Clinical characteristics and surgical outcomes of internal hernia after gastrectomy in gastric cancer patients: retrospective case control study

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Abstract

Background Although the internal hernia is rare after gastric cancer surgery, it is a serious complication, and prompt surgical treatment is essential. However, internal hernia has not been studied because of low incidence and difficulty of diagnosis. This study investigated the clinical characteristics and proper management of internal hernia after gastrectomy.

Methods From June 2001 to June 2016, patients who underwent gastrectomy, either open or laparoscopic (robotic) surgery, with potential internal hernia defect were enrolled. The hernia defect was not closed in any of the enrolled patients. The clinicopathological data of internal hernia patients were compared to patients without internal hernia to identify risk factors. Surgical outcomes of internal hernia were compared between patients who underwent early and late intervention group according to time interval from symptom onset to operation.

Results Of 5777 patients who underwent gastrectomy with possible internal hernia, 24 (0.4%) underwent emergency or scheduled surgery for internal hernia. Internal hernia through the Petersen space was observed in 15 cases, and through the jejunojejunostomy mesenteric defect in 9 cases. Low body mass index (odds ratio [OR] 4.403, $p = 0.003$) and laparoscopic approach (OR 6.930 $p < 0.001$) were statistically significant factors in multivariate analysis. Postoperative complication rate (16.7% vs. 50% $p = 0.083$) and mortality rate (8.3% vs. 25.0% $p = 0.273$) were slightly higher in the late intervention group.

Conclusions Although internal hernia is a rare complication, it is difficult to diagnose and cause serious complications. To prevent internal hernia, the necessity of hernia defect closure should be investigated in the further studies. Early surgical treatment is necessary when it is suspected.

Keywords Gastric cancer · Gastrectomy · Internal hernia · Petersen's hernia · Mesenteric defect

Laparoscopic surgery is becoming more frequent in gastric cancer because of similar surgical outcomes and better quality of life in comparison with open surgery [1, 2]. Unlike open surgery, laparoscopic surgery has the advantage of less adhesion than laparotomy, because it manipulates or dissects tissues using an instrument and affects less of the intestine and mesentery [3, 4]. However, this decreased adhesion may increase the incidence of internal hernia, due to active

movement of the small bowel through defects after gastrectomy and reconstruction. In several reports, laparoscopic gastrectomy had a higher incidence of internal hernia than open gastrectomy [5, 6].

Total or distal subtotal gastrectomy with Roux-en-Y anastomosis makes two potential hernia spaces. One is the defect between the Roux limb and the transverse colon, the so-called Petersen space, and the other is the mesenteric defect around the jejunojejunostomy. Gastrojejunostomy, or Billroth II anastomosis, may make a Petersen space after distal subtotal gastrectomy between the jejunal loop and transverse colon [7, 8]. Internal hernia can occur through these two potential spaces after gastrectomy and reconstruction after gastric cancer.

There are few studies on internal hernia after gastric cancer surgery. Several studies reported that the incidence of internal hernia ranges from 0.19 to 5%, but most included

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only a small number of patients with Roux-en-Y anastomosis because internal hernia is a rare complication [5, 9–11]. Therefore, the characteristics and proper management of internal hernia have not been well clarified.

This study aimed to identify the characteristics and risk factors of internal hernia after total or subtotal gastrectomy in gastric cancer patients and investigate the proper management of internal hernia.

Materials and methods

From June 2001 to June 2016, patients who underwent gastrectomy with potential internal hernia defect, such as total gastrectomy with Roux-en-Y anastomosis, subtotal gastrectomy with Billroth II anastomosis, or Roux-en-Y anastomosis due to gastric adenocarcinoma, were enrolled. The hernia defect was not closed in any of the enrolled patients. A patient was considered to have internal hernia only when internal hernia was identified through the Petersen space or mesenteric defect around the jejunojejunostomy during reoperation. Bowel resection was performed when the surgeon determined that the bowel was ischemic and not likely to be viable after reduction. When bowel ischemia was not severe and the bowel was viable after hernia reduction, only hernia site closure was performed, without bowel resection.

