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**Percutaneous endoscopic gastrostomy: Indications, technique, complications and management**

Rahnemai-Azar AA *et al*. Current practice in percutaneous endoscopic gastrostomy tube

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**Abstract**

Percutaneous endoscopic gastrostomy (PEG) is the preferred route of feeding and nutritional support in patients with functional gastrointestinal system who require long-term enteral nutrition. Besides its well-known advantages over the parenteral nutrition, PEG offers a superior access to gastrointestinal system over the surgical methods. Considering the fact that nowadays PEG tube placement is one of the most common endoscopic procedures performed worldwide, knowing its indications and contraindications is of paramount necessity in current medicine. PEG tubes sometimes are placed inappropriately in patients unable to tolerate adequate oral intake because of incorrect and unrealistic understanding of their indications and what they really can accomplish. Broadly two main indications of PEG tube placement are enteral feeding and stomach decompression. On the other hand, distal enteral obstruction, sever uncorrectable coagulopathy and hemodynamic instability constitute the main absolute contraindications of PEG tube placement in hospitalized patients. Although generally considered to be a safe procedure, there is a potential for both minor and major complications. Being aware of these potential complications, as well as understanding the routine aftercare of the catheter, can improve the quality of care for the patients with PEG tube. These complications generally can be classified into three major categories: endoscopic technical difficulties, PEG procedure-related complications and late complications associated with PEG tube use and wound care. In this review we described variety of the minor and major tube related complications as well as strategies for their management and avoidance. Different methods of percutaneous PEG tube placement into the stomach has been described in the literature with the “pull” technique being the most common one. At the last part of this review, the reader is presented with brief discussion of these procedures, techniques and related issues. In conclusion despite the mentioned PEG tube placement complications, it gained a worldwide popularity as a safe enteral access for nutrition in patients with functional gastrointestinal system.

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**Key words:** Gastrostomy tube; Percutaneous; Enteral feeding; Indication; Contraindication; Complication; Management

**Core tip:** After its first introduction in 1980, percutaneous endoscopic gastrostomy (PEG) tube has become the modality of choice for nutritional support in patients who require long term enteral feeding. In this review we described the indications and contraindications of PEG tube placement. Also potential complications of PEG tube as well as their management and preventive measures discussed in detail. Comprehensive review of all aspects of PEG tube, in addition to providing practical tips in aftercare and management of potential complications make this review unique amongst the similar articles.

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**Introduction**

The primary indication for enteral and parenteral feeding is the provision of nutritional support to meet metabolic requirements for patients with inadequate oral intake. Enteral feeding is usually the preferred method over parenteral feeding in patients with a functional gastrointestinal (GI) system because of the associated risks of the intravenous route, it’s higher cost and inability of parenteral nutrition to provide enteral stimulation and subsequent compromise of gut defense barrier[[1](#_ENREF_1),[2](#_ENREF_2)]. Moreover it has been shown that enteric feeding will decrease the risk of bacterial translocation and corresponding bacteremia[[3](#_ENREF_3)]. Tube feeding through the GI tract is mainly considered in patients with insufficient oral intake who have a functional GI system and tube insertion into their alimentary tract can be securely maintained.

Gastric feeding is the most common type of the enteral feeding. The access to insert the gastrostomy tube can be achieved by use of endoscopy, radiological imaging, or surgical techniques (open or laparoscopic). Percutaneous endoscopic gastrostomy (PEG) was first introduced in 1980 by application of the endoscopy to insert the feeding tube into the stomach[[4](#_ENREF_4)]. Because of low cost, being less invasive and lack of need for general anesthesia in most cases (which is the challenging factor in debilitated patients in whom gastrostomy tubes are most commonly placed), PEG is considered to be a better choice for introduction of the feeding tube than surgical methods[[5](#_ENREF_5),[6](#_ENREF_6)]. Currently PEG is the method of choice for medium- and long-term enteral feeding.

This article reviews the current knowledge about PEG in medical literature.

**Indications and efficacy**

Patients with adequate baseline nutritional status can tolerate up to 10 d of partial fasting (with maintenance fluids) before severe protein catabolism occurs. However, longer fasting periods depending on patient’s baseline health status can be unfavorable. To maintain or establish the adequate nutrition, enteral feeding is necessary for patients with insufficient oral intake. Nasoenteric tubes (nasogastric, nasoduodenal and nasojejunal) are usually reserved for short-term (< 30 d) enteral feeding in patients with intact protective airway reflexes.

