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EDITORIAL

Occurrence and prevention of incisional hernia following laparoscopic colorectal surgery

Xi-Wen Wu, Ding-Quan Yang, Ming-Wei Wang, Yan Jiao

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Abstract

Among minimally invasive surgical procedures, colorectal surgery is associated with a notably higher incidence of incisional hernia (IH), ranging from 1.7% to 24.3%. This complication poses a significant burden on the healthcare system annually, necessitating urgent attention from surgeons. In a study published in the *World Journal of Gastrointestinal Surgery*, Fan *et al* compared the incidence of IH among 1614 patients who underwent laparoscopic colorectal surgery with different extraction site locations and evaluated the risk factors associated with its occurrence. This editorial analyzes the current risk factors for IH after laparoscopic colorectal surgery, emphasizing the impact of obesity, surgical site infection, and the choice of incision location on its development. Furthermore, we summarize the currently available preventive measures for IH. Given the low surgical repair rate and high recurrence rate associated with IH, prevention deserves greater research and attention compared to treatment.

Key Words: Incisional hernia; Laparoscopy; Colorectal surgery; Risk factor; Prevention

Core Tip: Incisional hernia (IH) is a significant long-term complication following laparoscopic colorectal surgery. Investigating its high-risk factors can facilitate understanding its occurrence and development, enabling targeted preventive measures to reduce IH incidence and enhance the long-term outcomes for surgical patients.

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INTRODUCTION

Abdominal surgery is one of the most common surgical operations, needed by more than 43% of people aged 60 and older[1]. Incisional hernia (IH), a prevalent long-term complication following abdominal surgery, occurs in 3.8% to 30% of cases[2-4], compromising patients' skin integrity and quality of life[5]. Symptoms of IH include abdominal discomfort, pain, bowel dysfunction, difficulty walking, and even life-threatening conditions[1], necessitating significant medical resources (*e.g.*, 67.7 million euros per year in France[6]) for its management[3]. Surgical repair is typically the primary treatment for IH. Among abdominal surgeries, colorectal procedures have a higher risk of this complication, with an incidence rate ranging from 7.7% to 10.0%[3,4]. Moreover, the repair of IH following colorectal surgery poses greater challenges compared to other abdominal surgeries[6].

Minimally invasive surgical procedures have decreased the occurrence of postoperative IH when compared to conventional open surgeries[7]. However, laparoscopic colorectal surgeries still involve the creation of small abdominal extraction wounds for the removal of resected bowel segments, posing a risk for IH complications. Fan *et al*[8] conducted a retrospective study on 1614 patients who underwent laparoscopic radical resection for colorectal cancer in their article entitled "Clinical observation of extraction-site IH after laparoscopic colorectal surgery". They analyzed the occurrence and identified high-risk factors for IH in these patients. IH has long been discussed as a long-term postoperative outcome of open surgeries. With the increasing popularity and widespread use of minimally invasive surgical methods, exploring the high-risk factors for IH complications in laparoscopic colorectal surgeries will be more meaningful and helpful for future prevention and treatment strategies.

RISK OF IH FOLLOWING LAPAROSCOPIC COLORECTAL SURGERY

IH occurs due to incomplete healing of muscles or fascia at the abdominal incision site. The length of the abdominal incision is positively correlated with the risk of IH formation[9]. Although laparoscopic techniques have significantly reduced the incidence of IH compared to open colorectal surgeries[9-12], it still occurs in 1.7%-24.3% of patients who undergo laparoscopic colorectal surgery (Table 1)[2,8-22]. In the study by Fan *et al*[8], the incidence of IH in laparoscopic colorectal surgery patients was found to be 3.2%. Furthermore, factors such as incision outside the midline, advanced age, female gender, obesity, surgical site infection (SSI), comorbid chronic cough, and hypoalbuminemia were identified as independent risk factors for IH at the surgical site for laparoscopic colorectal cancer surgery. These findings are generally consistent with those reported by other medical centers worldwide[2].