Clinicopathologic factors of enrolled patients were retrospectively analysed, including patients' age, sex, preoperative body mass index (BMI): BMI 23 kg/m^2 was cut-off point for comparing the mesenteric fat amount indirectly [12], co-morbidity represented by American Society of Anesthesiologist score, type of gastrectomy and reconstruction, stage, adjuvant chemotherapy, and type of operation (bowel resection or bowel reduction).

The risk factors of internal hernia were identified by comparison of patients with and without internal hernia. Subgroup analysis was performed depending on type of gastrectomy. To identify the proper management of internal hernia, clinical presentations, such as symptoms at the hospital visit, strength of abdominal pain at admission, laboratory findings at admission, time interval from symptom to surgery, and surgical outcomes, such as type of operation (bowel resection or bowel reduction), complications, and mortality, were compared between patients with early and late intervention, according to time from symptom onset to operation. This study was approved by the Institutional Review Board of the National Cancer Center (No. NCC2018-0069).

All analyses were performed using SAS® version 9.1.3 for Windows® (SAS Institute, Cary, NC, USA). Categorical variables were compared using the Pearson χ^2 test or Fisher's exact test and continuous variables were compared using t test or Wilcoxon rank sum as appropriate. A logistic regression analysis was used to test univariate and multivariate associations between variables to investigate risk factors of internal hernia. All values are expressed as means ± standard error of the mean or median (IQR Q1, Q3). Statistical significance was set at $p < 0.05$.

Results

Patient characteristics and affecting factors

Of 5777 patients who underwent gastrectomy with possible internal hernia, 24 (0.4%) underwent emergency or scheduled surgery for internal hernia. Distal gastrectomy (62.7%) and Billroth II anastomosis (61.2%) were mainly performed. Open surgery was performed more frequently than laparoscopic surgery (63.6% vs. 36.4%). The median interval from the initial operation to the event of internal hernia was 20.9 months (7.0–36.3 months; Table 1; Fig. 1).

In univariate analysis, the incidence of internal hernia was significantly higher in patients with a low BMI (< 23 kg/m^2; $p = 0.001$) and those who underwent total gastrectomy ($p = 0.04$), Roux-en-Y anastomosis ($p = 0.015$), or laparoscopic surgery ($p < 0.001$) (Table 2). Multivariable analysis showed that a low BMI ($p = 0.003$) and laparoscopic surgery ($p < 0.001$) were independent risk factors (Table 2).

### Subgroup analysis depending on type of gastrectomy

In the distal gastrectomy group, 11 of 3625 patients had internal hernia (0.30%). A low BMI ($p = 0.032$) and laparoscopic surgery ($p = 0.005$) were significantly associated with internal hernia (Table 3). Among 2152 patients who underwent total gastrectomy with Roux-en-Y anastomosis, 13 (0.60%) had internal hernia. When the two groups were compared, the BMI was significantly lower in the internal hernia group ($p = 0.001$). Laparoscopic surgery was also significantly more common in the internal hernia group ($p = 0.002$) (Table 4).

Comparison of surgical outcome according to time interval from symptom onset to operation for internal hernia

Of the patients who underwent internal hernia surgery, those who received early intervention (early intervention group) had surgical treatment earlier than those who received late intervention (late intervention group) after symptoms had occurred (15 vs. 32 h, $p = 0.003$). All patients complained of abdominal pain, and the pain score was not statistically significant between the two groups.

Table 1 Clinicopathologic characteristics

Variable	Number of patients (%) (*n* = 5777)
Sex	
Male	3979 (68.9%)
Female	1798 (31.1%)
Age	58.6 ± 11.9
ASA	
1	1933 (33.5%)
2	3595 (62.2%)
3 or more	249 (4.3%)
BMI (kg/m^2)	
≥ 23	3094 (53.5%)
< 23	2683 (46.5%)
Type of gastrectomy	
Distal gastrectomy	3625 (62.7%)
Total gastrectomy	2152 (37.3%)
Reconstruction	
BII	3537 (61.2%)
Roux-en-Y	2240 (38.8%)
Approach	
Open	3672 (63.6%)
Laparoscopy	2105 (36.4%)
pStage	
I	3058 (52.9%)
II	1038 (18.0%)
III	1405 (24.3%)
IV	276 (4.8%)
Adjuvant chemotherapy	1984 (34.3%)
Internal hernia	
No	5753 (99.6%)
Yes	24 (0.4%)
Time interval from initial operation to event of internal hernia	20.9 (7.0–36.3)
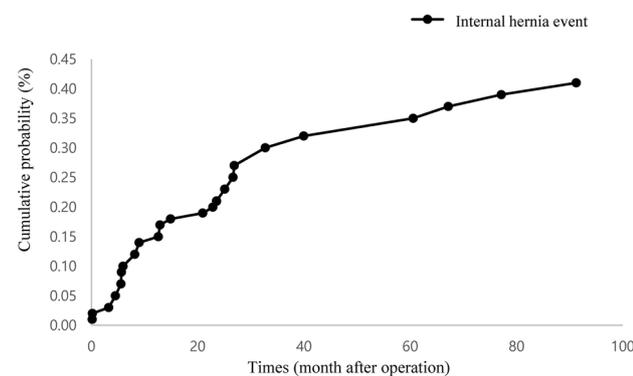
Fig. 1 Cumulative probability of internal hernia after gastrectomy

