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Case Report

Repeated Duodenal Stump Perforation Using a Stapling Device Following Subtotal Gastrectomy With Roux-en-Y Reconstruction for Advanced Gastric Cancer: Lessons From a Rare Case

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Closure of the duodenal stump using a stapling device is commonly applied in Roux-en-Y reconstruction after gastrectomy. However, serious and possibly fatal duodenal stump perforation can develop in extremely rare cases. We describe a case of subtotal gastrectomy with Roux-en-Y reconstruction followed by repeated duodenal stump perforations. A 79-year-old man with a long history of diabetes and hypertension was admitted to our institution with epigastralgia and right hypochondralgia. Computed tomography and an upper gastrointestinal imaging series revealed remarkable wall thickening of the gastric antrum and corpus. Upper endoscopy also showed a giant ulcerative lesion in the same area. The lesion was confirmed by histology to be poorly differentiated adenocarcinoma. The patient underwent open subtotal gastrectomy with Roux-en-Y reconstruction. However, duodenal stump perforation occurred repeatedly on postoperative days 1, 3, and 19, which caused peritonitis. The patient was kept alive

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through duodenal stump repair, an additional resection using a stapling device, and repeated drainage treatments; but he suffered considerable morbidity due to these complications. We report a case of a life-threatening duodenal stump perforation after subtotal gastrectomy, highlighting lessons learned from the profile and clinical course. Abdominal surgeons should be aware of the possibility of this serious complication of duodenal stump perforation, and be able to perform immediate interventions, including life-saving reoperation.

Key words: Duodenal stump perforation – Roux-en-Y – Gastrectomy – Gastric cancer – Stapling device

Gastric cancer remains the second leading cause of cancer mortality in the world. Surgical resection with lymphadenectomy is the only curative treatment. Enteric leakage is a significant complication of the gastroenterological surgery, and duodenal stump leakage is the main cause of postoperative mortality after Billroth II and Roux-en-Y reconstruction following gastrectomy.[1–3] Advances in surgical techniques and devices, and nutritional support have reduced mortality due to duodenal stump leakage to approximately 5%,[3,4] but this number could still be improved.

Several linear stapling devices have recently become available and are commonly used for performing an anastomosis or transaction of the digestive tract in gastroenterological surgery. However, there have been several reports of staple-line leaks in laparoscopic Roux-en-Y bypass, especially in bariatric surgery.[5–7] An anastomotic leakage can occur under certain unfavorable conditions in spite of the surgeon's experience level.[5] Nevertheless, surgeons should make every effort to avoid this complication. Moreover, once duodenal stump perforation occurs, every surgeon must take every necessary measure to avoid operative mortality via a systematic strategy. Herein, we describe the management of a case of repeated perforation of the duodenal stump after Roux-en-Y reconstruction in subtotal gastrectomy, highlighting lessons learned from the profile and clinical course, and propose a strategic algorithm for duodenal stump perforation in gastric surgery.

Case Report

A 79-year-old man with diabetes and hypertension had been regularly visiting the internal medicine department of our institution to receive oral antihyperglycemic drugs and hypotensive agents. The patient had complained of epigastralgia and right hypochondralgia for several days and was admitted to the hospital. He had no family history of these disorders. The patient had a body mass index of 26.3 kg/m^2. Laboratory data showed elevated hepatobiliary enzymes; aspartate aminotransferase (AST) of 381 IU/mL (normal range [NR]): < 35 IU/mL); alanine transaminase (ALT) of 289 IU/mL (NR: < 35 IU/mL); gamma-glutamyl transpeptidase (γ-GTP) of 664 IU/mL (NR: < 50 IU/mL); total bilirubin of 1.4 mg/mL (NR: 0.2–1.0 mg/dL); direct bilirubin of 0.7 mg/mL (NR: 0.0–0.2 mg/dL); and amylase of 344 IU/L (NR: 40–132 IU/L). These elevated hepatobiliary enzymes were likely due to a gall stone located in the common bile duct and a history of nonalcoholic fatty liver disease. Though stones might have passed through the common bile duct, stones were not identified on endoscopic retrograde cholangiopancreatography, and the hepatobiliary enzymes turned almost normalized afterward. The patient had mild elevation of fasting blood sugar levels (120 mg/dL: NR: 70–109 mg/dL) and HbA1C (6.5%: NR: 4.6–6.2%). Carcinoembryonic antigen ([CEA] 4.0 ng/mL: NR: < 5.0 ng/mL) and serum carbohydrate antigen ([CA 19-9] 23.4 U/mL: NR: < 37 U/mL) were within normal range. Computed tomography and an upper gastrointestinal imaging series revealed remarkable wall thickening of the gastric antrum and corpus (Fig. 1A). To make a definite diagnosis, the patient underwent upper endoscopy that showed a giant ulcerative lesion in the same area (Fig. 1B). The preoperative diagnosis was poorly differentiated adenocarcinoma. The patient underwent open subtotal gastrectomy with Roux-en-Y reconstruction (Fig. 2) and cholecystectomy. The length of the residual stomach was not sufficient to make an anastomosis to the duodenum. We therefore transected the duodenum using GIA 60-3.8 (Tyco Healthcare, Tokyo, Japan). Since the duodenal stump seemed to be vulnerable, we did not annex the seromuscular sutures. No periopera-

