

ESPGHAN Position Paper on Management of Percutaneous Endoscopic Gastrostomy in Children and Adolescents

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ABSTRACT

Objectives: This European Society for Pediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) position statement provides a comprehensive guide for health care providers to manage percutaneous endoscopic gastrostomy tubes in a safe, effective, and appropriate way.

Methods: Relevant literature from searches of PubMed, CINAHL, and recent guidelines was reviewed. In the absence of evidence, recommendations reflect the expert opinion of the authors. Final consensus was obtained by multiple e-mail exchange and during 3 face-to-face meetings of the gastroenterology committee of the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition.

Results: Endoscopically placed gastrostomy devices are essential in the management of children with feeding and nutritional problems. The article focuses on practical issues such as indications and contraindications.

Conclusions: The decision to place an endoscopic gastrostomy has to be made by an appropriate multidisciplinary team, which then provides active follow-up and care for the child and the device.

Key Words: adolescent, child, complications, endoscopy, gastrostomy, indications, percutaneous endoscopic gastrostomy

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The aim of this European Society for Pediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) position statement is to provide a comprehensive guide for health care staff on the safe, effective, and appropriate use of percutaneous endoscopic gastrostomy (PEG) tubes in children and young adults. This article focuses only on endoscopically placed gastrostomy tubes, with no detail provided on other intragastric (eg, surgically or radiologically placed) and postpyloric feeding tubes.

Furthermore, this document does not provide details of the nutritional support and expertise required to feed via a gastrostomy, but focuses on aspects relevant to the indications for, and immediate use of, a PEG tube. There are several excellent guidelines available on the use of enteral nutrition in children (1), with new ones presently being developed by the nutrition committee of ESPGHAN. It is mandatory for children requiring a PEG tube for nutritional supplementation to be assessed and monitored by appropriately trained allied health care professionals (eg, dietitians, nutrition nurse specialists, and speech and language therapists). The placement of such a device has implications for all aspects of a child's feeding. **Although it may serve to optimise nutritional support, the siting of a PEG should not mean oral feeding can be neglected and that the ultimate goal of returning to normal oral intake is abandoned. Weaning from enteral feeding can be particularly difficult in certain circumstances. If PEG feeds are started in the neonatal period or early infancy, or they are prolonged owing to feeding difficulties, then measures to stimulate or maintain oral feeding skills wherever possible, along with proactive psychological and speech therapy support, should be provided (2).**

The management of a child who needs a PEG should begin well before the insertion of the feeding tube and should involve a **multidisciplinary team of health care providers who are familiar with, and have access to, a range of alternative strategies to the insertion of a feeding tube. These may include feed or regimen changes, specific feeding therapy, speech and swallow assessments, and access to psychological support.** Although there may be situations in which a PEG may be required without trial of nasogastric tube (NGT), in most cases the team should

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ensure that alternatives are fully explored before resorting to insertion of a PEG. The ideal multidisciplinary team to manage this includes a paediatric gastroenterologist/surgeon, psychologist, dietician, play therapist, nutrition nurse, and speech and language therapist. Adequate preparation and planning, including discussion of ethical issues, reduces unexpected morbidity and ensures all parties have a clear understanding of the indication and rationale for such an intervention. In addition, ongoing and future strategies to increase oral and wean off PEG feeding should be discussed and planned for.

METHODOLOGY

In response to the request for practical guidance in this area, the ESPGHAN gastroenterology committee agreed on an outline and the scope of the position paper.

Literature reviews were carried out on PubMed using MESH terms “child, gastrostomy, enteral feeding, PEG, endoscopic gastrostomy,” while international guideline registries were searched for both adult and paediatric publications in this area. References in these documents were also searched to ensure acquisition of relevant source data. In the absence of evidence we relied on the expert of opinion and personal practice of the authors. The authors also had access to recently published book chapters prepared by one of the authors (3).

SUMMARY STATEMENTS

Indications

Nutritional support via gastrostomy is indicated in children requiring prolonged enteral tube feeding. The decision to insert a PEG should be taken by a multidisciplinary team, who should consider medical, ethical, psychological, and quality-of-life issues. Gastrostomy feeding is effective at reversing malnutrition and maintaining nutritional status.

Contraindications

There are few circumstances in which an expert operator cannot safely insert a PEG—on occasion this may require laparoscopic support.

Assessment of GERD Before PEG Insertion

PEG insertion does not cause gastroesophageal reflux (GER). There is no evidence that routine assessment of gastrointestinal (GI) anatomy or physiology is necessary before PEG insertion. Children with uncontrolled gastroesophageal reflux disease (GERD) who are also being considered for an antireflux procedure may require investigation.

PEG Insertion

An experienced team must carry out the PEG insertion. A paediatric surgeon must be available in case of complications.

Prevention of Complications

Antibiotics given at the time of the PEG insertion reduce postoperative infection rates. Accidental PEG removal requires urgent reinsertion of a tube to maintain track patency.

After Care and Removal

Family and caregivers should be trained how to use and manage the inserted device before discharge from hospital. PEGs should not be removed within 8 weeks of insertion to avoid

disruption of the track. They must be removed in the recommended manner and not allowed to pass through the GI tract.

BACKGROUND

Rationale and History Behind PEG

A gastrostomy tube is an artificial device placed into an opening made through the abdominal wall and into the stomach lumen. There has long been a need to provide safe intragastric nutritional support, whether this is to supplement inadequate oral intake, bypass an obstruction, vent the stomach, or avoid the risks of aspiration owing to an unsafe swallow. Until 1980 all permanent intragastric feeding tubes were sited surgically at laparotomy. Following the publication by Gauderer et al (4), it has become widely accepted that endoscopic siting of such tubes is less invasive, more rapid, creates less incisional pain, and reduces length of stay and procedure costs—as well as being at least as safe as the surgical approach. This meant that prolonged use of nasogastric (or orogastric) feeding tubes was no longer necessary, particularly in those children who had previously not been medically fit for more major abdominal surgery.

