ORIGINAL ARTICLE
pISSN 2234-778X • eISSN 2234-5248
J Minim Invasive Surg 2021;24(2):84-90

JMIS Journal of Minimally Invasive Surgery

Incisional hernia after minimally invasive gastrectomy in gastric cancer patients

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Purpose: Although there are several studies on the incidence and risk factors for incisional hernia (IH) after open surgery, data about IH after minimally invasive surgery (MIS) for gastric cancer is rare. This study aimed to identify the incidence and risk factors for IH after MIS in gastric cancer patients.

Methods: We analyzed the clinicopathologic data of patients who had laparoscopic or robotic gastric cancer surgeries between January 2006 and July 2019 at National Cancer Center, South Korea. Risk factors for development of IH were investigated with univariate and multivariate analyses.

Results: A total of 2,769 patients underwent laparoscopic-assisted or robot-assisted gastrectomy with extracorporeal gastric resection and reconstruction, while 1,469 underwent totally laparoscopic or totally robotic gastrectomy (TLRG) with intracorporeal gastric resection and reconstruction. IH repair was performed in 23 patients (0.5%) after gastric cancer surgery. In the multivariate analysis, female sex (odds ratio [OR], 5.23; 95% confidence interval [CI], 2.03–13.43; $p = 0.001$), high body mass index (BMI) of ≥25 kg/m^2 (OR, 4.23; 95% CI, 1.73–10.35; $p = 0.002$), larger tumor size (OR, 21.67; 95% CI, 5.37–87.34; $p < 0.001$), and intracorporeal procedure (OR, 5.63; 95% CI, 2.15–14.61; $p < 0.001$) were independent significant risk factors for IH.

Conclusion: IH after MIS for gastric cancer is not common. Female sex, high BMI, large tumor size, and intracorporeal procedure were significant risk factors for it in this study. Therefore, in patients with risk factors, surgeons should cautiously close the abdominal wall access wound after MIS for gastric cancer, to prevent IH.

Keywords: Stomach neoplasms, Minimally invasive surgical procedures, Incisional hernia

Received September 10, 2020
Revised 1st October 28, 2020
2nd November 12, 2020
3rd November 13, 2020
Accepted November 13, 2020

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INTRODUCTION

Incisional hernia (IH) is a common long-term complication after abdominal surgery. Its incidence rate after midline laparotomy ranges widely from 9% to 20% [1–3]. Since it uses smaller incisions than open surgery, laparoscopic surgery has many advantages such as reduced blood loss, less pain, and faster recovery, and it is being gradually used in a wide range of applications [4–6]. Furthermore, a systematic review and meta-analysis showed that the rate of IH after laparoscopic surgery is significantly lower than after open surgery [7].

Recently, laparoscopic gastrectomy has become more widely used for gastric cancer surgery. Several large-scale randomized clinical trials that compared laparoscopic gastrectomy and open gastrectomy in gastric cancer patients showed the non-inferiority of laparoscopic surgery with regard to short-term and long-term

surgical outcomes [8–10]. Initially, laparoscopic-assisted gastrectomy (LAG), with extracorporeal gastric resection and reconstruction through additional minilaparotomy incision, was mainly performed. However, nowadays, advancement in laparoscopic surgical equipment and surgical technique has led to increased use of totally laparoscopic gastrectomy (TLG), with intracorporeal gastric resection and reconstruction, and specimen removal through extension of umbilical port. TLG has several advantages over LAG, including smaller wounds and less invasiveness [11,12]. Furthermore, robotic surgery is also performed as a modality of minimally invasive surgery (MIS), and the number of cases managed this way has recently increased [13,14].

Several variables, such as specimen extraction site, high body mass index (BMI), and comorbidity, have been identified as independent risk factors associated with IH after laparoscopic colorectal surgery [15–17]. However, studies about the incidence and risk factors for IH after MIS for gastric cancer are few.

The purpose of this study was to identify the incidence rate and risk factors for IH after MIS in gastric cancer patients.

MATERIALS AND METHODS

Study design

This study was a retrospective case-control study. We analyzed the clinicopathologic data of gastric cancer patients who had laparoscopic or robotic gastric cancer surgeries between January 2006 and July 2019 in National Cancer Center, South Korea. Patients were divided into two groups depending on occurrence of IH after the gastric cancer surgery. Risk factors for development of IH in these patients were investigated by univariate and multivariate analyses.

