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# A Technical Guide to Enteral Access and Complications

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## Abstract

**Purpose of Review** Enteral nutrition is essential for those unable to maintain adequate caloric intake orally. Access to the gastrointestinal tract is necessary to deliver enteral nutrition. Many options for enteral access are available, raising questions in clinical practice regarding what type and timing of access is required.

**Recent Findings** Short-term enteral nutrition may be provided by nasogastric or nasoenteric access. Long-term enteral nutrition may require a percutaneous endoscopic gastrostomy or radiographic percutaneous gastrostomy. If long-term enteral nutrition is required and the stomach is not functional, jejunal access may be used, consisting of a percutaneous endoscopic gastrostomy with jejunal extension, direct percutaneous endoscopic jejunostomy, or surgical jejunostomy. Despite technique utilized, complications do exist. Early recognition and treatment of these complications are essential for patient outcomes and preservation of enteral access.

**Summary** This review addresses the different types of enteral access, including details on the indications, procedures, and complications so that providers may have better understanding and utilization.

**Keywords** Enteral · Nutrition · Access · Techniques · Complications

## Introduction

Nutrition is an extremely important aspect of health care. Malnutrition may arise from many factors, including lack of ingestion of proper nutrients, inability to adequately digest nutrients, or difficulties in absorbing nutrients. Poor nutrition can have significant consequences, leading to pulmonary, muscle, thyroid, immune system, and gastrointestinal dysfunction [1, 2]. In those with poor nutrition or at risk of malnutrition, supplemental nutrition may be required.

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Enteral nutrition is the preferred choice for the delivery of supplemental nutrition over parenteral nutrition. Enteral nutrition has been shown to support the functional and structural integrity of the gastrointestinal tract. Furthermore, enteral nutrition reduces inflammatory response and supports commensal bacteria [3, 4]. Ideally, supplemental enteral nutrition is achieved by feeding via the mouth; however, this may not be possible for various reasons. If feeding does not suffice, then enteral access must be considered to supply adequate caloric and protein requirements.

Enteral access is the placement of a tube from the outside of the body to the gastrointestinal tract to allow for supplemental nutrition. Many forms of enteral access are currently available, including nasogastric/nasoenteric tubes, gastrostomies, and jejunostomies. Table 1 this article will cover the concept of enteral access, including indications, techniques, and potential complications.

## Nasogastric and Nasoenteric Access

The first nasogastric (NG) tube delivered fluids into the stomach via a rigid tube in 1617 by Aquapendente [5]. By the 17th century, the NG tube transformed from a hollow

**Table 1** Types of enteral access

| Gastric access | Jejunal access |
|---|---|
| Nasogastric tube | Nasojejunal tube |
| Percutaneous endoscopic gastrostomy | Percutaneous endoscopic gastrostomy with jejunal extension |
| Radiographic percutaneous gastrostomy | Direct percutaneous endoscopic jejunostomy |
| Surgical gastrostomy | Surgical jejunostomy |

tube to a leather tube; however, by the late 1790's the standard of care was an eel skin covered whale bone utilized for hydration and feeding [5–7]. The rigid NG tube became flexible with capacity to not only deliver fluids and nutrition but also decompress the stomach in the late 1800's [5, 7]. By 1910, a weighted nasoduodenal (ND) tube was invented, followed by the weighted nasojejunal (NJ) tube in 1918 [5, 7]. By 1939, a double lumen jejunal tube was developed which provided the option to decompress and feed the patient [5, 7].

Patients requiring a NG or nasoenteric (NE) tube must have an accessible and functioning gastrointestinal tract and the need for short-term (4–6 weeks) nutritional support [8]. NG/NE tubes can provide hydration, nutrition, and medications via the gut. NG/NE feedings maintain the integrity and function of the gut by preventing atrophy of the intestinal villi, which promotes gut immunity and thereby improving systemic immunological defenses [9–12]. NG/NE tubes also provide decompression and drainage post-operatively and in small bowel obstructions and gastric lavage/irrigation of the stomach post-gastrointestinal bleeding [13, 14].

NG/NE tube placement is usually performed blindly at the bedside by experienced staff. Tube insertion depth varies between patients and is determined by the measurement from the tip of the nose-ear-xiphoid process [9, 13]. This is the appropriate length of the tube to place the tip of the NG tube at the fundus [9, 13]. Hospital protocols vary on the NG/NE tube placement. One study found lidocaine gel or atomized spray with or without a nasal vasoconstrictor (oxymetazoline) was shown to minimize discomfort and potential nose bleeds during insertion of the tube [15]. A recent meta-analysis noted a 26% reduction in pain and discomfort during NG/NE insertion with lidocaine gel in adults [16]. With the patient holding their chin to their chest, the tube is advanced to the predetermined mark while watching the patient for signs of coughing, shortness of breath and signs of aspiration for which, if observed, the tube should be removed [17].

