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Percutaneous Endoscopic Gastrostomy

A Practical Overview on Its Indications, Placement Conditions, Management, and Nursing Care

ABSTRACT

Percutaneous endoscopic gastrostomy (PEG) feeding represents the most effective and safest option for feeding patients with an impaired or diminished swallowing ability, despite having a functioning digestive system. The use of PEG has evolved to be useful in many situations beyond degenerative neuromuscular disorders, with an increasing body of evidence supporting the advantages of PEG tubes in oncologic and pediatric patients. Risk factors for complications after PEG tube placement include acute and chronic conditions associated with malnutrition and several organic disorders. Patients suitable for PEG tube placement should be individually identified to implement the advantages of this technique while minimizing risk events. The safety of placing a PEG tube in patients under antithrombotic medication has been investigated, as well as the advantages of antibiotic prophylaxis in reducing peristomal infection. Evidence supports the safety of early feeding after placement, thus resulting in lower costs. Percutaneous endoscopic gastrostomy-related complications are rare and mostly prevented by appropriate nursing care. Best medical practice and nursing care will ensure optimal performance leading to a wider acceptance, and greater utility of PEG by healthcare professionals, patients, and caregivers. This review aims to update knowledge relating to PEG tube indications, placement, management, and care in order to reinforce PEG feeding as the most valuable access for patients with a functional gastrointestinal system who have abnormalities in swallowing mechanisms.

Percutaneous endoscopic gastrostomy (PEG), first described in 1980, has become widely used to provide enteral nutritional support to patients who, despite having preserved absorption and motility functions of the gastrointestinal tract, are unable to ingest solid or liquid foods due to many disorders. In these cases, PEG tubes have arisen as an alternative to artificial parenteral nutrition (and especially to nasogastric tubes) for the administration of food directly into the stomach (which is recognized as the most suitable and physiological feeding option).

Background

Percutaneous endoscopic gastrostomy placement is an endoscopic technique that allows the placement of a flexible tube to create a temporary or permanent communication between the abdominal wall and the gastric cavity, ensuring the direct passing of food into the patient's digestive tract. Even when the use of PEG tube feeding has not been universally demonstrated to decrease risks of aspiration pneumonia (Onur et al., 2013) or long-term mortality, nor improved outcomes regarding weight maintenance when compared with nasogastric tube feeding in several groups of patients (Wang, Liu, Liu, Ye, & Huang, 2014), PEG feeding has been consistently demonstrated to be the feeding method with a lower probability of intervention failure, suggesting that the endoscopic procedure is more effective and safer than nasogastric tube feeding (Gomes et al., 2012).

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Since Ponsky and Gauderer described this technique (Gauderer, Ponsky, & Izant, 1980), PEG tubes have replaced other surgical (Shaver, Winer, & Snyder, 2014) and radiological (Laskaratos et al., 2013) gastrostomy techniques as the method of choice for long-term feeding of patients who are unable to maintain adequate nutrition in the presence of a normal gastrointestinal functioning. As a result, PEG use is recognized as a minimally invasive procedure that eliminates the need for general anesthesia and requires less instrumentation. It is therefore a valuable source of nutrition by enteral feeding in nursing homes and domiciliary environments (Dwolatzky et al., 2001; Lucendo & Friginal-Ruiz, 2014) when the administration period is expected to exceed 4 weeks and life expectancy of patients exceeds 2 months (Sartori et al., 1996). It is favored due to its simplicity, usefulness, safety, ease of operation, and low cost (Gauderer et al., 1980).

This article aims to review current evidence of the indications for and advantages of PEG tube placement in a variety of settings and pathological conditions. Placement techniques and procedural management of PEG tubes are also explained, and risks and potential complications are discussed. Finally, specific nursing care diagnoses are provided.

A PubMed library-based search was carried out for the period between January 1990 and March 2015, using the following individual and combined key words: 'PEG tube,' 'PEG tube feeding,' 'complications,' 'diet,' 'dietary intervention,' 'dietary treatment,' 'enteral or parenteral nutrition,' and 'risk factors.' References cited in the articles obtained were also searched to identify other potential sources of information. The results were limited to human studies available in English.

Indications for Percutaneous Endoscopic Gastrostomy

The option to feed a patient through a PEG tube should be considered in different situations, both in hospital and at home (Ditchburn, 2006). In fact, several acute and chronic conditions may be alleviated by feeding sufferers with an intact digestive tract through a PEG tube. A reduction in oral intake, generally due to neurodegenerative processes (Sampson, Candy, & Jones, 2009), represents the main reason for PEG placement in up to 90% of cases. In addition, a repeated bronchial aspiration of food or obstruction derived from oropharyngeal, neck, or esophageal tumors (Raykher et al., 2007) is another common indication. Table 1 includes the most frequent indications for PEG placement, classifying patients according to the chronicity of underlying diseases and the ability to recover.

