

# Safety analysis of natural orifice specimen extraction surgery for colorectal cancer

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## Summary

This study investigated the safety, feasibility, and clinical outcomes of natural orifice specimen extraction surgery (NOSES) by collecting clinical from patients who underwent complete laparoscopic radical resection for colorectal cancer versus those who underwent conventional laparoscopic radical resection for colorectal cancer. Patients with colorectal cancer were selected as the study sample and grouped according to the different surgical methods. A total of 182 patients were eligible for enrollment in the study, including 92 patients who underwent NOSES (NOSES group) and 90 patients who underwent conventional laparoscopic radical colorectal cancer surgery. In the NOSES group, a total of 14 cases were observed to have a postoperative abdominal infection, and the remaining 78 cases did not have an abdominal infection, which we refer to as the infected and uninfected groups in this paper for further analysis. There was no difference in surgical outcome between NOSES surgery and conventional laparoscopic surgery. Diabetes mellitus, prolonged drain retention, and prolonged operative time were risk factors for the development of abdominal infection in NOSES. In contrast, intraoperative use of specimen retrieval bags, use of transanal endoscopic operations, and intraoperative flushing of the abdominal cavity with dilute iodophenol were protective factors for the development of postoperative abdominal infections. NOSES for colorectal cancer is worth promoting because of its small trauma and quick postoperative recovery.

**Abbreviations:** NOSES = natural orifice specimen extraction surgery, TEO = transanal endoscopic operations.

**Keyword:** laparoscopic surgery, natural orifice specimen extraction surgery, rectal tumor, sigmoid colon tumor

## 1. Introduction

Colorectal cancer is a common malignant tumor of the gastrointestinal tract, the incidence rate is increasing year by year, and there is a tendency for gradual rejuvenation.<sup>[1]</sup> The primary treatment for colorectal cancer is still surgery. Reducing surgical trauma on the premise of treating disease is a dominant concept in the development of surgery today. In 2013, the first NOSES surgery for colorectal cancer was performed by Chinese surgeons. The advantages of NOSES surgery are well known to the majority of surgeons, however, the occurrence of postoperative complications is still very commentary, and there is still a lack of relevant research on abdominal infection after NOSES.<sup>[2]</sup> The Gastrointestinal Surgery Department of our hospital is the first local medical unit to carry out the NOSES operation, which has accumulated a great many clinical cases. For promoting the progress of surgical technology and increasing clinical data, this paper retrospectively analyzed the clinical data of 92 patients with colorectal cancer who underwent surgical resection via natural cavity and analyzed the risk factors and protective factors of postoperative abdominal infection.

*This study was supported by Hebei Province Science and Technology Support Program (CN).NO:2020397.*

*The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.*

*The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.*

*Data were obtained from the medical records database of Affiliated Hospital of Chengde Medical University, and the study was exempted by the database administrators.*

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## 2. Materials and Methods

### 2.1. Patients

The research method of this study is a clinical retrospective study, a retrospective analysis of patients with sigmoid and rectal tumors treated in the Department of Gastroenterology of our hospital from 2016 to 2021 August. The Ethics Review Committee approved this study of the Affiliated Hospital of Chengde Medical University (permit number: LL2020397). A total of 182 cases were sampled, of which 90 cases underwent conventional laparoscopic surgery (control group) and 92 cases underwent natural orifice specimen extraction surgery (NOSES group). Postoperative abdominal infection occurred in 14 of 92 NOSES samples and did not occur in 78. We further investigated the safety of NOSES surgery and the risk factors associated with the occurrence of postoperative infection in NOSES surgery according to whether the infection occurred. Nine cases were diabetic patients. Postoperative pathology showed: 9 cases of massive adenocarcinoma, 3 cases of protruding adenocarcinoma, 76 cases of ulcerative adenocarcinoma, 1 case of high-grade intraepithelial neoplasia, 1 case of hyperplastic

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*How to cite this article: Zheng S, Zhao Z, Zheng H, Li J, Yang J, Zhao E. Safety analysis of natural orifice specimen extraction surgery for colorectal cancer. Medicine 2022;101:34(e30087).*

*Received: 17 March 2022 / Received in final form: 11 June 2022 / Accepted: 29 June 2022*

*<http://dx.doi.org/10.1097/MD.000000000030087>*

polyp, 2 cases of villous tubular adenoma, no metastasis tumor. All patients had 3 days of oral laxatives lactulose, fasted 1 day orally, and polyethylene glycol electrolyte powder jejunal contents before surgery, half an hour before Prophylactic intravenous antibiotics. Fourteen cases of peritoneal cavity infection occurred (infected group); 78 cases of abdominal inflammation did not occur (noninfected group).

