Tips from the shop floor
Percutaneous gastrostomy: troubleshooting complications

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Introduction

Percutaneous Endoscopic Gastrostomy (PEG) was first described in 1980 (Gauderer, 1980), superseding surgical gastrostomy as a means of providing long-term enteral nutrition. Despite the commonality of this procedure, its associated morbidity and mortality rates are significant, with directly attributable rates of 1:30 and 1:150 respectively.

Poor patient selection and poor management are the principal factors contributing towards adverse outcomes. The 2004 National Confidential Enquiry into Patient Outcomes and Death (National Confidential Enquiry, 2004) recorded that 19% of PEG procedures performed were 'futile or not indicated at all'. This article provides a practical approach to avoiding and treating complications associated with PEG feeding.

Avoiding Complications

Three factors are important when contemplating PEG insertion: 'Patient', 'Procedure' and 'Preparation'. Each case should be considered on its own merits, taking into account the clinical scenario, underlying diagnosis and prognosis, patient wishes, ethical issues, and expected impact on quality of life.

Appropriate patient?

Table 1 describes the common indications for PEG feeding, and Box 1 contraindications. It is indicated in patients expected to be unable to maintain adequate oral intake for at least 2-3 weeks (Löser, 2005), in the absence of limited life expectancy.

The issue of PEG use in advanced dementia is contentious. Although there have been concerns that procedural risks may be much higher in these individuals, there is variability between case series and much of the observational data have potential confounding factors (Dharmarajan et al, 2001; Higaki et al, 2008). Nonetheless, there is currently no clear evidence that PEG feeding increases survival, reduces risk of aspiration or improves quality of life in this patient cohort. Consequently, the decision to proceed with an invasive procedure requires careful consideration and sensitive discussion about realistic goals of treatment (Peck et al, 2014).

Ethical considerations often arise in relation to artificial nutritional support. Therefore, it is important to take a multi-disciplinary team approach when assessing patient suitability for PEG insertion. In UK law, tube feeding is regarded as a medical treatment, requiring patient consent. The physician is ultimately responsible for the decision to provide, withhold or withdraw supplemental nutrition to an adult patient lacking mental capacity (in the absence of an advance directive or person with medical power of attorney). Family members and the patient next-of-kin should be consulted (or an Independent Mental Capacity Advocate (IMCA) if none available), but generally do not have formal decision-making responsibility (Lennard-Jones, 2000). Ethical considerations regarding adjunctive feeding in anorexia are described in a Royal College of Physicians report published in 2010 (Royal College of Physicians, 2010). Feeding should never be withheld unless it is deemed futile by the clinical team. Adjunctive feeding can be provided for patients being treated for anorexia nervosa against their will.

Appropriate procedure?

The enteral feeding method should match the patient's needs. Nasogastric tube (NGT) feeding should be used when the anticipated duration required is less than 3 weeks (Löser, 2005), with nasojejunal tube (NJT) feeding in those at risk from aspiration. A jejunal extension tube (JET) can be fitted to PEG tubes if aspiration of gastric contents has been demonstrated or suspected, although this may not be preventative.

Appropriate preparation?
Box 2 summarises a number of practical considerations that are helpful in optimising outcomes of PEG placement. In particular:

- Blood tests taken within the previous 5 days need exclude coagulopathy in patients at risk of bleeding (aim for INR <1.5), thrombocytopaenia (aim for platelet count >50-80 $x10^9$/L), and significant anaemia (aim for haemoglobin >100 g/L) (Löser, 2005).
- Stop drugs that interfere with coagulation. Warfarin should be held for 5 days prior to PEG insertion (with demonstration of INR normalisation), dabigatran or rivaroxaban for 3 days, and apixaban for 2 days (Scaglione, 2013). High risk patients can be bridged with low molecular weight heparin (LMWH), which should be stopped 24 hours prior to the procedure. Prophylactic dose LMWH and low dose aspirin can be continued. Clopidogrel should be held for 7 days in patients at low risk of thrombosis, but first discuss with a cardiologist in high-risk patients (e.g. recent coronary artery stents).
- MRSA-colonised patients should have topical suppression therapy prior to PEG placement.
- Treat overt sepsis prior to PEG insertion.
- Ensure patient nil by mouth for at least 8 hours before procedure, but essential medication should be given (e.g. anti-Parkinson's therapy or anticonvulsants).
- PEG should be performed in the morning, so that immediate complications can be recognised within working hours.
- Periprocedural IV antibiotics (e.g. ceftriaxone) should be administered.
- Medical and nursing staff should adhere to post-procedure advice.

