Interventional Management after Gastrectomy:
The Spectrum of Imaging Findings and Procedures

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Gastric cancer is the most common cancer in Korea, and is often treated by surgical resection. Many postoperative complications or tumor recurrence, however, are managed by the use of imaging-guided interventions. This review describes the spectrum of postoperative complications that occur following gastrectomy, with an emphasis on the interventional procedures used to manage postoperative complications and tumor recurrence.

Index words: Stomach cancer
Tomography, X-Ray Computed
Gastrectomy
Neoplasm recurrence, local
Radiography, interventional

Percutaneous Catheter Drainage
A small collection of fluid in the surgical bed is common in the immediate postgastrectomy period and usually resolves spontaneously. These collections generally do not require an interventional procedure, but they can be aspirated with a needle if there is strong clinical suspicion for infection (i.e., an unexplained fever). The loop of the jejunum or the gastric remnant (Fig. 1) can be mistaken for fluid collection on CT images. Air or fluid with a lower attenuation than that of the walls of the loop serves as a natural contrast agent within the lumen of the loop. Small-bowel folds or gastric folds are often outlined by fluid, which allow definitive identification of the loop. The introduction of oral contrast material within the loop makes definitive identification straightforward, but it is not administered in the immediate postoperative period at our institution.

Anastomotic leakage, jejunal stump leakage (Fig. 2), or duodenal stump leakage (Fig. 3) can lead to localized fluid collection or an abscess in the surgical bed. Anastomotic leakage causes a left subphrenic abscess due to negative intraabdominal pressure beneath the di-
aphragn that is related to respiration, and duodenal stump leakage usually results in a fluid collection or an abscess in the right subhepatic space (2). CT can demonstrate the presence of a small pneumoperitoneum, but a pneumoperitoneum alone is an extremely common postoperative finding. Direct communication between the abscess and the bowel via a narrow fistulous tract may be seen with the use of abscessography.

In most cases, the shortest transabdominal route is used for the drainage of an intraabdominal abscess. Transgression of the pleural space or small bowel is best avoided, but if inevitable, it can be carefully performed.

Fig. 1. The remnant stomach mimicking an abscess in a 54-year-old woman who had undergone a partial gastrectomy.
A. A transverse contrast-enhanced CT scan shows large fluid collection with an enhancing thin wall and air-fluid level, which was considered as an abscess.
B. A fluoroscopic image with contrast material injection via a catheter obtained 3 days after creation of drainage shows the remnant stomach and duodenum indicating the result of a partial gastrectomy with a Billroth I gastroduodenostomy. Note that the catheter tip was placed within the remnant stomach.

Fig. 2. Gastrointestinal bleeding at the blind end of the proximal jejunal limb in a 75-year-old woman who had undergone a total gastrectomy.
A. A transverse contrast-enhanced CT scan 14 days after surgery shows a small amount of pneumoperitoneum [arrowhead] in the right subphrenic space. A small collection of air at the esophagojejunalostomy [arrow] is observed in front of the suture material, which suggests anastomosis leakage. Note the small amount of fluid collection in the left subphrenic space with the surgical drain [curved arrow] and the minimal amount of pleural effusion [open arrow] in the left hemithorax.
B. Esophagography shows leakage of contrast material [arrow] at the blind end of the proximal jejunal limb.
C. Superior mesenteric arteriography through superselection of the jejunal branch at 37 days after surgery shows leakage of contrast material [arrow] at the blind end of the proximal jejunal limb. We undertook superselective embolization of the bleeding vessel with the use of Gelfoam pledges.
In general, a secondary pneumothorax or empyema can be easily managed with another catheter in the pleural cavity (Fig. 4). Transgression of the small bowel has only a small risk of contaminating the peritoneal cavity, and a subsequent enterocutaneous fistula is infrequent in a healthy bowel [3]. A transgluteal, transvaginal, or transrectal route can be used for a deep-seated pelvic abscess.

When the abdominal fluid collection has a cutaneous fistula or when CT shows postoperative fluid collection adjacent to the surgical drain, we prefer to catheterize the fistula or surgical drain tract as the route to gain entry into the abscess cavity; sometimes, a surgical drain is exchanged for a catheter (Fig. 5).

**Percutaneous Transhepatic Biliary Drainage (PTBD)**

PTBD has been routinely performed as the method of choice for biliary decompression. Most patients with jaundice have tumor recurrence such as duodenal stump recurrence, a metastatic lymphadenopathy in the

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**Fig. 3.** Duodenal stump leakage in a 61-year-old man who had undergone a partial gastrectomy.  
A. A transverse contrast-enhanced CT scan shows fluid collection with an air-fluid level in the liver hilum (arrow). Note the small pneumoperitoneum in the right subphrenic space (arrowhead) and subhepatic space (curved arrow).  
B. An abscessogram shows communication between the abscess and duodenum. Yellowish pus (20 mL) was aspirated at drainage.