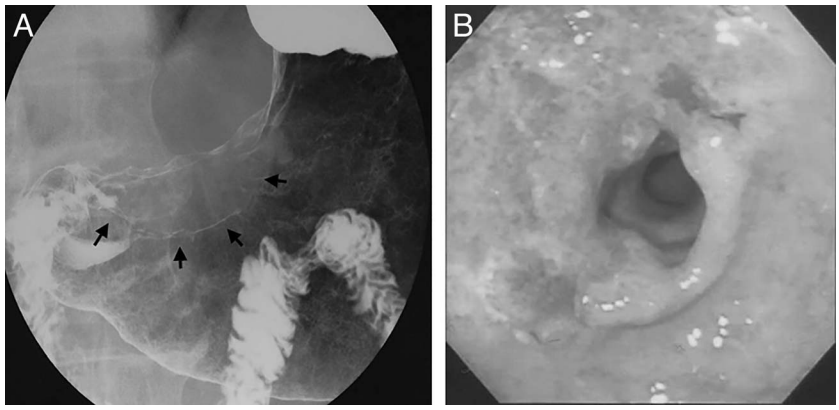

Fig. 1 (A) Computed tomography and an upper gastrointestinal imaging series revealed remarkable wall thickening of the gastric antrum and corpus. (B) Upper endoscopy revealed a giant ulcerative lesion at the gastric antrum and corpus.

tive complications were encountered. However, on the first postoperative day, approximately 300 mL of intestinal fluids drained through the tube to the foramen of Winslow. Subsequently, the patient started to complain of abdominal pain with peritoneal signs. We suspected there was an anastomotic leakage probably due to partial opening of the duodenal stump. Upon emergency exploration by open laparotomy, a perforation of the duodenal stump at the side of the posterior wall was identified. The perforation site located approximately 5 mm from the duodenal stump (Fig. 3A). We tried to repair the duodenal stump by an additional resection including the perforation site, using an endo-GIA Universal Roticulator 60-4.8 (Tyco Healthcare; Fig. 3B). We additionally placed drain tubes to the rectovesical pouch to look for a retained abscess or other complications. Histopathology of the resected duodenum including the perforation site revealed no cancerous infiltrate. On the third postoperative day, 770 mL of intestinal fluids once again drained through the tubes, and the patient again complained of peritoneal signs. We performed a third surgery. Another perforation of the duodenal stump at the side of the posterior wall was detected upon laparotomy (Fig. 4). With all repetitive Kocher's maneuvers, the duodenal stump was closely situated to the ampulla of Vater, and the residual duodenum was too short and vulnerable to be closed. We established draining of intestinal fluids to the external fistulas via a Foley catheter into the duodenum through the perforation site. We also established 2 other external fistulas, one for biliary and pancreatic tract decompression from the cystic duct of the gallbladder using a thin tube widely used for pancreatic duct drainage, and the other for duodenal decompression using a nasogastric tube from the side of the jejunojejunostomy. The patient slowly improved and intestinal fluid, bile, and pancreatic juice draining into the abdominal cavity reduced. However, on postoperative day 19, a massive hemorrhage of unknown origin was observed from the jejunal decompression tube and drain tube into the foramen of Winslow. This necessitated performing a fourth operation. The duodenal stump was completely ruptured and could no longer be closed in a typical manner. Therefore, we inserted a thicker Foley catheter into