Bowel resection was slightly more frequent in the late intervention group, albeit not statistically significant (33.3% vs. 50%, *p* = 0.408). 6 of 12 patients in the late group experienced postoperative complications, including 5 cases of intraabdominal abscess with sepsis, 2 cases of anastomosis site leakage, and 1 case of pneumonia. Three patients in the late group died, a slightly higher rate rather than that of the early group, but without statistical significance (8.3% vs. 25.0%, *p* = 0.273) (Table 5).

Discussion

This study investigated the clinical characteristics and surgical outcome of internal hernia in patients after gastrectomy due to gastric cancer. In previous studies, only patients who underwent Roux-en-Y reconstruction were studied, with a small number of patients that could be analysed. However, this study included patients who underwent Billroth II reconstruction, thereby involving a relatively large number of patients over a long period.

There is a wide range of reported incidences of internal hernia in previous studies. Most studies report incidences ranging from 1.8 to 5%, with a small number of patients from a single institution [5, 6, 9–13]. These differences may be due to different proportions of laparoscopy, total gastrectomy, and hernia defect closure. One study that included a relatively large number of patients reported 18 patients with internal hernia of the 8893 (0.19%) patients who underwent surgery for gastrectomy [5]. This study reported a relatively low incidence of internal hernia due to investigating all gastrectomies, regardless of gastrectomy type or reconstruction method, including those with little possibility of internal hernia such as Billroth I anastomosis, proximal gastrectomy and a short follow-up period of only 3 years after surgery. Conversely the incidence in another study was up to 5% [6]. We could not find significant difference in population demographics compared to the present study. However, Roux-limb length was longer (mean length was 60 cm) than in the present study (30–40 cm). The longer Roux-limb length might contribute to a wider mesenteric defect. This difference of the procedure could affect the incidence.

In this study, the risk factors of internal hernia were significantly higher in patients undergoing laparoscopic approach and total gastrectomy. These results are similar to those of other studies, in which total gastrectomy and laparoscopic approach are risk factors for internal hernia [5, 6, 10, 14]. Only one study reported that there was no difference between the open surgery and laparoscopy groups [9]. An increase in the incidence of internal hernia after laparoscopic surgery has also been reported in gastric bypass surgery for morbid obesity [15].

Table 2 Univariate and multivariate analyses for risk factors for internal hernia

	No internal hernia (N = 5753)	Internal hernia (N = 24)	p value	Multivariate analysis	
				OR	p value
Age	58.6 ± 12.0	59.8 ± 10.9	0.583		
Sex			0.601		
Male	3961 (99.6%)	18 (0.4%)			
Female	1792 (99.7%)	6 (0.3%)			
ASA			0.748		
1	1916 (99.5%)	17 (0.5%)			
2	3588 (99.6%)	7 (0.4%)			
3 or more	249 (100%)	0 (0%)			
BMI (kg/m^2)			**0.001**		**0.003**
≥ 23	3089 (99.8%)	5 (0.2%)		1	
< 23	2664 (99.3%)	19 (0.7%)		**4.403 (1.60–9.99)**	
Type of gastrectomy			**0.04**		0.687
Distal	3614 (99.7%)	11 (0.3%)		1	
Total	2139 (99.4%)	13 (0.6%)		1.315 (0.19–11.99)	
Reconstruction			**0.015**		0.341
Billroth II	3527 (99.7%)	10 (0.3%)		1	
Roux-en-Y	2226 (99.3%)	14 (0.7%)		2.731 (0.34–21.55)	
Approach			**< 0.001**		**< 0.001**
Open	3665 (99.8%)	7 (0.2%)		1	
Laparoscopy	2088 (99.2%)	17 (0.8%)		**6.930 (2.44–13.31)**	
pStage			0.130		
I	3042 (99.5%)	16 (0.5%)			
II	1035 (99.6%)	3 (0.4%)			
III	1400 (99.7%)	5 (0.3%)			
IV	276 (100%)	0 (0%)			
Adjuvant chemotherapy	1979 (99.7%)	5 (0.3%)	0.367		

