

Safety and survival outcomes of transanal natural orifice specimen extraction using prolapsing technique for patients with middle- to low-rectal cancer

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Abstract

Objective: The transanal approach to specimen collection, combined with the prolapsing technique, is a well-established and minimally invasive surgery for treating rectal cancer. However, reports on outcomes for this approach are sparse. We compared short- and long-term outcomes of conventional laparoscopic surgery (CLS) vs. transanal natural orifice specimen extraction (NOSE) using the prolapsing technique for patients with middle- to low-rectal cancer.

Methods: From January 2013 to December 2017, we enrolled consecutive patients with middle- to low-rectal cancer undergoing laparoscopic anterior resection. Totally, 50 patients who underwent transanal NOSE using the prolapsing technique were matched with 50 patients who received CLS. Clinical parameters and survival outcomes between the two groups were compared.

Results: Estimated blood loss (29.70±29.28 vs. 52.80±45.09 mL, P=0.003), time to first flatus (2.50±0.79 vs. 2.86±0.76, P=0.022), time to liquid diet (3.62±0.64 vs. 4.20±0.76 d, P<0.001), and the need for analgesics (22% vs. 48%, P=0.006) were significantly lower for the NOSE group compared to the CLS group. The incidences of overall complications and fecal incontinence were comparable in both groups. After a median follow-up of 44.52 months, the overall local recurrence rate (6% vs. 5%, P=0.670), 3-year disease-free survival (86.7% vs. 88.0%, P=0.945) and 3-year overall survival (95.6% vs. 96.0%, P=0.708), were not significantly different.

Conclusions: For total laparoscopic rectal resection, transanal NOSE using the prolapsing technique is effective and safe, and associated with less trauma and pain, a faster recovery, and similar survival outcomes compared to CLS.

Keywords: Natural orifice specimen extraction; transanal specimen extraction; rectal cancer; prolapsing technique; survival

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Introduction

Laparoscopic surgery is increasingly employed during colorectal cancer treatment. Several randomized controlled trials demonstrated that laparoscopic colorectal cancer resection resulted in reduced blood loss, improved bowel function recovery, shorter hospitalization, and similar long-term survival outcomes without increased perioperative morbidity and mortality when compared with open surgery (1-4). However, current laparoscopic techniques still require a mini-laparotomy to extract specimen and construct bowel anastomosis. This mini-laparotomy may cause postoperative pain, cosmetic problems, and wound-related complications (5,6). The use of laparoscopic low-anterior resection for the treatment of rectal cancer also poses other challenges. These challenges include determining appropriate distal transection line and constructing intracorporeal anastomosis, which may result in positive surgical margins and a high rate of abdominal perineal resection (7-9).

To resolve the problems mentioned above, a novel laparoscopic technique was developed. This technique combines a total intracorporeal anastomosis with natural orifice specimen extraction (NOSE) through the anus or vagina (10,11). This approach has been widely practiced in recent years because it eliminates the abdominal incision, resulting in less pain, better cosmesis, and decreased rate of wound-related complications, when compared with conventional laparoscopic surgery (CLS) (12-14). Moreover, several studies reported that total laparoscopic surgery with NOSE resulted in comparable long-term outcomes to CLS (15-17). NOSE, combined with the prolapsing technique, resolves issues related to selecting an appropriate distal transection line (18-20). This technique can accurately identify distal margin, which may contribute to organ preservation for patients with low-rectal cancer. However, reports on outcomes for this approach are sparse, especially compared with CLS. Therefore, we designed a case-matched study to evaluate short- and long-term outcomes of CLS vs. transanal NOSE using the prolapsing technique for patients with middle- to low-rectal cancer.