The gold standard for NG/NE placement confirmation is an abdominal x-ray showing midline placement of the tube [9, 13]. However, this may lead to increased radiation exposure to patients and costs given that it may occur multiple times during a hospitalization. Less reliable signs of NG/NE tube gastric placement are auscultation of air bolus in the epigastric area, tube aspirate of gastric contents, and lack of coughing during placement [9, 13]. Although commonly practiced, epigastric auscultation of bolused air has been noted to have a 20% false positive rate [9]. Tube aspirate may assist in verifying tube placement as stomach pH is 3.9 while off proton pump inhibitors (PPI); however, gastric (on PPI), intestinal, and lung pH may be over 6, thus making this less reliable for tube location [9, 13]. Tube aspirate color and consistency may be helpful determining placement. If the tube aspirate is pale yellow, straw-colored, and watery, it is likely pleural fluid; mucus-tan or off-white aspirate may by tracheobronchial secretions. Gastric aspirate color can range from green/cloudy, colorless/clear, bloody, brown, tan or off-white, all with a pH < 3.5; small bowel aspirate color ranges from bile colored, light to dark yellow or brownish green and pH of > 6 [13]. Providers have tried placing the proximal end of the NG/NE tube under water to check for "bubbling" that may occur if the tube is in the lung; however, bubbling has also been seen in gastric placement [9]. A meta-analysis found capnography, which tests for $CO_2$ concentrations in gases, was cost-effective, time-sparing, and accurate with sensitivity ranging from 88 to 100% and specificity from 95 to 100% but in only mechanically ventilated patients [18]. Capnography may not be available in every hospital; thus, abdominal x-ray remains the preferred test for reliable placement of NG/NE tube placement. Due to the blind nature of placement, all these different techniques just described may be performed to assess correct placement. As technology advances, direct visualization may remove the blindness of placement.

Nearly a century after its invention, two systems increased access to the stomach with more accuracy and speed, utilizing more advanced technology, and decreasing the blind aspect of NG/NJ placement. The CORTRAK*2® enteral access system (CORTRAK*2, Avanos Medical Incorporated, Alpharetta, GA) has an electromagnetic sensor with the capability to confirm tube placement via the transmitting stylet in three views at the patient's bedside [19, 20]. The signal from the stylet is triangulated and position tracing is transmitted in real time to the bedside monitor for visualization and confirmation of placement without an x-ray. The second enteral access system, the Covidien Kangaroo with IRIS® (Covidien Kangaroo with IRIS, Cardinal Health, Dublin, OH) technology possesses a 3 mm camera with real

time imaging providing direct visualization of the NG tube into the stomach [21]. Despite the benefits of direct visualization, these new technologies are costly and require some training on their use. Furthermore, this equipment is not found in many hospitals. Once the NG/NE tube is in place and confirmed, feeding may begin. However, complications may arise that requires early recognition and intervention.

Complications of NG/NE tube placement range from mild discomfort to life-threatening and organized into the following areas: Gastrointestinal, mechanical, respiratory, metabolic, and miscellaneous. Gastrointestinal complications are mild-to-moderate and may include nausea, vomiting, diarrhea (most prevalent), constipation, bloating, reflux, and cramping [22, 23]. The nutritional formula/feeding may contribute to the diarrhea due to the level of sorbitol within the formula, but the gut flora of the patient, speed of administration of the formula, and other medications such as antibiotics may also contribute to diarrhea. These mild-to-moderate complications are manageable and treated with medications.

Potential mechanical or tube-related complications from NG/NE tube placement and management range from mild-to-severe. Mild complications include hoarseness and nasopharyngeal pain. Moderate complications can be malposition, unwanted removal, tube clogging/patency, nasopharyngeal erosions/ulcers or bleeding, sinusitis, otitis media, and laryngeal, esophageal, gastric ulcerations, or bleeding due to the NG tube itself [9, 17, 22, 23]. Severe complications include tracheoesophageal fistula, variceal rupture, and gastric or duodenal perforation [22, 23]. Smaller NG/NE tubes (less than 12 mm) appear to have less severe complications than tubes greater than 14 mm, which may lead to ulceration and bleeding from the nose, posterior larynx, esophagus, and stomach and may potentially create trachea-esophageal fistulas [17]. However, smaller tubes tend to occlude, migrate out of position, and rupture [22, 23].