Complications of PEG

The PEG procedure has been quoted as having a 30-day mortality rate of between 10% and 29% (O'Toole, 2006), mostly related to underlying co-morbidity such as advanced dementia (Abuksis, 2000). Mortality rates associated directly with the procedure are considerably lower (0.7-2%). Major complications occur after about 3% of procedures, whereas minor complications occur in over 20%. Rates are similar regardless of the PEG technique used (O'Toole, 2006). They are more common in the context of malignant disease, severe malnutrition, extreme old age, diabetes and hypoalbuminaemia. Complications associated with PEG are shown in Table 2.

Immediate complications

Haemorrhage
Blood loss can prove fatal following PEG insertion. If due to vessel damage, it may respond to tightening the intra-gastric flange against the skin. If haemodynamic instability persists, interventional angiography or surgery may be necessary.

Recommendations:
Correct coagulopathy prior to PEG insertion (Veitch, 2009). Endoscopists must have adequate training to minimise the number of passes made with the trochar at the time of PEG insertion.

Peritonitis
Peritonitis can occur either immediately following the procedure, or soon after feeding commences. It typically presents with fever, abdominal pain and leukocytosis.

Recommendations:
Peritonitis occurring before feeding has commenced, or following colonic perforation, requires exploratory laparotomy (Westaby, 2010). Peritonitis, without colonic perforation as confirmed by CT scan, can be managed conservatively with IV antibiotics; withhold PEG feeding until clinically resolved.

Bowel perforation
This usually occurs following catheter protrusion through an anterior transverse colon. It may present acutely with abdominal pain, bowel obstruction or peritonitis. More often, however, it manifests following tube replacement with undigested feed passing per rectum or faecal material refluxing through the PEG, when the tip of the feeding tube lies in the colon. Ultrasound or CT are diagnostic. It is important to note that sub-diaphragmatic air (pneumo-peritoneum) is present after approximately 20% of PEG placements; this does not indicate perforation nor does it require intervention (Wiesen, 2006).

Recommendations:
Peritonitis following bowel perforation mandates emergency laparotomy. Otherwise, the PEG tube should not be used nor removed. Provide broad-spectrum antibiotics for 4 weeks, by which time the fistula tract will have formed and the tube can be retracted. The aberrant fistulous tract will then gradually close.

Delayed complications

Dislodgment
Patients may attend the Emergency Department reporting that their PEG tube has fallen out.

Recommendations:
The tract closes within 12-24 hours, so without delay pass a new, balloon-stabilised enteral tube or a low profile "button" (Rosenberger et al, 2011). If delay is likely, patency of an established tract can be maintained by passing an appropriately sized catheter; a 12 French Foley catheter often used, however a balloon gastrostomy tube is preferable if available. However, this should not be done if the PEG was created within the past month; instead a separately sited endoscopic or radiologic inserted gastrostomy (RIG) should be placed, followed by radiological exclusion of an ongoing leak before feeding commences. Try to avoid traction-removable tubes if dislodgement is recurrent.

Catheter occlusion
Over time, many PEG tubes become blocked due to the incorrect administration of medication or inappropriate flushing.

Recommendations:
Ensure that the tube is flushed with warm water following administration of feed or medication (Scott and Bowling, 2015). Do not use saline as there is a risk of crystallisation, nor wires or needles. Blocked tubes can be vigorously flushed with warm water, and alkalinized enzymes may help (e.g. Creon granules, completely dissolved in alkaline water made using alkaline drops available over-the-counter). Tubes can be used immediately once patent. Discuss with pharmacy whether any medications are incompatible with PEG administration.

Leakage
This is often due to excessive lateral tube motion or over-tight fixation of the PEG to the skin surface, causing pressure necrosis.

Recommendations:
Exclude distal intestinal obstruction and treat any cutaneous infection. Wider bore catheters usually still leak; often the PEG tube needs to be re-sited, having removed the original PEG a few days earlier.

Cellulitis and granulation tissue
Peristomal cellulitis used to be common in the week following PEG, occurring in approximately 15%. This has been reduced to about 3% with the use of peri-procedural antibiotics (Ahmad, 2003). It presents with localised erythema and tenderness. Systemic upset is rare and antibiotics may not be required. Infections are most commonly due to *Staphylococcus aureus* or β-haemolytic streptococci. *Candida* super-infection may also occur. Granulation tissue can occur at the skin surface, and become infected or bleed.

