Original Article

Short-term Outcome of Laparoscopic Anterior Resection with Natural Orifice Specimen Extraction (NOSE) for Left-Sided Colon Cancer

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Key Words
Laparoscopic colectomy;
Natural orifice specimen extraction;
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Purpose. Natural orifice specimen extraction (NOSE) after laparoscopic colorectal tumor resection may minimize abdominal mini-incisions, leading to decreased postoperative pain, early bowel function recovery, and shorter hospital stays. We report the short-term outcomes of left-sided colorectal cancer patients who underwent this advanced laparoscopic procedure and examine its safety and feasibility.
Methods. Consecutive patients who underwent laparoscopic anterior resection and NOSE for left-sided colorectal cancers were recruited from a single institution from January 2013 to March 2014. Exclusion criteria were a tumor size > 5 cm, complete colonic obstruction, colonic perforation, or a body mass index (BMI) > 33 kg/m^2. Patient characteristics, surgical information, and perioperative data were prospectively collected and retrospectively analyzed.
Results. The subjects were 41 patients (18 male and 23 female; median age, 65.7 years; mean BMI, 23.9 kg/m^2). The mean operation time was 226 minutes. Average tumor size was 2.8 (length) × 2.1 (width) cm. Postoperatively, the mean time to first flatus was 1.3 days, and the mean hospital stay was 5.2 days. One case with poor bowel preparation was converted to a conventional laparoscopic approach. There were no mortalities. One anastomosis leakage occurred, with a leak rate of 2.4%. Intra-abdominal abscess, prolonged ileus, and urinary tract infection occurred in one patient each. The overall complication rate was 9.8%.
Conclusions. Laparoscopic anterior resection and NOSE was safe and feasible for left-sided colon lesions when performed by an expert. Its advantages require elucidation in a prospective randomized comparative study using traditional laparoscopic assisted anterior resection.
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Laparoscopic colectomy is a proven safe and effective surgical approach to colorectal cancer.[1] Its short-term postoperative advantage was evidenced and comparable long-term oncological results to open surgery have also been shown.[2] In conventional laparoscopic colectomy (LC), an additional abdominal incision is needed to extract the specimen from the peritoneal cavity, which may raise the possibility of

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unnecessary bowel injury, a mesenteric tear, or an artery, vein, or nerve injury.[3] In some cases, a short or obese mesentery also increased the difficulty of specimen extraction. In recent years, natural orifice specimen extraction (NOSE) has been performed with greater frequency worldwide.[4-6] NOSE prevents minilaparotomy or elongation of the port site for specimen extraction, and bowel anastomosis is performed intracorporeally. The disadvantages of NOSE with intracorporeal anastomosis are the level of technical difficulty and the potentially increased risk of peritoneal contamination or surgical wound infection when the bowel lumen is opened in the peritoneal cavity. This study was undertaken to analyze our short-term results with NOSE for left-sided colorectal cancers.

Materials and Methods

Patient selection

This retrospective series enrolled all patients who underwent laparoscopic anterior resection and NOSE for left-sided colorectal tumors at our institution from January 2013 to March 2014. Demographic information was collected prospectively including age, gender, body mass index (BMI), American Society of Anesthesiology (ASA) class, tumor size, tumor location, operation time, conversion to LAP, pathologic TNM stage, time to passage of flatus, postoperative hospital stay, and perioperative complications. Perioperative complications were defined as those occurring within the first month of the surgical procedure. The contraindications for NOSE were a tumor size greater than 5 cm in diameter (based on computer tomography image studies reported by radiologists), a BMI exceeding 33 kg/m^2, and obstruction and perforation by the colonic lesion. All patients undergoing laparoscopic anterior resection were informed that the specimen retraction would be attempted via the anus.

Preoperative preparation

One-day antegrade bowel preparation was performed in all patients. An intravenous prophylactic antibiotic agent (cefmetazole 1 g) was administered 15 minutes before incision.

