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*Retrospective Study*

**Clinical observation of extraction-site Incisional Hernia after laparoscopic colorectal surgery**

Incisional Hernia after laparoscopic colorectal surgery

Bao-Hang Fan, Ke-Li Zhong, Li-Jin Zhu, Zhao Chen, Fang Li, Wen-Fei Wu

## **Abstract**

### **BACKGROUND**

After laparoscopic colorectal cancer surgery, there is a risk of incisional hernia at the site where the tumor specimen was removed.

### **AIM**

To investigate the incidence of incisional hernia(IH) at extraction sites after laparoscopic colorectal cancer surgery and the risk factors affecting the incidence of IH.

### **METHODS**

To retrospectively analyze 1614 patients who underwent laparoscopic radical colorectal cancer surgery with tumor extraction through the abdominal wall at our center between January 2017 and December 2022, to analyze the differences in the incidence of postoperative IH at different extraction sites and to analyze the risk factors affecting the incidence of IH.

### **RESULTS**

Among the 1614 patients who underwent laparoscopic radical colorectal cancer surgery in our center, 303 (18.8%) tumors were extracted through the supraumbilical midline incision, 923 (57.2%) through the infraumbilical midline incision, 171 (10.6%) through the umbilical incision and 217 (13.4%) through the off-midline incision. Of these, 52 patients developed IH in the abdominal wall, with an incidence of 3.2%. The incidence of postoperative IH was higher in the off-midline incision(8.8%) than in the middle incision group[the supraumbilical midline group (2.6%), the infraumbilical midline group (2.2%), and the umbilical incision group (2.9%)], and the difference was statistically significant ( $\chi^2 = 24.985$ ;  $P < 0.05$ ). The results of the univariate analysis showed that the occurrence of IH was associated with aged, obesity, female, chronic cough, incision infection and combined diabetes, anemia and hypoproteinemia ( $P < 0.05$ ). Multivariate analysis showed that off-midline incision, aged, female, obesity,

incision infection, combined chronic cough, and hypoproteinemia were independent risk factors for IH at the site of laparoscopic colorectal cancer surgical extraction ( $P < 0.05$ ).

## CONCLUSION

The incidence of postoperative IH at the site of extraction-site differs between different sites for laparoscopic colorectal cancer surgery, the infraumbilical midline incision is associated with a lower hernia rate and is suitable as a site for tumor extraction.

**Key Words:** IH; laparoscopy; colorectal cancer; incision infection

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**Core Tip:** After laparoscopic colorectal cancer surgery, there is a risk of incisional hernia at the site where the tumor specimen was removed. Here, we included 1614 patients after laparoscopic colorectal cancer surgery to analyze the differences in the incidence of incisional hernias at different sites of tumor specimen removal and to analyze the risk factors affecting the occurrence of incisional hernia.

## INTRODUCTION

In radical laparoscopic procedures for colorectal cancer, the tumor is typically extracted by enlarging the trocar. This is commonly achieved through incisions along the supraumbilical midline, infraumbilical midline, umbilical, and off-midline<sup>[1]</sup>. The length of these incisions, used to extract the tumor, typically measures approximately 4-6 cm. While this is significantly smaller than an open incision, it can lead to complications such as Incisional Hernia (IH). IH is a hernia of the abdominal wall that arises from inadequate healing of the tendinous layer of the abdominal wall. It is a

common complication following abdominal surgery with an incidence ranging from 2% to 11%<sup>[2]</sup>. Both traditional open and laparoscopic surgeries carry a risk of IH, thereby impacting the patient's postoperative recovery<sup>[3]</sup>. Previous research on IH has predominantly focused on traditional open surgery. However, studies examining the incidence and risk factors of IH following laparoscopic surgery are relatively scarce. To explore the potential variance in postoperative Incisional Hernia (IH) incidence following intraoperative tumor extraction *via* these incisions, and to scrutinize the risk factors influencing IH occurrence, this study undertook a retrospective analysis of clinical data from patients who underwent laparoscopic radical colorectal cancer surgery at our center over the past five years.

