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Enteric Access: IR Perspective

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Abstract

Gastrostomy tube placement may be needed for nutritional support, as in the setting of neurogenic dysphagia or head and neck malignancy, or for gastric decompression, as in the setting of malignant small bowel obstruction. Additionally, gastrojejunostomy or direct jejunostomy tubes may be needed in the setting of gastric outlet obstruction among other indications. Surgical, endoscopic, and percutaneous approaches are all well-described with generally similar outcomes. In this article, the standard radiologic percutaneous gastrostomy technique is reviewed including both the "push" and "pull" methods. Then, the special indications and techniques of advanced percutaneous enteral access such as percutaneous transesophageal gastrostomy and direct jejunostomy are discussed with examples shown.

Keywords

- gastrostomy
- jejunostomy
- advanced technique

In 1822, Alexis St. Martin suffered a gunshot wound to the left lower chest. Under the care of William Beaumont, his injuries eventually developed into a gastrocutaneous fistula which persisted for another 58 years, which established that a permanent opening to the stomach could safely be created.[1] This famous case has been surmised to have inspired a military surgeon, Christian Egeberg, to remark in 1841, "I cannot see why the indications should not be just as great to open the intestinal canal to put nourishment in as to open it to take a foreign body out." The first completed surgical gastrostomy creation was subsequently performed in 1846 by a French surgeon, Charles Sédillot.[2]

While there were many subsequent refinements in surgical technique in intervening years, a major step in the evolution of gastrostomy tube placement was the description of percutaneous endoscopic gastrostomy creation by Gauderer et al in 1980.[3] This was followed shortly thereafter by Preshaw describing fluoroscopically guided gastrostomy creation in 1981[4]; percutaneous, rather than transoral, insertion techniques were described by several authors in 1983.[5–7] Since then, radiologic percutaneous gastrostomy (RPG) placement has become widely accepted, with high technical success rates and low rates of complications.[8–10]

In this article, we discuss the standard RPG technique and describe additional radiologic techniques for challenging anatomic or physiologic cases.

Indications

The predominant indications for RPG are similar to those of other gastrostomy tubes: nutritional support or gastrointestinal decompression. The need for nutritional support can have many sources, including neurogenic dysphagia, head and neck malignancy with obstruction or impaired swallowing, head or throat surgery, medical conditions causing impaired absorption, or metabolically demanding states requiring high caloric intake (e.g., burns). Decompression may be requested for palliation in cases of small bowel obstruction as well as for diversion in the setting of enteric fistulae.[11] In cases of gastric outlet obstruction, lower esophageal sphincter incompetence (leading to aspiration), or gastroparesis, placement of a gastrojejunostomy or jejunostomy tube may be preferable.[12]

Contraindications

There are few absolute contraindications to RPG placement. These include uncorrected coagulopathy, peritonitis, bowel ischemia, and portal hypertension with gastric varices. Most of the relative contraindications are related to wound healing or technical feasibility. Ascites, long-term steroid use or immunosuppression, the presence of a ventriculoperitoneal shunt, open wounds, the presence of herniorrhaphy mesh, or hypoalbuminemia have been associated with infection or impaired wound healing.

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Ascites was previously considered an absolute contraindication due to the risk of poor tract healing leading to bacterial peritonitis from gastric and skin flora. O'Keeffe et al reported leakage of ascites in 24% of patients with ascites and tube displacement into the peritoneum in 4% of patients. Of note, gastropexy was not used in these cases.[13] It has been suggested that paracentesis and gastropexy can reduce that risk,[14–17] although a recent study reported an ascites leakage rate of 14% in patients with chronic ascites who underwent transabdominal gastrostomy creation.[18]

Steroids or immunosuppression, as with any invasive procedure, can impair wound healing, with an attendant increased risk of peritubal leakage.[11] Gastrostomy tube placement increases the risk of ventriculoperitoneal shunt infection and may also carry a risk of ascending meningitis.[19,20] Hypoalbuminemia has also been linked to higher complication rates, including increased short-term mortality, although it is not clear if optimizing serum albumin after placement could ameliorate this risk.[21–26]

Billroth partial gastrectomy, hiatal hernias, esophagectomy with gastric pull-through, colonic interposition, and an elevated left hemidiaphragm can preclude a percutaneous approach to the stomach. However, CT-guided gastric puncture, balloon dilation of the stomach, balloon occlusion of the gastric outflow, infracolic placement (through the transverse mesocolon), or percutaneous transesophageal gastrostomy (PTEG) can make these challenging approaches technically feasible.[27,28]

Approaches

There are many variations on RPG placement. These are often performed under moderate sedation, although in appropriate patients they can be placed with local anesthesia alone. Other patients have comorbidities that require general anesthesia.

