Percutaneous Endoscopic Gastrostomy in Children: An Update to the ESPGHAN Position Paper

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ABSTRACT

Background: The European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) position paper from 2015 on percutaneous endoscopic gastrostomy (PEG) required updating in the light of recent clinical knowledge and data published in medical journals since 2014.

Methods: A systematic review of medical literature from 2014 to 2020 was carried out. Consensus on the content of the manuscript, including recommendations, was achieved by the authors through electronic and virtual means. The expert opinion of the authors is also expressed in the manuscript when there was a lack of good scientific evidence regarding PEGs in children in the literature.

Results: The authors recommend that the indication for a PEG be individualized, and that the decision for PEG insertion is arrived at by a multidisciplinary team (MDT) having considered all appropriate circumstances. Well timed enteral nutrition is optimal to treat faltering growth to avoid complications of malnutrition and body composition. Timing, device choice and method of insertion is dependent on the local expertise and after due consideration with the MDT and family. Major complications such as inadvertent bowel perforation should be avoided by attention to good technique and by ensuring the appropriate experience of the operating team. Feeding can be initiated as early as 3 hours after tube placement in a stable child with iso-osmolar feeds of standard polymeric formula. Low-profile devices can be inserted initially using the single-stage procedure or after 2–3 months by replacing a standard PEG tube, in those requiring longer-term feeding. Having had a period of non-use and reliance upon oral intake for growth and weight gain—typically 8–12 weeks—a PEG may then safely be removed after due consultation. In the event of non-closure of the fistula the most successful method for closing it, to date, has been a surgical procedure, but the Over-The-Scope-Clip (OTSC) has recently been used with considerable success in this scenario.

Conclusions: A multidisciplinary approach is mandatory for the best possible treatment of children with PEGs. Morbidity and mortality are minimized through team decisions on indications for insertion, adequate planning and preparation before the procedure, subsequent monitoring of patients, timing of the change to low-profile devices, management of any complications, and optimal timing of removal of the PEG.

Key Words: balloon device, children, complications, enteral feeding, feeding tube, gastrostomy, nutrition, percutaneous endoscopic gastrostomy

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What Is Known

- Percutaneous endoscopic gastrostomy (PEG) is an interventional procedure that has become one of the most commonly performed in children.
- PEG insertion is a safe, quick and effective method that allows non-oral, enteral supportive nutrition in children who require it in the medium or long term.
- Despite the safety of the gastrostomy procedure, early or late complications can occur.

What Is New

- Feeding can be started 3 hours after gastrostomy tube placement in a stable child.
- Percutaneous laparoscopic-assisted endoscopic jejunostomy insertion is becoming more widespread.
- Single-stage PEG is becoming more popular with paediatric gastroenterologists.
- Closure of PEG fistulae may now occur with the Over-The-Scope-Clip placed by endoscopy.

The aim of this European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) position paper on management of percutaneous endoscopic gastrostomy (PEG) is to update all relevant information regarding gastrostomies in paediatric patients published since 2014 (1). Furthermore, new sections were added, such as quality of life in children with enteral tubes.

PEG tube insertion, mainly to deliver nutritional support to children that are unable to maintain adequate nutrition orally, has become a very common practice. A PEG may also allow delivery of medications and allow venting of the stomach when necessary. If feeding through a nasogastric tube (NGT) or naso-jejunal tube

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Synopsis of all recommendations is presented in Table 1.

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(NJT) for a duration of more than 3–6 weeks is necessary, PEG or PEG-J should be considered (2,3). It is the opinion of the authors that the number of absolute and relative contraindications for PEG insertion has decreased. At the same time, the number of indications for inserting a feeding tube has increased. Rates of PEG tube placement have risen, especially in the age group over 75 and in children. Children's average age at PEG tube insertion has decreased which confirms the trend over the last years (4).

The use of feeding tubes for enteral nutrition has permitted longer survival and transition to out-of-hospital care for higher numbers of children over the past decades, with improved quality of life not only for children but also for parents, including better weight and height gain of patients (5).

In line with the official ESPGHAN policy of periodic review of Societal papers, the ESPGHAN Endoscopy Special Interest Group (SIG) decided that it was necessary to update the position paper for PEG-J in paediatric patients.

METHODS

Scope and Purpose

The ESPGHAN position paper was developed for the management of gastrostomy tubes in children and adolescents in 2014 and was published in 2015 (1). Based on recent accumulated publications and experience, the ESPGHAN Endoscopy SIG agreed to review the current literature to provide an updated position regarding all aspects of PEG use and placement in children.

