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Review Article

Interventional radiology for post-gastrectomy complications

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ABSTRACT

Complications following gastrectomy can be life-threatening, but, they are commonly managed by interventional radiology. This review describes possible complications after gastrectomy by dividing them into vascular and non-vascular categories. Vascular complications are mostly arterial bleeding and varix bleeding. Non-vascular complications comprise abscess, fistula, benign anastomotic stricture, and malignant obstruction, e.g. afferent loop syndrome, by tumor recurrence. Interventional managements for treatment of post-gastrectomy complications are safe, effective, and less invasive compared with surgery.

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Keywords: Abscess; Gastrectomy; Hemorrhage

Introduction

In South Korea, gastric cancer is the second most common cancer and the third most common cause of death.¹ About 20,000 cases of gastrectomy are performed annually in South Korea. The most common cause of the surgery is gastric cancer, but many other diseases (e.g., benign gastric tumor, gastric ulcer, life-threatening obesity, etc.) contribute to the causes of the surgery.²

It is important to detect and treat complications after gastrectomy because some of them recover without treatment, but others might be life-threatening. Most of the complications are commonly managed by interventional radiology procedures.

This review describes possible complications after gastrectomy by dividing them into vascular and non-vascular categories, with emphasis on interventional procedures to manage these complications.

Vascular Complications

Arterial bleeding

Etiology

In the early postoperative period (within 24 hours after surgery), hemorrhage may originate from the anastomosis site due to

insufficient vascular ligation or hemostasis at the surgical field.³ In the late postoperative period (beyond 24 hours after surgery), on the other hand, it may originate from ruptured pseudoaneurysms.

Multidetector computed tomography angiography is the first-line imaging test for diagnosis of abdominal bleeding, since it allows a comprehensive display of surgical area as well as of the entire abdomen, detecting the hemorrhage, estimating its amount, revealing its specific source, and demonstrating its status whether still ongoing or spontaneously stopped.^{4,5}

Common primary bleeding sources are in common hepatic artery and splenic artery throughout the postoperative follow-up period, especially in patients who underwent gastrectomy and D1 plus or greater lymphadenectomy (Fig. 1).^{6,7} The hemorrhage may be caused by a weakened arterial wall due to arterial skeletonization (dissection of the arterial fibrous sheath or adventitial layer) after aggressive lymphadenectomy.⁸

Abdominal abscess, which will be discussed later in this article, can be a cause of bleeding at period several days after surgery by erosion of adjacent vessels. The abscess can develop in unusual or unexpected locations after surgery.⁹ Therefore, the bleeding site is not confined to the anastomosis site. Bleeding from the celiac trunk, superior mesenteric artery, and inferior mesenteric artery should be explored by angiography.^{3,8}

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Fig. 1. A 57-year-old male patient who underwent total gastrectomy and distal pancreatectomy with splenectomy for gastric cancer and intraductal papillary mucinous neoplasm in the pancreas. (A) Common hepatic arteriography shows massive extravasation of contrast media from left gastric artery stump (arrow). (B) The patient had stenosis in celiac os, and major hepatic arterial supply was through the superior mesenteric artery. Embolization from the common hepatic artery to celiac trunk using 12 coils (10 mm and 12 mm) and N-butyl cyanoacrylate was performed. (C) Completion aortography shows no evidence of residual arterial bleeding.

Fig. 2. An 80-year-old male patient who underwent subtotal gastrectomy. (A) Celiac arteriogram shows a pseudoaneurysm (arrow) from splenic artery (arrowhead). (B) Main splenic artery (arrowhead) was embolized with the use of microcoils and N-butyl cyanoacrylate glue. (C) Follow-up axial computed tomography shows infarctions of the gastric remnant (arrow) and the spleen (arrowhead).

