

Original Research Article

Influence of Suture Materials on Incisional Hernia Rate after Laparoscopic Colorectal Cancer Surgery: A Propensity Score Analysis

Akira Iwaya, Toshiyuki Yamazaki, Hitoshi Kameyama, Hiroaki Uehara, Motoharu Hirai, Masaru Komatsu, Akira Kubota, Tomohiro Katada, Kazuaki Kobayashi, Daisuke Sato, Naoyuki Yokoyama and Shirou Kuwabara

Department of Digestive Surgery, Niigata City General Hospital, Niigata, Japan

Abstract

Objectives: Incisional hernia is a common problem after colorectal surgery, and a laparoscopic approach does not reduce the incisional hernia rate. Previous reports have described the risk factors for incisional hernia; however, the impact of suture materials remains unclear. As such, this study compared the incisional hernia rate using different suture materials for abdominal wall closure after laparoscopic colorectal cancer surgery.

Methods: Patients undergoing laparoscopic colorectal cancer surgery between January 2014 and December 2016 were included in this study. We separated patients into the following two groups based on the suture materials used for abdominal wall closure: (1.) fast-absorbable group and (2.) non-absorbable group. The primary outcome was incisional hernia rate that was diagnosed using computed tomography. We compared outcomes between these two groups using propensity score matching.

Results: Before matching, 394 patients were included (168 in the fast-absorbable group and 226 in the non-absorbable group). After one-to-one matching, patients were stratified into the fast-absorbable group (n = 158) and the non-absorbable group (n = 158). The incisional hernia rate was higher in the fast-absorbable group than in the non-absorbable group (13.9% vs. 6.3%; P = 0.04). The median time to develop an incisional hernia was significantly shorter in the fast-absorbable group (6.7 months vs. 12.3 months; P < 0.01). The incidence of surgical site infection was not different between the two groups, but the incidence of suture sinus was lower in the fast-absorbable group (0% vs. 5.1%; P < 0.01).

Conclusions: The use of fast-absorbable sutures may increase the risk of incisional hernia after laparoscopic colorectal cancer surgery.

Keywords

incisional hernia, laparoscopic colorectal surgery, suture materials

J Anus Rectum Colon 2021; 5(1): 46-51

Introduction

Incisional hernia is a common problem with colorectal resection. Although a reduction in the incisional hernia rate was expected in minimally invasive surgery, several recent studies have shown that the rate of incisional hernia is similar between laparoscopic and open colorectal surgery[1-3].

Incisional hernia causes various problems such as abdominal pain, poor cosmetic appearance, incarceration, and need for re-operation[4,5]. The risk factors for incisional hernia after open or laparoscopic colorectal surgery have previously been described and include body mass index (BMI), sex, smoking, diabetes mellitus, wound infection, and midline incision[6-11]. The influence of suture materials on the inci-

sional hernia rate after abdominal wall closure remains unclear, and most studies have been conducted on open surgery rather than laparoscopic surgery. As such, this study aimed to compare the incisional hernia rate between fast-absorbable and non-absorbable sutures for abdominal wall closure after laparoscopic colorectal cancer surgery.

Methods

A retrospective analysis of 515 consecutive patients who underwent laparoscopic colorectal cancer surgery in our hospital between January 2014 and December 2016 was performed. From January 2014 until March 2015, we used fast-absorbable sutures (1-0 polyglycolic acid) for abdominal wall closure, and from April 2015 until December 2016, we used non-absorbable sutures (1-0 nylon braid). In all surgeries, a midline mini-laparotomy was performed at the vertical transumbilical incision. The incision length was decided on the basis of the tumor size, and a wound protector was used at the extraction site. The method of abdominal wall closure was an interrupted single-layer fascia suture using fast-absorbable or non-absorbable sutures. Postoperative computed tomography (CT) was performed every 6 months after laparoscopic colorectal cancer surgery for cancer surveillance. Exclusion criteria included conversion to an open approach, surgery without transumbilical specimen extraction, and patients who could not be followed up with CT for more than 12 months.

