

# Plastic wound protectors decreased surgical site infections following laparoscopic-assisted colectomy for colorectal cancer

## A retrospective cohort study

Yang Luo, MD, Yi-Er Qiu, MD, Yi-Fei Mu, MD, Shao-Lan Qin, MD, Yang Qi, MD, Ming Zhong, PhD, Min-Hao Yu, PhD\*, Li-Ying Ma, MD\*

### Abstract

Laparoscopic surgery is widespread and safe for the management of patients with colorectal cancer (CRC). Although the use of standard surgical techniques can prevent perioperative wound infections, surgical site infections (SSIs) remain an unresolved complication in laparoscopic-assisted colectomy. The present study investigated the ability of plastic wound protectors applied to the extraction incision during the externalized portion of the procedure to reduce the rate of infection in laparoscopic-assisted colectomy. We completed a retrospective review of the medical records of patients who underwent nonemergent laparoscopic-assisted between January 2015 and June 2016. Outcomes for patients with and without the use of a wound protector were compared. A total of 109 patients were included in this study. There was 1 patient in the wound protector group ( $n=57$ ) and 7 in the nonwound protector group ( $n=52$ ) who developed a wound infection at the colon extraction site ( $P=.02$ ). Furthermore, the average postoperative hospital stay in the wound protector group was shorter compared to the nonwound protector group ( $7.47 \pm 0.24$  vs  $8.73 \pm 0.54$  days,  $P=.03$ ). In conclusion, this study indicates that the use of a plastic wound protector during laparoscope-assisted colectomy does reduce postoperative wound infection rates, and the wound protectors are beneficial for specimen extraction and digestive tract reconstruction.

**Abbreviations:** CRC = colorectal cancer, SSI = surgical site infection.

**Keywords:** colorectal cancer, laparoscopic surgery, plastic wound protector, surgical site infections

## 1. Introduction

Surgical site infections (SSIs) are the most frequent complications in laparoscopic-assisted.<sup>[1]</sup> Despite the use of standard surgical techniques (antiseptic skin preparation, sterile draping, and antibiotics) that could prevent perioperative wound infections, wound infection following clean-contaminated procedures occurs in more than 10% of laparoscopic-assisted colectomy.<sup>[2–5]</sup> SSIs contribute substantially to postoperative morbidity and

mortality and have been shown to significantly increase the mean length of hospital stays and treatment costs.<sup>[6,7]</sup> Thus, devices to reduce SSI incidence are of great medical and economic importance.

Although there are many factors associated with SSIs after colorectal cancer (CRC) surgery, the most frequent pathogens are endogenous pathogens from the skin or gastrointestinal tract.<sup>[11]</sup> The plastic wound protectors were originally designed to be a simple, easy-to-use, and cost-effective device that reduces the contact between bacteria and incisions, and provides a relatively disease-free environment for the operator.<sup>[8]</sup> However, the role of plastic wound protectors in surgical procedures has been disputed. Some studies found that SSIs were significantly reduced by wound protectors in colorectal surgery,<sup>[9,10]</sup> while others reported they did not reduce SSIs at all.<sup>[11,12]</sup>

Therefore, this study assesses the role of plastic wound protectors in the prevention of wound infection following laparoscopic-assisted colectomy. We retrospectively analyzed clinical data of CRC patients who underwent laparoscopic-assisted colectomy in our hospital from January 2015 to June 2016 and determined whether plastic wound protectors can reduce wound infections. This study also investigated the impact of plastic wound protectors on surgical complications.

## 2. Patients and methods

### 2.1. Patients and study selection

A retrospective cohort study of 109 patients who underwent a laparoscopic-assisted colectomy was conducted at a single institution in the Department of Gastrointestinal Surgery at

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Department of Gastrointestinal Surgery, Ren Ji Hospital, School of Medicine, Shanghai Jiao Tong University, Shanghai, P.R. China.

\* Correspondence: Li-Ying Ma, Min-Hao Yu, Department of Gastrointestinal Surgery, Ren Ji Hospital, School of Medicine, Shanghai Jiao Tong University, No. 160 Pujian Road, Shanghai 200127, P.R. China (e-mails: mly525@126.com, fishmeangood@163.com).

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**Figure 1.** The wound protector group had a plastic wound protector that was placed through a 5 to 7-cm skin incision following mobilization of the colon and rectum or laparoscopic intestinal anastomosis.

Shanghai Renji Hospital from January 2015 to June 2016. Consecutive CRC patients who were treated with laparoscopic surgery were enrolled. Patients with diabetes, anemia, insufficient bowel preparation, and severe cardiac and pulmonary dysfunction were excluded from this study. Patients older than 75 years were also excluded. Patients undergoing a complete laparoscopic colon resection and rectum resection were excluded. The protocol was approved by the medical ethics committee of our hospital, and written informed consents for diagnosis and treatment were obtained from all patients prior to the procedures.

