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*Original Article*

# Clinical analysis of acute small bowel volvulus in the late postoperative period following gastrectomy

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**Abstract:** The occurrence of acute small bowel volvulus (SBV) in the late postoperative period after gastrectomy is a clinical rarity with few cases noted in medical literature. As such, we conducted this study to investigate the clinical features and clinical outcomes of late-onset SBV after gastrectomy, and to explore the predisposing factors of bowel necrosis in these patients. We performed a retrospective study of 39 patients with late-onset SBV after gastrectomy. Medical records and various laboratory and imaging parameters were collected in all cases. Our results showed that abdominal pain (100%) and nausea/vomiting (59.0%) were the most common symptoms. Adhesions/bands (82.1%) were the leading cause of late-onset SBV after gastrectomy. Computerized tomography (CT) was the imaging test of choice, which achieved a diagnostic accuracy of 55.9%. A characteristic "whirl sign" was discovered in 8 cases. Surgery was performed in all of our patients. However, there were still eight patients suffered from short bowel syndrome (SBS). Peritoneal signs, increased WBC counts, and decreased albumin-globulin ratio (AGR) were significantly associated with bowel necrosis. Meanwhile, the bowel necrosis was associated with a higher incidence of malnutrition/SBS ($P = 0.047$) and long duration of hospital stay ($P = 0.02$). We concluded SBV should be considered in patients with a history of gastrectomy complaining sudden abdominal pain, nausea, or vomiting. Abdominal CT is essential for early and prompt diagnosis. Once highly suspected or diagnosed of acute SBV, emergency laparotomy should be performed immediately to avoid catastrophic outcomes.

**Keywords:** Bowel necrosis, gastrectomy, postoperative, short bowel syndrome, small bowel volvulus

## Introduction

Small bowel volvulus (SBV) is a rare condition in which the small bowel and its mesentery are twisted around the mesenteric axis [1, 2]. It is a surgical emergency due to the risk of mesoaxial twisting of all the small bowel or a segment of it and its mesentery, which results in bowel necrosis from a compromised blood supply [3]. Typically, SBV can be categorized as primary and secondary types [4, 5]. The primary SBV is rare and often occurs without any apparent anatomic abnormalities or predisposing factors, while the secondary SBV is relatively common and could be caused by numerous predisposing factors such as postoperative adhesions/bands, anatomic disorders, and/or congenital malrotations [6, 7]. Accurate diagnosis and treatment are essential to avoid bowel necrosis, leading to high morbidity and mortality. The sudden start of the symptoms, mainly abdominal pain, nausea and vomiting are especially prominent in SBV, the differential manifestations with other forms of small bowel obstruction [8].

Although gastrectomy is the cornerstone treatment for patients with localized gastric cancer and refractory gastroduodenal ulcer, there is still a relatively high prevalence of postoperative complications [9, 10]. To the best of our knowledge, the occurrence of SBV in the late postoperative period after gastrectomy is a clinical rarity with few cases noted in medical literature. Because of its rarity, our understanding is solely based on case reports [1, 11]. Therefore, the present study is dedicated to investigate the etiologies, clinical manifestations, laboratory parameters, radiological examination findings, and clinical outcomes of acute SBV in the late postoperative period after gastrectomy, to emphasize the importance of a

**Table 1.** Demographic and clinical characteristics of the study population

| Characteristics | Value |
|---|---|
| Sex | |
| Male, No. (%) | 29 (74.4) |
| Female, No. (%) | 10 (25.6) |
| Age (year) | |
| Mean | 62.2 ± 8.3 |
| Median | 63 |
| Range | 46-81 |
| BMI (kg/m$^2$) | 17.6 ± 1.3 |
| Primary disease | |
| Gastric cancer, No. (%) | 30 (76.9) |
| Gastric ulcer, No. (%) | 9 (23.1) |
| Surgical procedure of primary disease | |
| Total gastrectomy with Roux-en-Y anastomosis, No. (%) | 9 (23.1) |
| Subtotal gastrectomy with Billroth-I anastomosis, No. (%) | 4 (10.3) |
| Subtotal gastrectomy with Billroth-II anastomosis, No. (%) | 14 (35.9) |
| Subtotal gastrectomy with Roux-en-Y anastomosis, No. (%) | 12 (30.8) |

Note. BMI, body mass index.

prompt diagnosis of this rare entity and the need of emergent surgical intervention as a therapeutic measure, because understanding these may prevent further morbidity and mortality.