Medical records were reviewed to collect data, including demographic information, diagnosis, comorbidities, history of smoking, use of steroids, BMI, tumor size, American Society of Anesthesiologists (ASA) grade, surgical site infection (SSI), suture sinus, and incisional hernia. CT was reviewed by two surgeons, and incisional hernia was retrospectively diagnosed on CT if there were findings of dehiscence in the abdominal fascia and prolapsed peritoneum or intestine. SSI was diagnosed by the latest Centers for Disease Control criteria. Microabscess or chronic granulomatous inflammation that resolved upon removal of the suture-knot was diagnosed as a suture sinus. The follow-up period was defined as the time from surgery to the last evaluation by CT.

The ethics committee of Niigata City General Hospital approved this study with a waiver of informed consent due to its retrospective nature.

We separated patients into two groups: (1.) fast-absorbable group and (2.) non-absorbable group. A propensity score matching model was performed to reduce covariate imbalance between the groups. A logistic regression analysis was performed to estimate the propensity score of each patient using the covariates, including sex, age, ASA grade, BMI, chronic obstructive pulmonary disease (COPD), diabetes mellitus, steroid use, history of smoking, and tumor

size. To identify the best non-absorbable group patient for each individual fast-absorbable group patient, a nearest neighboring matching method was performed. Comparative analyses of the patients in the fast-absorbable and non-absorbable groups were performed on one-to-one matching. Continuous variables were presented as medians (ranges). The Mann-Whitney U test was used for comparing non-parametric data. Fisher's exact test was used for comparing categorical data. We used the Kaplan-Meier method to assess the cumulative incidence of incisional hernia, and the difference in the curve was examined using the log-rank test. Statistical significance was defined as $P < 0.05$. All analyses were carried out using EZR[12], which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria).

Results

During the study period, 515 patients underwent laparoscopic colorectal cancer surgery. Of these, 121 patients were excluded after data collection. Before matching, 394 patients (168 in the fast-absorbable group and 226 in the non-absorbable group) matched the inclusion criteria. After propensity score matching, the patients were stratified into the fast-absorbable group ($n = 158$) and the non-absorbable group ($n = 158$) (Figure 1). The baseline characteristics of the overall and matched cohorts of patients included in the fast-absorbable and non-absorbable groups are summarized in Table 1. Before matching, the follow-up period was significantly longer in the fast-absorbable group. After matching, there was no statistically significant difference in sex, age, ASA grade, BMI, steroid use, history of smoking, tumor size, and follow-up period. Patients with COPD and diabetes mellitus were slightly more frequent in the fast-absorbable group, but there was no statistically significant difference. The cancer stage was also examined, but there was no statistically significant difference between the two groups. The median follow-up was 44.6 months for the fast-absorbable group and 48.0 months for the non-absorbable group.

The incidence of SSI, suture sinus, and incisional hernia are shown in Table 2. Twenty-two patients (13.9%) developed an incisional hernia in the fast-absorbable group compared with 10 patients (6.3%) in the non-absorbable group ($P = 0.04$). The median time to develop an incisional hernia was significantly shorter in the fast-absorbable group (6.7 months vs. 12.3 months; $P < 0.01$). The incidence of SSI was not significantly different between the two groups; however, the incidence of suture sinus was lower in the fast-absorbable group than in the non-absorbable group (0% vs. 5.1%; $P < 0.01$).

Figure 2 shows the cumulative incidence curve of incisional hernias. After 5 years, the cumulative incidence of in-