Prior to starting, the colon should be positively identified to prevent traversal of the colonic lumen. In a 2007 review, Friedmann et al found 28 cases of transcolonic placement in the literature. The most common symptoms were diarrhea and feculent leakage around the tube. Many were asymptomatic, and 10 were treated conservatively, while 14 were treated with surgery. Subsequently, colonic perforation or obstruction has been described.[29,30]

Oftentimes, barium is administered orally or via enteric tube prior to the procedure. However, air within the colon is often sufficient to identify this structure; when in doubt, a barium enema can also be performed.[31]

A nasal or oral gastric tube should be in place to insufflate the stomach. While there are many commercial choices on the market, a 4- or 5-Fr angiographic catheter can also be used, with or without a wire. When passing a tube is not technically feasible, ultrasound- or CT-guided insertion of an 18- to 22-gauge needle into the gastric lumen has been described to allow for insufflation. Once the gastrostomy tube has been placed, the needle can be safely removed without risk of bleeding.[32–36]

Smooth muscle relaxants such as scopolamine butyl bromide or glucagon can be given prior to insufflation to diminish peristalsis and spasm the pylorus. This allows for insufflation of the stomach in isolation. Note that glucagon has a short half-life (around 8 minutes) and can cause hyperglycemia in diabetics.[37]

Then, securement of the stomach to the abdominal wall is generally recommended because it prevents intraperitoneal leakage of gastric contents during tract dilation, and it allows safe recanalization of the tract and replacement of a tube if the gastrostomy tube becomes inadvertently dislodged prior to tract maturation.[38] T-tacks are commonly used for gastropexy, although other devices exist. There is no clear consensus on the number of T-tacks that should be used, although 2–3 is most commonly used. Contrast can be injected through the delivery needles to confirm intraluminal location prior to deployment.[39–41]

Through the middle of the gastropexy devices, an 18- or 19-gauge needle is inserted into the gastric lumen. Contrast is injected to confirm intraluminal location, and a stiff wire is inserted into the stomach. Over the stiff wire, the tract is dilated. Multiple methods exist to do this; however, the most common are serial dilators with a peel-away sheath, a telescoping dilator set with a peel-away sheath, or using an angioplasty balloon.[42]

Either through the peel-away sheath or over the angioplasty balloon, the gastrostomy tube is advanced into the gastric lumen. Confirmation of intraluminal location can be confirmed via aspiration of air through the tube, watching the distended stomach deflate fluoroscopically,

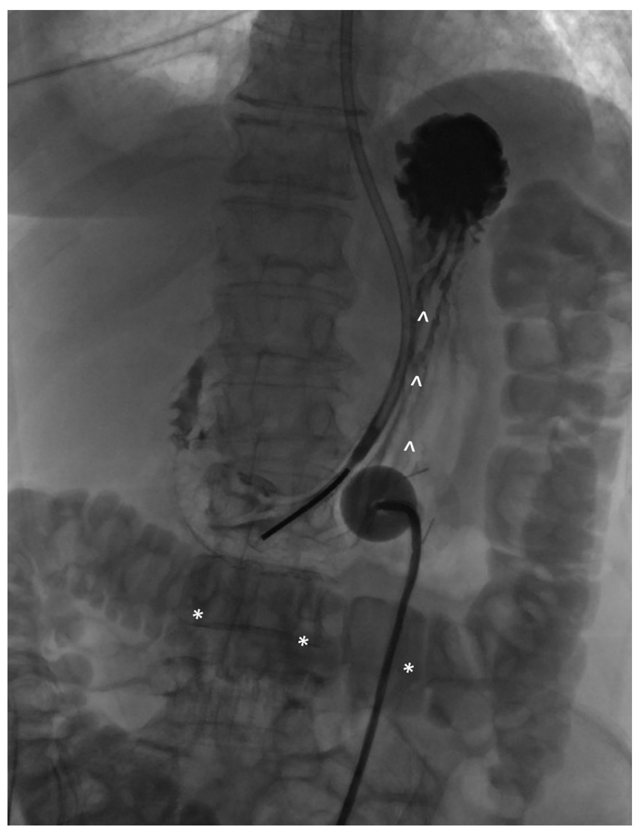

Fig. 1 Standard radiologic percutaneous gastrostomy tube placement. Note the transverse colon (*) and contrast opacifying gastric rugae (^), confirming direct placement into the gastric lumen.

injecting contrast to visualize rugae, and taking a lateral view to see contrast fall into the stomach. A cone-beam CT can be performed if further clarification is necessary (►**Fig. 1**).

Alternatively, a pull-through tube can be placed by navigating a wire through the gastric lumen, into the esophagus, and out the oral cavity. Over the wire, a mushroom-retention pull-through gastrostomy tube can then be advanced (►**Fig. 2**).

