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Review Article

Percutaneous endoscopic gastrostomy

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ABSTRACT

Percutaneous endoscopic gastrostomy (PEG) is a feasible and safe technique for patients who need long-term feeding and cannot eat orally. With the increasing maturity of PEG technique, a large number of patients receive PEG tube placement every year in the world. However, PEG tube placement is not necessary in some patients, and some other patients are not evaluated strictly, leading to serious complications. In a broad sense, the mainly two indications for PEG include long-term enteral nutrition and gastric decompression. On the other hand, the main contraindications of PEG are distal intestinal obstruction, severe coagulation abnormalities, and severe infection at the PEG site. In the first section of this review, the indications and contraindications of PEG are introduced. Although PEG tube placement is a relatively safe technique, it can still cause a number of complications, including minor and major complications. Through standard management and treatment, the outcome of most patients is very good. In the second section of this review, we describe a variety of minor and major tube-related complications, and the treatment and prevention of these complications. In addition, the preparation and post-insertion care are also very important for PEG, which can reduce the incidence of complications. In the last section of this review, we describe related issues about the preparation and post-insertion care of PEG. In conclusion, PEG tube placement is a widely accepted technique that can bring benefits to the right patients.

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Keywords: Complications; Indication; Management; Percutaneous endoscopic gastrostomy

Introduction

A number of cancers of larynx and gastrointestinal tract, and various swallowing difficulties, can block the passage of food along the digestive tract. There are several approaches available to provide nutritional support;¹ nasogastric tube (NGT) and gastrostomy. NGT is hardly accepted as it stimulates the nasopharynx, increase the risk of aspiration pneumonia caused by reflux, and reduce the quality of life.^{2,3} If enteral nutrition is required for more than 4 weeks, percutaneous access should be considered, depending on the clinical setting. Access to insert the gastrostomy tube can be achieved by the use of endoscopy,⁴ radiological guidance or surgical techniques.⁵ Surgical gastrostomy needs anesthesia or open placement of gastric fistula, which is painful and risky for patients.⁶ A meta-analysis demonstrated that percutaneous endoscopic gastrostomy (PEG) is associated with a lower probability of 30-day mortality compared to percutaneous radiologic gastrostomy (PRG), suggesting that PEG should be considered as the first choice for most patients.⁷ This article reviews the indications,

technique, outcome, and complications of PEG.

Indications and Contraindications

There are so many studies already proved that enteral nutrition have many positive effects compared with parenteral nutrition. These effects include preservation of the intestinal mucosal barrier, reduction of intestinal and other infections and improvement of the overall prognosis of patients with long-term artificial nutrition.⁸ European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines also recommends enteral over parenteral nutrition in order “to support intestinal functions to the greatest possible extent.”⁹ Enteral nutrition via PEG is technically and functionally feasible.¹⁰ However, PEG feeding has an uncertain benefit for some patients, such as those with diabetes or advanced dementia and in elderly patients aged over 80 years.¹¹ So, the patient’s needs, diagnosis, long-term survival rate, general condition should to be considered when deciding on PEG placement. The decision for tube placement is not only

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to improve the patient's survival and nutritional status, but also to improve their quality of life. So the patients must be strictly evaluated before PEG tube placement.

Of course, many diseases are accepted and data-supported as indications for PEG (Table 1).

Indications

Cancer

Head and neck cancer, pharyngeal cancer, esophageal cancer: More than 40% of patients with head and neck cancer have some degree of dysphagia,¹² because of the obstruction of the tumor, local edema due to high dose radiotherapy and/or chemotherapy and reduced appetite. The PEG tube can be inserted either prophylactically or therapeutically in these patients.¹³ Prophylactic PEG was widely placed. However, a predictive model is needed to identify patients at high risk of malnutrition, and to prevent unnecessary PEG-placement.¹⁴