Potential respiratory complications from NG/NE tube placement and management are severe and may be life-threatening. Aspiration of oropharyngeal (antegrade) or gastric (retrograde) contents is possible [22, 23]. Chun-Sick et al. found aspiration pneumonia risk is significantly increased in the setting of PPI and $H_2$RB as oropharyngeal/gut bacteria increase as the pH increases [24]. Of the NG/NE tubes placed, 1–4% placed in the bronchi [11, 22, 23, 25]. Therefore, direct visualization techniques may benefit and justify the costs. However, the enteral access systems are not without adverse events. The CORTRAK system secondary analysis of adverse events found that despite the three-way visual system, lung placement is possible, and clinicians may fail to recognize placement in the lungs [19]. Other potential NG/NE tube complications range from sore mouth, dry mucous membranes due to decreased saliva production due to mouth breathing, dysphagia due to presence of the NG/NE tube, abnormal liver function tests, and contamination of the tube feeding causing infections [23].

Despite these complications, NG/NE tubes serve an important role in enteral access for short-term enteral nutrition, regardless of the placement or confirmation method. If more long-term enteral nutrition is required, gastrostomies or jejunostomies may be considered.

## Gastric Enteral Access

In 1979, pediatricians Michael Gauderer and Jeffrey Ponsky devised the first percutaneous endoscopic gastrostomy (PEG). Gauderer, a pediatric surgeon, performed upper endoscopies on small children and was intrigued by the "glow of light" visible on the children's abdomen. On his service, he cared for children with severe neurological disorders that required laparotomy with feeding gastrostomy tube placement. With consultation with Dr. Ponsky, they developed a technique to perform an endoscopic-guided percutaneous gastrostomy [26]. The PEG was developed out of necessity and ingenuity. It has proved to be inexpensive, low-risk alternative to laparotomy and quickly became the favorable route of feeding and nutritional support for patients requiring long-term enteral nutrition, usually more than 4 weeks [27].

The PEG facilitates placement of a flexible tube that communicates between the abdominal wall and gastric cavity, allowing direct passage of nutritional support into the digestive tract. Feeding via a PEG has been found to be the preferred method for long-term feeding in patients unable to maintain adequate nutrition despite the normal functioning gastrointestinal tract [28]. PEG placement is a minimally invasive procedure that does not require general anesthesia and is typically preferred due to low risk, ease of use, and low cost [27].

The primary indications for PEG placement are dysphagia, impaired self-feeding, obstruction of the proximal gastrointestinal tract preventing enteral access, malnutrition secondary to malignancy, decreased oral intake related to radiation or chemotherapy, and gastric decompression. Table 2 the patient's life expectancy, diagnosis, and preferences must be considered and discussed with both the patient and family prior to the procedure, especially given the differences between family expectations and reality [28]. Table 3 contraindications include coagulation disorders, hemodynamic instability, sepsis, ascites, peritonitis, abdominal wall infection located at the PEG placement site, peritoneal dialysis, history of gastrectomy, and lack of informed consent. Age and weight typically do not contribute to contraindications [29, 30]. Pregnancy is usually thought to be contraindicated; however, rare special considerations have

**Table 2** Indications and contraindications for PEG placement

| Indications | Contraindications (relative & absolute) |
|---|---|
| Dysphagia | Inability to locate safe gastric access site |
| Impaired self-feeding | coagulation disorder |
| Proximal GI tract obstruction | Hemodynamic instability |
| Malnutrition due to malignancy | Sepsis |
| Decrease oral intake due to radiation or chemotherapy | Ascites |
| Gastric decompression | Peritonitis |
| | Abdominal wall infection at PEG site |
| | Peritoneal dialysis |
| | Prior gastrectomy |
| | Lack of informed consent |
| | Pregnancy > 29 Weeks |

**Table 3** Family expectations for PEGs and reality of PEGs

| Family expectations | Reality |
|---|---|
| Improve nutrition and hydration | Nutritional status does not necessarily improve |
| Prevent aspiration pneumonia | Continued risk of aspiration |
| Improve or maintain function | Survival rates same for PEG and spoon-fed patients |
| Improve survival | Mortality rates |
| Improve patient comfort | Restraints often required leading to discomfort and compromised autonomy |
| | Denied pleasure of eating |
| | Adverse effects with feeding tube due to complications |

been given to pregnant women with gestation of 29 weeks or less for treatment of hyperemesis gravidarum, trauma, and anorexia nervosa to minimize maternal and neonatal morbidity [31].