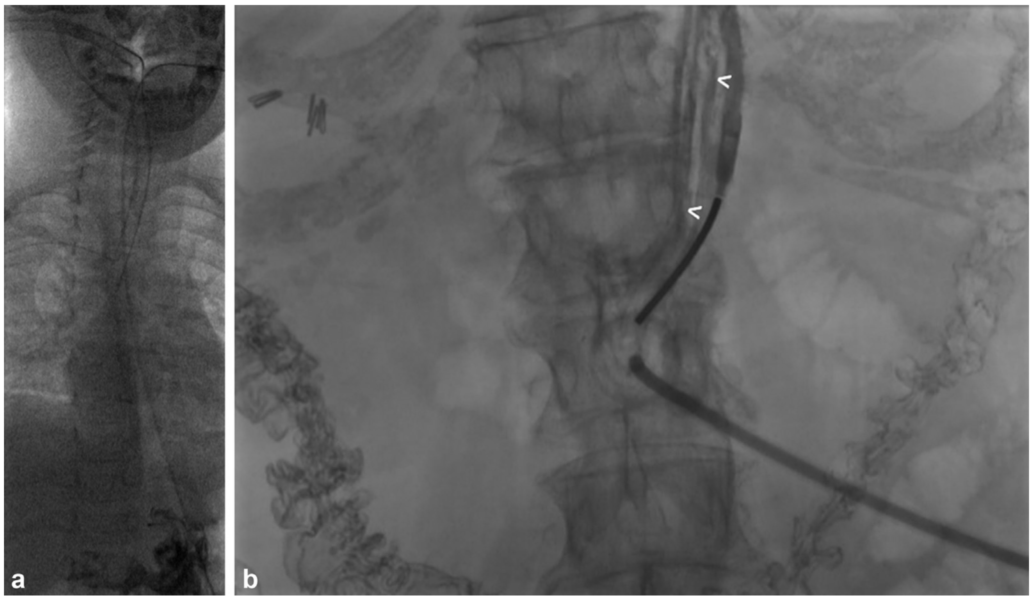

Fig. 2 Standard radiologic pull-through gastrostomy tube placement. (**a**) Retrograde catheterization of the esophagus and mouth from the gastric lumen allows for advancement of the tube from the oral cavity. (**b**) Completion imaging demonstrating contrast opacifying gastric rugae (^).

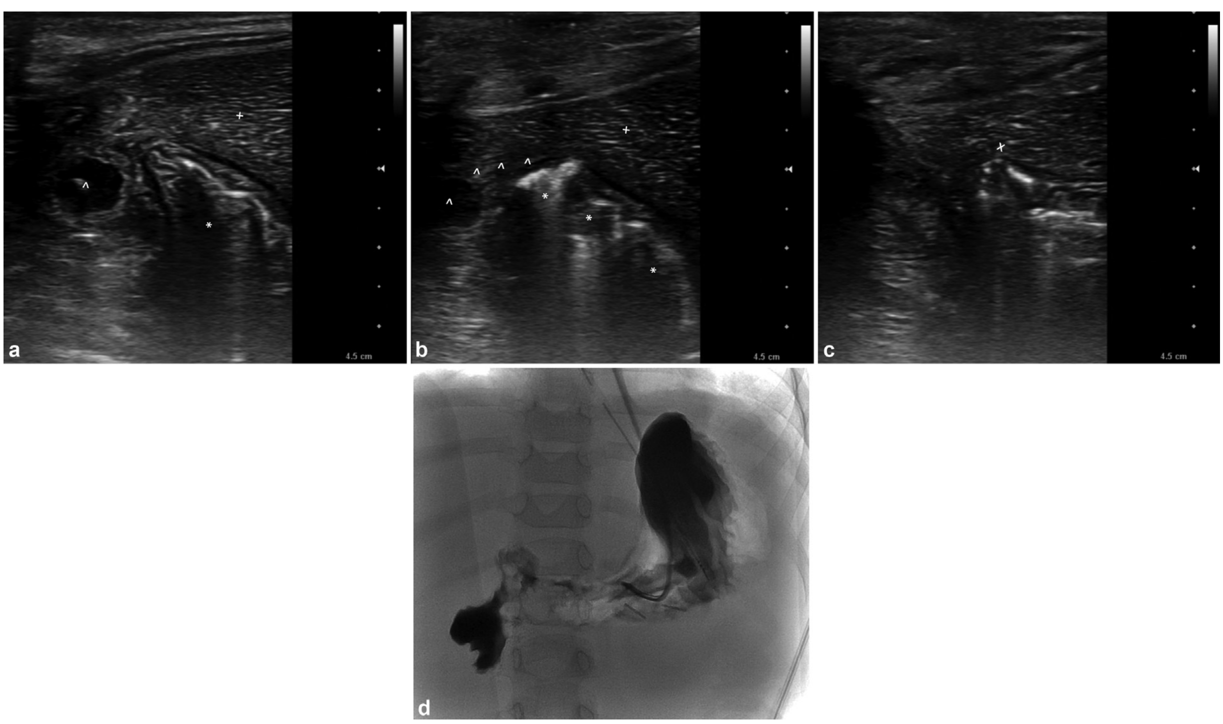

Fig. 3 Transhepatic gastrostomy tube placement. This patient was a 3-year-old with discontinuity of his duodenum after trauma, requiring venting gastrostomy placement prior to staged surgical repair. Due to extensive adhesions, particularly of his transverse colon to the deep surface of the liver, surgical placement carried prohibitively high risk of bowel perforation. (**a**) Sagittal ultrasound imaging demonstrating the liver (+), stomach (*), and transverse colon (^). (**b**) Due to adhesions, their spatial relationship between the liver (+), stomach (*), and transverse colon wall (^) persisted despite insufflation. (**c**) Ultrasound-guided needle puncture (x) through a small amount of liver parenchyma and into the stomach. (**d**) Final gastrostomy image.

