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Percutaneous Endoscopic Gastrostomy in Neurological Patients

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1. Introduction

Patients with neurologic dysfunction are at increased risk for malnutrition due to a combination of cognitive, behavioral and mechanical problems. Cohort studies have shown that 20-50% of hospital patients are malnourished (McWhirter & Pennington, 1994; Norman et al., 2008; Kurien et al., 2010), and 20-40% of critically ill patients show evidence of protein-energy malnutrition (Ziegler, 2009). Access for supplemental nutrition may be considered to meet the nutritional needs of any patient with a functional gastrointestinal tract who is unable to safely swallow (Kulick & Deen, 2011; McClave et al., 2009). The primary aim of enteral tube feeding is to avoid further loss of body weight, to correct significant nutritional deficiencies, to rehydrate the patient, to promote growth in children with growth retardation, and to stop the related deterioration of the quality of life of the patient due to inadequate oral nutrition intake (Loser et al., 2005). A variety of enteric feeding tube options exist, including endoscopically-placed nasogastric feeding tubes, percutaneous endoscopic gastrostomy (PEG), radiologically inserted gastrostomy (RIG), and per-oral image guided gastrostomy (PIG) (Laasch et al., 2003; Hoffer et al., 1999; Preshaw, 1981; Tao & Gillies, 1983; Wills & Oglesby, 1983; Gauderer et al., 1980). The endoscopic access routes have been more popular than radiologic routes, which despite being quite effective have been reserved as a PEG alternative in cases deemed too risky or difficult for the passage of an endoscope (de Baere et al., 1999; Galaski et al., 2009; Loser et al., 2005; Ozmen & Akhan, 2002). Enteral access can also be obtained surgically, but this has become much less frequent since the advent of these less-invasive techniques (Duszak & Mabry, 2003; Sleisenger et al., 2010). In cases where endoscopic access is not obtained, technical considerations and/or local availability play a role in determining whether a patient receives a radiological or surgical gastrostomy (Kurien et al., 2010; Leeds et al., 2010; Ljungdahl & Sundbom, 2006).

2. Techniques commonly employed in early feeding

The incidence of malnutrition worsens over time in patients who require prolonged hospitalization. Malnutrition is associated with increased morbidity and mortality in hospitalized patients; protein-calorie malnutrition is associated with skeletal muscle weakness, an increased rate of hospital-acquired infection, impaired wound healing, and prolonged recovery time. The relationship between malnutrition and adverse clinical outcomes is complex. Patients who are more difficult to feed are more critically ill and at

higher risk for death and complications. Commonly-employed techniques for early feeding to address nutritional deficiency include parenteral, nasogastric and nasoenteric feeding.

2.1 Parenteral access

In most cases enteral feeding is a viable option early during the course of hospitalization. Although early enteral nutrition has been shown to be associated with a significantly lower incidence of infections and a reduced length of hospital stay (Marik & Zaloga, 2001), enteral feeding is not always possible. In such cases, parenteral hydration and nutrition may be the only option to maintain healthy levels of fluid and nutrition. Studies suggest that in these instances patients with moderate-to-severe protein-energy malnutrition may benefit from parenteral nutrition (Heyland et al., 1998). Published guidelines suggest that when enteral feeding is not possible, parenteral nutrition should be initiated within 3-7 days; among such patients who have protein-energy malnutrition at the time of admission to the intensive care unit, the American Clinical Practice Guidelines suggest that parenteral nutrition should be initiated without delay (Ziegler, 2009).

This is not an option without inherent risks. A meta-analysis of well-designed intention-to-treat trials comparing enteral nutrition with parenteral nutrition in critically ill patients (with each study enrolling fewer than 200 patients) showed a significant reduction in mortality among patients receiving parenteral nutrition (Simpson & Doig, 2005). The risk of infection was significantly increased with parenteral nutrition. A systematic review of 13 randomized clinical trials involving critically ill adults showed a significant reduction in infectious complications with enteral nutrition, as compared with parenteral nutrition (Gramlich et al., 2004). In general, a catheter that is inserted for parenteral nutrition should not be used for any other purpose, such as phlebotomy or the administration of medications; and particular care must be taken to maintain the catheter and the percutaneous entry site with appropriate sterile access and dressing techniques (Ziegler, 2009; American Society for Parenteral and Enteral Nutrition, 2002; Mirtallo et al., 2004). The estimated daily cost of standard central venous parenteral nutrition is approximately \$60 to \$90, depending on additives (e.g., supplemental micronutrients). Personnel costs for monitoring by nutritional-support health professionals and for preparation of parenteral nutrition by pharmacists is approximately \$20 per day, with additional minor costs for intravenous tubing, nursing time. Central-vein parenteral nutrition may also be associated with mechanical, metabolic, and infectious complications (American Society for Parenteral and Enteral Nutrition, 2002; Ziegler, 2009).