Treatment

In the early postoperative period, relaparotomy is considered to be more effective than radiologic intervention.^{3,7} In the late postoperative period, however, angiography and transarterial embolization (TAE) should be considered as first-line treatment, since the bleeding site is difficult to find surgically due to adhesions, inflammatory reactions, and friability of postoperative tissues.^{6,7} Furthermore, TAE is a less invasive approach, irrespective of tissue adhesions and friability caused by primary surgery.

Arterial bleeding after gastrectomy can be effectively treated by TAE. Coils, N-butyl cyanoacrylate (NBCA), and polyvinyl alcohol particles are generally used as permanent embolic materials. Gelatin sponge particles can be used as transient embolic materials. However, since perfusion of the gastric remnant after subtotal gastrectomy through the short gastric artery is vital, complete embolization of the main splenic artery (any site between origin and splenic hilar portion of splenic artery) can significantly compromise blood supply, leading to infarction of the gastric remnant, as well as the spleen (Fig. 2).^{10,11} If TAE is inevitable, additional resection of the gastric remnant and/or spleen may be required to avoid infarction of the organ and following sepsis.^{11,12}

The placement of a stent graft in the splenic artery would not only treat bleeding but also salvage the spleen and/or the gastric remnant. However, it is difficult to place the stent graft, if the artery is tortuous.¹³

Varix bleeding

Etiology

Esophagogastric varices, which are the most common collateral vessels found in patients with portal hypertension, are usually resected in total gastrectomy. Instead, esophagojejunal varices develop on the anastomotic site after the surgery in patients with portal hypertension, although the reported incidence is rare.¹⁴ Dilated jejunal veins, which acquire a hepatofugal blood flow, commonly supply the esophagojejunal varices.¹⁵

Previous reports have indicated that altered hyperhemodynamics could aggravate varix formation. The elimination of venous collaterals around the anastomotic area during total gastrectomy decreases available draining veins that were decompressing portal hypertension, providing a factor that increased portal pressure. Hyperemia in the anastomotic region followed by surgery might also increase the venous outflow.¹⁶

Treatment

There are two treatment options available; obliteration of the bleeding varices (by endoscopic therapy, surgical ligation and re-anastomosis, or embolization), and portal decompression (by surgical or transjugular intrahepatic portosystemic shunt [TIPS], or splenectomy). Surgical and endoscopic procedures for esophagojejunal varices after the surgery is difficult because of deteriorated state of hepatic function, complicated configuration of the gastrointestinal tract, and postoperative adhesions. TIPS, and/or embolization of the varices could be treatment options. TIPS can reduce portal venous pressure, thereby decompressing esophago-

Fig. 3. A 65-year-old male patient who had liver cirrhosis and portal hypertension underwent laparoscopy-assisted distal gastrectomy for early gastric cancer. Contrast-enhanced axial computed tomography scan (A) and transhepatic superior mesenteric venography (B) show bleeding jejunal varix (arrow) communicating with the right inferior epigastric vein (arrowheads). Embolization of bleeding jejunal varix and right inferior epigastric vein was performed. Right common femoral vein was punctured, and distal portion of right inferior epigastric vein was selected and embolized using microcoils and a vascular plug. (C) Contrast medium extravasation to the jejunal lumen (arrow) was more clearly visible in venography through the inferior epigastric vein. Embolization using gelatin sponge and N-butyl cyanoacrylate glue was done. Tract embolization using coils was done. (D) Completion angiography shows no residual varix nor bleeding.

Fig. 4. A 54-year-old male patient who underwent total gastrectomy with esophagojejunostomy. (A) Coronal computed tomography (CT) scan shows a focal fluid collection in left subphrenic space (arrow), adjacent to esophagojejunostomy site. (B) Ultrasonography and fluoroscopy guided percutaneous catheter drainage procedure was performed to drain the fluid. (C) 10 days after the procedure, amount of fluid is decreased, leaving minimal, as shown in this follow-up coronal CT scan.

jejunal variceal pressure.

