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ORIGINAL ARTICLE

Success rate of natural orifice specimen extraction after laparoscopic colorectal resections

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Abstract
Purpose To date, no data have been available to inform which cases are appropriate for natural orifice specimen extraction (NOSE) after laparoscopic colorectal resections (LCRRs). Our aim was to evaluate the success rate and the factors affecting the failure in patients who were scheduled for NOSE after LCRRs.
Methods Seventy-two consecutive cases that were intended for NOSE after LCRR were enrolled. The transanal route was always chosen as the first option, and when it failed, the transvaginal route was tried in female patients. If both failed, the specimen was judged as unsuitable for NOSE and removed through an abdominal wall incision. Demographic data, surgical indications, resection localization, implemented procedures, incision sites, specimen extraction methods, specimen sizes, and failures of NOSE were recorded.
Results A total of 349 colorectal resections (240 open and 109 laparoscopic) in a 3-year period were examined. The subset of 72 consecutive patients who met the criteria were analyzed. Five cases required a conversion to open surgery during resections. In the remaining 67 patients, NOSE after LCRR was successful in 49 cases (73.1%) but failed in 18 (26.9%). Specimens were extracted from transanal and transvaginal routes in 37 (75.5%) and 12 (24.5%) patients, respectively. The failure rate of NOSE after LCRR was higher in males, in colonic lesions, and in large-sized tumors. The mean sizes of transanal and transvaginal extracted specimens were 3.5 ± 3.1 and 5.4 ± 1.4 cm, respectively ($p < 0.05$). The mean size of the tumors in the failed cases was 6.5 ± 4.2 cm ($p < 0.05$).
Conclusions Approximately 2/3 of the unselected LCRRs were suitable for NOSE. The success rate increased with female gender, small-sized tumors, and rectal resections.

Keywords Colorectal surgery · Laparoscopy · Minimal invasive surgery · Natural orifice endoscopic surgery · Minimal invasive surgical procedures

Introduction

Although laparoscopic colorectal resections (LCRRs) have been associated with lower risks of wound-related complications when compared with open resections, they still have a 10.3–22.7% rate of surgical site infection [1, 2] and a 6.0–10.8% incisional hernia risk [3, 4]. The mini-laparotomy, an inevitable part of conventional LCRR, is the main cause of those morbidities. This mini-laparotomy can also have a negative influence on the postoperative pain and convalescence period [5].

To decrease the wound-related complications, pain, and convalescence period after LCRR, recently, natural orifice specimen extraction (NOSE) has been examined. An early meta-analysis comparing the conventional LCRRs and NOSE after LCRRs reported a significant reduction in the length of hospital stay, acceleration in postoperative recovery with better cosmetic results, and in particular, less postoperative pain and fewer complications in the NOSE after LCRR [4]. Despite the encouraging early results, there were no data on which cases were appropriate for NOSE after LCRRs and what are the factors that influence the feasibility of NOSE. Our aim in this study was to evaluate the success rate and the factors affecting the

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failure in patients who were consecutively scheduled for NOSE after LCRRs.

Materials and methods

Our natural orifice surgery program was started in January 2013. Between January 2013 and December 2015, all of the cases that were intended for NOSE after LCRR were consecutively enrolled in this prospective cohort study. The approval of the ethics committee and the written informed consent of the patients were obtained. Our inclusion criteria were patients' approval for participation, being age 18 years or older, and non-emergent colorectal resections.

All the procedures were performed by the chief surgeon himself (CK) or under his supervision by six senior surgeons. The patients underwent surgery in a modified Lloyd-Davies position under general anesthesia. Pneumoperitoneum was established with a Veress needle, and the trocars were placed according to the LCRR type. All of the anastomoses were performed intracorporeally. As the extraction site, the transanal route was always chosen as the first option due to the large bowel transection during LCRR. By this approach, we aimed to avoid a separate incision to access another natural orifice. When the transanal specimen extraction failed, we switched the extraction site to the transvaginal route in female patients. The only criterion for switching from the transanal to transvaginal route was the size of the specimen. If the specimen size was too large to insert it into the distal intestinal orifice, we decided to switch to the transvaginal extraction in female patients. The vagina has always been our second choice as a route of colorectal specimen removal. After preparation of the vagina with a povidone–iodine solution, the uterus was retracted laparoscopically and the patient was then placed in a steep Trendelenburg position. A 3-cm-length transverse transvaginal posterior colpotomy was performed under laparoscopic control, and the colpotomy incision was enlarged bluntly with fingers. The specimen was grasped with an ovary clamp through the vaginal incision, and it was pulled into the vagina and delivered through the vagina. The vagina was irrigated with a povidone–iodine solution. The colpotomy was then closed with a running absorbable suture. A povidone–iodine-soaked vaginal pack was placed into the vagina for 12 h. We did not use endobags during extractions, but we prepared the extraction path with a lavage of povidone–iodine. In male patients who failed with the transanal route or in female patients who failed transanal and transvaginal routes, we removed the specimen through an abdominal wall incision. Patients who required abdominal wall incisions were categorized as the patients who were not suitable for NOSE after LCRRs.