Compared to the PEG tubes, nasoenteric tubes have more complications (irritations, ulceration, bleeding, esophageal reflux and aspiration pneumonia), lower subjective comfort and even lower feeding efficacy[[7-9](#_ENREF_7)]. Hence, PEG tube insertion is usually considered in patients at risk for moderate to severe malnourishment within 2-3 wk of nasoenteric tube feeding. However, there are unclear benefits of PEG feeding in certain patient populations, such as those with diabetes or advance dementia and in elderly patients with age more than 80[[10](#_ENREF_10),[11](#_ENREF_11)]. The decision for tube placement should be individualized according to the patient’s needs, preferences, diagnosis and life expectancy. The goal is not only to improve the patients’ survival and nutritional status, but also to improve their quality of life that is not necessarily correlated with nutritional improvement[[12](#_ENREF_12)]. Also the long-term survival rate of some patients is low just because of their underlying disease and this needs to be considered at the time of decision making for PEG placement[[11](#_ENREF_11)].

There is a great number of patients who can medically benefit from PEG. (Table 1) In a 4-year prospective study of 210 patients with both malignant and benign underlying diseases, the mean weight loss in the three-month period before starting the PEG tube nutrition was 11.35 +/- 1.5 kg, while the mean weight gain at the end of the 12-mo feeding *via* PEG tube was 3.5 +/- 1.7 kg[[13](#_ENREF_13)]. This finding suggests that initiation of PEG tube nutrition, as soon as medical necessity is established, can prevent further weight loss. However, another study published recently showed that better nutritional and metabolic parameters in PEG-fed patients do not always accompany with improvement in body composition parameters[[14](#_ENREF_14)].

**Neurological diseases and psychomotor retardation**

***Cerebrovascular disease/stroke***

Neurological dysphagia (along with cancer related reasons) is one of the most common reasons of referrals to PEG tube insertion. Dysphagia is a common finding after a stroke and it’s incidence is reported to be as high as 45% among those admitted to the hospital[[15](#_ENREF_15)]. Some experts recommend that patients who are not able to meet their nutritional needs by oral intake, should be started on nasogastric tube feeding in the first 24 h after their stroke[[16](#_ENREF_16)]. Nasogastric tube feeding alone might be enough in patients who need nutritional support for less than 4 wk, but PEG tube placement needs to be considered for longer periods[[17](#_ENREF_17)]. PEG feeding provides a safe and reliable means of nutrition in stroke patients and its superior results over the NG tube feeding in long-term has been shown[[18](#_ENREF_18),[19](#_ENREF_19)]. Early PEG nutrition is also desirable in stroke patients but decision must be weighed against it in patients with temporary dysphagia or those with short life expectancy due to underlying diseases. At least two-week wait time for PEG insertion is clinically appropriate to evaluate its medical necessity. After insertion of the PEG tube, routine follow up of the patients should be done to evaluate regaining of their swallowing ability. PEGs can be removed anytime if patients retrieve their ability of spontaneous swallowing.

***Motor neuron diseases/amyotrophic lateral sclerosis***

PEG is a standard method of feeding in patients with amyotrophic lateral sclerosis (ALS). In some patients the technique of PEG tube placement should be modified in a view of associated anatomic deformity. Also gastric insufflation during and after the procedure should be minimized due to inability of these patients to spontaneously lower their raised diaphragm[[20](#_ENREF_20)]. Although there are some concerns about the safety of PEG tube placement in patients with restricted pulmonary function, Czell *et al*[[21](#_ENREF_21)] showed that PEG can be done in these patients under procedural non-invasive ventilation (NIV) with minimal peri- and post-procedural complications. Also their data displayed no significant difference in long-term survival rate among patients with high (> 50%) and low (< 50%) forced vital capacity (FVC). This finding was in opposition to the results of other studies showing lower survival rate after PEG tube placement in patients with ALS who has low FVC (< 50%)[[22](#_ENREF_22)].

The role of PEG tube also has been described in nutritional support of other motor neuron and dysfunctional motor diseases like cerebral palsy and bulbar palsy[[23-25](#_ENREF_23)]. These patients frequently have feeding and swallowing problems that may lead to poor nutritional status, growth failure, chronic pulmonary aspiration and infection. The epidemiologic oxford feeding study reported significant correlation between the severity of motor impairments and need for gastrostomy feeding[[26](#_ENREF_26)].