Percutaneous transhepatic obliteration could be useful to treat bleeding esophagojejunal varices. Use of NBCA mixed and diluted with iodized oil,^{17,18} ethanol,¹⁹ and/or coils^{19,20} as embolic materials are reported. The NBCA can be diluted at various concentrations (1:1 to 1:6) depending on the size of esophagojejunal varices and location of the microcatheter (Fig. 3). After the management, careful follow-up for potential formation of varices in other areas of gastrointestinal tract should be needed, since it is not a fundamental treatment for portal hypertension itself.

Non-vascular Complications

Abscess & fistula

Etiology

Common to almost all reconstructive gastrointestinal surgery is the risk of an anastomotic leak, which can lead to a localized fluid collection or abscess in the surgical bed. Because of the post-operative changes in normal anatomic barriers due to transection of peritoneal ligaments and mesenteries during surgery, postoperative fluid collections or abscesses may develop in unusual or unexpected locations (e.g., the lesser sac and the left subphrenic, gastrohepatic, and gastrosplenic spaces).⁹

Duodenal stump fistula is one of the most challenging and life-threatening postoperative events despite its low incidence reported of 1.6% to 5%.²¹ Possible factors of the fistula formation include inadequate closure of the duodenal stump, devascularization, cancer involvement of resection line, inflamed duodenal wall, local hematoma, incorrect drain position, postoperative

duodenal distension.²² Leakage of bile or pancreatic juice causes localized peritoneal irritation, and subsequent bacterial infection may further aggravate the postoperative course, and it may be lethal.^{9,21}

Migita et al²³ reported higher rate of intra-abdominal abscess formation when elevated amylase level combined with bacterial positivity of drainage fluid in early postoperative period. Incidence of drain-fluid infection is increased when prophylactic drain placement is prolonged.²⁴

Treatment

Percutaneous catheter drainage with various imaging guidance (ultrasonography, computed tomography, or fluoroscopy) can be considered first to treat the abscess (Fig. 4). The shortest transabdominal route is used to drain an intraabdominal abscess in most cases. Transgression of the pleural space or small bowel can be carefully performed if it is unavoidable. A transgluteal, transvaginal, or transrectal route can be used for a deep-seated pelvic abscess.³

Percutaneous transhepatic biliary drainage (PTBD) procedure with placement of the drainage catheter tip at duodenal stump can be performed to decompress the duodenal stump leakage area as well as to drain bile and pancreatic fluids.^{25,26}

Direct communication between abscess and bowel via a narrow fistulous tract, or abscess-fistula complex may be seen using abscessography. Evacuation of the abscess cavity by percutaneous catheter drainage is usually sufficient in treatment of low-output fistulae. In high-output fistulae, following selective fistula cannulation may additionally be required.²⁷

Conservative treatment based on proper drainage, infection

Fig. 5. A 58-year-old male patient who underwent partial gastrectomy for gastric cancer. (A) Pre-procedural upper gastrointestinal contrast study shows narrowing of the anastomotic site (arrow). (B) Fluoroscopy guided sequential balloon dilation (15–20 mm) was done at the narrowing site.

Fig. 6. A 74-year-old male who underwent palliative total gastrectomy for advanced gastric cancer. (A) Upper gastrointestinal contrast study shows segmental stricture and fold thickening at just below the anastomosis site (arrow), suggestive of tumor invasion. (B) A multipurpose gastroduodenal catheter was introduced over the guide wire to measure length of the stricture, which was 70 mm. A covered self-expandable dual stent was inserted, so that nylon mesh fully covered the stricture site. (C) Completion contrast study shows an improved flow of contrast material through the stricture and no extraluminal leakage.

