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ORIGINAL ARTICLE

Totally laparoscopic resection with natural orifice specimen extraction (NOSE) has more advantages comparing with laparoscopic-assisted resection for selected patients with sigmoid colon or rectal cancer

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Abstract
Purpose The purposes of this study were to compare the short-term outcomes of natural orifice specimen extraction (NOSE) and laparoscopic-assisted resection for sigmoid colon cancer or rectal cancer and to appraise whether totally laparoscopic resection with NOSE had more advantages compared with conventional laparoscopic-assisted resection.
Methods Sixty-five patients who underwent totally laparoscopic resection with NOSE were assigned to NOSE group, and 132 patients who underwent laparoscopic-assisted resection were assigned to laparoscopic-assisted (LA) group. Data of all 197 cases were reviewed. Short-term outcomes (including operative outcomes, gastrointestinal recovery, hospital stay, and complication) of the two groups were compared.
Results Mean numbers of lymph nodes harvested were 17.0±8.3 and 18.9±11.6 in NOSE group and LA group, respectively, (P=0.248); mean operative times were 111.6±25.4 min and 115.3±23.0 min in the two groups (P=0.384); and the mean blood losses in these two groups were 70.2±66.1 ml and 126.3±58.6 ml, respectively, (P<0.001). Times to first flatus were 2.7±0.8 and 3.4±0.9 days (P<0.001), and times to first defecation were 3.3±0.6 and 3.9±1.1 days (P=0.002) in NOSE group and LA group, respectively. Hospital stay in NOSE group were 9.0±1.9 and 9.9±2.0 days in LA group. Incidences of peri-operative complications were 6.2 and 17.2 % in the two groups, respectively (P=0.031).
Conclusions Without compromising oncologic outcome, totally laparoscopic resection with NOSE had more advantages including less blood loss, less pain, faster recovery of intestinal function and shorter hospital stay compared with laparoscopic-assisted resection for selected patients with sigmoid colon cancer or rectal cancer.

Keywords Totally laparoscopic resection · Natural orifice specimen extraction · Sigmoid colon cancer · Rectal cancer · Short-term outcome

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Introduction

Minimal invasive surgery which represents the development tendency of surgical therapy for colorectal cancer has been accepted extensively by both patients and surgeons. For conventional laparoscopic-assisted resection, a small incision in the lower abdomen is needed after laparoscopic procedure aimed at extracting the specimen, and the small incision can bring some unexpected outcomes including pain, wound infection and incisional hernia for patients [1–3]. The advantages of minimal invasive surgery are reduced due to the existence of the small incision. Aimed at avoiding the small incision, a new technique of NOTES (natural orifice transluminal endoscopic surgery) was reported in 2004 [4]. However, the development of this technique is limited by specialized tools and skills. Based on above reasons, NOSE (natural orifice specimen extraction) which is considered as a prequel to NOTES is accepted and developed in the field of surgery [4]. Several studies confirmed that the extraction of sigmoid colon or rectum specimen through the anus during the

procedure of NOSE was reasonable and feasible [5, 6]. Between May 2012 and July 2013, some selective patients with sigmoid colon or rectal cancer underwent totally laparoscopic resection with NOSE in our hospital. A study was designed to compare the short-term outcomes of NOSE with conventional laparoscopic-assisted resection.

Materials and methods

Population

Data of selected patients with sigmoid colon cancer or rectal cancer underwent totally laparoscopic resection with NOSE or conventional laparoscopic-assisted resection in cancer hospital, Chinese Academy of Medical Sciences between May 2012 and July 2013 were reviewed. Definite diagnosis was confirmed by colonoscopy with biopsy for all patients before operation. Physical examination, abdominal computed tomography scan, abdominal ultrasound and barium enema were routinely used for preoperative evaluation. All operations were performed by a single surgeon who held laparoscopic approach skillfully. Choice of surgical procedures was strictly based on the patient's individual decision after providing informed consent concerning both methods and risks. The protocol was approved by the ethics committee of our hospital.