Literature Review

A systematic literature search was carried out using PubMed, MEDLINE, EMBASE, Cochrane Library, and Scopus databases between October 1, 2014 and September 1, 2020 using the following MESH terms: ((''Adolescent''[Mesh] OR ''Child''[Mesh] OR ''Infant''[Mesh] OR ''Paediatrics''[Mesh]) AND (''Gastrostomy''[Mesh] OR ''Jejunostomy''[Mesh]) OR ''PEG''[Mesh] OR ''PEGJ''[Mesh] OR ''Stomach feeding tube''[Mesh]) OR ''Endoscopic gastrostomy''[Mesh] OR ''Endoscopic jejunostomy''[Mesh])). Non-English literature was excluded.

Review, Consensus Process, Manuscript

The consensus group consisted of an international group of experts: paediatric gastroenterologists and a paediatric surgeon, all members of the ESPGHAN Endoscopy SIG. Each member of the consensus group provided disclosure of potential conflict of interest using the Society's conflict of interest web-based platform. A number of questions were posed and then assigned to one member of the group for analysis based on available literature and having written each section and proposed evidence-based Statements and Recommendations, these were then circulated to the consensus group for revision using the Delphi method until a unanimous consensus was obtained on each.

Funding Sources

No funding sources were needed for the development of this position paper.

ENTERAL TUBE FEEDING

Enteral tube feeding is defined as enteral nutrition administered via a trans-nasal tube or percutaneous stoma into the stomach or small intestine. Enteral tube feeding enables exclusive or supplemental enteral nutritional support in children who are not able to sustain their own growth, nutrition and hydration status or receive drug intake by mouth (6). Tubes can be inserted via the nose, that is, naso-gastric (NG) or naso-jejunal (NJ) or via a stoma created percutaneously with endoscopic assistance, that is, PEG; PEG with a jejunal extension (PEG-J); or directly into the jejunum (laparoscopically assisted percutaneous endoscopic jejunostomy (PEJ or LAPEJ)). Finally, the tube may also be placed surgically, that is, surgical gastrostomy or jejunostomy (7–13). Main indications that may require temporary or permanent enteral feeding are presented in Table 2.

INDICATIONS FOR PERCUTANEOUS ENDOSCOPIC GASTROSTOMY

The most frequent indication for PEG insertion is neurological impairment, adequate timing being proposed in the corresponding ESPGHAN guideline (14). In this condition, oral intake may be unsafe (swallowing disorders) and/or nutritionally inadequate with the oral intake being insufficient or taking too much time. Neuromuscular conditions such as Duchenne's muscular dystrophy are another group whose oral intake is either insufficient, or unsafe with respect to aspiration, that may benefit from non-oral nutritional support. Medical conditions in which the oral intake is insufficient to support higher than normal nutritional requirements may include cystic fibrosis or inflammatory bowel disease, in which an increased resting and total energy expenditure are present (15) and other indications include: cardiomyopathy with dyspnoea/tachypnoea precluding adequate oral intake (16,17); renal failure (aversion and vomiting due to uraemia (18)); cancer (19); metabolic diseases (special requirements or nocturnal feeding); short bowel syndrome; severe food aversion/eating disorders (20), oral malformations (21,22); and in rare occasions gastrostomy can be used for decompression of the stomach.

RECOMMENDATIONS

Gastrostomy is recommended to support enteral nutrition in order to avoid malnutrition in chronic severe diseases.

A PEG is indicated in situations of unsafe swallow.

A PEG is indicated when non-oral nutritional support is anticipated to be required for a period of longer than 3–6 weeks or when trans-nasal tube feeding is unsafe.

CONTRAINDICATIONS FOR PERCUTANEOUS ENDOSCOPIC GASTROSTOMY

Relative Contraindications

There are different possible contraindications to the PEG placement which should be carefully considered and managed by endoscopists and/or surgeons. Table 3 reports the contraindications (relative and absolute), related risks, and possible solutions reported in the literature.

The risk of blind endoscopic insertion should be evaluated case by case (23,24).

Ideally, all medical conditions that present potential contraindications should be dealt with before PEG insertion.

Anatomical or surgical conditions that can affect the position of intra-abdominal organs may be identified by radiology or endoscopy to evaluate the feasibility of an endoscopic approach.

