14 Definition of Postoperative Anatomy and Placement of PEJ

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Postoperative Anatomy

The advanced endoscopist performing balloon enteroscopy has to be well acquainted with the postoperative anatomy. Understanding the different types of small bowel reconstructions will help the endoscopist troubleshoot any difficulties that arise from altered anatomy while performing enteroscopy.

Before starting the procedure, it is important to first get as much information as possible about the underlying postsurgical anatomy of your patient [1]. Ideally, the endoscopist should review the surgical report to determine what type of surgery was done, how much bowel has been resected, how long were the limbs, and what type of anastomosis was made. If not available, then the review of existing abdominal imaging posterior to the surgery (e.g., computed tomography or magnetic resonance enterography, small bowel follow-through) might provide valuable information and be a road map before the endoscopy.

Before reviewing the most common postoperative anatomies encountered during small bowel enteroscopy, it is important to define the two main types of anastomoses: end-to-side and side-to-side. The type of anastomosis would depend on the method used to reconnect the bowel, for hand-sewn end-to-side and for stapled side-to-side.

End-to-side, also known as terminolateral anastomosis, is usually seen after laparotomy hand-sewn small bowel anastomosis (Fig. 14.1). In this situation, the endoscopist will encounter two openings (Fig. 14.2, Video 14.1). Side-to-side (Fig. 14.3), also known as laterolateral anastomosis, is commonly seen after laparoscopic stapled small bowel anastomosis. In this situation, the endoscopist will encounter three stomal openings (Video 14.2).

From an endoscopic view, it can be challenging to determine between the lumens of the anastomosed limbs. Usually the presence of a scar can aid with distinguishing between them. The efferent limb (limb used to reach the anastomosis) will have an intact mucosa on the contralateral portion of the small bowel wall to the anastomosis. This is different from the afferent limb, which would have a circumferential scar around the opening of the stoma. Therefore as a rule, to intubate the afferent limb, the anastomosis scar rim must be trespassed [2]. Careful observation of the peristaltic wave can also be

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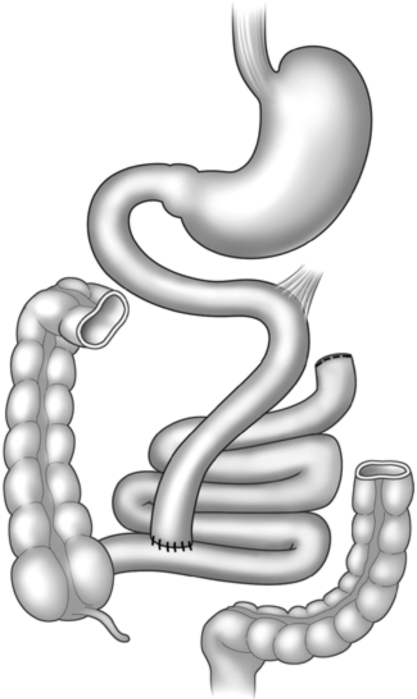

Fig. 14.1 End-to-side jejunoileal bypass. Reprinted with permission from Chousleb E, Rodriguez JA, O'Leary JP. Chapter 3. History of the Development of Metabolic/Bariatric Surgery. In: Nguyen NT, Rosenthal R, Ponce J, Morton J, Blackstone R (eds). The ASMBS Textbook of Bariatric Surgery, Vol. 1. New York, NY: Springer. 2014

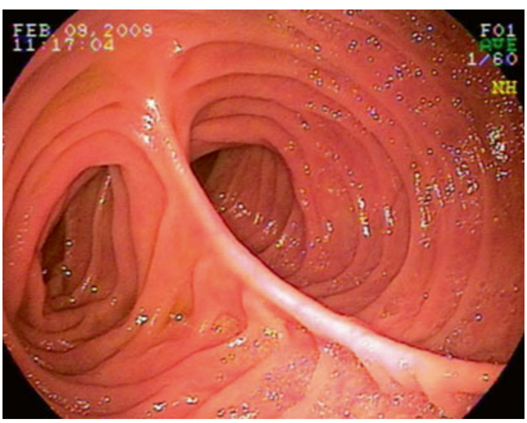

Fig. 14.2 Endoscopic view of an end-to-side anastomosis. Notice there are two stomal lumens