Recommendations:
Treatment involves regular antiseptic wound cleaning, sometimes supplemented by antibiotic therapy (refer to local guidelines for treatment of skin and soft tissue infections) (O'Toole, 2006). The PEG may need to be removed and infection treated before a new tube is sited. Granulation tissue can be treated surgically or by local application of silver nitrate.

Diarrhoea
This is usually due to intolerance to the feed (Scott, 2015). Very rarely, it may be caused by a gastrocolic fistula, which can be asymptomatic for months.

Recommendations:
Initially, try reduced osmolarity or low fibre feeds. Small doses of loperamide may also be helpful. A gastrocolic fistula is diagnosed by ultrasound or CT scan and can be managed by re-siting the PEG, as the residual track closes within days. This may require laparoscopic replacement if colonic interposition is present; this approach also allows excision of any residual fistula (Stroud, 2003).

Obstruction

Gastric outlet obstruction can occur if the internal flange lodges in the pylorus or duodenum, most frequently after replacement when PEG traction is not required. This presents with reflux of stomach contents adjacent to the PEG.

Recommendations:
Diagnosis is usually based on clinical symptoms and signs. Management involves partially withdrawing the tube and reaffixing it, usually with the 4 cm marker at the skin surface. Gastroparesis is an alternative diagnosis.

Buried bumper
This rare, but now well-recognised, complication arises when gastric mucosa overgrows the internal flange, and then occludes the tube lumen (Lee and Lin, 2008). Patients often complain of abdominal pain during feeding. This is believed to occur following excessive tension between the inner and outer bolsters.

Recommendations:
Endoscopic examination usually allows the bumper to be released using a needle knife sphincterotome; the PEG tube should then be replaced. It can be prevented by loosening the external fixation device to allow 10 mm "free play" the day following PEG placement, and thereafter rotating the tube every few days.

Reflux and aspiration
This is common following long-term PEG feeding, particularly in patients with delayed gastric emptying. Pulmonary aspiration should be suspected if acidic feed can be aspirated from the mouth or in the context of chest infections.

Recommendations:
Avoid medication that predispose to constipation or delayed gastric emptying, such as opioids or drugs with anticholinergic effects. Correct any electrolyte disturbances, reduce the rate of feed, avoid feeding the patient when supine, and prescribe prokinetics (e.g. metoclopramide) (O'Toole, 2006). A JET can be used but often will kink or revert into the stomach, in which case a surgically-placed jejunostomy or a PEJ should be considered.

Cosmetic
PEG tubes, particularly in younger patients, can be socially inhibiting.

Recommendations:
A button system can be placed once a fistulous tract is formed (> 4 weeks), although this must be routinely replaced every 6 months (Löser, 2005). There is no need to routinely change standard PEG tubes, and some have stayed in situ for over 10 years.

Conclusions
This article has highlighted the common adverse events associated with PEG tubes, as well as techniques to avoid and overcome them. Further information can be obtained from society guidelines (Westaby, 2010) or specialist texts (Marks and Harbord, 2013). Patient selection and preparation prior to the procedure is paramount to mitigate the appreciable risk of complications. The PEG procedure requires senior endoscopist input, and should be undertaken within the context of input from both

hospital and community nutrition teams. Multi-professional support is crucial to prevent, detect and manage early and late complications.

Key points

1. Avoiding inappropriate patient selection is key to reducing risk of mortality (1:150) and serious morbidity (1:30).
2. Careful preparation prior to PEG insertion minimizes complications.
3. PEG should be performed in the morning, by an experienced team.
4. Access to hospital and community multi-professional team members should be anticipated.
5. Most PEG complications can be easily resolved in expert hands.

Top tips

1. Patients with advanced dementia need very careful consideration and discussion prior to proceeding to PEG.
2. Pneumonia causes the majority of early deaths after PEG placement. Early recognition and treatment is key.
3. Flush PEGs with warm water after each administration of food or medication to maintain patency. Do not use saline.
4. Peristomal infection may respond simply to local wound clearing. If moderate or severe, or associated with systemic upset, prescribe antibiotics according to local guidelines.
5. If a PEG becomes dislodged, replace it within 12 hours otherwise the track will close. Foley catheters can be used as a temporizing measure should there be any delay. PEGs that have been *in situ* for less than 1 month will likely need to be re-sited.
6. In patients with recurrent aspiration despite PEG insertion, useful measures include: stopping drugs that impede gastric emptying; reducing the rate of feed administration; avoid feeding while supine; administering prokinetics; and attaching a PEJ extension.