An elevated body mass index (BMI) or visceral obesity is widely recognized as a significant risk factor for IH[13,23]. Patients with obesity grade II or above are 1.55 times more likely to develop IH compared to non-obese patients, and are more prone to surgical wound infections and postoperative sepsis[24]. Worse still, obesity poses challenges in repair, leading to higher recurrence rates[25,26]. In terms of treatment, mesh repair is preferred over suturing for IH in obese patients[27]. Early intervention within 6 months postoperatively can enhance IH repair when abdominal wall defects are small[27]. It is also recommended to stratify the management of obese patients based on BMI, or by measuring the preoperative visceral and subcutaneous fat composition with better predictive ability[28]. In particular, patients with a BMI ≥ 35.0 kg/m^2 may benefit from weight loss prior to repair surgery to reduce recurrence rates[24,29].

Additionally, factors such as smoking, traumatic complications[30], adjuvant chemotherapy for colon cancer[31], postoperative weight gain[32], elevated intra-abdominal pressure, and prior abdominal surgeries[33] are also associated with a higher incidence of IH.

PREVENTION OF IH

IH has a low surgical repair rate and high recurrence rate[3,34], with a failure rate of up to 60% for hernia repair surgeries [35]. Long-term outcomes of IH repair surgeries are often suboptimal, trapping patients in a vicious cycle of repeated surgical repairs[36]. Additionally, patients often hesitate to opt for surgical solutions[3], and those with small IH may be unaware of their condition[2]. Diagnostic methods relying on physical examination may miss 23%-30% of IH detected by medical imaging[37,38], leading to missed optimal treatment opportunities. Therefore, the focus must be placed on the

Table 1 Incidence and risk factors of incisional hernia after laparoscopic colorectal surgery

Ref.	Country	Incidence of IH (%)	Clinical risk factors
Kobayashi *et al*[2]	Japan	10	Female gender, obesity, and SSI
Fan *et al*[8]	China	3.2	Incision outside the midline, advanced age, female sex, obesity, SSI, hypoalbuminemia, and comorbid chronic cough
Laurent *et al*[9]	France	13.0	Open surgery
Jensen *et al*[10]	Denmark	5.2	Open surgery
Vignali *et al*[11]	Italy	17.3	Open surgery
Bartels *et al*[12]	Holland	10.1	Open surgery
Yamamoto *et al*[13]	Japan	8.5	Visceral fat area
Kuhry *et al*[14]	Multicenter	7.9	No
Mishra *et al*[15]	United Kingdom	15.9	Stoma closure site
Patankar *et al*[16]	United States	1.7	No
Singh *et al*[17]	Canada	7.8	Midline extraction site
Braga *et al*[18]	Italy	4.7	No
Winslow *et al*[19]	United States	24.3	No
Taylor *et al*[20]	United Kingdom	8.6	Conversion from laparoscopic to open surgery
Duepree *et al*[21]	United States	2.3	No
Petersson *et al*[22]	Multicenter	17.0	No

IH: Incisional hernia; SSI: Surgical site infection.

prevention of IH, rather than solely on its treatment.

Choice of incision site

Fan *et al*[8] categorized the incision sites for specimen retrieval into umbilical superior midline, umbilical inferior midline, umbilical, and non-midline groups. Their findings indicated that non-midline incision sites are more prone to IH. Lee *et al*[39], in their analysis of 17 studies on laparoscopic colorectal surgery, discovered that the risk of IH is significantly higher with midline incisions compared to non-midline incisions. However, another study reported no significant difference in the risk of IH between midline and non-midline incisions[40]. This contradiction may be attributed to heterogeneous data among different studies, necessitating further high-quality clinical data for validation. Compared to midline incisions, transverse incisions have been shown to reduce the occurrence of IH[39,41,42]. Specific modifications such as unilateral low transverse incision[39], muscle splitting periumbilical transverse incision[43], and non-muscle-cutting periumbilical transverse incision[44] offer unique advantages in reducing the risk of IH. Pfannenstiel incisions have demonstrated remarkable effectiveness in reducing IH rates[39,45]. Commonly used in gynecological surgeries, this incision is characterized by its relatively simple anatomical structure, inconspicuous scarring due to preservation of skin texture, and reduced need for postoperative non-opioid analgesics[46]. It is even considered a preferred approach for minimally invasive colorectal surgeries[45]. In summary, the selection of incision sites for laparoscopic colorectal surgeries requires careful consideration of multiple factors, including bleeding, IH, SSI, and aesthetics. Horizontal incisions, particularly Pfannenstiel incisions, represent an optimal choice for laparoscopic colorectal surgeries.