## 2.2. Inclusion and exclusion criteria

Inclusive criteria: (1) preoperative completion of colonoscopy and confirmed diagnosis of sigmoid or rectal tumors, including benign and malignant tumors; (2) laparoscopic NOSES operation.

Exclusion criteria: (1) NOSES surgery with conversion to open abdomen (2) inadequate preoperative bowel preparation; (3) preoperative tumor causing intestinal perforation or intestinal obstruction (4) emergency surgery

## 2.3. Diagnostic criteria for postoperative abdominal infection

Physical signs: high fever, abdominal pain, abdominal distension, abdominal drainage tube drainage fecal, or obvious peritonitis signs. Test: white blood cell and/or neutrophil ratio increased significantly, procalcitonin increased, and C-reactive protein increased. The bacterial culture of the peritoneal drainage fluid was positive. Examination: abdominal enhanced CT confirmed intra-abdominal infection.

## 2.4. Operation procedures

- (1) Exploration: After successful general anesthesia, lithotomy position, disinfection and towel laying, establishment of pneumoperitoneum, maintenance of air pressure at 12 mmHg, placement of poke card, routine exploration.
- (2) Dissection of the sigmoid colon: the sigmoid colon is pulled proximally, its mesentery is tensed, and the root of the inferior mesenteric artery is dissected. Enter the level of Told's hiatus. Continue dissection until the root of the inferior mesenteric artery. Continue dissecting the Told's hiatus up to the Told's line, remove the lymph nodes at the root of the inferior mesenteric artery, and clip the inferior mesenteric artery. The lateral peritoneum of the colon is dissected to 5 cm below the tumor.
- (3) Rectal dissection: According to the principle of total rectal mesenteric excision (TME), dissection was performed to 5 cm of the lower edge of the tumor.
- (4) Tumor resection and specimen removal: Dissect to 5 cm below the tumor. The upper rectum, the middle and lower sigmoid colon, and the corresponding mesentery were removed together. The distal intestinal canal was disinfected with iodophor cotton balls, and the rectal section was opened. A protective sleeve was placed through the anus, and the head of the anastomosis was fitted into the sleeve and delivered into the abdominal cavity from the anus. The intestinal canal was incised 15 cm from the upper edge of the tumor, and the head of the anastomosis was inserted to close the canal. The specimen was put into a protective sleeve and pulled out of the body from the anus.
- (5) Anastomosis: The anastomosis was completed by closing the distal rectal section and placing the anastomosis clutch. A pelvic drainage tube was placed.

## 3. Observation

The information collected included age, gender, body mass index, comorbidities, tumor size, tumor type, the distance from the tumor to the anal margin, intraoperative bleeding, time of

surgery, time of first feeding, time of drainage tube retention, use of retrieval bag, use of TEO, dilute iodophor flushing of the abdominal cavity, and purse sutures.

## 4. Statistical analysis

All patient's medical records were established in Excel and analyzed by SPSS 22.0 software. The measurement data were expressed as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ) and count data were expressed by n. A *T*-test was used to compare the variability of the underlying information between two independent samples. The correlation between all variables was tested using Spearman correlation analysis, and the strength of the correlation was assessed according to the correlation coefficient: a weak correlation at  $|r| = 0-0.25$ , a weak correlation at  $|r| = 0.25-0.5$ , a moderate correlation at  $|r| = 0.5-0.8$ , and a strong correlation at  $|r| = 0.8-1$ . A negative *r* value indicates a negative correlation and a positive *r* value indicates a positive correlation. Based on the results of correlation analysis, operative time, bleeding volume, iodine flushing, TEO, specimen retrieval, purse-string suture, drainage tube retention time, the distance between a tumor and anal margin, and diabetes were included in the logistic regression analysis. any *P* value less than .05 was considered as being statistically significant.