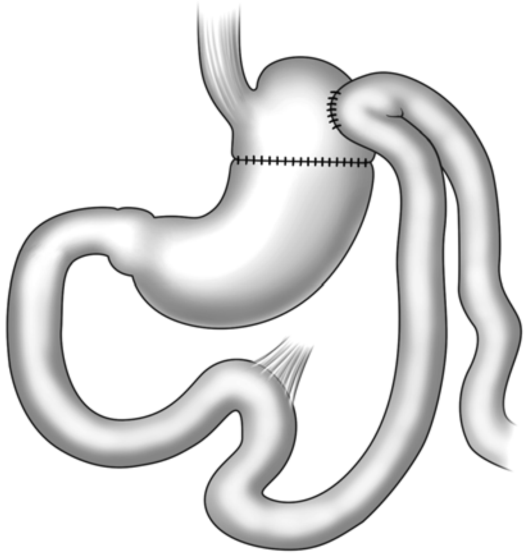

Fig. 14.3 Small bowel side-to-side anastomosis. Reprinted with permission from Chousleb E, Rodriguez JA, O'Leary JP. Chapter 3. History of the Development of Metabolic/Bariatric Surgery. In: Nguyen NT, Rosenthal R, Ponce J, Morton J, Blackstone R (eds). The ASMBS Textbook of Bariatric Surgery, Vol. 1. New York, NY: Springer. 2014

useful to differentiate between limbs. The efferent limb will have a peristalsis wave that will move away from the endoscope (natural downstream peristalsis), but the afferent limb will have a peristaltic wave that would move toward the endoscope, which is also known as antiperistalsis (Video 14.3). In spite of these distinctions, the limbs are not always distinguishable, and in these cases the endoscopist will have to rely on fluoroscopic guidance to confirm the direction toward the desired quadrant (e.g., right upper quadrant if in need to reach the papilla on a Billroth II patient), or they will need to advance the scope as far as possible. If this latter strategy is followed, then we recommend marking the mucosa (e.g., biopsy or tattoo) of the limb to be examined. This might save time later upon withdrawal of the scope back to the anastomosis, as the scope can commonly fall back briskly upon withdrawal due to bowel fixation and angulation at the level of the anastomosis. If the limbs' openings are not clearly distinguishable (e.g., biopsy or tattoo), it can be difficult to determine which was the limb recently examined.

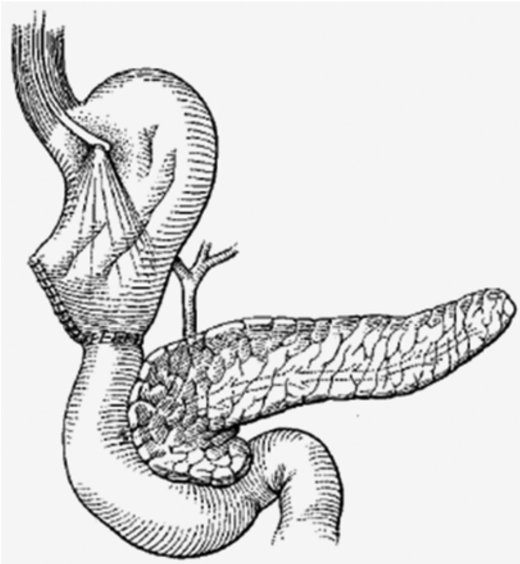

Fig. 14.4 Billroth I anastomosis diagram. Reprinted with permission Feitoza AB, Baron TH. Endoscopy and ERCP in the setting of previous upper GI tract surgery. Part II: postsurgical anatomy with alteration of the pancreaticobiliary tree. *Gastrointestinal endoscopy*. Jan 2002;55(1):75–79

Billroth I

In Billroth I, the distal stomach is resected and the remaining stomach is anastomosed to the duodenum (Fig. 14.4) [1]. The endoscopist will encounter an intact esophagus and GEJ. The length of the stomach would vary depending on the extent of gastric resection. The endoscopist will find the anastomosis by following the greater curvature of the stomach. The bulb might be small or not present at all, and the duodenum will typically appear straightened [1].

Billroth II

In Billroth II, the distal stomach and first portion of the duodenum are resected. Different to a Billroth I, the duodenal stump is closed and instead the stomach is anastomosed to the jejunum in an end-to-side fashion, creating a gastrojejunostomy with two stomas—one each leading to the efferent and afferent limbs (Fig. 14.5 [1], Video 14.4). To reach the major papilla, the afferent limb should be intubated. The afferent limb will end as a blind stump. The presence of bile and fluoroscopic confirmation of the direction of the scope toward the right upper quadrant or to cholecystectomy clips can help confirm the scope is within the afferent limb.

