Original Article

Natural Orifice Specimen Extraction during Colorectal Surgery: A Community Hospital Experience

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Purpose. Natural orifice specimen extraction (NOSE) after minimally invasive surgery may minimize abdominal incisions, thus leading to decreased postoperative pain and shorter hospitalization. We examined the safety and feasibility of NOSE in community hospital.
Material and Methods. We recruited patients from a single institution from April 2019 to May 2022 who underwent NOSE during laparoscopic or robotic surgery. Patient characteristics, surgical data, and hospitalization data were retrospectively collected and analyzed.
Results. Forty-eight patients (31 women and 17 men; median age, 60.3 years; mean body mass index, 23.4 kg/m^2) were included. Five had benign colon lesions and 43 had cancer. Forty-five patients underwent laparoscopic surgery and three patients underwent robotic surgery. The mean operative time was 239.2 minutes for laparoscopic anterior resection (AR) and for low anterior resection (LAR). The surgical procedure included 45 ARs or LARs, one right hemicolectomy, one total colectomy, and one Hartmann procedure. We retracted two specimens via the vagina and the other specimens via the anus. The average specimen length and width were 14.4 cm and 10.2 cm, respectively. For those with cancer, the average tumor length and width were 2.6 cm and 2.0 cm, respectively. Postoperatively, the mean time to first flatus was 1.7 days, the mean antibiotic usage time was 1.9 days, and the mean hospitalization was 6.8 days. There were no mortalities, morbidities, or local recurrences.
Conclusion. NOSE is safe and feasible during colorectal surgery in community hospital.

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Minimally invasive techniques have been considered the gold standard for colorectal surgery over the past two decades. However, the additional abdominal incision for specimen retrieval remains a problem. This additional wound may result in postoperative pain, surgical site infection, and incisional hernia.[1-3] Therefore, natural orifice specimen extraction (NOSE) has been used as an alternative to mitigate these unfavorable outcomes.

The disadvantages of NOSE with intra-corporeal anastomosis are the level of technical difficulty. It may increase the peritoneal contamination risk when we open the bowel lumen in the peritoneal cavity. The cancer cell spreading contamination, while extracting

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the specimen from natural orifice, is another concern. It may possible be the reasons that are reported using in medical center only. It is not widely practice in community hospital.

Our institute had reported an initial result of NOSE.[2] Now, we report our short-term outcome. We also introduced our NOSE surgical technique, including the anvil setup and intra-corporeal anastomosis.

Materials and Methods

Patient selection

This retrospective series enrolled all patients at our institution who underwent minimally invasive surgery with NOSE from April 2019 to May 2022. We reviewed the medical records and noted that the surgical approach was determined during a preoperative meeting involving the patient, the family of the patient, and the physician. All patients were informed that specimen retraction would be attempted via the anus or vagina.

Patients with a body mass index (BMI) more than 30 or tumor size larger than 5 cm were excluded. Tumors located between the sigmoid colon and upper rectum were preferred.

Demographic information was collected prospectively, including age, sex, BMI, American Society of Anesthesiology class, tumor size, tumor location, surgical procedure, operative time, operative blood loss, pathologic TNM stage, time to passage of flatus, postoperative hospitalization, antibiotic usage, and perioperative complications.

Preoperative preparation

Antegrade bowel preparation was performed 1 day before surgery if there was no contraindication. If the bowel was not clean during the morning check on the day of surgery, then an additional cleansing enema was administered. An intravenous prophylactic antibiotic agent (Flomoxef 1 g) was administered before the incision was created.

Anesthesia

We routinely utilized a bispectral index (BIS) monitor (MDoloris Medical Systems, Loos, France) to maintain the desired level of anesthesia.[4-6]

Surgical procedure

The surgical procedure was the same as that used for conventional laparoscopic colectomy.[1-3] Patients were placed in the Trendelenburg position. After the open insertion of a 12-mm balloon supra-umbilical port for the three-dimensional laparoscopy camera (Endoeye Flex 3D; Olympus, Tokyo, Japan), a 12- to 15-mmHg pneumoperitoneum was created. Subsequently, two 5-mm working ports were placed on the left and right middle abdomen. A 12-mm trocar was inserted in the right lower abdominal quadrant. If necessary, then an additional one or two 5-mm trocars were inserted in the left lower abdominal quadrant and/or right upper middle abdomen as assistive ports.