An increasing body of literature documents the potential value of prophylactic PEG tube placement at treatment initiation in patients with head and neck cancer, who are at increased risk of malnutrition and dysphagia (Lucendo Villarín, Polo Araujo, & Noci Belda, 2005). In these patients, enteral tube feeding is often required in response to dysphagia, odynophagia, or other side effects of treatments that lead to dehydration and/or weight loss during or after cancer treatment. The majority of studies published in the literature generally initiate nutritional support by a PEG tube in response to deterioration in swallowing or nutritional status when clinically indicated (Nugent, Parker, & McIntyre, 2010; Raykher et al., 2009; Scolapio, Spangler, Romano, McLaughlin, & Salassa, 2001). In contrast, other studies have reported on the starting of enteral feeding prior to treatment (Beer, Krause, Zuercher, & Stanga, 2005; Marcy et al., 2000; Nguyen et al., 2006; Wiggenraad et al., 2007), showing that prophylactic PEG placement and early tube enteral feeding was associated with a limited loss of weight, thus ensuring effective and safe nutrition and hydration of the patient during chemoradiation, according to retrospective chart reviews (Raykher et al., 2009; Wiggenraad et al., 2007). In addition, patients who require therapeutic PEG tube placement in response to significant weight loss during treatment suffered greater morbidity than patients who received PEG tubes prophylactically (Cady, 2007).

Systematic evidence to clearly support the early placement and use of a PEG tube in patients undergoing treatment for head and neck cancer are weak and the benefits versus risks still have to be defined (Locker et al., 2011). An increasing concern is that gastrostomy placement may lead to prolonged tube dependency and long-term dysphagia (Langmore, Krisciunas, Miloro, Evans, & Cheng, 2012; Mekhail et al., 2001). An ongoing randomized controlled trial (RCT) aimed at assessing the nutritional and clinical outcomes of patients with head and neck cancer undergoing prophylactic gastrostomy prior to treatment compared with standard practice to initiate tube feeding (Brown et al., 2014) is expected to shed light on this particular topic.

In the pediatric population, PEG insertion for enteral nutrition has become widely accepted after it has been demonstrated as an efficient and safe technique (even in small infants) and associated with an acceptable rate of complications (Fröhlich, Richter, Carbon, Barth, & Köhler, 2010). A range of experience from clinical studies showing a maintenance or improvement of an adequate nutritional status in patients with a variety of underlying disorders (as well as a high level of acceptance by caregivers) has been reflected in the rising number of medical conditions for which PEG feeding is indicated in children. These include not only neurological disorders or congenital malformations leading to oropharyngeal dysphagia,

TABLE 1. Indications and Contraindications for the Placement of a Percutaneous Endoscopic Gastrostomy

Indications	Contraindications
I. Patients with potentially reversible diseases in which it is expected that the PEG can be removed once the process is solved. Neurological diseases: Guillain–Barre syndrome, stroke, cranial trauma Anorexia nervosa Hyperemesis gravidarum Severe burns Multiple injuries and facial trauma Transplants with prior malnutrition Head and neck tumors treated with chemotherapy and radiotherapy Diseases of the esophagus	I. Local problems Nonswelling esophageal obstruction Active gastric pathology Total gastrectomy Extreme obesity Previous midline laparotomy (can hinder the location of the puncture site)
II. Patients who have irreversible diseases with prolonged survival in which the PEG is placed permanently and helps improve their quality of life. Neurological diseases: ALS, multiple sclerosis, demen-tia, Parkinson's disease, Alzheimer's disease, stroke, postanoxic encephalopathy, brain metastases, brain tumors, poliomyelitis, brain injury (traumatic or surgical) Progressive muscular dystrophy Head and neck tumors Facial malformations and oropharyngeal neoplasms of the esophagus and cardias Oropharynx tumors Dermatomyositis and polymyositis Amyloidosis Cystic fibrosis Short bowel syndrome Inflammatory bowel disease Scleroderma	II. Absolute contraindications Colonic interposition Partial or subtotal gastrectomy Massive ascites Portal hypertension (gastric varices) Peritoneal dialysis Active gastric pathology Coagulation disorders Sepsis Cardiorespiratory disease that prevents endoscopy
III. Patients with terminal and debilitating diseases with a relatively long-life expectancy (this indication should be individualized and consensual) Encephalitis Repeated stroke Advanced malignancies AIDS terminal stages Intestinal obstruction by peritoneal carcinomatosis Radiation enteritis Severe acute pancreatitis	
IV. Preventing malnutrition in pediatric illnesses Chemotherapy in oncologic disease Unpalatable formula in multiple food allergies Inadequate caloric intake Multiple congenital malformations Short bowel syndrome Oropharyngeal dysmotility Epidermolyis bullosa Unpalatable medications in renal failure	
V. Improving morbidity in patients undergoing radiotherapy for head and neck carcinomas	

Note. AIDS = acquired immune deficiency syndrome; ALS = amyotrophic lateral sclerosis; NGT = nasogastric tube ; PEG = percutaneous endoscopic gastrostomy.

but also medical and surgical conditions impairing an adequate caloric intake, special feeding requirements (i.e., unpalatable formula in multiple food allergies or metabolic diseases), or the need for continuous enteral feeding in short bowel syndrome and malabsorption.