***Dementia***

Most patients with advanced dementia are dependent on the others in their daily living activities including eating. In a prospective study of nursing home residents, 86% of patients with advanced dementia had eating problems[[27](#_ENREF_27)]. There are several mechanisms that are responsible for impaired self-feeding in this population: altered smell and anorexia resulting in lack of interest in food; apraxia interfering with task of eating, and dysphagia and loss of airway protective mechanisms leading to choking episodes and eating avoidance[[28-30](#_ENREF_28)]. Feeding problems are usually considered as one of the ominous symptoms of advanced dementia with a 6 mo mortality rate of 25%[[27](#_ENREF_27)], a similar life expectancy to some generally considered poor prognosis diseases like stage 4 congestive heart failure[[31](#_ENREF_31)]. This is consistent with the finding that independent of the age, patients with dementia undergoing PEG have worse prognosis than other patient subgroups with mortality rate of 54% after 1 mo and 90% after 1 year of tube insertion[[32](#_ENREF_32)]. In another study cited elsewhere, PEG has a higher mortality rate in demented patients who are at least 80-year old[[11](#_ENREF_11)]. The need for more aggressive palliative measures to prevent malnutrition in patients with advanced dementia is an important issue but to date, there is no published evidence showing that PEG feeding can prolong survival or provide palliation in this patient population[[33-36](#_ENREF_33)]. In a recent study designed to assess the effect of PEG feeding on pressure ulcer healing in patients with advanced dementia, patients with PEG were less likely to heal and more likely to develop new ulcer[[37](#_ENREF_37)]. Given all these findings, PEG may not provide any clinical benefit to this patient population and simple efforts like hand feeding can be a viable alternative[[38](#_ENREF_38)]. In one study, PEG tube insertion in nursing home residents with advanced dementia showed to be associated with significant increase in annual inpatient health care costs as well as in hospital and intensive care unit stay[[39](#_ENREF_39)].

***Psychomotor retardation***

Patients with psychomotor retardation are prone to malnourishment and gastroesophageal reflux due to pathophysiologic causes inherent to this condition. The long-term efficacy of PEG tube feeding in improving nutritional status of severely disabled and mentally retarded adults and children has been shown. However, the use of PEG in those with aspiration and gastroesophageal reflux is not recommended[[40](#_ENREF_40)].

***Reduced level of consciousness***

The decision to start enteral nutrition in some patients with severe cerebral injury is challenging, as their recovery time and the final outcome is not clear. Generally in order to prevent nutrition depletion, enteral feeding should be started as early as physiological function of the GI system restored. Some authors advocate to start PEG tube nutrition in severe cerebral injury patients if they don’t recover in 14 d[[41](#_ENREF_41)].

**Miscellaneous**

***Cancer***

More than 40% of patients with head and neck malignancy have some degree of malnutrition[[42](#_ENREF_42)]. The underlying mechanisms of this malnutrition include obstructive effect of the tumor, oropharyngeal mucositis due to aggressive treatment with high dose radiotherapy and/or chemotherapy and reduced appetite. The PEG tube can be inserted either prophylactically or therapeutically in this setting[[43-45](#_ENREF_43)]. In a recent study, the PEG tubes inserted prophylactically had lower complications compared to the therapeutic ones[[46](#_ENREF_46)]. Recently a modified transnasal technique is introduced in patients with oropharyngeal cancer, when routine method is not successful[[47](#_ENREF_47)].

***Gastric decompression***

In chronic unresolved gastrointestinal stenosis or ileus, PEG can be used to drain gastric secretions and resolve persistent nausea and vomiting[[48](#_ENREF_48),[49](#_ENREF_49)].

***Human immunodeficiency virus infection/acquired immunodeficiency syndrome***

PEG tube nutrition in HIV/ acquired immunodeficiency syndrome (AIDS) patients with wasting syndrome results in significant improvement of the body weight and nutritional serum markers like albumin and transferrin[[50](#_ENREF_50)]. In another study, children with AIDS who fed chronically by gastrostomy tube gained more weight and had lower length of hospital stay when enteral feeding started earlier[[51](#_ENREF_51)].

***Cystic fibrosis***

In patients with cystic fibrosis, the better nutritional status is associated with superior survival[[52](#_ENREF_52)]. On the other hand, the role of PEG tube feeding in improving nutritional status and also baseline pulmonary functional status of these patients has already been described[[53-55](#_ENREF_53)]. Therefore, some experts recommend the PEG tube insertion as an early intervention rather than as a last resort in malnourished patients with cystic fibrosis[[55](#_ENREF_55)].