Cancer with mechanical or functional bowel obstruction: Gastrointestinal decompression is one of the most useful therapeutic method for patients with mechanical or functional bowel obstruction caused by cancer. Compared with NGT, PEG is more comfortable and can be used to drain gastric secretions and resolve persistent nausea and vomiting in long term.¹⁵

Neurological disorders

Cerebrovascular disease/stroke: Stroke is the most common cause of acute dysphagia which can lead to malnutrition and affect quality of life. The prevalence of malnutrition following an acute stroke ranges from 8% to 34%.¹⁶ Most acute stroke patients recover from dysphagia within the first four weeks, although 15% of patients may develop long-term dysphagia.¹⁷ Some experts recommend that NGT feeding alone may be enough in patients who need nutritional support for less than four weeks, but PEG tube placement needs to be considered for longer periods.¹⁸ However, for patients with temporary dysphagia or with a shorter life expectancy due to an underlying disease, this decision must be weighed. At least a 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 patients should be performed to evaluate the recovery of their swallowing ability. PEG tubes can be removed at any time if patients regain spontaneous swallowing.⁵

Table 1 Accepted and Data-Supported Indications for Percutaneous Endoscopic Gastrostomy (PEG)

Variable	Indications
Cancer	Head and neck cancer
	Pharyngeal cancer
	Esophageal cancer
	Cancer with mechanical or functional bowel obstruction (PEG used as a decompression measure)
Neurological disorders	Cerebrovascular disease
	Amyotrophic lateral sclerosis
	Parkinson's disease
	Cerebral tumor
	Cerebral palsy
	Dementia
	Multiple sclerosis
	Severe brain damage from various reasons (trauma, persistent vegetative state, psychomotor retardation, etc.)

Neurodegenerative disease: The feeding and nutritional challenges of neurodegenerative diseases are significantly different from those of stroke, PEG is a standard method of feeding in those patients. But in a recent study, short-term mortality and morbidity associated with PEG were significant in patients with neurological disease, Age older than 75 years was associated with poor outcome.¹⁹ For these patients, careful patient selection, optimal timing of PEG tube insertion, and periprocedural care, comprehensive education of patients and carers to reduce morbidity, mortality, and cost-effectiveness are very important.¹⁹

Dementia: The 2015 worldwide prevalence of dementia was estimated to be 47.5 million, and it is expected to increase to 75.6 million by 2030.²⁰ Dysphagia also becomes more prevalent in elderly dementia. Even in its early stages, Alzheimer's dementia impairs the ability to focus on mastication and impacts the sensory aspects of swallowing.²¹ Similar to stroke, vascular dementia can affect the motor aspect of swallowing, resulting in difficulty in mastication and swallowing.²² There is much controversy about the use and timing of enteral feeding support in these patients with dysphagia. There is no evidence to suggest long-term survival rates improved in patients with advanced dementia who underwent PEG placement.²³ PEG may not provide any clinical benefit to these patients. So European Society of Gastrointestinal Endoscopy (ESGE) recommends refraining from PEG placement in patients with advanced dementia.

Severe brain damage: It is very difficult to start enteral nutrition in the patients with severe brain damage, because their recovery time is uncertain. Some authors suggest that PEG tube should be placed in severe brain damage patients if they do not recover in 14 days.²⁴

Contraindications

Absolute and relative contraindications of PEG tube placement are summarized in Table 2.

Absolute contraindications: Mechanical obstruction of the digestive tract (unless the procedure itself is indicated for decompression), active peritonitis, uncorrectable coagulopathy, or ongoing bowel ischemia, sepsis, abdominal wall infection at the selected site of placement, history of total gastrectomy.

Table 2 Contraindications

Variable	Contraindications
Absolute contraindications	Mechanical obstruction of the digestive tract
	Active peritonitis
	Uncorrectable coagulopathy (INR > 1.5, platelets < 50,000/mm ³)
	Ongoing bowel ischemia
	Sepsis
	Abdominal wall infection at the selected site of placement
	History of total gastrectomy
Relative contraindications	Recent gastrointestinal bleeding due to peptic ulcer disease
	Hemodynamic or respiratory instability
	Ascites
	Severe obesity
	Abdominal wall defects
	Peritoneal adhesions

INR, international normalized ratio.

