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REVIEW ARTICLE

Current status of internal hernia after gastrectomy for gastric cancer

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Abstract

Background Internal hernia is a well-known postoperative complication after Roux-en-Y gastric bypass. However, it has not been considered a recognized complication for gastric cancer.

Methods We reviewed the literature in the past decade to clarify the current status of internal hernia after gastrectomy including its incidence, high-risk factors, and treatment.

Results The incidence of internal hernia after gastrectomy was found to be between 0.2 and 5.63%, and the median interval time was less than 2 years. High-risk factors include laparoscopic approach, non-closure of all the mesenteric defects, and Roux-en-Y reconstruction. The rate of bowel resection was significantly higher than that of adhesive small bowel obstruction.

Conclusion The true incidence of internal hernia after gastrectomy is generally underestimated. Closure of all the mesenteric defects is one of the most effective methods to prevent postoperative internal hernia. Early surgical exploration is necessary when internal hernia is suspected.

Keywords Internal hernia · Gastric cancer · Petersen's hernia · Gastrectomy · Laparoscopy

Introduction

Internal hernia (IH) is a well-known post-surgical complication after Roux-en-Y gastric bypass (RYGB) [1]. Although closure of defects is laborious and challenging, routine closure of mesenteric defects has been suggested in bariatric surgery [2, 3]. However, IH has not been considered a recognized complication post-gastrectomy for gastric cancer (GC), which generates the same defects during the surgical procedure. Furthermore, the actual prevalence of this complication is mostly undervalued because the duration of follow-up is limited, and few studies investigated IH as a primary endpoint.

Total gastrectomy (TG) or distal gastrectomy (DG) with Roux-en-Y reconstruction creates at least two notable hernia spaces. One is between the Roux limb and the transverse colon, the so-called Petersen's space. The other is the mesenteric defect around the jejunojejunostomy, if retrocolic placement of the Roux limb is performed, and also the transverse mesocolon defect. These potential hernia spaces are also present during proximal gastrectomy (PG) with double-tract reconstruction (DTR) or jejunal interposition (JI). Each defect becomes a potential orifice for IH. This study reviewed the IH after gastrectomy due to GC using PubMed, Elsevier, and Baidu Scholar. We evaluated the literature in the past decade to elucidate the actual status of IH after gastrectomy, discussing its prevalence, treatments, and outcomes.

Incidence of IH

In the literature, the occurrence of IH after gastrectomy was found to be between 0.20 and 5.63%, and the median interval time was less than 2 years (Table 1) [4–14]. These differences may be due to different proportions of laparoscopy, reconstruction method, and closure of defects. Miyagaki et al. [7] reported 18 (0.20%) cases of IH among 8983 patients who underwent gastrectomy from 24 participating centers, indicating that IH was a negligible postoperative complication. However, this study included those with little possibility of

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Table 1 The incidences of IH after gastrectomy for gastric cancer

Author	Year	Incidence of IH (%)	Rate of PH (%)	Surgical approach	Interval time (m)	Bowl resection (%)
Takayama et al. [4]	2018	4/71 (5.63)	4/4 (100)	PG with JI	12.6	75.0
Kang et al. [5]	2019	59/4074 (1.45)	27/59 (45.8)	TG with RY DG with B II or RY or uRY PG with DTR	15.0	20.3
Han et al. [6]	2019	24/5777 (0.42)	15/24 (62.5)	TG or DG with RY DG with B II	20.9	41.7
Miyagaki et al. [7]	2012	18/8983 (0.20)	8/18 (44.4)	TG, DG or PG	13.7	16.7
Ojima et al. [8]	2017	10/529 (1.89)	2/10 (20.0)	TG with RY	2.8	40.0
Gong et al. [9]	2019	20/490 (4.08)	9/20 (45.0)	TG with RY	N/A	N/A
Yoshikawa et al. [10]	2014	12/428 (2.80)	5/12 (41.7)	TG or DG with RY	20.6	16.7
Kojima et al. [11]	2014	6/358 (1.68)	6/6 (100)	TG or DG with RY	11.6	0
Kelly et al. [12]	2013	16/298 (5.37)	7/16 (43.8)	TG or DG with RY	22.1	37.5
Kimura et al. [13]	2017	15/355 (4.23)	7/15 (46.7)	TG or DG with RY	N/A	13.3
Hanada et al. [14]	2015	10/460 (2.17)	3/10 (30.0)	TG or DG with RY	19.4	20.0

IH such as Billroth I anastomosis and PG with esophagogastrostomy. In this report, IH was observed only in patients with Roux-en-Y reconstruction, and the authors did not describe the proportion of various reconstruction methods in detail. In addition, another study revealed that the incidence of IH after Roux-en-Y reconstruction reached up to 5.37% [12].