Then, the following procedures were standardized for all patients with left-side colorectal cancer: an avascular retroperitoneal plane from the para-duodenum mesocolon was created; high ligation of the inferior mesenteric vein was performed; the splenic flexure was mobilized; high or low ligation of the inferior mesentery artery, dependent on the tumor location, was performed; partial mesorectal excision with nerve preservation was performed for upper rectal cancer patients; rectal stump irrigation was performed before resection of the distal part of the colon; fluorescence angiography with 0.1 mg/kg indocyanine green (TAIYO Pharma Tech Co., Ltd., Osaka, Japan) was performed,[7] and proximal and distal resections were performed using an Endo GIA stapler (Medtronics, Dublin, Ireland).

Then, specimen extraction was performed. The distal staple line on the rectum was resected with a scissors or energy device. The anus was dilated with a sizer (EEA; Ethicon Inc., Raritan, NJ). Gauze was sterilized with povidone-iodine and applied to the rectal stump. An extra-small Alexis wound protector (Applied Medical, Rancho Santa Margarita, CA) was introduced via the anus (Fig. 1A), and a Babcock

clamp was introduced via the anal Alexis wound protector. The specimen was grasped and removed via the anus (Fig. 1B). Wet gauze was placed in the anus to prevent pneumoperitoneum air leakage.

After transanal specimen extraction, the side-to-end single-stapling colorectal anastomosis[2,8,9] was performed. The circular stapler anvil was advanced to the abdomen via the anal Alexis wound protector. The proximal staple line on the colon was removed by a scissors or energy device. Gauze soaked with povidone-iodine was applied to the colon stump for sterilization. The anvil was placed inside the colon (Fig. 2A). The proximal site of the colonic lumen was occluded by the Endo GIA stapler (Fig. 2B). The serosa was closed with 3-O Vicryl™ (Ethicon Inc.) interrupting sutures. A hole was created on the proximal colon 3 to 4 cm from the edge (Fig. 2C) to allow penetration of the anvil shaft. The anvil was fixed with 2-O Prolene™ (Ethicon Inc.) intracorporeal purse-string sutures (Fig. 2D). The tissue resected with the stapler was extracted via the anus. The Alexis wound protector was removed from the anus. Purse-string sutures were used for the rectal stump. After the circular stapler gun was setup, purse-string sutures were used for fixation (Fig. 3A). The anvil of the circular stapler gun was reloaded, and a side-to-end single-stapling

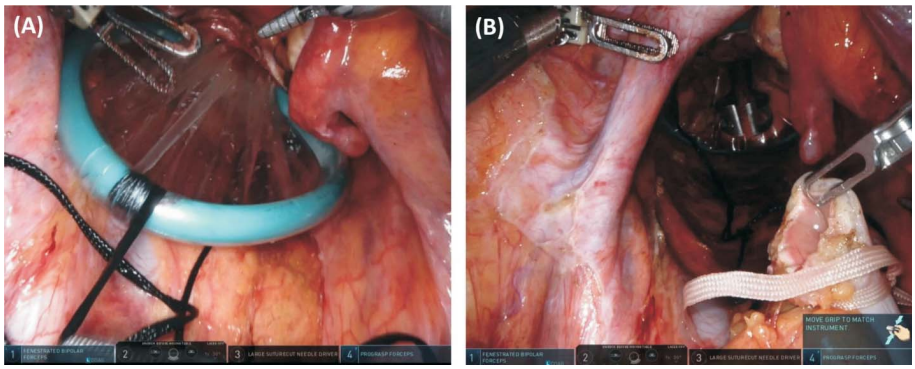

Fig. 1. (A) Extra-small Alexis wound protector introduced from the anus to the abdominal cavity. (B) A Babcock clamp via the Alex wound protector used to grasp the specimen and remove it via the anus.