Case 1: Poor Percutaneous Access

Colon, liver, or ribs can be interposed between the stomach and the anterior abdominal wall, even with insufflation of the stomach. Caudal-cranial angulation is oftentimes enough to create a window between these structures.

Infracolic placement can also be performed. This was first described by Mirich and Gray in 1989.[27] While there is theoretical risk of omental infarction, mesenteric ischemia or hemorrhage, or catheter malfunction from this approach, several retrospective studies report no adverse outcomes with infracolic placement.[43,44]

Transhepatic gastrostomy tube placement has been described without significant adverse effects, although this is limited by low numbers (►Fig. 3).[35,45] However, there are case reports of delayed bleeding and intrahepatic abscess formation associated with removal or exchange of the tube.[46,47]

Case 2: No Pylorus

In the absence of a pylorus, insufflating the stomach becomes impossible—the immediate escape of air to the small bowel prevents distension of the stomach and can also obscure the fluoroscopic view sufficiently to preclude safely continuing with tube placement. Some have described proceeding regardless, with CT-guided puncture of the stomach.[35,36] Additionally, balloon occlusion of the outflow tract can allow for insufflation of the stomach; however, the smaller stomach size after partial gastrectomy can still preclude safe gastrostomy tube placement[48] (►Fig. 4).

Case 3: Medical Contraindication for Gastrostomy Tube Placement

Some patients have such profound malnutrition that they may not be able to adequately epithelialize the gastrostomy tract, leading to long-term risks of tube dislodgement and peritonitis. Others have hostile sites for percutaneous access due to interposed structures, wounds, enterocutaneous fistulae, herniorrhaphy mesh, prior radiation, or peritoneal metastases with malignant ascites. In such cases, PTEG has been utilized for gastric venting and feeding (►Fig. 5).[28,49,50]

These can be done under moderate sedation, which can allow for identification of aberrant recurrent laryngeal nerve