TABLE 1. List of statements and recommendations

Statements	Recommendations
A multi-disciplinary team should be involved in the decision to place, and the preparation of a child and family for, PEG insertion	Gastrostomy is recommended to support enteral nutrition to avoid malnutrition in chronic severe diseases
Routine concomitant fundoplication in the absence of significant GERD is not necessary	A PEG is indicated in situations of unsafe swallow
Where it is desirable to avoid a second general anaesthetic then a single stage PEG may be inserted as long as the requisite experience is available to do so	A PEG is indicated when non-oral nutritional support is anticipated to be required for a period of longer than 3–6 wk or when trans-nasal tube feeding is unsafe
NJ tubes can be correctly inserted by radiological or direct-vision endoscopic means and provide short-term proof of the efficacy and safety of this enteral feeding route	Antibiotic prophylaxis to prevent PEG site infection is recommended
PEG-J tubes and direct PEJ tubes can be endoscopically placed and provide a longer-term solution to the patient requiring this enteral feeding route	The type of device must be chosen according to the experience of the team and expectations of the family
Several non-operative techniques and surgery can be used to close a fistula post-removal after one month of non-closure	The standard pull-through technique is generally recommended with a change to a low-profile balloon/button device once the tract has formed
Gastrostomy has an effect on the physical, psychological and social quality of life of children and their caregivers	Family and caregivers should be trained how to use and manage the inserted device before discharge from hospital
	If pneumoperitoneum persists longer than 3 days post-procedure, a bowel injury should be excluded
	Extra care should be taken in patients with severe scoliosis
	Feeding can be initiated as early as 3 h post procedure in stable child with no complications
	Iso-osmolar feeds of standard polymeric formula is the best type of food to start with after the PEG insertion
	Replacing the initial tube with a gastric balloon/button should be recommended to the families/child who will need long term enteral nutrition to improve quality of life
	Gastric balloons should be replaced every 6 mo, but buttons can be replaced annually
	LAPEJ is a more permanent method of transpyloric feeding than PEG-J
	Direct jejunostomy is no longer recommended due to the higher rate of complications
	The decision to permanently remove PEG tube should be broadly discussed and agreed between the parents, the child and the and the health team providing care
	Quality of life using validated questionnaires should be monitored at the beginning and periodically thereafter to evaluate the impact of PEG

GERD = gastroesophageal reflux disease; LAPEJ = laparoscopic assisted endoscopic jejunostomy; NJ = naso-jejunal; PEG = percutaneous endoscopic gastrostomy; PEG-J = percutaneous endoscopic gastrostomy with a jejunal extension; PEJ = percutaneous endoscopic jejunostomy.

In these instances, a laparoscopically assisted approach may be needed, thus a close collaboration among endoscopists and surgeons increases the success rate of PEG insertion (25). Ventriculoperitoneal (VP) shunts may be considered by some as a relative contraindication requiring surgical visualisation to place the PEG. Significant scoliosis may prevent adequate positioning of a PEG with the stomach positioned high up under the left costal margin.

TABLE 2. Main indications for enteral feeding

Unsafe swallow, as in cerebral palsy or in cleft palate
Inadequate oral intake for supplemental feeds, as in cystic fibrosis or congenital heart disease awaiting proper weight for surgery and some cases of Down syndrome
Long dependency on continuous feeds, as in prematurity or short gut syndrome
Long gap oesophageal atresia in neonates
Acquired conditions that may limit oral feeding (eg, severe oesophageal strictures due to caustic injuries)

PATIENT PREPARATION BEFORE PERCUTANEOUS ENDOSCOPIC GASTROSTOMY PLACEMENT

Initial Assessment and Counselling

A detailed clinical history and complete physical examination will enable the paediatric gastroenterologist to ensure that gastrostomy insertion is appropriately indicated and identify any possible contraindications or need for any further investigations before placement. For example, whilst a routine contrast study is unnecessary, children with congenital gastrointestinal anomalies may benefit from an upper gastrointestinal contrast study (26).

A multidisciplinary approach to decision making is important and involves assessment and input by a dietitian, nutrition or gastrostomy specialist nurse, a speech and language therapist and psychologist or play therapist, as required.

Involvement of the multidisciplinary professionals in a timely manner, allows consideration and management of all relevant issues in a way that deals with all aspects of each patient.

Pre-placement counselling enables the team to support children and their parents in the decision-making process with education, explore the expectations and reality of caring for a child with a

TABLE 3. Contraindications for PEG placement

Relative contraindications	Risks	Management
Active gastritis/peptic ulcer	Bleeding/perforation	Treatment before PEG placement
Minor Coagulation/bleeding disorders	Bleeding	Treatment before PEG placement
Previous abdominal surgery	Change in positions of intra-abdominal organs	US or X-ray, feasibility endoscopic assessment
Gastric varices	Bleeding	Adequate preparation and planning
Portal hypertension (94,95)	Bleeding, worsening of portal hypertension, severe peristomal varices development	Careful risk assessment and preparation
Ascites (96)	Unsuccessful procedure, bleeding, peritonitis	Careful evaluation for severe ascites, laparoscopically assisted approach
Kyphoscoliosis/spinal deformity	Change in positions of intra-abdominal organs	US or X-ray, feasibility endoscopic assessment
Peritoneal dialysis (97,98)	Unsuccessful procedure, bleeding, peritonitis	PEG placement before dialysis start or laparoscopically assisted approach
Microgastria/large hiatus hernia	Unsuccessful procedure	Careful cost/benefit evaluation
Severe psychosis/anorexia nervosa	Worsening of psychosis	Careful cost/benefit evaluation
Lack of clear identification of the stomach wall during endoscopy (99)	Unsuccessful procedure, perforation and peritonitis	X-ray, feasibility endoscopic assessment, laparoscopically assisted approach
Absolute contraindications		
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 Normalized Ratio; PEG = percutaneous endoscopic gastrostomy; PTT = Partial Thromboplastin Time; US = ultrasound.