PEG Versus Alternative Enteral Tubes

Only in cases of severe GERD or gastroparesis and gastric outflow obstruction is there a need to position a tube across the pylorus. Any additional clinical benefit is realised only if the tip of a feeding tube is sited beyond the ligament of Treitz in the jejunum, from where reflux of feed into the stomach or oesophagus is unlikely. Nasojejunal feeding may be used as a short- to medium-term solution for children with severe GERD or profound gastroparesis. Gastrojejunal feeding tubes or a surgical jejunostomy is an alternative. In all jejunally delivered feeds a more continuous delivery of nutrition is mostly required, as larger bolus feeds are nonphysiological and poorly tolerated (5).

The literature on gastrically placed tubes in adults suggests that each of 3 different routes of tube placement (ie, radiological guidance, open surgery, endoscopic placement) benefit the patient without significant differences in morbidity. Economically, the overall costs of PEG placement appear similar to those of a radiologically placed gastrostomy, whereas both are cheaper than surgical placement by laparotomy (6). The PEG itself has been shown to be cost-effective for the overall health care economy in children with neurodisability (7).

The experience in paediatrics suggests that laparoscopically assisted PEG placement has a role to play in certain children (8); however, this approach is not necessary for the routine placement of a PEG.

EVIDENCE OF BENEFIT

In addition to the specific complications of a PEG discussed below, there are other disadvantages of a PEG over an NGT. The additional expertise and infrastructure required to insert a PEG (or reinsert it when displaced) in a child are not available in all centres, and hence a longer-term NGT may be a safer option. In almost all cases a general anaesthetic will be required, which can pose significant risks for children with complex underlying medical issues. Carefully selected older children/young adults may, however, have a PEG inserted under conscious sedation, as is more common in adult practice. Rarely, there may be an unforeseen effect on a young person's body image, with the presence of a more permanent feeding device occasionally requiring psychological support to come to terms with such a change. The aim should always be to appropriately prepare a child/young person for such an eventuality well in advance of PEG insertion; however, there remain significant potential benefits of a PEG over an NGT in children (Table 1) (9–13).

Indications

The clinical value of a PEG depends on the indications for insertion. In the majority of cases the indications are nutritional, and hence the clinical benefit is easily measurable in terms of nutritional restitution (14). It has now been demonstrated in many paediatric subspecialties that nutritional support via gastrostomy is effective for children with chronic disease (15–17). The nutritional management of children with additional nutritional demands has, therefore, significantly improved. Children with chronic cardiac disease, chronic renal failure, and chronic inflammatory conditions (eg, cystic fibrosis and Crohn's disease) have all been shown to effectively use the additional nutrition provided by gastrostomy (18–20) (Table 2).

When first considering the placing of a PEG in a child, certain factors specific to the child must be considered. Only once factors such as weight, size, degree of scoliosis, previous abdominal surgery (eg, ventriculoperitoneal [VP] shunt) are considered, should an endoscopic gastrostomy insertion be scheduled with confidence. Moreover, this should be carried out by a team who are experienced in carrying out the procedure in children. Both paediatric gastroenterologists and surgeons may perform the procedure, the choice depending on locally available expertise. In all cases there should be a paediatric surgeon available to deal with complications, or in case a procedure needs conversion to a laparoscopic/open gastrostomy.

The final decision to insert a PEG should take into account a number of factors in addition to the purely medical need. These may include ethical, psychological, and quality-of-life issues (Fig. 1).

All these aspects should be addressed to ensure a successful PEG placement in a child. The timing of PEG insertion in an individual child depends on a number of factors. A PEG should only rarely need insertion as an "emergency." Alternative feeding strategies should be used until a considered and informed decision can be made as described above. In the United Kingdom it is accepted by the National Institute of Clinical Effectiveness that the expectation of continuous NGT use for a minimum of 4 weeks (www.nice.org.uk/CG032), or even 2 to 3 weeks (21), should prompt consideration for PEG insertion. These times are only advisory, as individual progress can vary widely for similar indications, for example, repeated NGT insertions in an infant of age <12 months can contribute significantly to oral aversion. This makes early PEG placement advisable if there is limited improvement in oral intake, whereas minimal tube dislodgement and improving oral skills in the same infant may warrant delaying the move to PEG insertion. It is important that PEG insertion remains an individualised process and that there should be no algorithms that seek to overly "standardise"

TABLE 1. Potential benefits of a PEG versus NGT

Less tube displacement/reinsertion
Reduced risk of aspiration
Better cosmetic appearance
Safer, more reliable enteral access
Optimises development of oral skills
Larger diameter, shorter tube length—less blockage
Cost-effective longer-term solution
Less interference in daily activities/better quality of life (9)
Avoids nasal irritation/congestion/septal trauma (10)
Reduced anxiety at mealtimes, shorter feeding times (11–13)
Reduces ENT complications

ENT = ear, nose and throat; NGT = nasogastric tube; PEG = percutaneous endoscopic gastrostomy.

the rate of this important decision-making process. Each case must be considered on individual merits.

Contraindications

Relative Contraindications

Although difficult to quantify, the presence of active gastritis or peptic ulcer disease may increase complications from post-operative bleeding and perforation. Ideally, these should be identified early and adequately treated before PEG insertion. It is clear that a PEG should not be inserted near/through an ulcerated anterior gastric wall. Any coagulation or bleeding disorder should be corrected before PEG insertion; it should be noted that previous abdominal surgery may have caused adhesions and led to changes in position of intra-abdominal organs.