## Materials and methods

We retrospectively reviewed the medical records of thirty-nine patients who were definitely diagnosed as acute SBV in the late postoperative period after gastrectomy at Jinling Hospital between January 2001 and January 2017. The diagnosis of acute SBV was established in accordance with clinical manifestations, radiological examination findings, and intraoperative evidences. The demographic and clinical parameters of the study population such as age and sex, body mass index (BMI), clinical manifestations, laboratory data, radiological investigations, surgical techniques, clinical outcomes and complications were analyzed and reviewed. The study was designed according to the ethical principles outlined by the Declaration of Helsinki and approved by the local ethics committee of Jinling Hospital.

All continuous variables were presented as mean ± SEM, and descriptive statistics were defined by number of cases and percentage. Standard statistical analyses were performed, including Student t test and $X^2$ test. The statistical analyses were performed using the SPSS statistical software (version 20; SPSS, Inc, an IBM Company, Chicago, IL). Statistical significance was accepted at the $P < 0.05$ level.

## Results

A total of thirty-nine patients with acute SBV in the late postoperative period after gastrectomy were reviewed for the present study, including 29 males (74.4%) and 10 females (25.6%) with an average age of 62.2 years old (range 46-81 years) (**Table 1**). BMI was 17.6 ± 1.3 kg/m$^2$. Of these patients, thirty (76.9%) were primary gastric cancer and nine (23.1%) were primary gastric ulcer. Totally, nine (23.1%) patients underwent total gastrectomy with Roux-en-Y anastomosis, four (10.3%) patients underwent subtotal gastrectomy with Billroth-I anastomosis, fourteen (35.9%) patients with Billroth-II anastomosis and twelve (30.8%) patients with Roux-en-Y anastomosis. No other abdominal surgery was performed in these patients.

All our patients presented with features of small bowel obstruction or acute abdomen. The most common presenting symptom was abdominal pain (39/39, 100%), followed by nausea/vomiting (23/39, 59.0%), failure to pass gas and stool (15/39, 38.5%), and abdominal distension (11/39, 28.2%) (**Table 2**). Totally, twenty-seven patients (69.2%) featured peritoneal signs, and six (15.4%) with positive shifting dullness. Laboratory data revealed an average white blood cell (WBC) of 13.3 ± 5.9 × 10$^9$/L with 27 cases (69.2%) over 10.0 × 10$^9$/L, and an average C-reactive protein (CRP) of 46.2 ± 35.4 mg/L with 36 cases (92.3%) over 8.0 mg/L. The serum levels of albumin (ALB) and globulin (Glo) were 31.8 ± 5.3 g/L and 23.6 ± 3.8 g/L, respectively. Imaging tests used and their diagnostic accuracy are summarized in **Table 2**. Plain X-rays were performed in all our patients, but most of them only showed nonspecific features of small bowel obstruction. Thirty-four (87.2%) abdominal CT scans were