Materials and methods

Patient cohort

Data were retrospectively collected from consecutive patients with middle- to low-rectal cancer who underwent

laparoscopic anterior resection from January 2013 to December 2017. Patients with the following characteristics were included: clinically staged as T1-3NxM0; a distance of 4-7 cm between the tumor and anal verge; tumor size ≤ 5 cm; and a body mass index (BMI) ≤ 30 kg/m². Patients with distant metastases, multiple primary tumors, those who underwent emergency surgery due to obstruction, bleeding, or perforation, and those who underwent abdominal perineal resection were excluded. Totally, 50 patients who underwent transanal NOSE with the prolapsing technique were identified and assigned to the NOSE group. These 50 cases were then matched with 50 patients who underwent CLS based on age, sex, BMI, surgery date, preoperative chemoradiotherapy, and pathological stage (Figure 1). Before surgery, all patients underwent the same assessments, including physical examinations, blood tests, colonoscopy to confirm the pathology, and rectal magnetic resonance imaging (MRI) to determine the local staging. Patients were excluded if pulmonary and abdominopelvic contrast-enhanced computed tomography (CT) scans showed distant metastases. The experienced colorectal surgical team completed curative R0 resections, adhering to the total mesorectal excision (TME) principle. Tumor stage was evaluated according to the American Joint Committee on Cancer (AJCC, seventh edition) staging system. Neoadjuvant chemoradiotherapy was given before curative surgery in patients with clinical stage II and III tumors. Patients diagnosed with pathological stages II and III received adjuvant chemoradiotherapy if they did not receive preoperative chemoradiotherapy. All enrolled patients gave written or oral consent to participate in the study. The Institutional Review Board Committee of the Cancer Hospital at the Chinese Academy of Medical Sciences approved this study (Approval No. 18-015/1617).

Surgery

With the patient in a modified lithotomy position, five trocars (2 mm \times 12 mm and 3 mm \times 0.5 mm) were placed; one trocar was positioned supraumbilical for the camera; while two trocars were positioned on the right and left quadrants, respectively. A pneumoperitoneum was maintained at 12-15 mmHg. After abdominal exploration, the patient was moved to the Trendelenburg position for full exposure of the pelvic cavity.

Standard techniques were performed laparoscopically in both groups, including high ligation of the inferior

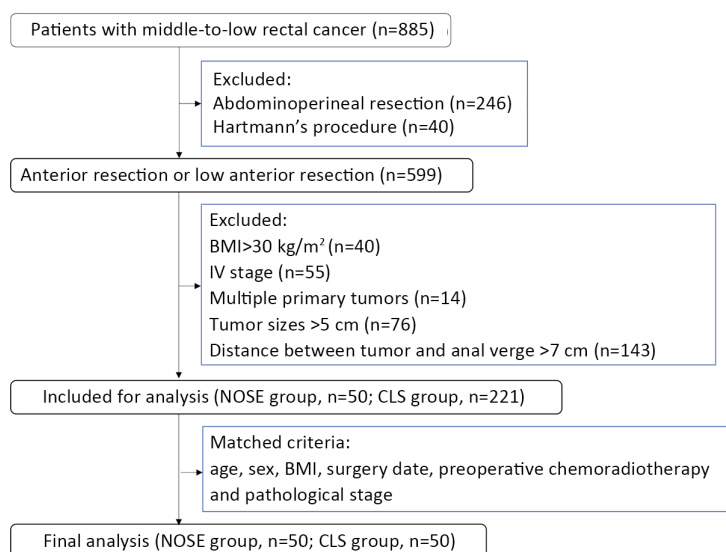


Figure 1 Flowchart of patients enrolled in this study. BMI, body mass index; NOSE, transanal natural orifice specimen extraction; CLS, conventional laparoscopic surgery.

mesenteric vessel, medial-to-lateral bowel mobilization, lymph node dissection, sharp pelvic dissection with nerve protection, and division of the distal rectum. Subsequently, the NOSE and CLS groups were subjected to different procedures. In the NOSE group, after adequate mobilization and division of the sigmoid colon and distal rectum, the main challenge associated with intracorporeal anastomosis was how to place the anvil head into the proximal bowel lumen. Here, we introduced the NOSE approach for digestive tract reconstruction. Briefly, after gentle dilation of the anus (three to four finger widths), a sterilized plastic sleeve was introduced into the rectum. The sleeve was usually taken to the distal sigmoid colon. An anvil head was inserted into the proximal sigmoid colon via the sleeve (Figure 2A), and transection of the sigmoid colon was achieved with a 60 mm linear stapler (Figure 2B) while the anvil head was in the sigmoid colon. The remaining stump was sterilized by povidone gauze. Then, a grasping forceps, inserted through the anus, was used to grab the rectal stump and gently everted the distal rectum extracorporeally (Figure 2C). The reverse rectal specimen was washed with 1–2 liters of saline mixed with povidone-iodine. Then, the distal rectum was transected using a curved cutter stapler (Figure 2D), and the specimen was extracted. Rectal and pelvic irrigation was performed again using the cytotoxic solution. After removing the anvil head from the proximal sigmoid colon (Figure 2E), a circular stapler was utilized to construct the end-to-end anastomosis (Figure 2F).

