

# Clinical Application of the Reverse Puncture Technique for Total Laparoscopic Colorectal Resection with Natural Orifice Specimen Extraction

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## Research

**Keywords:** total laparoscopic colorectal resection, natural orifice specimen extraction surgery, reverse puncture technique, feasibility, safety

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# Abstract

## Objective

To explore the feasibility, safety and short-term effects of the reverse puncture technique for total laparoscopic colorectal resection with natural orifice specimen extraction surgery (NOSES).

## Materials and Methods

The clinical data of 28 patients undergoing total laparoscopic anterior resection with NOSE from July 2016 to July 2019 were retrospectively analysed. The operation was performed following the principle of total mesorectal excision. The reverse puncture technique was used to put the anvil into the proximal sigmoid colon. Then, intra-abdominal anastomosis of the proximal colon and distal rectum was carried out, and the short-term efficacy was evaluated.

## Results

All 28 patients successfully underwent surgery, and the average operative time was 186 (160~220) min. The average time of anvil placement was 15 (12~18) min, the blood loss volume ranged from 60 to 150 ml, and the average length of hospital stay was 9.2 (7-11) d. All of the distal resection margins were confirmed to be negative by the pathological results. No surgery-associated complications, such as anastomosis stricture, leakage, or bleeding, were observed, and no local recurrence or metastasis occurred after 6 months of follow-up.

## Conclusion

Reverse puncture for total laparoscopic colorectal resection with NOSE can avoid purse-string sutures under laparoscopy and avoid the auxiliary incision at the abdominal wall, which minimizes pain after operation. This approach is safe and feasible with a shortened hospital stay and rapid recovery, which results in good short-term clinical outcomes.

## 1 Introduction

In 1991, a Japanese professor named Kitano performed the world's first laparoscopic radical surgery, which was quickly applied in the surgical treatment of colorectal tumours, becoming the mainstream minimally invasive surgical treatment<sup>[1]</sup>. Studies have shown that the short-term efficacy of laparoscopic colorectal surgery is better than that of traditional open surgery, and the long-term efficacy is no different from that of open surgery<sup>[2-4]</sup>. However, conventional laparoscopic surgery requires an auxiliary incision in the abdominal wall to complete specimen removal and digestive tract reconstruction. This auxiliary incision can cause postoperative pain, increase the risk of incision complications, affect the cosmetics of the abdominal wall, and even bring long-term adverse psychological suggestions to the patient; therefore, how to achieve better minimally invasive results and retain anal function has become a topic of focus. Recently, the trans-anal natural orifice specimen extraction (NOSE) technique, which makes a complete

laparoscopic operation without abdominal incision possible, has been widely used in laparoscopic colorectal surgeries<sup>[5-6]</sup>. However, how to place the anvil in the proximal sigmoid colon is a technical difficulty in alimentary canal reconstruction. We used reverse puncture technology to perform 28 total laparoscopic radical resections of colorectal cancer with satisfactory clinical effects between June 2016 and June 2019. The report is as follows.

## 2 Materials And Methods

### 2.1 Patient data

Twenty-eight patients (15 males and 13 females) with colorectal cancer underwent laparoscopic radical resection of colorectal cancer at our department between June 2016 and June 2019. The patient ages ranged from 46 to 78 years (mean:  $59.8 \pm 9.8$  years). The body mass index (BMI) ranged from 18.6 ~ 28.4 kg/m<sup>2</sup> (mean:  $21.8 \pm 9.8$  kg/m<sup>2</sup>). All patients were confirmed by colonoscopy and a pathology examination before the operation. The distance between the lowest margin of the tumours and the dentate line was 4.0–20 cm (4 ~ 5 cm in 5 patients, 5 ~ 20 cm in 23 patients). There were 3 cases of moderately differentiated adenocarcinoma and 25 cases of poorly differentiated adenocarcinoma. All patients were examined with pelvic magnetic resonance imaging (MRI) or computed tomography (CT) to assess the tumour stage, in which 7 tumours were T1N0M0, 11 were T2N0M0, 4 were T2N1M0 and 6 were T3N0M0. There were 4 cases of diabetes mellitus and 5 cases of hypertension before the operation.