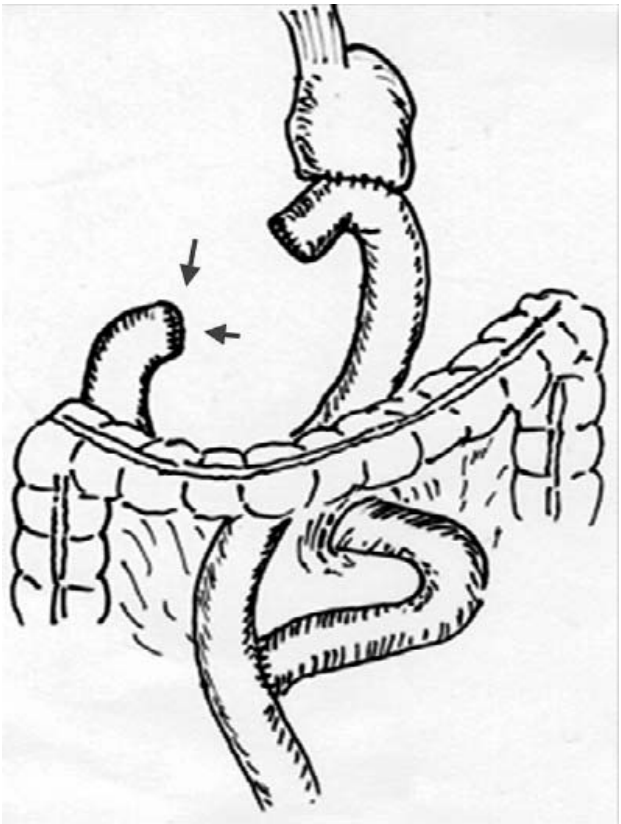

Fig. 2 Open subtotal gastrectomy with Roux-en-Y reconstruction in the present case.

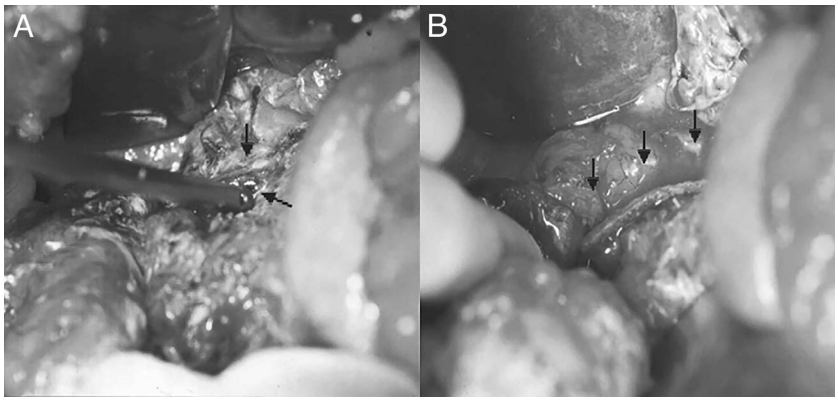

Fig. 3 (A) Upon emergency exploration by open laparotomy on the first postoperative day, a duodenal stump perforation on the side of the posterior wall was identified. (B) We repaired the duodenal stump by resection of the perforation site using endo-GIA.

the duodenum from the ruptured stump, and made interrupted sutures to close the stump. We also established a drainage system by placing irrigation tubes. Thereafter, we irrigated the abdominal cavity using saline, mainly around the duodenal stump (Fig. 5A, 5B). The patient improved. On postoperative day 31, fistulography demonstrated no leakage from the duodenal stump. The patient began oral fluid intakes and a fluid diet on postoperative days 23 and 43, respectively. The lesion was classified by pathology as Borrmann type 4 and was a poorly differentiated adenocarcinoma with vascular and lymphatic invasion and nodal metastases. According to the TNM classification, it was defined as T4a, N2, and M0, stage IIIB.[8] The patient survived all surgical complications, but malignant ascites and pleural effusion appeared due to the tumor. The patient succumbed to exacerbation of the original lesion about 4 months after the first operation.