2.2 Nasogastric access

Nasogastric tube (NG) feeding is the most common and oldest form of interventional feeding. Nasogastric tubes have the advantage of being simple to insert but are often poorly tolerated by the patient, and are difficult to maintain in position. They have a significant associated risk of aspiration (Ciocon et al., 1988), and carry a high risk for accidental displacement (Keohane et al., 1986; Payne-James & Silk, 1988).

The benefits of placing a nasogastric tube include the fact that little skill is required for tube placement and it enables early commencement of enteral feeding. This maintains intestinal function. The ability to use the tube for bolus feedings has the added advantage of being more physiologic than is continuous feeding. Manual placement of a nasogastric tube at the

bedside, without guidance, is often done without complications. Verification of the placement of the tube was once thought to be sufficiently accomplished by auscultation, listening for a gastric bubble as air is forced into the tube. Extraction of gastric contents is another such verification method: measuring pH of the gastric contents could allow for verification of the fluid extracted as that from the stomach, though in practice this is rarely done. Despite its simplicity, however, this method can result in insignificant and potentially lethal complications. These include misplacement, mucosal injury with bleeding and/or esophageal, gastric, or intestinal perforation. These complications require immediate treatment.

Enteral feeding can usually be continued after misplacement or bleeding. With perforation, however, alternative feeding such as Total Parenteral Nutrition (TPN), along with antibiotics and bowel rest, are undertaken. It is common for the nasogastric tube not to be inserted far enough and to be left in the distal esophagus or, in the extreme situation, placed in the trachea or bronchial tree rather than passed into the stomach. These placements will increase the risk of aspiration. To ensure correct placement in the stomach, at least 50 cm of the tube should be. While placement can be initially assessed by the insufflation of 50 mL of air—which should be easily audible by auscultation (with bubbling) in the epigastrium—confirmation of correct placement should be sought by radiography before feeding commences. Correct placement is confirmed when the shadow of the tube is detected below the level of the diaphragm.

The decision to move from a nasogastric tube to a gastrostomy tube is based on a number of factors including the length of time that is being considered for the enteral feeding. Often when initially placed, it is not clear how long will be the need for the NG feeding. What is initially placed as a very short term measure may, due to complications with treatment, evolve into a more chronic situation. The majority of patients requiring nutritional support will need it for less than one month, and nasogastric tube feeding is by far the most commonly used route of access. Fine bore nasogastric tubes have reduced the incidence of complications, such as rhinitis, esophageal reflux, strictures and esophagitis that were associated with the large bore Ryle's tube (Pearce & Duncan, 2002).

2.3 Nasoenteric access

Nasoenteric tube placement is more invasive than the corresponding nasogastric procedure and, therefore, carries a greater risk of mucosal injury if the tube is placed manually. As the control of delivery of fluid by the stomach is bypassed, nasoenteric feeds should be given as a constant infusion and not in bolus form. Furthermore, since the stomach is bypassed, bacterial suppression by gastric acid is lost and a sterile feed must be given via a 'closed' system.

The complications of nasoenteral feeding tubes have become less common since the introduction of fine bore nasoenteral feeding tubes in the 1970s. These tubes are easier to pass, more flexible and are less likely to cause erosions, esophagitis, or strictures. Local complications are common, however, with patients noting discomfort when the tubes are passed, and with tube maintenance as the securing devices are manipulated. This is again dependent largely on the tube's diameter, softness and type of tip. As in other methods of tube access, detection of correct placement is not an insignificant concern. Patients most at risk from misplacement of nasogastric tubes include those on ventilators, those who have altered level of consciousness and/or those with neuromuscular abnormalities, such as reduced gag, swallow, and cough reflexes.

Other complications of nasoenteral access include the development of tracheo-esophageal fistula, which may develop when large-bore nasoenteric tubes are used. Commonly, nasoenteric tubes become displaced, particularly in the critically ill and/or those who have altered levels of consciousness.

