Laparoscopic High Anterior Resection with Transrectal Natural Orifice Specimen Extraction Has Better Short-Term Recovery and Psychological Wellness Outcomes Compared to Conventional Laparoscopy

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Abstract

Background: Transrectal natural orifice specimen extraction (NOSE) is less invasive compare to traditional laparoscopic-assisted anterior resection (LAR). However, psychological evaluation of patients after transrectal LAR-NOSE is needed to evaluate its clinical feasibility. This study aimed to compare patient outcomes between LAR and LAR-NOSE.

Methods: We studied 215 patients with colorectal cancer who underwent surgery between June 2015 and April 2018; they were randomized into two groups: LAR-NOSE (n=109) and LAR (n=106). Data on pain, anxiety, and depression were collected and compared. Pain was assessed by a visual analogue scale (VAS) and anxiety and depression by the self-rating anxiety scale (SAS), self-rating depression scale (SDS), and state-trait anxiety inventory. The overall survival and 5-year disease-free survival (DFS) rates were noted.

Results: The extraction success rate in the LAR-NOSE group was 87.1% (95/109 cases). The LAR-NOSE SAS (44.21 ± 8.46) and SDS (37.29 ± 8.98) scores were significantly lower than the LAR scores (51.04 ± 9.12 and 44.65 ± 9.27 , respectively; $P < 0.05$) 1 week postoperatively. The LAR VAS scores were significantly higher on postoperative days 1–3 ($P < 0.05$). LAR-NOSE was associated with faster operational and intestinal recovery times, less blood loss, and shorter postoperative hospitalization ($P < 0.05$). However, 5-year DFS between the groups was the same.

Conclusion: patients in the LAR-NOSE group showed better outcomes related to postoperative anxiety and depression, postoperative complications, and short-term postoperative recovery. Our results suggest transrectal NOSE as a feasible and potentially preferable method for treatment in selected patients.

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Background

Colorectal cancer is one of the most prevalent malignant tumors globally, and its morbidity and mortality have been increasing each year, and seriously threatens the quality of life and health of millions[1]. Rectal cancer accounts for approximately 30% of all colorectal cancers[2]. Laparoscopic-assisted anterior resection (LAR) with natural orifice specimen extraction (NOSE) is a relatively new surgical method for treating colorectal cancer. The NOSE procedure was first applied in colectomy in 1991, and the term “NOSE” was coined by Palanivelu in 2008[3, 4]. The NOSE surgery involves taking out the specimen through the natural cavity and then performing laparoscopic bowel reconstruction. Compared with traditional LAR, NOSE does not require additional abdominal incisions to remove specimens[5]. It reduces not only postoperative pain but also the occurrence of surgical complications, contributing to rapid recovery after surgery[6, 7]. Since its first report, the NOSE technique has not been widely adopted due to its difficulty and high failure rate in obese patients[8]. However, with the development of minimally invasive surgical concepts and innovations, such as three-dimensional laparoscopy and da Vinci robot-assisted procedures, NOSE is becoming more feasible and effective[9, 10].

Patients with malignant tumors often experience severe negative emotions and mental illness after diagnosis[11]. Among these negative emotions, anxiety and depression are closely related. Anxiety is mainly expressed as restlessness, while depression is mainly expressed as apathy[12, 13]. Studies have shown that patients with malignant tumors have a 2–3 times higher risk of depression compared with healthy people[14]. The estimated prevalence of anxiety in patients with colorectal cancer ranges from 1.0–47.2%, while that of depression ranges from 1.6–57%[15]. It has been shown that psychological changes, such as anxiety and depression significantly reduce treatment efficacy and an individual's quality of life[16]. The anxiety in patients with colorectal cancer is associated with the fear of iatrogenic injury, clinical treatment effects, cancer pain, surgical stress, and treatment complications; these anxieties can all lead to psychological distress in patients[17]. In the surgical treatment of colorectal cancer, different surgical methods have been associated with psychological changes in the levels of anxiety and depression in patients. Several studies have compared psychological outcomes associated with different colorectal surgeries and found that patients undergoing laparoscopic surgeries had better psychological well-being than those undergoing open surgeries[18].