**Table 2.** Clinical and laboratory parameters of the study population

| Characteristics | Value |
|---|---|
| Symptoms | |
| Abdominal pain, No. (%) | 39 (100) |
| Nausea/vomiting, No. (%) | 23 (59.0) |
| Failure to pass gas and stool, No. (%) | 15 (38.5) |
| Abdominal distension, No. (%) | 11 (28.2) |
| Signs | |
| Peritonitis, No. (%) | 27 (69.2) |
| Positive shifting dullness, No. (%) | 6 (15.4) |
| Laboratory findings | |
| WBC, × $10^9$/L | 13.3 ± 5.9 |
| CRP, mg/L | 46.2 ± 35.4 |
| ALB, g/L | 31.8 ± 5.3 |
| Glo, g/L | 23.6 ± 3.8 |
| Imaging tests | |
| Plain X-ray, No. (%) | 39 (100) |
| Accuracy, No. (%) | 3 (7.7) |
| CT scan, No. (%) | 34 (87.2) |
| Accuracy, No. (%) | 19 (55.9) |
| Whirl sign, No. (%) | 8 (23.5) |
| Preoperative diagnosis | |
| Acute SBV, No. (%) | 21 (53.8) |
| Small bowel obstruction, No. (%) | 14 (35.9) |
| Acute abdomen, No. (%) | 4 (10.3) |
| Duration of primary surgery to SBV | |
| < 1 year, No. (%) | 5 (12.8) |
| > 1 year and < 5 years, No. (%) | 23 (59.0) |
| > 5 years and < 10 years, No. (%) | 8 (20.5) |
| > 10 years, No. (%) | 3 (7.7) |
| Duration of symptoms to admission (hour) | 9.2 ± 7.5 |
| Duration of admission to surgery (hour) | 7.6 ± 7.9 |
| Etiologies | |
| Adhesions/bands, No. (%) | 32 (82.1) |
| Internal hernia, No. (%) | 7 (17.9) |
| Surgical technique | |
| Bowel resection, No. (%) | 28 (71.8) |
| Anastomosis, No. (%) | 15 (53.6) |
| Simple devolvulation, No. (%) | 11 (28.2) |

Note. ALB, albumin; CRP, C-reactive protein; CT: computed tomography; Glo, globulin; SBV, small bowel volvulus; WBC, white blood cell.

arranged, which achieved a diagnostic accuracy of SBV of 55.9 percent. A characteristic "whirl sign" involving the small bowel and mesentery around the mesenteric axis was discovered in eight (23.5%) cases, which strongly suggested a SBV (**Figure 1A**). In addition, CT angiography (CTA) was conducted in three patients due to suspicion of vascular variation. On CTA, the torsion of the small vessels arising from the superior mesenteric artery could be seen, with no relevant primary vascular stenosis or occlusion (**Figure 1B**). Preoperative diagnosis was acute SBV in 21 patients (53.8%), small bowel obstruction in 14 (35.9%), and acute abdomen in 4 (10.3%).

The duration of primary surgery to presentation of acute SBV symptoms ranged from 7 months to 21 years (average 56.9 ± 54.0 months). Overall, three cases developed symptoms more than ten years after gastrectomy, with the longest up to 21 years. The evolution time of the symptomatology until hospitalization was 9.2 ± 7.5 hours (**Table 2**).

All of the patients in our study received hydration, prophylactic antibiotics, and nasogastric tube decompression as initial managements. Emergency laparotomy was carried out on 28 of our patients, while therapeutic exploratory laparotomy was also performed after conservative treatment failed in the other 11 cases. The duration of admission to exploratory laparotomy was 7.6 ± 7.9 hours. Intraoperatively, segmental small bowel dilatation was discovered in all cases. Thus, a clockwise or counterclockwise rotation of the mesentery was detected in all cases. Necrotic small bowel loops were observed in 28 patients (71.8%). The etiologies of SBV were classified into two groups based on surgical findings: adhesions/bands and internal hernias. Adhesions/bands were noted in 32 (82.1%) patients, and internal hernias were found in 7 (17.9%) patients. No evidence of congenital malrotation could be found. In view of these findings, extensive adhesiolysis and release of the volvulus were carried out in all cases. Bowel resection was performed in 28 patients who accompanied by small bowel necrosis, while primary anastomosis was performed in 15 patients. Due to the absence of vascular compromise, simple devolvulation of the affected segment of small bowel was performed in the other 11 patients. The surgical technique is described in **Table 2**. Mean length