Choice and improvement of suturing techniques for closure

The suturing of abdominal wounds is a crucial factor that directly impacts the occurrence of IH. Studies have demonstrated that the use of monofilament sutures can reduce the incidence of IH[47]. Partial fascial closure techniques may increase the risk of postoperative abdominal wall hernia[31]. Hughes abdominal closure experiments have initially shown promise in reducing the risk of IH[48,49], but further clinical validation is still required[50]. Compared to traditional continuous suturing with large bite stitching techniques, the small bite technique has been shown to lower the high risk of IH at midline incisions. Additionally, it can reduce the incidence of high-risk factors such as SSI and abdominal ruptures[51,52].

The type of suture material used is also associated with the occurrence of IH. The employment of absorbable sutures has been shown to reduce the risk of fistula and sinus tract formation[47]. Advances in suture material, such as the use of polyurethane and barbed polydioxanone elastomeric sutures, have been found to enhance collagen type I deposition at the wound site, thereby decreasing the incidence of IH[53].

Prophylactic mesh implantation

The favorable outcomes of prophylactic mesh implantation in reducing IH formation have led to its widespread adoption and endorsement, particularly in surgeries and sites with a high incidence of IH[54]. Following closure of an abdominal stoma, 30%-80% of patients experience IH at the stoma closure site[55,56], which is associated with factors such as high BMI, anastomotic hernia, diabetes, colostomy, trocar site, and malignancy surgeries[57,58]. Preventive biologic mesh implantation during closure of an abdominal stoma can strengthen the abdominal wall, thereby safely reducing the occurrence of IH[59,60]. Prophylactic mesh implantation also effectively mitigates the high incidence of IH following midline laparotomies[61,62], and decreases the risk of IH in obese patients by 80%[63,64]. This approach not only minimizes the risks associated with high-risk factors for IH[65] but also preserves the surgical outcomes without any compromise[54]. The safety of prophylactic mesh use has been confirmed in both elective and emergency surgeries, alleviating surgeons' concerns about potential complications such as local infection, intestinal obstruction, fistula, or mesh erosion[66,67].

Stapled mesh stoma reinforcement technique

The stapled mesh stoma reinforcement technique (SMART) enhances the idea of using prophylactic mesh insertion for strengthening wounds by using new technology breakthroughs. It utilizes two circular staplers of varying sizes to accommodate different stoma positions, allowing for accurate cutting of fascia and mesh. The mesh is then stapled securely to the muscular abdominal wall and its edges are attached to the deep fascia[68]. This technology has demonstrated a significant reduction in the occurrence of IH while maintaining biological safety[56,69]. SMART cleverly circumvents issues associated with prophylactic mesh implantation, including prolonged mesh placement and fixation time, as well as laparoscopic surgical difficulties[69], thereby facilitating ease of operation and wider adoption. Furthermore, SMART mitigates complications associated with mesh implantation, such as infection, retraction, stenosis, erosion, and fistula formation[56,70]. Nevertheless, further randomized controlled trials, long-term follow-ups, and extensive data analysis are required to confirm the effectiveness and indications of SMART.

Discovery and identification of predictive biomarkers for IH

The detection and identification of biomarkers offer significant assistance in assessing the risk of IH. Calaluce *et al*[71] conducted a genome-wide microarray analysis, revealing expression differences in 174 genes in the skin and fascia of patients with non-IH and recurrent IH postoperatively. Notably, eight genes, including *PCOLCE2, COL1A1*, and *COL3A1*, directly involved in collagen synthesis, further confirm the decrease in collagen I/III ratio in the skin and fascia of patients with IH[72]. Additionally, Böhm *et al*[73] employed antibody microarrays to identify 25 proteins with differential expression levels in the preoperative plasma of patients with IH, related to wound healing, inflammatory factors, and cell adhesion. When stable and highly specific biomarkers become commonly used, they will offer a more accurate and personalized prediction of IH risk, surpassing the existing dependence on high-risk factor evaluations.