Placing nasoenteral feeding tubes postpylorically can be difficult; spontaneous transpyloric passage of standard feeding tubes after 24 hours is only in the order of 30% and does not seem to be affected by tip profile or addition of a weight to the tip of the feeding tube (Pearce & Duncan, 2002).

3. Techniques commonly employed for long-term feeding

As a result of some of the difficulties encountered with nasogastric and nasoenteric feeding tubes, alternative routes of tube feeding have been developed, some of which have proven useful for long term feeding (Pearce & Duncan, 2002). Tube enterostomies can be placed using surgical, endoscopic, or radiological methods into the gastrointestinal tract.

3.1 Percutaneous endoscopic gastrostomy

First described in 1980, PEG has become the most commonly-employed method of enteral access, due to its relative ease of deployment in most patients and overall tolerability. PEG placement is a common indication for endoscopy of the upper gastrointestinal tract (Park et al., 2011; Srinivasan et al., 2009), and is now much more widely used than surgical or radiological insertion. Rates of PEG insertion have risen in recent years: in 1989, 15,000 PEG tubes were placed; in 1995, 121,000 PEG tubes were placed, and in 2000, more than 216,000 tubes were inserted for feeding (Delegge, 2008; Grant et al., 1998; Roche, 2003; Duszak & Mabry, 2003). The greatest increase in feeding tube placement has occurred in those 75 years of age and older (Freeman et al., 2010; Lewis et al., 2004). Various treatment guidelines have been developed to assist clinicians in navigating the clinical and ethical issues informing the decision to place a PEG (Ritchie et al., 2007; Greff, 1999; Loser et al., 2005; Maillet et al., 2002; Niv & Abuksis, 2003; Rosner, 1997).

PEG is commonly used in patients with neurologic dysfunction who have intact cognition and/or a high likelihood to maintain their current baseline, or recover their premorbid neurologic function (DeLegge et al., 2005; Gauderer et al., 1980). A recent meta-analysis found that PEG carries a lower risk of intervention failure when compared with use of nasogastric (NG) tube, although no significant difference in mortality rates between comparison groups, or pneumonia irrespective of underlying disease was found (Gomes et al., 2010). When compared with NG access, PEG has been shown to be a more reliable enteral access tube, allowing patients to receive more calories daily because of a reduction in tube dysfunction (Park et al., 1992; Sleisenger et al., 2010). However, the unproven efficacy of enteral nutrition in prolonging survival and improving quality of life in many clinical settings, and the potential for multiple complications have tempered the “enthusiasm” for performing this procedure for nutritional support in many clinical situations (Potack & Chokhavatia, 2008); nevertheless, gastrostomy feeding has the potential to reduce mortality, length of hospital stay, and complications in carefully selected patients who are likely to be or later become nutritionally depleted for longer than four to six weeks (Green, 1999; Kurien et al., 2010; Wicks et al., 1992).

The gastrostomy tube can be placed via a “pull” (Ponsky-Gauderer) technique, be pushed into place by a “push” (Sacks-Vine) method, or secured via the “introducer” (Russell)

procedure, where the stomach is be directly punctured and a Foley catheter placed over a guidewire. A wide variety of commercial PEG systems are available. The tube diameters commonly used range from 6 mm to 8 mm. In general, small-diameter tubes should be avoided in patients with poor gastric emptying who require intragastric administration of medication. If a PEG with jejunal extension is required, such as for patients with gastroparesis, a wide (for example, 8 mm diameter) tube is required that can be cannulated with a narrow (for example, 5.3 mm diameter) jejunal tube (O'Keefe, 2009).

3.1.1 Indications for percutaneous endoscopic gastrostomy

Placement of a PEG tube should be considered for patients who continue to require enteral feeding beyond 4 weeks; it is also indicated as first-line intervention in conditions where enteral feeding is expected to be required for longer than 2–4 weeks (O'Keefe, 2009). Neurogenic indications for gastrostomy include dysphagia from a variety of causes, including stroke, brain injury, cerebral palsy, brain tumors, HIV encephalopathy, neonatal encephalopathy, and neurodegenerative syndromes; non-neurological indications include such conditions as head and neck cancer, surgery to the mouth and throat, aspiration, Crohn's disease, severe burns, and decompression of the stomach in obstructing intra-abdominal malignancy (Buchholz, 1994; Laasch et al., 2003; Nishiwaki et al., 2009; El-Matary, 2008; Naik et al., 2009; Park et al., 2011). The most common indication for PEG in children and adults is neurogenic dysphagia (El-Matary, 2008; Miller et al., 1989; Nicholson et al., 2000; Friedman et al., 2004; Srivastava et al., 2005). Enteral access can also facilitate the delivery of medications in patients whose illness limits their ability to take them by mouth (Phillips & Nay, 2008; El-Matary, 2008; Loser et al., 2005); and it can also facilitate hydration in these patients (Sleisenger et al., 2010).