Petersen's hernia (PH)

Approximately 7.9–27% of IH occur at Petersen's space in laparoscopic RYGB, with a high rate of bowel resection and mortality [15]. An apparent long biliopancreatic limb results in a greater gap from the root of the small bowel mesentery to the transverse colon and a larger Petersen's space in RYGB than that in Roux-en-Y reconstruction after gastrectomy. In addition, the lower edge of Petersen's space is higher in gastrectomy, making the small bowel difficult to pass through. Thus, we intuitively believe that PH after gastrectomy is rare, and it was not routinely closed in the past [7, 11]. However, previous literature showed that the proportion of PH was higher after gastrectomy than that after RYGB, which varied between 20 and 100% (Table 1). Many centers have routinely closed Petersen's space after reconstruction in recent years [11, 16]. A retrospective study from China showed that the incidence of PH in the group with closed Petersen's space was considerably lesser than that in the non-closure group (p=0.04) [17].

Factors associated with IH

Laparoscopic approach

Laparoscopic surgery is less likely to cause adhesion than open surgery (Table 2). Han et al. [6] revealed that the occurrence of IH is significantly elevated after laparoscopic gastrectomy than open surgery (0.81% vs. 0.19%, p<0.01). Multivariable analysis demonstrated that laparoscopic surgery is an independent risk factor for postoperative IH (p<0.01). These results were similar to those of other studies, in which the laparoscopic method was found to be a risk factor for IH [7, 8, 12]. Two other studies found no difference between open surgery and laparoscopy [4, 10], possibly due to the limited number of cases. Despite the lack of strong evidence from prospective research, most surgeons gradually accepted the fact that laparoscopic gastrectomy is a risk factor for IH than open surgery. Considering the widespread usage of laparoscopy for GC, the prevention and treatment of IH should cause more concern.

Closure of mesenteric defects

The high risk of postoperative IH is closely related to defects after digestive tract reconstruction. Some studies have revealed a considerable reduction in IH incidence or no incidence after hernia site defect closure after gastrectomy (Table 3). The study with closure of jejunojejunostomy mesenteric defect or Petersen's space alone also supports this fact. The results showed that IH at the jejunojejunostomy mesenteric defect was observed in 3.4% (5/149) patients without closure of this defect, while no IH was found in 206 patients with closure (p<0.01); PH was observed in 2.8% (7/250) patients without closure of this defect, and no PH was found in the 105 patients with closure [13]. On the contrary, Kelly et al. [12] concluded that the occurrence of IH is significantly lowered post-gastrectomy, and regular closure of mesenteric defects may not considerably affect the occurrence of IH. Currently, no consensus exists on the management of mesenteric defects after gastrectomy. We

Table 2 Incidence of internal hernia between laparoscopy and open surgery

Author	Reconstruction method	Surgical approach	Incidence of IH (%)	*p*
Takayama et al. [4]	PG with JI	Laparoscopy	3/38 (7.89)	0.38
		Open	1/33 (3.03)	
Han et al. [6]	TG or DG with RY DG with B II	Laparoscopy	17/2105 (0.81)	0.01
		Open	7/3672 (0.19)	
Miyagaki et al. [7]	TG or DG with RY	Laparoscopy	6/1246 (0.48)	0.03
		Open	12/7504(0.16)	
Ojima et al. [8]	TG with RY	Laparoscopy	6/122 (4.9)	0.01
		Open	4/407(1.0)	
Yoshikawa et al. [10]	TG or DG with RY	Laparoscopy	6/178 (3.37)	0.64
		Open	6/250 (2.40)	
Kelly et al. [12]	TG or DG with RY	Laparoscopy	5/34 (14.71)	0.01
		Open	11/264 (4.17)	
Hanada et al. [14]	TG or DG with RY	Laparoscopy	1/110 (0.91)	0.51
		Open	9/350 (2.57)	