Surgical procedure

The patient was placed supine, in a modified lithotomy position, and tilted toward the right side in a reverse Trendelenburg position. The surgical team included a camera operator, a first assistant, and a scrub nurse. Four trocar ports were used for this procedure. The first cannula was established using the "open" method, whereby a 12-mm trocar is placed into the umbilicus. This method can reduce the incidence of intra-abdominal organ injury. The abdomen was then insufflated with CO_2 to 10-12 mmHg, and the optical device was introduced through the first trocar, followed by the insertion of operating trocars under direct vision. A 5-mm trocar was inserted into the right middle abdomen and a 12-mm trocar was placed in the right lower guardant. Finally, a 5-mm trocar was placed in the left middle abdomen. In some patients, a fifth trocar would be placed in the left lower quadrant.

The dissection started with the identification of the inferior mesenteric vein at the inferior border of the pancreas near the duodenal fossa, and the vein was explored and divided using an energy device. The dissection proceeded posteriorly and medial-to-lateral in between the avascular plane of Toldt's fascia and the descending and sigmoid colon. The mobilization included both medial-to-lateral and superior-to-inferior approaches. When laparoscopic anterior resection and NOSE is performed, splenic flexure mobilization is required. After mobilization of the splenic flexure, the dissection was carried out medially and caudally to the Treitz ligament and downward along the right anterior border of the aorta to open up the visceral peritoneal at the level of the sacral promontory, and proceeded into the upper rectum. Following this step, the inferior mesenteric artery was easily identified and ligated at its origin with careful preservation of the hypogastric nerves. The final step for mobilization of the left side colon was dissection beyond Waldyer's fascia of the rectum, followed by incision along the left lateral paracolic ligament to complete the mobilization of the entire left side colon.

After the proximal and distal surgical margins were established according to oncologic principles, the pericolic fat and attaching mesocolon were divided using a bipolar energy device. The bilateral ends of the disease-containing colon were ligated intracorporeally using silk with an adequate margin (Fig. 1A), and thorough irrigation of the rectum was performed using beta-iodine solution to avoid stool contamination while transecting and opening the distal rectal lumen. Laparoscopic scissors were then used to transect the rectum just distal to the tied and sutured end-side, and the rectum stump was opened circumferentially (Fig. 2A). A cotton string was then inserted into the peritoneum via a 12-mm port and pulled out from the opened rectal stump to the anus by a 17-cm Babcock forceps. This cotton string was used to introduce the setting of the rectal conduit with an XS-sized Alexis wound retractor (Applied Medical, Rancho Santa Margarita, CA). After tying the anal-side cotton string to one of a pair of Alexis rings, we pushed this ring into the rectum lumen and inserted it into the abdominal cavity by pulling the port-side cotton string (Fig. 2B). Finally, one Alexis ring was set on the opened rectal stump and the other on the anus, so that the rectal conduit for specimen extraction was prepared after maturation of the Alexis wound retractor.

Before transection of the proximal end of the specimen, we clamped the descending colon with a laparoscopic Bulldog clip to prevent contamination by bowel contents (Fig. 1B). The sigmoid was transected by laparoscopic scissors just beside the proximal tied suture so that the specimen was completely separated, and the proximal colon stump was opened. An intracorporeal purse-string suture was created laparoscopically around the opened proximal stump with 2-O Prolene. The anvil head attached to the circular stapling device (CDH 29; Ethicon Endo-Surgery) was placed into the peritoneal cavity through the rectal Alexis conduit and then inserted into the proximal colon stump and fixed by tying the prepared purse-string suture (Fig. 2C). The Bulldog clip was then removed.

After lubricating the Alexis conduit with sterilized jelly, we inserted a Babcock to grasp the separated specimen and extracted it from the anus (Fig. 3). The cotton string fixed into the inner side Alexis ring

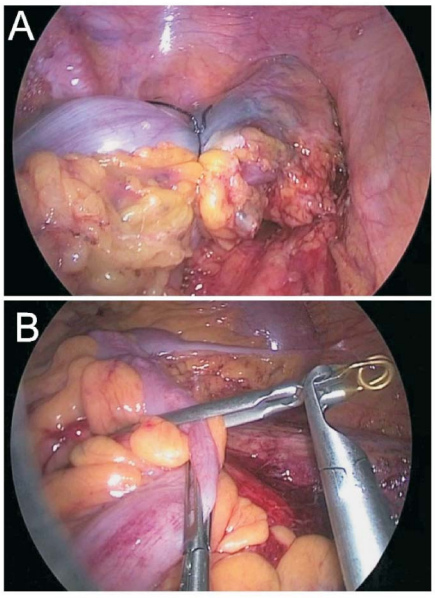

Fig. 1. (A) The bilateral ends of the disease-containing colon were ligated intra-corporeally; (B) The descending colon was clamped with a laparoscopic Bulldog clip.