Fig. 7. A 62-year-old male patient who underwent pylorus-preserving pancreaticoduodenectomy for pancreatic cancer. (A) Coronal computed tomography image shows an enhancing soft tissue near the afferent loop (arrow), followed by upstream dilation of afferent loop, suggestive of afferent loop syndrome due to bowel metastasis. An 18-mm diameter, 8-cm length dual stent was placed. (B) Completion tubography shows improved flow through the stent.

control and nutritonal support, are the cornerstone of the management of duodenal fistula. If daily drainage amount of duodenal stump fistula fluid (median, 500 mL; range, 300–1,000 mL), or a previous conservative treatment was unsuccessful, percutaneous catheter drainage can be applicable.^{22,28} Temporary occlusion of common bile duct with occlusion balloon with external bile drainage through PTBD catheter to decrease bile fluid excreting to duodenal stump was reported.²⁸

Benign stricture

Etiology

Postoperative anastomosis site stricture is a common com-

plication of gastric surgery, occurring in 1.6% to 40% of patients.^{29,30} Contributing factors may include mechanical stapling, mismatched staple sizes, additional serosal sutures, delayed oral intake, and postoperative anastomotic ischemia and leaks.^{30–33} In the early postoperative period, strictures are usually secondary to edema or early scar formation. In the late postoperative period, not only benign strictures but also recurrent tumor should be considered as causes of anastomosis site narrowing.³⁴

Treatment

Fluoroscopy or endoscopy guided balloon dilation is safe and effective for strictures whether in early or late postoperative periods (Fig. 5).^{35–39} Fluoroscopy guided balloon dilation has some

advantages over endoscopy guided dilation. Identification of the proximal and distal ends of the stricture and visual control of the entire balloon catheter during placement are possible. Moreover, fluoroscopy enables immediate detection and correction of misplacement or incomplete dilation of the balloon catheter during balloon inflation.⁴⁰ Endoscopy has a role when tissue biopsy is needed.

Temporary placement of a retrievable expandable metallic stent can be effective for patients who show resistance to balloon dilation.⁴¹ Late complications caused by stent migration or new stricture formation should be considered.⁴²⁻⁴⁴

Malignant obstruction

Etiology

Rate of recurrent malignant obstruction following various types of gastrectomy remains high.^{34,45,46} The obstruction can occur not only at anastomosis site but also at non-anastomosis site. Tumor recurrence leads to anastomotic narrowing in 19% of patients and to jejunal obstruction in 4% of patients after total gastrectomy.³⁴

Afferent loop syndrome, which is not uncommon complication following pancreaticoduodenectomy patients (13%),⁴⁷ can also occur uncommonly after Billroth II gastrojejunostomy (approximately 0.3%).⁴⁸

Treatment

Stent placement is an effective palliative treatment for patients with recurrent malignant obstruction after various types of gastrectomy (Fig. 6).⁴⁹ Covered nitinol stent placement is mostly used in South Korea. Covered stent has an advantage of preventing in-stent tumor ingrowth, thus preventing recurrent stenosis. However, stent migration occurs more often than uncovered stents in the esophagus.^{46,50,51} New techniques or new models, e.g., double-layered stent, dual stent, coaxial technique are reported to prevent both migration and restenosis.⁵²⁻⁵⁴ In patients having afferent loop syndrome, and in areas of high migration risks due to severely angulated strictures, placement of a covered self-expandable dual stent (outer partially covered stent and inner bare-metal stent) is a palliative treatment modality (Fig. 7).^{51,55} The percutaneous approach using PTBD or enterostomy tubes can be considered when the lesion is in the proximal or mid portion of the afferent bowel loop, or the patient who should undergo PTBD.⁵⁵⁻⁵⁸ Peroral stent insertion is a better option when the lesion is in the distal portion of the afferent loop, or percutaneous approach is contraindicated, e.g., in patient having massive ascites.⁵⁵ Percutaneous approach increases the invasiveness, therefore should be reserved as the latter option.

Conclusion

Interventional managements for treatment of post-gastrectomy complications are safe and less invasive compared with surgical procedures such as re-laparotomy. Correct diagnosis of the complication and appropriate interventional procedures can be performed in patients suffering from the complications, especially who cannot endure repeated surgical treatment.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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