## **MATERIALS AND METHODS**

### **Patient characteristics**

This study is a retrospective analysis of medical records from 2,679 patients who underwent radical colorectal cancer surgery at our center between January 2017 and the present. Inclusion criteria were as follows: (1) Patients with preoperative ancillary tests indicating colorectal cancer who underwent radical colorectal cancer surgery in our hospital; (2) The surgical procedure was either laparoscopic or da Vinci robot-assisted radical tumor resection; (3) Tumor specimens were extracted by enlarging the trocar. Exclusion criteria included: (1) Patients who underwent open surgery, hand-assisted laparoscopic surgery (HALS), Miles' surgery, or transitioned from laparoscopic surgery to open surgery; (2) Patients who underwent Natural Orifice Specimen Extraction Surgery (NOSES); (3) Patients who required multiorgan resection. A total of 1614 eligible patients were included in the final study.

All patients in the cohort underwent tumor excision *via* trocar enlargement and incision protector placement. The extent of the incision was determined by the size of the tumor. All patients were subjected to a 'three-step suture' procedure, which involved suturing the anterior sheath of the rectus abdominis and the peritoneum, the abdominal wall's fat layer, and the skin layer respectively.

### **Method of follow-up**

Patient data were gathered utilizing a hospital information system (HIS), short message service (SMS), and telephone follow-up. The preoperative, perioperative, and postoperative details of all patients included in this study were meticulously recorded. The follow-up period was delineated from the day following surgery until the final outpatient follow-up visit to evaluate the onset of Inguinal Hernia (IH). This follow-up primarily encompassed laboratory examinations such as routine blood tests, liver and kidney function assessments, serum electrolyte measurements, fasting blood glucose levels, among others. Additionally, physical examinations and imaging evaluations were conducted. Notably, the imaging examinations predominantly involved abdominal CT scans and abdominal ultrasounds. An incisional hernia was characterized by either a palpable physical examination or an abdominal wall defect as evidenced by imaging data. The follow-up duration for incisional hernia was consistent with the postoperative follow-up period following tumor surgery, which entailed biannual check-ups for the initial two years. From the third year onwards, the frequency of follow-ups was adjusted to every six months. Routine abdominal CT scans were performed during the postoperative surveillance of the tumor. Patients identified through imaging as having occult incisional hernia or abdominal wall defects, but without manifesting symptoms of incisional hernia, were subjected to a 1-3 month follow-up period. This monitoring process encompassed an abdominal physical examination, color Doppler ultrasound, and, if deemed necessary, additional abdominal CT scans.

This study examined several prognostic factors influencing incision healing, including gender, age, obesity, diabetes, anemia, hypoproteinemia, chronic cough, radiotherapy and chemotherapy, as well as postoperative incision infection. The definition of elderly patients was set at those aged 60 years or older; obesity was characterized by a BMI exceeding 30kg/m<sup>2</sup>; anemia was identified by hemoglobin levels below 90 g/L; hypoproteinemia was denoted by serum albumin concentrations under 35 g/L; chronic cough encompassed both preoperative chronic cough and

perioperative new chronic cough; the positioning of the incision referred to the location of the enlarged trocar used for tumor specimen collection, which could be categorized into median incision and paramedian incision (including supraumbilical midline incision, infraumbilical midline incision, and umbilical incision); and the chemoradiotherapy received by patients was defined as either preoperative or postoperative.

### Statistical analysis

SPSS 26.0 software was used for statistical analysis. <sup>1</sup> Categorical variables were reported as frequency (%), and quantitative variables were reported as mean  $\pm$  SD except where otherwise noted. Categorical variables were analyzed with the  $\chi^2$  or Fisher exact test. Quantitative variables were analyzed with a t-test. Univariate analysis was performed to define the risk factors for extraction site IH for all patients, and multivariate analysis was performed using logistic regression to analyze independent risk factors with the postoperative IH. <sup>5</sup> Statistical significance was assumed when p value was  $<0.05$ .