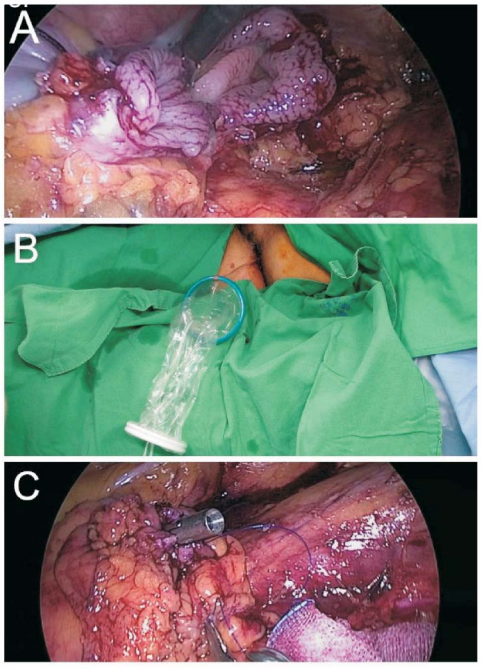

Fig. 2. (A) The rectum was transected with laparoscopic scissors; (B) The Alexis ring was inserted into the abdominal cavity; (C) An intra-corporeal purse-string suture was created and the anvil head was fixed.

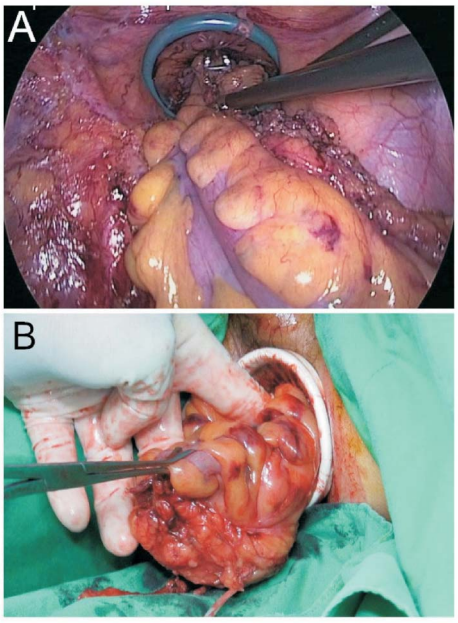

Fig. 3. Specimen extraction through the anus; (A) intra-abdominal view; (B) extra-abdominal view.

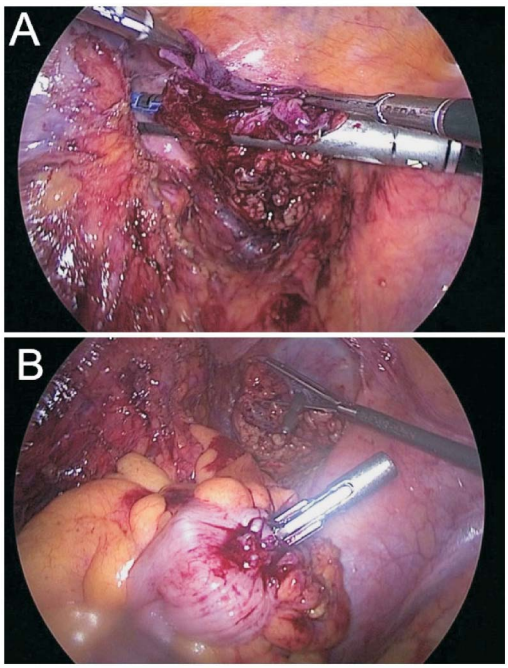

Fig. 4. (A) The rectal stump was closed with a laparoscopic linear stapler; (B) end-to-end colorectal anastomosis with a circular stapler device.