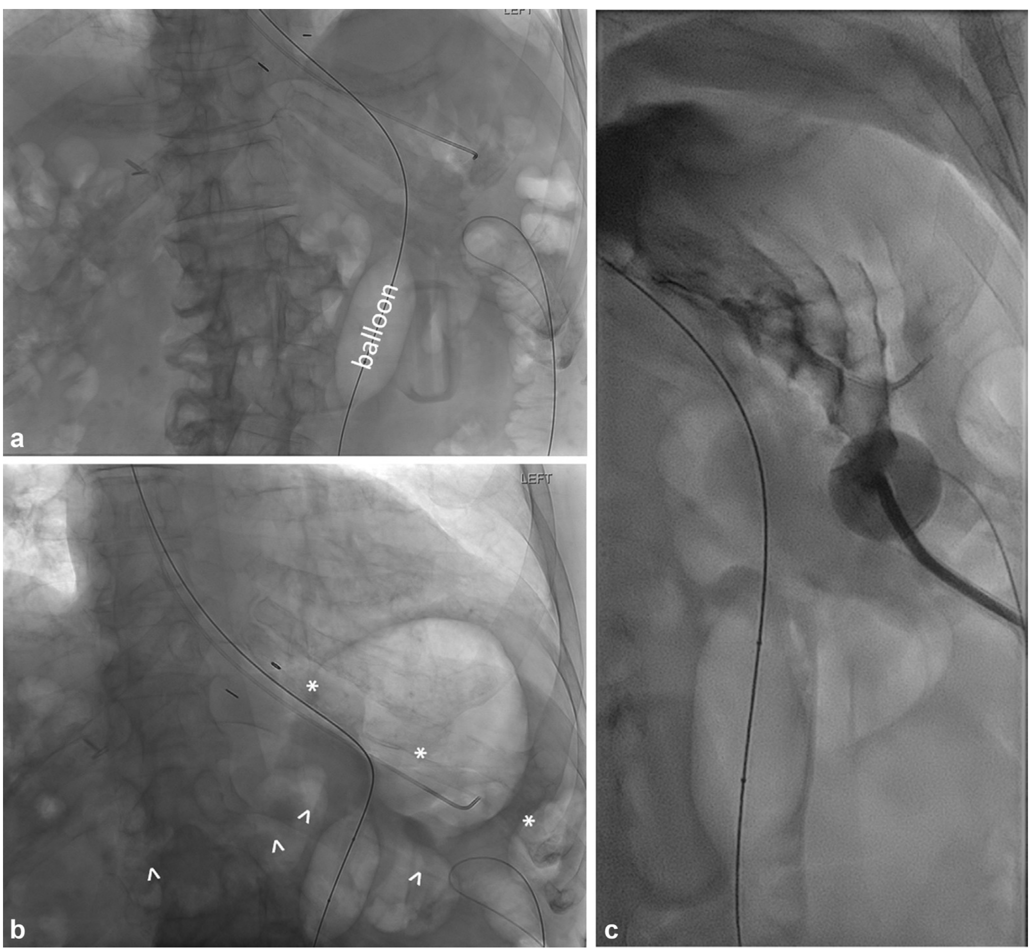

Fig. 4 Balloon occlusion of the outflow tract. This patient had a Billroth I distal gastrectomy for peptic ulcer disease in 1983. He subsequently developed oropharyngeal cancer and required enteric access prior to starting radiation; however, the gastric remnant was small and high, and insufflation was not possible due to the lack of a pylorus. (**a**) An occlusive balloon was advanced to the proximal alimentary limb over wire through the nares and inflated. (**b**) The gastric remnant was then insufflated and, with steep caudal angulation, a window between the costal margin (*) and colon (^) allowed for access to the stomach for gastrostomy tube placement. (**c**) Final gastrostomy tube placement.

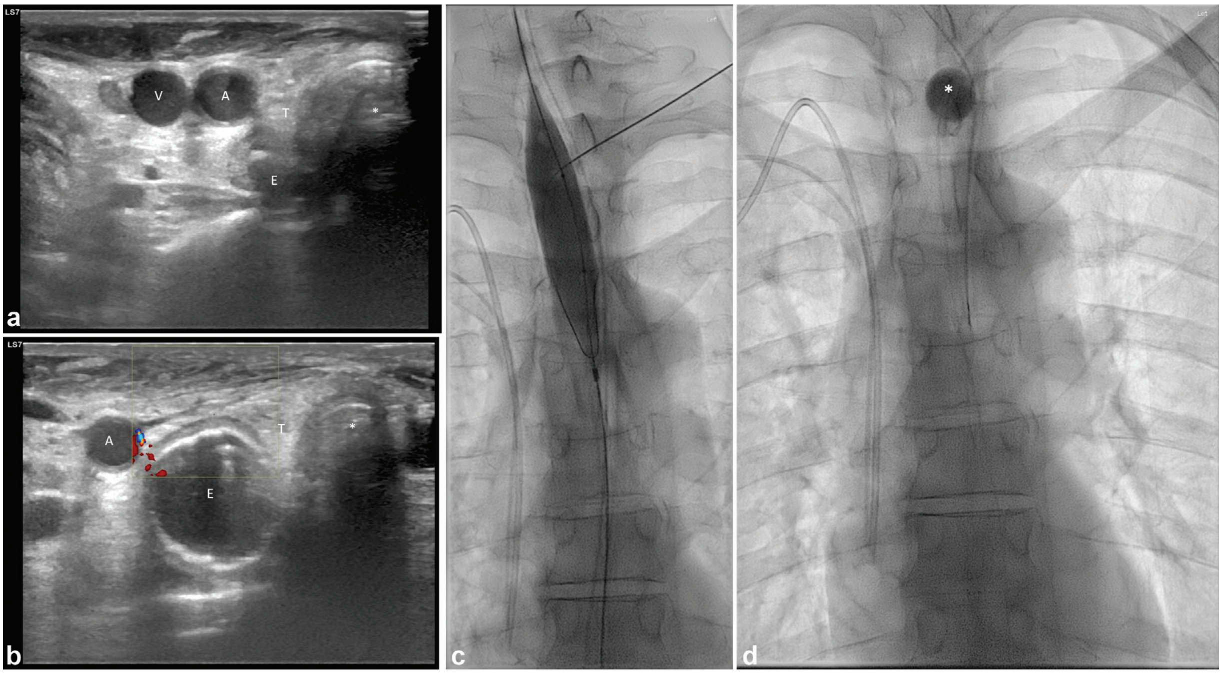

Fig. 5 Transesophageal gastrostomy tube placement. This patient was a 44-year-old female with anorexia nervosa presented with severe malnourishment and malnutrition. Due to her inability to maintain adequate nutrition via oral and parenteral routes, gastrostomy tube placement was requested for supplemental nutrition. Due to ascites and profound hypoalbuminemia (1.2 g/dL at initial consultation), there was consensus between IR, general surgery, and gastroenterology that she was at high risk for poor wound healing, and that the risk of bacterial peritonitis could potentially be fatal in her case. Therefore, the decision was made to place a percutaneous transesophageal gastrostomy tube. (**a**) Transverse ultrasound image of the left neck showing the relationship between the left internal jugular vein (V), left common carotid artery (A), thyroid gland (T), trachea (*), and esophagus (E). (**b**) After hydrodissection of the space between the carotid artery (A) and thyroid gland (T), a 16-mm angioplasty balloon was inflated in the cervical esophagus (E) to serve as a target for percutaneous puncture. (**c**) The space between the carotid artery and thyroid gland was traversed with a 22-gauge needle to the edge of the esophagus. Puncture of the balloon was performed with fluoroscopic guidance. (**d**) The tract was dilated, and a 12-Fr MIC jejunostomy tube (*; Avanos Medical Devices, Alpharetta, GA) was cut to length and placed with the distal end in the stomach and the balloon retention at the esophagostomy.