Patients who underwent totally laparoscopic resection with NOSE were assigned as NOSE group and patients who received conventional laparoscopic resection were assigned as laparoscopic-assisted (LA) group. Two methods of NOSE were performed for patients in the NOSE group. Inclusion criteria for method one were as follows: patients were diagnosed of sigmoid colon cancer or rectal cancer, 18 to 75 years old, distance of tumor from the anal verge was 6 to 30 cm, tumor size <6.0 cm, BMI (body mass index) ≤28 and without neoadjuvant therapy. For some rectal cancer patients, the former technique of NOSE was not suitable to be performed due to the relatively lower position of tumor or narrow pelvis. Another method of NOSE was performed for these kinds of patients. Inclusion criteria for method two were as follows: patients with rectal cancer, 18 to 75 years old, tumor which located below the peritoneal reflection had difficulty to be transected transabdominally, sigmoid colon was long enough which was evaluated by pre-operative barium enema, tumor size <6.0 cm, BMI (body mass index) ≤28 and without neoadjuvant therapy. Benign lesion, familial adenomatous polyposis coli and multiple primary carcinomas were excluded from this study. Short-term outcomes including operative time; blood loss; conversion rate; number of lymph nodes harvested; status of distal margin, circumferential resection margin (CRM), time to first flatus, time to first defecation, time to ambulation, and intra- and post-operative complications were compared between the two groups. Post-operative pain was rated by the patient on a subjective analog pain scale ranging from 0 to 10, with 0 representing no pain at all and 10 the worst pain imaginable. Pain was also assessed by a blinded investigator at 24 after surgery. Wexner Continence Grading Scale [7] was used for evaluating anal continence after the recovery of intestinal function.

Technique

The patient was positioned in modified lithotomy. Four trocars were used: a 12-mm super-umbilical port was created to introduce the laparoscope, the other three trocars were created in the right lower quadrant (12-mm port), right upper quadrant (5-mm port), and left lower quadrant (5-mm port). Then, the patient was adjusted to the Trendelenburg position in order to expose the sigmoid colon, rectum and inferior mesenteric artery. According to radical principle, laparoscopic skill was applied. Mobilization of bowel, ligation of inferior mesenteric vessel and dissection of lymph nodes were performed laparoscopically, and total mesorectal excision principle was followed for rectal cancer. Then, different procedures were performed for laparoscopic-assisted approach and totally laparoscopic resection with NOSE.

For the technique of laparoscopic-assisted resection, a small incision was made in the hypogastrium, transection of rectum was completed through an abdominal incision, then the specimen was removed, and the bowel was prepared for anastomosis. Circular stapler was used for anastomosis for all rectal cancer and most of the sigmoid colon cancer, and for some sigmoid colon cancer which the tumor site was comparatively higher, three straight line cutting device were used.

For method one of NOSE, placed a cross clamp distal to the tumor after an adequate mobilization of the sigmoid colon or rectum to ensure that the segment bearing a tumor was isolated. For sigmoid colon cancer, the position of clamp was 10–12 cm distant from the anal verge and 1.5 to 2.0 cm from the tumor for rectal cancer. Transected distal rectum by an ultrasound knife after fully disinfecting the rectal lumen. Put an anvil head into an abdominal cavity through the anus and rectal stump. Made a longitudinal incision about 2 cm on proximal colon wall and put the anvil head into the colon lumen through the incision, then transected the proximal colon in close proximity to the upper pole of the incision by an Endoscopic Linear Cutter-Straight (YZB/USA 3859–2010; Ethicon Endo-surgery, LLC) (Fig. 1). Removed the trocar which was in the right lower quadrant and insert a soft tissue retractor (Product Model: HK-120/130-120/100) into the abdominal cavity via the wound. Held one of a pair of the soft tissue retractor rings and pulled out of the anus, placed another ring in the opened rectal stump. Extracted the specimen through the soft tissue retractor. Then, reclosed the rectal opening by another Endoscopic Linear Cutter-Straight (Fig. 2). End-to-end colorectal anastomosis was performed with a circular stapler using the double-stapling technique.

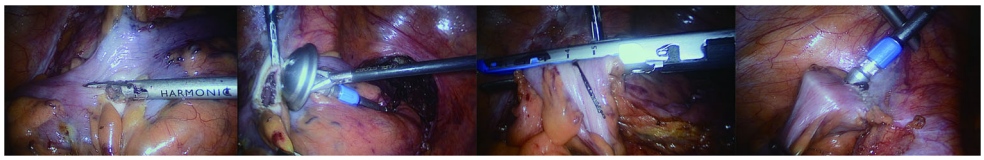

Fig. 1 The procedure of setting an anvil head in proximal colon stump

For method two of NOSE, transected sigmoid colon by an Endoscopic Linear Cutter-Straight after adequate mobilization. The distance of sigmoid colon stump from the upper margin of tumor was at least 15 cm. Held the sigmoid colon stump by a long Babcock Grasper which was put into the lumen through the anus and pulled out of the intestinal canal from the anus. Disinfected the intestinal mucosa around tumor lesion after releasing the pneumoperitoneum (Fig. 3). Transected the distal rectum by electrotome and removed the specimen. Held the edge of the rectal stump by two hemostatic forceps with the view to avoiding retraction. Put a long Babcock Grasper into the abdominal cavity and pulled out the sigmoid colon through the rectal stump and anus. Reopened the sigmoid colon stump and fixed an anvil head on the stump. Then, sent the sigmoid colon back to the abdominal cavity. Disinfected the rectal stump and reclosed the rectal opening a contour (YZB/USA 0572–2010; Ethicon Endo-surgery, LLC). Sent the rectum back to the pelvic cavity and completed the end-to-end colorectal anastomosis under laparoscopy after rebuilding the pneumoperitoneum.