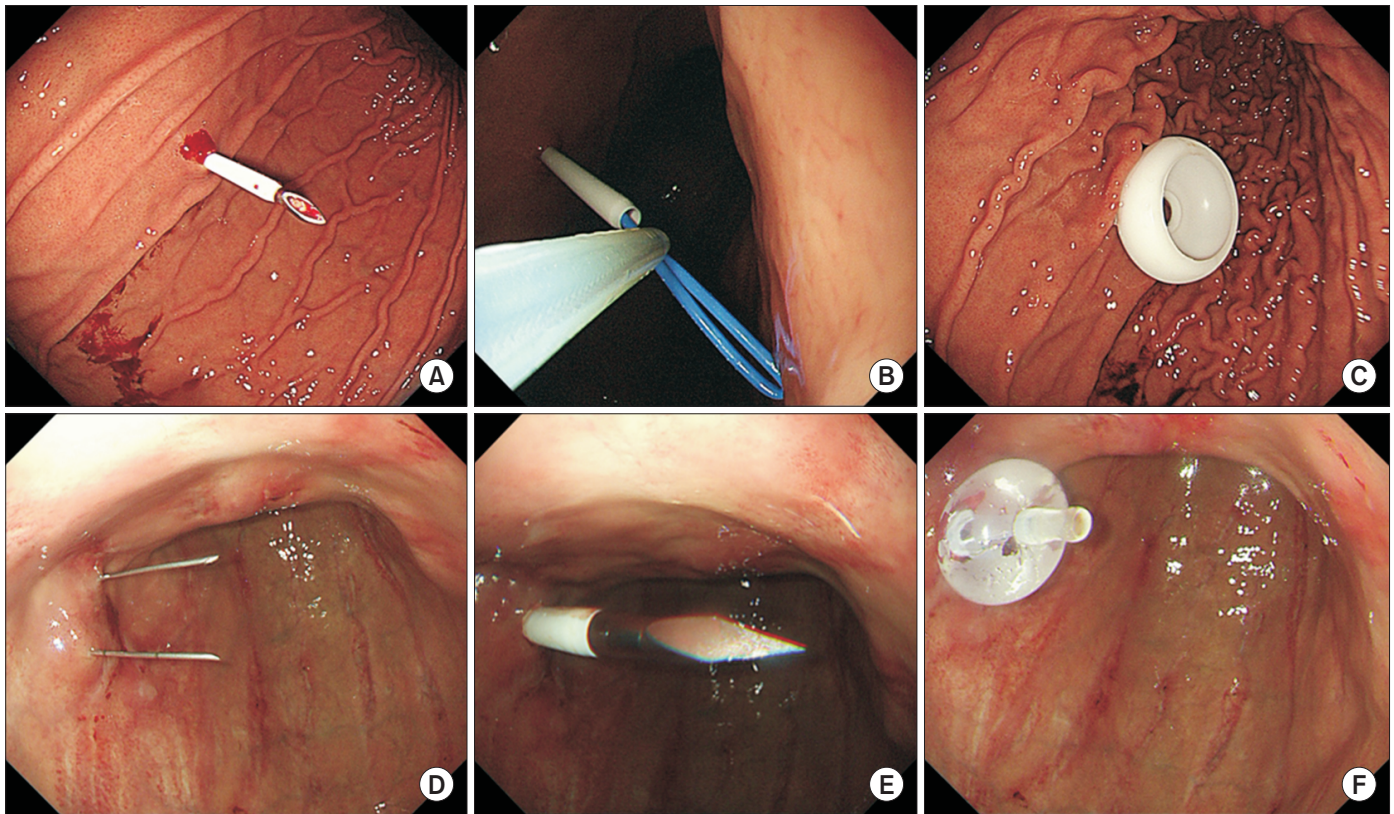


Fig. 1. Percutaneous endoscopic gastrostomy (PEG) using the pull (A–C) or the push (D–F) techniques. (A) A needle is inserted into the stomach. (B) The guidewire is grasped by the endoscopist using a snare. (C) The tube is pulled from the puncture site until the internal fixation bumper apposes the anterior wall of the stomach. (D) Double-lumen gastropexy needle is inserted into the stomach. (E) Penetration of the gastric wall using trocar and a peel-away sheath. (F) The tube balloon has been filled with sterile water. Reused from the article of Cui et al (Med Sci Monit. 2019;25:9651–7).²⁶

Relative contraindications: Recent gastrointestinal bleeding due to peptic ulcer disease with high risk of rebleeding, as well as hemodynamic and respiratory instability.²⁵ Generally, ascites is considered a relative contraindication for PEG tube placement due to concerns of ascitic fluid leakage. In these cases, Gastropexy devices could be used to secure the stomach to the anterior abdominal wall, reducing the risk of ascitic fluid re-accumulation and leakage.²⁵ Severe obesity, abdominal wall defects and the presence of peritoneal adhesions are also relative contraindications for PEG tube placement, in such cases, more careful planning of the potential target location for PEG placement should be given.

Insertion Techniques

There are two major techniques for PEG tube placement: the “pull” technique and the “push” technique (Fig. 1).²⁶

As introduced before, the “pull” technique introduced by Gauderer et al⁴ in 1980. In this technique the dedicated wire is inserted through a needle in the abdominal wall into the stomach (Fig. 1A), grasped by the endoscopist using an endoscopic biopsy forceps or snare (Fig. 1B), and then taken out through the esophagus and mouth. Subsequently the string is fixed to the external end of the feeding tube and the tube is pulled from the mouth to the stomach and then out through the abdominal wall and the puncture site until the internal fixation bumper apposes the anterior wall of the stomach (Fig. 1C). PEG placement using the “pull” technique has replaced surgical gastrostomy.²⁷ In nowadays, the “pull” technique is the most widely accepted technique for PEG