Similarly, a prior suspicion of gastric varices allows adequate preparation and planning of the procedure should significant bleeding occur during tube insertion. Portal hypertension is frequently considered an absolute contraindication for PEG placement, as the PEG constitutes a de novo portosystemic shunt and severe peristomal varices can develop. In addition to the potentially causing severe and intractable bleeding, these could become a major obstacle for future liver transplantation. Saying that, there is limited evidence of such scenarios being published in the literature. The only small paediatric series from Duche et al (22) described the uncomplicated insertion of PEG in 5 children. Four of them had Alagille syndrome in whom portal hypertension rarely occurred, whereas other studies confirm the feasibility of PEG insertion in this scenario, even though with careful preparation and adequate expertise being mandatory requirements (23). In addition, it is widely accepted that children with cystic fibrosis (CF) who need longer-term nutritional supplementation clearly benefit from PEG insertion despite the potential long-term risks of portal hypertension (20).

Caution should also be exercised with any degree of ascites, although moderate degrees of ascites still allow safe PEG placement (24). Endoscopic PEG placement in presence of massive ascites should be decided on a case-by-case basis, but may still be possible with adequate preparation and sufficient endoscopic/surgical expertise. The presence of a VP shunt rarely causes difficulties for PEG insertion, although laparoscopic assistance may be helpful (25–27).

Children with significant neuromuscular/neurodevelopmental disorders may present with moderate-to-severe kyphoscolioses. This may again alter the position of intra-abdominal organs or potentially cause partial/complete intrathoracic positioning of the stomach. In this group of children a contrast study of the upper GI tract, or an endoscopy before PEG placement, may be helpful—particularly in children with more severe spinal deformity. Inter-costal PEG insertions in children have been reported (28).

In children with renal failure wherein peritoneal dialysis is required, the preference would be for use of an NGT; however, if longer-term gastric access is required, PEG placement should

TABLE 2. Clinical indications for a PEG

Optimise nutritional status and growth
Preempt undernutrition (eg, chemotherapy/radiotherapy and transplant)
Maintain hydration
Support unpalatable diet (eg, metabolic disease, exclusive enteral nutrition)
Decompress gastric stasis
Improve adherence to medication
Ensure safe feeding access/prevent aspiration
Improve quality of life for child and caregivers

PEG = percutaneous endoscopic gastrostomy.

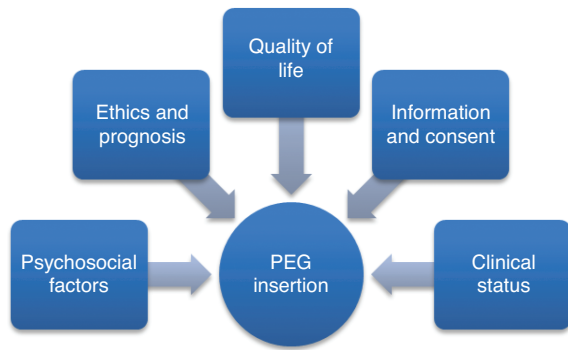


FIGURE 1. Factors to consider before PEG insertion.

preferably be considered several weeks in advance of commencing this type of dialysis. This is to allow adequate healing of the track and firm attachment of the stomach to the abdominal wall. Placement of a PEG during peritoneal dialysis has been associated with additional complications and should be laparoscopically assisted to allow suturing of the stomach to the abdominal wall (29,30). Both microgastria and a large hiatus hernia are also relative contraindications. Severe psychosis and possibly anorexia nervosa (31), along with a clearly limited life expectancy, should all prompt discussion and careful consideration as to whether this procedure should be contraindicated or is truly in the best interests of the patient.

In addition to factors identified before the procedure, a relative contraindication is the lack of direct indentation on endoscopic views or clear identification by transillumination of the stomach wall during the actual procedure. This may reflect the interposition of inflated small bowel, colon, or other intra-abdominal organs between the stomach and abdominal wall. Although the risk of perforation and peritonitis is then increased, experienced endoscopists/paediatric surgeons may still safely manage to insert a PEG.

Absolute Contraindications to PEG

Absolute contraindications are extremely rare, but given the alternative surgical approaches available, the risk of blind endoscopic insertion is not always required (Table 3).

LEGAL AND ETHICAL ISSUES

There are likely to be several clinical scenarios in which the maintenance of a fine-bore NGT is preferable to PEG insertion. This is particularly likely when nutritional/physiological requirements are already met by an NGT, and there is no clear further benefit to a patient's quality of life (32). A careful analysis of the risks and benefits between the team and family is required. Parents may need additional time to meet other families using a gastrostomy and/or to

digest fully the implications of a gastrostomy. Education by specialist nurses may help the family and child familiarise themselves with the various devices and obtain a clearer understanding of longer-term care before PEG insertion. It can be valuable for smooth postoperative care and management if children are prepared for the gastrostomy by appropriately trained play therapists. At first the concept of putting a "tube directly into the stomach" can be a shock for a child, as well as the parents of a severely ill child. Many parents are already burdened by the underlying disease of their child and feel that this procedure represents an unnecessary additional insult. Therefore, the physician proposing the procedure may face initial resistance when trying to obtain consent.

As a result, the date for gastrostomy insertion may need to be delayed for all parties to feel comfortable with the procedure. Only in exceptional circumstances should a gastrostomy require urgent or emergency insertion, as less-invasive, temporary alternatives are almost always feasible.

European countries differ in who should provide informed consent for PEG insertion. This, however, should always be obtained from at least 1 caregiver with appropriate parental responsibility. In the older child, who is able to understand the reasons for PEG placement and the associated risks, it is the child who can provide informed consent. If this is not done, then a discussion about risks and benefits of the procedure should be documented in the patient's medical records. Age-appropriate information should be made available. Time to read and understand this written information is required, as well as sufficient opportunity to discuss the procedure in detail.