In the CLS group, a 4–7 cm long mini-laparotomy was created to transect the proximal sigmoid colon and the distal rectum for the end-to-end colorectal anastomosis. Generally, protective stomas are made for patients with diabetes, or for those who received neoadjuvant therapies, or those with anastomoses within 2 cm of the dentate line.

Follow-up

Patients' follow-up was conducted quarterly for 2 years, bi-annually for the next 3 years, then annually for the remainder of the study, as described previously (21). A clinical history, physical exam, blood test (including carcinoembryonic antigen), chest and abdomen CT scans, and a pelvis MRI were completed at each follow-up. A colonoscopy was performed in the first year after surgery. If no advanced adenoma was found, colonoscopies were performed at 3 years, then every 5 years. The deadline for the follow-up was March 1, 2020. At the last follow-up, the Wexner score was collected, which has become a widely used for assessment of severity of fecal incontinence (22).

Statistical analysis

Consecutive patients from the NOSE and CLS groups were matched in a 1:1 ratio using 20% of the standard deviation of the propensity score. Matching conditions were mentioned above. Continuous variables were described as $\bar{x} \pm s$, and categorical variables were presented as number (frequency) and compared by Chi-square or

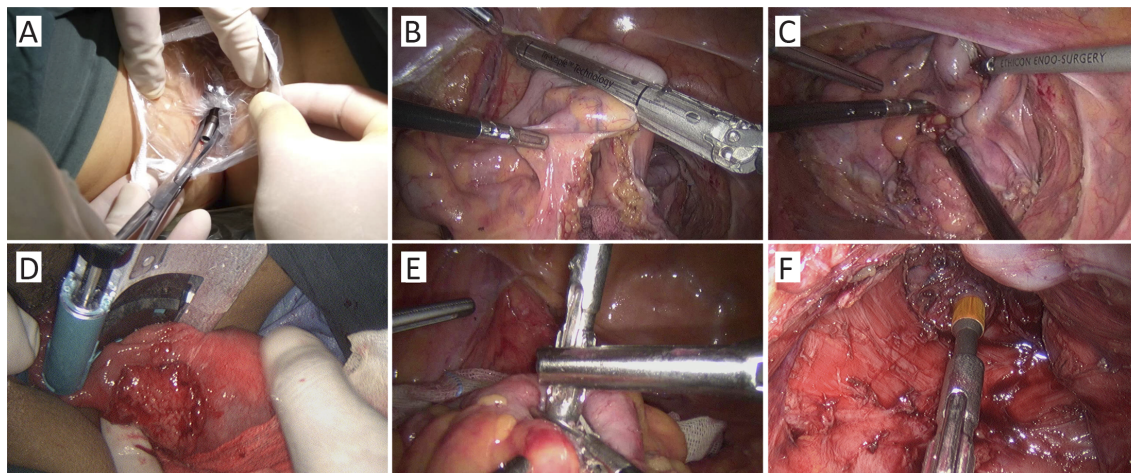


Figure 2 Surgical procedure. (A) Anvil was introduced into bowel lumen through anus; (B) Sigmoid colon was transected using endoscopic linear cutter staplers; (C) Distal rectum was extracted from anus; (D) Distal rectum was transected using curved cutter stapler; (E) Anvil head was extracted from sigmoid colon; (F) An end-to-end anastomosis was performed.