## RESULTS

### Clinical characteristics

<sup>2</sup> In this study, 2,679 patients who underwent radical colorectal cancer surgery at our hospital from January 2017 to December 2022 were selected, and after the exclusion, 1,614 patients were finally included in the study. Of these, 303 (18.8%) tumors were extracted through the supraumbilical midline incision, 923 (57.2%) through the infraumbilical midline incision, 171 (10.6%) through the umbilical incision and 217 (13.4%) through the off-midline incision. All patients in the group were grouped according to the incision sites through which the specimens were extracted, and the patients' basic clinical information and perioperative conditions were presented (see Table 1).

### Comparison of the rate of occurrence of IH

Table 2 shows the comparative results of the incidence of IH: 52 of the 1614 patients included in the study developed postoperative IH in the abdominal wall, with an incidence of IH of 3.2%. The incidence of postoperative IH was higher in the off-midline incision(8.8%) than in other groups [the supraumbilical midline group (2.6%), the infraumbilical midline incision (2.2%) and the umbilical incision group (2.9%)], and the difference was statistically significant ( $\chi^2 = 24.985$ ;  $P < 0.05$ ).

#### **Univariate analysis of factors associated with IH at the extraction site**

To investigate the risk factors influencing the development of IH, a univariate analysis was performed on 1614 patients enrolled in the group according to whether they had IH. The proportion of patients with obesity (17.3% in the IH group vs. 4.4% in the non-IH group) and the proportion of patients with comorbid diabetes (53.8% in the IH group vs. 14.5% in the non-IH group), anemia (19.2% in the IH group vs. 10.6% in the non-IH group), hypoproteinemia, chronic cough (75% in the IH group vs. 35.5% in the non-IH group) and incision infection were higher than those in the non-IH group. All were statistically significant ( $p < 0.05$ ), while there were no significant differences between the two groups regarding the number of patients who received radiotherapy. (see Table 3)

#### **Multivariate analysis of factors associated with the risk of extraction-site IH**

Further multifactorial logistic regression analysis showed that off-midline incision (OR=1.627), aged (OR=2.231), female (OR=2.273), obesity (OR=3.299), Combined with chronic cough (OR=2.401), anemia (OR=6.634) and incision infection were influential factors associated with the risk of extraction-site IH ( $p < 0.05$ ) (see Table 4)

### **DISCUSSION**

The findings of this study demonstrate that the rate of extraction-site Inguinal Hernia (IH) varies across different abdominal wall sites, with a significantly higher incidence observed in off-midline incisions compared to median incisions (including



supraumbilical midline incisions, infraumbilical midline incisions, and umbilical incisions). The author posits that the paramedian incision penetrates the abdominal cavity *via* the rectus abdominis. This approach necessitates the removal of more tissue layers than the midline incision, necessitating the severance of the rectus abdominis muscle bundle, which complicates suture placement. Upon closure of the abdominal cavity, excessive suture tension can induce bleeding and muscle tears, thereby hindering wound healing and heightening the risk of incisional hernia. It may also directly contribute to incisional hernia due to inadequate closure of the abdominal wall caused by insufficient tension, a factor contributing to the high incidence of incisional hernia following paramedian incision. Furthermore, the anatomical layers of the median abdominal incision were accurately delineated, facilitating the suture of the appropriate tissue layers without complications such as abdominal wall muscle tearing during suturing, thus promoting wound healing. Furthermore, the data presented in Table 1 indicate a higher prevalence of anemia and hypoproteinemia among patients in the subumbilical incision group. However, the incidence rate of incisional hernia is notably lower in this group. Consequently, the impact of incision position on the occurrence of incisional hernia becomes evident. However, these findings contrast with several prior studies<sup>[5-8]</sup> that tend to eschew the use of median incisions. This discrepancy does not negate the findings of this study. The variance in results among studies is attributed to factors such as the number of cases included and the grouping method employed. For instance, in studies examining extraction-site IH following laparoscopic surgery by Cigdem Benlice's team from Cleveland<sup>[9]</sup> and Lawrence Lee's team from Canada<sup>[10]</sup>, the grouping incorporated "from laparoscopic colorectal surgery to open surgery" and "HALS" in the midline group, leading to the conclusion that IH was higher after midline incisions. The authors contend that the incision size significantly exceeds that of laparoscopic surgery, whether transitioning from laparoscopic colorectal surgery to open surgery or HALS. The extended incision is identified as a risk factor for Intra-operative Hemorrhage (IH), leading to an increased incidence of IH in the midline group and potentially biasing the final results.