All patients received perioperative intravenous antibiotics (cefotiam) and underwent a mechanical bowel preparation (polyethylene glycol and electrolyte powder) the day before surgery. All the patients underwent an initial laparoscopy and laparoscopic mobilization of the respective colon.<sup>[13]</sup> After attaining adequate mobilization, an extraction site measuring 5 to 7 cm on the anterior abdominal wall was created.<sup>[14]</sup> Each patient in the wound protector group had a plastic wound protector (Beijing HangTian KaDi Technology R&D Institute, China) used in the surgery, which was placed through the incision (Fig. 1). Each patient in the nonwound protector group had iodoform gauze applied, which covered the edge of the wound (Fig. 2). The decision whether to use a wound protector was based on the surgeon's preference for neoplastic procedures. Wounds were assessed daily during the patients' hospital stay and at the time of follow-up, 10 to 14 days postoperatively. Wound infection was defined by wound erythema, cellulitis, localized pain, swelling, tenderness, or purulent or culture-positive wound discharge within 30 days of surgery.<sup>[15]</sup>

## 2.2. Statistical analysis

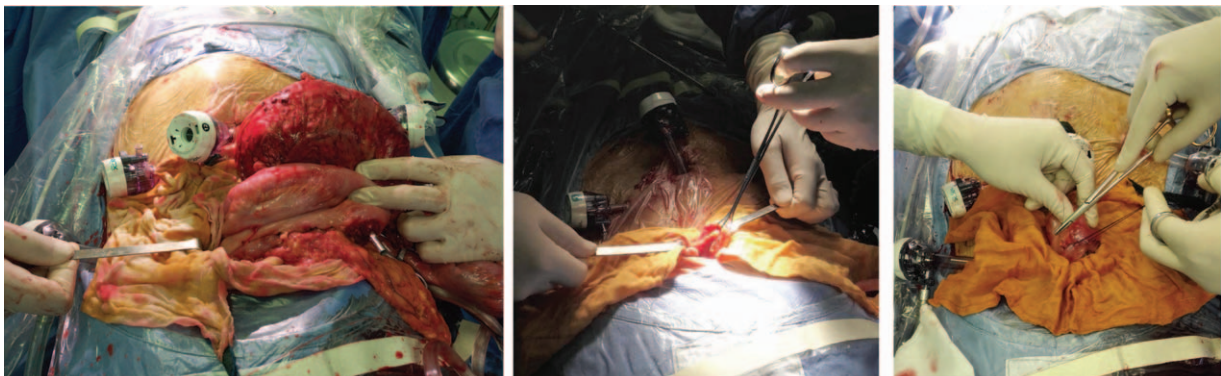
All analyses were conducted using IBM SPSS 16.0 software (SPSS Inc., Chicago, IL). Data from the 2 groups were compared using Student *t* test. Continuous data are expressed as the means  $\pm$  standard deviation. For the univariate analyses, comparisons of categorical variables were performed using a chi-squared test or Fisher exact test. Statistical significance was accepted as  $P < .05$ .

## 3. Results

### 3.1. The patients' clinicopathologic features

From January 2015 to June 2016, there were 389 colorectal patients undergoing operation by the same surgeon's group in Ren Ji Hospital. Patients were excluded from the analysis if they had received emergency surgery ( $n=48$ ), had comorbidities (diabetes, anemia, severe cardiac dysfunction, or pulmonary dysfunction;  $n=61$ ), were older than 75 years ( $n=73$ ), were stage IV ( $n=21$ ), or had rectal cancer ( $n=73$ ). Finally, 109 patients were included in this study, which were divided into the wound protector group ( $n=57$ ) and the nonwound protector group ( $n=52$ ; Fig. 3).

For the entire series, the 109 included patients comprised 59 men and 50 women, with a median age of  $58.61 \pm 1.12$  years (range: 22–75 years). The mean body mass index was  $21.66 \pm 0.21 \text{ kg/m}^2$  (range:  $17.36\text{--}27.28 \text{ kg/m}^2$ ). Histologically, there were 96 adenocarcinomas and 13 mucinous carcinomas. Upon tumor location evaluation, there were 61 lesions located in the left side of the colon and 48 lesions located in the right side of the



**Figure 2.** The nonwound protector group had iodoform gauze that covered the edge of the skin incision following mobilization of the colon and rectum.