Table 3 Incidence of internal hernia with closing of the mesenteric defects or not

Author	Reconstruction method	Closure of the mesenteric defects	Incidence of IH (%)	*p*
Ojima et al. [8]	TG with RY	No	6/75 (8.0)	0.047
		Yes	0/47(0)	
Kojima et al. [11]	DG or TG with RY	No	6/268 (2.24)	0.16
		Yes	0/90 (0)	
Kelly et al. [12]	TG or DG with RY	No	16/281 (5.69)	0.35
		Yes	0/17 (0)	
Hanada et al. [14]	TG or DG with RY	No	9/244 (3.67)	0.04
		Yes	1/216 (0.46)	
Hosoya et al. [18]	DG or TG with RY	No	4/58 (6.90)	0.03
		Yes	0/115 (0)	

insist that closing all defects contributes to reducing IH after gastrectomy.

Route of Roux limb

As for the position of the Roux limb, the retrocolic route has three potential sites for IH, namely, the transverse mesocolon defect, Petersen's space, and the jejunojejunostomy mesenteric defect. The antecolic route lowers the potential sites from three to two, including Petersen's space and the jejunojejunostomy mesenteric defect. The antecolic route might be better as it eliminates one of the most common sites for herniation. In fact, most reports showed no considerable variation in the occurrence of IH between the retrocolic and antecolic routes after gastrectomy (Table 4). Only one study reported that the incidence of IH (10%, 1/10) in the retrocolic route was significantly higher than that in the antecolic route (2.63%, 11/418; p=0.013) [10]. However, Kimura et al. [13] revealed that IH in the retrocolic route occurred earlier than that in the antecolic route. Furthermore, the retrocolic route is a risk factor for intestinal obstruction compared with the antecolic route, and massive bowel resection was mostly conducted in patients in the retrocolic group.

Reconstruction methods

IH was observed mostly in patients with Roux-en-Y reconstruction after TG or DG. This finding was attributed to the fact that Roux-en-Y reconstruction has at least two defects (jejunojejunostomy mesenteric defect and Petersen's space) for IH; however, Billroth II reconstruction has Petersen's space only, and no mesenteric defect is created in Billroth I reconstruction. Han et al. [6] revealed that the occurrence of IH with Roux-en-Y reconstruction was higher than that of Billroth II and other reconstruction methods (7.1% vs. 1.4%, p<0.01). Kang et al. [5] also reported that Roux-en-Y reconstructions after DG lead to a considerably elevated incidence of IH relative to Billroth II reconstruction (5.93 vs. 1.14%, p<0.01), and no IH was observed in 2361 patients with Billroth I reconstruction. Another operation involving

Table 4 Incidence of internal hernia with the position of the Roux limb

Author	Surgical approach	Route of Roux limb	Incidence of IH (%)	*p*
Takayama et al. [4]	PG with JI	Retrocolic	3/54 (5.56)	0.96
		Antecolic	1/17 (5.88)	
Kang et al. [5]	TG or DG with RY PG with JI	Retrocolic	1/60 (1.67)	0.62
		Antecolic	110/4038 (2.72)	
Yoshikawa et al. [10]	TG or DG with RY	Retrocolic	1/10 (10)	0.01
		Antecolic	11/418 (2.63)	
Kelly et al. [12]	TG or DG with RY	Retrocolic	1/42 (2.38)	0.35
		Antecolic	15/256 (5.86)	
Kimura et al. [13]	TG or DG with RY	Retrocolic	2/128 (1.56)	0.23
		Antecolic	5/122 (4.10)	
Hanada et al. [14]	TG or DG with RY	Retrocolic	7/193 (0.58)	0.14
		Antecolic	3/193 (1.12)	

different reconstruction methods is PG. Considering reflux esophagitis and anastomotic stenosis post-esophagogastrostomy, DTR and JI have been considered to be the most significant alternative reconstruction methods for PG [18, 19]. Takayama et al. [4] reported four cases of PH among 71 patients after PG with JI reconstruction. Another study reported six cases of IH in 264 patients with DTR, and no IH occurred in 39 patients with EG during the same period [5].