Patient inclusion criteria were as follows: ☐ tumour diameter < 5 cm and tumour invasion less than half of the circle of the intestinal wall; ☐ neoadjuvant radiotherapy and chemotherapy were not performed before the operation; ☐ pelvic MRI showed that the tumour did not invade the surrounding tissue, and the stage was no more than T3; and ☐ chest and abdominal CT showed no distant organ metastasis.

### 2.2 Surgical procedure

Before the operation, full communication with the patients' family members and signing of informed consent were needed. Routine intestinal preparation included oral antibiotics 3 days before the operation and oral magnesium sulfate 1 day before the operation. After successful anaesthesia, the patient was placed in a modified lithotomy position. The pneumoperitoneum pressure was 12–14 mmHg (1 mmHg = 0.133 kPa). After confirming that the tumour could be resected, the operation was performed according to the principle of total mesothelial excision (TME). The adipose tissue and lymph nodes adjacent to the mesenteric artery root were excised. Under the left mesenteric artery, the inferior mesenteric artery and vein were clamped and cut [Figure 1]. The loose tissue space around the rectum was separated, and the anal-caudal ligament was cut on the posterior wall of the rectum. Attention was paid to protect the ureteral tracts and pelvic autonomic nerve plexus. After the rectum was fully dissociated between the two layers of fascia in the pelvic visceral wall, the rectum was closed and cut with an endoscopic linear cutter 10 cm away from the upper edge of the tumour.

The method of specimen removal depended on the distance between the tumour and the dentate line. When the inferior margin of the tumour was less than 5.0 cm from the dentate line, trans-anal pull-out resection was performed. The assistant disinfected the perineum, fully expanded the anus, and clamped the proximal end of the rectum with oval forceps through the anus [Figure 2]. The tumour-bearing intestinal canal and mesentery were slowly pulled out through the anus, repeatedly disinfected with iodine, and rinsed with distilled water. The distant rectum was closed with a curved rectal stapler at a distance of more than 2 cm from the lower edge of the tumour, and the specimen was removed [Figure 3]. The distal rectum was resented into the pelvic cavity, waiting for anastomosis. In cases where the lower edge of the tumour was more than 5.0 cm away from the dentate line, the specimens were taken through the anus after resection, and the intestines were ligated with sterile gauze strips at the top and bottom of the distal and proximal bowel incision lines, respectively. The anus was fully expanded, the anus and bowel were rinsed with dilute iodophor water, the distal bowel was cut along the pre-cut line with an ultrasonic knife, the completely removed specimen was placed in a sterile specimen bag, and the distal bowel cavity and anus were disinfected with iodophor once more. Oval forceps were used to remove the specimen bag through the anus.

The reverse puncture technique was used to insert the anvil. A 4 cm long 2 - 0 silk thread was placed in front of a 29 stapler (end-to-end stapler, Johnson & Johnson Company) in advance, the trans-anal or main operation hole was used to deliver the anvil into the abdominal cavity, and an ultrasonic knife was used to cut the anterior wall of the proximal sigmoid longitudinally approximately 2 cm. The assistant reversely pulled the thread fixed at the end of the stapler seat in the opposite direction, reserving a gap of approximately 0.5 cm where the thread proceeded. An Endo-Cutter (Ethicon or Medtronic) was used to close the intestinal stump, pull the anvil out of the reserved gap with the wire, and complete the insertion of the anvil in the cavity [Figure 4].