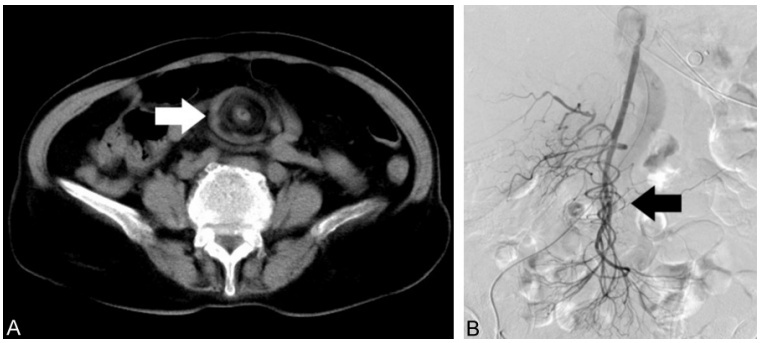


**Figure 1.** A: Abdominal computed tomographic (CT) scan revealed a "whirl sign" involving the small bowel and mesentery around the mesenteric axis (white arrow); B: CT angiography (CTA) revealed a distortion of the superior mesenteric artery (SMA) indicating small bowel volvulus (black arrow).

of resected bowel was 68.8 ± 72.1 cm (range 0-380 cm).

We further compared the differences between necrosis and non-necrosis groups of our patients. Risk factors were summarized in **Table 3**. Peritoneal signs (85.7% in necrosis vs 27.3% in non-necrosis, $P < 0.01$), increased WBC counts (14.3 ± 6.5 × $10^9$/L in necrosis vs 10.6 ± 2.8 × $10^9$/L in non-necrosis, $P = 0.04$), and decreased albumin-globulin ratio (AGR) (1.3 ± 0.2 in necrosis vs 1.5 ± 0.3 in non-necrosis, $P = 0.01$) were significantly associated with bowel necrosis. Meanwhile, our results showed that patients in the necrosis group displayed longer duration of symptoms to surgery (18.5 ± 14.9 hours in necrosis vs 12.5 ± 11.0 hours in non-necrosis, $P = 0.12$) and elevated CRP levels (51.8 ± 40.2 mg/L in necrosis vs 31.7 ± 9.9 mg/L in non-necrosis, $P = 0.06$) compared with the non-necrosis group, although the differences were not statistically significant. Other clinical and laboratory results, including positive shifting dullness (14.3% in necrosis vs 18.2% in non-necrosis, $P = 0.76$), serum levels of ALB (31.8 ± 5.0 g/L in necrosis vs 32.0 ± 6.1 g/L in non-necrosis, $P = 0.46$) and Glo (24.1 ± 3.4 g/L in necrosis vs 22.3 ± 4.7 g/L in non-necrosis, $P = 0.10$) showed no significant differences between the two groups.