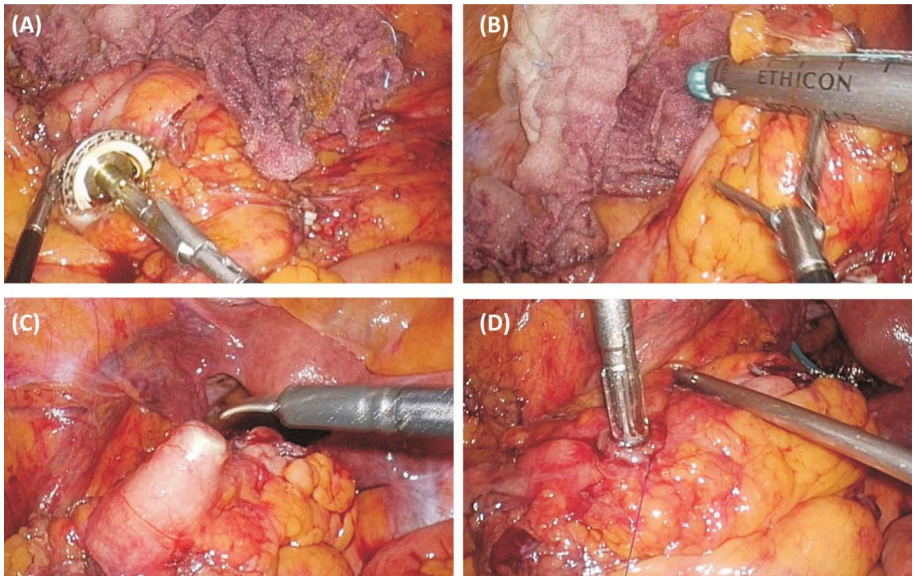

Fig. 2. (A) Placement of the anvil in the proximal colon. (B) Closure of the proximal colon lumen with the Endo GIA. (C) Creation of a hole in the proximal colon 3 to 4 cm from the edge. The anvil shaft penetrated the colon wall. (D) Fixation of the anvil with purse-string sutures.

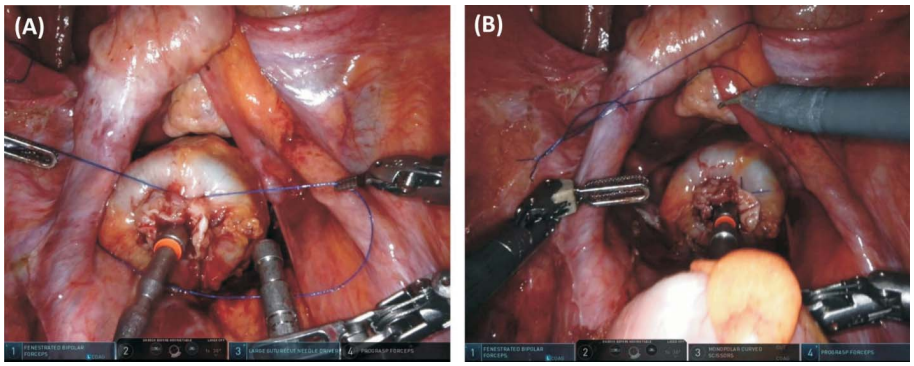

Fig. 3. (A) The circular stapler gun and purse-string sutures. (B) The anvil was connected to the circular stapler gun.

colorectal anastomosis was created (Fig. 3B). Three additional colonic serosa sutures were used for tension release. Evaluation was performed during the intraoperative colonoscopy.