### **3 Results**

All patients in this group successfully underwent laparoscopic trans-anal pelvic anastomosis, and none of them converted to open surgery. prophylactic ileostomy was conducted in 4 patients with diabetes, and closed after 3 months after surgery. The operation time was 160–220 min (average 186 min), the anvil placement time was 12–18 min (average 15 min), intraoperative blood loss was 60–150 ml (average 100 ml), and the postoperative hospital stay was 7–11 days (average 9.2 days). No anastomotic leakage, stenosis, bleeding or other complications occurred. The distal margin of the resected specimen was negative. The postoperative pathological TNM stage was as follows: 6 patients in stage I, 17 patients in stage II, and 5 patients in stage III. The number of postoperative pathological lymph nodes was 5–24, with an average of 15.5. All the patients were treated with the FOLFOX regimen for 6 cycles. After 6 months of follow-up, no anastomotic recurrence, puncture hole implantation or distant metastasis was found.

### **4 Discussion**

Compared with traditional open surgery, laparoscopic-assisted radical colorectal cancer surgery has the advantages of clear anatomical levels, less trauma, and fast recovery, while the effectiveness and safety of the operation are not significantly different from those of open surgery<sup>[2-4]</sup>; therefore, it has been widely accepted and developed by the majority of clinical workers. However, laparoscopic-assisted radical surgery requires an auxiliary incision of approximately 5 cm in the abdomen to remove the tumour, and an anvil is placed to complete digestive tract reconstruction. This may increase not only patient trauma but also the risk of incision infections, hernia or tumour implantation and metastasis<sup>[7-8]</sup>. In 2008, Palanivelu<sup>[9]</sup> reported the first laparoscopic colorectal cancer surgery performed with the NOSE technique, which made it possible to complete laparoscopic radical resection of colorectal cancer without an abdominal incision.

Specimens can be obtained through two natural lumens of the rectum or vagina, and trans-anal removal is more physiological because it does not increase trauma<sup>[6]</sup>. At present, there are three ways to remove the specimen<sup>[6, 10]</sup>: eversion resection, pull-out resection and pulling out after resection. Each method has its own operating characteristics and skills. The optimal method used to remove the specimen can be determined by the operator according to the location and size of the tumour, the degree of patient obesity and the method used to reconstruct the digestive tract<sup>[11-12]</sup>. We realized that during the operation of sphincter preservation for low and ultra-low rectal cancer, due to the limited space of the pelvic floor, it is difficult to cut and close the distal bowel of the tumour at the ideal position at one time due to the angle of the instrument, so it is difficult to ensure that the undercut margin is enough; moreover, this may increase the risk of anastomotic leakage after the operation. Therefore, if the distance between the lower edge of the tumour and the dentate line is less than 5.0 cm, the specimen can be pulled out and resected under direct vision, which can ensure the resection of enough distal intestine and reduce the risk of tumour recurrence and implant metastasis. If the distance between the lower edge of the tumour and the dentate line is more than 5.0 cm, the specimen can be removed through the anus after resection. During the operation, the following points should be considered: 1. When using eversion to pull out, the rectum should be fully free, and the rectum sacrum fascia should be removed to ensure that the distal rectum has enough free length, which is conducive to pulling out the intestine with the tumour completely<sup>[13]</sup>. 2. The assistant should fully expand the anus before removing the specimen and then use oval forceps to extend through the incision of the rectal stump; with the assistance of the operator, the rectal stump should be clamped, and the distal rectum and its mesentery should be slowly and forcefully pulled to the anal side and removed from the anus. During the operation, violent pulling should be avoided to avoid tearing the bowel. 3. Iodophor was used to disinfect the dragged intestine repeatedly, and then, the intestine was washed with distilled water to reduce the possibility of tumour cell exfoliation and metastasis. 4. To reduce the incidence of postoperative anastomotic leakage, preventive ileostomy is recommended for patients with low rectal cancer complicated with diabetes<sup>[6, 12]</sup>.