***Crohn’s disease***

Enteral nutrition is an important part of the treatment in patients with Crohn’s disease, especially among children who require elemental diet. Its role is not only shown in reversal of the malnutrition and improving the weight gain and linear growth, but also in reduction of the steroid requirements[[56](#_ENREF_56)]. Concern of fistula formation had many physicians refrained from considering PEG tube insertion in this population, but overtime its safety in usage and after removal has been reliably demonstrated[[57](#_ENREF_57),[58](#_ENREF_58)]. However, considering the large number of oral nutritional supplements and other nutritional alternatives available, nowadays it is uncommon to insert the PEG tube for enteral feeding in patients with crohn’s disease.

**Contraindications**

Medical necessity, like any other surgical intervention, must be clearly established prior to the PEG tube insertion. Some of the absolute contraindications of the PEG tube placement are summarized in Table 2. Besides these absolute contraindications conditions like the presence of non-obstructing oropharyngeal or esophageal malignancy, hepatomegaly, splenomegaly, peritoneal dialysis, portal hypertension with gastric varices and history of previous partial gastrectomy are considered as relative contraindications.

***Special considerations***

In patients with prior abdominal surgery, PEG tube can be inserted after confirming a “safe tract” with no interposed bowel[[59](#_ENREF_59)]. In obese patients PEG can be safely performed with minor modification even in patients with extreme BMI (> 60 kg/m2)[[60](#_ENREF_60)[61](#_ENREF_61)].

During pregnancy, the PEG tube insertion might be complicated with potential risks of uterine and fetal injury. However tube insertion has been reported in pregnant women up to 29-wk gestation with no major complication after applying special precautions[[62-65](#_ENREF_62)].

Generally ascites considered as a relative contraindication for the PEG tube placement because of concerns about the ascetic fluid leakage. There are some case reports of successful tube insertion, after paracentesis or modifications of the placement technique, even in patients with massive ascites[[66-68](#_ENREF_66)]. However in a case series of patients with cirrhosis, the patient group with ascites had higher mortality rate. Therefore, experts have concluded that the risks of the PEG tube insertion in cirrhotic patients with ascites outweighs its overall benefits[[69](#_ENREF_69)].

When medically indicated, there is no age or weight limit in PEG tube placement. The safety of PEG insertion even in very small (3 kg) and medically complex infants has been determined[[70](#_ENREF_70)].

**Complications**

The PEG tube insertion is usually considered as a safe procedure, but complications can occur with variable rate based on population of the study. These complications can be classified as minor or major (Table 3). Although there is a low procedure-related mortality in most studies, the mortality rate might increase in patients with underlying comorbidities[[71](#_ENREF_71)].

**Major complications**

Major complications are not common but can occur after PEG tube insertion. As mentioned, mortality after PEG is very rare and is usually due to the underlying co-morbidities.

***Bleeding***

Bleeding from the PEG tract, gastric artery, splenic or mesenteric vein injuries (massive retroperitoneal bleeding) and also rectus sheath hematoma has been reported[[72-74](#_ENREF_72)]. In hemodynamically unstable cases, fluid support should be started immediately with close monitoring of the vital signs. Usually bleeding can be controlled with simple pressure over the abdominal wound, however endoscopic or surgical exploration of the bleeding source may be needed in some cases. Using standard technique with consideration of anatomical structures and correcting coagulation disorders before the PEG tube insertion can be helpful in bleeding prevention.

***Aspiration pneumonia***

Aspiration pneumonia is one of the serious and potentially fatal complications of the PEG tube feeding. Although PEG tube is usually preferred over the nasoenteric tube in high-risk patients, there is little data available about the comparable risk of aspiration between these two routes of feeding[[75](#_ENREF_75)]. In fact, despite its widespread usage, insertion of the PEG tube in patients with neurologic dysphagia failed to reduce the risk of aspiration pneumonia[[76](#_ENREF_76)]. In a study among stroke patients, 18% suffered from aspiration pneumonia which was even higher than PEG site infection rate in the same study[[77](#_ENREF_77)]. Aspiration pneumonia is quite common in this patient population and its risk increases with high-volume feeds and prone position[[78](#_ENREF_78)]. A jejunal extension can be considered in patients with significant risk of aspiration but its usage has been associated with more tube dysfunction and dislocation rate[[79](#_ENREF_79)].