The use of PEG feeding in pediatric oncology has increased in the last few years. In these particular situations of early PEG feeding, PEG placement is able to reverse weight loss (Parbhoo, Tiedemann, & Catto-Smith, 2011). Thus, it represents a relatively safe way to prevent malnutrition in children with cancer and subsequently might play a role in the oncological outcome (Schmitt et al., 2012).

Contraindications

There are few absolute contraindications to PEG placement, mainly including technical limitations as a result of anatomical particularities such as lack of transillumination with an inability to access the anterior gastric wall, colonic interposition, severe ascites, uncorrectable advanced coagulopathy, portal hypertension with significant gastric varices leading to unassumable risk of bleeding and finally, pharyngeal or esophageal obstruction blocking the passage of the gastroscope to the stomach preventing a PEG tube placement. The remaining are considered relative contraindications (Table 1).

Currently, prior abdominal surgery is not considered as a contraindication to PEG placement, with clinical studies showing that a PEG can be safely placed in these patients (Foutch, Talbert, Waring, & Sanowski, 1988) with a high success rate (Eleftheriadis & Kotzampassi, 2001). Gastric surgery may represent a unique challenge to the endoscopist, with a 28% of placement failure recorded in a retrospective report (Foutch et al., 1988).

Preparing the Patient for a PEG Tube Placement

Informed Consent

Informed consent should be obtained from patients or their legal surrogate decision makers in a consensual way by healthcare professionals. The intention of informed consent is to enhance the patient's care by providing them or their caregiver with complete information on the benefits and risks of tube feeding and medications before PEG insertion (Rahnemai-Azar, Rahnemaiazar, Naghshizadian, Kurtz, & Farkas, 2014). Patients with advanced dementia and dysphagia usually undergo PEG placement, so consent for a treatment in a patient without legal capacity should be obtained from nominated legal substitutes.

Antiplatelet and Anticoagulant Medication

Percutaneous endoscopic gastrostomy is classified as an invasive interventional endoscopic procedure (Eisen et al., 2002) that can result in bleeding, a complication that has been reported in approximately 2.5% of procedures in the early literature (Luman et al., 2001; Schapiro & Edmundowicz, 1996). Patients undergoing PEG are typically treated with aspirin and/or other antithrombotic agents, which are commonly used for treating or preventing several cardio- and cerebrovascular diseases. A major dilemma concerning patients taking these medications includes the potential risk of bleeding as a result of endoscopic intervention versus the risk of thromboembolic events when such medications are withheld.

Recent guidelines from the American Society of Gastrointestinal Endoscopy (ASGE) (2009) for the use of anticoagulant and antiplatelet therapy for endoscopic procedures recommend that patients who are taking clopidogrel or ticlopidine should have these medications discontinued 7–10 days before PEG placement. With regard to aspirin and other nonsteroidal anti-inflammatory drugs, endoscopic procedures may be performed while the patient is receiving this medication in the absence of a pre-existing bleeding diathesis (ASGE Standards of Practice Committee et al., 2009). However, the ASGE guidelines are based on expert opinion and best clinical practice, because no supporting data from prospective RCT trials are available.

Several recent large retrospective cohort studies (Lee, Im, et al., 2013; Lee, Kang, et al., 2013; Richter et al., 2011; Richter-Schrag et al., 2011; Ruthmann et al., 2010; Singh et al., 2012) and a systematic review with a meta-analysis (Lucendo, Sánchez-Casanueva, Redondo, Tenías, & Arias, 2015) have been carried out to determine whether there is an association between periprocedural aspirin, clopidogrel, or ticlopidine use and bleeding in patients who underwent PEG tube placement. According to these studies, post-PEG bleedings were rare events found in 2.67% (95% CI, 1.66%–3.91%) of the entire population and in 2.7% (95% CI, 1.5%–4.1%) of patients not receiving antiplatelet therapy. The use of aspirin or clopidogrel before or after PEG was not associated with procedure-related bleeding in any study according to the pooled relative risk (RR) for bleeding in patients under aspirin, when compared to controls (1.43, 95% CI, 0.89–2.29), while the pooled RR for clopidogrel was 1.21 (95% CI, 0.48–3.04). The use of dual antiplatelet therapy was not a risk factor for postprocedure bleeding according to the Lucendo et al. (2015) meta-analysis, the polled RR being 2.13 (95% CI, 0.77–5.91) (Lucendo et al., 2015).