Neurogenic dysphagia secondary to *stroke* is the most common cause for PEG insertion in adults (James et al., 1998; James et al., 2005; Rimon et al., 2005; Gencosmanoglu, 2004); dysphagia occurs in around 40% of patients at the time of diagnosis, with up to 10% of stroke patients suffering long-term dysphagia (Barer, 1989; Gordon et al., 1987; Kidd et al., 1995; Laasch et al., 2003; O'Neill, 2000; Smithard et al., 1996). Early feeding (within the first week) via PEG is no longer recommended in the most recent guidelines for management of acute stroke, as it has not been shown to improve long-term survival, complication rates or length of hospitalization (Koretz et al., 2007; Kulick & Deen, 2011). More recent guidelines recommend the early initiation of NG tube feeds for dysphagic patients with acute ischemic stroke (within 48 hours), and not placing PEG within the first two weeks (Ringleb et al., 2008). Others have recommended continuing the NG feeds for the first month in patients whose swallow function does not recover (Hill, 2008).

Patients with hypertensive *intracerebral hemorrhage* may benefit from early enteral nutrition based on observational data (Lee et al., 2010); however, no randomized data exist. Data is similarly lacking for the use of PEG in dysphagic patients with *Parkinson's disease* (Deane et al., 2001).

A recent meta-analysis of nutritional support in *head-injured* patients concluded that, while data are lacking, early feeding may be associated with a trend toward better outcomes in terms of survival and disability (Perel et al., 2006).

Amyotrophic Lateral Sclerosis (ALS) is another condition where PEG is routinely employed (James et al., 1998; James et al., 2005; Rimon et al., 2005; Mitsumoto et al., 2003). In addition to progressive issues with dysphagia, ALS patients have increased energy needs, and it has

been suggested that PEG can play an important role in preventing additional muscle loss (Desport et al., 1999; Spataro et al., 2011; Vaisman et al., 2009). Recent guidelines recommend ALS patients receive PEG when oral intake is limited and body weight begins to decline (Andersen et al., 2007; Radunovic et al., 2007; Spataro et al., 2011). Some have recommended PEG be placed for weight loss of more than 10% over baseline and before forced vital capacity (FVC) falls below 50%; however, safe PEG insertion has been documented in patients with FVC below 50% (Gregory et al., 2002; Spataro et al., 2011). Limited data from non-randomized studies suggest a survival advantage and improved nutrition with enteral feeding (Katzberg & Benatar, 2011; Chio et al., 1999; Mazzini et al., 1995; Spataro et al., 2011). No randomized controlled trials exist.

Multiple sclerosis (MS) is also associated with progressive dysphagia prompting the use of PEG; small case reports have demonstrated an improvement in comorbid disease states, such as pressure ulcer healing, in patients with MS and dysphagia who receive tube feedings (Annoni et al., 1998; Sleisenger et al., 2010).

More than 36,000 older patients with *dementia* receive a PEG tube each year (Gillick, 2000; Sleisenger et al., 2010). PEG placement in elderly patients with dementia is controversial (Palecek et al., 2010; Delege, 2009; Garrow et al., 2007; Gillick, 2000; Cervo et al., 2006; Chernoff, 2006). No randomized controlled trials exist in this patient population, and observational studies do not show any evidence of increased survival with PEG; nor was there any reduction in pressure ulcers, improvement in quality of life, function behavior or psychiatric symptoms of dementia (Sampson et al., 2009). However, while earlier data suggested worse clinical outcomes in patients with dementia or significant cognitive impairment who received PEG, more recent data suggests outcomes in these populations are no different than in other patient populations receiving PEG (Freeman et al., 2010; Delege, 2008; Higaki et al., 2008; Gaines et al., 2009). As in other patient populations, the decision to insert a PEG tube in an elderly demented patient should always be made on an individual basis (National Collaborating Centre for Acute Care, 2006; Kurien et al., 2010; Rabeneck et al., 1997).

