The postoperative stomach

Courtney A. Woodfield, Marc S. Levine

Department of Radiology, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA 19104, USA

Received 10 November 2004; received in revised form 14 December 2004; accepted 17 December 2004

Abstract

Gastric surgery may be performed for the treatment of a variety of benign and malignant diseases of the upper gastrointestinal tract, including peptic ulcers and gastric carcinoma. Radiographic studies with water-soluble contrast agents often are obtained to rule out leaks, obstruction, or other acute complications during the early postoperative period. Barium studies may also be obtained to evaluate for anastomotic strictures or ulcers, bile reflux gastritis, recurrent tumor, or other chronic complications during the late postoperative period. Cross-sectional imaging studies such as CT are also helpful for detecting abscesses or other postoperative collections, recurrent or metastatic tumor, or less common complications such as afferent loop syndrome or gastrojejunal intussusception. It is important for radiologists to be familiar not only with the radiographic findings associated with these various abnormalities but also with the normal appearances of the postoperative stomach on radiographic examinations, so that such appearances are not mistaken for pseudoleaks or other postoperative complications.

The purpose of this article is to describe the normal postsurgical anatomy after the most commonly performed operations (including partial gastrectomy, esophagogastrectomy and gastric pull-through, and total gastrectomy and esophagojejunostomy) and to review the acute and chronic complications, normal postoperative findings, and major abnormalities detected on radiographic examinations in these patients.

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Keywords: Stomach surgery; Stomach postoperative diagnostic imaging; Stomach surgery complications; Stomach surgery normal findings

1. Introduction

Gastric surgery often is performed for the treatment of benign and malignant diseases of the upper gastrointestinal tract. Postoperative radiographic examinations are obtained in many of these patients to rule out leaks, obstruction, or other abnormalities after surgery. It therefore is important for radiologists to be familiar with the normal postoperative findings as well as the complications associated with gastric surgery and their radiographic appearances. This article reviews the major forms of gastric surgery, the postoperative anatomy, associated complications, and the normal postoperative findings and various abnormalities detected on radiographic examinations in these patients.

2. Imaging techniques

The approach to imaging the postoperative stomach depends on the type of surgical procedure that has been performed, the postoperative time period (i.e., early or late), and the patient’s clinical status and presenting complaints. Upper gastrointestinal contrast studies and CT are the primary imaging tests used to evaluate the postoperative stomach, often in a complimentary fashion.

2.1. Upper gastrointestinal contrast examinations

When an anastomotic leak or staple line dehiscence is suspected in the early or late postoperative periods, most surgeons will ask for an upper gastrointestinal study with water-soluble contrast material (e.g., diatrizoate meglumine and diatrizoate sodium [Gastroview]; Mallinckrodt, St. Louis, MO) as the initial imaging test [1]. The examination begins with scout images of the lower chest and upper abdomen to assess the presence or absence of a dilated viscus, extralu-
minal gas collections, free intraperitoneal air, or pneumato-
sis as well as the location of surgical drains, clips, and su-
tures. Scout images can be obtained in frontal and, if nec-
essary, oblique positions (collimated and magnified on the
region of surgery), so that surgical material is not later mis-
taken for a small anastomotic leak. If the type of surgery
is unknown, the pattern of surgical staples on the initial
scout images can also help determine the operative proce-
dure[2,3].

Water-soluble contrast material is recommended as the
initial contrast agent for the evaluation of upper gastroin-
testinal leaks, as it has no known damaging effects on the
mediastinum or peritoneal cavity[4–7]. The patient ingests
the contrast agent in the upright position to evaluate swal-
lowing function and transit of contrast material from the
esophagus into the stomach. The patient is then placed in
a semi-recumbent position to ensure adequate coating of the
postoperative stomach, including all anastomoses and staple
lines. If the patient is unable to drink, contrast material can
also be administered via a nasogastric tube or percutaneous
gastrostomy tube.