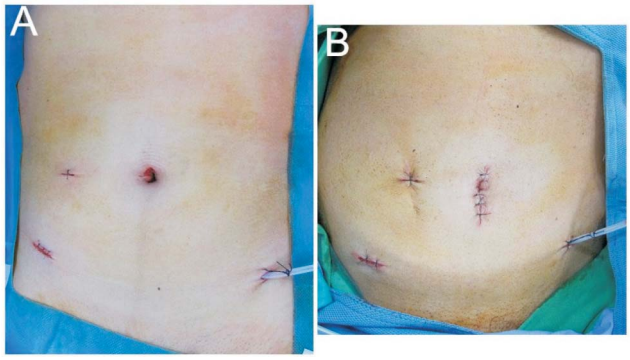

Fig. 5. Postoperative abdominal wound after; (A) natural orifice specimen extraction; (B) conventional laparoscopic colectomy.

was caught and pulled out transanally, simultaneously removing the Alexis wound retractor. The rectal stump was then closed with a laparoscopic linear stapler just below the edge of the stump opening (Fig. 4A). The additional transected short cuff of rectum was put into a specimen bag and retrieved through the 12-mm port. After the pelvic cavity was irrigated with 2 liters of saline, end-to-end colorectal anastomosis was performed intra-corporeally with a circular stapler device in the usual manner (Fig. 4B). Finally, a pelvic drain tube was placed near the anastomosis. To ensure a tight anastomosis, water-air leakage testing was performed, and the anastomosis was inspected by proctosigmoidoscopy or colonoscopy. A postoperative abdominal incision wound is shown in Fig. 5.

Postoperative care

After the operation, a prophylactic antibiotic was not used routinely. Intravenous cefmetazole was prescribed only if intraperitoneal contamination occurred during the operation. Patients were offered a liquid diet soon after recovery from anesthesia, and no dietary restrictions thereafter if they did not develop postoperative ileus. Medicine for postoperative pain control was used depending on the patient's request and not routinely administered. No epidural pain-control was allowed in this study; meperidine intramuscular injection was used for postoperative pain relief. The urinary catheter was removed on the first postoperative day, and all patients were mobilized early. Discharge criteria included tolerance of at least six general meals without nausea or vomiting, absence of abdominal distention, flatus passage, and no signs of infection or leakage.

Results

Forty-one patients (18 males and 23 females) with diagnoses of left-sided colorectal cancer underwent laparoscopic anterior resection and NOSE between January 2013 and March 2014. The average age was 65.7 years, with a BMI of 23.9 kg/m^2. Tumors were located in the D-colon (n = 2, 4.8%), S-colon (n = 25, 60.9%), rectosigmoid junction (n = 9, 22%), and rectum (n = 5, 12.2%). Patient perioperative characteristics are shown in Table 1 and pathological results are summarized in Table 2. The median operation time was 226 minutes, and no intra-operative complications occurred with the exception of one patient who was converted to conventional laparoscopic assisted colectomy because of stool contamination during anastomosis due to poor bowel preparation. Postoperatively, patient care followed the guidelines of our enhanced recovery program, and the mean time to passage of flatus was 1.3 days, with a hospital stay duration of 5.2 days. There were no mortalities. Postoperative outcomes are shown in Table 3. One patients developed anastomosis leakage, with a leak rate 2.4%. Anastomosis leakage was diagnosed according to clinical symptoms and abdominal computer tomography, which revealed fluid accumulation and fat stranding around the anastomosis region. No peritoneal free air or bowel perforation was observed. This patient received a second surgery including a repeat anastomosis and protective ileostomy. One patient developed an intra-abdominal abscess 3 days postoperatively. No secondary surgery was performed in this case, and the clinical symptoms improved with antibiotic treatment and intra-abdominal drainage. One patient developed urinary tract infection, and another patient had postoperative ileus. The overall morbidity rate including surgical and medical complications was 9.8%.