In addition to the incision location, numerous factors influence the incidence of extraction-site IH, encompassing both operator and patient characteristics. A multifactorial analysis indicated that factors such as age, obesity, female gender, combined anemia, and concurrent respiratory disease emerged as independent risk factors for IH. This finding aligns with prior research on IH following abdominal surgery<sup>[11-13]</sup>. Patients presenting these conditions exhibit delayed wound healing rates and are prone to wound infection or suboptimal wound healing, thereby amplifying the risk of IH<sup>[14]</sup>. Consequently, operators must exercise caution during suturing for patients with these predisposing conditions and closely monitor wound recovery to mitigate perioperative infections and minimize IH incidence. Operational variables, including the surgeon's suturing proficiency and suture selection variances, can directly influence IH occurrence. The author posits that the incision location is not the sole determinant of extraction-site IH events. Beyond patient predispositions, it is imperative to acknowledge the significance of suture technique and material selection irrespective of incision sites<sup>[15]</sup>.

In conclusion, the findings of this study tentatively indicate that the incidence of incisional hernia (IH) following laparoscopic radical colorectal cancer extraction is more likely when the tumor is removed *via* the off-midline incision compared to other incisions. Consequently, it is recommended to avoid such an approach whenever possible. Furthermore, the significance of the suturing technique should not be overlooked. It is imperative to implement stringent perioperative management for patients at high risk of IH, including those with advanced age, obesity, female gender, combined diabetes, anemia, and chronic cough. This will help prevent incisional infection and poor healing, thereby reducing the prevalence of IH.

## **CONCLUSION**

The incidence of postoperative Intrahepatic Hypertension (IH) at the extraction site varies across different laparoscopic colorectal cancer surgery sites, with the off-midline incision being avoided whenever possible. Apart from the off-midline incision, factors

such as age, female gender, obesity, incision infection, combined chronic cough, and hypoproteinemia were identified as independent risk factors for IH at the site of laparoscopic colorectal cancer surgical extraction.

## **ARTICLE HIGHLIGHTS**

### ***Research background***

After laparoscopic colorectal cancer surgery, there is a risk of IH at the site where the tumor specimen was removed.

### ***Research motivation***

IH that occur after laparoscopic colorectal cancer surgery affected the recovery of patients and caused a great burden to patients.

### ***Research objectives***

This study aimed to investigate the incidence of IH at extraction sites after laparoscopic colorectal cancer surgery and the risk factors affecting the incidence of IH.

### ***Research methods***

This study presents a retrospective analysis of medical records from 1614 patients who underwent radical colorectal cancer surgery at our center between January 2017 and the present. The focus is on examining the incidence rate of IH and factors influencing this incidence.

### ***Research results***

The incidence of postoperative IH was higher in the off-midline incision(8.8%) than in other groups [the supraumbilical midline group (2.6%), the infraumbilical midline incision (2.2%) and the umbilical incision group (2.9%)], and the difference was statistically significant ( $\chi^2 = 24.985$ ;  $P < 0.05$ ). Apart from the off-midline incision, factors such as age, female gender, obesity, incision infection, combined chronic cough, and

hypoproteinemia were identified as independent risk factors for IH at the site of laparoscopic colorectal cancer surgical extraction.

### ***Research conclusions***

The incidence of postoperative IH at the extraction site varies across different laparoscopic colorectal cancer surgery sites, with the off-midline incision being avoided whenever possible. Apart from the off-midline incision, factors such as age, female gender, obesity, incision infection, combined chronic cough, and hypoproteinemia were identified as independent risk factors for IH at the site of laparoscopic colorectal cancer surgical extraction

### ***Research perspectives***

According to the results of this study, a off-midline incision should be avoided at the site where the tumor specimen is removed for subsequent colorectal cancer surgery.

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PRIMARY SOURCES

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