The fluoroscopist initially should focus on anastomoses
and staple lines (the most likely sites of perforation), ob-
taining early spot images of these regions in order to avoid
missing a small leak. The position of the patient in which a
leak is best visualized often depends on the type of surgery
performed (e.g., left posterior oblique position for a pyloro-
plasty). Small anastomotic leaks may appear as blind-ending
tracks or as self-contained extraluminal collections extending
away from surgical anastomoses[8]. The presence of con-
trast material in a surgical drain also indicates the presence
of a small leak, even when leaks are not otherwise visual-
ized on these studies. Larger leaks may be manifested by
broader channels of contrast material extending away from
surgical anastomoses into peri-anastomotic collections or by
free extravasation of contrast material into the mediastinum
or peritoneal cavity[8].

If no leak is detected with water-soluble contrast mate-
rial, the study should be repeated with barium, which has
been found to be a better medium than water-soluble contrast
agents for visualizing subtle postoperative leaks, presumably
because of its greater radiodensity and adherence properties
[4–7]. Recent work has shown that high-density (250%, w/v)
barium is even more sensitive than low-density (60–100%,
w/v) barium for visualization of subtle leaks missed with
water-soluble contrast agents (Fig. 1)[9]. We therefore be-
lieve that high-density barium should be given routinely to
these patients to detect postoperative leaks not visualized with
water-soluble contrast media.

When symptoms develop in the late postoperative period
(i.e., more than 30 days after surgery) in patients who are
reasonably mobile and cooperative, a double-contrast up-
er gastrointestinal study may be performed to better eval-
uate the gastric and esophageal mucosa for inflammatory
changes, strictures, or recurrent tumor. These postoperative
studies require a larger dose of intravenous glucagon (1 mg
versus 0.1 mg) to prevent rapid transit of barium and air
through the gastric remnant into the small bowel, which can
limit the diagnostic value of this examination. When the
primary purpose of the study is to evaluate the postsurgi-
cal anatomy, rule out obstruction, or assess the integrity of

![Fig. 1. Leak from esophagojejunal anastomosis seen only with high-density barium.](image-url)
gastric staple lines after gastric bypass surgery, however, a single-contrast study remains the radiographic examination of choice.

As in single-contrast upper gastrointestinal studies, the patient initially ingests the high-density barium in the upright position to evaluate for laryngeal penetration or aspiration, esophageal mucosal abnormalities, and transit of barium through the upper gastrointestinal tract. The patient is then positioned more horizontally and rotated to ensure adequate coating of gastric mucosal surfaces before obtaining double-contrast views of the stomach. Depending on the type of surgery, the position in which the gastroenteric and enteroenteric anastomoses are best visualized is variable. Prone positioning may be helpful for filling the effenter and afferent jejunal loops. Prone swallowing can also be performed to better evaluate esophageal motility and distensibility.

2.2. Computed tomography

When patients develop generalized symptoms (e.g., abdominal pain) in the early or late postoperative periods, CT scans may be obtained with contiguous 5-mm axial sections from the lung apices or lung bases to the pubic symphysis after administration of both oral and intravenous contrast material. If these patients have clinical signs or symptoms of a leak, water-soluble contrast media should be used rather than barium as the oral contrast agent. CT provides greater detail about the overall anatomy than upper gastrointestinal contrast studies and is better able to define the nature, location, and extent of postoperative collections. Small amounts of extraluminal fluid, contrast material, and air that are not visible on fluoroscopic images can be readily detected on CT, suggesting the presence of a postoperative leak that otherwise might be missed. CT is also useful for evaluating recurrent tumor, metastases, wound complications, and postoperative pancreatitis [10].

2.3. Nuclear medicine

Scintigraphic gastric emptying studies can be used to evaluate postoperative motility disorders, including gastrointestinal stasis, dumping syndrome, and diarrhea. Gastric emptying studies may be performed by having the patient ingest a Tc-99m sulfur colloid-labeled liquid or solid meal after an overnight fast. Images of the stomach are obtained in the anterior and posterior projections every 15 min for 1 h after completion of a liquid meal and for 2 h after completion of a solid meal. A time-activity curve can then be plotted to determine the half-emptying time of the stomach. Normally, liquids empty from the stomach in an exponential fashion, with a half-time of 40 min (range 12–65 min), while solids empty from the stomach in a linear fashion with a half-time of 90 min (range 45–110 min) [11].