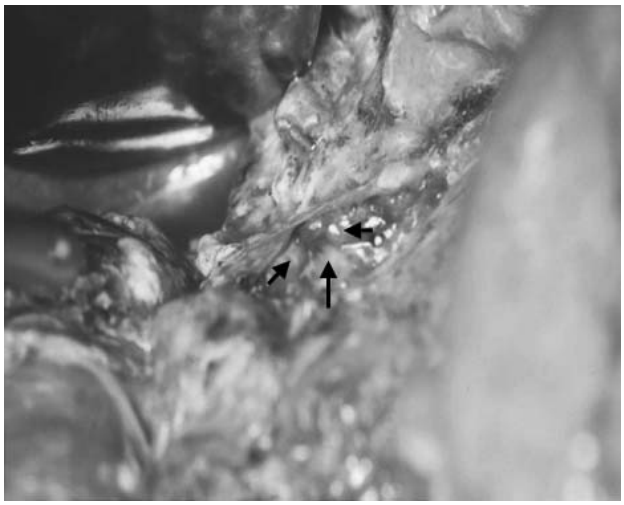

Fig. 4 A second duodenal stump perforation on the side of the posterior wall occurred.

Discussion

Causes of repeated perforation of the duodenum in subtotal gastrectomy may be as follows: misfiring of stapling device, staple-line bleeding, staple–line leaks, etc. Gonzalez *et al*[5] stated that the incidence of staple-line leaks appears to be independent of the number of Roux-en-Y gastric bypasses performed by the surgeons. In addition, Baker *et al*[9] described that staple-line leaks are a seemingly unavoidable complication of stapling associated with bariatric surgery. They also categorized staple-line leaks into 2 main categories: mechanical/tissue and ischemic causes. The staple-line perforation in the present case is likely from mechanical pressure based on the short amount of time from the first operation to the perforation. Baker *et al*[9] also described that increasing compression will produce excess tissue shear or tensile stress resulting in tissue tearing. In the present case, the stapling device may have damaged adjacent tissue. Second, intestinal vulnerability due to chronic blood supply insufficiency caused by the patient's diabetes could have caused the repeated perforations of the duodenum. Preoperatively, the patient had mild glucose intolerance and had been diagnosed with diabetes for over 5 years. Preoperatively, the patient was obese with a high body mass index (26.3 kg/m^2) and HbA1c (6.5%). However, subtotal gastrectomy should have been a tolerable surgery for him. A combination of chronic blood supply insufficiency and excessive mechanical compression by a linear stapling device could have caused the perforation. A third potential cause could have been cancerous infiltration into the duodenum. However, histopathology from the resected duodenum at the second operation revealed no cancer cell infiltrates. Fourth, pressure and tension on the duodenal stump possibly were increased by acute afferent loop obstruction, but

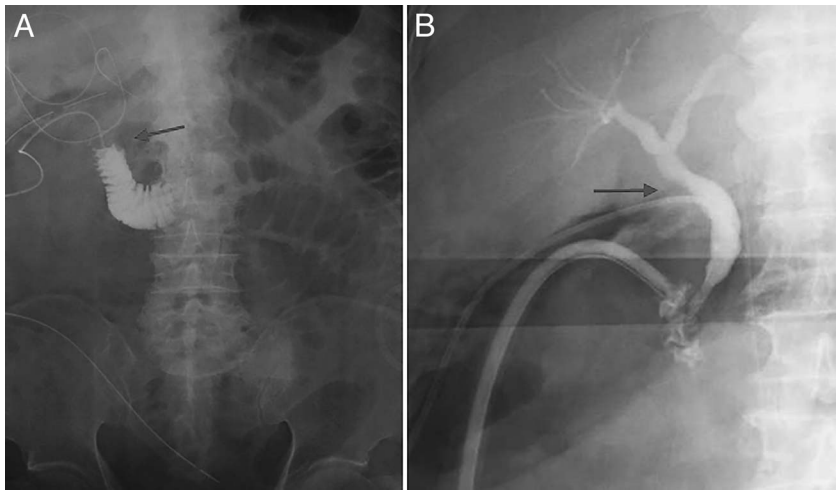

Fig. 5 (A) A Foley catheter was placed through the perforation site (arrow). (B) A thin drainage tube was placed in the bile duct through the cystic duct of the gallbladder (arrow).

intraoperative findings proved this hypothesis incorrect. We conclude that the cause of multiple duodenal stump perforations remains unknown, but consider the stapling device to have been the most likely cause. While mechanical stapler is generally regarded as a good alternative to the hand-sewing technique when used in gastric reconstruction, Kim *et al*[10] reported that duodenal stump leakage is induced significantly more frequently by using stapling device than by hand-sewn closure (hand-sewn: 0 out of 263 cases, staple: 13 out of 919 cases).