Postoperative complications appeared in 13 cases (33.3%) including incision infection (4/39, 10.3%), intra-abdominal infection (3/39, 7.7%), intestinal fistula (2/39, 5.1%) and malnutrition/short bowel syndrome (SBS) (8/39, 20.5%). Among them, two patients suffered from both intestinal fistula and intra-abdominal infection. Mortality rate was 7.7 percent (3 patients). Two (5.1%) patients died of multiple organ failure, and one (2.6) died of sepsis. Causes of morbidity and mortality were described in **Table 4**. Median hospital stay was 32.5 ± 23.4 days (range 9-128 days). To further investigate the correlation between clinical outcomes and bowel necrosis, we performed Student t test and $X^2$ test. Clinical variables included complications, duration of hospital stay, and mortality were analyzed. **Table 5** showed the clinical variables between these two groups. Patients with bowel necrosis were associated with a higher incidence of malnutrition/SBS (28.6% in necrosis vs 0.0% in non-necrosis, $P = 0.047$) and long duration of hospital stay (37.1 ± 25.8 days in necrosis vs 20.7 ± 8.1 days in non-necrosis, $P = 0.02$). In addition, patients in our cohort with bowel necrosis also had a higher incidence of incision infection (10.7% in necrosis vs 9.1% in non-necrosis, $P = 0.88$), intra-abdominal infection (10.7% in necrosis vs 0.0% in non-necrosis, $P = 0.26$), intestinal fistula (7.1% in necrosis vs 0.0% in non-necrosis, $P = 0.36$), and a higher mortality rate (10.7% in necrosis vs 0.0% in non-necrosis, $P = 0.26$) than those without bowel necrosis, although the differences were not statistically significant. We speculated that the limited sample size of the present study might be the primary factor in the prevention of discovery, and believed that larger multicenter studies would be a great advance for exploring the clinical outcomes between necrosis and non-necrosis groups.

## Discussion

Although adult SBV is reported to be common in some areas of Africa, Middle East, and Asia [2, 12], the development of acute SBV in the late postoperative period after gastrectomy is a clinical rarity with few cases noted in medical literature. The etiologies, clinical features and clinical outcomes of this complication is therefore not well understood. It has been proposed that predisposing factors could include postoperative adhesions/bands, weight reduction,

**Table 3.** Clinical and laboratory parameters between necrosis and non-necrosis groups

| | Necrosis (n = 28) | Non-necrosis (n = 11) | *P* value |
|---|---|---|---|
| Clinical presentations | | | |
| Peritoneal signs, No. (%) | 24 (85.7) | 3 (27.3) | < 0.01* |
| Positive shifting dullness, No. (%) | 4 (14.3) | 2 (18.2) | 0.76 |
| Laboratory parameters | | | |
| WBC, × $10^9$/L | 14.3 ± 6.5 | 10.6 ± 2.8 | 0.04* |
| CRP, mg/L | 51.8 ± 40.2 | 31.7 ± 9.9 | 0.06 |
| ALB, g/L | 31.8 ± 5.0 | 32.0 ± 6.1 | 0.46 |
| Glo, g/L | 24.1 ± 3.4 | 22.3 ± 4.7 | 0.10 |
| AGR | 1.3 ± 0.2 | 1.5 ± 0.3 | 0.01* |
| Duration of symptoms to surgery (hour) | 18.5 ± 14.9 | 12.5 ± 11.0 | 0.12 |

Note. AGR, albumin-globulin ratio; ALB, albumin; CRP, C-reactive protein; Glo, globulin; WBC, white blood cell. *Statistically significant ($P < 0.05$).

**Table 4.** Postoperative morbidity and mortality causes of the study population

| Characteristics | Value |
|---|---|
| Morbidity | |
| Incision infection, No. (%) | 4 (10.3) |
| Intra-abdominal infection, No. (%) | 3 (7.7) |
| Intestinal fistula, No. (%) | 2 (5.1) |
| Malnutrition/short bowel syndrome, No. (%) | 8 (20.5) |
| Total Mortality | |
| Multiple organ failure, No. (%) | 2 (5.1) |
| Sepsis, No. (%) | 1 (2.6) |

**Table 5.** Complications and hospital courses between necrosis and non-necrosis groups

| | Necrosis (n = 28) | Non-necrosis (n = 11) | *P* value |
|---|---|---|---|
| Complications | | | |
| Incision infection, No. (%) | 3 (10.7) | 1 (9.1) | 0.88 |
| Intra-abdominal infection, No. (%) | 3 (10.7) | 0 (0.0) | 0.26 |
| Intestinal fistula, No. (%) | 2 (7.1) | 0 (0.0) | 0.36 |
| Malnutrition/SBS, No. (%) | 8 (28.6) | 0 (0.0) | 0.047* |
| Hospital stay (day) | 37.1 ± 25.8 | 20.7 ± 8.1 | 0.02* |
| Mortality, No. (%) | 3 (10.7) | 0 (0.0) | 0.26 |