3. Types of gastric surgery

3.1. Partial gastrectomy

Partial gastrectomy with gastroduodenostomy or gastrojejunostomy may be performed for treatment of benign and malignant diseases of the stomach, such as gastric ulcers and gastric carcinoma. The site and extent of gastric resection depends on the nature and location of the lesion. Antrectomy with gastroduodenostomy can be used to treat refractory or complicated ulcers in the distal stomach, but this procedure is not often performed because of high rates of bile reflux across the gastroduodenal anastomosis into the stomach. Instead, surgery for ulcers in the distal stomach usually consists of antrectomy and gastrojejunostomy. Subtotal gastrectomy with wide surgical margins of resection and gastrojejunostomy is the preferred surgery for distal gastric carcinomas [12].

3.1.1. Postoperative anatomy

In a partial distal gastrectomy with gastroduodenostomy (Billroth I procedure), the connection between the stomach and duodenum is an end-to-end anastomosis using the entire free edge of the stomach (Polya procedure) or a portion of the free edge with closure of the remaining portion of the stomach (Hofmeister modification) (Fig. 2). Trapping of ingested barium in the distorted folds and outpouchings of the gastric
Fig. 3. Partial gastrectomy with gastrojejunostomy (Billroth II procedure). Spot image from double-contrast barium study shows widely patent gastrojejunal anastomosis (arrows) with barium in afferent and efferent loops of proximal jejunum.

Partial gastrectomy with gastrojejunostomy (Billroth II procedure) is more commonly performed than a Billroth I procedure because of fewer complications related to bile reflux [14]. With this procedure, the entire free edge of the stomach (Polya procedure) or a portion of the free gastric edge (Hofmeister modification) is anastomosed to the jejunum via an end-to-side anastomosis (Fig. 3). With the latter procedure, the oversewn edge of the gastric remnant may be manifested by plication defects along both lateral margins of the gastrojejunal anastomosis, mimicking residual or recurrent tumor near the anastomosis occasionally may be difficult to distinguish from recurrent ulcers [13].

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Fig. 4. Partial gastrectomy with plication defects at gastrojejunal anastomosis. Spot image from double-contrast barium study shows relatively symmetric plication defects (arrows) on both margins of gastrojejunal anastomosis. This finding should not be mistaken for recurrent tumor.

A loop type gastrojejunal anastomosis is created by anastomosing the free end of the stomach to the side of a continuous jejunal segment. The portion of the duodenum or jejunum proximal to the anastomosis is described as the afferent loop, which carries potentially harmful bile and pancreatic secretions toward the stomach. The portion of jejunum distal to the anastomosis is described as the efferent loop. Loop type gastrojejunostomies can be positioned anterior (anteccolic) or posterior (retrocolic) to the transverse colon. A retrocolic anastomosis often is preferred, as it results in a shorter afferent loop and, presumably, fewer postoperative complications [14]. However, an antecolic anastomosis may be favored in patients with gastric carcinoma in order to avoid positioning the gastrojejunal anastomosis in the lesser sac, where tumor is more likely to recur [10].

A Roux-en-Y reconstruction entails separating a segment of proximal jejunum from the remaining small bowel. The proximal end of the intact jejunum is anastomosed in a side-to-end fashion to the free edge of the stomach, and an end-to-side jejunojejunostomy is created between the resected jejunal segment and the more distal jejunum. This Roux-en-Y reconstruction is superior to the loop type gastrojejunal anastomosis because it decreases bile reflux from the small bowel into the stomach, thereby minimizing or preventing the development of bile reflux gastritis in most patients [15].

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3.1.2. Postoperative complications
3.1.2.1. Acute.Leaks from any of the surgical anastomoses or suture lines (including the gastroduodenal, gastrojejunal, and jejunjejunal anastomoses and blind-ending duodenal stump) account for most of the early postoperative complications after partial gastrectomy. Dehiscence of the duodenal stump is a particularly serious complication, as extraluminal bile and pancreatic secretions in the peritoneal space...
Fig. 5. Leak from gastrojejunal anastomosis after partial gastrectomy and gastrojejunostomy. Spot image from study with water-soluble contrast agent shows focal leak (black arrow) from left lateral aspect of gastrojejunal anastomosis into large gas-containing extraluminal collection (white arrows) in left subphrenic space. (Note how gastric remnant is collapsed on this view). Contrast studies can be used to detect and localize both large and small anastomotic leaks (Fig. 5). Findings on CT that suggest the presence of a leak (even if one is not visualized directly) include pneumoperitoneum, oral contrast material in an extraluminal location, and findings associated with an intraabdominal abscess (Fig. 6) [16]. In other patients, postoperative edema and spasm at the gastrojejunal or jejunojejunal anastomoses may cause varying degrees of gastric outlet obstruction or small bowel obstruction that resolves spontaneously.