PRACTICAL CONSIDERATIONS

Examination, Investigation, and Preparation

Having taken a detailed history and made the decision to proceed to PEG insertion, the patient should undergo a full external physical examination. This should be focused on the detection of complicating factors during the procedure. All those factors listed under relative and absolute contraindications should be sought in the examination—including signs of previous abdominal surgery, the degree of any musculoskeletal abnormalities and their impact on spinal deformity, and the presence of any organomegaly and ascites. Once the physical examination is complete, specific investigations may be necessary.

Assessment of GERD Before PEG Insertion

The concerns that PEG placement can induce GER in children are misplaced (33–35). Given that many devices are placed in children with potential or documented significant GERD (ie, CF, neurologically impaired children), caution is, however, needed to minimise the risks of postoperative reflux in children who are already at higher risk for aspiration. Significant preexisting reflux (eg, persistent vomiting, erosive esophagitis) or reflux in the presence of an unsafe swallow, chronic respiratory disease (eg, CF requiring lung transplant), or progressive neurological deterioration should prompt discussion around the need for a surgical antireflux procedure, at which time a gastrostomy should also be inserted.

There is no systematic requirement for a prophylactic fundoplication if a PEG placement is required in a child with clinical reflux, as this has only shown to be indicated in situations of erosive oesophagitis (36); however, a detailed evaluation of the clinical history and associated symptoms provides valuable guidance in determining the significance and the importance of GER disease. In all cases, patients should be evaluated at least clinically to determine the presence of GERD and its importance before PEG

TABLE 3. Absolute contraindications to PEG insertion

Uncorrectable coagulopathy (INR > 1.5, Quick Test < 50%, PTT > 50 s, platelet count < 50,000/mm ³)
Clear interposition of enlarged organs (eg, liver, colon)
Frank peritonitis

INR = international normalization ratio; PEG = percutaneous endoscopic gastrostomy; PTT = partial thromboplastin time.

placement. Evidence that oesophageal impedance \pm pH-metry before PEG will predict later problems with GER is limited (34,37–39). Esophagoscopy concomitant to PEG may help to assess the presence of esophagitis, but its predictive value on GERD outcome has not been evaluated. In usual care, asymptomatic children do not require investigation for GERD before PEG insertion.

The authors do not recommend the routine assessment of coagulation status in children with no other risk factors. Children with liver disease, malabsorption, severe malnutrition, or those who are on immunosuppression may, however, have an increased risk of coagulopathy, and therefore would warrant screening. If spinal deformity or clinical history suggest abnormal anatomic positioning of the stomach/intestine in the abdomen, a contrast radiological study may be helpful. The use of a routine preoperative upper GI contrast study is NOT advised to rule out malrotation.

Depending on the clinical scenario and the indications for PEG insertion, prior investigation with upper endoscopy to rule out erosive oesophagitis, gastritis, or peptic ulcer disease may be advisable. There is no evidence to support an additional routine upper endoscopy on all of the children before PEG.

Antibiotic prophylaxis (eg, one of the most commonly used regimens is a single, preoperative dose of broad-spectrum cephalosporin) for the classic “pull technique” PEG insertion does reduce the incidence of wound infection and postoperative inflammatory complications in adults, and hence is almost universally recommended; however, when using the “push technique” of PEG insertion or the new “introducer” PEG gastrostomy (40), the infection rate appears low indeed and prophylactic antibiotics have not been shown to further reduce infection in adults. Low weight should not be considered as a limiting factor. PEG is now widely used in children of all ages, including neonates weighing as little as 2.5 kg (41,42).

TECHNIQUES

Pull Technique: Seldinger/Gauderer

PEG placement should be carried out in an operating room environment by appropriately trained staff. The procedure is normally carried out under general anaesthesia and usually takes approximately 15 minutes. PEG placement is carried out by a team of 2 operators: an endoscopist together with an appropriately trained assistant, who is responsible for skin puncture and insertion of the guide wire.

Various PEG placement kits are available. They typically contain a gastrostomy tube with internal and external retaining devices, a skin trocar, a guide wire, and a plug adaptor for the tube. Gastrostomy tubes are made from polyurethane or silicone rubber. These relatively inert materials are well tolerated. They are available in a range of sizes from French Gauge 9 to 24, with sizes 12 to 15 being suitable for most of the children. Some form of tube-retaining device is required both internally and externally to prevent the tube from either falling out or sliding back into the stomach.

The patient is placed in the supine position, and the anterior abdominal wall is cleaned using an appropriate operative skin disinfection protocol. An endoscopic examination of the oesophagus and stomach is then performed. The duodenum is not examined so as to minimise intestinal air distension. Intestinal distension tends to displace the stomach upward under the rib cage, making percutaneous gastric puncture more difficult. The stomach is inflated however, so as to bring the anterior gastric wall in close contact with the abdominal wall, and this helps to displace other organs such as the colon away from the gastrostomy site.

The endoscopist's assistant now identifies the correct skin puncture site. The intention is to enter the stomach close to the

junction of the gastric antrum and body. The site is located by using endoscopic transillumination—a bright point of light should be seen on the abdominal wall. If a clear point of transillumination cannot be identified, the assistant should not proceed with the puncture. This difficulty strongly suggests either that the stomach is displaced up beneath the ribs or that the colon lies interposed between the stomach and the abdominal wall. The assistant applies digital compression at the proposed insertion site, and the endoscopist confirms that this is a suitable entry point in the stomach. The correct insertion point is usually mid-way between the umbilicus and the junction of the costal margin and left mid-clavicular line. Some operators may first insert a needle so that the endoscopist can confirm the correct location. The assistant now performs the puncture by holding the trocar perpendicular to the abdominal wall and pushing it through into the inflated stomach. The endoscopist confirms entry of the trocar and its overlying plastic sheath.