gastrostomy and discuss the potential risks, benefits and tube maintenance issues. This can be further supported by providing the families with procedure-specific information leaflets and videos. Age-appropriate information leaflets and videos (eg, *https://www.cincinnatichildrens.org/health/g/g-tube-care*) are beneficial in involving children and young people in the decision-making process. There also needs to be consideration of the availability of language-specific information.

Consent should specifically include risks such as infection, bleeding, other viscous perforation such as colonic transfixation by the trochar, failure of the procedure with other procedures which may be needed, including laparoscopy/laparotomy.

Gastro Oesophageal Reflux Disease

Asymptomatic children do not require investigation for gastro-oesophageal reflux disease before PEG placement (1).

Routine anti-reflux surgery at the time of gastrostomy placement is not recommended (27), not even in patients with neurological impairment (28). Significant pre-existing reflux or reflux in the presence of an unsafe swallow, chronic respiratory disease or progressive neurological deterioration should prompt endoscopy and pH or pH/impedance on or off anti-reflux medication for consideration of an anti-reflux procedure along with the PEG placement (1).

A PEG-J is an alternative to fundoplication and gastrostomy for children with neurological impairment and gastro-oesophageal reflux that failed medical management, or in gastroparesis or gastric outlet obstruction and lastly where there is functional or anatomical obstruction of the duodenum, for example, superior mesenteric artery (SMA) syndrome (29).

Antibiotic Prophylaxis

Lack of pre-operative antibiotics was noted to be an independent predictive factor for major complications in children having a surgically placed gastrostomy device (30). A Cochrane review published in 2013 in adults concluded that systemic prophylactic antibiotics during gastrostomy tube placement do reduce peristomal infection (31).

A number of studies have indicated that this is good practice (32,33). A recent randomised placebo-controlled trial, by Alessandri et al (34), of a single dose of iv co-amoxiclav showed a clear reduction in the rate of PEG-related infection from 21% in the placebo group to 5% in the treatment arm. Therefore, it remains advisable to use prophylactic antibiotics for PEG insertion.

STATEMENTS

An multidisciplinary team (MDT) should be involved in the decision to place, and the preparation of a child and family for PEG insertion.

Routine concomitant fundoplication in the absence of significant gastroesophageal reflux disease (GERD) is not usually necessary.

RECOMMENDATION

Antibiotic prophylaxis to prevent PEG site infection is recommended.

PERCUTANEOUS ENDOSCOPIC GASTROSTOMY TECHNIQUES

Gastrostomy placement is one of the most common procedures performed in children (35). Until 1980 the procedure was purely surgical, then Gauderer, a paediatric surgeon, and Ponsky, an adult surgeon, established a new and effective endoscopic method of gastrostomy placement in children and adults (36). PEG

placement should be carried out in an appropriate setting such as an endoscopy suite or operating theatre by appropriately trained staff (1) under general anaesthesia and usually takes approximately 15–20 minutes.

In conditions such as severe scoliosis, before PEG placement, radiological imaging to optimize the location of the tract for feeding tube insertion may be considered.

A detailed description of the technique of placement is out of the scope of this Guideline as it has been described in detail elsewhere and is an established procedure (37,38).

Push One-Step Percutaneous Endoscopic Gastrostomy

One-step gastrostomy insertion is an increasingly used technique.

A gastropexy is performed under endoscopic control and the anterior gastric wall is juxtaposed to the abdominal wall with three fasteners which under tension from an assistant (these are anchored with special clips flush with the skin after PEG balloon placement and usually are extruded after 6 weeks or once the tract is matured). The puncture site is identified at the centre of the gastropexy and the trocar is inserted under direct vision by the endoscopist into the gastric lumen. A J-shaped guidewire is then passed through the trocar over which is passed a multi-section dilator which has an increasing diameter as inserted, the feeding tube is then passed through the dilator as it is peeled away into the stomach and, the balloon is inflated (39).

This technique 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, especially for neurological patients (40) and allows primary insertion of a balloon/PEG. This means to avoid another hospital admission and anaesthesia. In settings where these facilities are expensive, the higher initial cost of the one-step button may turn out to be cost-effective (41). The one-step device is also preferable in patients with a higher anaesthetic risk, previous cardiac or oesophageal surgeries as the passage of the large bumper down the oesophagus is avoided.