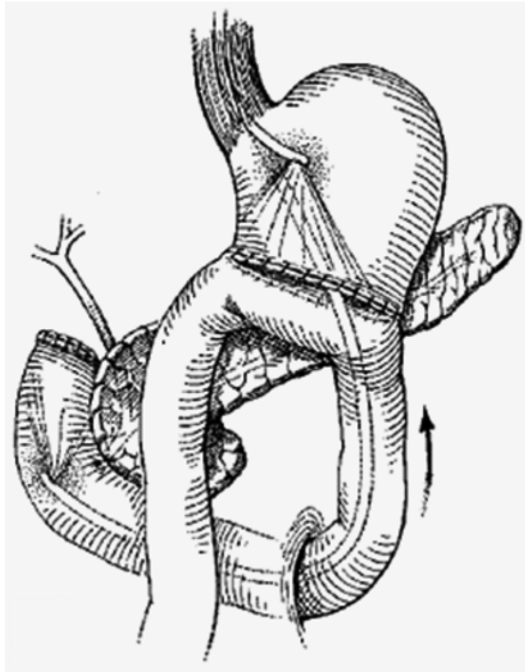

Fig. 14.5 Billroth II anastomosis diagram. Reprinted with permission Feitoza AB, Baron TH. Endoscopy and ERCP in the setting of previous upper GI tract surgery. Part II: postsurgical anatomy with alteration of the pancreaticobiliary tree. *Gastrointestinal endoscopy*. Jan 2002; 55(1):75–79

Braun Anastomosis

This is a side-to-side jejunojejunal anastomosis commonly seen during Billroth II reconstruction to divert bile from the gastric remnant by creating an anastomosis between both the efferent and afferent limbs (Fig. 14.6) [1].This means that the endoscopist would encounter a side-to-side anastomosis after intubating either opening of the gastrojejunal anastomosis. This Braun anastomosis is approximately 15 cm from the gastrojejunal anastomosis [1].

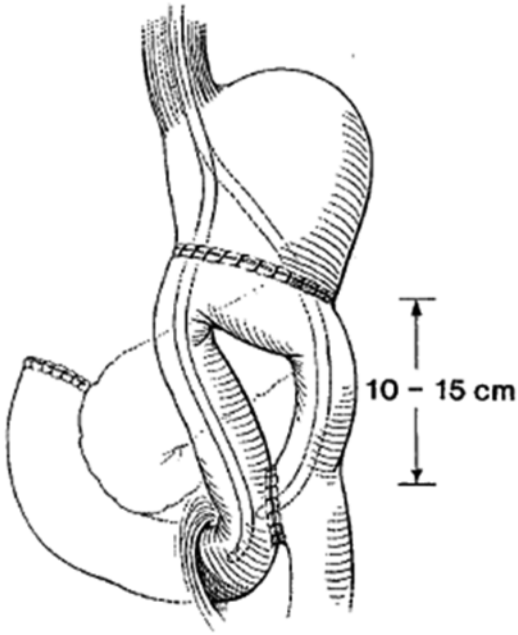

Fig. 14.6 Braun anastomosis diagram. Reprinted with permission Feitoza AB, Baron TH. Endoscopy and ERCP in the setting of previous upper GI tract surgery. Part II: post-surgical anatomy with alteration of the pancreaticobiliary tree. *Gastrointestinal endoscopy*. Jan 2002;55(1):75–79

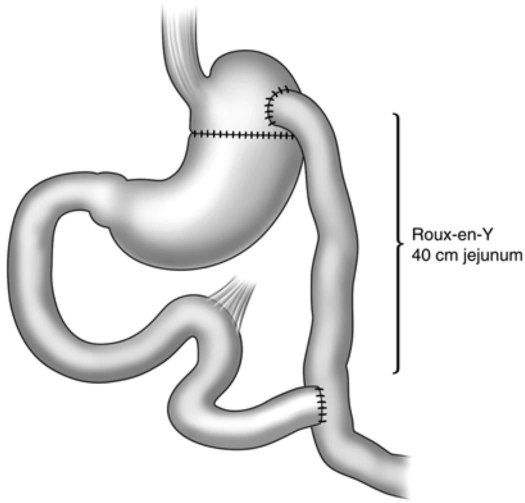

Fig. 14.7 Roux-en-Y limb for gastrojejunostomy. Reprinted with permission from Chousleb E, Rodriguez JA, O'Leary JP. Chapter 3. History of the Development of Metabolic/Bariatric Surgery. In: Nguyen NT, Rosenthal R, Ponce J, Morton J, Blackstone R (eds). The ASMBS Textbook of Bariatric Surgery, Vol. 1. New York, NY: Springer. 2014