The trocar is withdrawn while leaving the sheath in situ to provide a secure track for the guide wire. The guide wire is passed through the plastic sheath, the endoscopist grasps it with the forceps, and the sheath is then withdrawn as the guide wire is slowly drawn into the stomach. The entire assembly including endoscope, forceps, and guide wire is then withdrawn. The guide wire now passes through the abdominal puncture, into the stomach and out through the mouth. The proximal end of the guide wire is tied to a loop on the end of the gastrostomy tube. The distal end of the guide wire is gently pulled, drawing the tube and its internal bolster through the mouth, down the oesophagus, into the stomach and out through the puncture site, until the internal retaining device comes to lie on the anterior gastric wall. Sometimes it is necessary to make a small incision at the puncture site to facilitate passage of the gastrostomy tube out through the skin.

The distal end of the tube, still attached to the guide wire, is now cut off. An outer retaining device such as a disk is passed over the external tube, and this holds the tube at the abdominal wall so that it cannot slip back into the stomach. It is important to ensure that this external retaining device is not so loose as to be ineffective, or so tight as to cause pressure damage. Local anaesthetic may be injected around the incision point to reduce postoperative discomfort.

The tube is now cut to the desired length and the adaptor plug is inserted. A small amount of iodinated disinfectant may be applied to the external retaining device. A dry dressing is applied to the site for removal after 24 to 48 hours. Finally, the endoscope should be reinserted to confirm that the inner retaining device is positioned correctly and to ensure that there is no bleeding.

Push Techniques and the 1-Step Balloon Gastrostomy

The “introducer” PEG technique avoids the passage of the PEG catheter through the oropharynx, and thus prevents the carriage of microorganisms to the peristomal site. Despite its introduction 22 years ago, the technique has, however, not become so popular among endoscopists because of its technical difficulties and associated complications. Recently, improved introducer PEG kits using endoscopic gastrostomy were shown to be both safe and easy to perform (43,44). The introducer technique always involves a stage in which the stomach is fixed to the abdominal wall. The gastrostomy is performed under endoscopic control: the anterior gastric wall is sutured with 2 silk sutures to the abdominal wall or fastened to the abdominal wall with 3 T-fasteners inserted in a 1- to 1.5-cm triangular configuration before PEG insertion. The puncture site is identified at the centre of the gastrostomy under endoscopic guidance. First a trocar and then a guide wire is introduced into

the stomach to create the stoma track. The dilators are advanced over the guide wire and dilate the stoma track to the appropriate diameter (12–16 French, although more usually 16 French). The gastrostomy device (low-profile gastrostomy tube) is usually inserted through a plastic “peelable” sheath. The time required to carry out this procedure ranges from 15 to 30 minutes, and as for the “pull” technique, 2 operators are required: one to perform the endoscopy, and the other to carry out the gastropexy and insert the device. Improved devices (gastropexy systems and peelable dilators), reduction of wound infection rate, and the growing confidence in the technique are all likely to see a steady increase in the use of these approaches in the paediatric age group.

One major advantage of the push technique is to allow initial placement of a skin-level “low-profile” gastrostomy. This offers an advantage over a traditionally placed PEG tube because it avoids a second general anaesthetic for removal of the tube and replacement with a low-level device; however, it is slightly more technically challenging to insert. Although new devices are now available with appropriate sizes for children (14 and 16 French), the published experience in children remains limited (44). A recent series in children suggested a 1-step button is a rapid and safe technique. The technique required a 6- to 9-month learning curve (>30 cases), which then dramatically reduced the rates of complication, particularly wound infection (F. Gottrand, unpublished data).

Readjustment of PEG in First 24 Hours

Children should be admitted overnight to ensure adequate pain control and safe initiation of feeds. In the immediate post-operative period, the patient’s general condition is monitored and the abdomen is examined for signs of peritonitis or significant pneumoperitoneum. Most of the children require some analgesia during the first 2 days. For 1 week, daily aseptic cleaning of the site is recommended and a sterile dressing can be applied. Subsequently, simple washing is sufficient and a dry dressing may be placed over the outer collar. Occlusive dressings are not recommended as they increase the risk of local infection.

Laparoscopic-Assisted Percutaneous Gastrostomy

Laparoscopic assistance for PEG insertion is outside the scope of this paper, as it involves additional surgical intervention during PEG insertion. It may be a prudent choice if there are concerns about the safe insertion of the trocar into the stomach across the peritoneal space. In circumstances wherein anatomic anomalies may prevent direct puncture, or previous surgery/peritoneal sepsis may have caused significant adhesions, a planned laparoscopic-assisted PEG insertion may be a safer first approach (45–47).

Replacing the PEG With “Button” or “Balloon” Device

After a period of 2 months or more, once the gastrostomy tract has healed, the gastrostomy tube can be replaced by a more convenient device known as a “gastrostomy button” or “balloon gastrostomy.” This device lies flush with the skin on the outside and provides a more acceptable and less obtrusive way to connect an extension set and tube feeds. They consist of a shorter (0.5–4.5 cm in length) and wider (eg, 14–16 French) tube, just sufficient to traverse the fixed track, with some form of internal retaining device. Their fixed length requires measurement of the formed track before insertion of the new device. This can be done with a graduated

measuring device before selection of the correct length of device. The previous PEG track may require gentle dilatation over a guide wire to accommodate the wider button or balloon gastrostomy. The new devices are most commonly retained by an externally inflatable internal balloon or alternatively an internal self-expanding dome. When inserting the latter type of button, an obturator is pushed down into the button stretching it lengthwise, so that the dome narrows allowing passage of the device through the tract. Once the button is in place, removal of the obturator allows the dome to expand automatically, thereby holding the button securely in place. They can be inserted and removed quite easily, usually without need for sedation or general anaesthesia. When not in use they are sealed with their attached stopper. The only disadvantages are that they are more expensive than a simple gastrostomy tube, and they may need to be changed every 4 to 6 months (48,49).