Fisher's exact tests. T-tests and Mann-Whitney U tests for normally and non-normally distributed values, respectively, were utilized to compare continuous data. Disease-free survival (DFS) was defined as the time between the date of surgery and the first tumor recurrence (local or distant metastases), and overall survival (OS) was defined as the time between the date of surgery and the time of death or last follow-up. Local recurrence (LR) rate, DFS and OS rates were calculated using Kaplan-Meier plots. Log-rank tests were utilized to compare LR, DFS, and OS rates. IBM SPSS software (Version 25.0; IBM Corp., New York, USA) was used for all analyses. $P < 0.05$ were deemed statistically significant.

Results

Baseline characteristics

Consecutive patients with middle- to low-rectal cancer undergoing laparoscopic anterior resection were enrolled between January 2013 and December 2017. A total of 100 patients were identified in this study, and 50 patients from each group were matched. The baseline clinicopathological characteristics of the two groups including age, sex, BMI, American Association of Anesthesiologists (ASA) classification, neoadjuvant therapy, history of abdominal surgery, adjuvant therapy, and pathological tumor stage were not significantly different; however, the tumor to anal verge distance in the NOSE group was significantly shorter compared that in the CLS group, as summarized in *Table 1*.

Postoperative outcomes

As shown in *Table 2*, mean operative times were similar in the two groups (NOSE 162.24 ± 43.26 vs. CLS 145.86 ± 49.97 min, $P = 0.083$). The mean estimated blood loss of the NOSE group was significantly reduced compared with the CLS group (29.70 ± 29.28 vs. 52.80 ± 45.09 mL, $P = 0.003$). All study patients underwent the planned surgery, with no transition to open surgery. Neither group experienced intraoperative complications. Time to first flatus, defecation, and liquid diet, and the postoperative hospitalization period were shorter in the NOSE group compared to the CLS group. However, differences were not statistically significant, except for time to first flatus and liquid diet. Although the visual analog scale score was not prospectively recorded, patients in NOSE group required less additional postoperative analgesia (22% vs. 48%, $P = 0.006$) in comparison to those in CLS group. Furthermore, the NOSE group required fewer analgesia administrations.

Postoperative complications were encountered in four patients in NOSE group and seven patients in CLS group. Three patients in NOSE group developed anastomotic leakage; two were treated with a palliative stoma and one with conservative therapy. One patient in the NOSE group had an intestinal obstruction that required gastrointestinal decompression along with cessation of oral intake. No patients developed complications related to the prolapsing technique, such as anal avulsion or bleeding. In the CLS group, three patients developed anastomotic leakage, and

Table 1 Patient characteristics

Variables	n (%)		P
	NOSE (N=50)	CLS (N=50)	
Age (year) ($\bar{x}\pm s$)	56.94 \pm 10.70	54.10 \pm 9.80	0.169
Sex			0.391
Male	32 (64)	36 (72)	
Female	18 (36)	14 (28)	
BMI (kg/m ²) ($\bar{x}\pm s$)	23.90 \pm 3.20	24.66 \pm 2.59	0.197
ASA classification			0.182
I	3 (6)	7 (14)	
II	47 (94)	43 (86)	
Neoadjuvant therapy			0.218
No	46 (92)	42 (84)	
Yes	4 (8)	8 (16)	
History of abdominal surgery			0.790
No	42 (84)	41 (82)	
Yes	8 (16)	9 (18)	
Adjuvant therapy			0.315
No	30 (60)	25 (50)	
Yes	20 (40)	25 (50)	
Pathological TNM stage			0.528
I	25 (50)	24 (48)	
II	6 (12)	10 (20)	
III	19 (38)	16 (32)	
Distance between tumor and the anal verge (cm) ($\bar{x}\pm s$)	5.26 \pm 0.99	5.66 \pm 0.87	0.034

BMI, body mass index; ASA, American Society of Anesthesiologists; NOSE, natural orifice specimen extraction; CLS, conventional laparoscopic surgery.

one developed a rectovaginal fistula; all were treated using a palliative stoma. Additional postoperative complications in the CLS group included a pelvic abscess, urinary retention, and ileus; all had a healthy recovery without surgery. No surgery-related deaths occurred.