placement in clinical practice.

The “push” technique, or namely the “introducer” technique was first introduced by Russell et al.²⁸ In this technique, double-lumen gastropexy needle is used (Fig. 1D), then operator uses the dedicated trocar and overlying peel-away sheath for puncture of the abdominal wall and anterior gastric wall through the skin incision (Fig. 1E). A balloon-type tube is then introduced through the sheath and once the tube balloon has been filled with sterile water under endoscopic visualization, the sheath is peeled away (Fig. 1F). The “push” technique for PEG placement in cases where the “pull” technique is contraindicated, for example in severe esophageal stenosis or in patients with head and neck cancer or esophageal cancer. In order to prevent deflection of the stomach and tube misplacement, T-fasteners or a dedicated suturing device should be used in the “pull” technique.²⁹

Complications

Since the PEG tube was introduced in 1980,⁴ it is considered as a feasible and safe procedure. PEG has no inferiority to surgical gastrostomy in terms of morbidity or mortality,^{30,31} with success rates of 95% to 100%.²⁵ However, major and minor complications may occur depending on a variable reason. These complications are summarized in Table 3.

Table 3 Complications of Percutaneous Endoscopic Gastrostomy (PEG)

Variable	Complications
Minor complications	Wound infection/wound bleeding
	Peristomal leakage
	Tube blockage
	PEG site herniation
	Subcutaneous emphysema and pneumoperitoneum
	Self-extraction
	Gastric outlet obstruction
	Granuloma formation
Major complications	Bleeding
	Internal organ injury
	Buried bumper syndrome
	Aspiration pneumonia
	Metastatic seeding
	Necrotizing fasciitis
	Fistula formation