Asepsis, tumour free and anvil placement are the three key points for completing a colorectal cancer operation. The technical difficulty resides in how to place the anvil in the proximal sigmoid colon stump safely and fix it under aseptic and tumour-free conditions; this is also the key point to consider when

completing digestive tract reconstruction under a complete laparoscope. Reverse puncture is a new type of buttress insertion method. It was first used in laparoscopic oesophagojejunostomy and further used in laparoscopic gastric cancer and colorectal cancer<sup>[14-16]</sup>. The reverse puncture method is usually used to enter the abdominal cavity through the anus or through the main operation hole. The proximal sigmoid colon needs to be cut, which may violate the sterile operation principle. Studies have shown<sup>[17-18]</sup> that adequate intestinal preparation before the operation and standard aseptic and tumour-free conditions during the operation can effectively avoid postoperative abdominal infections. Compared with conventional laparoscopic surgery, the probability of postoperative abdominal infections in patients treated with the NOSE technique does not increase significantly. The iatrogenic spread of tumours caused by compression during the process of removing specimens through the natural cavity has also been the focus of debate. According to literature reports<sup>[19-20]</sup>, the local tumour recurrence rate of patients after NOSE surgery is not higher than that after conventional laparoscopic surgery, and there is no literature report on patients with tumours implanted in the natural cavity after NOSE surgery. This is due to the sufficiently accurate assessment of tumour location, size, and depth of invasion using pelvic MRI or enhanced CT before surgery. A tumour diameter of more than 6 cm, a tumorous intestinal obstruction, and tumour invasion of the serosa surface were used as the exclusion criteria for NOSE surgery<sup>[21]</sup>. In addition, many techniques have been used in clinical practice to prevent the iatrogenic spread of tumours, including the use of sterile protective devices when obtaining specimens and avoiding excessive strain on the lesions during specimen collection<sup>[22-23]</sup>. Therefore, as long as the surgical indications are strictly grasped, NOSE surgery can fully guarantee the requirements of tumour-free technology. Compared with conventional laparoscopic-assisted surgery, there is also a certain technical difficulty associated with the reverse puncture procedure to place the anvil under full laparoscopy. We realize that after a short-term learning curve, with the skilled surgical skills of the surgeon and the tacit cooperation of the assistant, the placement of the anvil can be completed quickly.

The application of the reverse puncture technique in NOSE total laparoscopic colorectal resection can simplify the operation steps. There is no auxiliary incision in the abdominal wall, so it is minimally invasive, and the occurrence of complications is not increased. The effects of laparoscopic NOSE and traditional laparoscopic radical resection of colorectal cancer on postoperative rehabilitation were compared. The results showed that the NOSE technique can significantly shorten the postoperative hospital stay and exhaust time, inhibit the release of inflammatory factors, and reduce the impact on the immune function of the body; it also has good clinical application value. Ma et al<sup>[24]</sup> analysed 837 colorectal cancer patients in 9 clinical studies and confirmed that laparoscopic trans-anal NOSE surgery is as safe as a conventional laparoscopic operation. Our preliminary study<sup>[25]</sup> also showed that patients had no abdominal auxiliary incision and experienced light pain, a fast postoperative recovery, a short hospital stay, and satisfactory short-term results. No anastomotic recurrence, puncture hole implantation, or distant metastasis was found during 6 months of follow-up, which is worth further clinical application. However, due to the small sample size and short follow-up time of this group of patients, it is necessary to further verify the long-term effect through multicentre and large-scale clinical trials.

# Declarations

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## Authors' contributions

QI Kong contributed to the conception and data collection of the study. YB Xia and XX Huang contributed to the provision of the study materials or patients. Y Jin and H Hu contributed to the data analysis and interpretation. L Xu and LC Wu drafted the manuscript. All authors read and approved the final manuscript.

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## Availability of data and materials

All data are available from the corresponding author

## Ethics approval and consent to participate

The authors state that this study was approved by the Ethics Committee of Yijishan Hospital at Wannan Medical College and have followed the principles outlined in the Declaration of Helsinki for all human or animal experimental investigations. In addition, informed consent has been obtained from the participants involved.

## Consent for publication

All authors have given their consent for publication.

## Conflicts of interest

The authors declare no conflict of interest.