FEEDING CONSIDERATIONS

Commencing Feed After PEG Insertion

Although data from adults suggest that PEG insertion can be done at the bedside followed by immediate use of the gastrostomy, there is no such published evidence in children. The paediatric literature remains cautious on how rapidly to introduce feeds, although there appears no increased risk if this is done at 4 hours (50). One author’s personal experience (F.G.) confirms in >500 PEG placements that feeding can be started within 4 to 6 hours of PEG insertion, without the need of a clear fluid test feed or additional prokinetics.

Type and Rate of Feed

Details of enteral feeding regimens used for children with a gastrostomy are also beyond the scope of this paper; hence, only a few general principles about choice of feed following gastrostomy insertion will be considered. As feeds crudely differ in the rate at which they leave the stomach this may impact on the risks of postoperative gastro-oesophageal reflux (51). There is no evidence available that suggests routine use of a clear fluid test feed or dilute or hypotonic feed improves the rate at which full feeds are tolerated. If anything, these measures simply delay the time taken to reach optimal nutrition (52).

The type of feed used post-PEG insertion will at least in part depend on whether the child was receiving preoperative nutritional supplementation by an NGT. If this was the case and the feeds were well tolerated, then rapidly increasing the rate of the same feed may be possible. It has been well demonstrated in critically ill adults that gastric residual volumes are poor predictors of aspiration risk (53).

As clear fluids have the fastest gastric emptying (54), the highest risk infants may benefit from an initial test feed, using a full target volume and rate, but given as oral rehydration solution. If this is tolerated, then the choice of feed depends on a number of factors, which include age, degree of supplementation, history of feed intolerance, severity of preexisting gastro-oesophageal reflux, and potential risks of aspiration.

Iso-osmolar feeds cause less delay in gastric emptying than hyperosmolar feeds (55). Whether or not feeds may be delivered by bolus or need initiating by continuous feeds is largely determined by the previous feeding history (56).

If a child had previously tolerated enteral feeds given by gravity via NGT in 4-hourly boluses, then this should also be possible via the PEG. In a situation wherein no nutritional supplementation has been given by NGT before PEG placement, then small gravity boluses or, in cases of higher risk of aspiration, continuous feeds could be started. Continuous intragastric feeds are not physiological and may lead to slower gastric emptying and

higher baseline pH values than bolus feeds. The latter promotes bacterial growth, which, particularly in children with significant dysmotility, may further exacerbate this clinical problem. Although excessive bolus feeds may lead to abdominal discomfort and distension, bolus feeds per se contribute to distal colonic motor suppression, and hence allow better water absorption in the ascending colon (51). If a feed is administered too rapidly via a PEG, this may, however, lead to “dumping.” This exaggerated physiological and unpleasant reaction is caused by sudden arrival of high-volume, highly refined carbohydrate in the small bowel and can lead to typical symptomatology (57).

PEG CARE

It is quite normal to experience some clear or coloured discharge from around the site for the first 7 to 10 days postplacement while the site is healing.

The site should be cleaned daily with warm soapy water; after cleaning it is essential to ensure the area is fully dry. The use of creams and powders around the tube should be avoided as this may contribute to irritation and softening of the skin, which can lead to superficial skin infection.

In addition to the observation of the site for infection, a PEG requires daily care (Table 4). One should also check and document any erythema, skin breakdown, granulation tissue, and pain, swelling or offensive discharge.

Baths can be given once the incision site has healed. This is normally a minimum of 48 hours after the gastrostomy has been placed. Swimming is permitted, but should not be encouraged for 2 weeks following gastrostomy placement.

Dressings that cover, sit under, or occlude the gastrostomy are not recommended and usually not required. In specific circumstances dressings may be helpful, such as silver dressings for the treatment of excessive granulation tissue formation and antimicrobial dressings in the presence of minor, superficial infection.

Flushing of the gastrostomy tube is essential to maintain tube patency, prevent tube blockages, and reduce bacterial overgrowth. Commonly, 20 mL of water is recommended, with smaller volumes used in certain circumstances, for example, if a child is fluid restricted and to avoid fluid volume overload.

Caregivers should be instructed not to pull on the tube and to avoid any persistent tension as, for some devices more than others, this may lead to progressive migration of the bumper into the tract, leading to “buried bumper syndrome” (see COMPLICATIONS). This means that the internal disc/retaining device of the PEG gradually migrates into the submucosa of the gastric wall and

TABLE 4. Daily care of the PEG tube by parent/caregiver

Perform hand hygiene
Clean the gastrostomy site and external fixation plate/device
Measure the length of tubing from skin level to proximal end of adaptor
Release the fixation on the external fixation device
Release the tubing from the fixation device
Move the fixation device away from the skin
Clean the tube, fixation device, and site
Push 2–4 cm of the tube into the stomach
Rotate the tube by turning it in your fingers
Gently pull the tube back until resistance is felt
Place fixation device into normal position and anchor tubing to fixation device
Remeasure tubing to ensure all the tube is proximal to fixation device
If tube is shorter, undo fixation device and pull back to desired length and fix

PEG = percutaneous endoscopic gastrostomy.

TABLE 5. Competencies for tube care

Administration of medications
Administration of feed
Cleaning and care of gastrostomy site
Gastrostomy tube care
Changing the gastrostomy tube (if appropriate)
Minimising tube blockage
Troubleshooting/emergency care

potentially further into the peritoneum. This makes safe endoscopic removal of the PEG extremely difficult and frequently impossible. Although it may be retrieved by endoscopy, a laparotomy is often required to safely remove the “buried bumper” and repair the damaged track.