***Internal organ injury***

Anyintra- abdominal organ, more likely colon[[80](#_ENREF_80)] and small bowel[[81](#_ENREF_81)] and rarely liver[[82](#_ENREF_82)] and spleen[[73](#_ENREF_73)], is at risk of injury during PEG tube placement. Also few cases of complete laceration of the stomach following tube insertion have been reported in the literature[[83](#_ENREF_83)]. Iatrogenic perforation of the bowels during PEG tube insertion is more common among patients in their extreme ages due to laxity of the colonic mesentery[[84](#_ENREF_84)]. Patients with bowel injury may develop the classic signs of peritoneal irritation. However in some instances, the diagnosis is challenging since candidates for PEG tube nutrition are not always easily communicable due to their underlying altered mental statues. In addition, the persistence of transient subclinical pneumoperitoneum occurs during PEG[[85](#_ENREF_85)] limits the utility of plain films in diagnosis of suspected visceral perforation. A watchful follow-up is important after any PEG tube insertion and there should be a low threshold for further investigation. Performing CT scan with water-soluble contrast, or incase of hemodynamic instability fluoroscopy, is a useful alternative to confirm gastrointestinal integrity in this setting. Any evidence of active leakage of contrast into the peritoneal cavity in the presence of the signs of peritonitis warrants for emergent surgical intervention.

***Necrotizing fasciitis***

Necrotizing fasciitis is a very rare but potentially fatal complication of the PEG[[86-88](#_ENREF_86)]. This complication is an acute surgical emergency and characterized by rapidly spreading infection along the fascial planes resulting in the abdominal fascia necrosis. Traction and pressure on the PEG tube are two main factors have been shown to increase the risk of abdominal wall necrotizing fasciitis following PEG tube placement[[89](#_ENREF_89)]. Keeping the external bumper 1-2 cm away from the abdominal wall can take off the pressure on the PEG wound and potentially prevent this complication. Treatment requires immediate wide surgical debridement, broad-spectrum empiric antibiotics and intensive care support.

***Buried bumper syndrome***

Buried bumper syndrome can occur in tubes with internal bumper as early as 3 wk after PEG tube insertion[[90-93](#_ENREF_90)]. Excessive tension between the internal and external bumpers causes ischemic necrosis of the gastric wall and subsequently migration of the tube toward the abdominal wall. The tube becomes dislodged anywhere between the gastric wall and the skin along the PEG tract. This complication can be presented as feeding problems, periostomal leakage, or pain and and swelling of the tube insertion site[[94](#_ENREF_94)]. The tube should be removed as soon as the diagnosis made, since grave complications such as perforation of the stomach, peritonitis and death may follow without appropriate management[[95](#_ENREF_95)]. Depending on type, the PEG tube can be removed by endoscopy[[94](#_ENREF_94),[96](#_ENREF_96)], surgical incision[[97](#_ENREF_97)] or simply by external traction of the tube[[98](#_ENREF_98),[99](#_ENREF_99)]. This complication can be easily avoided by regular checking of the PEG tube position, leaving a small distance between the external bumper and the resident’s skin and daily 180-360 degree rotation of the tube.

***Tumour seeding of the stoma***

This is a rare complication of PEG in patients with head and neck cancer. Generally it is believed that seeding occurs during “pull” or “push “ method when the tube gets in contact with oropharyngeal cancer during insertion[[100-103](#_ENREF_100)]. However, some authors consider hematogenous or lymphatic spread of the tumor cells as main mechanism of metastasis in some instances[[104](#_ENREF_104),[105](#_ENREF_105)]. The diagnosis usually delayed until metastasis enlarges enough to be visible or cause local presentations like bleeding or infection. In case of suspicion, diagnosis can be confirmed by biopsy and CT scan[[106](#_ENREF_106)].

**Minor complications**

***Granuloma formation***

The development of hyper-granulation tissue around the gastrostomy tube is one of the common complications observed in patients with PEG tube[[107](#_ENREF_107),[108](#_ENREF_108)]. Although the exact mechanism of granuloma formation has not been recognized, factors like friction from a poorly secured tube and excess moisture from fluid leakage causing skin breakdown at the exit site seems to be responsible[[107](#_ENREF_107),[109](#_ENREF_109)]. The presence of granuloma itself is not a life threatening complication, but it’s moist and highly vascularized surface prone the patients to wound infection, biofilm formation and bleeding. While wide variety of treatment options from application of topical antimicrobial agents and low dose steroids to cauterization by silver nitrate and surgical removal has been described in the literature, none proved to be more effective than others[[107](#_ENREF_107),[110](#_ENREF_110)].