Minor complications

Wound infection/bleeding

PEG site infection or bleeding is the most common minor complication. Bleeding from the PEG tract can usually be controlled with simple pressure over the wound or tightening the external bolster against the skin.³² The prevalence of wound infection in PEG varies between 5%–65%.³³ Minor wound infections usually resolve with the application of local antiseptics and daily dressing changes, but in cases of persistent infection further investigation is warranted. Wound swabs can be cultured to tailor the systemic or local antibiotic treatments. Besides, antibiotic prophylaxis can reduce the infection rate to 3%.^{33,34} The current gold standard for antibiotic prophylaxis is the intravenous administration of a single dose of a beta-lactam antibiotic (or appropriate alternative antibiotic, in the case of allergy). The optimal timing is 30 minutes before the procedure.³⁵ Besides prophylactic antibiotic administration, the adherence to a full sterile, aseptic technique and avoidance of excessive pressure between the skin and the external bumper have also been shown to decrease the risk of wound infection.³⁶

Tube blockage

Tube blockage is a common problem in patients with long-term enteral nutrition by PEG. During 18 months of follow-up, 16% to 31% of PEG tubes had at least 1 time of significant blockage, of which 7% needed to be removed.³⁷ To avoid tube blockage, there are several tips, such as frequent flushing with water (before and after feeding), administering liquid medication or well-ground pills.

Percutaneous endoscopic gastrostomy site herniation

Herniation through PEG site is an extremely rare complication with only six other cases reported in the literature.^{38,39} When a hernia is suspected, a computed tomography (CT) scan will confirm the diagnosis, as this is a surgically correctable entity, and can be safely managed via laparoscopic or open techniques. To prevent this complication, operator should avoid inserting the PEG tube through linea alba, as this is an area of potential weakness; and use cut and push technique rather than traction which can create a more permanent passage.³⁸

Subcutaneous emphysema and pneumoperitoneum

Subcutaneous emphysema is a very rare complication of PEG.⁴⁰ When an emphysema is suspected, a ultrasonography or CT scan will confirm the diagnosis. If there are no accompanying symptoms, most subcutaneous emphysema is self-limited and benign. It may be treated by repositioning the tube or replacement of the tube with one of a large enough.

Pneumoperitoneum is common after PEG procedure and its prevalence is reported to be as high as 50%.⁴¹ It is thought that air escapes through the small opening in the stomach during the interval between the initial needle puncture and the PEG tube passage through the abdominal wall.⁴² Pneumoperitoneum is usually self-limiting, it does not cause any unfavorable consequences.

Self-extraction

Inadvertent PEG tube removal occurs in 1.6% to 4.4% of patients.⁴³ If a PEG tube is displaced less than one month after placement, the stomach may have separated from the abdominal wall, resulting in a free perforation. If recognized early, the replacement PEG tube can be placed close to or even through the same PEG tube site.⁴⁴ If recognized too late, a NGT should be placed, and antibiotic should be started, a new PEG should be placed within 7 to 10 days.⁴⁵ In patients with a mature abdominal tract, the PEG tube can be replaced without endoscopy.

Gastric outlet obstruction

Gastric outlet obstruction is a rare complication of PEG tubes, because of part of the PEG tube migrates to the pyloric area.⁴⁶ It can be avoided by properly using external bolster to anchor the PEG tube.

Granuloma formation

The granuloma formation around the gastrostomy tube is a common complication in patients with a PEG tube.⁴⁷ The reason for granulation tissue develops around the tube site may be the leakage from the edge of the tube or insufficient care in a long time.⁴⁸ Leakage and bleeding may be seen at the edge of the tube. The granulating tissue can be treated with surgical or chemical cauterization and wound care.