Regarding anticoagulation, ASGE guidelines recommend that warfarin should be discontinued 3–5 days before the PEG procedure and bridged with low-molecular-weight heparins (LMWH) or unfractionated heparin (UFH) in the case of a high risk of thromboembolic complications. Low-molecular-weight

heparins should be discontinued at least 8 hours before the PEG procedure; UFH infusion is recommended to be discontinued 4–6 hours before PEG and restarted 2–6 hours after the procedure is completed (ASGE Standards of Practice Committee et al., 2009). The safety of these recommendations has been demonstrated, because the use of LMWH did not increase the risk of bleeding in the aforementioned observational studies (Singh et al., 2012). In addition, one study has suggested that patients undergoing therapeutic anticoagulation or those with increased INR values have no elevated risk of bleeding during PEG placement (Richter-Schrag et al., 2011). The safety of maintaining antiplatelet therapy in a PEG placement tube should be evaluated with further RCTs, but available data supporting the individual decision to maintain these drugs in those patients with high thrombotic risk cannot be determined with evidence at the current time.

Preventing Peristomal Infection

Although PEG is considered a relatively minor surgical procedure, it is associated with general complications, with wound infection being the most common problem. The placement of a PEG tube is not considered a sterile technique and patients undergoing placement are often vulnerable to infection for a variety of reasons, including older age, compromised nutritional intake, immunosuppression, and underlying disease such as malignancy and diabetes (Lee et al., 2002). Bacteria colonizing the nasopharyngeal and upper digestive tract may cause peristomal infection in PEG placement using the pull technique (Hull, Beane, Bowen, & Settle, 2001), a complication that is described with a frequency of up to 32% without antibiotic prophylaxis (Grant, 1993; Luman et al., 2001; Mahadeva, Sam, Khoo, Khoo, & Goh, 2009).

A systematic review with meta-analysis of RCTs demonstrated a significant reduction in the incidence of peristomal infection when intravenous prophylactic antibiotics were administered (pooled odds ratio [OR] = 0.31; 95% CI, 0.22–0.44) (Lipp & Lusardi, 2013). The most commonly used antibiotics to prevent peristomal infection are intravenously administered beta-lactamics, including coamoxiclav, cefotaxime, cefoxitin or cefazolin, prior to PEG. A recent RCT, however, comparing the administration of 20 mL of cotrimoxazole solution deposited in a newly inserted PEG catheter compared to cefuroxime prophylaxis given intravenously before PEG was at least as effective at preventing wound infections (Blomberg, Lagergren, Martin, Mattsson, & Lagergren, 2010).

PEG Placement Technique

Nursing duties during a PEG placement include: ensuring proper patient preconditions for the procedure, providing the necessary supplies, appropriate equipment disposal, assistance with the PEG tube placement, and providing technical support and an accurate collaboration with other members of the endoscopic team.

Patient Preparation

After fasting for at least 6 hours and having a recent normal blood coagulation analysis, the medication the patient receives should be verified, especially regarding the suspension of anticoagulants or antiplatelets, if needed. A venous access should be inserted, and to prevent septic complications, broad spectrum antibiotics should be administered intravenously 30 minutes before, the PEG insertion unless a 20-ml liquid solution of sulfamethoxazole and trimethoprim is going to be administered through the PEG tube immediately after being inserted (Lagergren, Mattsson, & Lagergren, 2013).

The abdominal skin should be shaved if needed and disinfected with a colorless disinfectant. Dentures must be removed and oral secretions suctioned if necessary. After this, cleaning and disinfection of the oropharyngeal cavity are required by swabbing with a suitable antiseptic solution.

Materials

The PEG device is usually marketed as a kit, including syringe and needle, scalpel, trocar, thread-guide, tube, and snare. In addition to these supplies, medication for sedation, analgesia, and local anesthesia should be provided, together with the tools to administer them and to aspirate oropharyngeal secretions if required.

Placement Technique

Insertion of a PEG tube usually requires a team of three people (generally two endoscopists/gastroenterologists and a nurse). The patient is placed supine, monitored, and oxygen by nasal cannula administered. After disinfecting the abdominal wall to create a sterile field, the patient should undergo a complete esophagogastroduodenoscopy (EGD) with maximum air/carbon dioxide insufflation for the extension of the wall of the stomach. The exact site of PEG insertion is determined by gastroscopic transillumination and manual palpation from outside for visualized confirmation of the appropriate placement into the lower part of the stomach.