Previously defined methods were used to remove the specimen through a natural orifice [6–8]. Transcolonic extraction of a right colonic specimen via colonoscopy [9] and intracorporeal division of the mesenterium from the intestine to reduce the specimen size [10] were both attempted when necessary. For rectal and sigmoid colon resections, we used two techniques. The divided and closed distal bowel stump was opened again. The anus was dilated gently using two fingers, and the proximal closed colonic segment in the abdomen was delivered transanally using an ovarian clamp under laparoscopic guidance [6]. We also used the everting technique for distally located small tumors [7]. In the more proximal colon resections, a colonoscope was placed per anal and moved proximally in the colon till to reach the colonic closed end under the laparoscopic guidance. Laparoscopically, the stump of the colon was opened with endoscopic scissors and the colonoscope was visualized in the colon. A colonoscopic snare was deployed, and the intraperitoneal complete free colonic specimen was grasped. The specimen was moved into the colon with the help of the endoscopic graspers and pulled gently through the large bowel by colonoscope. All the anastomoses were performed intracorporeally [9].

Demographic data, indications for surgery, resection localization, implemented procedures, incision sites, specimen extraction methods, specimen sizes, and failures of NOSE were recorded. Descriptive statistics were used to summarize the given data. For comparison of continuous and countable variables, Student's t and Chi-square tests were used, respectively. $P < 0.05$ was accepted as significant.

Results

A total of 349 colorectal resections (240 open and 109 laparoscopic) over a 3-year period were examined. A subset of 72 consecutive patients who met the criteria of the study were analyzed. In five patients, a conversion to open surgery was required. These were due to adhesions (n:2), local invasion to adjacent organ (n:2), and small bowel mesenteric injury (n:1). In the remaining 67 patients, the surgical procedures were continued with the intention of NOSE after LCRR. The mean age of these 67 patients was 57.9 $\pm$ 13.4 years, and 40 (60%) of them were male. Only six of the lesions were benign (9%) and most lesions were in the rectum or rectosigmoid (45%). The remaining lesions were distributed among the other segments of the colon. The number of right, transverse, and left colon resections was 17, 1, and 15, respectively. Thirty cases were treated by anterior or low anterior resection, and four cases of familial adenomatous polyposis cases were treated by total proctocolectomy and ileal pouch anal anastomosis.