3.1.2.2. Chronic. One of the most common complications of a Billroth II partial gastrectomy in the late postoperative period is postsurgical scarring at the gastrojejunal anastomosis, resulting in the development of anastomotic strictures, with varying degrees of gastric outlet obstruction. Such strictures can lead to bloating, nausea, and nonbilious vomiting. Barium studies and CT may reveal a markedly dilated gastric remnant containing large amounts of fluid and debris. When barium studies are performed, it is important to visualize anastomotic strictures in profile at fluoroscopy in order to optimally assess their width and length. Because of overlap between the distal portion of the gastric remnant and proximal jejunum on frontal views, the strictures often are best seen on steep oblique or lateral spot views. When anastomotic strictures obstruct the gastrojejunal anastomosis, fluoroscopically or endoscopically guided dilation procedures can be performed to relieve the obstruction without the need for surgery in most cases [17–19].

A Billroth II partial gastrectomy may be complicated by an “afferent loop syndrome,” defined as obstructive dilatation of the afferent loop of duodenum and proximal jejunum, with accumulation of bile and pancreatic secretions in the obstructed loop. Patients typically present with postprandial fullness, nausea, and bilious vomiting. With current surgical techniques, the prevalence of the afferent loop syndrome is less than 1% [20]. Obstruction of the afferent loop can be acute and complete or chronic and partial; causes include internal small bowel hernias, anastomotic strictures, adhesions, recurrent tumor, and intraperitoneal metastasis [20–22]. The dilated afferent loop may not be visible on abdominal radiographs if the obstructed limb is filled with fluid. On barium studies, delayed gastric emptying (with preferential filling of the efferent loop and little or no filling of the afferent loop) should suggest the diagnosis. However, the afferent loop also may not be visualized on barium studies in as many as 20% of patients [23]. CT is the imaging modality of choice for diagnosing an afferent loop syndrome; the dilated, fluid-filled afferent loop as well as the cause of obstruction can be identified in most cases (Fig. 7) [22,24,25]. Treatment usually entails converting a simple loop gastrojejunostomy to a Roux-en-Y reconstruction [14].

Chronic reflux of bile across gastrojejunal and jejunojejunal anastomoses into the gastric remnant can lead to bile reflux gastritis, which occurs in 5–15% of all patients after partial gastrectomy [28]. Edema and inflammation of the gastric wall may be manifested on barium studies by thickened, nodular folds with or without associated ulcers in the peri-anastomotic region of the gastric remnant (Fig. 8). Surprisingly, there is not a strong correlation between the degree of inflammation and the degree of symptoms in these patients [14]. If intractable epigastric pain or bilious vomiting develops, however, the Billroth II procedure can be converted...
Fig. 7. Afferent loop obstruction after partial gastrectomy and gastrojejunostomy. Contrast-enhanced CT shows moderately dilated, fluid-filled duodenum (arrowheads) between aorta and superior mesenteric artery (small arrow). Note how efferent loop is also mildly dilated (large arrow). This patient had postsurgical adhesions (not visualized on image) causing afferent loop obstruction.

Fig. 8. Bile reflux gastritis. Spot image from double-contrast barium study shows thickened, irregular folds in gastric remnant after partial gastrectomy and gastrojejunostomy. (Arrow denotes gastrojejunal anastomosis).

Fig. 9. Bezoar in gastric remnant. Contrast-enhanced CT shows dilated gastric remnant as a large, inhomogeneous mass (arrows) containing debris and mottled gas. This patient had a stricture at gastrojejunal anastomosis (not visualized on image) after partial gastrectomy and gastrojejunostomy.

and contrast material in the crevices of the mass (Fig. 9). Bezoars usually are freely mobile within the gastric remnant, enabling differentiation from gastric tumors, which are attached to the gastric wall. Smaller bezoars may float along the gastric air-fluid interface, appearing as round or ovoid filling defects, and are lower in attenuation than particulate debris and food in the stomach on CT [27]. Gastric outlet obstruction is the major complication of gastric bezoars, but small bowel obstruction occasionally may occur if a bezoar passes spontaneously into the small intestine. Gastric bezoars often can be treated by mechanical break-up at endoscopy, but surgery usually is required to relieve bezoar-related small bowel obstructions [28].