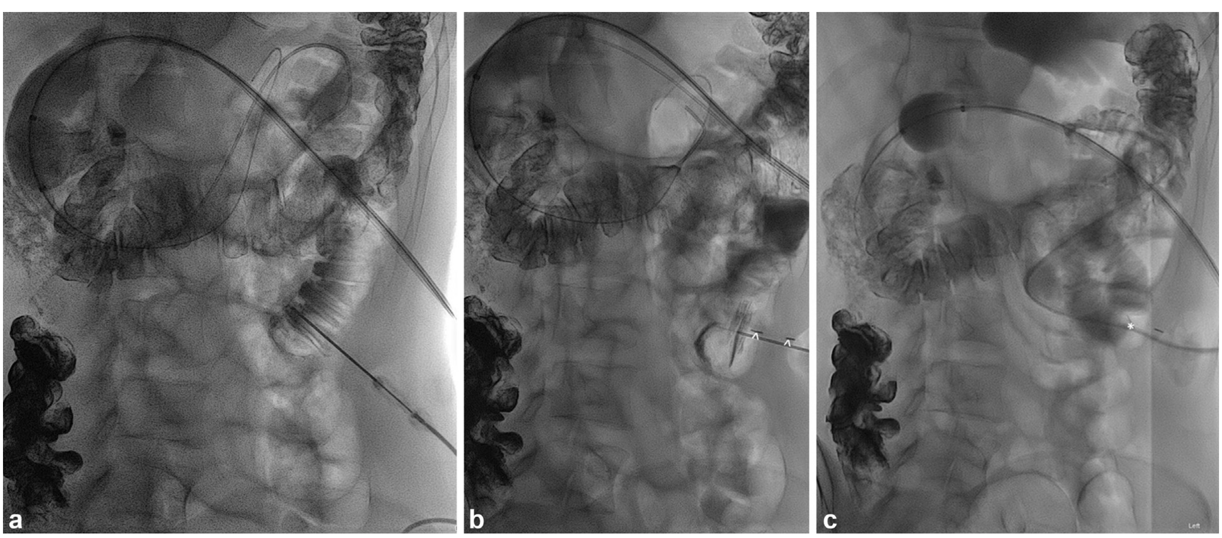

Fig. 6 Fluoroscopic jejunostomy tube placement. A 23-year-old female with cyclic vomiting and SMA syndrome had recurrent reflux of gastrojejunostomy tubes into her stomach and esophagus, requiring direct jejunal access for nutrition. (**a**) Through the existing gastrojejunal access, the small bowel was insufflated, and a proximal anterior loop of jejunum was targeted fluoroscopically in a steep right anterior oblique projection. Contrast was injected through the T-tack delivery needle to confirm intraluminal placement. (**b**) After two T-tacks (^) were placed to secure the jejunum to the abdominal wall, the jejunum was punctured with an 18-gauge needle. (**c**) Over a wire, the tract was dilated, and a 12-Fr MIC jejunostomy tube (*; Avanos Medical Devices, Alpharetta, GA) was placed.

if the patient develops breathy dysphonia during infiltration of the soft tissues with local anesthetic.

The most common adverse event after PTEG is displacement of the tube, which will often present with recurrence of bowel obstruction symptoms and decreased tube output. Site infection is uncommon.[51] Nausea and vomiting are reportedly lower when compared with decompressive nasogastric tubes.[52]

Case 4: Jejunal Access

While the focus of this article has mainly been gastric access, jejunal access can be necessary due to gastric outlet or duodenal obstruction, discontinuity between the stomach and small bowel, or aspiration due to an incompetent lower esophageal sphincter.[17]

Existing gastrostomy stomas can be converted to a gastrojejunostomy tube by manipulating an angiographic catheter through the stoma, pylorus, and duodenum to the proximal jejunum. Over a wire, the angiographic catheter can be exchanged for a balloon-retention gastrojejunostomy tube. Alternatively, the catheterization of the jejunum can be performed through the lumen of a pull-through gastrostomy tube; the angiographic catheter can be exchanged over wire for a purpose-built jejunal extension.

Primary gastrojejunostomy tube placement can also be safely performed.[53] If using a pull-through gastrostomy tube, there is essentially no technical difference in placement of the gastrostomy tube or jejunal extension. If placing a balloon-retention gastrojejunostomy tube, catheterization of the jejunum is performed prior to tract dilation. The use of a peel-away sheath may prevent strain on the gastropexy devices caused by friction between the gastric wall and silicone of the gastrojejunostomy tube during advancement.[17]

Primary percutaneous jejunostomy tube placement can also be performed with fluoroscopic, CT, or ultrasound-guided approaches (►**Figs. 6** and **7**). Due to the motility of the intestine, puncture-resistance of the intestinal wall, and small size of the jejunal lumen, these can be very technically challenging, with a reported technical success rate of 85 to 95% in the literature.[54–56]

Reestablishing a previous jejunostomy site has a higher technical success rate and lower complication rate, because the jejunal wall is already surgically adherent to the abdominal wall and thus no longer mobile.[56,57] The tract can often be seen under ultrasound (►**Fig. 8**).