## 5. Result

### 5.1. Basic information

The differences in general data (gender, age, BMI) between the NOSES group and the control group were not statistically significant ( $P > .05$ ). Among the 92 patients in the NOSES group, 47 were male and 45 were female, with a mean age of ( $61.05 \pm 10.14$ ) years, a mean BMI of ( $24.09 \pm 3.19 \text{ kg/m}^2$ ), and a tumor distance from the anal verge of ( $11.94 \pm 6.19 \text{ cm}$ ). In the control group, there were 44 males and 46 females in 90 patients with a mean age of ( $59.58 \pm 10.98$ ) years, a mean BMI of ( $25.12 \pm 3.92 \text{ kg/m}^2$ ), and a tumor distance from the anal verge of ( $11.50 \pm 3.49 \text{ cm}$ ) (Table 1).

### 5.2. Analysis of operation-related indexes

The NOSES group had a mean postoperative hospital stay of ( $11.55 \pm 3.79$ ) days, mean operative time ( $111.00 \pm 33.54 \text{ min}$ ), mean operative bleeding ( $36.66 \pm 12.84 \text{ ml}$ ), mean time to initial deflation ( $3.96 \pm 2.65$ ) days, mean postoperative feeding time ( $4.23 \pm 2.56$ ) days, and mean intraoperative lymph nodes detected ( $11.88 \pm 3.57$ ). In the control group, the mean postoperative hospital stay was ( $15.90 \pm 7.47$ ) days, the mean operative time was ( $100.75 \pm 35.29 \text{ min}$ ), the mean operative bleeding was ( $36.00 \pm 16.28 \text{ ml}$ ), the mean time to first exhaustion was ( $4.96 \pm 1.85$ ) days, the mean postoperative feeding time was ( $5.01 \pm 2.04$ ) days, and the mean intraoperative lymph nodes were ( $12.25 \pm 3.56$ ). The operative time, postoperative hospital stay, and drainage tube removal time were statistically significant in both groups (Table 2).

**Table 1**  
Basic Information.

Group	Control	NOSES
Gender		
Male	44	47
Female	46	45
Age	$59.58 \pm 10.98$	$61.05 \pm 10.14$
BMI	$25.12 \pm 3.92$	$24.09 \pm 3.19$
DTAM (cm)	$11.50 \pm 3.49$	$11.94 \pm 6.19$

DTAM = Distance between tumor and anal margin.

**Table 2**

**Analysis of surgical indicators in the NOSES and control groups.**

Group	Control	NOSES	T	P
OT (min)	100.75±35.29	111.00±33.54	1.998	0.047
BL (mL)	36.00±16.28	36.66±12.84	-0.249	0.893
ET (min)	4.96±1.85	3.96±2.65	2.394	0.660
PET (d)	5.01±2.04	4.23±2.56	1.848	0.156
DURT (d)	11.3±1.6	9.10±1.10	-3.936	0.032
LND (n)	12.25±3.56	11.88±3.57	0.563	0.675
PHS (d)	15.90±7.47	11.55±3.79	-2.046	0.042

BL = blood loss, DURT = drainage tube retention time, ET = exhaust time, LND = lymph node dissection, OT = Operation time, PET = postoperative eating time, PHS = postoperative hospital stay.

**Table 3**

**Clinical indicators and demographics of infection in the NOSES group.**

Group	Infected	Non-infected	T/X <sup>2</sup>	P
Gender			0.448	.503
Male	6	41		
Female	8	37		
Age	58.00±9.03	60.62±10.50	1.828	.073
Diabetes	4	5	4.333	.037
BMI	24.59±3.34	23.57±3.21	1.612	.112
OT (min)	130.07±37.52	108.15±34.52	2.160	.033
BL (mL)	49.29±6.16	42.24±24.21	1.078	.284
ET (min)	3.29±1.49	3.39±2.39	-0.157	.876
PET (d)	3.07±1.73	3.76±2.83	-0.875	.384
DURT (d)	12.50±2.59	9.91±1.61	3.612	.003
LND (n)	12.14±3.26	11.03±4.13	0.960	.340
DTAM	11.14±2.14	13.92±4.66	1.908	.061

DTAM = distance between tumor and anal margin.