An investigation of the psychological status of patients after transrectal LAR-NOSE is needed for the proper clinical evaluation of its feasibility. The long-term clinical efficacy of transrectal NOSE for colorectal cancer is also underreported, and there are conflicting results regarding its oncological safety and risk for infection[19]. Therefore, this prospective randomized controlled study aimed to provide a theoretical basis for the clinical application of NOSE surgery by comparing the psychological and long-term clinical outcomes of patients after LAR or LAR-NOSE surgery.

Materials And Methods

Patients and surgical procedure

This was a prospective randomized controlled study. Patients who received treatment at the Department of Gastrointestinal Surgery of Shanghai East Hospital from June 2015 to April 2018 were enrolled in the study. The inclusion criteria were as follows: patients older than 18 years with high rectal and sigmoid colon cancers. The exclusion criteria were as follows: (1) preoperative examinations suggesting tumor metastasis to distant organs; (2) anal stenosis; (3) acute ulcerative colitis or Crohn's disease; (4) tumor diameter > 5 cm; (5) body mass index > 32 kg/m²; and (6) neoadjuvant chemoradiotherapy.

Treatment interventions

Patients were randomly divided into the LAR-NOSE and LAR groups (1:1). The research was approved by the Ethics Committee of the Clinical Trial Center, Tongji University. The research was registered with Tongji University (Registration No: SHDFYY2015-098). All patients signed written informed consent.

Total mesorectal excision was used for both LAR and transrectal LAR-NOSE surgeries[20]. In LAR, specimens were removed using a ventral midline abdominal incision, and the intestine was reconstructed with double staplers. In transrectal NOSE, the specimen was removed from the rectum without an incision

in the abdomen (Supplement Fig. 1 and Video). None of the patients underwent diverting ileostomy. Instead, an anal drainage tube was used during recovery.

Primary outcome

The primary outcome measure was postoperative psychological well-being. Validated tests used for measuring psychological well-being were the self-rating depression scale (SDS) [21], self-rating anxiety scale (SAS) [22, 23], and the state-trait anxiety inventory (STAI) [23, 24]. The SDS includes 10 positive and 10 reverse-scored items (20 items total) and has been demonstrated to be relatively reliable [25–27]. The SDS uses a four-point scoring scale where higher total scores indicate higher levels of depression. The SAS has 20 items, scoring from 1 “nonexistence” to 4 “persistence.” The higher the total score, the higher the degree of anxiety. The STAI has 40 items and is divided into two parts, state-anxiety inventory (S-AI) and trait-anxiety inventory (T-AI), each with 20 items. The STAI was used to distinguish between transient state anxiety and trait anxiety. The S-AI reflects anxiety in a stressed state related to an event, while the T-AI measures anxiety as a personal characteristic. The STAI also uses a four-point scoring scale where higher scores are related to more severe anxiety symptoms. Psychological well-being was measured 3 days before surgery (baseline) and postoperatively at 1 and 24 weeks.

Secondary outcomes

The secondary outcome measures were the perioperative clinical results and long-term oncological outcomes based on preoperative and postoperative clinical information. Postoperative indicators included surgical time, intraoperative blood loss, maximum tumor diameter, postoperative pathology, postoperative bowel recovery, days of postoperative hospitalization, operative complications, and local recurrence. The oncological outcomes were recorded for 5 years postoperatively. A patient’s pain during surgery was compared using the visual analogue scale (VAS) score [28]. The VAS scores were collected and evaluated on postoperative days (PODs) 1, 2, and 3, where a score of 0 indicated no pain and that of 10 indicated severe pain. The more severe the pain, the higher the VAS score.

Psychological measures

The assessment of psychological function was performed approximately 1 week preoperatively (baseline) and 5 weeks and 6 months postoperatively by psychometric measurements.

Statistical analysis

All statistical analyses were performed with SPSS version 17.0 software (IBM Corp., Armonk, NY, USA). Continuous data (surgical indexes, VAS, SDS, SAS, and STAI scores) were summarized as means $\pm$ standard deviation and were compared using Student’s *t*-test. Categorical variables were presented as percentage (%) and were compared using Fisher’s exact test. The survival function in terms of overall survival (OS) and disease-free survival (DFS) was analyzed with the Kaplan–Meier estimate. A *P* value of < 0.05 was considered statistically significant.