Percutaneous Endoscopic Gastrostomy With a Jejunal Extension Technique

This technique is performed after a previous gastrostomy and sufficient time is allowed for gastric adhesion to the abdominal wall. It is required that the initial gastrostomy allows a minimum diameter of a 10–12F tube. The procedure is done using a neonatal scope - for this technique, sedation is not necessary. The endoscope is introduced into the gastrostomy site after removal of the gastrostomy device and advanced to the jejunum.

The guidewire is inserted through the operating channel of the endoscope that is then removed, leaving the guidewire in place. The gastro-jejunal tube is then slid over the guidewire and placed in the distal part of the duodenum/jejunum. The gastric balloon is then inflated. Radiological position confirmation is not necessary but can occur.

Another way of insertion is via endoscopy, when the PEG is removed and the PEG-J tube is then inserted and guided into the jejunum under direct vision using a standard endoscope. The small cotton loop at the tip can be grasped by a haemostatic endo-clip and this can then be deployed to anchor the tip of the tube in the jejunum.

STATEMENT

Where it is desirable to avoid a second general anaesthetic then a single stage PEG may be inserted as long as the requisite experience is available to do so.

RECOMMENDATION

The type of device must be chosen according to the experience of the team and expectations of the family. The standard pull-through technique is generally recommended with a change to a low-profile balloon/button device once the tract has formed.

PERCUTANEOUS ENDOSCOPIC GASTROSTOMY CARE

Children should be admitted overnight to ensure adequate pain control and safe initiation of feeds. In the immediate postoperative period, the patient's general condition is monitored and the abdomen is examined for signs of peritonitis or significant pneumoperitoneum. Despite the recommended use of a long-acting local anaesthetic such as bupivacaine during the procedure, most 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 if a tube was used. Occlusive dressings are not recommended as they increase the risk of local infection (1). The most important defence for preventing skin breakdown is performing proper hygiene at the gastrostomy tube site and protecting the skin from moisture, friction, and trauma (42). In some centres it is routine to slightly loosen the anchoring device the next day to account for site tissue swelling.

It is quite normal to experience some clear or coloured discharge from around the site for the first 7–10 days post-placement while the site is healing. A glycerine hydrogel-based wound dressing has been shown to prevent peristomal infections after PEG in adult patients with cancer (43). This was not confirmed by a recent paediatric trial (44). The use of antibiotic/steroid topical application can be helpful in the prevention of local infection/inflammation.

In addition to the observation of the site for infection, a PEG requires daily care.

Baths can be given once the incision site has healed. This is normally a minimum of 48 hours after the gastrostomy has been placed. In case of one step gastrostomy button technique, the patient is not allowed to bathe as long as the gastropexy bumpers are in place. Taking a shower is allowed. Swimming is permitted but should not be encouraged for 2 weeks following gastrostomy placement.

Silver or hydrocolloid dressings may be helpful despite variable result for the treatment of excessive granulation tissue formation (45). Anti-microbial dressings may be needed in the presence of minor, superficial infection.

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''). To prevent a ''buried bumper'', in the case of a PEG with a thin internal bolster, the tube should be carefully pushed into the stomach by 1–2 cm and then rotated once a week from day 7 post-insertion (46). This should not occur in those PEG tubes that have thicker internal bolsters where buried bumper is not seen.

TABLE 4. Early/late complications after PEG placement

Early complication	Late complications
Abdominal wall abscess or cellulitis	Impaired wound healing—granulation—peristomal infection—track dehiscence
Intraperitoneal leakage of gastric contents	Intraperitoneal leakage of gastric contents
Gastric perforation	Gastric perforation
Transhepatic placement	Transhepatic placement
Epigastric artery bleeding and pseudoaneurysm	Malpositioning of the gastrostomy catheter within the abdominal wall
Aspiration pneumonia	Aspiration pneumonia-GERD worsening
Transcolonic placement	Transcolonic placement
Pneumoperitoneum (>3 days)	Post pyloric migration with possible dumping syndrome, mucosal damage-ulcer, lumen obstruction, pancreatitis
Hemo-peritonitis	Buried bumper syndrome
Tube clogging	Mechanical tube problems: dislocation, clogging, porosity, kinking or fracture
	Track disruption with PEG exchange to button
	Gastroparesis

GERD = gastroesophageal reflux disease; PEG = percutaneous endoscopic gastrostomy.