In patients with malignant duodenal obstruction, palliative duodenal stent placement may be performed percutaneously under minimal sedation[58] (►**Fig. 9**).

Conclusion

Enteric access is commonly required for venting or nutrition. Many of these patients have complex medical or surgical

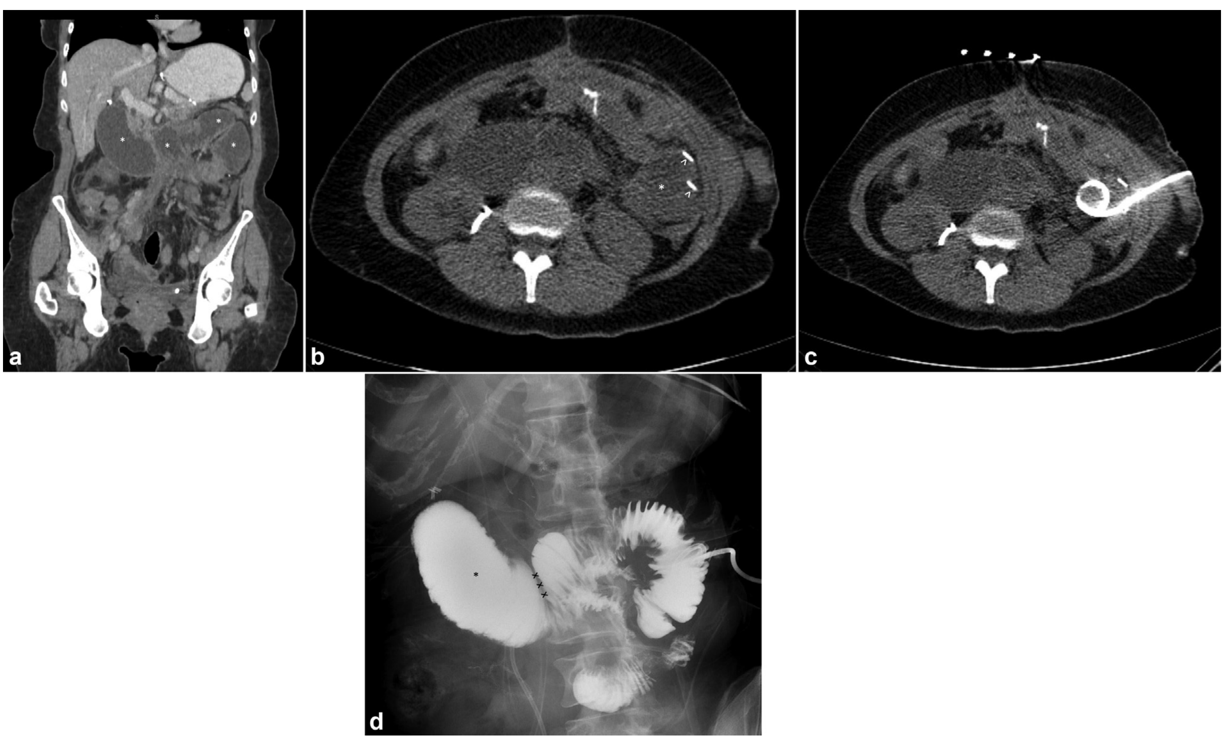

Fig. 7 CT-guided jejunostomy tube placement. A 54-year-old female was transitioning to hospice due to advanced ovarian cancer. She developed a closed-loop small bowel obstruction related to metastases and surgical adhesions, and decompression was requested for palliation. (**a**) Coronal post-contrast CT of the abdomen and pelvis showing the closed-loop obstruction (*). Because the obstructed bowel was very superficially located at the left flank, it appeared amenable to percutaneous drainage. (**b**) Two T-tacks (^) were placed with CT fluoroscopic guidance into the obstructed jejunum (*). (**c**) The space between the T-tacks was punctured with an 18-gauge needle, which was exchanged over wire for a 10-Fr pigtail drainage catheter. (**d**) Subsequent fluoroscopic image demonstrates decompression of the obstructed portions of the duodenum and proximal jejunum. Note the mild distension of the duodenum (*) proximal to the superior mesenteric artery (x).