To prevent a “buried bumper,” the PEG should be carefully pushed into the stomach by 1 to 2 cm and then rotated once a week from day 7 postinsertion.

Teaching of all parties involved in the care of the PEG commences before PEG placement and at the time of the decision to proceed to insertion. Teaching initially includes the demonstration of different devices, provision of printed, age-appropriate literature, and explanation of the planned surgical procedure. However, in addition to teaching the child and family, support for staff involved in caring for each patient in the community may be necessary. There are several key aspects of PEG use and care that should be taught. The family and caregivers should have the following competencies assessed to confidently be able to manage their child’s PEG tube (Table 5).

PROVISION OF SUPPLIES

Following the placement of the gastrostomy, community nurses should be informed of the make, model, and size of tube, and given specific advice about care of the particular device. The community dietician is informed of feeding requirements and the need for specific feed-related supplies. If a child requires pump feeding, then training of the caregivers is required before discharge home.

The child will require follow-up, typically provided by nurse specialists 3 months after placement of the gastrostomy. Thereafter, annual review of the device is usually adequate to ensure removal/replacement is discussed. Between routine appointments caregivers should have access to appropriately trained professionals who are able to respond to difficulties that may arise with a gastrostomy. This may be by provision of a telephone advice line and/or emergency clinic appointment to prevent unnecessary hospital readmission or unplanned interventions. One key point is to inform and train the caregiver in case of accidental removal of the tube/button. This is an emergency because the gastrocutaneous fistula can spontaneously close within 6 hours. Placing a new tube to keep the gastrocutaneous fistula open is therefore needed. In most cases families and caregivers are provided with a replacement tube/button (or measuring device) for reinsertion to maintain patency of the track in case of accidental removal.

REMOVAL OF THE PEG

All internal PEG retaining mechanisms must be removed when removing or changing a PEG to a different device. This may be done by snaring the internal bolster with an endoscope, then cutting the PEG tube externally and withdrawing the length of tube and bolster up through the oesophagus and out of the mouth. If “cut and pushed,” internal bolsters can be retained or perforate the bowel (58). This should not be done before 2 to 3 months after

insertion to avoid potential track disruption on reinsertion of the balloon gastrostomy. It is good practice to confirm the internal position of the balloon endoscopically before completing the procedure. Some devices are designed to collapse and may be pulled through the track externally. For such ‘‘traction’’ devices, it is prudent to allow longer (minimum 4 months) for the track to become really well established and the gastric wall to become strongly adherent to the abdominal wall. This minimises the chance of track disruption with the force of pulling the internal bolster through the track (59). The position of the first newly inserted balloon gastrostomy is then checked by contrast before first use to ensure it is correctly sited in the stomach.

There are reports of single PEGs being in situ for up to 10 years, but a more usual duration is approximately 2 to 3 years, after which time they are replaced under anaesthesia for a new/more suitable tube in advance of tube failure.

Old tubes tend to deteriorate, becoming fissured and porous, may be colonised with organisms such as *Candida* (60), and can become prone to obstruction. This complication of PEG tubes has been reported to cause >50% of tube failures after a period of 12 or more months.

Most replacement tubes are retained by a water-filled balloon. These balloons are prone to leakage and rupture, and hence require frequent tube replacement (typically 5 months) (49). If a gastrostomy tube is intentionally removed, spontaneous closure of the fistula usually occurs rapidly. The fistula closes in <1 month in approximately 75% of patients. Persistence of a gastrocutaneous fistula is associated with a long duration of the gastrostomy (61).

COMPLICATIONS

There are now a number of larger studies defining the complication rate of PEG insertion in children (62,63). The most recent from Boston Children’s Hospital suggests 11% have at least 1 complication in a median 5-year follow-up (Tables 6 and 7). Complications may also be classified as early and late.

Early Complications (Insertion Related)

Early complications as a direct result of PEG placement occur within 30 days of insertion. These include the following:

1. Pneumoperitoneum
This is a frequent postoperative finding and is identified radiologically in 5% to 50% of patients (64). It is usually of minor clinical consequence, but may be a sign of iatrogenic bowel injury and hence should not be dismissed in the relevant clinical context.
2. Colonic injury or gastrocolic fistula

TABLE 6. Major complications

Gastric perforation
Gastrocolic fistula
Internal leakage
Track dehiscence
Peritonitis
Periprocedure aspiration pneumonia
Subcutaneous abscess
Bleeding
Gastric outlet obstruction
Cellulitis/necrotising fasciitis
Massive pneumoperitoneum
Buried bumper syndrome

TABLE 7. Minor complications

Tube blockages
Tube dislodgements
Tube degradation
External leakage
Unplanned removal
Transient gastroparesis
Gastric wall ulceration
Overgranulation
Site infections

This complication is uncommon, but owing to the displacement of the transverse colon over the anterior gastric wall it can lead to puncture of the colon during the blind insertion of the needle/trocar (65). Risk factors include under- or overdistension of stomach, a left diaphragmatic hernia, and significant kyphoscoliosis. This complication may be detected either early or late, frequently after many months to years, and even only on exchange or final removal of the PEG tube. Clinical signs include the presence of undigested feed in stools, diarrhoea immediately after feeding, faeculent vomiting, or discharge from the gastrostomy track.

3. Small bowel injury
This is most common in children who have undergone prior abdominal surgery and occurs owing to adhesions that have fixed small bowel loops anterior to the liver, making them highly susceptible to injury during trocar insertion.
4. Stoma leak
Insignificant gastric leakage is common after PEG placement and may only need gentle tightening of the external fixation device to ensure close apposition of the internal bumper to the gastric wall. More persistent leaks may however lead to peritonitis.