Ideally, the insertion site of the PEG tube is in the median line (linea alba) to prevent hematoma formation and infections in the rectus muscle compartments. Next, a needle is inserted through the skin into the stomach at the location where the PEG tube is to be placed.

Three different methods are utilized for PEG tube insertion. Due to their safety and effectiveness, the two

most widely established techniques are the pull-through method, initially described by Sacks and Vine (Sacks et al., 1983), and the push-method, originally described by Gauderer and Ponsky (Gauderer et al., 1980). In both cases, the endoscope enters through the mouth of the patient to the stomach to localize the best point to place the tube. In the pull-through method, a needle is inserted through the skin into the stomach at the location where the PEG tube is to be placed. A pull wire is introduced into the stomach and fastened with an endoscopic snare or forceps. Then, the endoscope is slowly withdrawn until the wire appears at the mouth of the patient and is fixed to the PEG device. The PEG tube is introduced through the mouth into the stomach, indicated by meeting a resistance in the inner part of the tube, to reach its final position emerging from inside of the stomach through the percutaneous insertion site on the abdomen.

The push method requires the puncture of the stomach with a double gastropexy scalpel performed under general anesthesia, with a distance of 2 cm between the two points. Between these two fixations, a puncture cannula is advanced into the stomach and a feeding tube is inserted through it. Thereafter, the puncture cannula is removed. The intragastral fixation balloon is filled with a syringe with saline solution to prevent a dislocation. Gastropexy sutures will be removed after some days. This technique avoids the passage of the PEG tube along the patient's upper aerodigestive tract.

The third method for PEG insertion, described by Russell (Russell Brotman, & Norris, 1984), consists of inserting the tube through the abdominal wall after using stents and should be considered when the passage of the tube through the mouth needs to be prevented.

Several retrospective series have compared the pull-through and push methods (Köhler et al., 2015; Kozarek, Ball, & Ryan, 1986; Pang & Wong, 2012; Tucker et al., 2003). In general, pull-through PEGs carried out by endoscopic teams were technically easier; pull PEG showed an overall significantly higher rate of complications, dislocations, and occlusions, but not in patients with advanced head, neck, and esophageal cancer, among whom push-PEGs are preferred. As such, the final decision as to which PEG tube should be used depends on individual conditions.

A repeat endoscopic visualization to determine optimal placement and to ensure the absence of immediate complications is always recommended; in particular, to set the internal bumper under direct vision, which is paramount to prevent a buried bumper syndrome (McClave & Jafri, 2007).

Patient Care After PEG Placement

It is recommended the patient be on bed rest for at least 6 hours after placement. All vital signs should be closely monitored as well as any occurrence of abdominal pain, fever, or gastrointestinal bleeding. It is advisable to keep a peripheral venous line inserted for at least 6 hours in case complications arise. In addition, some analgesia may be required during the first 2 days, especially in the case of children (Heuschkel et al., 2015).

The Moment for Initiating PEG Feeding

Feeding through PEG tubes has traditionally been delayed until the following day after placement due to the fear of immediate postprocedural complications, including peritoneal leakage and bleeding. However, several observational studies (Cobell et al., 2014; Vyawahare et al., 2013), RCTs (Choudhry, Barde, Markert, & Gopalswamy, 1996; McCarter, Condon, Aguilar, Gibson, & Chen, 1998), and a systematic review with a meta-analysis (Bechtold et al., 2008) have evaluated the differences between early feeding (i.e., starting liquid and/or nutritional formula administrations in the first 3–6 hours after placement) and delayed feeding (i.e., from 12 hours after insertion up to the following day). In early feeding, no significant differences in local infections, diarrhea, bleeding, GERD, fever, vomiting, stomatitis, leakage, and death were noted among patients. Furthermore, in addition to early feeding being safe and well tolerated, it also results in a reduction of costs and a decrease in hospitalization.

Parallel results have also been reproduced among pediatric patients (Islek, Sayar, Yilmaz, & Artan, 2013). Therefore, early feeding through PEG tube is recommended as it provides the patient and healthcare systems with the safest and most cost-effective results.

Complications of PEG

The insertion of a PEG tube is a safe method with few complications (that are clinically minor and easily resolved). The incidence rates for serious and minor complication have been estimated to be 3% and 6%, respectively. Immediate mortality after the procedure is less than 1% (Schrag et al., 2007; Vanis, Saray, Gornjakovic, & Mesihovic, 2012). Table 2 describes the most common complications, their causes, and measures for resolution.