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## Figures

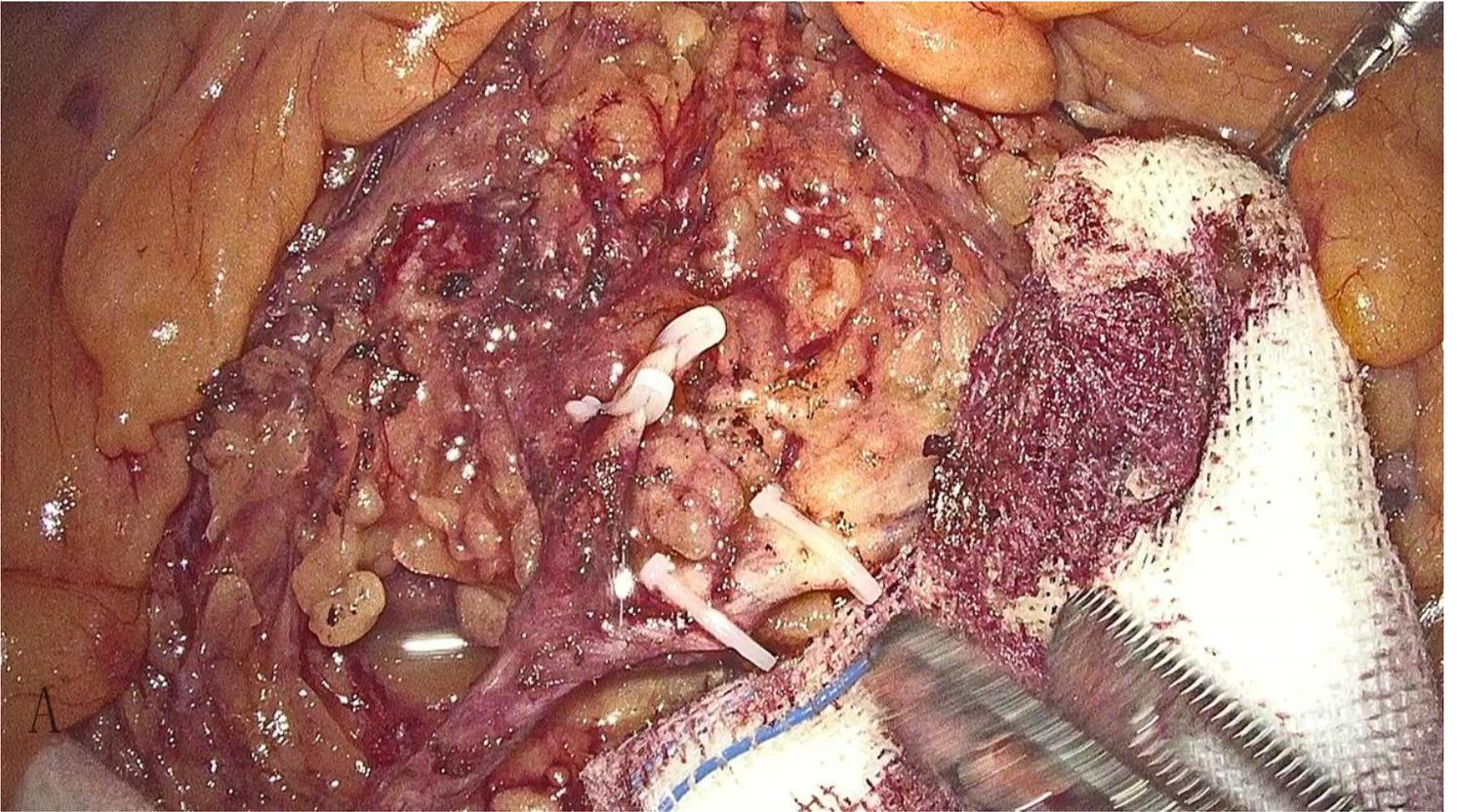
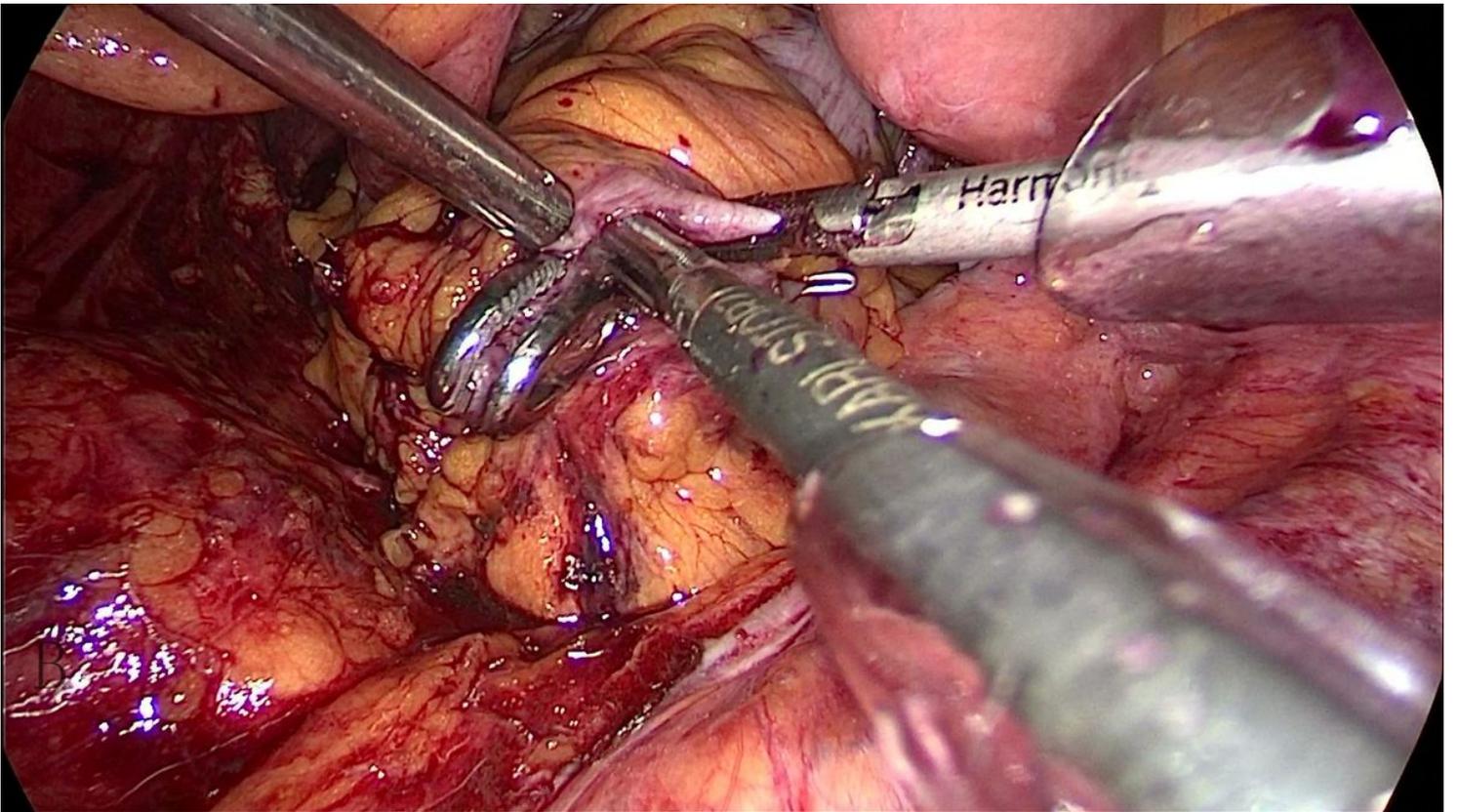