Peristomal leakage

The incidence of peristomal leakage is 1% to 2%, it especially occurs within the first few days after PEG tube placement.⁴² Several factors increased the risk of peristomal leakage, such as excessive cleansing with hydrogen peroxide, infections, gastric hypersecretion, buried bumper syndrome (BBS) and excessive side torsion along the PEG tube, and lack of external bolster to stabilize the tube.⁴⁸ Patient-specific factors inhibit wound healing (malnutrition, immunodeficiency, diabetes) and can lead to peristomal leakage. Prevention of peristomal leakage must focus on the reduction of risk factors, while barrier creams containing zinc and skin protectants are also recommended.⁴⁸

Major complications

Bleeding

Acute bleeding is not common after PEG tube placement, with a reported incidence of 2.5%.⁴³ The most common causes of acute bleeding are vessel injury. Bleeding from the gastric artery, superior mesenteric artery, splenic or mesenteric vein injuries have been reported.^{49,50} Risk factors include anatomic aberration, anticoagulation, and antiplatelet therapy.²⁵ To prevent bleeding, with consideration of abnormal anatomy and correcting coagula-

tion disorders before PEG tube placement can be useful. In cases of hemodynamic instability, supporting therapy should be the critical therapy, then angiographic embolization or surgery can be operated.

Internal organ injury

Any organ around the stomach can be injured during the PEG tube placement. The injury of colon, small bowel, liver, and spleen have been reported.^{49,51–53} The displacement of the transverse colon can result in colonic injury during PEG placement. The most common causes are inadequate gastric insufflation. As we all know, colonic injuries usually result in peritonitis and the treatment is surgery in most cases. The injury of small bowel after PEG placement are rare. It can cause intraabdominal spillage acutely or result in an entero-cutaneous fistula. To diagnose early, a watchful follow-up is important after the PEG tube placement. Liver and spleen injury during PEG placement is not common, but is a potential life-threatening complication.⁵⁴ If liver or spleen injury is suspected, transabdominal ultrasound or a CT scan must be performed. A surgery is the best treatment for liver or spleen injury. To avoid the injuries, the tube insertion site should be chosen accurately.

Buried bumper syndrome

BBS is a rare but serious complication of PEG, in which the internal bolster migrates from the gastric and lodges anywhere between the gastric wall and the skin along the PEG tract.⁵⁵ It has a reported prevalence of in 1% to 4% of cases.^{55,56} BBS occurs as result of excessive tension between the internal and external bumpers leading to ischemic necrosis of the gastric wall and subsequent migration. Other possible contributing factors include obesity, weight gain, and chronic cough. Common symptoms include feeding difficulties, peristomal leakage, the occurrence of abdominal pain.⁵⁵ BBS is diagnosed by endoscopic or CT demonstration of the migrated internal bumper. The tube should be removed as soon as diagnosed. To prevent BBS, The 2020 ESGE guideline recommends that daily tube mobilization (pushing inward) along with a loose position of the external PEG bumper (1–2 cm from the abdominal wall).

Aspiration pneumonia

Aspiration pneumonia is a potentially life-threatening complication of PEG tube feeding. It is more common when patients are fed with NGT. It has a reported prevalence of in 0.3% to 1.0% PEG cases.⁵⁷ Risk factors for aspiration include supine position, sedation, neurological dysphagia, and advanced age.⁵⁸ To prevent aspiration pneumonia, a jejunal extension can be considered.

Necrotizing fasciitis

Necrotizing fasciitis is a very rare, but serious complication of PEG placement.⁵⁹ Risk factors for necrotizing fasciitis are diabetes, wound infections, malnutrition, and impaired immunity. To prevent necrotizing fasciitis, keep the external bumper 1 to 2 cm away from the abdominal wall can relieve the pressure on the PEG wound. Once necrotizing fasciitis is diagnosed, the standard treatment is immediate wide surgical debridement, broad-spectrum empiric antibiotics and intensive care support.⁵

Metastatic seeding

This is a late complication at the PEG site; it is seen mainly with head and neck cancer and esophagus cancer. It has been reported with an incidence of < 1%.^{60,61} Risk factors for it include primary head and neck cancer, less differentiated, large tumor

size. In order to reduce this complication, it is reasonable to place the PEG use the pull-string or direct-introducer technique.³⁰

Fistula formation

Actually, this complication includes two; gastrocolocutaneous fistula and gastrocutaneous fistula. Gastrocolocutaneous fistula occur rarely after PEG placement, and resulting from the displacement of the colon over the anterior gastric wall. It is usually discovered months after the PEG placement when the original PEG tube is removed. The treatment is PEG tube removal to allow the fistulous tract to heal. If it failed, an endoscopic approach, using endo clips, or surgery is necessary.