In children and adults with *intellectual disability/mental retardation*, feeding via PEG has been shown to improve nutritional status and quality of life in certain patients (Loser et al., 2005; Mathus-Vliegen et al., 2001) but not others (Lee & MacPherson, 2010); no randomized studies have been performed.

3.1.2 Complications of percutaneous endoscopic gastrostomy

Despite its strong safety record, PEG tube placement can be associated with an overall complication rate of 4.9–50% (Amann et al., 1997; Fröhlich et al., 2010). Complications are more likely to occur in elderly patients with comorbid illness, particularly those with an infectious process or who have a history of aspiration (Naik et al., 2009); it is therefore important to recognize that some patients are too frail for the sedation necessary for the endoscopy, particularly those patients with severe respiratory disease (Nicholson et al., 2000). Potential risk factors for complications in younger patients include age less than 1 year, mental retardation, scoliosis, constipation, hepatomegaly, previous upper abdominal surgery, presence of ventriculoperitoneal shunt, peritoneal dialysis and coagulopathy (Fröhlich et al., 2010; Vervloessem et al., 2009; von Schnakenburg et al., 2006).

Inadequate transillumination is considered the primary absolute contraindication for PEG placement because this indicates the inability to oppose the anterior gastric wall to the

abdominal wall; this could result from organomegaly, severe ascites or an interposed colon (Nicholson et al., 2000). An absolute contraindication to PEG placement is the inability to bring the anterior gastric wall in apposition to the abdominal wall. Prior gastric resection, ascites, hepatomegaly and obesity are some conditions which may impede gastric transillumination and subsequent PEG placement. Percutaneous endoscopic gastrostomy feeding should not be used when gastrointestinal obstruction is present. Relative contraindications to PEG include neoplastic, inflammatory and infiltrative diseases of the gastric and abdominal walls (Nicholson et al., 2000).

Pneumoperitoneum can be rather common among those that receive a PEG. This can occur when air escapes into the peritoneal cavity during the puncture of the abdominal wall and the stomach. In much of medical practice the detection of air within the peritoneal cavity frequently indicates a perforated abdominal viscus that requires emergent surgical management. On radiograph, pneumoperitoneum appears as a characteristic radiolucency seen below the diaphragm on chest radiograph or in a superiorly dependent location on abdominal radiograph; in the appropriate clinical setting, the radiographic presence of intraperitoneal air often is believed to be a diagnostic finding. In fact, pneumoperitoneum reflects visceral perforation in 85% to 95% of all occurrences. In 5% to 15% of cases, however, pneumoperitoneum does not reflect perforation and results from another source that does not require emergency surgery. In a recent review, the most common abdominal etiology of non-surgical peritoneum (NSP) was retained postoperative air (prevalence 25% to 60%). NSP occurred frequently after peritoneal dialysis catheter placement (prevalence 10% to 34%) and after gastrointestinal endoscopic procedures (prevalence 0.3% to 25%, varying by procedure). The most common thoracic causes included mechanical ventilation, cardiopulmonary resuscitation, and pneumothorax. Clinicians should maintain a high index of suspicion for nonsurgical causes of pneumoperitoneum and should recognize that conservative management may be indicated in many cases (Mularski et al., 2000). In one study of patients undergoing PEG placement, of the 65 patients who underwent PEG placement, 13 developed a pneumoperitoneum on the initial chest radiograph; 10 of the 13 patients experienced complete resolution of pneumoperitoneum at 72 hours, and in 3 patients, the free air persisted but was of no clinical significance (Wiesen et al., 2006). Wiesen et al. conclude that pneumoperitoneum following PEG is of no clinical significance and hence, does not warrant any further intervention (Garcia-Bueno et al., 1998; Wiesen et al., 2006).