Pathological outcomes are summarized in *Table 3*. No significant differences were detected in tumor size, pathological type, differentiation, pathological T and N category, or perineural and vascular invasion. Although the resected bowel length in the NOSE group was shorter than that in the CLS group ($P=0.011$), the harvested lymph node quantity was similar in both groups. The distal resection margin (DRM) in the NOSE group was smaller than that in the CLS group (0.94 ± 0.56 vs. 1.28 ± 0.83 cm, $P=0.019$). Fast frozen pathology was performed in cases with DRM <1 cm. No patients in the NOSE group had a positive distal margin. This indicated that the distal margin could

be accurately identified using the prolapsing technique.

Long-term outcomes

The median follow-up length was 44.52 months. During the follow-up period, eight patients in the NOSE group developed recurrences, including three lung metastases, three intraluminal local recurrences, one liver metastasis, and one local lymph node metastasis. Seventy-five percent (6/8) of recurrences occurred within 36 months after the initial surgery. Two patients in the NOSE group died because of tumor recurrence, and one for another reason. In the CLS group, eight patients developed recurrences, including three lung metastases, two liver metastases, one intraluminal local recurrence, one local lymph node metastasis, and one concomitant local recurrence and liver metastasis. Seventy-five percent (6/8) of recurrences occurred within 36 months after the initial surgery. Three

Table 2 Operative and postoperative outcomes

Variables	$\bar{x} \pm s$		P
	NOSE (N=50)	CLS (N=50)	
Operation time (min)	162.24±43.26	145.86±49.97	0.083
Estimated blood loss (mL)	29.70±29.28	52.80±45.09	0.003
Conversion to open surgery	0	0	–
Time to first flatus (d)	2.50±0.79	2.86±0.76	0.022
Time to first defecation (d)	3.28±0.78	3.56±0.81	0.082
Time to liquid diet (d)	3.62±0.64	4.20±0.76	<0.001
Postoperative hospitalization (d)	9.14±4.48	9.52±4.32	0.667
Analgesia requirement [n (%)]			0.006
No	39 (78)	26 (52)	
Yes	11 (22)	24 (48)	
Times of analgesia requirement*	1.73±0.91	4.58±1.44	<0.001
Protective stoma [n (%)]			0.836
No	32 (64)	31 (62)	
Yes	18 (36)	19 (38)	
Postoperative complications [n (%)]	4 (8)	7 (14)	0.324
Anastomotic leakage	3	3	
Anastomotic stenosis	0	0	
Anastomotic bleeding	0	0	
Ileus	1	1	
Rectovaginal fistula	0	1	
Pelvic abscess	0	1	
Urinary retention	0	1	
Wound infection	0	0	

*, 35 patients are available for analysis; NOSE, transanal natural orifice specimen extraction; CLS, conventional laparoscopic surgery.

patients in the CLS group died due to tumor recurrences, and one for another reason. No patients developed recurrences related to the incision site or extraction site in either group. The details of patients with tumor recurrences are summarized in Table 4. The LR rate was comparable in both groups (6% vs. 5%, $P=0.670$; Figure 3A). Three-year DFS and OS rates were similar for the NOSE and CLS groups (DFS: 86.7% vs. 88.0%, $P=0.945$; Figure 3B; OS: 95.6% vs. 96.0%, $P=0.708$; Figure 3C).

Wexner score was collected at the last follow-up, and data were available for 38 patients in the NOSE group and 36 patients in the CLS group. Patients with a stoma ($n=7$), or who were dead ($n=7$), or who refused to answer the questionnaire ($n=12$) were excluded from the analysis. In both groups, 21 (55.3%) patients had no incontinence (0 point). Each group had 14 (36.8%) patients with minor incontinence (1–9 points). Three (7.9%) patients in the NOSE group and one patient in the CLS group (2.8%)

experienced severe incontinence (10–19 points). There were no significant between-group differences in postoperative complications ($P=0.633$) (Figure 4).