Establishment of prediction model for IH

The development of an accurate abdominal IH risk prediction model holds promise for IH prevention and management. Veljkovic *et al*[74] employed a logistic linear regression model to integrate four independent predictors of IH risk: The ratio of fascia suture length to incision length, SSI, suture removal time, and BMI. They created an IH risk scoring system formula [p (%) = 32 (suture to incision ratio) + 30 (SSI) + 9 (time) + 2 (BMI)], dividing the risk of IH into three levels. Additionally, Goodenough *et al*[75] used Cox regression to derive hazard ratios and converted them into points to create the HERNIA score. They stratified IH patients using the HERNIA score = 4 (laparotomy) + 3 (hand-assisted laparoscopy) + 1 (chronic obstructive pulmonary disease) + 1 (BMI ≥ 25). Basta *et al*[4,76] has been dedicated to establishing and refining IH models[4,76,77]. Ultimately incorporating smoking and relevant medical history as risk factors, they used beta coefficients to weight 16 variables, resulting in the Penn Hernia Calculator, a specific IH prediction tool with excellent risk discrimination ability (*C*-statistic = 0.76-0.89)[4]. Amro *et al*[35] further validated the Penn Hernia Calculator in clinical practice, demonstrating its wide applicability and potential for facilitating the monitoring and management of high-risk IH populations.

Currently, the majority of prediction models lack independent clinical validation and statistical data elaboration, leading to limited calibration, discrimination, and feasibility[77]. It is crucial to broaden the incorporation of high-risk factors or biomarkers, and enhance and improve the clinical implementation and verification of these models. Ultimately, our objective is to develop and promote an integrated, real-time risk assessment tool for surgery and nursing[4] that is tailored for healthcare professionals in surgical settings.

Other factors

Intraoperative protection, postoperative treatment, and postoperative care are paramount in safeguarding the surgical site from contamination. This prevents the occurrence of SSI, which can lead to a 16.7% reduction in iatrogenic abdominal wall defects[2,78,79]. Furthermore, laparoscopic repair techniques have been shown to decrease both the rate of postoperative SSI and the recurrence of IH[80].

While single-incision laparoscopic surgery (SILS) offers the advantage of reduced abdominal wall trauma and improved cosmetic outcomes[81], studies indicate that the risk of developing IH is three times higher with SILS compared to traditional laparoscopic procedures[82], particularly when the umbilicus is used as the incision site[83]. Special consideration should be given to individuals at high risk for laparoscopic IH, and surgical choices including minimally invasive methods should be approached with great care.

The long-term non-oncological outcomes of laparoscopic colorectal surgery, particularly IH, have received limited attention despite their significant burden on societal medical resources. Preventing IH is crucial as it can significantly reduce the physical and economic toll associated with hernia repair[6]. There is an urgent need to identify the risk factors for IH and the technical issues related to their formation rate, enabling clinicians to identify high-risk patients and implement targeted prevention and follow-up strategies more effectively. It is recommended that Fan *et al*'s research[8] incorporate smoking, postoperative treatment regimens, and weight changes[30-32] into risk analysis and leverage these multiple high-risk factors to create a IH model tailored to the local context. Validating this model through rich clinical resources can help fill the clinical gap in precise prevention of IH.

CONCLUSION

IH remains a significant complication after laparoscopic colorectal surgery. Given its challenging treatment and high recurrence rate, this editorial underscores the imperative of preventing IH and summarizes measures to do so. Notably, the identification and prevention of high-risk groups, as well as the optimization of surgical techniques and patient management, hold paramount importance in reducing the risk of IH and alleviating the associated healthcare burden.

FOOTNOTES

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