Replacement is sometimes required if a PEG is inadvertently removed; premature removal of PEG tubes by either the patient or healthcare staff occurs in 2% of patients and can lead to significant complications if not promptly recognized and appropriately treated (Galat et al., 1990; Larson et al., 1987; Marshall et al., 1994; Orlando Regional Medical Center Department of Surgical Education, 2009). Agitated or delirious patients who inadvertently pull out their PEG tube often can be successfully managed with nasogastric suction and PEG replacement (Galat et al., 1990; Marshall et al., 1994). A Foley catheter can be inserted through the tract and feeding restarted until the PEG is replaced either endoscopically with a standard PEG tube or non-endoscopically with a button gastrostomy. Anecdotally, the PEG tract closes in 24–48 hours when the patient is treated with bowel rest with or without nasogastric suction. Subsequent placement of a PEG tube in a new site is often successful. Signs of peritonitis mandate treatment with antibiotics and a surgical consultation. If a PEG tube is inadvertently removed from a mature tract (> 3–4 weeks old), a Foley catheter can be

inserted to maintain tract patency, but this should not be attempted if the PEG tract is immature. Burke et al. have evaluated the use of an air contrast insufflation through a recently replaced gastrostomy tube as a quick and cost-effective method for confirming appropriate positioning. Following an initial case report, the authors subsequently reported their experience with gastrostomy tube confirmation using 240 mL of room air instilled into the stomach, with before and after radiographs. Twenty-nine gastrostomy tubes were replaced using air insufflation and 19 tubes using water-soluble contrast followed by fluoroscopy. At two weeks post-procedure, the authors found no difference between the two techniques in terms of complications or mis-positioned tubes (Burke et al., 2006; Burke et al., 2005; Burke & Hoaglin, 2007; Orlando Regional Medical Center Department of Surgical Education, 2009).

Peritonitis is a feared complication of PEG that often carries a high mortality rate. Intraperitoneal leakage of gastric contents, wound dehiscence, and delayed stoma closure can cause peritonitis (Pearce et al., 2000). Peritonitis complicates up to 2.3% of procedures in large series (Luman et al., 2001). We have previously described the case of a 33-year-old brain-injured patient whose PEG insertion was complicated by inadvertent malpositioning and subsequent infection; after initially being placed through the liver, the PEG tube migrated out several weeks later, resulting in intra-abdominal feed collection, peri-hepatic abscess formation, and peritonitis (Burke & Geller, 2009). Other such cases have been recorded with one large series reporting this in 2.3% of the cases (Luman et al., 2001).

Hemorrhage occurs in up to 2.5% of PEG placements (Larson et al., 1987; Schapiro & Edmundowicz, 1996). During the procedure hemorrhage may be caused by puncture of gastric wall vessels; the most common cause of hemorrhage post-PEG is due to the ulceration of the gastric mucosa underneath the internal bumper when applied in very tight approximation to the mucosa (Potack & Chokhavatia, 2008). Post-PEG hemorrhage is managed similar to other episodes of upper gastrointestinal bleeding. Diagnostic upper endoscopy is often performed. If endoscopy does not reveal a bleeding source, it is useful to loosen the external bolster on the PEG tube to free it from the gastric mucosa and evaluate for underlying ulceration (Cappell & Abdullah, 2000).

Visceral perforation is also a concern in PEG placement. As concerns the small intestine, normally the greater omentum restricts the small bowel from positioning in the upper abdomen; in children with prior abdominal surgery, however, adhesions could displace the small bowel in front of the liver (Fröhlich et al., 2010; Wilson et al., 1990). Small bowel volvulus around the PEG and subsequent obstruction has also been reported (Alawadhi et al., 1991; Al-Homaidhi & Tolia, 2001; Hoffer et al., 1999). Additionally, loosening of the external bolster can allow migration of the internal bumper through the pylorus into the small bowel, mimicking small bowel obstruction (Hoffer et al., 1999; Mollitt et al., 1998; Schrag et al., 2007).

Wound Infection is a common occurrence, with local infection found to occur in up to 23% of cases (Lee et al., 2002). The majority of infections (>70%) are minor (Gossner et al., 1999). Trials of use of prophylactic systemic antibiotics have demonstrated significant reductions in the rate of these infections, while attempts to use topical antibiotics at the peristomal site have been met with much less success. As many patients with PEG tube placement are hospitalized, there is a risk for nosocomial colonization that complicates this use of antibiotics.

Excessive leakage at the peristomal site is one of the more commonly encountered complications of PEG placement, and has been reported in 1-2% of the cases (Lin et al., 2001). It can result from mechanical factors such as side torsion on the tube with ulceration on one side of the tract and absence of an external bolster (McClave & Chang, 2003). Side torsion with ulceration in the tract may require stabilization of the PEG tube with a commercial clamping device that prevents side-to-side motion. If there is increased granulation tissue around the peristomal site, this may be addressed with topical silver nitrate.