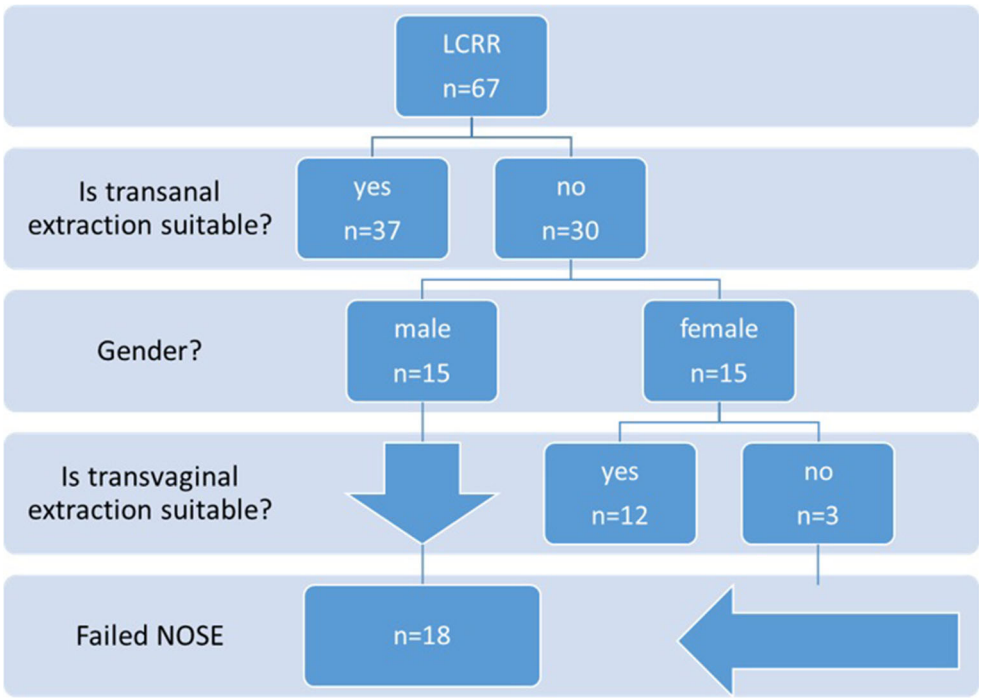

Fig. 1 Results of the NOSE after LCRR

In four cases, an additional organ resection was necessary. Two liver resections (one right hepatectomy and one wedge resection) were performed for metastasis, one gastric resection was for local invasion of transverse colon cancer, and a synchronous cholecystectomy was performed for cholelithiasis. The mean width of the tumors in the pathological specimens was 4.6 ± 3.4 cm. The mean length of large bowel was 25.2 ± 22.6 cm.

The NOSE after LCRR was successful in 49 cases (73.1%) but failed in 18 cases (26.9%). Transanal extraction was successfully performed in 37 (75.5%) of cases where NOSE was possible. The overall success rate was 68.1%. Right colonic resection specimens were removed through the colon by an endoscope in two patients (transcolonic extraction). As a different technique, division of the mesentery to reduce the size of the specimen was performed in two more patients and the specimens were extracted through the anus. In the remaining 12 cases, transanal removal was not possible due to the size of the specimen. In those cases, the specimens were extracted through the vagina in female patients. Intracorporeal mesenteric division was performed to facilitate extraction through the vagina in 2 cases. In the failed cases, the specimens were removed through abdominal incisions (suprapubic *n*:12, midline *n*:4, paramedian *n*:1, and right lower quadrant *n*:1). The results of the NOSE after LCRR are summarized in the flowchart (Fig. 1).

The failure rate of NOSE after LCRR was higher in males, in colonic lesions, and in large-sized tumors (Table 1). Failure rates were 3.3-fold higher in males than in females and 13.7-fold higher in colonic resections than in rectal resections. There were three failures in female patients. In two cases, the specimens were too bulky for extraction even from the vagina. In the last case, during the transvaginal extraction there was an iatrogenic sigmoid colon perforation. The mean sizes of transanal and transvaginal extracted specimens were 3.5 ± 3.1 and 5.4 ± 1.4 cm, respectively ($p < 0.05$). The mean size of the tumors in the failed cases was 6.5 ± 4.2 cm.

There were three (4.4%) NOSE-related morbidities: one bladder injury that was repaired by laparoscopic suturing, one sigmoid colon injury that required a stoma, and one anal trauma not requiring treatment. We had no pelvic abscess, specimen fracture, or spillage of tumor. Only in one case, there was a gross fecal contamination. The fecal material was cleaned laparoscopically, and no conversion was necessary. There was no intraabdominal, natural orifice path or abdominal wound infection in this case. The range of the follow-up was 4–39 months with a mean 21.1 months. There was no recurrence at extraction sites.

Discussion

According to a report in the USA, the percentages of colon and rectal cancer patients treated with laparoscopic surgery increased from 35 and 14% in 2006 to 51 and 34% in 2010, respectively [11]. It was demonstrated that laparoscopic

Table 1 Successful NOSEs compared with failed cases

Parameter	Natural orifice specimen extraction		*p*
	Successful (*n*:49)	Failed (*n*:18)	
Age	56.9 ± 13.4	60.5 ± 13.3	0.34
Gender			
Male	25 (62.5%)	15 (37.5%)	0.02
Female	24 (89.9%)	3 (11.1%)	
Pathology			
Malign	45 (73.8%)	16 (26.2%)	0.71
Benign	4 (66.6%)	2 (33.3%)	Benign
Bowel disease			
Cecal cancer	3	4	0.004
Appendix carcinoid	1	–	
Crohn's disease	2	–	
Ascending colon cancer	1	4	
Hepatic flexure cancer	2	–	
Transverse colon cancer	–	1	
Splenic flexure cancer	1	–	
Descending colon cancer	1	2	
Sigmoid colon cancer	7	4	
Rectosigmoid cancer	5	–	
Rectal cancer	24	1	
Familial polyposis coli	2	2	
Colon/rectum			
Colonic pathology	18 (54.5%)	15 (45.5%)	0.0005
Rectal pathology	29 (96.7%)	1 (3.3%)	
Colonic and rectal pathology	2 (50%)	2 (50%)	
Surgical procedure			
Right colon resection	9 (52.9%)	8 (47.1%)	0.002
Transverse colon resection	–	1 (100%)	
Left colon resection	9 (60.0%)	6 (40.0%)	
Anterior or low anterior resection	29 (96.7%)	1 (3.3%)	
Total proctocolectomy and J pouch	2 (50%)	2 (50%)	
Additional resections			
Liver resection	1	1	0.69
Cholecystectomy	1	–	
Gastric resection	–	1	
Width of tumor	3.9 ± 2.9	6.5 ± 4.2	0.008
Length of resected bowel	21.2 ± 19.4	36.5 ± 27.6	0.015