Surgical procedures

In this study, two types of surgery were defined as extracorporeal or intracorporeal procedure, depending on gastric resection and reconstruction method. Laparoscopic or robot-assisted gastrectomy (LRAG) consisted of gastric resection and specimen removal and reconstruction through additional minilaparotomy, and it included distal gastrectomy, total gastrectomy, proximal gastrectomy, and pylorus-preserving gastrectomy [18]. Totally laparoscopic or robotic gastrectomy (TLRG) consisted of intracorporeal gastric resection and reconstruction, and the specimen was removed by extension of the umbilical port; it included the same types of gastrectomy as are done in extracorporeal anastomosis. In extracorporeal procedure, we made one camera port at the umbilicus and four trocar ports at the left upper quadrant, left lower quadrant, right upper quadrant, and right lower quadrant. All surgical procedures for dissection, except gastric resection and reconstruction and specimen extraction, were performed using laparoscopy or robotics. Surgeons performed additional vertical or transverse minilaparotomy in the epigastric area for gastric resection, specimen extraction, and extracorporeal anastomosis. In intracorporeal procedure, port sites were the same as for extracorporeal anastomosis, but surgeons performed a minilaparotomy by extending the umbilical port site instead of making another epigastric incision. All surgical procedures, including gastric resection and reconstruction, were performed intracorporeally, and the specimen was extracted through the minilaparotomy.

The minilaparotomy incisions of LRAG and umbilical extension wounds of TLRG were closed either layer by layer or as one layer, using absorbable suture materials such as Vicryl (Ethicon, Somerville, NJ, USA) or Maxon (Medtronic, Minneapolis, MN, USA), and with continuous or simple interrupted suture technique according to each surgeon's preference.

Statistical analysis

For the BMI, we divided the group by <25 kg/m^2 and ≥25 kg/m^2. And for the tumor size, we divided the group by <10 cm and ≥10 cm. In general, statistical analysis was performed based on the median or mean tumor size, but we considered the clinically meaningful size as 10 cm and analyzed it based on this.

Continuous variables were evaluated with Student *t* test. Categorical data were compared with chi-square test or Fisher exact test. Multivariate analysis of risk factors for IH was performed with logistic regression.

All analyses were performed with SAS version 9.1.3 for Windows (SAS Institute, Cary, NC, USA). The *p* values of <0.05 were considered statistically significant.

RESULTS

Between January 1, 2006 and July 31, 2020, 4,238 patients underwent laparoscopic or robotic gastric cancer surgery in the study center. Among them, 2,769 underwent LRAG, while 1,469 underwent TLRG. IH repair was performed in 23 patients (0.5%) after gastric cancer surgery, with median follow-up period of 43 months.

The baseline clinicopathologic characteristics of enrolled patients are shown in Table 1. Male patients were dominant in the non-IH group (n = 2,608, 61.9%), while female patients were dominant in the IH group (n = 17, 73.9%). Median BMI was 23.9 kg/m^2 in non-IH group and 26.6 kg/m^2 in IH group. Median age was 59.1 years in non-IH group and 61.3 years in IH group. The incidence rates of IH in extracorporeal and intracorporeal procedures were 0.2% and 1%, respectively (n = 8 and n = 15, respectively; $p = 0.002$). The median interval from gastric cancer

Table 1. Demographics of enrolled patients

Variable	Non-IH group	IH group	*p* value
No. of patients	4,215	23	
Age (yr)	59.1 ± 12.0	61.3 ± 13.4	0.367
Sex			<0.001
Male	2,608 (61.9)	6 (26.1)	
Female	1,607 (38.1)	17 (73.9)	
Body mass index (kg/m^2)	23.9 ± 3.3	26.6 ± 4.4	<0.001
ASA PS classification			0.849
I	1,433 (34.0)	7 (30.4)	
II	2,543 (60.3)	15 (65.2)	
≥III	239 (5.7)	1 (4.3)	
Tumor size (cm)	3.29 ± 2.0	4.5 ± 3.4	<0.001
Histology			0.222
WD	774 (18.4)	2 (8.7)	
MD	751 (17.8)	5 (21.7)	
PD	1,126 (26.7)	4 (17.4)	
SRC	1,506 (35.7)	12 (52.2)	
Other	58 (1.4)	0 (0)	
Pathologic stage			0.914
I	3,680 (87.3)	20 (87.0)	
II	391 (9.3)	2 (8.7)	
III	134 (3.2)	1 (4.3)	
IV	10 (0.2)	0 (0)	
Surgical approach			0.511
Laparoscopic	3,874 (91.9)	22 (95.7)	
Robotic	341 (8.1)	1 (4.3)	
Gastric resection			0.178
PPG	272 (6.5)	0 (0)	
DG	3,416 (81.0)	19 (82.6)	
PG	118 (2.8)	0 (0)	
TG	409 (9.7)	4 (17.4)	
Anastomosis method			0.002
Extracorporeal	2,761 (65.5)	8 (34.8)	
Intracorporeal	1,454 (34.5)	15 (65.2)	
LN dissection			0.016
<D2	1,803 (42.8)	9 (39.1)	
≥D2	2,412 (57.2)	14 (60.9)	
LN harvest	36.0 ± 13.5	39.3 ± 13.1	0.717
Adjuvant chemotherapy	445 (10.6)	3 (13.0)	0.149
Days on admission	8.3 ± 5.9	8.4 ± 3.9	0.934
Postoperative complication[a]	159 (3.8)	2 (8.7)	0.217