Partial gastrectomies (Billroth I or II) for treatment of peptic ulcer disease may be complicated by anastomotic (marginal) ulcers, most commonly in the proximal jejunum abutting the anastomosis (Fig. 10) [29]. These marginal ulcers can be difficult to differentiate from postsurgical jejunal outpouchings on barium studies, so endoscopy may be required for further evaluation [30]. Rigidity of the anastomosis, focal edema, and thickened gastric folds are secondary signs that may help differentiate these ulcers from postsurgical changes at the anastomosis [3]. Potential causes of recurrent ulcers after partial gastrectomy include retained gastric antrum and gastrinomas [31].

Patients who have had a partial gastrectomy for gastric cancer are also at continued risk for developing recurrent tumor. Local and regional lymphadenopathy and peritoneal implants are the two most common forms of recurrent tumor [32–34]. CT can be used to detect both nodal and peritoneal metastases as well as hematogenous metastases to the liver, lungs, adrenals, kidneys, and bones. Recurrent tumor at the gastrojejunal anastomosis may be manifested by focal thickening of the bowel wall on CT and by plaquelike, ulcerative, or polypoid lesions on barium studies [3,13]. In-
filtrative tumors may be manifested on barium studies by narrowing of the gastric remnant, which has straightened, irregular contours [13]. Whenever imaging tests raise concern about the possibility of recurrent tumor in the gastric remnant, endoscopy and biopsy should be performed for a more definitive diagnosis.

Patients who have undergone a partial gastrectomy for benign disease, particularly peptic ulcer disease, are also at risk for developing carcinoma in the gastric remnant 10 or more years after the original surgery. These “stump” carcinomas typically involve the distal aspect of the gastric remnant at or near the gastrojejunal anastomosis [13,35,36]. Mucosal damage in the gastric remnant from chronic reflux of bile and pancreatic secretions is thought to play a role in the development of stump carcinomas [37]. These tumors may appear on barium studies as infiltrating, polypoid, ulcerative, or plaque-like lesions at or near the anastomotic margin (Fig. 11) [13].

Jejunogastric intussusception and gastrojejunal intussusception are rare complications after partial gastrectomy, with a reported incidence of only 0.1% [38]. In a jejuno gastric intussusception, the efferent loop (rather than the afferent loop) usually intussuscepts into the gastric remnant. This intussusception can be visualized by a variety of imaging modalities including CT, ultrasound, and barium studies. On CT, a segment of proximal jejunum, along with adjacent mesenteric fat and vessels, is seen to extend into the gastric remnant [39]. On barium studies, the intussuscepted loop of jejunum may be manifested by a coiled-spring defect in the gastric remnant [13]. Conversely, a gastrojejunal intussusception may be manifested on barium studies by narrowing of the distal portion of the gastric remnant with a coiled-spring defect in the proximal jejunum abutting the anastomosis (Fig. 12).

3.2. Esophagogastrectomy and gastric pull-through

Esophagogastrectomy with gastric pull-through and a cervical or intrathoracic esophagogastric anastomosis is performed for both benign and malignant diseases, most notably esophageal and proximal gastric carcinomas [40]. This operation may be done via a transthoracic or transhiatal approach. A right transthoracic esophagogastric anastomosis is often used for tumors of the upper two-thirds of the esophagus, while a left transthoracic esophagogastric anastomosis is reserved primarily for tumors of the distal esophagus or at the gastric cardia [40]. A transhiatal esophagogastric anastomosis without a thoracotomy may be performed for tumors of the thoracic or cervical esophagus [40]. No significant differences have been found in the 5-year survival rates after esophagogastrectomy and gastric pull-through performed via transthoracic and transhiatal approaches [41].