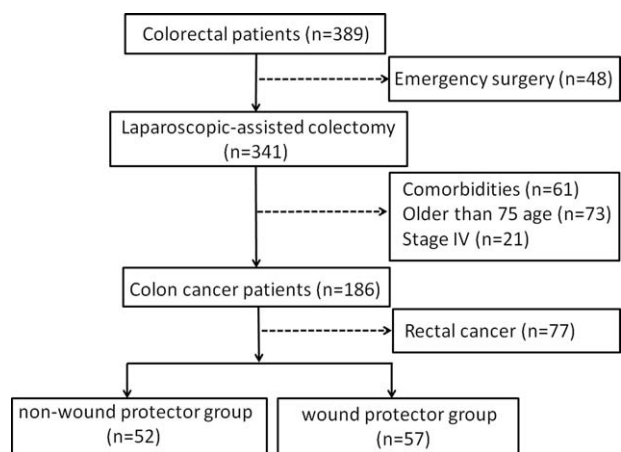


Figure 3. Flow chart of patient selection in this study.

colon. Upon TNM stage analysis, there were 11 stage I, 54 stage II, and 44 stage III patients. Upon complication analysis, 20 of 109 patients had medical complications for appropriate treatment and these patients were discharged from our hospital. Wound infection occurred in 8 of 109 patients (7.34%), who were treated with antibiotics and dressing. Anastomotic leakages occurred in 2 of 109 patients (1.83%), who were given conservative treatments such as fasting and antibiotics for slight anastomotic leakages or a loop ileostomy for severe anastomotic leakages, which is necessary to prevent fecal contamination. Uroschisis occurred in 4 of 109 patients (3.67%), which prolonged the use of indwelling catheters. Obstruction occurred in 6 of 109 patients (4.59%), who were given conservative treatments such as fasting and drugs to promote peristalsis.

**Table 1**  
The comparison of demographic features in 109 colorectal cancer patients.

Demographic features	Nonwound protector (n=52, 47.71%)	Wound protector (n=57, 52.29%)	P
Gender			
Male	30 (57.69)	29 (50.88)	.30
Female	22 (42.31)	28 (49.12)	
Age, y			
>65	27 (51.93)	31 (54.39)	.47
≤65	25 (48.07)	26 (45.61)	
BMI, kg/m <sup>2</sup>			
<18.5	5 (9.62)	4 (7.02)	.88
18.5–24.99	41 (78.85)	46 (80.70)	
>24.99	6 (11.53)	7 (12.28)	
Tumor size			
>5 cm	21 (40.38)	26 (45.61)	.36
≤5 cm	31 (59.62)	31 (54.39)	
Tumor location			
Left colon	32 (61.54)	29 (50.88)	.18
Right colon	20 (38.46)	28 (49.12)	
TNM stage			
I	6 (11.54)	5 (8.77)	.86
II	26 (50.00)	28 (49.12)	
III	20 (38.46)	24 (42.11)	
Histology			
Adenocarcinoma	48 (92.31)	48 (84.21)	.16
Mucinouscarcinoma	4 (7.69)	9 (15.79)	

BMI=body mass index, TNM=tumor, node, and metastasis.

**Table 2**  
The comparison of operative factors in 109 colorectal patients.

Operative factors	Nonwound protector (n=52, 47.71%)	Wound protector (n=57, 52.29%)	P
Operative time	130.6±2.77	126.8±3.10	.37
Blood loss	69.81±4.42	65.00±4.16	.43
Postoperative exhaust time	75.23±3.06	69.68±2.43	.15
Postoperative hospital stay	8.73±0.54	7.47±0.24	<b>.03</b>

Bold value represents the P values with significant differences.

### 3.2. The evaluation of short-term outcomes of wound protectors use in colon cancer patients

A comparison of the patient demographic and perioperative data for the wound protector and nonwound protector groups are listed in Tables 1 and 2. The average postoperative hospital stay in the wound protector group was shorter compared to those cases in which a wound protector was not used (7.47±0.24 vs 8.73±0.54 days, P=.03). There were no differences in operative time (126.8±3.10 vs 130.6±2.77 minutes, P=.37), blood loss (65.00±4.16 vs 69.81±4.42 mL, P=.43), or postoperative exhaust time (69.68±2.43 vs 75.23±3.06 minutes, P=.15) between the 2 groups. Similarly, there were no differences in age, sex, or body mass index.

Fifty-seven patients underwent laparoscopic-assisted colectomy with the use of a wound protector during specimen extraction and anastomosis. Demographic data are described in Table 3. Of the 7 patients (12.28%) with medical complications, the most common complication was adhesive intestinal obstruction (n=3, 5.26%), followed by uroschisis (n=2, 3.51%), and the complications with the lowest incidences were anastomotic leakage (n=1, 1.75%) and wound infection (n=1, 1.75%). However, in the nonwound protector group, the most common complication was wound infection (n=7, 13.46%), followed by adhesive intestinal obstruction (n=3, 5.77%), and uroschisis (n=2, 3.85%), and the complications with the lowest incidence was adhesive intestinal obstruction (n=1, 1.92%). Therefore, the wound infection rates were significantly lower in the wound protector group compared to the nonwound protector group (1.75% vs 13.46%, P=.02), while there were no differences in other complications (uroschisis, adhesive intestinal obstruction, and anastomotic leakage).