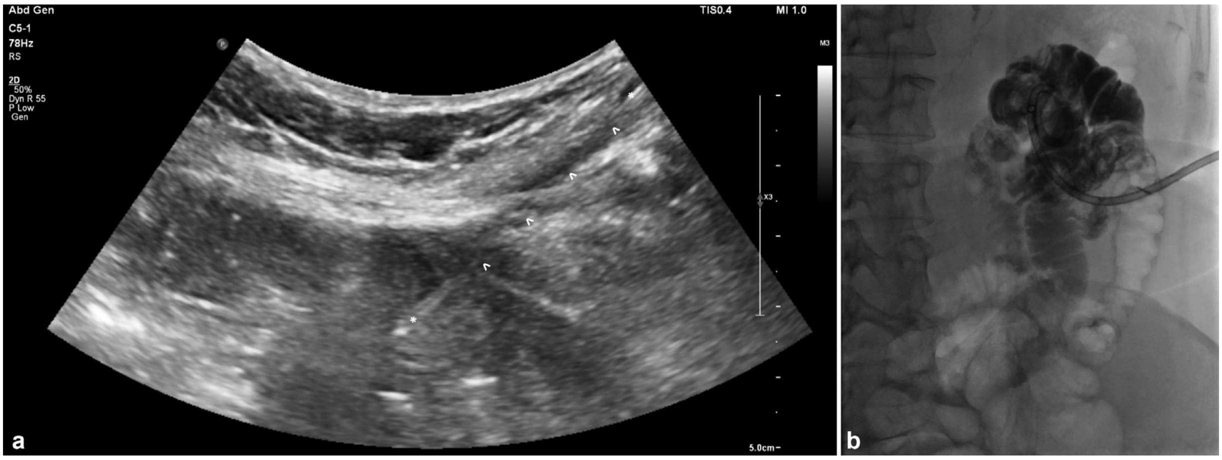

Fig. 8 Ultrasound-guided jejunostomy tube placement. A 48-year-old female with previous resection of a small bowel neuroendocrine tumor had a jejunostomy tube for nutritional support after the resection. This was subsequently removed when the patient was able to maintain nutritional goals via oral intake alone. Unfortunately, she again began losing weight and required the jejunostomy tube. (**a**) Ultrasound of the site of the jejunostomy tube demonstrates a hypoechoic scar (^) from the skin, through the abdominal wall, and into jejunum. This was punctured under real-time ultrasound guidance with a 22-gauge needle (*). (**b**) The tract was dilated to allow for placement of a 10-Fr pigtail catheter, which was subsequently exchanged for a balloon-retention jejunostomy tube 2 weeks later.

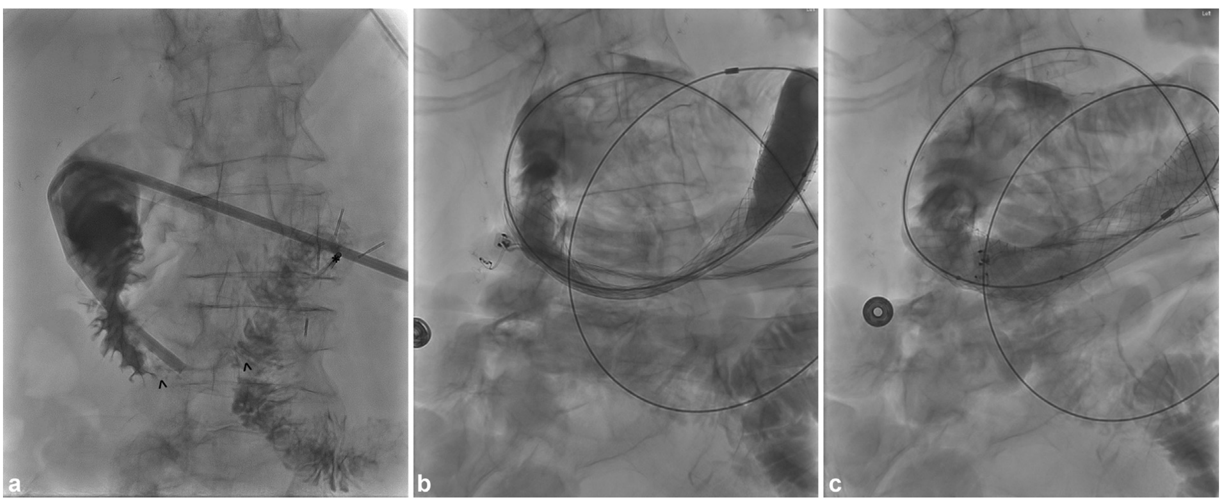

Fig. 9 Transgastric duodenal stent placement. A 92-year-old female presented with duodenal obstruction due to pancreatic cancer. While her nutritional needs were met by a gastrojejunostomy tube, she ultimately elected for hospice and requested a duodenal stent to allow for oral intake. (**a**) Contrast injection from a 12-Fr sheath placed via gastrojejunostomy tract demonstrates high-grade stenosis of the D3 portion of duodenum (^). Contrast was injected in the D4 portion via 5-Fr angiographic catheter (*) to elucidate the extent of the stenosis. (**b**) Through the sheath, a 22-mm WallFlex duodenal stent (Boston Scientific, Marlborough, MA) was deployed across the stenotic portion of the duodenum. (**c**) After post-molding the stent with an angioplasty balloon, the duodenum was widely patent, allowing ready transit from stomach to jejunum.

history which precludes standard access techniques. However, the imaging tools used by interventional radiology allow for obtaining access in many of these challenging patients.

Conflict of Interest
None declared.

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