Values are presented as number only, mean ± standard deviation, or number (%).
IH, incisional hernia; ASA PS, American Society of Anesthesiologists physical status; WD, well-differentiated; MD, moderately-differentiated; PD, poorly-differentiated; SRC, signet ring cell; PPG, pylorus preserving gastrectomy; DG, distal gastrectomy; PG, proximal gastrectomy; TG, total gastrectomy; LN, lymph node.
[a]Clavien-Dindo classification ≥ 3.

Table 2. Risk factors for incisional hernia after laparoscopic gastric cancer surgery

Variable	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Sex				
Male	1		1	
Female	4.11 (1.55–10.95)	<0.001	5.23 (2.03–13.43)	0.001
Body mass index (kg/m^2)				
<25	1		1	
≥25	3.01 (1.30–6.97)	0.007	4.23 (1.73–10.35)	0.002
Tumor size (cm)				
<10	1		1	
≥10	16.45 (4.69–57.68)	<0.001	21.67 (5.37–87.34)	<0.001
Anastomosis method				
Extracorporeal	1		1	
Intracorporeal	6.74 (2.389–19.02)	0.002	5.63 (2.15–14.61)	<0.001
LN dissection				
<D2	1		1	
≥D2	3.34 (1.11–10.04)	0.016	2.58 (1.05–6.64)	0.050

OR, odds ratio; CI, confidence interval; LN, lymph node.

surgery to IH repair surgery was 14 months (14 ± 12 months).

Table 2 shows univariate and multivariate analyses of risk factors for IH after gastric cancer surgery. Incidence rate of IH was significantly higher among female patients and those who had intracorporeal procedure ($p = 0.001$ and $p < 0.001$, respectively). BMI was significantly higher and tumor size was significantly larger in the IH group ($p = 0.002$ and $p < 0.001$, respectively). In the multivariate analysis, female sex, higher BMI (≥25 kg/m^2), larger tumor size (≥10 cm), and intracorporeal procedure were independent significant risk factors for IH. D2 lymph node dissection was a significant risk factor for IH in univariate analysis, but it was not significantly different between the IH and non-IH groups in multivariate analysis.

Of the patients who had extracorporeal procedure, two had IH in the umbilical area, two in the epigastric area, and five at other port sites. All of the patients who had intracorporeal procedure had IH in the umbilical area (Table 3). Application of mesh during IH repair was based on the surgeon's preference; thus, 14 patients received mesh reinforcement, while nine patients did not. There were two cases of reoperation for IH repair and both occurred in patients who did not have mesh reinforcement during the first hernia repair.

Table 3. Characteristics of incisional hernia in the present study

Variable	Patient (n = 23)
Hernia site	
Laparoscopic or robot-assisted gastrectomy	9
Umbilical area	5 (55.6)
Epigastric area	2 (22.2)
Other port sites	2 (22.2)
Totally laparoscopic or robotic gastrectomy	14
Umbilical area	14 (100)
Other port sites	0 (0)
Mesh application during incisional hernia repair	23
Mesh reinforcement	14 (60.9)
No mesh reinforcement	9 (39.1)
Reoperation of recurrent incisional hernia	2
Mesh reinforcement during the first hernia repair	0 (0)
No mesh reinforcement during the first hernia repair	2 (100)

Values are presented as number (%).