After gastrostomy placement family and caregivers should be trained to confidently be able to manage their child's tube/button. One key point is to inform and train the caregiver in case of accidental tube/button removal. This is only really relevant to buttons/balloons and not to PEG tubes. This is an emergency because the gastro-cutaneous fistula can spontaneously close within 6 hours. Placing a new tube or button to keep the gastro-cutaneous 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 the patency of the track in case of accidental removal. Empowering staff nurses with the knowledge and the necessary resources and tools to confidently educate parents, along with a standardized process, may improve overall outcomes (47). In case parents do not have a replacement tube, they should go to the nearest health facility. The same tube (if still available) or a Foley catheter may be gently inserted, and the tube taped to the skin to keep patency of the tract until specialised care is available and a proper replacement can be performed.

RECOMMENDATION

Family and caregivers should be trained on how to use and manage the inserted device before discharge from the hospital.

COMPLICATIONS

These are detailed in Tables 4 and 5. The insertion of a PEG tube is a safe procedure; however, complications are possible. They can be classified by severity (minor vs. major) or time of occurrence (gastroscopy- or procedure-related, or early or late post-procedural) (48). The early complications include endoscopy-related bleeding, internal organ injury, pneumoperitoneum, cellulitis, and minor wound infections (49). Bleeding is a rare complication of PEG placement and can originate in the gastrostomy tract/abdominal wall or from injury of a large vessel (eg, gastric artery, splenic or mesenteric veins) (50). Clinical manifestations can be oozing of blood around the gastrostomy, haematemesis, melena or signs of unexplained cardiovascular compromise. The minor bleeding in the puncture site usually ceases spontaneously or after pressure applied to the abdominal wound (51). A CT scan with water-soluble contrast in a patient with haemodynamic instability after the procedure can exclude gastrointestinal complications (52). Internal intra-abdominal organ injury, most likely colon and small bowel, rarely liver and spleen, may occur during the placement of the gastrostomy tube. Pneumoperitoneum may occur few hours after the procedure, and it can be considered a normal finding without consequences rather than a complication (53). The presence of a pneumoperitoneum with no clinical symptoms should not preclude feeding. When the free air persists 72 hours after PEG insertion, associated with clinical symptoms such as abdominal distension, a potential bowel injury should be considered (54). Redness,

TABLE 5. Minor/major complications after PEG placement

Minor complications	Major complications	
Granulation	Infection	Buried bumper
Infection	Cellulitis	Malposition
Leakage	Peritonitis	Ileus
Skin erythema, necrosis	Sepsis	Intraabdominal bleeding
Unplanned tube removal	Dehiscence	Pneumonia
Tube migration	Leakage	Gastric ulcer
Tube obstruction	Peritonitis	Tracheo-oesophageal fistula
Vomiting	Gastrocolic fistula	
Gastric atonia	Massive pneumoperitoneum	
Oesophagitis	Perforation (oesophagus, small intestine, colon)	
Fever	Fistula post removal	
Oesophageal haematoma		

swelling, bleeding, and cellulitis can be classified as early complications. Identification of early complications after the insertion of feeding tubes in paediatric patients is important and post-operative care is essential to identify and treat these conditions.

Apart from early and intra-procedural complications, there are also several late complications related to PEG placement (Table 4), and categorisation into minor and major can also be helpful (Table 5). The Clavien-Dindo classification is a well-established method for assessing complications, but disagreement regarding the classification of certain complications represents an inherent weakness when analysing the data. The most recent literature review in 2018, on PEG-related complications, which included 18 articles from 1994 to 2017, in total 4631 patients, 1518 (32.8%) had minor complications (51). The most common minor complications were superficial: granulation tissue (n = 478, 10.3%); local infection (n = 384, 8.3%); external leakage (n = 279, 6%); and skin erosion or erythema (n = 188, 4.1%). Unplanned tube removal after the post-operative period occurred in 65 cases and tube migration and obstruction developed in 2%. Major complications developed in 464 (10%) patients, of which almost 50% were related to infections, gastrocolic fistulas in 21 patients (0.45%), oesophagus and bowel perforations in 13 patients (0.3%) and buried bumper syndrome in 1%.

Very rare complications include the development of necrotizing fasciitis or haemo-peritonitis. As highlighted in the recent ESPGHAN Guidelines for the Evaluation and Treatment of Gastrointestinal and Nutritional Complications in Children With Neurological Impairment, these patients may go through a period of worsened reflux symptoms after PEG insertion, that may respond to slower advancement of enteral nutrition or necessitate a brief period of change to continuous feeding schedule or even sustain and require anti-reflux surgery in due course (14). PEG may promote an increased number of non-acid reflux episodes although this is rarely clinically relevant (55).

Patients with PEG may develop metabolic 'dumping syndrome' characterized by post-prandial tachycardia, diaphoresis, lethargy, refusal to eat, gas bloat, and watery diarrhoea in association with bolus feeds, usually if the vagus nerve is compromised during simultaneous fundoplication and not due to the PEG procedure itself (56).

