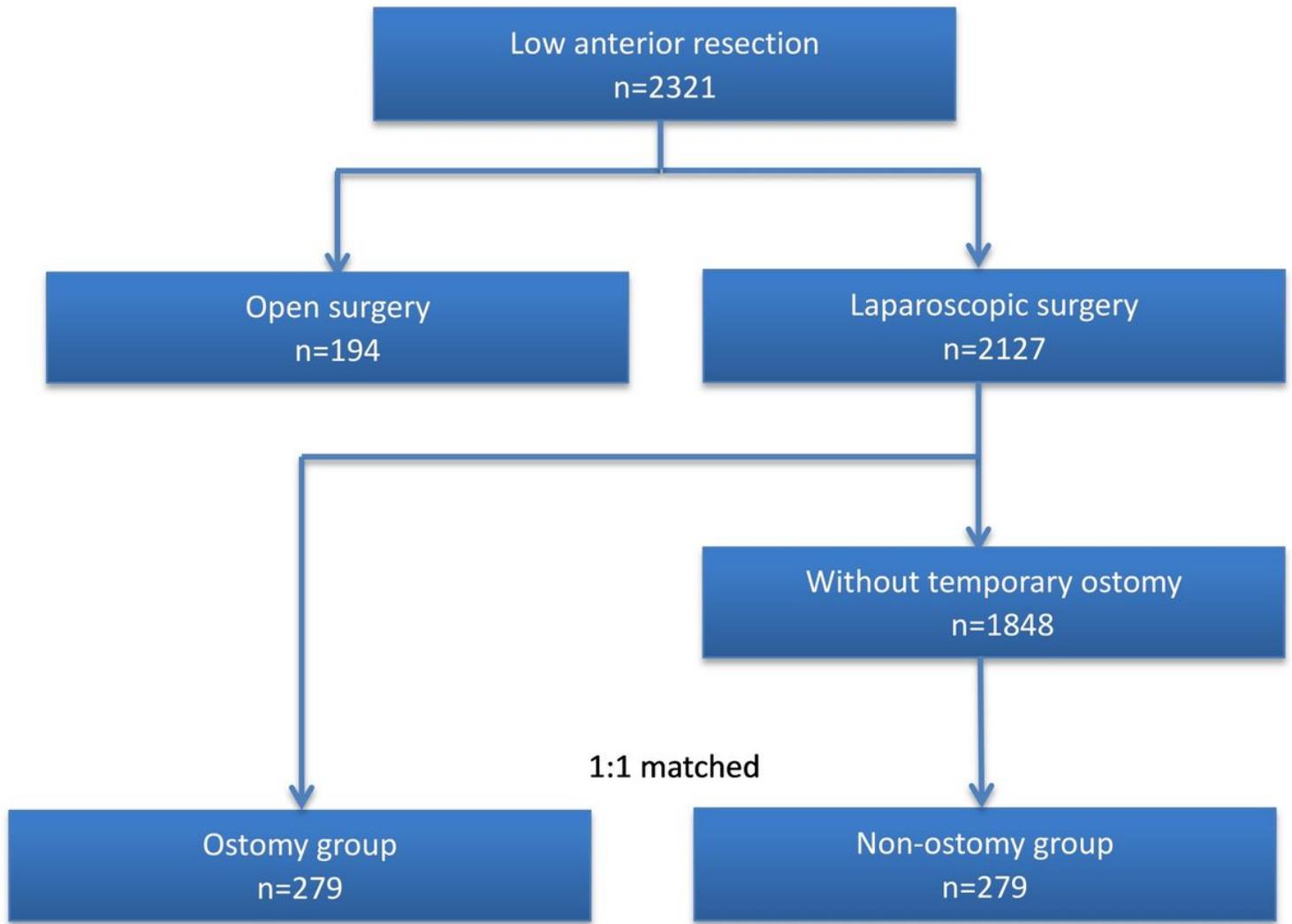


Figure 1

Patient flow in the study. Laparoscopic surgery requires bowel mobilization, division, ligation of vessel and lymphadenectomy were done intracorporeally.