**Fig. 4.** The transpleural approach of catheter drainage in a 57-year-old man who had undergone a partial gastrectomy.  
A. A transverse contrast-enhanced CT scan shows fluid collection with mottled gas in the left subphrenic space (F). Note the pleural effusion in both the thorax and atelectasis in the left thorax.  
B. A fluoroscopic image obtained at drainage shows an abscess cavity in the left subphrenic space. Note that another catheter was inserted in the left thorax to prevent a significant pneumothorax.
hepatoduodenal ligament, and a peribiliary metastasis (2). Although Whipple’s operation has been infrequently undertaken in patients with stomach cancer, a benign stricture can occur at the choledochojejunostomy site in these cases.

Peribiliary metastasis has been revealed as thickening and enhancement of the biliary duct wall [Fig. 6]. In our experience, a cholangiogram shows abrupt obstruction of the common bile duct in cases of duodenal stump recurrence or metastatic lymphadenopathy, and shows gradual tapering in cases of a peribiliary metastasis.

**Biliary Stenting**

The principal disadvantage of PTBD is that it is an uncomfortable procedure for patients and serves as a source of skin irritation or infection. Furthermore, PTBD requires periodic catheter flushing and catheter exchange. Biliary stent insertion using a covered or uncovered self-expanding metallic stent has become an accepted palliative treatment for patients with inoperable obstructive jaundice [Fig. 7] (4).

**Gastrointestinal Balloon Dilation and Stenting**

Postoperative stenoses can occur in the early postoper-
ative period, caused by regional vascular damage during surgery or an inflammatory complication during hyperplastic healing, and rarely occur because of improper surgical technique. Stenoses can be managed by balloon dilation (Fig. 8), or temporary stent placement [3]. Malignant obstruction at anastomotic sites in recur-

Fig. 7. Biliary and gastric outlet obstruction in a 53-year-old woman who had undergone a partial gastrectomy with a Billroth I gastroduodenostomy.
A. A transverse contrast-enhanced CT scan shows a recurred mass lesion (arrow) encasing the proper hepatic artery. Note dilation of the intrahepatic biliary duct and suture material (arrowheads) at the site of the gastroduodenostomy.
B. A radiograph from an upper GI examination shows severe stenosis with shouldering at the gastroduodenostomy site. Note the tube in the biliary tract.
C. A fluoroscopic image obtained after placing a biliary (8 mm diameter and 10 cm length) and gastroduodenal stent (15 mm diameter and 18 cm length) shows good patency of the stents.

Fig. 8. A benign stricture at an anastomosis in a 59-year-old man who had undergone a total gastrectomy.
A. A fluoroscopic image obtained after swallowing water-soluble contrast material shows a long stricture at the anastomosis (arrow).
B. Ballooning with a 20 mm diameter balloon catheter at the anastomosis was undertaken.
C. A radiograph of an upper GI examination after balloon dilation shows no stenosis at the anastomosis.
rent gastric carcinoma is a pre-terminal event that causes nausea, vomiting, dysphagia, and nutritional deficiency, which lead to a progressive deterioration in the quality of life of a patient. A CT scan may show bowel wall thickening and enhancement around the anastomosis, or multiple enlarged soft tissues that are regarded as lymphadenopathy. Barium studies can show clearly stenosis or obstruction of the bowel, but the presence of a tandem lesion should be carefully examined. With improving stent design and delivery systems, we can usually manage these problems with the use of a self-expandable covered metallic stent [Figs. 7, 9] [5].

Acute colonic obstruction usually necessitates rapid intervention, and placing a metallic stent can replace the

![Fig. 9. Local tumor recurrence with efferent loop obstruction in a 58-year-old man who had undergone a total gastrectomy.](image)

**A.** A transverse contrast-enhanced CT scan shows an ill-defined mass lesion (arrowheads) engulfing the suture material at the site of esophagojejunostomy.
**B.** Esophagography shows two tandem stenotic sites of an efferent loop (arrowheads).
**C.** A fluoroscopic image obtained after placing a covered stent (18 mm diameter and 10 cm length) shows good patency of the stent.