Table 1. Patient demographic characteristics

Patient characteristics	N = 41
Age (years), Median (range)	65.7 (40-92)
Gender	
Female (%)	23 (56.1%)
Male (%)	18 (43.9%)
BMI, Median (range)	23.9 (15.4-33.6)
ASA	
1-2	27 (65.9%)
3-4	14 (34.1%)
Albumin	4.1 (3.2-5.1)

Table 2. Pathology results

NOSE (n = 41)	
Location	
D-colon	2 (4.8%)
S-colon	25 (60.9%)
Rectosigmoid	9 (22%)
Rectum	5 (12.2%)
Tumor size	
Length (cm), range	2.8 (0.2-6)
Width (cm), range	2.1 (0.2-4.5)
T stage	
T1, Tis	12 (29.3%)
T2	13 (31.7%)
T3	15 (36.6%)
T4	1 (2.4%)
N stage	
N0	30 (73.2%)
N1	9 (22.0%)
N2	2 (4.9%)
M stage	
M0	40 (97.6%)
M1	1 (2.4%)

Discussion

Laparoscopic colectomy has been performed with increasing frequency worldwide over the past decades. Although it improved short-term outcomes as compared to open colorectal surgery, this procedure is often criticized for the required additional 3-5 cm ab-

Table 3. Postoperative outcomes of NOSE (N = 41)

Operation time (minutes), range	226 (140-360)
Time to passage of flatus (days), range	1.3 (1-3)
postoperative hospital stay (days), range	5.2 (3-13)
Complication	
Anastomosis leakage	1 (2.4%)
Intra-abdominal abscess	1 (2.4%)
Wound infection or complication	0
Prolonged ileus	1 (2.4%)
UTI	1 (2.4%)
Mortality	0
Overall complications	4 (9.8%)

dominal incision needed to remove the specimen. Such a 3-5 cm wound may increase the incidence of adverse effects such as postoperative wound pain, incision hernia, and wound infection. Occasionally, injuries to the intestinal vessels and nerves can occur during specimen retrieval, causing unnecessary intraoperative complications and delaying the recovery of bowel function.[3-6] Furthermore, transabdominal specimen extraction through a small incisional wound can be difficult in obese patients owing to a thick and short mesentery.[7] Therefore, removing the specimen through a normal orifice is an elective option.

The NOSE procedure has been criticized for its potential to increase intra-abdominal contamination due to the intra-corporeal transection of the large bowel. Costantino et al. reported a higher peritoneal contamination rate in patients receiving a NOSE procedure, but there was no significant difference in clinical outcomes compared with conventional LAC.[8] Kim et al. showed that complication rates after NOSE and conventional LAC were similar.[1] No surgical wound infection occurred in our study, but one patient developed an intra-abdominal abscess that was noted three days after the operation and proved by a computerized tomography scan with symptoms of fever, leukocytosis, and abdominal pain. Bowel preparation, a distal rectal washout, a detachable clip at the proximal colon, and intra-corporeal ligation of the proximal and distal parts of the specimen with silk before bowel resection may prevent stool spillage. One case was converted to conventional LAC due to poor bowel preparation and stool spillage that occurred when the bowel lumen was opened. The conversion rate in our study was 2.4%. In this series, one patient developed anastomosis leakage 5 days postoperatively. The cause of leakage is highly related to the double stapling method, and cross stapling is probably the reason for the anastomosis leakage.[9] Incidence rates of anastomotic leak in laparoscopic colorectal surgery reported in the literature range from 2.5-12%. Gorianinov et al. reported a 2.9% leakage rate after laparoscopic intracorporeal stapled anastomosis.[10] In our study, the anastomosis leakage rate was 2.4%, and is comparable to the published results. The mean time to flatus passage in our study was 1.3 days, and the mean postoperative hospital stay was 5.2 days. The overall complication rate after NOSE in our study was 9.8%. In previous studies, reported overall complication rates after conventional laparoscopic colectomy range from 12.1-21%.[1,3] Otherwise, NOSE provided better cosmetic results compared with conventional LAP.[3]

In NOSE procedures, the most frequent routes of specimen retraction are the anus and vagina. Previously, specimen retraction through the vagina was frequently used in gynecological surgery.[3] In colorectal surgery, several studies reported the safety and feasibility of trans-vaginal specimen extraction in laparoscopic right hemicolectomy for female patients.[11,12] The potential risks of using the vagina as the route of specimen retraction in anterior resection of rectal lesions include infertility, dyspareunia, and rectovaginal fistula.[3] In this study, the anus was used for specimen extraction, and we clearly demonstrated the feasibility and safety of this procedure. The only disadvantage of removing the specimen through the anus is the injury to the anal sphincter muscles the may result in anal incontinence and stenosis. A large series of NOSE procedures after total mesorectal excision for rectal cancer was reported by Franklin et al., showing a 1.1% rate of postoperative fecal incontinence and a 1.7% rate of postoperative anal stenosis.[13] In our series, no fecal incontinence or anal stenosis was observed during the clinical follow-up period. Therefore, gentle anal dilatation before specimen retraction may decrease the rate of complications, and we believe that the anus can be a good route of specimen retraction.