Note. SBS, short bowel syndrome. *Statistically significant ($P < 0.05$).

and rapid filling of the empty bowel with large quantities of poorly digestible food [1, 13]. Postoperative adhesions/bands are thought to play an important role in the development of SBV, which may create an axis around which the small bowel can rotate [14]. In our study, it has been confirmed that adhesions and bands were the most frequent related conditions of SBV after gastrectomy (n = 32, 82.1%). Weight reduction after gastrectomy is considered to be another predisposing factor, which leads to decreased intra-abdominal fat. The absence of excessive fat padding of the mesentery and retroperitoneum permits increased bowel mobility and makes it easy to twist [15]. In our series, the average BMI was 17.6 kg/$m^2$, which was slightly lower than normal level and might have contributed to rotating the small bowel and its mesentery. Furthermore, rapid food transit into the empty bowel may produce a heavy segment of the small bowel, which may alter the small bowel motility and make it easily drift to a lower resistant part of the abdominal cavity [13]. Of note, we did not evaluate this parameter due to the imperfect data of retrospective analysis. However, we speculate that SBV in these patients might be caused by a heavy bowel portion, which contained food, that is prevented from drifting freely in the abdominal cavity by the adhesions/bands and is thus ultimately forced to rotate around a mesenteric axis. In addition, previous literature has estimated that secondary volvulus is more frequent among males, which is similar to our data [16].

Early diagnosis is necessary to avoid life-threatening complications and to achieve good outcomes. However, it can be difficult because

symptoms are sometimes nonspecific, and laboratory findings are often unremarkable. The clinical features described in our patients confirmed the results of previous publications, with sudden abdominal pain the most frequent symptom followed by nausea and vomiting [8, 17]. Peritoneal signs were present in 69.2% of our patients. In our cases, the serum levels of WBC and CRP were obviously higher than normal standards, while the serum level of ALB was distinguished lower than the normal, suggesting the status of inflammatory response of body in patients with acute SBV in the late postoperative period after gastrectomy. Apart from a thorough medical history and good physical and laboratory examinations, the imaging tests are also important for the prompt diagnosis of SBV [3]. However, plain X-rays usually show nonspecific features, presenting low accuracy in the diagnosis of the SBV, as referred to in our study. CT scan of the abdomen is the imaging technique of choice, which may facilitate preoperative diagnosis. Partial or complete small bowel obstruction may be revealed, and the "whirl sign" is highly suggestive of SBV. Most cases are diagnosed as SBV based on the presence of a "whirl sign" on CT scan. Other characteristic CT findings can include bowel wall edema and intra-peritoneal fluid [3, 8]. In our patients, a total of thirty-four CT scans have been performed, a test that in our series achieves an accuracy of 55.9% in the diagnosis of SBV, and 23.5% with positive "whirl sign". But CT scan may not make a definitive diagnosis in some cases, as in 15 of our patients. Angiographic appearance of the twisted mesenteric vessels may also suggest SBV. However, CTA may be time-consuming and invasive, limiting its use under emergency situations. Although our results referring to CT scan accuracy were as low as 55.9%, other authors have reported accuracy of 80-90% [8]. Therefore, we think that this test should be performed in all the patients suspicious of having SBV, especially those cases with previous gastrectomy presenting a nonspecific small bowel obstruction pattern. In our experience, timely diagnosis depends on maintaining a high degree of suspicion and conventional imaging studies which will depict the SBV. In case of doubt, exploratory laparotomy is helpful in order to avoid dreadful consequences.