![Fig. 10. Metastatic linitis plastica to the rectum and urinary bladder in a 47-year-old man who had undergone a gastrectomy.](image)

**A.** A transverse contrast-enhanced CT scan shows concentric rectal wall thickening and mucosal enhancement (arrow). There is also thickening of the posterolateral wall of the urinary bladder (arrowheads). A proctoscopic and cystoscopic biopsy confirmed tumor infiltration to the rectum and bladder.
**B.** A fluoroscopic image obtained after placing two covered stents (24 mm diameter and 10 cm length and 24 mm diameter and 12 cm length) in tandem, reveals good patency of the stents.
need for an emergency surgical colostomy. Previously, stent placement was used mainly as a preoperative treatment of colorectal carcinoma to facilitate primary anastomosis and to avoid a colostomy. We have used self-expandable stents to avoid the need for a colostomy with colorectal obstruction due to a colorectal metastasis (Fig. 10) or peritoneal seeding. Self-expanding stents must be flexible enough to overcome the curvature of the sigmoid colon, and the diameter of the expanded stent must be large enough to relieve a colorectal obstruction [6, 7].

**Percutaneous Enterostomy**

A percutaneous enterostomy may be created to decompress a bowel obstruction, particularly in the small bowel or right colon, which is not appropriate for stent placement. Bowel obstruction can cause dehydration, electrolyte imbalance, abdominal pain, and bowel perfo-

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**Fig. 11.** Local tumor recurrence with afferent loop syndrome in a 57-year-old man who had undergone a total gastrectomy

A. A transverse contrast-enhanced CT scan shows a markedly dilated duodenum (D) indicating afferent loop syndrome. Note the fluid collection in the right perirenal space that is supposed to be related to pancreatitis.

B. A fluoroscopic image obtained at enterostomy shows complete obstruction of the anastomosis (arrow); 500 mL of dark brownish fluid was removed.

**Fig. 12.** A periureteral metastasis in a 70-year-old man who had undergone a total gastrectomy

A. A transverse contrast-enhanced CT scan shows a thickened, well-enhanced left ureter wall (arrow).

B. A fluoroscopic image obtained at drainage shows smoothly tapering of the left ureter.
ration. Patients with afferent loop obstruction can present with jaundice or symptoms of pancreatitis (Fig. 11). In these cases, percutaneous transhepatic biliary drainage may induce life-threatening sepsis caused by reflux of the bowel content into the bile duct through the drainage tube. Direct percutaneous tube enterostomy of the obstructed afferent loop is a safe and effective palliative procedure (8).

Percutaneous Nephrostomy (PCN)
Urinary tract obstruction can be caused by a retroperitoneal lymph node metastasis, peritoneal seeding, a periureteral metastasis, or a combination of these conditions. All patients with hydronephrosis should not undertake percutaneous nephrostomy, but patients with an increased serum creatinine level and sepsis that is secondary to ureteral obstruction usually require PCN. Retroperitoneal lymphadenopathy and peritoneal seeding are readily detected on a CT scan.

A periureteral metastasis may manifest as minimal infiltration of the retroperitoneal fat in front of the psoas muscle or thickening and enhancement of the ureteral wall (Fig. 12).

Gastrointestinal Bleeding Embolization
Immediate postoperative hemorrhage (within 24 hours) may originate from inadequate vascular ligation or hemostasis, which usually is corrected by surgery. Early postoperative bleeding (several days after surgery) is usually associated with an abdominal abscess (Fig. 2). Abscesses are often related with Anastomosis leakage or pancreatitis, and leakage of pancreatic juice can destroy the bowel wall. Therefore, the bleeding site is not confined to the anastomosis site, and bleeding from the celiac trunk, superior mesenteric artery, and inferior mesenteric artery should be explored by the use of angiography. Delayed gastrointestinal bleeding (several months after surgery) is commonly caused by a recurrent tumor (Fig. 13). In cases with a splenic artery pseudoaneurysm due to pancreatitis, it is better simply to occlude the parent artery due to a weak wall.

Conclusion
Many complications or tumor recurrence are demonstrated by the use of cross-sectional imaging, and can be safely and effectively managed by utilizing imaging-guided interventions. Together, diagnostic and interventional radiologists have important roles in the assessment and management of a variety of conditions after performance of a gastrectomy.

References

Fig. 13. Gastrointestinal bleeding from a recurred mass at esophagojejunostomy in a 60-year-old woman who had undergone a total gastrectomy two years prior and had undertaken placement of an esophageal stent at esophagojejunostomy five months prior. Superior mesenteric arteriography shows a small collection of extravasated contrast media [arrow] at the esophagojejunostomy site. Note the subtraction artifact of an esophageal stent [open arrow] at the proximal jejunal limb. We undertook superselective embolization of the bleeding vessel with the use of Gelfoam pledgets.
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