DISCUSSION

MIS is becoming popular for stomach surgeries. Incidence and risk factors for IH after open surgery are well known, but study of IH after MIS for gastric cancer is limited [19–21]. Recently, although not with respect to gastric cancer surgery, there have been reports that IH occurs more frequently in single-incision laparoscopic surgery (SILS) than in laparoscopic surgery using multiple ports [22–26]. This is presumed to be due to the large umbilical port made in SILS. In recent years, TLRG, with intracorporeal gastric resection and reconstruction and specimen removal through extension of the umbilical port, tends to be preferred because it eliminates the need for additional minilaparotomy. Moreover, SILS is also increasingly being attempted by many surgeons. Overall, umbilical port extension is becoming common; and therefore, the risk for IH, especially in the umbilical area, is increasing. However, only few studies have shown tendency of increased IH rate after intracorporeal procedure using extended umbilical incision, especially in gastric cancer surgery [27]. In this present study, it was clearly observed that IH occurred more frequently after intracorporeal procedure than after extracorporeal procedure. Furthermore, incidence rate of IH was significantly higher with female sex, high BMI, and large tumor.

For gastric cancer surgery, high BMI have been shown as risk factors for IH in previous studies [27]. High BMI has also been consistently identified as a risk factor for IH irrespective of the type of surgery, site of operation, and use of open surgery or laparoscopic surgery. The results of our study also support existing studies [27].

Most existing studies evaluated risk factors for IH differently by sex, but a previous study on gastric cancer surgery reported female sex as a significant risk factor [27]. IH through umbilical incision was frequently encountered in this study, but the reason for its high incidence among females is unclear. It is supposed that the fat distribution of females is more accumulated in the subcutaneous layer than in intra-abdominal viscera as found in males. Thick subcutaneous fat of obese female patients therefore makes the closure of fascia difficult and results in IH [28].

Large tumor size was also a significant risk factor for IH in this study. Surgeons attempted to make the smallest possible incisions for extraction of the specimens. The larger the tumor, the larger the specimen, and the longer the incision needed for specimen removal. Hence, extended umbilical incision for removing large specimen during TLRG would have increased the risk of IH [29].

As the result of this study, umbilical wound is more vulnerable to IH than epigastric wound, especially in patients who have risk factors like high BMI, female sex, and large tumor size. Therefore, surgeons should take care to prevent IH in such patients and should be cautious during closure of surgical wound.

Mesh reinforcement could be considered to prevent the recurrence of IH after repair. There were two patients in this study who underwent reoperation due to recurrence of IH after repair. The first patient was 74-year old female patient and she underwent LADG. IH was found at umbilical wound and her BMI was 23.7 kg/m^2. The second operation for recurred hernia was done 6 months after the first hernia operation. The second patient was 52-year old female patient and she underwent TLDG. IH was found at umbilical wound and her BMI was 30.7 kg/m^2. The second operation for recurred hernia was done 1 year after the first hernia operation. In a previous study, mesh reinforcement reduced the recurrence rate of IH [30]. Therefore, surgeons should be mindful of the possibility of IH recurrence and consider mesh reinforcement during hernia repair in order to prevent recurrence.

This study has several limitations. First, it has the inherent limitations of a retrospective study from one center even though the data volume is large; accordingly, some potential risk factors for IH, such as specific suture technique and wound infection, could not be analyzed. Second, diagnosis of and decision to repair IH were up to surgeons' experiences and preferences. Some surgeons opted for surgical hernia repair, while other surgeons decided on observation for similar cases. Therefore, selection bias could have existed, and the number of IH cases could have been underestimated. Third, these results may not accurately represent the real incidence of IH because not all patients were followed up postoperatively in our institution. Fourth, wound infection and suture material or method could affect IH but those were excluded to analyze because of lack of data. It should be included to analyze in further study.

In conclusion, IH after MIS for gastric cancer patients is not very common. Female sex, high BMI, large tumor size, and intracorporeal procedure were significant risk factors for IH after MIS for gastric cancer in this study. Therefore, in patients with risk factors, surgeons should cautiously close the surgical wound after MIS for gastric cancer, in order to prevent IH.

NOTES

Ethical statements

The Institutional Review Board of the National Cancer Center approved this study (No. NCC2020-0182). The study was conducted according to the principles of the Declaration of Helsinki. Informed consent was waived because of the retrospective nature of the study.

Authors' contributions

Conceptualization: SCC, KWR

Formal analysis: All authors
Methodology: SCC, KWR
Writing–original draft: SCC
Writing–review & editing: All authors
All authors read and approved the final manuscript.

Conflict of interest

All authors have no conflicts of interest to declare.

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