Prior to PEG placement, irrespective of technique, informed consent must be obtained. Additionally, assessment of coagulation and NPO status should be confirmed and a broad-spectrum antibiotic administered prior to procedure initiation. Prior to the initiation of the procedure, needed supplies should be assembled, some of which include sedative medications, local anesthetic, suction for oropharyngeal secretions, cardiac monitor, supplemental oxygen, and endoscope. Typically, the PEG device is packaged as a kit by the manufacturer that includes syringe and needle, scalpel, trocar, thread-guide, feeding tube, and snare. Figure 1 the abdominal wall should be inspected noting any scars or wounds/tubes that may inhibit tube placement. Once the patient has been adequately sedated the procedure, the skin at the site of the PEG will be disinfected and procedure performed by sterile field over the abdomen. At that point, the PEG placement may begin.

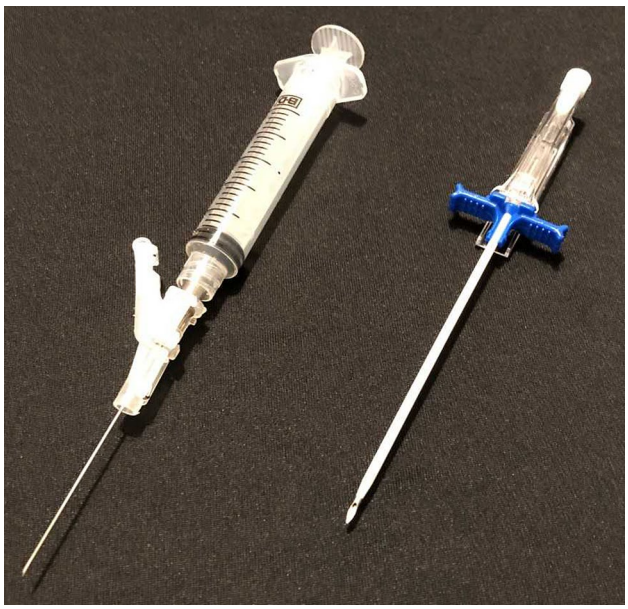

**Fig. 1** Typical safe tract needle and trocar

An endoscopy exam is completed prior to the start of PEG procedure, often performed in the supine position. Once completed, identification of the ideal safe site for PEG placement will be performed in a 3-step mechanism. The first step, transillumination, is performed by aiming the endoscope tip anteriorly to the stomach wall so that the light may be seen through the skin of the abdominal wall. Figure 2 Transillumination visualization may be difficult in obese patients or in those with excessing scarring. The second step, finger indentation, is performed by an assistant placing their index finger on the preferred abdominal wall location site in a downward pressing fashion. The endoscopist watches for the indentation within the stomach. Once the proposed site is identified, the third and final step of aspiration is performed. Aspiration requires a syringe with a needle to be inserted to