The end-to-end anastomosis was performed in the same manner as the side-to-end anastomosis except there was a difference in the anvil setup on the proximal colon. We used purse-string sutures on the proximal colon and placed the anvil inside. Then, we used purse-string sutures to fix the anvil. If the specimen was extracted via the vagina, then the vagina was closed with 3-O Vicryl™ sutures. Right hemicolectomy was performed in the same manner as conventional laparoscopic right hemicolectomy.[10] We utilized three ports. After the first supra-umbilical 12-mm balloon trocar was inserted as a camera port, another 5-mm trocar was placed in the right lower middle abdomen, and a 12-mm trocar was placed in the midline 4 cm above the pubic synthesis. The medial-to-lateral approach was used and D3 dissection was performed. An intracorporeal stapled functional side-to-side isoperistaltic ileocolic anastomosis was created. The subtotal colectomy was performed in the same manner as conventional laparoscopic subtotal colectomy for benign colon disease. For the robotic left hemicolectomy or AR cases, the trocar site placement was modified using the Institute® da Vinci Xi® Clinical Specialty Guide.

Postoperative care

After surgery, a prophylactic intravenous antibiotic (Flomoxef) was prescribed for 1 day. Patients were offered liquids soon after recovery from anesthesia. There were no dietary restrictions after the patients could tolerate liquids. All patients were allowed early mobilization. Proton pump inhibitor therapy (Lanxoprazole) was administered intravenously 1 day after surgery.

Postoperative acetaminophen (Scanol) was administered to alleviate pain. Meperidine was administered intramuscularly if the oral medication did not relieve the pain. The urinary catheter was usually removed on the first postoperative day. An intra-abdominal drain was not routinely used. Discharge criteria included tolerance of general meals for at least 1 day, stool passage, and no signs of infection or leakage.

Results

The population included 48 patients (Tables 1 and 2). Five patients had benign colon lesions and 43 had cancer. There were 17 male and 31 female patients with a median age of 60.3 years and mean BMI of 23.4 kg/m^2.

Three patients did not undergo preoperative bowel preparation. Seven patients were administered an enema (Fleet®) before surgery. The other 38 patients underwent oral antegrade bowel preparation with two packs of Bowklean® powder 1 day before surgery.

The five benign colonic lesions were pan-colon polyposis, sigmoid polyposis, sigmoid tubulovillous adenoma, sigmoid diverticulosis, and sigmoid colovesical fistula. The patient with pan-colonic polyposis underwent laparoscopic subtotal colectomy. The other patients underwent laparoscopic AR.

Table 1. Patient characteristics

Characteristics (N=48)	
Age (years)	60.3 (±13.2)
Sex	
Women (%)	31 (64.6%)
Men (%)	17 (35.4%)
BMI	23.4 (±3.1)
ASA	
1	1 (2%)
2	23 (48%)
3	24 (50%)
Benign (5)	
Polyps	3
Diverticulosis	1
Colo-vesical fistula	1
Malignancy (43)	
Stage Tis	2 (4.7%)
Stage T1	18 (41.9%)
Stage T2	7 (16.3%)
Stage T3	15 (34.9%)
Stage T4	1 (2.3%)

Values are presented as the mean ± standard deviation unless otherwise indicated.
BMI, body mass index; ASA, American Society of Anesthesiology.

Table 2. Tumor characteristics

Malignancy (43)	
Location	
Hepatic flexure	1 (2.3%)
Descending colon	2 (4.7%)
Sigmoid to the upper-third of the rectum	39 (90.7%)
Lower-third of the rectum	1 (2.3%)
Tumor size	
Length (cm)	2.6 (±1.2)
Width (cm)	2.0 (±1.0)
Lymph nodes harvested	16.9 (±6.6)
T stage	
T1, Tis	13 (30.2%)
T2	11 (25.6%)
T3	15 (34.9%)
T4	4 (9.3%)
N stage	
N0	39 (90.7%)
N1	4 (9.3%)
N2	0
M stage	
M0	42 (97.7%)
M1	1 (2.3%)

Values are presented as the mean ± standard deviation unless otherwise indicated.