Duodenal stump perforation after gastrectomy can be fatal. Kumagai *et al*[11] mentioned that duodenal stump leakage was observed more frequently in Roux-en-Y reconstruction than in Billroth-I reconstruction in laparoscopy-assisted distal gastrectomy. Treatment of duodenal stump leakage is a key step in Billroth-II and Roux-en-Y reconstruction due to the high risk of morbidity and mortality associated with this complication.[4] Mortality caused by duodenal stump leakage remains 5% despite advances in surgical techniques, antibiotics, and nutritional support.[3] Among the records of 8033 patients who underwent gastrectomy for gastric adenocarcinoma in a single institute, duodenal stump leakage was observed in 3.1% of 162 patients with complications that required re-operation.[12] Gong DJ *et al* also described duodenal stump leakage occurred in 3 among 44 patients with postoperative morbidity.[2] Once a perforation occurs, duodenal fluids, including bile and pancreatic juice, start to leak into the abdominal cavity. Peritonitis can associate with intra-abdominal bleeding and infection, possibly resulting in death. In the present case, the patient was saved by persistent, continuous drainage of bile, pancreatic juice, and intestinal fluids and by irrigation of the abdominal cavity by saline. Though we had not previously experienced a similar case, and we do not know how to avoid this complication, there are some points that we must reflect upon. We omitted seromuscular sutures at the first operation because of the vulnerability of the duodenum. However, even with seromuscular sutures, the perforation would likely still have occurred, because the perforation site was 5 mm from the duodenal stump. A duodenal stump is generally made simply by a laparoscopic suturing device without reinforced seromuscular sutures. Whether GIA or endo-GIA was used for transection of the duodenum did not impact the perforation in the present case. We took advantage of an endo-GIA Universal to close the perforated stump more thoroughly than using GIA, but another perforation still occurred. It is possible that hand-sewn sutures may have helped to avoid excessive tension on the duodenal stump in the second surgery. Placing a decompression tube into the duodenum to reduce pressure on the blind end of duodenum may also have helped. Further, if we had established a draining system with tubes in the pancreatic duct and bile duct separately to divert fluids, the fourth operation may have been avoided. Collectively, we should not have finished reoperation without decompression of duodenum and biliary tract. Besides, if possible, an external fistula of the pancreatic duct should be indwelled under direct visual guidance of intraoperative endoscopy or some means. In spite of the complications arising in this case, suturing devices are absolutely essential for abdominal surgery, especially minimally invasive surgery. The Endo-GIA Tri-staple (Covidien,