Discussion

We successfully performed total laparoscopic anterior resection using the prolapsing technique for rectal cancer with transanal specimen extraction and demonstrated the effectiveness and safety of this technique. Compared with the CLS group, patients in the NOSE group experienced less estimated blood loss and pain, and a faster recovery. Meanwhile, there was no increase in complications associated with the NOSE procedure, thus demonstrating the superiority of this approach. More importantly, long-term survival outcomes and bowel function were similar for the two groups.

Laparoscopic surgery has been extensively used in recent

Table 3 Pathological outcomes

Variables	n (%)		P
	NOSE (N=50)	CLS (N=50)	
Tumor size (cm) ($\bar{x}\pm s$)	3.29±1.47	3.75±1.05	0.074
Length of bowel resection (cm) ($\bar{x}\pm s$)	13.32±3.94	15.49±4.38	0.011
Distal resection margin (cm) ($\bar{x}\pm s$)	0.94±0.56	1.28±0.83	0.019
Pathological type			0.646
Adenocarcinoma	47 (94)	48 (96)	
Mucinous adenocarcinoma	3 (6)	2 (4)	
Tumor differentiation			0.461
Well	3 (6)	5 (10)	
Moderate and poor	47 (94)	45 (90)	
Pathological T stage			0.151
T1–2	34 (68)	27 (54)	
T3–4	16 (32)	23 (46)	
Pathological N stage			0.529
N0	31 (62)	34 (68)	
N1–2	19 (38)	16 (32)	
Number of lymph node harvested ($\bar{x}\pm s$)	20.54±8.28	20.02±6.84	0.733
Perineural invasion			0.134
No	43 (86)	37 (74)	
Yes	7 (14)	13 (26)	
Vascular invasion			0.220
No	42 (84)	37 (74)	
Yes	8 (16)	13 (26)	

NOSE, transanal natural orifice specimen extraction; CLS, conventional laparoscopic surgery.

years for treating colorectal cancer. However, CLS still requires an abdominal incision for specimen extraction and anastomosis, and this 4–7 cm incision is associated with some complications. The NOSE technique was developed to eliminate the need for an abdominal incision. This allowed the intraoperative abdominal operation and anastomosis procedures to be performed laparoscopically. The specimen was extracted through a natural orifice such as the vagina or anus. Two prospective randomized clinical trials, which compared the short-term outcomes in NOSE vs. CLS groups, were recently published. These trials demonstrated that the NOSE group experienced less pain, required less analgesia, and experienced lower wound infection rates compared to the CLS group; additionally, perioperative morbidity did not increase (12,14). Also, several retrospective studies suggested that patients who underwent NOSE recovered intestinal function faster and experienced better cosmetic outcomes than patients treated with CLS (13,16). More importantly, recent studies have

indicated that the long-term survival outcomes, including LR, DFS and OS, were comparable between the NOSE and CLS groups (15,17).

Previous studies have demonstrated that NOSE was effective and safe for use in patients with colorectal cancer. However, this technique might not be suitable for patients whose lesions are located in the lower rectum, because of the difficulty in determining appropriate distal transection and cutting the distal rectum. To resolve this problem, NOSE combined with the prolapsing technique was developed. Several studies suggested that transanal specimen extraction using the prolapsing technique for total laparoscopic rectal resection was effective and safe in selected patients (18–20). However, these studies had some limitations, such as small cohort sizes and no comparison with CLS, for determining clinical outcomes and long-term survival.

In the short-term, patients in the NOSE group experienced less blood loss, required less analgesia, and