The sample data of the noninfected group consisted of 78 cases, 41 males and 37 females, with a mean age of (60.62±10.50) years, a mean BMI of (23.57±3.21 kg/m<sup>2</sup>), and a mean distance of the tumor from the anal verge (13.92±4.66 cm). The sample of the infected group consisted of 14 patients, 8 males, and 6 females, with a mean age of (58.00±9.03) years, and a mean BMI of (24.59±3.34 kg/m<sup>2</sup>), and a mean distance of the tumor from the anal verge (11.14±2.14) (Table 3).

There was no statistical difference in intraoperative bleeding, time to first postoperative bowel movement, time to first postoperative meal, and number of lymph nodes removed between the infected and non-infected groups (*P*>.05). The comparison of the operative time and drainage tube retention time between the two groups was statistically significant (*P*<.05). The non-infected group had a mean operative time (108.15±34.52 min), mean operative bleeding (42.24±24.21 mL), mean time to first exhaustion (3.39±2.39 days), mean postoperative feeding time (3.76±2.83 days), mean intraoperative lymph nodes detected (11.03±4.13), mean time to drainage tube removal (9.91±1.61 days). The infected group had a mean operative time (130.07±37.52 min), mean operative bleeding (49.29±6.16 mL), mean time to first exhaustion (3.29±1.49 days), mean postoperative feeding time (3.07±1.73 days), and mean intraoperative lymph nodes detected (12.14±3.26), mean time to drainage tube removal (12.50±2.59 days) (Table 3).

**5.3. Correlation and regression analysis**

In the NOSES group, we performed a correlation analysis. we found that diabetes mellitus, time to surgery, intraoperative

**Table 4**

**Analysis of the correlation of abdominal infection factors.**

Project	Correlation coefficient	P
Age	-0.126	.231
BMI	0.108	.304
Diabetes	0.268	.010
Operation time	0.246	.018
Blood loss	0.249	.016
DURT	0.257	.013
Iodine Flushing	-0.231	.027
TEO	-0.259	.013
Specimen Retrieval	-0.326	.002
purse-string suture	-0.344	.001
LND	0.140	.184
PET	-0.050	.635
DTAM	-0.410	.021

DTAM = distance between tumor and anal margin, DURT = drainage tube retention time, LND = lymph nodes number, PET = postoperative eating time.

blood loss, and time to drainage tube removal were positively associated with abdominal infection. The distance between the tumor and anal margin, iodophor flushing, use of specimen retrieval bags, use of TEO, and purse-string suturing were negatively correlated (Table 4). The rate of combined diabetes mellitus was significantly higher in patients with abdominal infection than in those without abdominal infection, and the difference was statistically significant (*P*<.05). Abdominal infection after NOSES was associated with the duration of the operation time, duration of drainage tube retention, the distance between the tumor and anal margin, abdominal iodophor irrigation, use of specimen retrieval bags, use of TEO, and purse suturing. The longer the duration of the operation time, the longer the duration of drainage tube retention, and the lower the tumor location, the higher the chance of abdominal infection. Intraoperative use of specimen pouch, abdominal iodophor irrigation, use of TEO, and purse sutures were protective factors for the occurrence of abdominal infection after NOSES surgery for colorectal cancer (Table 5).

**6. Discussion**

In this study, there was no statistically significant difference in the recovery time of gastrointestinal function, intraoperative bleeding, the number of intraoperative lymph nodes cleared, and postoperative complications between the two groups (*P*>.05). This indicates that laparoscopic NOSES surgery has the same results as a conventional laparoscopic surgery, and there is no significant difference in the perioperative treatment results. Under the condition of the same indications, laparoscopic NOSES surgery can replace traditional laparoscopic surgery. However, in terms of operative time, the operative time of the NOSES group (111.00±33.54 min) was longer than that of the conventional laparoscopic surgery (100.75±35.29 min), and the length of operative time mostly depended on the surgeon's mastery of operative proficiency. The postoperative hospital stay was significantly lower in the NOSES group (11.55±3.79 days) than in the control group (15.90±7.47 days). The difference in hospitalization time between the two groups once again demonstrated that patients who underwent complete laparoscopic radical colorectal cancer without incisional anastomosis recovered quickly after surgery and could be discharged early, which reduced the financial burden on patients.