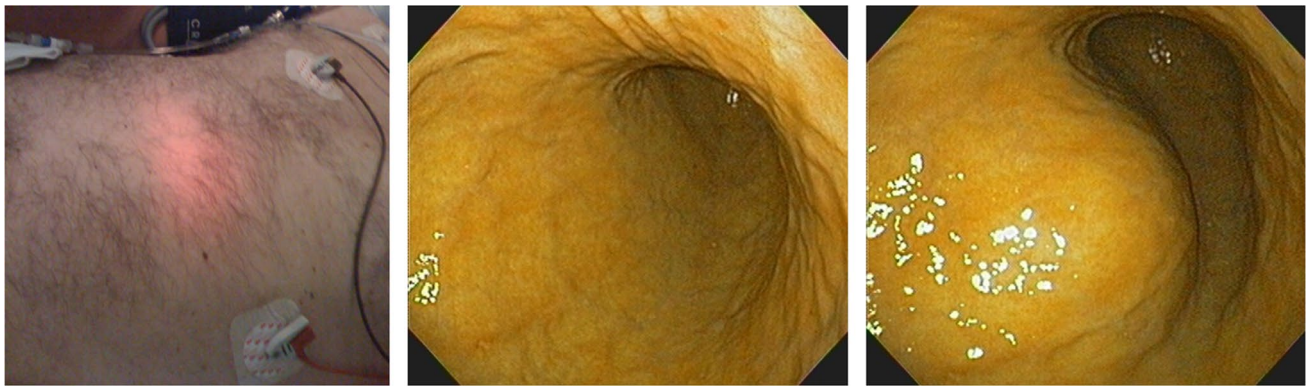

**Fig. 2** Appropriate transillumination and finger indentation

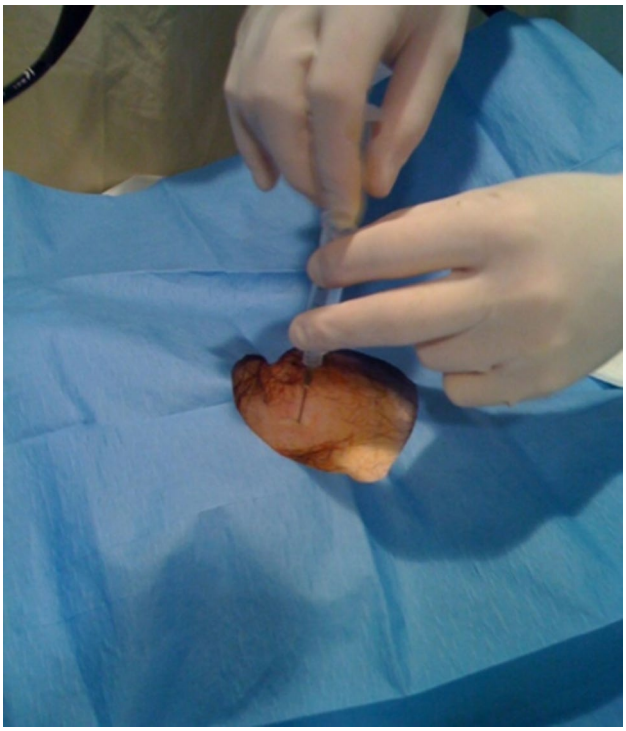

**Fig. 3** Safe tract technique

identify structures that may lay between the abdominal and gastric wall. This is called safe tract assessment. Figure 3 Aspiration usually occurs when local anesthetic (lidocaine or xylocaine) is given at the surface and deeper. As the needle advances, suction is applied to aspirate any fluid the needle may encounter. If the fluid aspirate is brown or air the needle and no visualization of needle in the stomach, the needle may be in the colon. There is a potential to pierce a vessel resulting in a bloody aspirate. If abnormal aspirate is found, the needle should be removed with little complication and evaluation for a new site should be performed by repeating the previous steps. If no abnormal aspiration is identified and needle has air with visualization of stomach access, the local anesthetic can be administered as needle withdrawn. With successful completion of the three steps PEG placement may proceed.

Two common techniques for endoscopic gastrostomy placement are typically practiced, the pull and the push techniques. Figure 4 the pull method which has been updated and modified over the years [27]. This method requires an endoscope to be intubated into the stomach, the stomach insufflated, moving the stomach wall closer to the abdominal wall. Once confirmation of safe site is performed and local anesthetic administered, a small incision is performed, generally around 1 cm and just a few millimeters in depth. A large-bore trocar with a needle is inserted through the incision into the gastric lumen under direct observation with the endoscope. The needle is then removed from the trocar, allowing a looped insertion wire to pass through the hollow trocar into the stomach. This looped wire is then grasped by the endoscopist with a snare and the endoscope is withdrawn through the mouth with the wire firmly gripped by the snare. Securing the tapered end of the gastrostomy to the wire, the guidewire is withdrawn via the abdominal opening, pulling the feeding tube down into the stomach. Confirmation of gastrostomy placement is often completed through direct visualization with the endoscope, confirming that the internal fixation bumper is against the gastric wall. Figure 5 the external bolster fixation is then placed 2–3 mm away from the abdominal wall. To adequately place the external bolster, two methods are used, the two-hand or the one-hand technique. Figure 6 in the two-hand technique, one hand is holding the tube and the other hand is advancing the external bolster. The limitations of this technique are slippage of the hand on the external bolster and the lack of feel on tightness. Therefore, one of the authors of this article (Bechtold) advocates using a one-hand technique. In this technique, the gastrostomy is grasped by the 3rd, 4th, and 5th digits with the gastrostomy across the palm.