Late Complications

1. Site infection: 30% to 40% (66)
Peristomal wound infection is one of the most common complications of PEG. The likelihood of wound infection is the result of bacterial load at the stomal site and other factors relating to the patient’s primary condition, such as malignancy or immunosuppression. Early stomal infections may derive from oropharyngeal flora as the PEG traverses the mouth, pharynx, and oesophagus, or it may arise from the puncture of colonised abdominal skin.
A recent Cochrane analysis (67) reviewed 12 randomised controlled trials of adults undergoing PEG insertion, comparing prophylactic antibiotics to placebo with peristomal infection as the primary outcome. There were significantly fewer infections in the prophylactic antibiotic group (9.4% vs 24.2%); hence, the review supports the use of prophylactic antibiotics in reducing perioperative stomal infection rates.
In a recent prospective study on complications of PEG in children (62), 6 infections were observed of 92 children (6.5%). There have been further recent developments to reduce the incidence of stomal infections by the application of antimicrobial wound dressings (68).
As prevention of site infection is key, careful attention should be paid to hand hygiene before and after accessing the gastrostomy. When preparing feeds for administration, high standards of hygiene should be maintained, although the site does not need treating aseptically once the track has healed.

If discharge occurs around site or erythema is present, the site can be swabbed and evidence of colonisation and antibiotic sensitivities obtained. The site is almost always colonised without causing tissue infection, although pain around the site and tissue swelling suggest bacterial invasion. Depending on clinical status, the child may need topical or systemic antibiotics. Less than 5 mm of erythema around the outer stoma site is common and is likely owing to local irritation by movement of the external bumper or minimal leakage.

2. Buried bumper

This is most common in the second year after insertion and occurs in approximately 2% of children (69–71). This may be minimised by ensuring a correctly fitting device at regular review, particularly to ensure increasing tube length in line with weight gain.

The internal flange migrates through the gastric wall and potentially into the peritoneal space. Signs include difficulty infusing fluid and feeds, with an increasing difficulty in moving and rotating the PEG during the weekly cares. If suspected, a contrast study via the PEG or an upper endoscopy is warranted. It may be necessary to discontinue feeds until a diagnosis is made, as complications include sudden peritonitis and the formation of intraperitoneal or abdominal wall abscesses. In some cases it is possible to pass a guide wire through the tube lumen under endoscopic control, gently dilate the tract with a dilator, and use the patent tract to insert a button. Otherwise, the existing PEG system may be removed using a needle knife sphincterotome, after which the preexisting tract may be dilated over a guide wire.

3. Granulation tissue

Overgranulation at the gastrostomy site is seen as red/pink tissue at the stomal border that extends above the surrounding skin. This is a common complication that is usually owing to an ill-fitting device, wherein excessive movement or leakage leads to an excessive healing response. The granulation tissue has a tendency to bleed easily and may become inflamed or infected. It tends to discharge continuously and may cause local pain due to an increasingly distorted stoma and hence ill-fitting device.

TREATMENT OF COMPLICATIONS

Nausea, Vomiting, and Abdominal Distension

Although a small pneumoperitoneum is common after PEG insertion, more major intraperitoneal collections of air may be a cause of significant symptoms in the immediate postinsertion period, and may require drainage. Other causes include sepsis, peritonitis, and bowel injury; hence, there should be a low threshold for early surgical review. Feeds should be discontinued and re-introduced more slowly once surgical causes are excluded, increasing feeds more slowly as tolerated.

Diarrhoea

Infective causes should be excluded first, especially if associated with vomiting. Thereafter a dietician should review the feeding regimen, including the type of feed, the volume, and the rate of feeding to ensure these factors are not contributing to diarrhoeal losses. One should also consider a possible gastrocolic fistula.

Overgranulation

This common occurrence may be associated with bleeding or stoma leakage. Treatment options include silver nitrate, topical

corticosteroids, cryotherapy, or surgical debridement. Silver nitrate does not cause any pain if applied only to the granulation tissue and is helpful to shrink down excessive granulation tissue. Caution is required not to burn the surrounding normal skin, so that covering the surrounding skin with a thick layer of white soft paraffin before cauterisation can be helpful. If the overgranulation leads to excessive pain, discharge, recurrent infection, and a persistently ill-fitting tube, then occasionally surgical debridement is necessary. Leakage due to an ill-fitting device can be improved through proton pump inhibitor use to protect the surrounding skin.

Tube Blockage

This should be minimised by thoroughly flushing with water after drug/feed use. Crushed tablets, as well as potassium and iron supplements, are known to cause tube blockage.

Common treatment practices include flushing with higher pressure using smaller-volume syringe. The use of sodium bicarbonate or phosphate-containing soft drinks may lead to tube degradation, so it should be avoided (72). If all measures fail, the tube must be changed.

RECENT DEVELOPMENTS

Early Feeding

There is no widely accepted way of starting feeds after PEG insertion. There is a trend to start using the PEG much earlier, almost immediately after insertion, as soon as the patient is awake. The major driver for this is to reduce hospital length of stay. There is still no robust evidence in children on the best time to start using a newly inserted PEG, on whether or not an initial challenge is best done with water, or dilute or normal feed; or on how fast the feeding rates may be increased. These questions should be addressed in larger multicenter studies.

Potential Benefit of Using Push Techniques

The increasing use of push techniques for the insertion of PEG may allow reevaluation of the need for routine use of antibiotic cover before PEG insertion. As larger series are reported, it is clear that the risk of infection with this approach is less than with the conventional pull techniques (10% vs 30%) (73–75).

CONCLUSIONS

The use of endoscopically placed gastrostomy devices has become a key part in the management of children with feeding and nutritional issues. Few absolute contraindications exist in which such techniques cannot be used to improve the care of individual patients. The techniques and devices continue to evolve to reduce complications such as infection and displacement. It remains important that the decision to place an endoscopic gastrostomy is made by an appropriate multidisciplinary team, which then provides active follow-up and care for the child and device.

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