**Table 3**  
The comparison of postoperative complications in 109 colorectal patients.

Postoperative complications	Nonwound protector (n=52, 47.71%)	Wound protector (n=57, 52.29%)	P
Wound infection			
No	45 (86.54)	56 (98.25)	<b>.02</b>
Yes	7 (13.46)	1 (1.75)	
Anastomotic leakage			
No	51 (98.08)	56 (98.25)	.73
Yes	1 (1.92)	1 (1.75)	
Uroschisis			
No	50 (96.15)	55 (96.49)	.66
Yes	2 (3.85)	2 (3.51)	
Intestinal obstruction			
No	49 (94.23)	55 (94.74)	.62
Yes	3 (5.77)	3 (5.26)	

Values in parentheses indicate percentage values. Bold value represents the P values with significant differences.

#### 4. Discussion

Several large multicenter randomized control trials have demonstrated that laparoscopic surgery for CRC is associated with better short-term results and equivalent oncologic results when compared to open surgery, especially for postoperative pain and the rate of wound infection.<sup>[16–20]</sup> However, SSIs, which are associated with increased morbidity and mortality rates, are still one of the most frequent postoperative complications after laparoscopic surgery for CRC, with rates of 4.9% to 6.3%.<sup>[6,20]</sup>

Patients with SSIs have to extended length of hospitalization time and increased costs of treatment.<sup>[21]</sup> In addition, SSIs is a risk factor for incisional hernia, which may require an additional operation.<sup>[22,23]</sup> Furthermore, SSIs could lead to systemic infection and even death.<sup>[21]</sup> These adverse factors caused the patients' physical and mental injury. What is more, the treatment of these infections consumes additional hospital resources ranging from the administration of antibiotics and dressing to telephone or outpatient follow-up for wound reevaluation.<sup>[24,25]</sup>

The preventive effects of plastic wound protectors on wound contamination and subsequent infection have been investigated since 1960s, although there have been conflicting reports. Initially, Harrower<sup>[26]</sup> reported that patients undergoing intestinal and biliary surgery using a wound liner had a lower incidence of postoperative wound infection (2.4% vs 15%). Then, Nystrom and Brote<sup>[27]</sup> also reported that a plastic wound drape could reduce wound infections in appendicitis operations. Recently, studies have demonstrated that wound protectors had practical significance in reducing SSIs during gastrointestinal and biliary surgeries.<sup>[28–30]</sup> Nevertheless, Kercher et al<sup>[12]</sup> reported no protective effect with the use of a wound protector in a retrospective analysis of clinical data from 141 performed laparoscopic CRC operations. A similar conclusion has been reached by Kercher following a group of 109 patients. Williams et al<sup>[31]</sup> drew a unanimous conclusion. In this study based upon comparing the clinical data from CRC patients in the wound protector and the no wound protector groups, the results showed that the wound protectors can significantly reduce wound infection rates, thus promoting increased hospital turnover and reduced hospital stays.

The previous study showed silicone film is the main components of the plastic wound protectors, which could effectively prevent the abdominal tumor cells planting wound incisions. However, there are no definitive data to indicate that rate of tumor seeding is decreased by using plastic wound protectors in surgical procedure.<sup>[32,33]</sup> Furthermore, current data suggest that the wound recurrence is rare, and there are no significant differences between laparoscopic colectomy and previous open colectomy.<sup>[34]</sup> In this study, we have not observed wound recurrences in the 109 patients after undergoing laparoscopic-assisted colectomy with or without plastic wound protectors, due to lack of samples and short follow-up. In the next, we will continue to use plastic wound protectors in CRC patients who undergo laparoscopic colectomy to explore the risk factors of wound recurrence.

The present study has several limitations. The single-institution, retrospective nature of our investigation is prone to selection bias. We minimized this bias by including all colectomies that met the selection criteria during the defined study period. Another noteworthy limitation is whether the plastic wound protector was used in surgery. Finally, there were not enough patients with CRC to include in the study. Despite these limitations, this study

presents significant findings that underscore the need for future randomized prospective trials.

#### 5. Conclusion

Our data indicate that the use of a plastic wound protector during laparoscope-assisted colectomy does reduce postoperative wound infection rates. Furthermore, it is beneficial for specimen extraction and digestive tract reconstruction. However, further trials could be necessary to determine whether there are oncological benefits to the use of plastic wound protectors during laparoscope-assisted colectomy.

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