Identifying Risk Factors for Complications

There are several retrospective reports raising awareness of the risk factors for PEG-related complications, with the aim of decreasing patient discomfort and healthcare costs (Arora, Rockey, & Gupta, 2013; Figueiredo et al., 2007; Higaki, Yokota, & Ohishi, 2008; Lang et al., 2004; Lee et al., 2014; Light, Slezak,

TABLE 2. Complications of PEG: Causes and Attitudes of Resolution

Problem	Possible Cause	Prevention/Intervention
Necrotizing fasciitis	Necrosis of the superficial fascia	Broad-spectrum antibiotics Surgical debridement
Bleeding from the puncture site or the gastric mucosa	A surrounding vessel injury	Produce compressive hemostasis by increasing the traction of the tube If it does not stop, remove the tube and perform endoscopic coagulation
Aspiration	Aspiration of refluxed content from the stomach	Raise the head of the bed Apply feeding technique correctly If aspiration happens, feeding should be stopped, respiratory therapy started, and antibiotics should be prescribed
Irritation or infection in the skin around the stoma	Excessive pressure on the stoma Lack of periestomal hygiene Gastric fluid output	Adjust the distance between the external retention ring and the stoma Clean the stoma following policy Put gauze underneath the retention ring and change it daily Consult a wound care expert
Obstruction of the PEG tube	Dried food or drug product clogging inside the tube Lack of flushing water after and between administering food or medication	Always flush with water after administration of food or drugs Flush with warm water using a syringe Avoid placing objects through the tube lumen in an attempt to dislodge a clog in order to prevent tube rupture or perforation of the stomach Administer pancreatic enzymes mixed with bicarbonate solution if ordered If not successful in opening the obstruction, the tube may need to be replaced
Tube extraction	The PEG tube comes out accidental or voluntary	Immediately replace the tube If not immediately available, place a Foley catheter temporarily through the stoma
The tube cannot be rotated	Burial of the tube in the abdominal wall	Rotate and push the tube gently inward. If unable to turn, remove and substitute the tube
Nausea and/or vomiting	High osmolarity of the formula Infusion excessively fast Lactose-intolerance Excessive fat content in the diet	Appropriately dilute the formula Return to previous infusion rate Manage lactose-free diet Use low-fat diet
Diarrhea	Hyperosmolar solution Lactose intolerance Poor absorption of fats Diet-cold	Use isotonic diets and/or dilute the hypertonic ones Suppress lactose Use low-fat formulas
Constipation	Low-fluid administration Insufficient fiber intake	Administer fluids in adequate amounts Increase the amount of fiber in the nutritional formula
Peristomal granuloma	Proliferation of granulation tissue through the stoma	Resection and/or cauterization of tissue

Note. PEG = Percutaneous Endoscopic Gastrostomy.

Porter, Gerson, & McCord, 1995; Smith, Perring, Engoren, & Sferra, 2008). Among the nonmodifiable risk factors, advanced age has been shown to increase the risk of death after PEG insertion in 1% per year (Arora et al., 2013); specifically an age of more than 75 years has been identified as a predictive factor for early death 1 month after PEG insertion (OR = 2.49; 95% CI, 1.47-4.21) (Light et al., 1995).

Malnutrition, expressed both as a decreased body mass index and low serum albumin levels, is repeatedly

associated with high mortality and high complication rate after PEG, as well as the presence of comorbidities. In fact, high C-reactive protein levels and abnormal leukocyte counts were related to an increased early mortality rate in PEG placement (Lee et al., 2014). The coexistence of congestive heart failure, renal failure, urinary tract infection, previous aspiration, chronic pulmonary disease, coagulopathy, pulmonary circulation disorders, metastatic cancer, and liver disease were also strongly associated with an increased mortality. The sum of several risk factors in the same patient also greatly increases the likelihood of early death after insertion of a PEG tube; thus, the presence of 3 risk factors multiplied by 6 the probability of death at 1 month compared with patients who had no risk factors (Light et al., 1995).

The risk of complication, including death, should always be assessed individually in each patient undergoing PEG tubes insertion; nevertheless, we must always bear in mind that enteral feeding is preferred to parenteral feeding in the nutritionally depleted patient and PEG feeding remains the safer, easier, and cheaper method for tube feeding for a wide range of severely compromised patients. Indeed, the indication for PEG is strongly associated itself with mortality (Arora et al., 2013).

The PEG tube placement by an inexperienced endoscopist has been identified as a modifiable risk factor related to early complications. Furthermore, the insertion of the internal bumper of a PEG tube in the upper body of the stomach represented a significant risk factor for early and late complications (Lee et al., 2014).

Interestingly, some recent multicenter retrospective research has shown that users of proton pump inhibitors (PPIs) (defined as patients who were taking standards doses of PPIs at least 48 hours before PEG placement) were associated with adverse PEG-related complications (including mortality, bowel perforation, postprocedural gastrointestinal bleeding, peritonitis, fever, pneumonia, peristomal leaks, or infection) when compared with non-PPIs users (Im et al., 2014).