3.2.1. Postoperative anatomy

Transthoracic esophagogastric anastomosis using separate right thoracotomy and abdominal incisions (Ivor Lewis esophagogastric anastomosis) involves mobilization of the stomach through the esophageal hiatus of the diaphragm and a cervical or intrathoracic esophagogastric anastomosis is performed via a transthoracic or transhiatal approach.
Fig. 12. Antegrade gastrojejunal intussusception. Spot image from barium study shows narrowing (white arrow) of gastric remnant with coil-spring defect (black arrows) in proximal jejunum abutting gastrojejunal anastomosis due to gastrojejunal intussusception.

In contrast, transhiatal esophagectomy involves mobilization of the stomach through a high upper abdominal incision. The esophagus is dissected inferiorly via the abdominal incision and superiorly via a second cervical incision. The esophagus is then transected proximally, and a high cervical esophagogastric anastomosis is created [40]. A concomitant pyloroplasty or pyloromyotomy usually is performed for both transthoracic and transhiatal esophagectomies to facilitate gastric emptying.

3.2.2. Postoperative complications

3.2.2.1. Acute. The most serious early complication after esophagogastrectomy and gastric pull-through is a leak at the esophagogastric anastomosis related to postoperative ischemia or surgical technique [42]. Transhiatal esophagectomy is associated with a higher rate of anastomotic leaks, but these leaks typically occur in the neck, where they are less likely to cause mediastinitis or sepsis [43]. As a result, cervical leaks can be managed conservatively without need for surgery in most cases. However, intrathoracic leaks at the esophagogastric anastomosis frequently are complicated by mediastinitis and sepsis; mortality rates as high as 60% have been reported in patients with intrathoracic leaks after esophagogastrectomy [43]. As a result, early surgical repair of intrathoracic leaks generally is advocated.

Large or persistent pleural effusions, pneumomediastinum, and mediastinal widening, are all secondary signs of anastomotic leaks on chest radiographs [44]. Leaks from the esophagogastric anastomosis may be manifested on contrast studies by blind-ending tracks, sealed-off extraluminal collections, or free extravasation of contrast material into the mediastinum (Fig. 13). Because these patients often have an end-to-side esophagogastric anastomosis, incomplete filling of the proximal gastric pouch can be mistaken for a leak in this region (Fig. 14A). Such pseudoleaks can be differentiated from true leaks by placing the patient in a recumbent or even a Trendelenberg position to obtain adequate filling of the proximal gastric pouch (Fig. 14B). CT is also helpful for identifying the presence and extent of mediastinal abscess collections resulting from such leaks (Fig. 15). Because of the high mortality rates associated with intrathoracic leaks from the esophagogastric anastomosis, many surgeons ask for routine contrast studies 7–10 days after surgery in order to detect clinically silent leaks before oral feedings are initiated.

Other early complications after esophagogastrectomy include obstruction at the esophagogastric anastomosis secondary to postoperative edema and spasm and obstruction or leaks at the pyloromyotomy site. Extrinsic compression of the intrathoracic stomach where it traverses the esophageal hiatus of the diaphragm is also a frequent cause of delayed gastric emptying (Fig. 16). The latter patients are at risk for swallowing dysfunction and subsequent aspiration [44–46].
Fig. 14. Pseudoleak from esophagogastric anastomosis. (A) Initial spot image from study with water-soluble contrast agent shows apparent extraluminal collection of contrast material (arrows) abutting esophagogastric anastomosis. (B) Repeat view after administration of barium with patient in recumbent position shows end-to-side esophagogastric anastomosis (small arrows) with more complete filling of proximal pouch (large arrows) of intrathoracic stomach. This patient did not have a leak.

3.2.2.2 Chronic. Delayed postoperative complications after esophagectomy and gastric-pull through include alkaline reflux esophagitis, benign anastomotic strictures from postsurgical scarring or alkaline reflux esophagitis, recurrent tumor, aspiration, and fistula formation between the esophagus and adjacent mediastinal structures secondary to recurrent tumor or radiation therapy [44,47]. Anastomotic leaks have also been reported in the late postoperative period [47].