Statistical analysis

Statistical analyses were performed using statistical software package SPSS version 16.0. A P value less than 0.05 was considered to be statistically significant. Categorical variables were analyzed by chi-square test, and continuous variables were analyzed by the Student's t test.

Results

Data of 65 patients who underwent totally laparoscopic resection with NOSE (method one: 51, method two: 14) and 132 patients who received laparoscopic-assisted resection concurrently were reviewed. All 197 cases met the inclusive criteria. No patient in the NOSE group was converted to laparoscopic-assisted or open resection and no patient in LA group was converted to open resection.

Age, gender, concomitant diseases, BMI, ASA (American Society of Anesthesiologists), abdominal operation history and operation type were matched between the two groups. The comparison results of tumor size, distance of tumor from the anal verge for rectal cancer, tumor site and TNM staging were shown in Table 1.

Adenocarcinoma was confirmed by post-operative pathology for all patients. For rectal cancer, there was no positive CRM and distal margin in the two groups. The mean numbers of lymph nodes harvested were 17.0±8.3 and 18.9±11.6 in the NOSE group and LA group, respectively, (P=0.248).

The mean operative times were 111.6±25.4 min in the NOSE group and 115.3±23.0 min in the LA group (P=0.384), and the mean blood losses in these two groups were 70.2±66.1 and 126.3±58.6 ml, respectively, (P<0.001). Time to first flatus, time to passing of first defecation and time to ambulation in the NOSE group were all obviously shorter than that in the LA group (Table 2). The pain scores at 24 h after surgery were shown in Table 2. In two groups, no patient used prophylactic analgesics post-operatively.

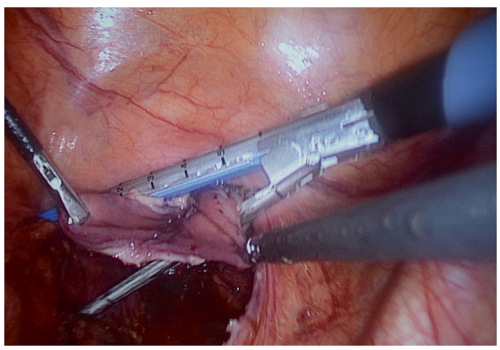

Fig. 2 Reclose the openings of rectal stump

Fig. 3 Pull out the intestinal canal from anus

Table 1 Comparisons of two groups for general parameters

Parameters	NOSE group (n=65)	LA group (n=132)	P value
Gender			0.422
Male	32	57	
Female	33	75	
Age, year (mean ± SD)	56.1±9.3	55.5±9.5	0.085
BMI, kg/m^2 (mean ± SD)	23.7±2.9	23.1±3.1	0.105
ASA			0.176
I	10	10	
II	50	106	
III	5	16	
Concomitant diseases			0.189
Yes	18	49	
No	47	83	
Abdominal operation history			0.660
Yes	13	23	
No	52	109	
Tumor site			0.361
Sigmoid	27	46	
Rectum	38	86	
Tumor size, cm (mean ± SD)	2.9±1.5	3.7±1.7	0.059
Distance of tumor from anal verge, cm (mean ± SD)	14.1±6.1	14.5±6.6	0.072
Tumor differentiation			0.179
Well	11	11	
Moderate	51	112	
Poor	3	9	
TNM staging			0.430
I	11	14	
II	25	58	
III	29	60	

LA laparoscopic-assisted

Four patients had post-operative complications in the NOSE group: one patient had intra-peritoneal hemorrhage, and he was cured by giving hemostatics and transfusion; one patient had wound infection of the right lower quadrant, and the wound infection healed after open drainage and using antibiotics; two patients had anastomotic leakage, and they were cured by washout and drainage. Twenty-three patients in the LA group had complications: six patients had anastomotic leakage and 17 patients had incision complication including two patients who experienced incision complication and ileus simultaneously. There was no statistically significant difference for the incidence of anastomotic leakage between the two groups (P=0.623). Five patients used pain killer after operation in the NOSE group and 31 patients in the LA group (P=0.007). No patient suffered from fecal incontinence after operation, all patients could control their defecation satisfactorily.

Discussion

Laparoscopic-assisted colorectal cancer resection has been accepted extensively by most surgeons and patients. For this approach, a small incision is required for dissecting lumen, extracting specimen and reconstructing. Aimed at avoiding the disadvantages resulted from the small incision, NOTES technique is recommended. However, this approach is difficult to be accepted. As a transient mode, technique of totally laparoscopic resection with NOSE emerges as the times require [4], and it is accepted by surgeons for the treatment of colorectal cancer.