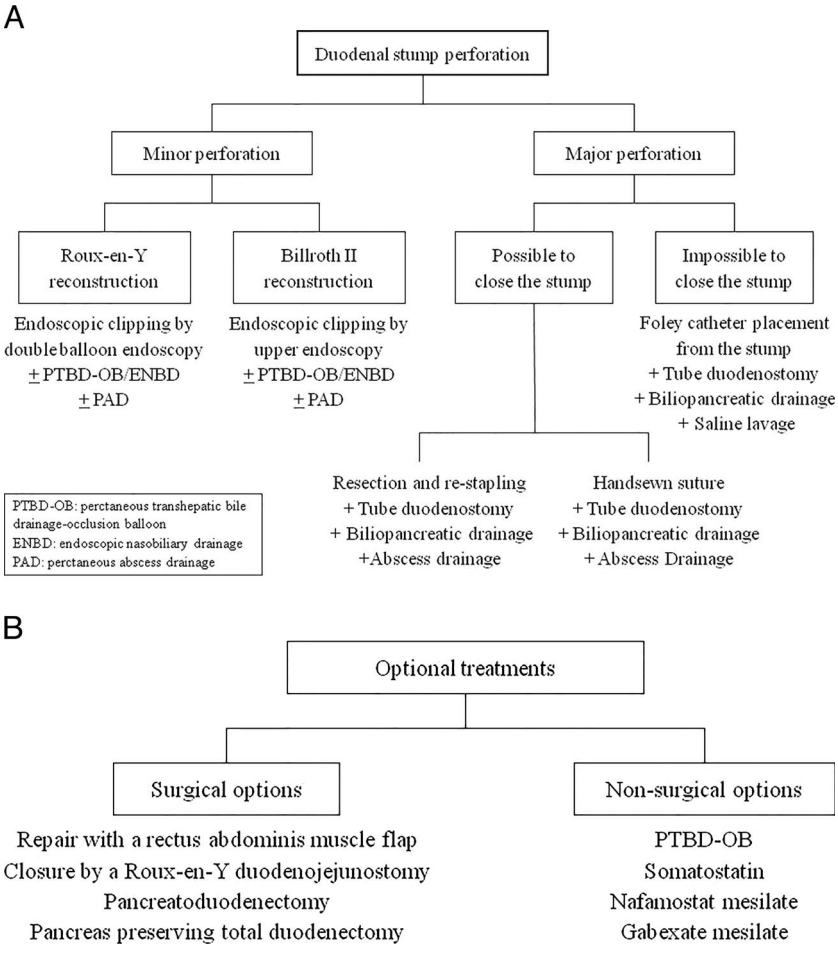

Fig. 6 (A) Our recommendation of strategic algorithm for duodenal stump perforation in gastrectomy. (B) Other optional treatments for duodenal stump perforation in gastrectomy.

Tokyo, Japan) is technically improved over the Endo-GIA Universal. This device is useful in transecting thick organs and can reduce pressure on tissue adjacent to the staple line. However, no matter how stapling devices improve, it may be impossible to be perfect.

Moreover, in a recent study, duodenal stump perforation associated morbidity rate has reached 84%, while mortality rate ranged from 5 to 16%.[13–15] This rate should not be ignored. Through the present case and review of the literature, we propose a strategic algorithm for duodenal stump perforation following gastrectomy in Fig. 6A and 6B. Whether the approaches in the algorithm are feasible or not depends on the conditions of each case; however, we have to make a strategic plan on the basis of previous occurrence of duodenal perforation. Because no matter how stapling devices improve, it may be impossible to reduce complications to zero. As shown in Fig. 6A, if the perforation site is minor, endoscopic treatment can be an option, while immediate surgical intervention is required if the perforation is major. Lee *et al*[16] described a successful endoscopic clipping in a case of duodenal stump leakage after Billroth II gastrectomy. Re-stapling or hand-sewn sutures with tube duodenostomy for decompression and percutaneous trans-hepatic bile drainage with occlusion balloon (PTBD-OB) are preferable.[13,17] While PTBD-OB can be well applied in cases of bile duct dilatation, external fistula of the bile via a cystic duct of the gallbladder is available even for the cases without bile duct dilatation. Even if the stump is firmly repaired in the second surgery, a decompression tube for duodenum and PTBD-OB or bile drainage via a cystic duct should be performed. These treatments may make sense in reducing back pressure and in protecting the exposure of physiologically activated pancreatic juice from the repaired stump. However, re-stapling or hand-sewn sutures should not be indicated depending on the intraoperative conditions such as tissue fragility of the stump. In such cases, placing a Foley catheter at the stump, tube

duodenostomy from the jejunum, and PTBD-OB or bile drainage via a cystic duct as an external fistula can be the only option.[18] Constructing the system of peritoneal perfusion by saline may also help to promote healing a duodenal fistula as the present case showed. Nonsurgical options such as somatostatin, nafamostat mesilate, and gabexate mesilate are naturally applicable as non-stressed supplementary treatment (Fig. 6B).

In conclusion, we report a case of a life-threatening duodenal stump perforation after subtotal gastrectomy. Abdominal surgeons should be aware of the possibility of this serious complication of duodenal stump perforation, and be able to perform immediate interventions, including life-saving re-operation. Bearing a strategic algorithm in mind may be helpful for abdominal surgeons in treating this devastating complication.