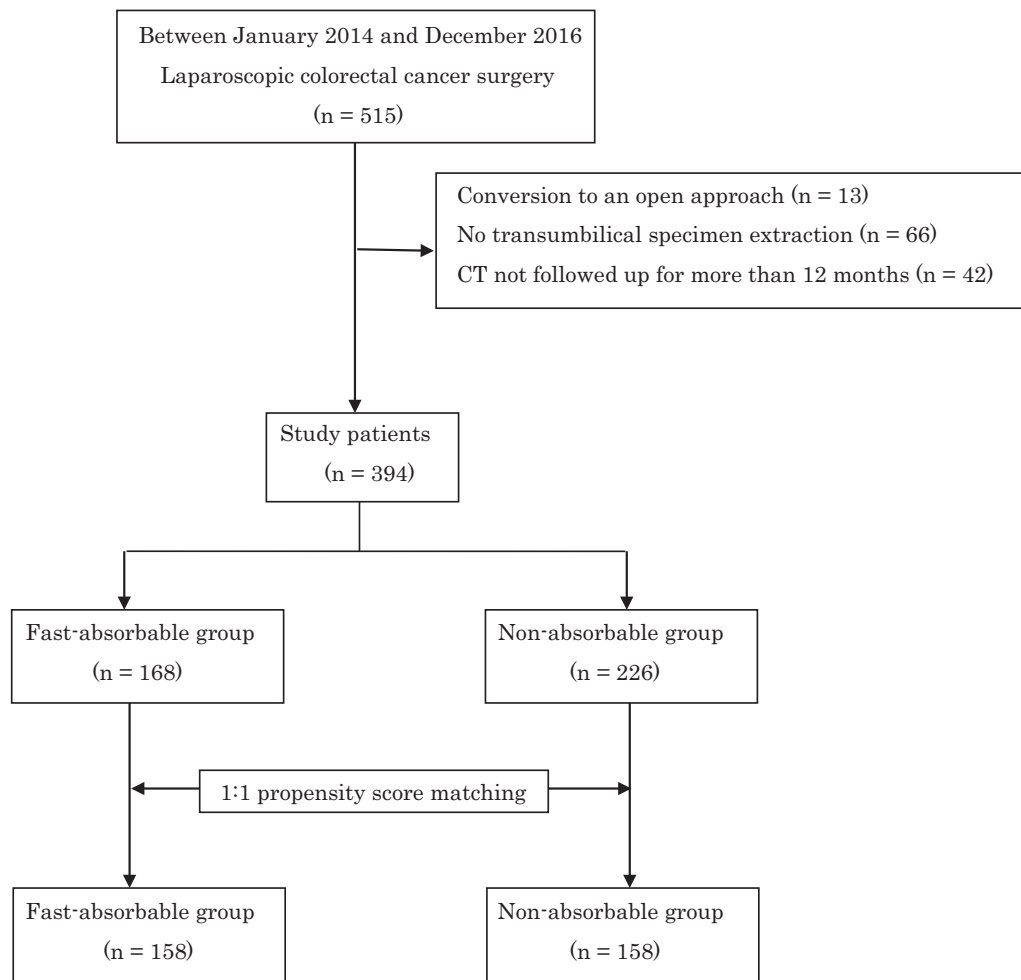


Figure 1. Flowchart of patient selection.

Table 1. Patient Demographics in the Two Groups.

	Overall cohort			Matched cohort		
	Fast-absorbable group (n = 168)	Non-absorbable group (n = 226)	P value	Fast-absorbable group (n = 158)	Non-absorbable group (n = 158)	P-value
Age*	67 (39-97)	67 (30-89)	0.97	66 (39-97)	67 (30-89)	0.66
Gender (Male/Female)	103/65	131/95	0.50	96/62	93/65	0.82
ASA grade (I/II/III)	29/130/9	49/161/16	0.38	28/122/8	34/115/9	0.64
Body mass index (kg/m ²) *	23.5 (16.5-38.7)	23 (12.6-34.6)	0.47	23.5 (16.5-29.6)	23.3 (15.7-34.6)	0.57
COPD	8 (4.8%)	17 (7.5%)	0.26	7 (4.4%)	5 (3.2%)	0.77
Diabetes mellitus	36 (21.4%)	39 (17.3%)	0.48	31 (19.6%)	28 (17.7%)	0.77
Steroid use	4 (2.4%)	5 (2.2%)	0.91	4 (2.5%)	4 (2.5%)	1.00
History of smoking	85 (50.6%)	128 (56.6%)	0.23	83 (52.5%)	83 (52.5%)	1.00
Tumor size (mm) *	36 (6-104)	35 (0-95)	0.21	35 (6-104)	35.5 (0-95)	0.93
Follow-up period (months) *	43.8 (3.5-68.8)	43.0 (11.1-60.3)	0.02	44.6 (3.5-68.8)	48.0 (11.1-60.3)	0.11

*Median (range)

ASA: American Society of Anesthesiologists

COPD: Chronic Obstructive Pulmonary Disease

Table 2. Comparison of Outcomes between the Two Groups after Matching.