The pathology results of the patients with cancer are summarized in Table 2. The average tumor length and width were 2.6 cm and 2.0 cm, respectively. The average number of harvested lymph nodes was 16.9 (range, 5-38). One patient with hepatic flexure colon cancer underwent laparoscopic right hemicolectomy, and the specimen was extracted via the vagina. Two tumors were located in the descending colon. One tumor was found in a patient with lower-third rectal cancer. The other 39 tumors were sigmoid colon cancer or upper-third rectal cancer. Two patients underwent combined surgery. One sigmoid cancer patient underwent oophorectomy because of direct invasion with T4b pathology. Another patient with rectal cancer adherent to the cervix and cecum underwent total hysterectomy and partial cecostomy; the specimen was extracted via the vagina and had T4b pathology. The mean follow-up time was 14.1 months (standard deviation, ±11.6 months). No local recurrence was observed. Two patients had distal metastasis. One female patient with initial pT3N2aM0 stage IIIB rectal cancer had lung and liver metastasis 22.4 months after surgery. A male patient with initial pT3N2bM0 stage IIIC sigmoid cancer had lung metastasis 10.4 months after surgery.

The surgery data are listed in Table 3. Three patients underwent robotic surgery and 45 underwent laparoscopic surgery. The mean operative times were 239.2 minutes for laparoscopic AR/LAR and 361.3 minutes for robotic AR. The mean blood loss was 11.3 mL. Of the 42 patients with left-side colon cancer, 38 underwent high ligation of the inferior mesenteric artery. The mean anastomosis was 8.2 cm from the anal verge; there were 29 side-to-end and 17 end-to-end anastomoses. The average length and width of the specimens were 14.4 cm and 10.2 cm, respectively.

Postoperatively, the mean time to first flatus was 1.7 days (Table 4) and the mean antibiotic usage time was 1.9 days. The intra-abdominal drain was a 19-Fr Jackson-Pratt drain; it was used in 14 patients for a mean duration of 3.7 days. Patients were hospitalized for a mean of 6.8 days.

Two patients required prolonged antibiotic usage, including one patient with pneumonia before the Hart-

Table 3. Operative outcomes

Surgery	
Laparoscopy	45
Robotic	3
Surgical procedure	
Laparoscopic right hemicolectomy	1
Laparoscopic total colectomy	1
Laparoscopic Hartmann	1
Laparoscopic AR/LAR	42
Robotic AR/LAR	3
Combined surgery	
Partial cecostomy with hysterectomy	1
Oophorectomy	1
Operative time (minutes)	
Laparoscopic right hemicolectomy	219
Laparoscopic total colectomy	200
Laparoscopic Hartmann	272
Laparoscopic AR/LAR[a]	239.2 (±68.7)
Robotic AR/LAR[a]	361.3 (±119.8)
Blood loss (mL), range	11.3 (2-50)
Inferior mesenteric artery (for left-side colon cancer)	
High ligation	38 (90.5%)
Low ligation	4 (9.5%)
Specimen characteristics	
Length (cm)	14.4 (±10.2)
Mesentery vascular length (cm)	10.2 (±2.7)
Specimen extraction	
Anus	46
Vagina	2
Anastomosis from anal verge (cm)	8.2 (±1.8)
Anastomosis	
Side-to-end	29 (60.4%)
End-to-end	17 (35.4%)
Right hemicolectomy, side-to-side	1
Hartmann	1

Values are presented as the mean ± standard deviation unless otherwise indicated.
AR, anterior resection; LAR, low anterior resection.

mann procedure to control the bleeding of the tumor and one patient with a colo-vesical fistula.

Acetaminophen was prescribed to alleviate pain after surgery. Extra pain control with intramuscular long-acting nalbuphine decanoate 150 mg was administered to eight patients before surgery. Additional pain control with intramuscular meperidine after surgery was required for eight patients (14 injections were recorded). The average dosage of Meperidine was 12.3 mg. There were no mortalities or morbidities.

Table 4. Postoperative outcomes

Postoperative outcomes	
Time to flatus passage (days)	1.7 (±1.0)
Postoperative hospitalization (days)	6.8 (±1.5)
Drain usage (patients)	19 (39.6%)
Drain removed (days)	3.7 (±0.8)
Foley removed immediately after surgery (patients)	8 (16.7%)
Foley removed (days)[a]	1.8 (±0.7)
Additional pain control	
Long-acting nalbuphine (patients)	8 (16.7%)
Nalbuphine dosage (mg)	25 (±56.5)
Meperidine (patients)	8 (16.7%)
Meperidine dosage (mg)	12.3 (±30.1)

Values are presented as the mean ± standard deviation unless otherwise indicated.
[a] Excluding the colo-vesical fistula case.