Statistically significant values are given in bold

One of the particular findings of the present study is that low BMI is associated with internal hernia. Other studies have reported that postoperative weight loss, as well as low BMI, are associated with internal hernia [5, 6]. This can be explained by the fact that patients with lower BMI have thinner mesenteric fat, and consequently a larger mesentery defect, which contributes to a greater possibility of internal herniation. One study reported that a decrease in mesentery fat in gastric bypass was associated with internal hernia [16].

Although there was not a statistically significant difference in the rates of bowel resection, postoperative complications, or mortality in patients who underwent early and late intervention, probably due to the small number of patients, the late intervention group showed a relatively worse surgical outcome than the early intervention group in the present study. This result suggests that early surgical treatment may reduce surgical complications when internal hernia is suspected. However, the rate of

symptoms was not statistically significant between the early and late intervention groups. Physical examination or laboratory findings are also not sufficient for diagnosis of internal hernia and decision to provide surgical treatment. For this reason, if internal hernia is suspected, abdominal computed tomography (CT) scan without delay is essential. However, other studies have reported that internal hernia is difficult to diagnose via CT scan, and its specificity and sensitivity are known to be 77% and 63%, respectively [17]. According to one study, only 2/3 of internal hernia patients were diagnosed with internal hernia prior to surgery [9]. Rather than relying on any particular study, the patient's symptoms and various tests should be combined to more expeditiously determine the proper treatment.

Several gastric Roux-en-Y bypass surgery studies have suggested hernia defect closure [18–20]. Some studies have reported a decrease in internal hernia occurrence or no occurrence after hernia site defect closure in gastric

Table 3 Internal hernia after distal gastrectomy

	No internal hernia (N = 3614)	Internal hernia (N = 11)	p value
Age	60 (51–68)	58 (52–66)	0.905
Sex			0.523
Male	2472 (99.7%)	8 (0.3%)	
Female	1142 (99.7%)	3 (0.3%)	
ASA			0.302
1	1184 (99.4%)	8 (0.6%)	
2	2289 (99.8%)	3 (0.2%)	
3 or more	141 (100%)	0 (0%)	
BMI	23.6 (21.6–25.7)	20.6 (19.5–24.0)	**0.032**
Approach			**0.005**
Open	1875 (99.9%)	1 (0.1%)	
Laparoscopy	1739 (99.4%)	10 (0.6%)	
Reconstruction			0.242
Billroth II	3527 (99.7%)	10 (0.3%)	
Roux en Y	87 (98.9%)	1 (1.1%)	
Hernia site			–
Petersen		11 (100%)	
JJ mesentery defect		0 (0%)	
pStage			0.280
I	2113 (99.6%)	9 (0.4%)	
II	645 (100%)	0 (0%)	
III	736 (99.7%)	2 (0.3%)	
IV	120 (100%)	0 (0%)	
Adjuvant-chemoTx.			0.363
Yes	2498 (99.6%)	9 (0.4%)	
No	1116 (99.8%)	2 (0.2%)	
Time interval from initial operation to event of internal hernia (month)	–	17.9 (3.2–32.7)	