	Fast-absorbable group (n = 158)	Non-absorbable group (n = 158)	P-value
Incisional hernia	22 (13.9%)	10 (6.3%)	0.04
Months to hernia diagnosis*	6.7 (3.5-30.8)	12.3 (11.1-29.4)	<0.01
Surgical site infection	2 (1.3%)	1 (0.6%)	>0.99
Suture sinus	0	8 (5.1%)	<0.01

*Median (range)

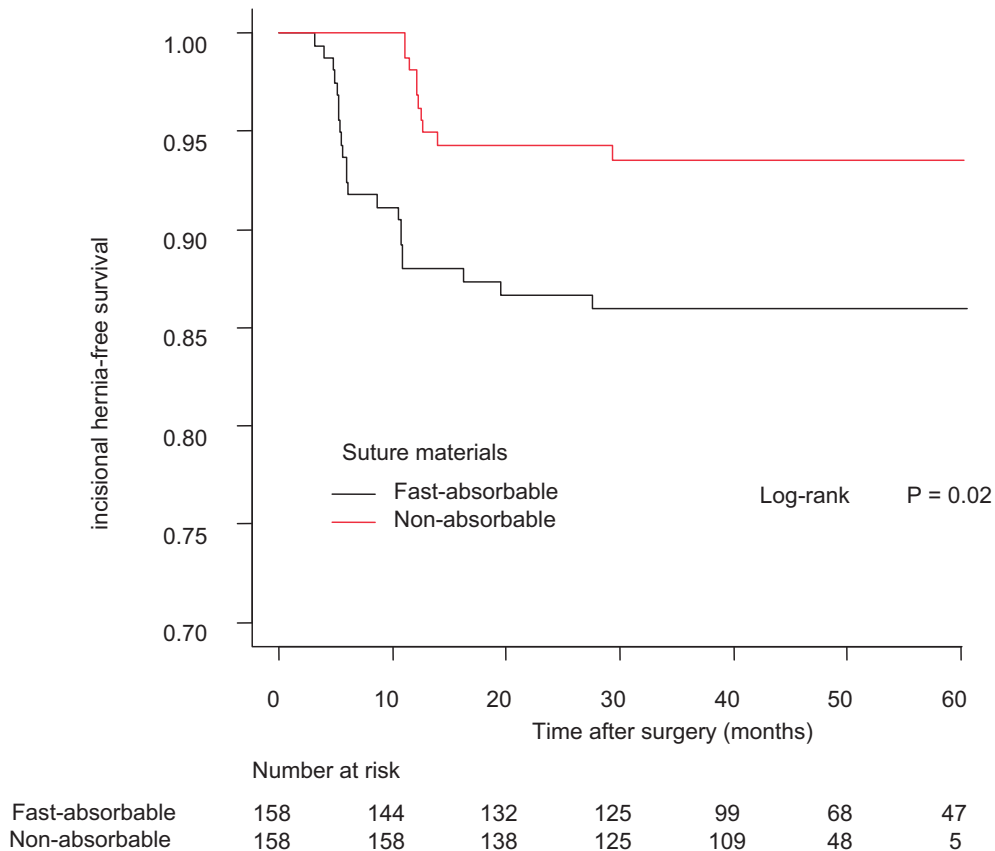


Figure 2. Kaplan-Meier analysis for incisional hernia free-survival.

incisional hernias was higher in the fast-absorbable group than in the non-absorbable group (14.1% vs. 6.5%; P = 0.02). The Kaplan-Meier curve also showed that most incisional hernias developed within 2 years after surgery in both groups. Of the patients with incisional hernia diagnosed by CT in both groups, 15 patients (46.9%) complained of symptoms at the time of diagnosis. Only 4 patients (12.5%) underwent hernia repair.