Results

Patients

Patients from the study site between January 2015 and April 2018 were randomly divided into the LAR-NOSE (n = 109) and LAR (n = 106) groups (Fig. 1). We excluded 13 patients because of missing postoperative data. The preoperative baseline characteristics of the two groups are presented in Table 1. The mean ages of the patients in the LAR-NOSE and LAR groups were 61.4 ± 12.3 and 62.5 ± 12.1 years, respectively. There were no differences in preoperative indices between the two groups (Table 1).

Success rate of transrectal NOSE and failure reasons

The extraction success rate in the LAR-NOSE group was 87.1% (95/109 cases). In 14 patients, the specimen failed to be extracted transrectally due to the patients being overweight (4 cases), tumor size exceeding the incision size (6 cases), thick mesenteric fat (2 cases), and a narrow pelvis (2 cases). None of the patients needed conversion from laparoscopy to open surgery. For the intention to treat analysis, the 14 unsuccessful NOSE patients were included in the LAR-NOSE group.

Intraoperative results and short-term recovery

No statistical differences in the maximum diameter of tumor, lymph node metastasis, and pathological results were found between the LAR and LAR-NOSE groups. The LAR-NOSE procedure was technically complex because of the total laparoscopic anastomosis and had a significantly longer operative time (167.0 ± 45.0 vs. 146.2 ± 42.1 min, $P < 0.05$). The patients in the LAR group had more intraoperative bleeding than those in the LAR-NOSE group (156.1 ± 112.4 vs. 80.2 ± 31.4 mL, $P < 0.001$). Compared with that in the LAR group, the postoperative intestinal recovery time was less in the LAR-NOSE group (25.4 ± 6.2 vs. 16.2 ± 6.0 h, $P < 0.001$). The duration of hospital stay after surgery in the LAR-NOSE group was shorter compared to the LAR group (8.4 ± 2.1 vs. 11.6 ± 4.2 days, $P < 0.001$). The rate of operative complications in the LAR-NOSE patients (7/109, 8%) was significantly less than that in the LAR patients (16/106, 15%). The LAR-NOSE group had three cases of postoperative anastomotic leakage, one case of intestinal obstruction, one case of trocar site infection, and two cases of intra-abdominal infections. The LAR group had three cases of anastomotic leakage, five cases of wound infections, and seven cases of intra-abdominal infections (Table 2).

Postoperative pain, depression, and anxiety

The mean length of abdominal incision in the LAR group was 9.6 ± 2.7 cm, and the mean length of tractor incision in the LAR-NOSE group was 1.9 ± 0.5 cm. The VAS scores on POD 1 in the LAR-NOSE and LAR groups were 5.0 ± 1.8 and 5.7 ± 2.1 , respectively, which were significantly different ($P < 0.05$). On POD 2, the VAS score in the LAR-NOSE group was 4.4 ± 1.6 , which was significantly lower than that in the LAR group (4.9 ± 1.8) ($P < 0.05$). On POD 3, the VAS score in the LAR-NOSE group was 2.5 ± 1.3 , while that in the LAR group was 2.9 ± 1.5 , which was significantly higher ($P < 0.05$). Table 3 shows the significantly different postoperative VAS scores between the LAR-NOSE and LAR groups ($P < 0.01$). There were no statistical differences in the SAS, SDA, or STAI scores before surgery or 24 weeks postoperatively. The SAS and SDS scores in the LAR-NOSE group 1 week postoperatively were 44.21 ± 8.46 and 37.29 ± 8.98 ,

respectively. These scores were significantly lower than those in the LAR group (51.04 ± 9.12 and 44.65 ± 9.27 , respectively, $P < 0.05$). The SAS and SDS scores in the LAR-NOSE group 24 weeks postoperatively were 38.28 ± 7.38 and 35.38 ± 9.87 , respectively, which tended to be lower than those in the LAR group (39.25 ± 6.23 and 36.52 ± 8.31) but were not statistically different. Compared with the patients in the LAR group (51.04 ± 8.18), those in the LAR-NOSE group had significantly lower S-AI scores (45.21 ± 8.72 , $P < 0.05$) 1 week after surgery. There was no statistical difference in the T-AI scores 24 weeks after surgery between the two groups (Fig. 2a–d).

DFS and locally recurrent cancer

The long-term oncological patient outcomes were recorded for a maximum of 5 years with a median follow-up period of 42 months. The recurrence rate in the LAR-NOSE group was 6.4% (7/109 cases) and was not statistically different from that in the LAR group (6.6%, 7/106 cases). The OS and DFS showed no statistical differences between the LAR-NOSE and LAR groups (Fig. 2e–f).