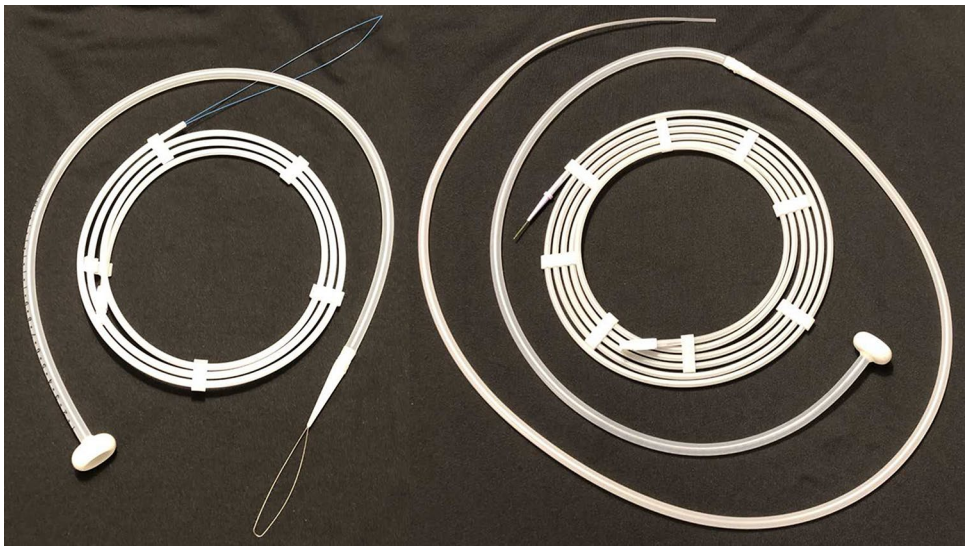

**Fig. 4** Differences between the pull and push technique tubes and guidewires

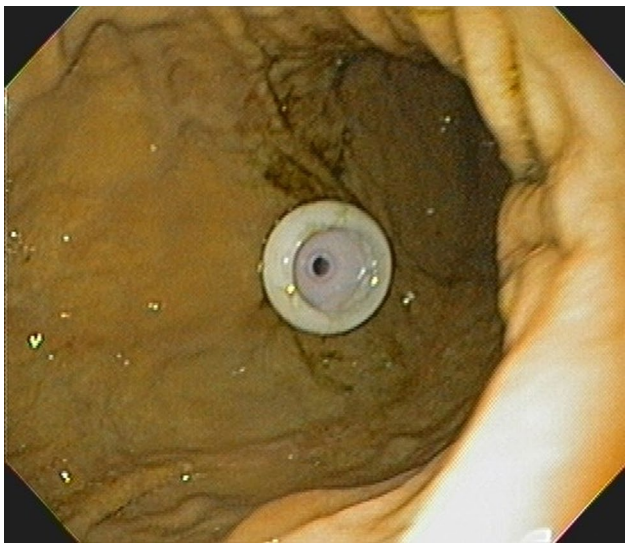

**Fig. 5** Examination of internal bolster on second-look endoscopy

The thumb and 1st digit then slowly advance the external bolster while the other digits hold tight on the gastrostomy. This technique nearly eliminates slippage and offers the best feel for tension on the gastrostomy and bolster. Once the bolster is placed, an external dressing is applied over the gastrostomy and site. The push technique is like the pull technique in every aspect except how the tube is passed. In this technique, a guidewire is inserted into the stomach via the hollow large-bore trocar that was inserted into the abdominal wall, grasped by the endoscope, and withdrawn through the mouth. However, the feeding tube is then pushed over the guidewire, into the stomach and pulled out through the abdominal wall incision. The guidewire is removed via the mouth after gastrostomy in place. The two techniques offer similar efficacy rates and no difference in complication rates.

Once the PEG is in place special attention to both the internal and external bolster fixation is a priority so that complications do not arise. A poorly secured PEG may slide in and out of the stoma, potentially leading to many potential complications. Daily visual monitoring of the PEG position is recommended especially in individuals who were dehydrated prior to placement as rehydration can cause expansion of tissue and tightening as a result. Establishment of the mature fistula usually takes 2–3 weeks.