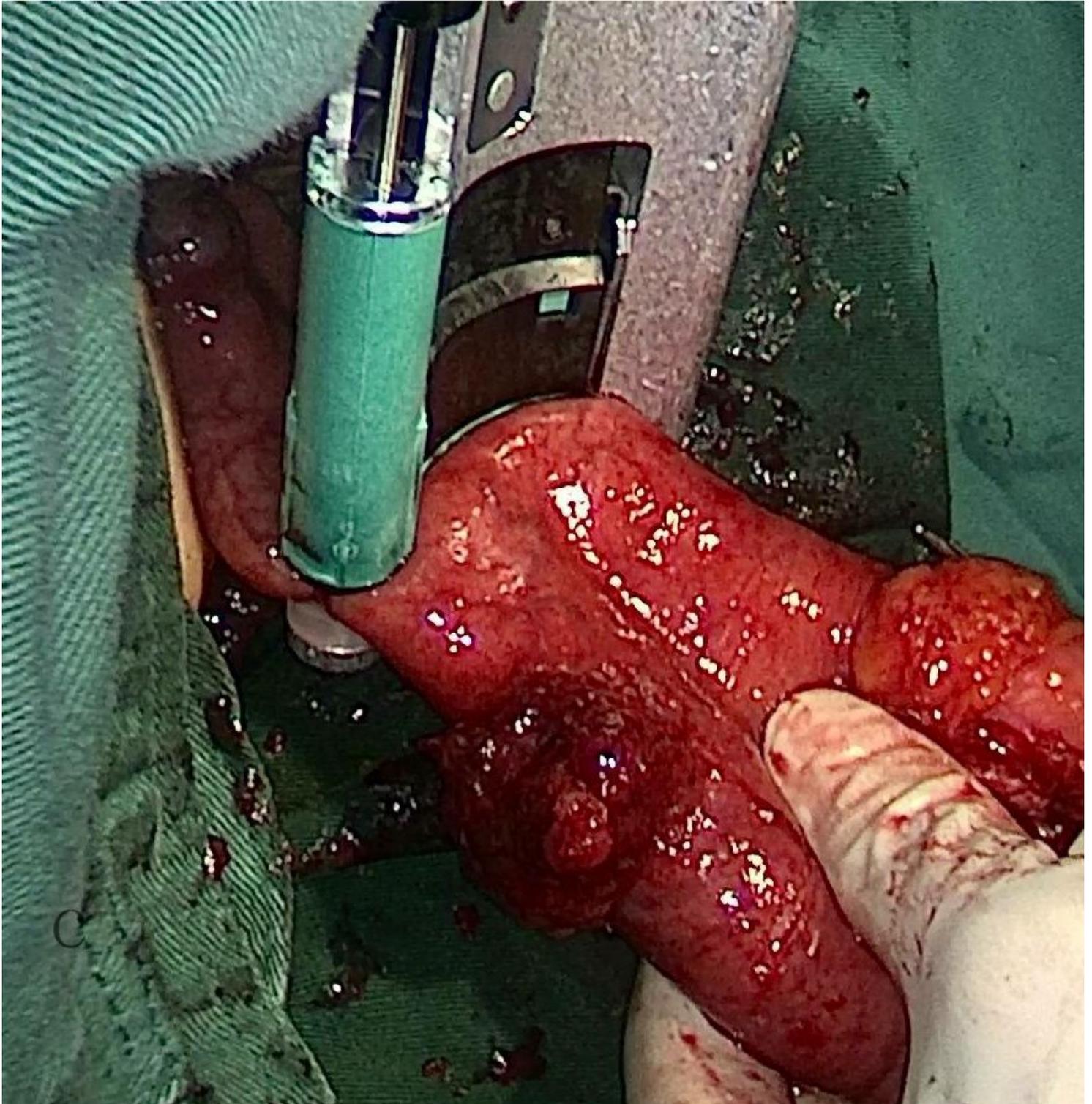
Figure 1

Total mesorectal excision with the left colonic artery preserved



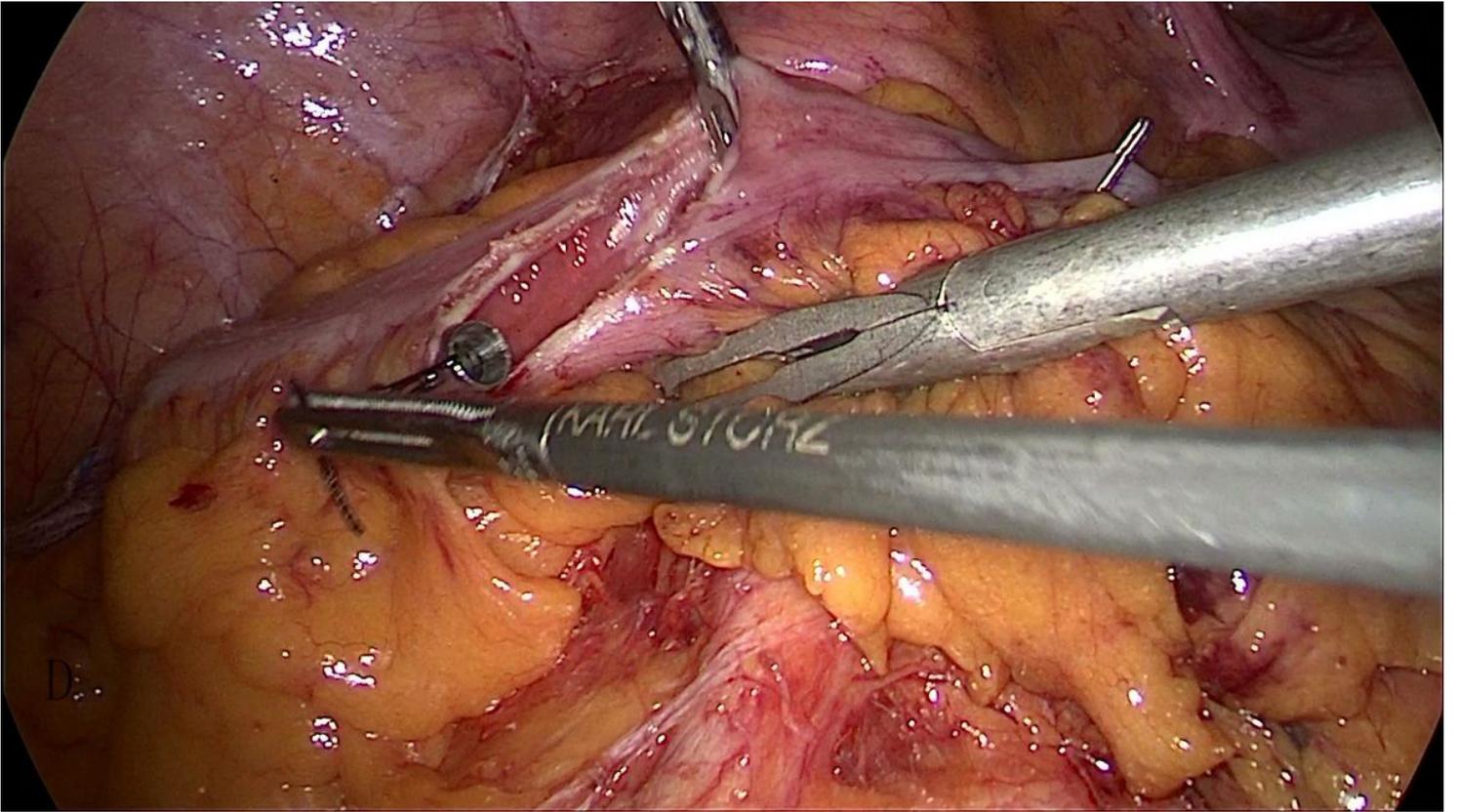
**Figure 2**

Pulling out the intestine and mesentery with tumours with oval forceps



**Figure 3**

Specimen removed from the lower margin of the tumour



**Figure 4**

Inserting the anvil into the intestine with a pull thread