***Local wound infection***

The tube site infection is the most common minor complication following PEG. The prevalence varies between 5%-25% in different studies, and in some series reported to be even as high as 65%[[111](#_ENREF_111),[112](#_ENREF_112)]. Although mild redness around the stoma site is common due to tube movements, extension of the redness and addition of purulent discharge or other signs of systemic inflammation should raise suspicion about the wound infection. Minor infections usually resolve with applying local antiseptics and daily dressing changes, but in cases of persistent infection further investigation is warranted. Periostomal swabs, while considered to have restricted results, can be cultured to tailor the systemic or local antibiotic treatments. The effectiveness of prophylactic antibiotic administration in preventing systemic and local infection has been studied in several articles[[112-119](#_ENREF_112)]. Systematic review of ten eligible randomized controlled trials (RCTs), which evaluated prophylactic antimicrobials in 1100 patients, showed statistically significant reduction in the incidence of periostomal infection with prophylactic antibiotics (pooled OR = 0.31, 95%CI: 0.22-0.44)[[120](#_ENREF_120)].

The current gold standard for antibiotic prophylaxis is intravenous administration of a single dose of cephalosporins in the first one hour before PEG tube insertion. Recent efforts on exploring other prophylactic alternatives, found co-trimoxazole administered immediately through a newly inserted PEG catheter just as effective in preventing periostomal infection[[121](#_ENREF_121),[122](#_ENREF_122)].

Recent emergence of Methicillin-Resistant Staphylococcus aureus (MRSA) as a PEG-site infection pathogen, generally resistant to cephalosporins, has raised concerns over the use of prophylactic antimicrobials. Some studies showed benefits of pre-PEG MRSA screening and nasopharyngeal decolonization of MRSA in reducing periostomal wound infection rate[[123](#_ENREF_123),[124](#_ENREF_124)].

***Periostomal leakage***

This complication is more common among debilitated patients, those with previous gastric surgery and also patients with underlying medical conditions that predispose them to delayed wound healing. Periostomal leakage usually occurs within the first few days after PEG tube placement, although it can happen even in patients with a mature PEG tract. Evaluation of the leakage should include examination of the patient for any evidence of infection, ulceration, buried bumper[[83](#_ENREF_83)] or any other potential causes such as tube displacement, slowed gastric emptying, excessive gavage or residual, and enlarged gastric fistula. Intervention generally starts with meticulous prevention and continues with treatment of specific causes including underlying disease condition[[125](#_ENREF_125)]. Inserting a larger tube through the same PEG tube tract will create more problems such as further tissue breakdown resulting in an even larger stoma. In patients with mature PEG tract, the PEG tube can be completely removed, allowing the tract to close completely. When medically indicated, another PEG tube can then be placed in another location on the abdominal wall.

***Tube dislodgment***

Tube dislodgment can occur when the gastrostomy tube either slides in or out of the gastrointestinal tract. If the tube slides too far into the gastrointestinal tract it can obstruct the gastric outlet. If the internal balloon deflates or the external bumper or disc is inadvertently removed, the gastrostomy tube can slide out. This is one of the common causes of emergency department presentation in patients with PEG tube and in some studies reported to occur in up to 12.8% of patients[[126](#_ENREF_126),[127](#_ENREF_127)]. In the existence of a mature abdominal wall tract *e.g.* dislodgment of the tube more than a month after placement, PEG tube can be replaced safely through the same tract with out endoscopy. In case of any doubt, a water-soluble contrast study can be done to confirm the location of replaced tube prior to feeding. The rest of the cases should be managed by endoscopic placement of new PEG tube either near or even through the dislodged tube site[[110](#_ENREF_110),[128](#_ENREF_128)].

***Gastric outlet obstruction***

Although rare, PEG tube migration to the pyloric area can cause gastric outlet obstruction. Symptoms may include abdominal cramps and nausea and vomiting. This complication usually happens when the external bolster migrates away from the abdominal wall, allowing the PEG tube to slide forward through the PEG tract into the duodenum[[129](#_ENREF_129),[130](#_ENREF_130)]. Maintaining the position of the external bumper at 1-2 cm distance from the skin is the key factor in preventing the tube from being pulled into the stomach.