Discussion

This study aimed to compare the clinical and psychological outcomes of patients who underwent LAR with those of patients who underwent LAR-NOSE for high rectal and sigmoid colon cancer. Our results show that the outcomes of LAR-NOSE patients were superior in terms of postoperative pain, anxiety, and depression. Even without an abdominal incision, patients' postoperative pain was slightly lower after LAR-NOSE than after LAR.

The patients in both groups were most likely worried or fearful about colorectal cancer diagnosis and radical surgery, as the baseline anxiety and depression scores were similar between the two groups. This type of state-related anxiety can be relieved after surgery. However, the different surgeries caused different levels of postoperative anxiety and depression[29], where the surgical outcomes were closely connected to postoperative anxiety and depression[30]. For example, a low risk of incision dehiscence and better postoperative clinical recovery results were noted in the LAR-NOSE group. As expected, the postoperative SAS, SDS, and STAI scores reflected greater psychological well-being in the LAR-NOSE patients. The prevalence of depression and anxiety in patients with colorectal cancer is approximately 57%[15]. Therefore, patients with high anxiety and depression levels may benefit psychologically from LAR-NOSE.

In patients with colorectal cancer, postoperative pain has been associated with psychological well-being; thus, it is important to recognize and treat it appropriately[31]. Our results demonstrate that transrectal LAR-NOSE surgery can significantly reduce postoperative pain (Table 3); thus, the postoperative anxiety levels in LAR-NOSE patients are expected to be lower than those in LAR patients. The differences may appear immediately after surgery as there may be a short period of depression due to surgical stress and anesthesia; however, after the anticipation subsided, there was not much difference between the two patient groups.

The surgical results showed no differences based on the T or N stage or the distance from the tumor to the verge between the two groups. Since LAR-NOSE does not require opening the abdominal wall for specimen extraction[32], the operative time was shorter, and intraoperative blood loss was less than those in the LAR group (Table 2). Total laparoscopic bowel reconstruction in LAR-NOSE avoids unnecessary damage to the abdominal viscera, which leads to faster recovery of intestinal function, less pain, lower rate of surgical complications, and shorter postoperative hospital stay.

The oncological outcomes and local recurrence are a priority during any transrectal LAR-NOSE procedure. Our study showed that the anastomotic recurrence rates and 5-year DFS were not different between the two patient groups. This could be due to the use of a sleeve specimen bag during surgery, which improves the method of specimen extraction and stapling anvil insertion into the proximal colon[33]. Specifically, our experience with transrectal LAR-NOSE indicates three important procedures: (1) putting the specimen protector into the abdomen using the 12-mm tractor while maintaining sterility, (2) inserting the stapling anvil through the sleeve bag and placing it into the sigmoid colon, and (3) removing the tumor using the protection sleeve. These measures are effective in avoiding intra-abdominal infection and decrease the residual tumor during transrectal LAR-NOSE.

This study shows that transrectal LAR-NOSE is a safer and more feasible colorectal cancer treatment than LAR. Patients who underwent LAR-NOSE treatment had better psychological function and rapid clinical recovery. However, the failure rate of transrectal specimen extraction and conversion to conventional laparoscopy was relatively high because of the learning curve in the early stages of the study. NOSE failures in LAR-NOSE were likely due to patient obesity, large tumor size, mesentery thickening, and a narrow pelvis.

The current study has several limitations. First, factors that affect the feasibility of performing transrectal LAR-NOSE were not included and therefore need to be retrospectively studied to define risk parameters. Second, the patients included in this prospective randomized controlled study were relatively few, and the participants were all recruited from a single center. The clinical efficacy and psychological function of patients who undergo LAR-NOSE should be confirmed by a multicenter prospective case–control trial with a larger sample size in future studies.

Conclusion

Transrectal LAR-NOSE is less invasive and has better short-term efficacy and psychological outcomes than LAR. We found significantly fewer operative complications in LAR-NOSE, but long-term oncological safety was the same between the two groups. Therefore, transrectal NOSE is a feasible and preferable alternative treatment in selected patients with colorectal cancer.