Management of acute SBV following gastrectomy is surgical intervention consisting of a laparotomy, release of the volvulus, and resection of the necrotic bowel with or without anastomosis [6-8]. During surgery, careful devolvulation of the involved segment is needed when the bowel is viable. Every effort must be made to avoid iatrogenic bowel injury during this process. Necrotic segments of the small bowel should be removed by partial or massive bowel resection as required. Of note, resection of bowel is indicated only in cases of nonviability to avoid complications of postoperative SBS. To avoid recurrence of the volvulus, bowel fixation or appropriate resection of the small bowel may also be conducted. As in our cases, the rate of bowel resection was high to 71.8% with primary anastomosis performed in 53.6% cases, the rate of simple devolvulation was 28.2%. Unfortunately, 20.5% patients suffered from SBS with catastrophic complications caused by massive small bowel resection. However, most of our patients (n = 36, 92.3%) survived as a result of good preoperative decision and proper postoperative care, only 3 patients died of multiple organ failure (n = 2) and sepsis (n = 1). The outcome was dependent on the speed of diagnosis leading to surgical intervention and the amount of small bowel resected. This was essential in our series.

The most frequent complications included malnutrition/SBS (n = 8, 20.5%) and incision infection (n = 4, 10.3%), followed by intra-abdominal infection (n = 3, 7.7%) and intestinal fistula (n = 2, 5.1%). Previous studies recommended resection and anastomosis in all SBV regardless of whether bowel necrosis was present [16, 18]. However, resection and anastomosis imply a higher surgical aggression and consequently an increasing rate of postoperative complications. Therefore, we think that the decision of whether to perform a resection must be individualized in each patient, depending on general status, comorbidities, and intra-operative findings, comparing surgical risk with the possibility of postoperative morbidity and mortality.

To the best of our knowledge, no single diagnostic clinical sign identified the presence of bowel necrosis, and no single laboratory test was found to reliably differentiate necrotic from viable small bowel. In this study, we calculated

the clinical and laboratory parameters to evaluate the risk factors of bowel necrosis in patients with acute SBV in the late postoperative period after gastrectomy. Our results demonstrated that peritoneal signs were associated with the presence of bowel necrosis ($P < 0.01$), as also occurs with increased WBC counts ($P = 0.04$) and decreased albumin-globulin ratio (AGR) ($P = 0.01$). However, since the parameters of positive shifting dullness, serum levels of WBC, ALB and Glo, and duration of symptoms to surgery between these two groups were not significant enough to reach statistical standard, larger multicenter studies were expected to further explore the risk factors of bowel necrosis in patients with acute SBV in the late postoperative period after gastrectomy.

We also considered bowel necrosis was the predisposing factor for the presence of postoperative malnutrition/SBS and long hospital stay in current study. Although the differences of other morbidity (incision infection, intra-abdominal infection, and intestinal fistula) and mortality were not statistically significant between bowel necrosis and non-necrosis groups. We speculate that the limited sample size of the present study might be the primary factor in the prevention of discovery, and believe that larger multicenter studies will be a great advance for exploring the different prognostic outcomes between these two groups.

In conclusion, SBV is a rare late-onset complication following gastrectomy but it represents a surgical emergency. The main aim is to achieve an early diagnosis to prevent or decrease the amount of necrotic small bowel. Sudden abdominal pain and nausea/vomiting in patients with a history of gastrectomy could indicate the occurrence of SBV. CT scan is the imaging test of choice for its diagnosis and sometimes can be confirmed by the finding of a "whirl sign". When diagnosed early, surgery solely accounts for lower morbidity and mortality. However, when the diagnosis is delayed, necrosis of small bowel may occur, which may be fatal. In case of doubt, we recommend emergency laparotomy should be performed immediately to avoid catastrophic outcomes resulting in bowel necrosis and ultimately death.

## Disclosure of conflict of interest

None.

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## References

[1] Tan EC, Jager GJ, Bleeker WA and Van Goor H. Portal venous air in an adult patient with obstructive small bowel volvulus. Dig Surg 2002; 19: 400-402.