At present, the incidence and mortality rate of colorectal cancer in China is still high, ranking third and fifth in the incidence and mortality rate of malignant tumors, respectively.<sup>[3]</sup> Surgery is still the primary and only reliable treatment modality. With the development of surgical techniques,

**Table 5****Inclusion of variables with significant correlation analysis in the regression analysis.**

Risk factors	B	SE	Wald $\chi^2$	P	OR	95% CI
Operation time	0.015	0.007	4.029	.045	1.015	1.000–1.029
Blood loss	0.036	0.024	2.170	.141	1.037	0.988–1.087
Iodine Flushing	−1.278	0.601	4.523	.033	0.279	0.086–0.905
TEO	−2.198	1.036	4.503	.043	0.111	0.015–0.845
Specimen retrieval	−3.096	1.319	5.507	.019	0.045	0.003–0.600
Purse-string suture	−0.718	0.924	0.604	.437	0.488	0.080–2.982
DURT	0.891	0.295	9.107	.023	2.437	1.367–4.347
DTAM	−0.362	0.171	4.457	.035	0.696	0.498–0.974
Diabetes	1.756	0.751	5.525	.019	5.840	1.341–25.439

DTAM = distance between tumor and anal margin, DURT = drainage tube retention time.

NOSES technology has been introduced into radical colorectal cancer surgery, which further reduces the trauma of colorectal cancer surgery and has the advantages of avoiding incision-related complications, reducing postoperative pain, and making the abdominal wall incision more aesthetically pleasing. However, bacteriological and oncological safety concerns have been raised, and there is a lack of evidence from clinical studies in a multicenter, large sample, or even randomized controlled trials.<sup>[4,5]</sup> The problems associated with postoperative infection after NOSES surgery for colorectal cancer remain of considerable research value, and there are few relevant reports on the analysis of risk factors for postoperative infection after NOSES surgery have been discovered. The results of this study showed that of the 92 patients who underwent surgery, 14 developed abdominal infections, an infection rate of 15.22%, which is generally consistent with existing studies by other authors (11%–26%). Logistic regression analysis finally screened that preoperative operative time, duration of drainage tube retention, abdominal iodophor flushing, use of specimen retrieval bags, use of TEO, the distance between the tumor and anal margin, and diabetes were related ( $P < .05$ ), while intraoperative use of specimen retrieval bags, use of TEO, intraoperative flushing of the abdominal cavity with dilute iodophor were protective factors for the development of postoperative abdominal infection ( $P < .05$ ). In this study, the blood glucose of 9 diabetic patients was always controlled within the normal range during hospitalization, but the results of the study still showed that people with diabetes are more prone to infection. That may be related to the impaired immune system of diabetic patients, which leads to increased susceptibility to bacteria, and the poor blood supply of peripheral circulation caused by microvascular disease.<sup>[6,7]</sup>

The use of the specimen bag reduces the possibility of intestinal contents being squeezed into the abdominal cavity during transanal dragging of the specimen, and the ventral side of the bag is coated with iodophor to prevent infection. The use of TEO, on the other hand, mainly reduced the damage to the distal residual intestinal canal and anal sphincter during the dragging process.<sup>[8–10]</sup> This study failed to prove that purse-string suture of the dangerous triangle is helpful for the prevention of postoperative abdominal infection, but studies have confirmed this,<sup>[11,12]</sup> which may be related to the limited number of cases in this study and the surgical team Suture technology is related.

We acknowledge the limitations of this article. It was a retrospective study and did not do complete randomization. The sample size was not large enough.

## 7. Conclusion

The results demonstrated that diabetes mellitus, prolonged drainage tube retention, and prolonged operative time were

risk factors for the happens of abdominal infection after NOSES. In contrast, the use of intraoperative specimen retrieval bags, the use of TEO, and intraoperative flushing of the abdominal cavity with dilute iodophor were protective factors for the development of postoperative abdominal infections. Strictly using the specimen bag, TEO, and diluted iodophor to flush the abdominal cavity, and pulling out the drainage tube as soon as possible according to the situation can help prevent the occurrence of postoperative abdominal infection. Therefore, active measures should be taken to prevent the occurrence of abdominal inflammation, improve the quality of life of patients after surgery, and achieve rapid recovery.

## Acknowledgments

We would like to thank all the staff in the Department of gastrointestinal surgery, Affiliated Hospital of Chengde Medical University for their contribution to our research.

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