McSweeney et al found that patients with neurologic disorders had less major complications, because they are usually hospitalized and are under increased supervision (57), whereas Fortunato et al (58) found that the same patient cohort had elevated risk for wound infection.

However, several published articles agree that patients with ventriculo-peritoneal (VP) shunt have higher risk during PEG insertion (51,59,60) and laparoscopic-assisted PEG could be considered. In oncological and bone marrow-transplanted children, neutropenia was associated with higher site infection (61). As per recent review by Balogh et al hepatomegaly, coagulopathy, oesophageal stenosis and peritoneal dialysis were described as possible risk factors (50); however, age under 1 year, neurological compromise, severe scoliosis, constipation and upper abdominal surgery were not related to complication rate (51) although thoraco-abdominal deformity may be associated with higher risk of leakage (62). Laparoscopic-assisted PEG is recommended in high-risk patients.

RECOMMENDATIONS

If pneumoperitoneum persists longer than 3 days post-procedure, a bowel injury should be excluded.
Extra care should be taken in patients with severe scoliosis.

PERCUTANEOUS ENDOSCOPIC GASTROSTOMY FEEDING TECHNIQUES INCLUDING TYPES OF FOOD

Adult data indicate that very early feeding (even one hour) after the PEG placement is safe (63). Data in children are scarce. The last ESPGHAN recommendation stated that introducing feeds at 4 hours post-PEG placement in children is safe (1). That recommendation was based on a prospective randomized controlled study involving 69 children, which showed that feeding at 4 hours versus 12 hours post-PEG procedure was safe, well tolerated and led to a shortened hospitalization stay (64). Two other prospective randomized trials in children compared early (3 hours) versus late 6 hours (65) or 8 hours (66) feeding after PEG placement. Both studies concluded that feeding could start as soon as 3 hours after the procedure with no increase in complication rate. All three paediatric randomized controlled trials evaluated the introduction of early feeds after the pull PEG placement technique. These three studies were recently recognized in a meta-analysis confirming that early feeding after PEG placement may be a safe alternative to delayed feeding, although the quality of evidence was low (65). Therefore, based on available data, feeding can be initiated as early as 3 hours post-procedure in stable children with no complications.

There is no evidence available that suggests routine use of a clear fluid test or dilute or hypotonic feed after the procedure. In fact, it has been suggested that these measures delay the time to full enteral intake and prolong hospital stay (1,64–66).

There is no general recommendation on the type of the enteral feed used after the procedure. It largely depends on numerous factors, among others age, energy requirements, degree of supplementation (proportion of nutrition provided enterally), presence of feed intolerance, allergy, severity of pre-existing gastro-oesophageal reflux disease with possible risks of aspiration (1). The great majority of children before PEG placement were enterally fed via NGT. In those children, the type of feed post-PEG insertion will depend on the food regimen tolerated by NG tube enabling a more rapid increase in the amount of formula (1). Adult and animal studies indicate that iso-osmolar formula causes less delay in gastric emptying comparing to hyperosmolar feeds (67). Although data for neonates and children are scarce and inconclusive, it is prudent to start with iso-osmolar feeds of standard polymeric formula in children in whom enteral formula was not used before and who have no pre-existing cow's milk allergy (7,68). Regarding the mode of the delivery, bolus feeding is more physiological and should be the first choice. In case of severe gastro-oesophageal reflux disease or if bolus feeding is not tolerated continuous feeding can be used as an alternative (7). Regardless of the mode of the delivery (bolus or continuous) excessive feeds may lead to abdominal discomfort and distension or ''dumping.'' Therefore, the volume of the feeds should be gradually increased and, in some children, small boluses during the day could be combined with the overnight continuous feeding via enteral pump (14).

Long-term feeding regimen requires dietetic surveillance and follow-up which is not the remit of this paper.

RECOMMENDATIONS

Feeding can be initiated as early as 3 hours post-procedure in a stable child with no complications.
Iso-osmolar feeds of the standard polymeric formula are the best type of food to start with after the PEG insertion.

REPLACEMENT OF INITIAL GASTROSTOMY DEVICE

In the majority of children, a standard PEG is inserted in the first instance to safely establish a gastrostomy tract. Once a stoma tract is formed the feeding tube is changed to skin level balloon or non-balloon gastrostomy button (GB) by endoscopy under general anaesthesia. In general, endoscopic centres wait at least 6 weeks to perform the second procedure; however, studies in healthy animals showed that the stoma tract is completely matured in 1 week (69). Maturation and stable gastropexy may be delayed in immunocompromised patients, children with obesity, diabetes mellitus and on corticosteroid therapy. Studies in humans have not been performed, but it seems probable that one month after a PEG procedure is sufficient to schedule a child for the second procedure. The appropriate length of the device (available between 0.8 and 10 cm, but usually between 0.8 and 4.5 cm) is determined by a stoma measuring device. The length of the GB depends on individual differences of the abdominal wall, body weight and degree of scoliosis (70).