Discussion

The performance of laparoscopic surgery is increasing worldwide. However, the additional abdominal incision required for specimen extraction may offset the scarless cosmetic effect of minimally invasive surgery, increase postoperative wound pain, incisional hernia, and wound infection rate. Occasionally, injuries of the bowel, intestinal vessels, and nerves can occur during specimen retrieval, thus causing unnecessary intraoperative complications.[11-13] Therefore, the removal of the specimen through a normal orifice is a beneficial alternative.

NOSE is performed based on the current conventional laparoscopic platform without additional specialized instruments. Although NOSE has the advantages of omitting the mini-laparotomy wound, it has not been widely adopted because of the concerns of tumor spreading, breach of intraperitoneal sterility, and the complexity of the surgical technique.[14] Even the meta-analyses,[15-17] retrospective case-control studies,[18-20] and randomized trials[21] have shown that NOSE did not achieve inferior results or higher infection rates. Intraperitoneal bacterial contamination and tumor cell spillage have led to safety concerns.[8,14,22] The recently reports still be limited to expert centers. We had reported our NOSE experience, and suggested it may be adopted in community hospital.

No local recurrence was observed during our study. In practice, we select patients with tumors smaller than 5 cm because of oncological concerns.[3,11,18] A large, bulky, friable tumor may cause tumor compression and dispersion when it is extracted via the anus. This may cause tumor cell spillage and implantation and is not in compliance with the non-touch surgical principle for cancer.[19] We excluded obese patients with a BMI more than 30 kg/m^2 because a bulky tumor size and thickened mesentery may increase the difficulty of specimen extraction[23] and may result in tumor dispersion and tumor cell scattering.

Further to eliminate the potential risks of cancer cell exfoliation, implantation, and local recurrence at the bowel stump or vagina opening, the TEO® (Transanal Endoscopic Operation), plastic disposable sleeve, tissue retrieval bag, and double-ring retractor should be applied to cover the orifice. Double-sided stapling of the colon cancer specimen may provide further security and prevent tumor spread while manipulating the colon tissue. At our institute, we prefer rectal stump washing before stapling, double-sided stapling of the colon tumor specimen, and an extra-small Alexis wound protector for the orifice.

Regarding the risk of infection, we found no instances of surgical site or intra-abdominal infections. However, we were unable to identify any specific factors that could be associated with infection risk during our chart review. According to the literature, the rates of intra-abdominal and surgical site infections typically range from 1.1% to 1.39%[8,20] and 0.43% to 0.46%,[8,16] respectively. These rates are not inferior to those reported for traditional laparoscopic surgery.

To minimize infection risk, we recommend adhering to surgical sterilization principles, such as using gauze soaked with povidone-iodine to sterilize the colon and rectal stump during surgery.

While bowel preparation is generally not recommended for left-side colon surgery,[20,21] we opted to perform bowel preparation for 45 patients due to the occasional risk of bowel content contamination during surgery. Additionally, anesthesia medication, such as alfentanil, opioids, and Buscopan®, can help decrease bowel motility, which is important in preventing such contamination. To monitor the appropriate level of anesthesia and nociception/anti-nociception balance, the Analgesia Nociception Index with BIS monitor can be useful.[4-6] This index utilizes Fourier transform during electrocardiography to evaluate the autonomic nervous system based on its parasympathetic component. Since gastrointestinal motility is influenced by the parasympathetic nervous system, monitoring these factors can aid in reducing bowel motility and peristalsis.

Based on our experience, intracorporeal placement and fixation of the anvil in the proximal colon can be challenging and may cause bowel spasms and decreased motility.[9] The first step of the procedure is to stabilize the proximal colon in the left lower quadrant, and mobilization of the splenic flexure can be helpful in achieving adequate bowel length. To assist with the placement of the anvil, an assistant can provide counter-traction to stabilize the open end of the proximal colon. However, this counter-traction may not be sufficient to widen the colon, and its primary purpose is to stabilize the colon and facilitate anvil placement.