Colon perforation is another complication of PEG insertion. The transverse colon is apposed to the greater curvature of the stomach; and if the stomach is not well insufflated during placement of the PEG tube, the colon may not be completely displaced out of the field, thus leading to puncture by the gastrostomy tube (Hogan et al., 1986). One such example is illustrated in Figures 1, 2 and 3. This complication is seen more frequently in pediatric populations, where it occurs at a rate of 2%-3.5% (Khattak et al., 1998). The early presentation of this complication is that of peritonitis or large bowel obstruction, although many patients present months later with partial large bowel obstruction or diarrhea due to leakage of feedings into the colon (Hogan et al., 1986). Intractable diarrhea has been described as a possible presenting sign of PEG placement through the transverse colon (Burke & Carayannopoulos, 2005).



Fig. 1. PEG tube exiting transverse colon

Diagnosis of colon perforation is confirmed by barium enema examination, colonoscopy, or CT scan. Patients who do not manifest signs of obstruction or peritonitis can be managed by tube removal. In most cases, the fistula will close and a second gastrostomy can be performed (Hogan et al., 1986; Potack & Chokhavatia, 2008; Schapiro & Edmundowicz,

1996). If obstruction or peritonitis is present or the fistula does not close despite PEG removal, operative takedown of the fistula is necessary (Cappell & Abdullah, 2000; Patwardhan et al., 2004; Potack & Chokhavatia, 2008; Schapiro & Edmundowicz, 1996). Anecdotal reports support the practice of using a fluid-filled syringe attached to the finder needle during PEG placement for reducing the risk of colonic perforation. Aspiration of air bubbles prior to visualizing the needle in the stomach suggests the presence of interposed bowel between the abdominal wall and stomach (Potack & Chokhavatia, 2008). Friedmann et al. identified 6 hospitalized patients who had misplacement of a PEG into the colon, and a review of the English literature revealed another 22 adult cases with this complication (Friedmann et al., 2007). Of the total 28 cases, 8 had previous abdominal pathology. Seventeen patients developed symptoms after tube replacement, whereas in 11 the tube had not been changed. Fourteen had diarrhea, 11 presented with fecal discharge in or around the tube, and 3 were asymptomatic. Thirteen showed colocutaneous fistula without residual connection to the stomach. Ten patients were treated surgically and 14 conservatively by removal of the tube. One patient had colonoscopic clipping of the fistula. Clinicians should therefore suspect misplacement of the tube into the colon when there is recurrent severe diarrhea of undigested food or fecal content in the tube, particularly after tube replacement; and treatment may be conservative in most cases (Friedmann et al., 2007).



Fig. 2. PEG tube entering transverse colon

Buried bumper syndrome is defined as migration of the PEG tube into the gastric wall and the subsequent epithelization of the ulcer site (Safadi et al., 1998). Buried bumper syndrome often occurs months to years after PEG placement (median duration was 35 months after PEG placement) as the patient develops abdominal pain; difficulty feeding or flushing the tube; and the inability to advance, withdraw, or rotate the tube (Horbach et al., 2007). Buried

bumper is thought to arise from excessive traction on the tube causing it to erode into the gastric wall. The incidence of this complication has lessened with newer tube designs which utilize a softer internal bumper (Schapiro & Edmundowicz, 1996). Treatment involves removing the tube (which may require upper endoscopy), allowing the tract to close while an alternative method of feeding is established, and then placing a new PEG tube in a different location (Horbach et al., 2007).