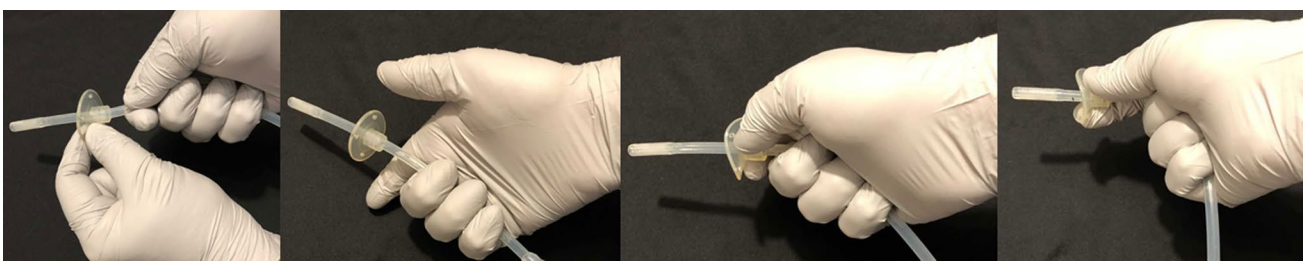

**Fig. 6** Two-hand (far left) and one-hand technique (right 3 frames) for advancement of external bolster

### Radiographic Percutaneous Gastrostomy (RPG)

An alternative to PEG is radiographic percutaneous gastrostomy (RPG). In 1981, Dr. Preshaw, a Canadian surgeon, performed the first radiological gastrostomy placement using fluoroscopy [32]. This technique eliminates the need for endoscopy by using fluoroscopy to identify the stomach and avoid organs. Thus, radiographic procedure can be performed on individuals who endoscopy is contraindicated such as those with esophageal strictures or masses. An interventional radiologist performs this procedure under guidance of fluoroscopy, ultrasound (US), or computed tomography (CT) [33]. In this technique, a NG tube is used to inflate the stomach; however, in situations when an NG tube cannot be passed, oral effervescent sodium bicarbonate may be used. CT or US can guide direct gastric puncture. Similar to the push PEG procedure, a skin incision is performed, and the stomach is punctured with a large-bore needle, allowing for the passage of a guidewire. The needle is removed, and the tract is dilated. The feeding tube is advanced over the guidewire. Confirmation of position is completed by injecting contrast material at the end of the procedure [33]. For whichever method is chosen, a functioning stomach is required for the gastrostomy. If the patient suffers from severe gastric dysmotility or is at high-risk for aspiration, a gastrostomy may not be the best choice. In these situations, small bowel feeding is the best option.

## Jejunal Enteral Access

Three options are currently available for jejunal feedings: Percutaneous endoscopic gastrojejunostomy (PEGJ), direct percutaneous endoscopic jejunostomy (DPEJ), and surgical jejunostomy [34]. Typically, when access is needed for less than 6 months, a PEGJ is chosen whereas a DPEJ is chosen for more lengthy use [35].

### Percutaneous Endoscopic Gastrostomy with Jejunal Extension (PEGJ)

The procedure for PEGJ placement is similar to that of PEG placement followed by passage of a jejunal extension into the small bowel beyond the ligament of Treitz so that the extension will not fall back into the stomach or proximal small intestine when the endoscope and guidewire are withdrawn. Given the small size of the jejunal extension and the length, it is difficult to keep the J-extension in the jejunum. Three techniques are utilized. First, the J-extension is grabbed by snare or forceps through the endoscope (either enteroscope or pediatric colonoscope) and dragged down to the jejunum. At that point, the snare or forceps is loosened and gently taken off the J-extension. Slowly, the endoscope is removed. The issue with this technique is that the friction forces between the endoscope and the J-extension are significant and may lead to the J-extensive sticking to the endoscope and coming back to the stomach. To help avoid this common problem, two other methods was introduced. Second, a suture is tied to the end of the J-extension and passed through the gastrostomy. The suture is then grabbed endoscopically by an endoscopic clip. The clip is closed, and the J-extension is dragged to the jejunum. At which point, the clip is opened and closed on small bowel mucosa, trapping the suture against the surface, holding the tube in place. The endoscope is slowly withdrawn. However, it is common for the friction force of the endoscopic and the J-extension to overcome the strength of the clip, effectively dislodging the clip and having the J-extension fall back to the stomach. Therefore, a third method, the key-hole method, has been introduced. In the key-hole methods, a snare is passed through the gastrostomy and opened. The endoscope is then passed through the snare and advanced to the jejunum. A thin guidewire (such as one used for endoscopic retrograde cholangiopancreatography) is passed through the scope. The endoscope and guidewire are exchanged, with the endoscope being removed slowly while keeping the guidewire in place. Once in the stomach, the endoscope is pulled back through the open snare. The snare then closed on the guidewire. The snare is then pulled out via the gastrostomy. The side of the guidewire that is going out via the mouth is then pulled out through the gastrostomy. The J-extension is passed over the guidewire to the jejunum and guidewire removed. In this method, no friction forces are encountered leading to a more secure placement.

### Direct Percutaneous Endoscopic Jejunostomy (DPEJ)

This procedure is like the pull technique PEG placement but in the jejunum. The endoscopist often uses a pediatric endoscope or an enteroscope. Additional time is often needed to reach the small bowel and identify the ideal jejunal direct puncture site [36]. The largest difference is the safe site technique needed to assure proper position. In this procedure, a longer needle is often used to access the small bowel. The safe site technique requires the needle to be advanced slowly while giving aspiration pressure. The needle should fill with air at the same time the needed is endoscopically visualized in the jejunum. If not or other exudate is encounter, reposition and perform again. This is repeated multiple times to assure no organs or vessels are penetrated.