No anastomosis leakage occurred in this series. We recommend the routine use of indocyanine green during minimally invasive surgery. Intraoperative fluorescence angiography with indocyanine green is associated with lower anastomotic leakage rates after colorectal resection.[7,24] We also recommend splenic flexure takedown for an adequate left-side colon length and tension-free anastomosis. A wound protector is necessary for the specimen extraction orifice.

And using the correct anvil sizes that fit the bowel lumen is crucial. The additional sutures for anvil fixation and stapling close to the proximal colon end are the same. The end-to-end and side-to-end anastomoses are chosen based on the anastomosis location or the judgement of the surgeon. We prefer end-to-end anastomoses for AR and side-to-end anastomoses for LAR. The use of purse-string sutures is another challenge for inexperienced surgeons. Therefore, practice and experience are necessary.[25,26] We used a side-to-end single-stapling colorectal anastomosis technique. Compared with the double-stapling anastomosis technique, the purse-string suturing of the rectal stump has the advantage of preventing further distal rectal stump

dissection, the single-stapling technique has the advantage of preventing the formation of "dog ears," and the side-to-end colorectal anastomosis has better blood perfusion and functional outcomes than the straight anastomosis. The anastomosis is reinforced by sutures and is checked during intraoperative colonoscopy.[2]

The lack of the mini-laparotomy wound minimized the pain experienced by patients. We noted that the additional Meperidine was prescribed for only eight patients, with an average dosage of 12.3 mg. Less pain led to improved mobilization and enhanced recovery after surgery. Bowel function return and flatus occurred within a mean of 1.7 days after surgery. The average hospitalization was 6.8 days.

There were 50% patients in this study had comorbidities and an American Society of Anesthesiology score of 3. And there is no patient noted local recurrence, anastomosis leakage, or intra-abdominal abscess.

Conclusion

This study demonstrated the feasibility and safety of NOSE in clinical practice. NOSE does not require specific devices and can be performed using conventional laparoscopic or robotic surgery. The technique is feasible for well-trained laparoscopic surgeons and is safe for carefully selected patients without obesity and without large tumors.

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原　著

地區醫院大腸直腸手術使用經自然孔腔標本取出的短期經驗報告

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目的　微創手術合併使用經自然孔腔標本取出，因為減少腹壁切口，因而減少術後傷口疼痛和住院天數。我們報告大腸直腸手術運用經自然孔腔標本取出後的短期成果，並討論是否在地區醫院為安全及有效的手術方式。

方法　我們回朔收集從 2019 年 4 月至 2022 年 5 月，在中國醫藥大學新竹附設醫院實行經自然孔腔標本取出手術患者，分析及報告病人的基本資料、手術相關過程和術後恢復結果。

結果　共 48 位病人，含 31 位女性、17 位男性。平均年齡 60.3 歲。平均 BMI 23.4。43 位癌症患者，跟 5 位大腸良性疾患。3 位接受機器手臂手術，45 位腹腔鏡手術。腹腔鏡前位或低前位切除術手術時間平均為 239.2 分鐘。術式涵蓋 45 位前位切除術或低前位切除術、1 位右側大腸切除、1 位全大腸切除、1 位哈特曼氏手術。除了 2 個手術檢體是從陰道取出外，其他是從肛門取出。手術標本平均長度為 14.4 公分，平均寬度 (血管長度) 為 10.2 公分。對於 43 位癌症患者，腫瘤平均大小為長 2.6 公分、寬 2.0 公分。術後排氣時間為 1.7 天，平均抗生素使用 1.9 天。平均術後住院天數為 6.8 天。無手術後併發症及死亡案例。無局部復發案例。

結論　在地區醫院臨床實務上，經自然孔腔標本取出手術運用在大腸直腸手術上，是一個安全且有效的方法。

關鍵詞　經自然孔腔標本取出手術、大腸直腸手術、地區醫院。