Discussion

Several recent studies have shown that laparoscopic colorectal surgery did not reduce the incisional hernia rate compared with open surgery[1-3]. A midline mini-

laparotomy is commonly performed for extracting specimens in laparoscopic colorectal surgery; however, the incisional hernia rate in midline mini-laparotomies has been reported to be nearly 20%[13,14]. In this study, the incisional hernia rate after laparoscopic colorectal cancer surgery was comparable with the rates of recent studies.

Previous studies have reported various risk factors for incisional hernia during colorectal surgery[6-11]. One previous report questioned whether using non-absorbable or absorbable sutures could prevent incisional hernias[15]. Absorbable sutures may increase the risk of the sutures losing strength before the underlying fascia has sufficiently recovered its structural integrity[15]. Polyglycolic acid sutures keep strength for about 3-4 weeks and are completely absorbed

within 60 days. In this study, the incisional hernia rate was higher in the fast-absorbable group (13.9% vs. 6.3%; $P = 0.04$). Moreover, the median time to develop an incisional hernia was significantly shorter in the fast-absorbable group (6.7 months vs. 12.3 months; $P < 0.01$). These observations may be related to thread absorption. In 2015, a guideline for abdominal wall closure was published from the European Hernia Society[16]. This guideline recommended the avoidance of fast-absorbable sutures and suggested the use of a slowly-absorbable monofilament sutures. On the other hand, it was reported that nylon sutures reduced the incisional hernia rate compared with both fast-absorbable and slowly-absorbable sutures[17]. The best suture material for preventing incisional hernia remains unclear. Also, suture materials have so far been studied in the case of open laparotomy, but not in the case of laparoscopic surgery. To our knowledge, this is the first report to study the influence of suture materials on the incisional hernia rate after laparoscopic colorectal surgery.

In this study, incisional hernia was diagnosed not only by physical findings but also by CT criteria. It was reported that as much as 30% of incisional hernia cases are missed when the diagnosis was based solely on physical findings [18,19]. In this study, patients routinely underwent CT for cancer surveillance, so identifying incisional hernia by both clinical and CT criteria were feasible.

In this study, there was no difference in the incidence of SSI between the fast-absorbable and non-absorbable groups. However, the incidence of suture sinus was lower in the fast-absorbable group than in the non-absorbable group (0% vs. 5.1%; $P < 0.01$). All suture sinuses resolved promptly when the suture-knots were removed. However, patients may be slightly uncomfortable until the suture sinus heals. In the future, we would like to compare the difference in the incidence of incisional hernias and suture sinuses between non-absorbable and slowly-absorbable sutures after laparoscopic colorectal cancer surgery.

One limitation of this study is the difference in follow-up time between the two groups. In a postoperative cohort study of 564 patients with a 10-year follow-up, Mudge et al. reported that 79% of incisional hernias were detected within 36 months[20]. The median follow-up period for both groups was more than 3 years in this study, and the incisional hernia rate did not seem to be influenced by the follow-up duration. Another limitation includes the retrospective nature of our analysis and the potential of selection bias. To control for selection bias, we used propensity score matching.

In conclusion, incisional hernias after laparoscopic surgery for colorectal cancer are relatively common, and the use of fast-absorbable sutures may increase this risk.

Conflicts of Interest

There are no conflicts of interest.

Author Contributions

A. Iwaya reviewed the patient's medical records and the scientific literature and wrote the manuscript. T. Yamazaki supervised and critically reviewed the manuscript. All other authors critically reviewed and approved the final version of the manuscript.

Approval by Institutional Review Board (IRB)

The ethics committee of Niigata City General Hospital approved this study.