Declarations

Disclosure

Ethics approval and consent to participate

The research was approved by the Ethics Committee of the Clinical Trial Center, Tongji University. The research was registered with Tongji University (Registration No: SHDFYY2015-058S). All patients signed written informed consent.

Competing interests

No competing financial interests exist.

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Authors' contributions

WKJ conceived and designed the study. LD and JZY revised the power analyses and wrote the data analyses section. ZYY and LJ bear overall responsibility for the design, ethical conduct and publication of the study. Administrative, technical and material support was provided by LMC, ZHR, GDD, JDD and LY. All authors edited the draft and contributed substantially to the manuscript; they all approved this submission.

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Tables

Table 1
Preoperative Clinical Indexes between LAR-NOSE and LAR groups

	LAR(n = 106)	LAR-NOSE(n = 109)	P value
Age,mean ± SD, y	62.5 ± 12.1	61.4 ± 12.3	0.509
Sex			
male	52	59	0.457
female	54	50	
BMI,mean ± SD,kg/m ²	22.4 ± 2.7	22.8 ± 1.9	0.209
Distance of tumor from anal margin,mean ± SD,cm	11.9 ± 2.8	11.4 ± 2.5	0.168
Preoperative serum CEA			
normal	80	78	0.516
abnormal	26	31	
Preoperative serum CA199			
normal	82	84	0.959
abnormal	24	25	
LAR: Laparoscopic Anterior Resection NOSE :natural orifice specimen extraction * Statistically significant difference.			

Table 2
Intraoperative results and short-term clinical recovery

Parameters	LAR(n = 106)	LAR-NOSE(n = 109)	P value
Duration of surgery ,mean ± SD,min	146.2 ± 42.1	167.0 ± 45.0	0.002*
Intraoperative bleeding ,mean ± SD,mL	156.1 ± 112.4	80.2 ± 31.4	< 0.001*
Tumor size,mean ± SD, y	3.6 ± 1.4	3.4 ± 1.2	0.262
Distal resection margin,mean ± SD, cm	8.9 ± 2.4	9.2 ± 2.6	0.381
pT stage			
T1/T2	49	47	0.647
T3/T4	57	62	
pN stage			
N0	60	58	0.647
N1/N2	46	51	
Bowel function recovery, mean ± SD, h	25.4 ± 6.2	16.2 ± 6.0	< 0.001*
Postoperative hospital stay,mean ± SD,d	11.6 ± 4.2	8.4 ± 2.1	< 0.001*
Post-operative complication			
YES	16	7	0.833
NO	90	102	
LAR: Laparoscopic Anterior Resection NOSE: natural orifice specimen extraction * Statistically significant difference.			

Table 3
The visual analogue scale of postoperative pain

Time	LAR(n = 106)	LAR-NOSE(n = 109)	P value
POD 1,mean ± SD	5.7 ± 2.1	5.0 ± 1.8	0.009*
POD 2,mean ± SD	4.9 ± 1.8	4.4 ± 1.6	0.032*
POD 3,mean ± SD	2.9 ± 1.5	2.5 ± 1.3	0.038*
LAR: Laparoscopic Anterior Resection NOSE: natural orifice specimen extraction * Statistically significant difference.			

Figures

Figure 1

Patients from the study site between January 2015 and April 2018 were randomly divided into the LAR-NOSE (n=109) and LAR (n=106) groups

Figure 2

These scores were significantly lower than those in the LAR group (51.04 ± 9.12 and 44.65 ± 9.27 , respectively, $P < 0.05$). The SAS and SDS scores in the LAR-NOSE group 24 weeks postoperatively were 38.28 ± 7.38 and 35.38 ± 9.87 , respectively, which tended to be lower than those in the LAR group (39.25 ± 6.23 and 36.52 ± 8.31) but were not statistically different. Compared with the patients in the LAR group (51.04 ± 8.18), those in the LAR-NOSE group had significantly lower S-AI scores (45.21 ± 8.72 , $P < 0.05$) 1 week after surgery. There was no statistical difference in the T-AI scores 24 weeks after surgery between the two groups. The long-term oncological patient outcomes were recorded for a maximum of 5 years with a median follow-up period of 42 months. The recurrence rate in the LAR-NOSE group was 6.4% (7/109 cases) and was not statistically different from that in the LAR group (6.6%, 7/106 cases). The OS and DFS showed no statistical differences between the LAR-NOSE and LAR groups.

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