Patients with head and neck cancer have a higher risk for procedure-related mortality following gastrostomy than mixed patient populations according to a systematic review specifically conducted to define the optimum technique for gastrostomy placement in these particular patients (Grant et al., 2009). This research also showed that major complication rates following radiologically inserted gastrostomies were greater than those following PEG placement in patients with head and neck cancer.

Removal and Replacement of the PEG

After 2–3 weeks of being placed, a fistulous gastrocutaneous tract is formed, allowing the easy removal of the gastrostomy tube. A PEG tube can be removed when the reason for its placement has been resolved: in these cases, the gastrocutaneous fistula will spontaneously close after 24–72 hours. Most PEG tubes, however, are placed because of chronic or progressive disorders, so the tube should be periodically replaced, after a half-life of 3–6 months that can be extended up to 12–18 months if properly cared for.

A PEG tube can be removed by strong and sustained traction until the internal bumper goes through the stoma (percutaneous method); alternatively, the tube can be removed with aid of endoscopy, by linking the gastric bumper of the tube with a polypectomy snare (endoscopic method). A recent observational retrospective study has analyzed the advantages of both methods of PEG removal in terms of associated complications (Lee, Im, et al., 2013a; Lee, Kang, et al., 2013b). The immediate complication rate was lower with the percutaneous removal method, with no significant differences in the later complication rate between the two methods. Peristomal bleeding was not associated with antiplatelet or warfarin use, age, gender, or short interval tube replacement. In contrast, old age was a significant risk factor of mechanical complications during PEG tube replacement (OR, 3.83; 95% CI, 1.04–14.07, $p = .043$). The authors concluded that the percutaneous method may be safer and more feasible for replacing PEG tubes in older patients to prevent such mechanical complications as esophageal injury. These results should be further validated with prospective RCTs. Subsequently following removal, a replacement gastrostomy tube is inserted through the stoma into the stomach and the balloon tip is filled with saline or methylene blue (between 6 and 20 ml, depending on the manufacturer and model); the tube is fixed externally with a retention ring.

The substitution of a PEG tube is an easy technique that should be learned by primary care professionals to reduce economic costs, patient anxiety, and that of their caregivers (thus providing greater comfort) (Yagüe-Sebastián, Sanjuán-Domingo, Villaverde-Royo, Ruiz-Bueno, & Elías-Villanueva, 2013). In case of tube removal, accidental or intentional, its early reimplantation is a priority to avoid the closure of the gastrocutaneous fistula. Where early access to an endoscopy unit is not possible, or the necessary equipment is not available, a Foley-type catheter with an inflated balloon in the gastric lumen can be used to preserve the tract and ensure the continued nutrition and hydration of the patient.

"Buried Bumper Syndrome": A Potentially Fatal Complication

Buried bumper syndrome (BBS) is an uncommon and late complication of PEG (with most cases occurring

months to years after placement) that occurs when the internal bumper of the PEG tube erodes into the gastric wall and lodges itself between the gastric wall and the skin. If not adverted, it can lead to a variety of additional severe complications including wound infection, peritonitis, and necrotizing fasciitis (Biswas, Dontukurthy, Rosenzweig, Kothuru, & Abrol, 2014; Khalil, Kibria, & Akram, 2010).

The most common management of BBS consists of removing the PEG tube smoothly, by external traction and replacing it with a new PEG tube using the pull-through method or balloon replacement tube, after dilation of the old tract (Lee & Lin, 2008). An alternative and successful endoscopic method, which has been lately described, consists of introducing a conventional papillotome over a wire into the stomach, drawing it back as far as possible and making incisions in all four directions to advance the tube with the internal bumper into the stomach (Born, Winker, Jung, & Strebel, 2014; Müller-Gerbes, Aymaz, & Dormann, 2009).

Concern over BBS in the endoscopic literature has increasingly led to recommendations for loose placement of the external bolster. It should be noted that leaving the external bolster too loose at the time of PEG placement increases the risk of leakage and peritonitis (McClave & Jafri, 2007) due to internal leakage of gastrointestinal secretions and enteral formula into the peritoneal cavity. In almost all cases, the technique of PEG placement itself brings the gastric and anterior abdominal walls into opposition, forming a seal, which is ensured by the contraction of the thick gastric musculature around the PEG tube (Haslam, Hughes, & Harrison, 1996).

Nursing Care of the Patient With PEG Tube

Proper long-lasting care is essential in avoiding PEG-related complications, guaranteeing the correct nutritional status of the patient, and ensuring an extended half-life for the tube. Nursing care should include four distinct aspects.