Diagnosis of IH

The majority of patients show nonspecific symptoms including nausea, abdominal pain, vomiting, and abdominal pain that occasionally radiates to the back. Tachycardia has been reported as a key clinical predictor in postoperative IH after bariatric surgery [20]. Yoshikawa et al. [10] reported the same results, i.e., 83% of patients presented with IH after gastrectomy with tachycardia (>90 bpm). The white blood cell count and CRP level are usually normal. CT is the preferred choice for patients with clinical suspicion of IH. Miyagaki et al. [7] reported that 14 cases (78%) of 16 patients with IH after gastrectomy were diagnosed with preoperative CT. Yoshikawa et al. [10] reviewed 12 patients with IH after gastrectomy, and small intestinal dilation and whirl sign were present in 100% and 83%, respectively. Instead of focusing on a specific examination, the symptoms of patients and different tests should be combined to more expeditiously determine the proper treatment.

Treatment of IH

IH may cause massive small bowel necrosis and serious consequences, such as short bowel or even death, particularly when early detection and surgical treatment have been delayed. Kang et al. [5] reported 111 cases of IH after gastrectomy identified by CT or surgical exploration, and 52 (46.8%) patients underwent non-surgical treatment. Considering the specificity of CT for IH, the indication could not be established for non-surgical treatment of IH. Given the differences in the basic characteristics of patients, the mortality rates may vary. Thus, we chose the rate of bowel resection as a relatively objective sign to reflect the consequences of IH. The rate of bowel resection caused by IH after gastrectomy is shown in Table 1, which was significantly higher than the rate of adhesive small bowel obstruction [21]. Another study compared the surgical outcome on the basis of time interval from symptom onset to surgery for IH [6]. The result showed that bowel resection was more frequently observed in the late intervention group, and poor surgical results were revealed in the late intervention group. This result suggested that early surgical treatment is needed when IH is suspected after gastrectomy. Because of the dilated intestine, emergency surgical treatment is mostly performed in an open fashion, and laparoscopic exploration can also be considered with no obvious expansion of the bowel.

Surgical treatment involves hernia reduction and closure of each defect or bowel resection. At times, massive bowel resection is inevitable because of extensive bowel necrosis, resulting in short bowel syndrome and even death. Jang et al. [22] reported a patient with the whole small bowel and Roux-en-Y limb necrosis caused by PH after subtotal gastrectomy with Roux-en-Y reconstruction. They connected the remnant stomach and the jejunum by forming a new Roux-en-Y anastomosis using a segment of the transverse colon as a new Roux limb by two-phase operation. In IH patients without bowel necrosis, adhesion often makes it difficult to distinguish the direction of the hernia. It is feasible to look for the hernia into the intestinal canal through the ileocecal area and pulling it toward the ileocecal area. Another aspect is to close all defects. Currently, no consensus exists on the management of mesenteric defects created after gastrectomy. A study

recommended that the space between stitches should be established at ≤1 cm during closure of mesenteric defects [23]. Paroz et al. [24] suggested the closure of each mesenteric defect via running nonabsorbable suture after laparoscopic RYGB. Intuitively, nonabsorbable suture should be a better choice in this procedure. However, Ojima et al. [8] routinely closed all mesenteric defects using a 3-0 absorbable suture and reported that no patients developed IH since 2013. Aghajani E et al. [25] reported the technique of closing the defects with a hernia stapling device for obesity surgery, which can easily be used in gastrectomy for GC as well.

Conclusions

The true incidence of IH after gastrectomy is generally underestimated because the duration of follow-up is limited and few studies investigated it as a primary endpoint. We admitted that selection bias is unavoidable in retrospective studies, but a randomized controlled trial is always difficult in such a relatively rare postoperative complication. Although closure of all mesenteric defects is technically difficult, time-consuming, and laborious, it is the most effective method to prevent postoperative IH. Furthermore, surgeons should emphasize the early recognition of IH. Instead of focusing on a specific examination, the symptoms of patients and different tests should be combined to more expeditiously determine the proper treatment. Early surgical exploration is necessary when IH is suspected.

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Availability of data and material Not applicable.

Declarations

Ethics approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of The Second Affiliated Hospital of Soochow University.

Consent to participate Not applicable.

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Conflict of interest The authors declare no competing interests.

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