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References

1. Hoya Y, Mitsumori N, Yanaga K. The advantages and disadvantages of a Roux-en-Y reconstruction after a distal gastrectomy for gastric cancer. *Surg Today* 2009;**39**(8):647–651
2. Gong DJ, Miao CF, Bao Q, Jiang M, Zhang LF, Tong XT *et al*. Risk factors for operative morbidity and mortality in gastric cancer patients undergoing total gastrectomy. *World J Gastroenterol* 2008;**14**(42):6560–6563
3. Koksoy FN, Gonullu D, Catal O, Kuroglu E. Risk factors for operative mortality and morbidity in gastric cancer undergoing D2-gastrectomy. *Int J Surg* 2010;**8**(8):633–635
4. Shao QS, Wang YX, Ye ZY, Zhao ZK, Xu J. Application of purse-string suture for management of duodenal stump in radical gastrectomy. *Chin Med J (Engl)* 2011;**124**(7):1018–1021
5. Gonzalez R, Haines K, Gallagher SF, Murr MM. Does experience preclude leaks in laparoscopic gastric bypass? *Surg Endosc* 2006;**20**(11):1687–1692
6. Simper SC, Erzinger JM, Smith SC. Comparison of laparoscopic linear staplers in clinical practice. *Surg Obes Relat Dis* 2007;**3**(4):446–450; discussion 450–451
7. Carrasquilla C, English WJ, Esposito P, Gianos J. Total stapled, total intra-abdominal (TSTI) laparoscopic Roux-en-Y gastric bypass: one leak in 1000 cases. *Obes Surg* 2004;**14**(5):613–617
8. Sobin LH, Gospodarowicz MK, Wittekind Ch, eds. TNM Classification of Malignant Tumors. 7th ed. New York, NY: Wiley & Blackwell, 2010:70–74
9. Baker RS, Foote J, Kemmeter P, Brady R, Vroegop T, Serveld M. The science of stapling and leaks. *Obes Surg* 2004;**14**(10):1290–1298
10. Kim KH, Kim MC, Jung GJ. Risk factors for duodenal stump leakage after gastrectomy for gastric cancer and management technique of stump leakage. *Hepatogastroenterology* 2014;**61**(133):1446–1453
11. Kumagai K, Hiki N, Nunobe S, Jiang X, Kubota T, Aikou S *et al*. Different features of complications with Billroth-I and Roux-en-Y reconstruction after laparoscopy-assisted distal gastrectomy. *J Gastrointest Surg* 2011;**15**(12):2145–2152
12. Oh SJ, Choi WB, Song J, Hyung WJ, Choi SH, Noh SH *et al*. Complications requiring reoperation after gastrectomy for gastric cancer: 17 years experience in a single institute. *J Gastrointest Surg* 2009;**13**(2):239–245
13. Vasiliadis K, Fortounis K, Kokarhidas A, Papavasiliou C, Nimer A, Stratilati S *et al*. Delayed duodenal stump blow-out following total gastrectomy for cancer: heightened awareness for the continued presence of the surgical past in the present is the key to a successful duodenal stump disruption management. A case report. *Int J Surg Case Rep* 2014;**5**(12):1229–1233
14. Orsenigo E, Bissolati M, Socci C, Chiari D, Muffatti F, Nifosi J *et al*. Duodenal stump fistula after gastric surgery for malignancies: a retrospective analysis of risk factors in a single centre experience. *Gastric Cancer* 2014;**17**(4):733–744
15. Cozzaglio L, Coladonato M, Biffi R, Coniglio A, Corso V, Dionigi P *et al*. Duodenal fistula after elective gastrectomy for malignant disease: an Italian retrospective multicenter study. *J Gastrointest Surg* 2010;**14**(5):805–811
16. Lee JY, Ryu KW, Cho SJ, Kim CG, Choi IJ, Kim MJ *et al*. Endoscopic clipping of duodenal stump leakage after Billroth II gastrectomy in gastric cancer patient. *J Surg Oncol* 2009;**100**(1):80–81
17. Cozzaglio L, Cimino M, Mauri G, Ardito A, Pedicini V, Poretti D *et al*. Percutaneous transhepatic biliary drainage and occlusion balloon in the management of duodenal stump fistula. *J Gastrointest Surg* 2011;**15**(11):1977–1981
18. Oh JS, Lee HG, Chun HJ, Choi BG, Lee SH, Hahn ST *et al*. Percutaneous management of postoperative duodenal stump leakage with Foley catheter. *Cardiovasc Intervent Radiol* 2013;**36**(5):1344–1349