Gastrocutaneous fistula occurs after PEG removal. Generally, the gastrocutaneous tract usually starts to heal in 24 hours, and complete in a few days. However, in some cases the tract fails to heal and a gastrocutaneous fistula persists. Studies showed that longer PEG duration has a more possibility of fistula formation.⁶² Once diagnosed, endoscopic approach, using endo clips to close the fistula is first choice, if it fails, surgery is necessary.⁶³

Preparation

Firstly, ensure that sufficient informed consent of patients or their relatives. The purpose of informed consent is not only to declare the risks and benefits of PEG, but also to guide the patient and their carers how to use and care the tube.

Then, before the procedure, patient should fast overnight (6 hours for solids and 2 hours for clear liquids, longer if there is gastric motility disorder).

At last, patient should receive prophylactic antibiotic (single intravenous dose of a beta-lactam antibiotic, or suitable alternative in case of allergy) 30 minutes before PEG tube placement.

Post-Insertion Care

Peristomal pain is common after PEG tube placement, the prevention of peristomal pain after PEG placement should be administered when ensure the procedure is achieved. To avoid peritoneal leakage, feeding was delayed to the next day, even a longer time in some centers. But two meta-analyses showed no differences in complications and early mortality (< 72 hours) when feeding was started within 3 to 4 hours after PEG placement as compared with feeding was delayed (> 24 hours).^{64,65} Moreover, another study showed that early feeding after PEG tube placement could also help reduce inpatient stay.⁶⁶ So feeding was started within 3 to 4 hours after PEG placement is safe and effective.

After the PEG tube placement, the skin and the PEG site should be cleaned using sterile saline every day. The external bolster should be placed tightly, about 0.5 cm above the skin, to prevent leakage during the first 3 to 5 days. A sterile “Y” shaped dressing should be applied under the external site for the first week. After 7 to 10 days, the wound has completely healed, the tube can be slightly moved up and down about 2 to 5 cm in order to prevent infection and BBS.⁶⁷

The tube should be flushed before and after every time of feeding. Medication administration through PEG tube requires careful evaluation. The use of medication in liquid form is preferred. If crushed solid forms are administered through PEG tube, these should be optimally flushed through, in order to avoid tube blockage. If the tube is blocked, it can be cleared by a 20/50 mL syringe filled with warm water attaching to the tube and carrying out a pull and push technique. Pancreatic enzymes mixed with bicarbonate is useful in some studies.⁶⁸

Removal of Percutaneous Endoscopic Gastrostomy

When a PEG tube is no longer needed, it should be removed. In some cases with complications such as peristomal leakage and BBS, the tube should also be removed. Before removing the tube, a strict evaluation must be done. Make sure the patient can keep weight stable without using the PEG tube. Besides, in order to avoid the risk of internal leakage and peritonitis, a PEG tube should not be removed within 4 weeks after the PEG tube placement.⁶⁹ In patients with previous bowel surgery, the use of endoscopic removal of PEG tubes is recommended.⁷⁰ Generally, the PEG tract usually starts to heal in 24 hours, and complete in a few days. However, in some cases the tract fails to heal and a gastrocutaneous fistula persists. Once diagnosed, endoscopic approach, using endo clips to close the fistula is first choice, if it fails, surgery is necessary.⁶³

Conclusions

PEG had proven to be a very safe technique. PEG tube placement has many indications and contraindications, the patient must be carefully evaluated. PEG may result in many complications, mainly including minor and major. Through standard management and treatment, the outcome of most patients is very good. Therefore, it is very important to know how to perform a PEG, choose the right patients and operation timing, and how to manage after the operation, how to reduce the incidence of complications, and how to deal with complications after the occurrence.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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