Table 1. Indication for PEG: Adapted from (Stroud, 2003)

Indications	**Example**
Selected cognitive impairment	Head injury, stroke, dementia in carefully selected cases
Neurologically unsafe swallow	Stroke, multiple sclerosis, motor neurone disease, Parkinson's disease, cerebral palsy
Mechanical disorders of swallowing	Oropharyngeal and oesophageal malignancy or strictures, facial injury requiring reconstructive surgery with prolonged recovery
Partial failure of intestinal function, where nutritional requirements cannot be met by oral intake alone	Short bowel syndrome, fistulae, cystic fibrosis, Crohn's disease, palliative drainage of gastric secretions in presence of chronic GI stenosis/ileus

Box 1. Contraindications to PEG: Adapted from (Löser, 2005)

Serious coagulation disorders (INR >1.4, platelets <50-80 $x10^9$/L)
Interposed organs (e.g. liver, colon)
Marked peritoneal carcinomatosis
Severe ascites
Peritonitis
Planned oesophagectomy
Severe psychosis
Limited life expectancy
End-stage dementia (unless multidisciplinary agreement procedure in patient best interests)

Prior abdominal surgery is not a contraindication, but is associated with a higher risk of colonic perforation. Intra-abdominal varices constitute a relative contraindication.

Box 2. Avoiding complications: Adapted from (Löser, 2005)

Prior to procedure
Optimise nutritional state
Treat intercurrent sepsis
Normalise haemoglobin, platelets and coagulation parameters
Obtain informed consent
Fast for at least 8 hours (except for essential tablets)
Peri-procedural antibiotic prophylaxis

Subsequent to procedure
Maintain low tension traction on external fixation plate for 24 hours
Loosen external fixation device to 1 cm from the skin surface after 24 hours
Rotate feeding tube 360° weekly (unless jejunal extension tube in situ)
Clean tube and renew dressings, initially daily
Nutrients can be administered 4 hours after uncomplicated tube placement
Ensure multi-professional support via nutrition team

Table 2. PEG, early complications

Complication	Prevention	Management
Early Complications		
Post-procedural pneumonia	Treat sepsis prior to PEG placement. Optimise mouth care. RIG if ventilatory impairment. Avoid throat analgesia and excess sedation during insertion; use liberal oral suction	Early identification and antibiotic therapy
Bleeding	Delay PEG if coagulopathy	Apply traction to internal bumper. Consider surgery.
Early peristomal infection	Optimal wound care. Avoid excessive tightening of external fixator	Local antisepsis ± systemic antibiotic therapy
Peritonitis	Experienced endoscopist to place PEG	Exploratory laparotomy if occurs prior to feed, or if radiology demonstrates displaced bumper or leakage into peritoneal cavity. Otherwise conservative management with antibiotics
Displacement (early)	Ensure traction maintained on internal bumper for 4 weeks after PEG, allowing 10 mm "play".	Consider replacement under radiologic guidance if within 2-4 weeks of initial placement.

Table 3. PEG, late complications

Late Complications		
Aspiration pneumonia	JET unless impaired airway protection. Remain at least semi-recumbent for 60 min post feed. Avoid bolus feeding. Prevent/treat delayed gastric emptying. Avoid constipation	Antibiotic therapy
Displacement (late)	Avoid traction-removal PEG tubes in confused patients. Check traction-removal PEG internal balloon	Replace balloon-retained or low-profile PEG within 24 h

	weekly	
Leakage and peristomal infection	Prevent excessive lateral movement (maintain external fixator at no more than 1 cm)	Air dry skin and use barrier cream. Consider antibiosis. Proton pump inhibitor + prokinetics. Consider tube removal for ≈ 1 day. Resite PEG.
Stoma granulation	Optimal wound care	Steroid/antibiotic ointment. Silver nitrate or argon plasma cautery
Buried bumper	Rotate feeding tube 360˚ weekly (unless JET). Avoid over-tightening external fixator	Endoscopic release then PEG replacement. JET tube to maintain nutrition if bumper cannot be removed
Colo-cutaneous fistula	Experienced endoscopist	Resite PEG if mature fistulous tract
Metastasis from oro-pharyngeal or oesophageal malignancy	PEG placement using direct puncture technique; or place RIG	Oncology advice
Tube blockage	Careful flushing after feed/medication	Warm water flush. Alkaline pancreatic enzyme flush. Avoid saline flush. Fluoroscopic guidewire

JET, jejunal extension tube; PEG, percutaneous endoscopic gastrostomy; RIG, radiologic inserted gastrostomy.

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