Roux-en-Y Gastrojejunal Bypass

Roux-en-Y gastrojejunal bypass (RYGB) can be performed with gastrectomy (e.g., gastric cancer) or without gastrectomy (e.g., gastric bypass for weight loss) (Fig. 14.7). With either gastric bypass or partial distal gastrectomies, the endoscopist will encounter a normal esophagus and normal gastroesophageal junction. The gastric pouch will be connected distally to the jejunum in an end-to-side anastomosis. If the RYGB was performed for weight loss, the gastric pouch would be significantly smaller and will have a suture line or scar laterally [3]. This gastrojejunal anastomosis can have a length of 10–12 cm and will commonly have two small bowel limbs: a short blind limb and the efferent or Roux jejunal limb (Video 14.5) [3]. The length of the Roux limb can vary between 50 and 150 cm, with longer limbs used for weight loss surgeries and shorter ones for gastrectomy patients [3]. At the end of the Roux limb, the endoscopists will find a jejunojejunal anastomosis. If the Roux-en-Y was performed for gastric bypass, the afferent limb will lead to the papilla and the stomach remnant can be entered in a retrograde fashion through an intact pylorus (Video 14.5). In a gastrectomy with Roux-en-Y, the limb will end in a blind stump similar to that seen on Billroth II anastomosis.

Biliopancreatic Diversion with Duodenal Switch

A biliopancreatic diversion with a duodenal switch consists of a partial gastrectomy (vertical sleeve gastrectomy) with preservation of the distal antrum, pylorus, and duodenal bulb; transection of the small bowel approximately half way between the ligament of Treitz and the ileocecal valve; and two enteroentero anastomoses—one

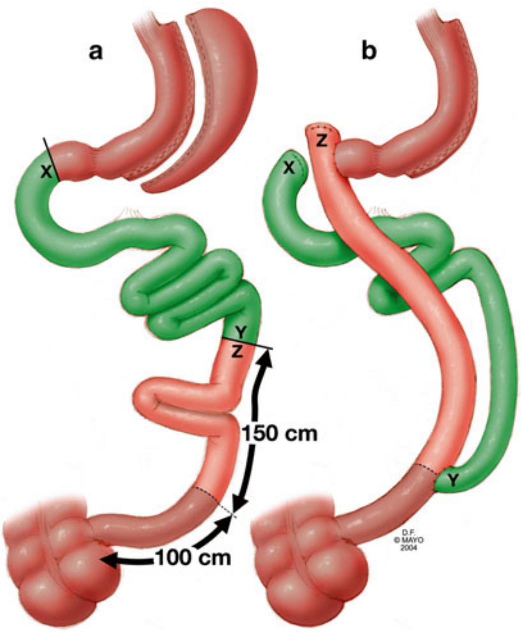

Fig. 14.8 Biliopancreatic diversion with duodenal switch diagram. From Decker GA, Swain JM, Crowell MD, Scolapio JS. Gastrointestinal and nutritional complications after bariatric surgery. Am J Gastroenterol 2007;102:2571–80. Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved

between the duodenal bulb and the limb attached to the ileocecal valve (also known as the alimentary limb) and the second between the limb attached to the papilla (also known as the biliopancreatic limb) and the alimentary limb (Fig. 14.8) [4].

The endoscopist will encounter a normal esophagus and GEJ and then will find a stomach with a vertical sleeve gastrectomy. This means the lesser curvature will be intact and there will be a long vertical scar on the contralateral wall. The stomach would have a tubular shape but will have a preserved pylorus. Once the pylorus is transverse, the endoscopist will encounter the duodenal bulb and, soon after, an anastomosis with the alimentary limb. If the endoscopist continues down the alimentary limb, the endoscopist will reach a second enteroentero anastomosis. This anastomosis will have two open stomas: one into the biliopancreatic limb and the other into the common channel. Distal to the anastomosis into the common channel limb, the endoscopist will reach the ileocecal valve. If the papilla needs to be reached, the biliopancreatic limb will have to be intubated. This limb is considerably longer when compared to Roux-en-Y gastrojejunal bypass.