Fig. 3. PEG tube properly positioned, internal stomach view

3.2 Post-pyloric access

One concern about the use of nasogastric feeding in critically ill patients is the risk of reflux and aspiration of gastric contents; gastric reflux is often caused, however, by factors other than feeding (O'Keefe, 2009). These include sepsis, trauma, drugs, body position, gastroparesis, esophageal dysmotility, and obesity (O'Keefe, 2009). Gastric reflux, therefore, need not be a contraindication to gastric feeding; if gastric reflux persists despite the employment of preventative strategies, postpyloric enteral feeding may be employed (O'Keefe, 2009). Thus, in cases of gastroduodenal motility problems, pyloric stenosis or aspiration, a jejunal catheter, such as a PEG with jejunal extension (PEG/J) or direct percutaneous endoscopic jejunostomy (DPEJ), can be used (Niv et al., 2009; Kwon et al., 2010; Ho, 1983); such access systems can also be used to administer medications intra-jejunally, for example in therapy-resistant Parkinson's disease (Mathus-Vliegen, 2000). There are conflicting data in the recent literature about whether or not jejunal feeding definitely reduces the rate of reflux and aspiration (Loser et al., 2005; Finucane & Bynum, 1996; Lazarus et al., 1990; Mathus-Vliegen & Koning, 1999). Although PEJ was originally introduced to prevent aspiration, there remains a 2.4% risk of aspiration with post-pyloric feeding; the major indication for PEJ is significant impairment of gastric emptying (Cecil et

al., 2008; Gutierrez & Balfe, 1991). No significant difference in inpatient mortality and length of stay was found in a recent observational study comparing PEG and PEJ (Poteet et al., 2010). PEJ insertion is also considered technically more demanding than PEG (Pearce et al., 2000). As an alternative to endoscopically-placed jejunostomy tubes, fluoroscopically-guided catheters can be placed. Percutaneous radiologic gastrojejunostomy (PRGJ) involves a longer and narrower tube than that placed in the stomach, and is thought to carry the potential for more frequent complications, such as tube blockage; PRGJ can be considered as a conversion from gastrostomy or placed as a primary option (Given et al., 2005; Shin & Park, 2010; Hoffer et al., 1999). Percutaneous radiologic jejunostomy (PRJ) is indicated in patients whose stomach is inaccessible for gastrostomy placement, or in those who have had a previous gastrectomy (Given et al., 2005; Shin & Park, 2010).

3.3 Surgical gastrostomy

Surgical gastrostomy is indicated for patients in whom PEG, RIG or PIG cannot be performed, or as an adjunctive procedure at the time the patient is undergoing surgery. Indications include esophageal atresia, stricture development, cancer, dysphagia due to neuromuscular disorders, or after trauma. Complications include local irritation, hemorrhage, skin excoriation from leaking of gastric contents, and wound infection. This procedure has largely been replaced by the PEG for its improved simplicity, and reduced costs (Pearce & Duncan, 2002). Surgical gastrostomy is technically simple but does involve an abdominal incision under general anesthesia. As most patients receiving surgical gastrostomy are malnourished, often with multiple medical problems, the operative risk is high and the gastrostomy site may heal poorly, causing leakage and not an insignificant amount of morbidity (Shellito & Malt, 1985).

4. Conclusion

Patients with neurologic dysfunction are at risk for malnourishment. The provision of supplemental nutrition, such as that afforded by percutaneous endoscopic gastrostomy, is potentially beneficial in many of these patients, but is not a risk-free procedure. Risks and benefits, ethical considerations, as well as the specific approach to be employed in any particular patient, must be weighed and discussed as part of the decision-making process. An awareness of the potential complications and their manifestations will both aid the clinician in advising patients about the decision to pursue gastrostomy, and help ensure a safer post-procedure course.

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6. References

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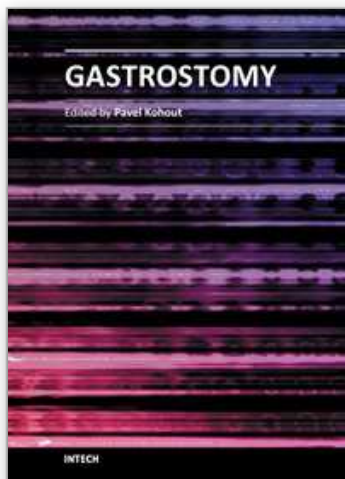
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The gastrostomy placement is a method of providing nutrition to the patients who are unable to eat. In this book you can find chapters focused on the use of gastrostomy in children, patients with neurological impairment and patients with head and neck tumours. Home enteral nutrition is suitable for all of these groups of patients and is far easier with gastrostomy. The new indications (especially in very young children) required new techniques such as: laparoscopic gastrostomy, laparoscopy assisted endoscopic gastrostomy with/without fundoplication, ultrasonography assisted gastrostomy. All information about these techniques can be found in this book. This book does not serve as a basic textbook, but as an interesting reading material and as an aid for physicians who are already familiar with the indication for gastrostomy and want to know more.

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