Table 4 Clinicopathological details of patients with tumor recurrence

Case	Group	Gender	Age (year)	Stage	Time of recurrence (month)	Site of recurrence	Treatment after recurrence	Outcome
1	NOSE	Male	71	T2N0M0	6.47	Local	Surgery	Alive
2	NOSE	Male	58	T2N0M0	23.27	Lung	Surgery	Alive
3	NOSE	Male	40	T3N2M0	23.83	Lung	Chemotherapy	Dead
4	NOSE	Male	42	T2N0M0	24.77	Local lymph node	Radiotherapy	Alive
5	NOSE	Male	65	T3N1M0	34.97	Liver	Chemotherapy	Alive
6	NOSE	Female	52	T3N1M0	35.30	Lung	Surgery	Alive
7	NOSE	Male	71	T3N1M0	44.00	Local	Radiotherapy	Dead
8	NOSE	Female	46	T2N1M0	48.87	Local	Surgery	Alive
9	CLS	Male	61	T4aN2M0	6.83	Local and liver	Chemotherapy	Dead
10	CLS	Male	44	T3N2M0	13.23	Lung	Chemotherapy	Dead
11	CLS	Male	59	T3N2M0	13.87	Liver	Radiofrequency ablation	Alive
12	CLS	Female	34	T3N2M0	15.23	Lung	Radiofrequency ablation	Alive
13	CLS	Male	64	T3N2M0	22.23	Liver	Chemotherapy	Dead
14	CLS	Male	42	T2N0M0	25.30	Local lymph node	Radiotherapy	Alive
15	CLS	Female	54	T3N2M0	42.87	Lung	Radiofrequency ablation	Alive
16	CLS	Male	49	T3N2M0	63.33	Local	Surgery	Alive

NOSE, transanal natural orifice specimen extraction; CLS, conventional laparoscopic surgery.

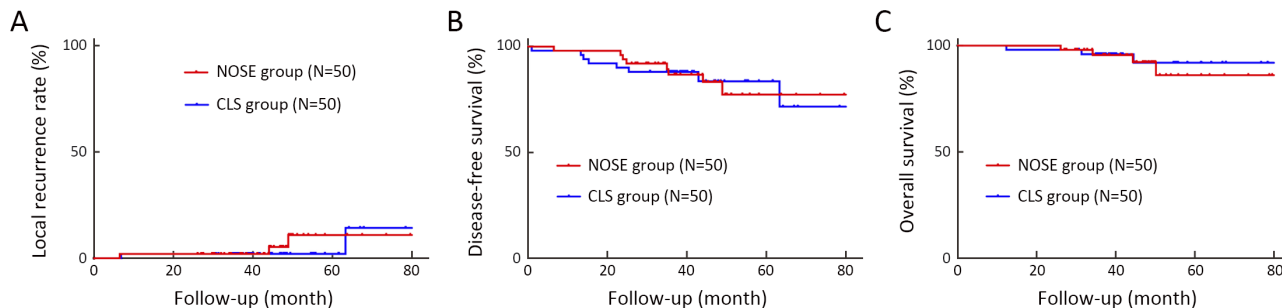


Figure 3 Survival outcomes. (A) Overall local recurrence rate in NOSE group and CLS group ($P=0.670$); (B) Three-year DFS rate in NOSE group and CLS group ($P=0.945$); (C) Three-year OS rate in NOSE group and CLS group ($P=0.708$). NOSE, transanal natural orifice specimen extraction; CLS, conventional laparoscopic surgery; DFS, disease-free survival; OS, overall survival.

experienced quicker intestinal function recovery. Compared to the CLS group, there was no change in the mean operative time or in the incidence of perioperative complications. Potential reasons for the superior short-term outcomes include the absence of an abdominal incision. This might reduce both blood loss and the need for analgesics during the intraoperative period. Meanwhile, earlier ambulation, due to less incision pain, might promote bowel functions. Total laparoscopic surgery also prevents the intraabdominal organs from contacting the external environment; thus, the internal environment is less disturbed, contributing to the faster recovery of intestinal

function.

This study compared long-term survival outcomes between the NOSE and CLS groups. The major concern surrounding this prolapsing technique is the fear of tumor cell exfoliation and implantation. Although three patients in the NOSE group developed local recurrences, no patients experienced recurrences related to the extraction site or multifocal pelvic sidewall recurrences (23). During the NOSE procedure, the oncological principle was not changed; meanwhile, irrigation of the pelvic cavity and distal rectum after bowel eversion could further decrease the potential risk of tumor spillage. However, we still found