Placement of Percutaneous Endoscopic Jejunostomy

Percutaneous endoscopic jejunostomy (PEJ) allows placement of a feeding tube directly into the jejunum. PEJ is an alternative to other direct methods of jejunal access, such as interventional radiology jejunostomy (IR-J) or surgical jejunostomy (SJ), and to the more commonly used technique for jejunal feedings, percutaneous endoscopic gastrostomy (PEG) tube with jejunal extension (PEG-J) [5]. There is no head-to-head study comparing these four techniques, but a recent review by Murphy et al. [6] summarizes the outcomes, adverse events, and reintervention rates published to date between these techniques (Table 14.1). PEJ allows jejunal access without the morbidities of surgery, but it does require sedation and in some cases general anesthesia, which is a disadvantage when compared to IR-J.

The most common indications for PEJ is the need for jejunal feedings due to previously failed PEG-J, previous gastrectomy, gastroparesis, recurrent aspiration, dysphagia, or poor nutritional status in patients with expected future foregut surgery (e.g., esophageal or gastric cancer resection) precluding PEG placement and gastric outlet or proximal small bowel obstruction [5].

The relative and absolute contraindications are similar to PEG. Absolute contraindications include uncorrected coagulopathy, thrombocytopenia or tense ascites, small bowel obstruction precluding distal scope passage, or intra-abdominal sepsis. Relative contraindications include obesity, small bowel dysmotility, eating disorders, functional nausea, vomiting, or abdominal pain. If it is uncertain that enteral feedings will be tolerated, a trial of nasojejunal feeding before PEJ placement can be considered [6].

Table 14.1 Outcomes of different methods of percutaneous jejunostomy placement

Procedure	First attempt success rate (%)	Overall adverse event rate (%)	Serious adverse event rate (%)	Reintervention rate (%)
PEG-J	88–93	35–56	0–3	22–56
IR-J	85–95	7.7–11.3	5–11	NA
PEJ	68–86	22–35	2–6.3	13.5–16.7
SJ	~100	12–35	0.6–4	1–8

Adapted from [6]
PEG-J percutaneous endoscopic gastrostomy tube with jejunal extension, *IR-J* interventional radiology jejunostomy, *PEJ* percutaneous endoscopic jejunostomy, *SJ* surgical jejunostomy

Placement Technique

PEJ placement uses the same principles and technique as a PEG placed by the pull technique [6]. Likewise, the use of an aseptic sterile technique and periprocedural antibiotics is recommended. To reach the jejunum, push enteroscopy with a pediatric colonoscope has been used most frequently, but there are also reports using balloon-assisted enteroscopy [7, 8].

Once the endoscope is advanced beyond the ligament of Treitz, the puncture site is selected by a combination of transillumination and finger indentation. If these two techniques fail to identify a clear window for needle puncture, one can consider the use of fluoroscopy [9], a long 15 cm needle [10], magnetic anchor [11], and/or transabdominal ultrasound guidance [12] as aids for successful bowel needle puncture:

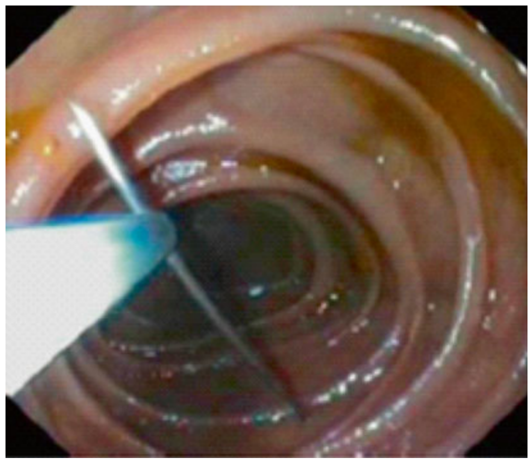

Fig. 14.9 Endoscopic view of the needle secured by snare after bowel puncture. Reprinted with permission from Aktas H, Mensink PB, Kuipers EJ, van Buuren H. Single-balloon enteroscopy-assisted direct percutaneous endoscopic jejunostomy. *Endoscopy*. Feb 2012;44(2):210–212