PEG Tube Care

As highlighted earlier, the PEG tube may be used immediately after insertion, but it is recommended to wait approximately 3–6 hours before administering solutions to the patient in order to observe any early complication, in particular bleeding. Small amounts of water and nutritional formula should be administered initially and progressively increased up to the fully prescribed volume within a 2- to 3-day period (Friginal-Ruiz, Gonzalez-Castillo, & Lucendo, 2011).

The tube and its components (plugs and retention rings) should be cleaned daily with a swab, mild soap, and warm water, rinsing and drying well after being used. The cap should remain closed when the tube is not in use. Checking periodically for proper inflation of the balloon in replacement tubes is also necessary. To avoid injury from decubitus over the abdominal and gastric walls, the tube should be daily rotated, clockwise and counterclockwise. Daily monitoring to ensure that external support does not press onto the patient's skin is required, as is changing the mounting location of the tube. A dressing between the skin and external fixation should not be placed, at this would cause undue pressure. Only in cases where drainage is needed, a dressing may be used but it should be changed frequently when soiled (Friginal-Ruiz, Gonzalez-Castillo, & Lucendo, 2011).

Stoma Care

During the first 2 weeks after PEG insertion, the peristomal area should be cleaned daily with soft soap and water, from the inside out, drying well and disinfecting with antiseptic and sterile gauze around the stoma—checking that there is no irritation, inflammation, or gastric secretions. A small liquid drainage from granulation tissue of the stoma may be normal during these first weeks.

It is recommended that the patient uses loose clothing so as not to press the stoma. If the stoma is not red, the patient can shower within a week.

Care During Feeding

An adapted nutritional formula should be used, rather than grinding regular foods, as regular food must contain high amounts of water or oil to reach a proper consistency for administration through the tube. Regular food will not have an adequate and balanced supply of nutrients and will be generally deficient in protein and excessive in fat.

The prescribed formula may be administered by gravity, using a syringe or low-pressure feeding pump, either continuously or intermittently. The patient must be positioned at a 30°–45° angle to facilitate gastric emptying and prevent reflux. This position must be maintained for an hour after completion of the feeding. The feeding formula should be administered at room temperature, starting at low volumes, increasing progressively as tolerance rises (Lucendo & Friginal-Ruiz, 2014).

After food or drugs administration, it is necessary to instill 50 ml of water to flush any residue from the tube. In the absence of a fluid restriction, it is recommended to use a large flushing volume when possible. In case of continuous nutrition, flushing should be done every 4–6 hours. A syringe sized 30 ml or greater is recommended to avoid too much pressure and consequently the rupture of any component of the PEG tube (Reising & Neal, 2005).

In case of PEG tube obstruction, the use of pancreatic enzymes mixed with a bicarbonate solution has been shown to be an effective method for unclogging the tube; after that, the PEG should be flushed with warm water (Schrag et al., 2007).

The patency of the tube can be checked by slowly aspirating gastric contents. It has been recommended that if the aspirate volume is greater than 100 ml, the content should be reintroduced. Wait for one hour before increasing the volume (Friginal-Ruiz, Gonzalez-Castillo, & Lucendo, 2011).

Administering Medication Through the PEG Tube

The evidence regarding the effectiveness of nursing interventions in minimizing the complications associated with administering medication via enteral tubes is limited, with a lack of high-quality research on many important issues. However, a systematic review by Phillips and Nay (2008) provides some recommendations to be considered when administering medications to a patient carrying a PEG tube.

Many kinds of medication will be diluted in water and are therefore considered unmixed. Flush with 5–30 ml of water after each and never mix medications with formula. Enteric coated and sustained release pills should never be crushed; chewable, cytotoxic preparations, or sublingual tablets are not recommended to be administered via the PEG tube. Bulk-forming tablets, such as Metamucil, are prohibited. Hypertonic and concentrated drugs should be diluted in water before administration. Warfarin, phenytoin, morphine sulfate, and aluminum-containing antiacids should not be given in conjunction with feeding because of delayed drug response (Tracey & Patterson, 2006).

If available, liquid medications are preferable since they may prevent occlusion of silicone PEG tube and nasoenteral tubes compared to solid forms. Diarrhea has been attributed to the sorbitol content in many liquid medications, rather than the drug itself, and sorbitol is therefore not advised. Effervescent drug preparation should also be avoided to prevent tube occlusion (Blumenstein, Shastri, & Stein, 2014).

Conclusions

Feeding through a PEG tube is the desirable method for patients with dysphagia or who are unable to feed orally, despite having a functioning digestive system. The technique has become more widespread because of its simplicity, safety, and low cost. For correct execution, specific training for professionals responsible for these procedures is required. In turn, they should provide training and information to other professionals and caregivers involved in the patient's care. The administration of adequate, customized, and personalized attention to each case, and the adoption of strategies to prevent, identify, and treat early complications will provide safe and effective care to patients with a PEG tube. ✪

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