IRB number: 20-049

References

1. Braga M, Frasson M, Vignali A, et al. Laparoscopic vs. open colectomy in cancer patients: long-term complications, quality of life, and survival. *Dis Colon Rectum*. 2005 Dec; 48(12): 2217-23.
2. Llaguna OH, Avgerinos DV, Lugo JZ, et al. Incidence and risk factors for the development of incisional hernia following elective laparoscopic versus open colon resections. *Am J Surg*. 2010 Aug; 200(2): 265-9.
3. Kössler-Ebs JB, Grummich K, Jensen K, et al. Incisional hernia rates after laparoscopic or open abdominal surgery—a systematic review and meta-analysis. *World J Surg*. 2016 Oct; 40(10): 2319-30.
4. O'Dwyer PJ, Courtney CA. Factors involved in abdominal wall closure and subsequent incisional hernia. *Surgeon*. 2003 Feb; 1(1): 17-22.
5. Lee L, Mappin-Kasirer B, Sender Liberman A, et al. High incidence of symptomatic incisional hernia after midline extraction in laparoscopic colon resection. *Surg Endosc*. 2012 Nov; 26(11): 3180-5.
6. Sabajo CR, Olthof PB, Roos D, et al. Incisional hernia after laparoscopic-assisted right hemicolectomy. *World J Surg*. 2019 Dec; 43(12): 3172-8.
7. Sadava EE, Kerman Cabo J, Carballo FH, et al. Incisional hernia after laparoscopic colorectal surgery. Is there any factor associated? *Surg Endosc*. 2014 Dec; 28(12): 3421-4.
8. Yamamoto M, Takakura Y, Ikeda S, et al. Visceral obesity is a significant risk factor for incisional hernia after laparoscopic colorectal surgery: A single-center review. *Asian J Endosc Surg*. 2018 Nov; 11(4): 373-7.
9. Drosdeck J, Harzman A, Suzo A, et al. Multivariate analysis of risk factors for surgical site infection after laparoscopic colorectal surgery. *Surg Endosc*. 2013 Dec; 27(12): 4574-80.
10. Lee L, Mata J, Droscher RA, et al. Incisional hernia after midline versus transverse specimen extraction incision: A randomized trial in patients undergoing laparoscopic colectomy. *Ann Surg*. 2018 Jul; 268(1): 41-7.
11. Lee L, Abou-Khalil M, Liberman S, et al. Incidence of incisional hernia in the specimen extraction site for laparoscopic colorectal surgery: Systematic review and meta-analysis. *Surg Endosc*. 2017 Dec; 31(12): 5083-93.
12. Kanda Y. Investigation of the freely available easy-to-use software 'EZ R' for medical statistics. *Bone Marrow Transplant*. 2013 Mar; 48(3): 452-8.
13. Widmar M, Keskin M, Beltran P, et al. Incisional hernias after la-

- paroscopic and robotic right colectomy. *Hernia*. 2016 Oct; 20(5): 723-8.
14. Singh R, Omiccioli A, Hegge S, et al. Does the extraction-site location in laparoscopic colorectal surgery have an impact on incisional hernia rates? *Surg Endosc*. 2008 Dec; 22(12): 2596-600.
 15. Patel SV, Paskar DD, Nelson RL, et al. Closure methods for laparotomy incisions for preventing incisional hernias and other wound complications. *Cochrane Database Syst Rev*. 2017 Nov; 11(11): CD005661.
 16. Muysoms FE, Antoniou SA, Bury K, et al. European Hernia Society guidelines on the closure of abdominal wall incisions. *Hernia*. 2015 Feb; 19: 1-24.
 17. Zucker BE, Simillis C, Tekkis P, et al. Suture choice to reduce occurrence of surgical site infection, hernia, wound dehiscence and sinus/fistula: A network meta-analysis. *Ann R Coll Surg Engl*. 2019 Mar; 101(3): 150-61.
 18. Baucom RB, Beck WC, Holzman MD, et al. Prospective evaluation of surgeon physical examination for detection of incisional hernias. *J Am Coll Surg*. 2014 Mar; 218: 363-6.
 19. Naguib N, Rafique H, Dhruva Rao PK, et al. A review of the incidence of iatrogenic hernia in both laparoscopic and open colorectal surgery: Using CT as the gold standard of detection, cohort study. *Int J Surg*. 2015 Jul; 19: 87-90.
 20. Mudge M, Hughes LE. Incisional hernia: A 10 year prospective study of incidence and attitudes. *Br J Surg*. 1985 Jan; 72(1): 70-1.

Journal of the Anus, Rectum and Colon is an Open Access journal distributed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. To view the details of this license, please visit (<https://creativecommons.org/licenses/by-nc-nd/4.0/>).