1. After application of lidocaine within the desired needle tract, the needle is advanced with constant negative pressure suction until simultaneously air is aspirated and the needle is visualized within the lumen of the jejunum. If only air is suctioned and the needle is not visualized, then this suggests that the needle has entered another loop of bowel or hollow viscera at which point, the needle should be removed and a new puncture site selected.
2. The endoscopist will need to immediately secure the needle with a snare to avoid migration of the loop of bowel away from the abdominal wall (Fig. 14.9) [8]. This step is the major difference with conventional PEG placement. The use of antispasmodics to reduce small bowel peristalsis has also been suggested as an aid to prevent migration of the small bowel [6].
3. A small incision is then made with a scalpel on the skin and subcutaneous tissue, which is followed by trochar introduction in the same tract as the needle. The trochar is then secured with the snare and the needle is removed (Fig. 14.10) [8]. The guidewire is fed through the trochar and then secured with the snare.
4. The scope is withdrawn and the guidewire is pulled through the patient's mouth. The feeding tube is attached to the guidewire and,

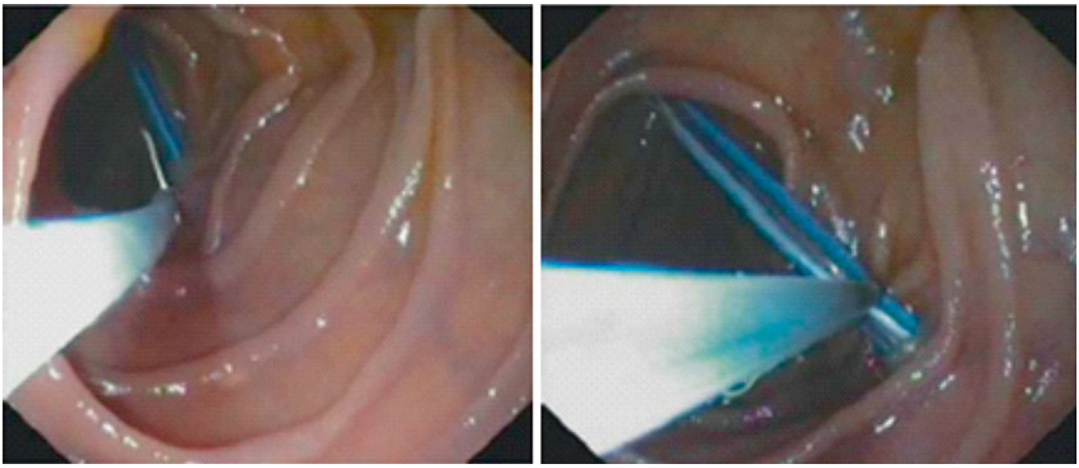

Fig. 14.10 The trochar is passed next to the needle and then secured with the snare. Reprinted with permission from Aktas H, Mensink PB, Kuipers EJ, van Buuren H. Single-balloon enteroscopy-assisted direct percutaneous endoscopic jejunostomy. *Endoscopy*. Feb 2012; 44(2):210–212

using the pull technique, the feeding tube is pulled through the abdominal wall and snug into the wall of the jejunum [6]. The scope can be reintroduced to confirm and photo document appropriate placement of the internal bumper of the feeding tube [6].

The success rate of PEJ placement can range from 68 to 86 % [5, 13–15]. The most common causes for failed PEJ placement include: absence or suboptimal transillumination and indentation, failure to reach the jejunum, and sedation complications [5, 13–15]. Increased success rates have been described in patients with previous gastric or esophageal resections, which are probably due to the shorter distance required to reach the jejunum and adhesions of the jejunum to the anterior abdominal wall that might facilitate bowel puncture. On the other hand, obesity has been described as cause for failed placement due to decreased transillumination and indentation from a thicker abdominal wall pannus [6, 15]. Complications rates range from 2 to 6.3 % for severe adverse events. See Table 14.2 [6].

Table 14.2 Adverse events reported in largest series of PEJ placement

Severe adverse events	Mild and moderate adverse events
Bleeding $n=4$	Infection $n=47$
Bowel perforation $n=8$	Pain $n=34$
Jejunal volvulus $n=6$	Chronic fistula $n=9$
Aspiration $n=1$	Aspiration $n=4$
Abscess $n=1$	Hematoma $n=1$
Necrotizing fasciitis $n=1$	Tube leak $n=13$
Jejunal obstruction $n=1$	Tube malfunction $n=3$
Sepsis $n=1$	Site ulceration $n=1$

Adapted from [6]

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Video Legends

Video 14.1 - End-to-side anastomosis.

Video 14.2 - Side-to-side anastomosis. Small bowel anastomosis with 3 stomal openings.

Video 14.3 - Peristalsis and antiperistalsis at a small bowel anastomosis.

Video 14.4 - Billroth II anastomosis.

Video 14.5 - Roux-en-Y gastric bypass.