surgery for colorectal cancer was associated with lower morbidity, less pain, faster recovery, and shorter hospital stay when compared with open resections [12]. Long-term oncological results were found to be as safe as open surgery, and the widespread use of laparoscopic colorectal cancer surgery was justified by the early and late outcomes [13]. Although dissection and division are performed via small incisions a larger incision for removal of the specimen is required. NOSE removes the need for this larger abdominal incision, with the anus and vagina being the most common NOSE sites.

There has been concern over potential bacterial contamination if NOSE is employed. However, whilst contamination rate of peritoneal fluid is higher after NOSE (100 vs 89%), there was no significant difference in infectious outcome between NOSE and conventional extraction [14–16]. Similarly, we did not observe any intraabdominal infectious complication in our NOSE cases. Nevertheless, lavage using povidone–iodine solution to the extraction path was our routine practice.

The vagina was first used in minimally invasive surgery to remove the gallbladder [17] and later used as an

extraction site for colon, kidney, and spleen [18–20]. The vagina has always been our second choice as a route of colorectal specimen removal in our cases. We chose this option when transanal removal could not be accomplished or was not expected to be possible. It is an important advantage to be able to perform the first incision under direct view in transvaginal NOSE. This procedure can also be performed safely intracorporeally by pushing a tampon toward the posterior wall of the vagina. If the vagina is not deep, we prefer the entrance under direct view, and if the vagina is deep, the patient is severely obese, and access to posterior fronix is challenging, we prefer intracorporeal colpotomy by pushing a tampon into the vagina. The flexible structure of the vagina compared with the colon allows the passage of larger specimens. In the literature, Wilson et al. [21] removed 8-cm- and Yagci et al. [10]—included in our study as well—removed 9-cm-sized right colon masses, respectively, transvaginally without any problem. We suggest that non-traumatic access into intraperitoneal cavity, being able to open and close under direct view, and recovering without scarring are the positive aspects of the vaginal entrance. Gynecologists routinely do not close posterior colpotomy wounds [22]. If difficulty is experienced when using the technique, the vaginal incision can be left open.

Tumor size is an important factor affecting the success of the transanal NOSE procedure. In the literature, tumor size as an inclusion criterion for studies on the transanal NOSE procedure has been confined to a maximum of 6.5 cm [23]. If a tool is placed in the anal canal while the specimen is being removed, tumor size decreases even further [24, 25]. We do not consider the specimen size as a restricting criterion alone for the removal of a transanal specimen. Given the three-dimensional structure of the mass, some masses have a shape that allows removal more easily than a tissue with a smaller volume. Another important consideration is the tumor location. We failed to remove small tumors located in the cecum or right colon in some of our cases. The more distally the tumor was located, the more successful the results we obtained. On the other hand, we can suggest that the consistency of the tumor is important in removal, as well. We did not have a challenge in removing transanally a 12-cm-sized villous adenoma specimen located in the sigmoid colon. It can be predicted that mesentery resected along with the specimen will affect the success of both transanal and transvaginal NOSE procedures as well as the size of the removed bowel and tumor. Therefore, body mass index (BMI) can be used as a factor in patient selection [23, 26–28].

To date, the factors affecting the success of specimen removal from the natural orifices in colorectal tumors have not been analyzed. Our experience will aid in the selection of patients for NOSE.

Conclusions

In patients who required an LCRR for a mass, the success rate of NOSE was 73.1%. If the converted cases at the resection stage were included, the overall success rate decreased to 68.1%. Rectal resections, smaller lesions, and female patients had a higher chance for NOSE after LCRRs.

Compliance with ethical standards

Conflict of interest Authors declare that they have no conflict of interest.

Ethical approval The ethical committee has approved the study.

Informed consent The written informed consent was obtained from the patients.

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