In our practice, NOSE will not be performed in patients with a tumor size exceeding 5 cm in size and in obese patients with mesenteric obesity (BMI exceeding 33 kg/m^2). This is because bulky tumor size and a thickened mesentery may increase the difficulty of specimen extraction, potentially resulting in iatrogenic tumor perforation, serosa tears, and injury to the anal sphincters. Therefore, routine measurement of the tumor and mesenteric fat by computer tomography is mandatory, and may provide the surgeon with detailed information that can be used to avoid erroneous surgical planning.

In our practice, tumors were located from the

D-colon to the upper rectum (from 40 cm to 10 cm above the anal verge). The most common tumor locations were the S-colon (61%) and rectosigmoid colon (22%), and these two locations were more conducive to NOSE. The procedure would be difficult to perform when the tumor location is above the D-colon. The most difficult component of NOSE is performing the intra-corporeal anastomosis. The procedure consists of an intra-corporeal purse string suture of the proximal bowel, a placed anvil on a circular stapler, distal rectal stump closure, and bowel anastomosis using a circular stapling device. A surgeon desiring to perform laparoscopic AR and NOSE requires the ability to perform intra-corporeal suturing. This procedure is considered an advanced technique that involves a learning period, even for an experienced laparoscopic surgeon. Moreover, while performing intracorporeal anastomosis, the prevention of proximal stump stool spillage is relatively important. In this series, we used a laparoscopic Bulldog clamp to clamp the proximal colon, usually the descending colon, to prevent stool spillage. Besides proximal clamping, we suggest adequate bowel preparation and intra-operative distal rectal irrigation to prevent intra-abdominal contamination.

Conclusions

In conclusion, this study demonstrated the safety and feasibility of laparoscopic anterior resection using the NOSE method. However, this is a challenging procedure, requiring skillful techniques to overcome the difficulty of intra-corporeal suturing. Although this study showed a decrease of post-operative pain, acceptable perioperative complication rate, and possible improvement of cosmetic results, we stress that this is an advanced procedure, and not suitable for the novice surgeon.

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原　著

左側大腸直腸癌使用經自然孔腔標本取出手術的短期手術結果

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目的　大腸直腸癌使用經自然孔腔標本取出手術，可以減少腹壁切口，減少術後傷口疼痛，較早恢復腸道功能和減少住院天數。本篇文章將報告左側大腸直腸癌運用經自然孔腔標本取出手術後短期的手術成果，並討論此手術是否為安全及有效的手術方式。

方法　從 2013 年 1 月至 2014 年 3 月，在單一醫院連續收集 41 例左側大腸直腸腫瘤行經自然孔腔標本取出手術。排除條件為腫瘤大於 5 公分、腸阻塞或穿孔、或 BMI 大於 33。病人的年齡、性別、腫瘤位置大小、手術過程及術後恢復結果皆列入評估。

結果　41 位病人其中 18 位為男性、23 位為女性。平均年齡 65.7 歲，平均 BMI 為 23.9，平均手術時間為 226 分鐘。腫瘤平均大小為長 2.8 公分、寬 2.1 公分。平均術後排氣時間為 1.3 天，平均術後住院天數為 5.2 天。一個病人因腸道準備不完全，手術改變成傳統腹腔鏡手術。無手術後死亡案例。但有一例出現腸吻合處滲漏，滲漏比率為 2.4%。另有一個病人有發生手術後腹內膿瘍。總計嚴重及輕微併發症發生比率為 9.8%。

結論　本篇回朔性病例分析的文章顯示，對於有經驗的腹腔鏡手術醫師來說，經自然孔腔標本取出手術運用在左側大腸直腸腫瘤是一個安全且有效的方法。但此手術的好處，仍須前瞻性隨機試驗和傳統腹腔鏡手術比較而得知。

關鍵詞　腹腔鏡大腸切除、經自然孔腔標本取出手術、NOSE、前位切除術。