As the accumulation of experience, totally laparoscopic resection for colorectal cancer is gradually developed and implemented. The safety and feasibility of totally laparoscopic resection for colorectal cancer has been confirmed [8]. For

Table 2 Comparisons of two groups for operative outcomes and post-operative recovery

Outcomes	NOSE group	LA group	P value
Operative time, min (mean ± SD)	111.6±25.4	115.3±23.0	0.384
Blood loss, ml (mean ± SD)	70.2±66.1	126.3±58.6	<0.001
Length of distal margin, cm (mean ± SD)	2.3±0.5	2.1±0.6	0.179
Number of lymph node (mean ± SD)	17.0±8.3	18.9±11.6	0.248
Time to first flatus, day (mean ± SD)	2.7±0.8	3.4±0.9	<0.001
Time to first defecation, day (mean ± SD)	3.3±0.6	3.9±1.1	0.002
Time to ambulation, day (mean ± SD)	2.7±0.8	3.8±0.5	0.001
Hospital stay, day (mean ± SD)	9.0±1.9	9.9±2.0	0.009
Pain score	3.8±1.2	6.1±1.2	<0.001
Peri-operative complication, case (%)	4 (6.2)	23 (17.2)	0.031
Anastomotic leakage, case (%)	2 (3.1)	6 (4.5)	0.623
Pain killer, case (%)	5 (7.8)	31 (23.5)	0.007

LA laparoscopic-assisted

example, a study designed by Roscio F et al. [9] compared the different outcomes between totally laparoscopic and laparoscopic-assisted right colectomy for neoplasia. They confirmed that totally laparoscopic right colectomy resulted in an encouraging short-term outcome, low incidence of major complications and preservation of oncologic principles, without affecting operative times. Polignano FM et al. [10] documented that for the treatment of stage IV colorectal cancer, surgical access trauma, post-operative morbidity and hospital stay could be reduced, and the short-term oncological outcome was not compromised. The results of study designed by Nishimura A et al. [4] showed that totally laparoscopic sigmoid colectomy was feasible, safe and oncologically acceptable for selected cases.

Patients with colorectal cancer have benefited from the technique of NOSE. Advantages of this technique include the less pain, less intra-operative blood loss, faster recovery of intestinal function, lower complication rate and cosmetic effect [8, 11]. In a previous study designed by Park JS et al. [12], the short-term outcomes of NOSE and conventional laparoscopically assisted right hemicolectomy were compared, the average times to passage of flatus were 2.7 and 3.1 days, and the hospital stays were 7.9 and 8.8 days, respectively. Its results also confirmed that patients experienced less pain after NOSE. Nishimura A et al. [4] reported that all patients who experienced NOSE in his study were able to walk at post-operative day 1, and the post-operative complication rate was 11.8 %. There was no statistically significant difference in operative time between the two groups in our study, and the blood loss was obviously less in NOSE group compared with that in LA group. The recovery of intestinal function in the NOSE group was faster. Some reasons could be used for illustration: avoiding the procedure of opening and closing the abdominal wall, the intra-operative blood loss might be reduced in the NOSE group and the operative time should be shortened. Intra-abdominal organs had the chance to avoid contacting the external environment for nearly all the procedures were performed laparoscopically, so that the disturbance for internal environment of patients was slight [13]. As no abdominal incision, pain after NOSE was slight, and there was almost no need to worry about incision dehiscence for these patients; in addition, these patients might have earlier ambulation. All of what were mentioned above account for the faster recovery of intestinal function.

Complication rate in NOSE group was lower than that in the LA group (6.2 % vs 17.2 %, $P=0.031$), incision complication was the key reason for this difference. Whether squeeze and expansion of rectal stump resulted from procedure of pulling out specimen might lead to the increase of anastomotic leakage rate? In our study, the result proved that the incidence of anastomotic leakage did not increase in the NOSE group compared with the LA group (3.1 % vs 4.5 %, $P=0.623$).

Some doubts about NOSE mainly focused on contamination which included the bacterial contamination and tumor cell contamination. However, Bucher P et al. [14] confirmed that intra-corporeal bowel opening for anastomosis completion did not increase the risk of infection during colorectal surgery. McKenzie S et al. [1] reported that the risk of tumor seeding during transvaginal delivery was no higher than that associated with transabdominal extraction if a specimen bag was used. There was no case of abdominal cavity infection in our study; for tumor cell contamination, long-time follow-up was needed.

Our study confirmed that comparing with laparoscopic-assisted resection for selected patients with sigmoid colon cancer or rectal cancer, totally laparoscopic resection with NOSE had more advantages including less pain, less blood loss, faster recovery of intestinal function and shorter hospital stay.

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