Contraindications to DPEJ are like PEG and include coagulopathy issues, proximal GI obstruction preventing passage of the endoscope into the jejunum, and inability to oppose the small bowel to the anterior abdominal wall. In addition, consideration of inflammatory or infiltrative diseases of the small bowel should be made [37].

**Table 4** Complications of enteral access

| Upper endoscopy | Gastrostomy/jejunostomy procedure | Gastrostomy/jejunostomy use & wound care |
|---|---|---|
| Cardiopulmonary Compromise | Sepsis | Peristomal pain |
| Aspiration | Peritonitis | Abscess or wound infection |
| Hemorrhage | Colocutaneous fistula | Necrotizing soft tissue infection |
| Reaction to sedatives | Gastric outlet obstruction | Buried bumper syndrome |
| Perforation | Migration/dislodgement | Peristomal leakage |
| | Organ perforation | Site herniation |
| | Bleeding (intra- or retro-peritoneal, abdominal wall) | Bleeding |
| | | Ulceration |
| | | Ileus |
| | | Tube dislodgement or clogging |
| | | Diarrhea |

### Surgical Jejunostomy (SJ)

Given the improved technology and techniques of percutaneous access to the GI tract, surgical jejunostomies have become much less common. Over the past two decades, the laparoscopic approach has become a popular procedure over an open gastrostomy but may have more overall complications [38]. In patients unable to tolerate endoscopy, surgical jejunostomy may be a good option. Furthermore, these tubes may be placed more distally in the jejunum as compared to DPEJ, thereby reducing likelihood of aspiration significantly.

## Potential Complications

As with any medical procedure, complications may arise. Complications from long-term enteral access placement are rare but may be serious, requiring the physician to discuss with the patient or their representative prior to the procedure and informed consent. Potential complications can be divided into three categories related to: (1) Upper endoscopy, (2) gastrostomy/jejunostomy procedure or (3) gastrostomy/jejunostomy use and wound care Table 4.

Although mortality from upper endoscopy is relatively low, a few potential complications warrant inclusion and include cardiopulmonary compromise, aspiration, hemorrhage, reaction to the sedative medications, and perforation [39].

Gastrostomy/jejunostomy procedure related potential complications occur in less than 3% of the time. These include sepsis, peritonitis, colocutaneous fistula, gastric outlet obstruction, gastrostomy/jejunostomy migration or dislodgement, organ perforation, and intraperitoneal, retroperitoneal, or abdominal wall bleeding [39–41]. Pneumoperitoneum is a common phenomenon, occurring in greater than 50% of cases and is often self-limiting requiring conservative management.

Gastrostomy/jejunostomy use and wound care related complications are often minor and include peristomal pain, abscess formation/wound infection, necrotizing soft tissue infection, buried bumper syndrome, peristomal leakage, site herniation, gastrointestinal bleeding and ulceration, ileus, tube dislodgement, clogged tube, and diarrhea [28, 39]. An extensive review article was published in 2017 on the management of these complications [42].

Once the enteral access is chosen, performed, secured, and verified, enteral feeding may be initiated. For NG/NJ tubes, feeding may begin as soon as the tube is verified in correct position. For PEGs, feedings may be initiated within 3 h of placement. The early feeding after PEG has been shown effective and safe in multiple retrospective studies, randomized controlled trials, and meta-analyses [14, 43–46]. For jejunal access via surgical jejunostomy, feedings are usually delayed or started the next day based on clinical judgment.

## Conclusion

Many types of enteral access are available for patients depending on their clinical needs and physiology. Once access is chosen and performed, careful consideration and early recognition of potential complications must be performed to maximize the delivery of nutrients to the patient.

**Author Contributions** MB and MMK equally contributed to the conception and design of the research; MB contributed to the design of the research; MB and MMK contributed to the acquisition and analysis of the data; MB, MMK, and LS contributed to the interpretation of the data; and MB, MMK, and LS drafted the article. All authors (MB, MMK, LS) critically revised the article, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final article.

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**Data Availability** All data and materials are available upon request.

## Declarations

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**Ethical Approval** None required due to review of the literature.

**Consent for Publication** All authors consent to the publication of this manuscript.

**Research Involving Human and Animal participant** All studies with human and animal subjects in this paper were previously published and followed ethical standards.

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