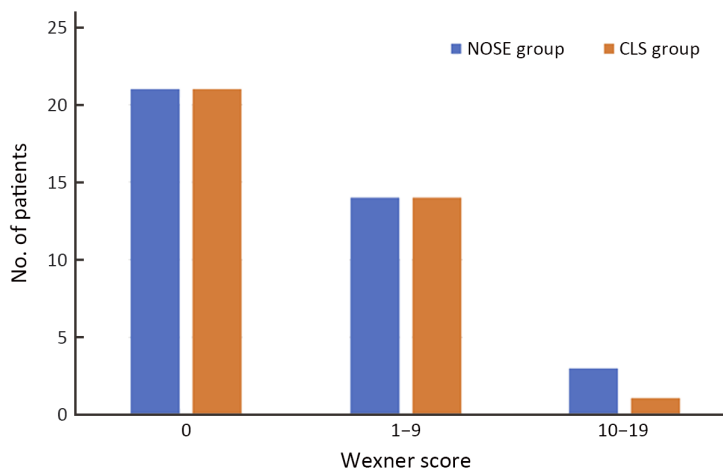


Figure 4 Wexner score in NOSE group and CLS group ($P=0.633$). NOSE, transanal natural orifice specimen extraction; CLS, conventional laparoscopic surgery.

that the pathological stage of the tumor recurrence cases in the NOSE group was lower than that in the CLS group. There were several reasons for this situation. First, the sample size of this study was small, and the retrospective cohort might cause selection bias. Second, the follow-up time was not enough, and the longer survival outcomes remained to be investigated. Third, our first experience to perform NOSE might inevitably cause tumor cell exfoliation or implantation, and these three cases with stage T2N0M0 who experienced tumor recurrences in the NOSE group all occurred in 2013 and 2014, although the oncological principle was not changed during the NOSE procedure. On the whole, the LR rate with 6% in the NOSE group was comparable to the historical LR rates after conventional TME or transanal TME (3,24), and large and prospective randomized clinical trials should be conducted to further confirm the safety of NOSE.

The DRM in the NOSE group was shorter, and the mean DRM was <1 cm, possibly due to the closer distance between the tumor and the anal verge afforded by the NOSE procedure. For patients where the DRM was <1 cm, fast-frozen pathology was performed, and no patients had a positive distal margin. During the follow-up period, five patients developed local recurrences, and DRM <1 cm was detected in two cases; more intriguingly, these two local recurrences occurred three years later after initial excision. Hence, a shorter distal resection negative margin is not likely to elevate the LR rate; on the contrary, the distal margin could be accurately identified during the prolapsing procedure.

Given the fact that the rectum is everted, there may be

concerns related to bowel function. In this study, we found that the Wexner score was similar in both groups. Although four patients experienced severe incontinence, receiving radiotherapy ($n=3$) and having a tumor located in lower rectum ($n=1$) might explain the observed episodes of fecal incontinence. Careful case selection is an essential prerequisite to performing this technique. Patients with large tumors or obesity were excluded from the NOSE group; therefore, this approach was successfully completed in all 50 patients, without conversion to open surgery.

Another concern is the potential risk of contamination in the process of intracorporeal bowel opening. Human and animal studies have found increased peritoneal contamination during the NOSE procedure; however, this did not translate into increased infectious complications (25,26). The prolapsing procedure could decrease the risk of intracorporeal contamination because the distal rectum was transected extracorporeally. Also, repeated pelvic irritation could contribute to a lower risk of infectious morbidity.

This study has several limitations. First, although we used the matching method to compare the clinical outcomes between the two groups, the analysis was limited by its retrospective nature and selection bias. Second, although we provided the Wexner score at the last follow-up, we did not collect the Wexner form at baseline. Also, we only evaluated the fecal continence score, and subjective data such as urgency and objective data such as manometric pressures, and sonographic anal sphincter appearance were not provided. To address this, we designed a prospective randomized clinical trial to evaluate postoperative health-

related quality of life in the CLS group vs. the NOSE group (ChiCTR1900026970). Finally, the sample size of this study was small, which may limit the statistical power.

Conclusions

Our results demonstrate the effectiveness and safety of transanal NOSE using the prolapsing technique compared to CLS in patients with middle- to low-rectal cancer. However, large and prospective randomized clinical trials should be conducted to confirm our conclusions.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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