***Pneumoperitoneum***

Pneumoperitoneum is a common finding after PEG tube insertion and its prevalence reported to be as high as 50% in some studies[[110](#_ENREF_110),[131](#_ENREF_131)]. In fact, post- PEG pneumoperitoneum is not generally considered as a complication, because it does not cause any unfavorable consequences. This condition is usually related to air insufflation associated with the endoscopic procedure and needle puncture of the abdominal wall. In the absence of peritoneal signs, the presence of pneumoperitoneum should not prevent initiation or continuation of the PEG feeding. However, the potential for bowel injury should be considered when free air (no matter how small it is) persists after 72 h of PEG insertion[[84](#_ENREF_84),[132-134](#_ENREF_132)] .

**Preparation**

Informed consent should be obtained from patients or their legal surrogate decision makers. A considerable number of the patients undergoing PEG tube placement don’t have required mental capacity to give informed consent, due to advanced dementia or other underlying medical conditions impairing their cognitive function (stroke, advanced cancer, failure of other internal organs). Obtaining consent from this population can become complicated. Several studies suggest that quality of informed consent in patients undergoing PEGs is inadequate[[135](#_ENREF_135),[136](#_ENREF_136)]. The intent of informed consent is aimed to enhance the patient’s care by giving the patient complete information on the benefits and burdens of tube feeding before PEG insertion.

Patients should fast overnight (8 h) and receive prophylactic antibiotics one hour before PEG tube placement. The current gold standard is intravenous administration of 1-2 g cephazolin in the first one hour before tube insertion[[137](#_ENREF_137)].

***Insertion technique***

Since its first introduction by Gauderer *et al*[[4](#_ENREF_4)] , several different techniques have been developed to insert the PEG tube. Generally all of these methods share a common concept of insertion of the gastrostomy tube through the abdominal wall at a point that stomach and abdominal wall are in closest contact. Herein we describe briefly 3 techniques used more commonly than others in clinical practice: “pull” technique, “push” (guide wire) technique and introducer (Russell) method. Finding the tube insertion site on the abdominal wall by endoscopic trans-illumination and one to one indentation is the first critical step among all these techniques.

The “pull” technique is the method initially introduced by Gauderer *et al*[[4](#_ENREF_4)] and nowadays considered to be the most common technique utilized to insert the PEG tube. In this method a string is inserted through a needle in the course of abdominal wall into the stomach, grasped with endoscopic biopsy forceps and then taken out through the esophagus and mouth. Subsequently the string is affixed to the external end of feeding tube and the tube is pulled whole the way down from mouth to esophagus, stomach and then out though the abdominal wall.

The first portion of “push” technique is like “pull” technique. A guide wire is inserted to stomach and pulled out through the mouth with endoscope. The feeding tube is pushed over the guide wire into the stomach and out the puncture site[[138](#_ENREF_138)]. There have been no reported significant difference in complication and efficacy rates between the pull and push methods[[138](#_ENREF_138),[139](#_ENREF_139)].

Introducer (Russell) technique[[140](#_ENREF_140)] uses Seldinger method to place a guide wire into the stomach under the endoscopic view. Afterwards, a dilating catheter and sheath is passed over the guide wire and after removal of the guide wire the feeding tube is advanced through the peel-away sheath.

Long-term protruding gastrostomy tubes may not be favorable in some patients due to risk of periostomal leakage, inadvertent catheter dislodgment and cosmetic issues. These regular tubes can be replaced by a skin level low profile button gastrostomy tube after maturation of stoma canal upon selected patient’s request[[141-143](#_ENREF_141)]. Their higher expenses and replacement need every 6 mo limits their routine use and they are often reserved for adolescent patients for cosmetic reasons. Although one-step button gastrostomy tube insertion can be done similar to the routine “pull technique” PEG tube placement, generally it is recommended to wait until complete maturation of the stoma[[144](#_ENREF_144)].

**Post-insertion Care**

After PEG tube insertion adequate pain relief should be administered. Many patients report abdominal discomfort after PEG insertion due to inflation of stomach during procedure. Traditionally feeding was delayed until next day with the fear of peritoneal leakage risk after feeding. Many studies investigated the safety of early feeding from h to 6 h after PEG insertion, including a meta-analysis that found feeding initiated as early as 4 h after PEG placement is safe[[145-150](#_ENREF_145)].

The stoma should be examined (for signs like pain, discoloration, swelling, exudation, pus and leakage around the stoma) and cleaned daily. Tube should be rotated about 180 degrees and moved up and down about 1-2 cm in the stoma site on a daily basis after the stoma has completely healed.