Alkaline reflux esophagitis may be manifested on double-contrast studies by mucosal nodularity, thickened folds, or ulceration in the distal esophagus above the esophagogastric anastomosis. Anastomotic strictures typically appear on barium studies as short, ringlike areas of narrowing at the

Fig. 15. Mediastinal abscess due to intrathoracic leak from esophagogastric anastomosis after esophagectomy and gastric pull-through. Contrast-enhanced CT shows rim-enhancing extraluminal collection (large arrows) in right posterior mediastinum, containing fluid and gas. Note how collection is posterolateral to intrathoracic stomach (small arrow). Previous studies with water-soluble contrast material showed a leak from right side of esophagogastric anastomosis as the cause of this collection.
esophagogastric anastomosis (Fig. 17), whereas strictures from alkaline reflux esophagitis appear as longer segments of smooth, tapered narrowing in the distal esophagus (Fig. 18). When strictures develop, a jet of barium sometimes can be seen streaming through the anastomosis into the intrathoracic stomach, also known as a “jet phenomenon,” an indirect sign of narrowing at the esophagogastric anastomosis (see Fig. 17) [48]. In contrast, eccentric anastomotic narrowing with associated mass effect should suggest recurrent tumor [44]. CT can also be used to evaluate for local tumor recurrence as well as distant metastases. Recurrent tumor may be manifested on barium studies or CT by a soft tissue mass in the mediastinum causing an extrinsic impression on the intrathoracic stomach [49].

3.3. Total gastrectomy and esophagojejunostomy

Total gastrectomy and esophagojejunostomy are performed for surgical treatment of both benign and malignant gastric diseases, including proximal gastric carcinomas and severe gastric dysmotility [50,51]. The reported postoperative morbidity and mortality and 5-year survival rates of total gastrectomy for gastric carcinoma are similar to those of partial gastrectomy [14,52].

3.3.1. Postoperative anatomy

After a complete gastric resection, intestinal continuity most commonly is restored with a Roux-en-Y type anastomosis between the esophagus and jejunum. Most surgeons separate the esophagojejunostomy at least 40 cm from the jejunoejunal anastomosis to minimize reflux of bile and pancreatic secretions into the esophagus. A proximal jejunal pouch often is created near the esophagojejunal anastomosis [53]. Both the esophagojejunal anastomosis and proximal small bowel can be readily evaluated on barium studies. However, barium often does not reflux across the enteric anastomosis, limiting visualization of the Roux limb. The esophagojejunal anastomosis and proximal jejunal stump both can be identified on CT.

3.3.2. Postoperative complications

3.3.2.1. Acute. Anastomotic leaks and transient anastomotic narrowing (usually related to postoperative edema and spasm) are the most common early complications after total gastrectomy and esophagojejunostomy [8,54]. The prevalence of anastomotic leaks ranges from 11–12%, and as many as one-third result in postoperative deaths [8,54]. Anastomotic leaks are most often located at the esophagojejunal anastomosis (Fig. 1) or, less commonly, at the jejunoejunal anastomosis or blind-ending jejunal stump [55].
3.3.2.2. Chronic. Delayed postoperative complications after total gastrectomy and esophagojejunostomy include jejuno-oesophageal reflux (with or without alkaline reflux esophagitis), esophageal strictures, anastomotic narrowing secondary to benign strictures or recurrent tumor, and af- ferent loop obstruction. Delayed anastomotic leaks may also be detected for the first time on contrast studies performed as long as 7 months after surgery [8].

Reflux of bile and pancreatic secretions from the jejunum into the esophagus can result in the development of severe alkaline reflux esophagitis. Barium studies may reveal thick- ened, nodular folds or ulceration in the esophagus [8]. A Roux-en-Y reconstruction decreases reflux of bile into the esophagus but does not entirely eliminate this complication, so alkaline reflux esophagitis can also develop in these pa- tients [8,56].

Structure formation at the esophagojejunal anastomosis may be caused by postsurgical scarring, alkaline reflux esophagitis, or recurrent tumor [50]. Benign strictures at the esophagojejunal anastomosis typically appear on barium studies as smooth, tapered segments of symmetric narrowing. In contrast, irregular, eccentric narrowing should be worri- some for recurrent tumor, necessitating endoscopy for fur- ther evaluation [8]. CT may also reveal recurrent tumor at the esophagojejunal anastomosis (manifested by asymmetric wall thickening) or evidence of metastatic disease outside the gastrointestinal tract.

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