Statistically significant values are given in bold

Table 4 Internal hernia after total gastrectomy with Roux en Y anastomosis

	No internal hernia (N = 2139)	Internal hernia (N = 13)	p value
Age	60 (49–68)	65 (54–72)	0.191
Sex			0.765
Male	1489 (99.3%)	10 (0.7%)	
Female	650 (99.5%)	3 (0.5%)	
ASA			0.714
1	741 (98.8%)	9 (1.2%)	
2	1290 (99.6%)	4 (0.4%)	
3 or more	108 (100%)	0 (0%)	
BMI	23.0 (20.8–25.3)	20.8 (19.1–21.4)	**0.001**
Approach			**0.002**
Open	1790 (99.6%)	6 (0.3%)	
Laparoscopy	349 (98%)	7 (2.0%)	
pStage			0.244
I	929 (99.1%)	7 (0.7%)	
II	390 (99.1%)	3 (0.8%)	
III	664 (99.6%)	3 (0.4%)	
IV	156 (100%)	0 (0%)	
Adjuvant-chemoTx.			0.264
Yes	863 (99.7%)	3 (0.3%)	
No	1276 (99.2%)	10 (0.8%)	
Hernia site			
Petersen		4 (30.8%)	
JJ mesentery defect		9 (69.2%)	
Time interval from initial operation to event of internal hernia	–	23.5 (9.2–33.4)	

Statistically significant values are given in bold

cancer surgery [11, 13]. However, the recently published two randomized controlled trials on the closure of mesenteric defect after bariatric surgery showed slightly a different result. The conclusion of the first study showed equivalent internal hernia and postoperative complication rate [21]. The second study reported that the closure of the internal hernia defect reduced the internal hernia rate but at the same time increased the incidence of early major postoperative complications requiring surgical treatment [22]. Considering the effect of the reducing of internal hernia and procedure-related complication, the necessity of hernia defect closure should be investigated in the future.

The present study has several limitations. First, it was conducted retrospectively at a single institution, and thus did not include internal hernia patients who were treated at other hospitals. Second, to demonstrate risk factor related to amount of mesentery fat, only the preoperative BMI was measured and the change of BMI could not be evaluated in the present study. Third, the incidence of internal hernia could be underestimated. The diagnosis of internal hernia with CT scan was difficult without specific sign and had not been firmly established [17]. Therefore, non-surgical or spontaneous reduction cases of internal hernia were not included in the present study.

Conclusion

Although internal hernia is a rare complication, it is difficult to diagnose and cause serious complications. To prevent internal hernia, the necessity of hernia defect closure should be investigated in the further prospective or randomized studies. Because diagnosis of internal hernia is

Table 5 Comparison of surgical outcome according to time interval from symptom onset to operation

	Early intervention group (N = 12)	Late intervention group (N = 12)	p value
Age	60.0 ± 8.0	61.5 ± 13.7	0.748
Sex			0.346
Male	10 (83.3%)	8 (66.7%)	
Female	2 (16.7%)	4 (33.3%)	
BMI	20.7 ± 3.1	20.8 ± 1.8	0.888
ASA			1.000
1	8 (66.6%)	9 (75.0%)	
2	4 (33.3%)	3 (25.0%)	
3 or more	0	0	
Comorbidity			
Hypertension	1 (8.3%)	1 (8.3%)	
Diabetes	1 (8.3%)	0 (0%)	
Ischemic heart disease	0 (0%)	1 (8.3%)	
COPD	2 (16.6%)	0 (0%)	
Liver cirrhosis	1 (8.3%)	1 (8.3%)	
Hernia site			0.673
Peterson	8 (66.7%)	7 (58.0%)	
JJ site mesentery defect	4 (33.3%)	5 (41.7%)	
Abdominal pain score (Numeral rating scale)	9 (8–10)	8 (7–10)	0.340
Lab			
White blood cell (10^9/L)	10.40 (5.68–138.60)	9.45 (5.43–134.80)	0.659
Segment neutrophil (%)	71.7 (61.3–85.9)	74.8 (61.3–87.5)	0.696
C-reactive protein (mg/L)	0.27 (0.06–0.45)	0.19 (0.07–0.54)	0.058
Time from onset to operation (h)	15 (9–18)	32 (23–75)	**0.003**
Bowel resection	4 (33.3%)	6 (50%)	0.408
Postoperative complications	2 (16.7%)	6 (50%)	0.083
Mortality	1 (8.3%)	3 (25.0%)	0.273

Statistically significant value is given in bold

not easy and delayed diagnosis of internal hernia can lead to poor prognosis, early surgical treatment is necessary when it is suspected.

Compliance with ethical standards

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