Tube should be flushed before and after every feeding and administration of medicine to prevent clogging of the tube and subsequent blockage. This blockage especially happens in small-bore feeding tubes secondary to feeding with thick formulas, inadequately crushed medications or incompatibilities between medications and enteral feeds. In addition to regular flushing of the tube, dissolving medications in water before administration and preferential utilization of liquid forms of medications over solid-based forms are other preventive measures that should be taken to prevent clogging of the tube. If the tube is blocked, attempt can be made to clear it by means of attaching a 50 ml syringe filled with warm water to the tube and doing a pull and push technique. Gentle squeezing the tube can help in some cases. Using pancreatic enzymes mixed with bicarbonate solution, prior to flushing with warm water, has shown to be an effective method in unclogging of the tube in some studies[[110](#_ENREF_110),[151](#_ENREF_151)].

**Removal of PEG**

Removal of PEGs is recommended when the tube is no longer needed or when complications such as persistent leakage or buried bumper syndrome require its removal. Experts have suggested using “cut and push” technique for removal of PEGs in adults[[152-154](#_ENREF_152)] however, reports of serious and sometimes fatal complications such as small bowel perforation and obstruction favor the use of endoscopic removal of PEG[[155](#_ENREF_155)]. In children tube should always be removed by endoscopic procedure due to high risk of complications[[156-158](#_ENREF_156)].

Generally PEG tract closes in first few days after PEG removal however occasionally a gastrocutaneous fistula persists. Several factors like prolonged time of tube in place, local infection and underlying poor tissue healing contribute to delayed maturation of the PEG tract. Several methods to close fistula include hemoclip placement and endoscopic band closure[[159](#_ENREF_159),[160](#_ENREF_160)].

**Conclusion**

Since its introduction in 1980, PEG has gained a world-wide acceptance as a safe technique for providing enteral feeding in patients with poor oral intake who have functional GI system. PEG tube placement has many indications, and is the recommended type of tube where not contraindicated. PEG tubes can have minor or even major complications, but most patients do well with them. Pull technique is the most common, but other techniques are possible or even necessary in certain situations. Knowing when and how to place PEG tubes, as well as how to manage and even remove them, is an important part of the management of many patients. Quality and safe care of PEG tubes begin at pre-insertion screening and through post-insertion aftercare. Prevention of and proper management of complications are critical to ensuring successful outcome.

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**Table 1 Conditions for which patients are commonly referred for insertion of a percutaneous endoscopic gastrostomy tube**

|  |
| --- |
| Neurological diseases and psychomotor retardation   * Cerebrovascular disease * Motor neuron disease (ALS) * Multiple sclerosis * Parkinson’s disease * Cerebral palsy * Dementia * Cerebral tumor * Psychomotor retardation   Reduced level of consciousness   * Head injury * Intensive care patients * Prolonged coma   Cancer   * Head and neck cancer * Esophageal cancer   Miscellaneous   * Burns * Congenital anomaly (*e.g.* trachea esophageal fistula) * Fistulae * Cystic fibrosis * Short bowel syndromes (such as Crohn’s disease) * Facial surgery * Poly-trauma * Chronic renal failure * HIV/AIDS   Gastric decompression   * Abdominal malignancy |

HIV/AIDS: Human immunodeficiency virus infection/acquired immunodeficiency syndrome.

**Table 2 Contraindications**

|  |
| --- |
| Serious coagulation disorders (INR > 1.5, PTT > 50 s, platelets < 50000/mm3)  Hemodynamic instability  Sepsis  Severe ascites  Peritonitis  Abdominal wall infection at the selected site of placement  Marked peritoneal carcinomatosis  Interposed organs (*e.g.* liver, colon)  History of total gastrectomy  Gastric outlet obstruction (if being used for feeding)  Severe gastroparesis (if being used for feeding)  Lack of informed consent for the procedure |

**Table 3 Complications reported**

|  |
| --- |
| **Minor:**  Wound infection  Tube leakage to abdominal cavity (peritonitis)  Stoma leakage  Inadvertent PEG removal  Tube blockage  Pneumoperitoneum  Gastric outlet obstruction  Peritonitis  **Major:**  Aspiration pneumonia  Hemorrhage  Buried bumper syndrome  Perforation of bowel  Necrotizing fasciitis  Metastatic seeding |

PEG: Percutaneous endoscopic gastrostomy.