[2] Coe TM, Chang DC and Sicklick JK. Small bowel volvulus in the adult populace of the United States: results from a population-based study. Am J Surg 2015; 210: 201-210, e2.

[3] Lin YP, Lee J, Chao HC, Kong MS, Lai MW, Chen CC, Chen SY and Luo CC. Risk factors for intestinal gangrene in children with small-bowel volvulus. J Pediatr Gastroenterol Nutr 2011; 53: 417-422.

[4] Zheng ZH, Huang JL, Wei HB, Liu JP and Huang Y. Adult congenital intestinal malrotation accompanied by midgut volvulus: report of eight cases. Int J Clin Exp Med 2014; 7: 1614-1618.

[5] Takemura M, Iwamoto K, Goshi S, Osugi H and Kinoshita H. Primary volvulus of the small intestine in an adult, and review of 15 other cases from the Japanese literature. J Gastroenterol 2000; 35: 52-55.

[6] Cong Q, Li X, Ye X, Sun L, Jiang W, Han Z, Lu W and Xu H. Small bowel volvulus in mid and late pregnancy: can early diagnosis be established to avoid catastrophic outcomes? Int J Clin Exp Med 2014; 7: 4538-4543.

[7] Frazee RC, Mucha P Jr, Farnell MB and van Heerden JA. Volvulus of the small intestine. Ann Surg 1988; 208: 565-568.

[8] Ruiz-Tovar J, Morales V, Sanjuanbenito A, Lobo E and Martinez-Molina E. Volvulus of the small bowel in adults. Am Surg 2009; 75: 1179-1182.

[9] Kim MC, Kim W, Kim HH, Ryu SW, Ryu SY, Song KY, Lee HJ, Cho GS, Han SU, Hyung WJ; Korean Laparoscopic Gastrointestinal Surgery Study (KLASS) Group. Risk factors associated with complication following laparoscopy-assisted gastrectomy for gastric cancer: a large-scale Korean multicenter study. Ann Surg Oncol 2008; 15: 2692-2700.

[10] von Holstein CS. Long-term prognosis after partial gastrectomy for gastroduodenal ulcer. World J Surg 2000; 24: 307-314.

[11] Chin GS, Heng R, Neesham DE and Petersen RW. Small intestinal volvulus following laparotomy for endometrial clear cell carcinoma in a woman with a past history of total gastrectomy and Roux-en-Y anastomosis for gastric carcinoma. Gynecol Oncol 2002; 87: 319-322.

[12] Karabulut Z and Doğan P. Small bowel volvulus secondary to post appendectomy adhesion band. Turk J Gastroenterol 2013; 24: 298-299.
[13] Sakamoto T, Miyata M, Nakamuro M, Izukura M, Kamiike W and Matsuda H. The development of a small bowel volvulus in the early postoperative period following a distal gastrectomy: report of a case. Surg Today 1994; 24: 1078-1080.
[14] Sherer DM and Abulafia O. Postcesarean small bowel volvulus. Case report and review of the literature. Gynecol Obstet Invest 2001; 51: 69-72.
[15] Vaez-Zadeh K, Dutz W and Nowrooz-Zadeh M. Volvulus of the small intestine in adults: a study of predisposing factors. Ann Surg 1969; 169: 265-271.
[16] Iwuagwu O and Deans GT. Small bowel volvulus: a review. J R Coll Surg Edinb 1999; 44: 150-155.
[17] Liao YC, Chiu HH and Huang TC. Education and imaging. Gastrointestinal: small bowel volvulus. J Gastroenterol Hepatol 2008; 23: 1625.
[18] Kim KH, Kim MC, Kim SH, Park KJ and Jung GJ. Laparoscopic management of a primary small bowel volvulus: a case report. Surg Laparosc Endosc Percutan Tech 2007; 17: 335-338.