The GBs are of different diameter (FG 12–24). The primary tube can be sized from FG 9 to FG 24. In infants, gastrostomy tubes of smaller diameter, for example, FG 9 are often placed. In such a case the formed stoma channel may require dilatation to accommodate the wider GB (71).

Low-profile tubes should be recommended to the families/child for long term enteral nutrition to improve the quality of life in children with feeding tubes; however, the physician should give the parents/child the possibility of choice whether to perform the replacement or not. Necessity for a repeat GA may be a contraindication in some children, hence the potential advantage of a single-stage PEG in these circumstances. The primary device can stay in place for one year or even more. In a German study, 85% of parents answered that the GB is advantageous over primary gastrostomy tube due to mobility, patient comfort at physiotherapy, swimming or night-time sleep, and higher parent satisfaction (70).

According to the manufacturer instructions GB should be replaced every 3 months on an outpatient basis, but in the majority, these are safe to replace less frequently; however, if the device is in place for more than 6 months the probability of balloon rupture increases. The average lifetime of the GB is 5–6 months (72). The durability of non-balloon buttons is longer, and they can be replaced annually (73). Besides longer tube durability also smaller internal bolster size, which can relieve partial gastric outlet obstruction, are possible advantages of non-balloon low-profile devices (74). The disadvantages are pain/discomfort during tube replacement, because of the insufficient collapse of the internal retainer, and the need for trained health workers to replace the non-balloon tube, or sedation of the patient.

Complications in children undergoing button replacement may occur but are very rare. In a retrospective study performed in a paediatric emergency department tube displacement occurred in 3 of 237 children (75). Although the procedure is easy to perform sometimes control contrast-enhanced imaging is necessary. The use of point-of-care ultrasound instead of radiation contrast technique to confirm the proper position of the button was described recently (76). Major complications such as fistula disruption or duodenal perforation are also possible (24).

RECOMMENDATIONS

Replacing the initial tube with a gastric balloon/button should be recommended to the families/children who will need long term enteral nutrition to improve quality of life.

Gastric balloons should be replaced every 6 months, but non-balloon PEGs can be replaced annually.

NASO-JEJUNAL TUBE, PERCUTANEOUS ENDOSCOPIC GASTROSTOMY WITH A JEJUNAL EXTENSION, LAPAROSCOPIC ASSISTED ENDOSCOPIC JEJUNOSTOMY

Enteral nutrition via nasogastric tube or PEG intra-gastric administration may not be indicated because of severe gastro-oesophageal reflux disease and/or delayed gastric emptying and/or antro-duodenal dysmotility/duodenal obstruction including conditions such as Superior mesenteric artery (SMA) syndrome.

In some of these circumstances, and mainly in neurologically impaired children, post-pyloric feeding can be crucial, thereby avoiding the need for parenteral nutrition. NJ feeding is often employed for short to medium term and often if significant gastro-oesophageal reflux disease and aspiration are issues—this may provide ''proof-of-concept'' for longer-term more definitive small intestinal feeding. PEG-J may be entertained. For delivery of long term post-pyloric feeding, a direct jejunostomy tube (PEJ) provides more stable and secure jejunal access compared with a PEG-J extension with less reported complications of blockage/displacement, with consequently a decrease in the need for radiological/endoscopic replacement/intervention (77,78).

An NJ tube may be placed radiologically or endoscopically. For endoscopic placement a ''silk'' 6, 8 or 10 FG feeding tube is first placed into the stomach, then an endoscope is introduced and the tip of the tube (or preferably the small cotton loop at the tip) is grasped with biopsy or grasping forceps. A newer and more useful technique involves using a single-use pre-loaded rotatable two-pronged haemostatic clip device and attaching the loop to the device and drawing it back into the biopsy channel. The endoscope is then introduced into the jejunum and the clip is attached to the luminal wall thus anchoring the NJ tube tip. If simple forceps are used, then the NJ tube can be inadvertently pulled back by friction into the stomach—unless the forceps are advanced at the same rate as the endoscope is withdrawn back into the stomach to leave the tube tip in the jejunum—the forceps are then opened and retrieved, and the tube may be re-grasped in the stomach as the endoscope is then removed from the patient again preventing proximal tube displacement. This problem does not occur if a haemostatic clip technique is employed. A similar technique can be employed to place the jejunal portion of a PEG-J. A single-stage PEG-J can be placed if there is no prior PEG stoma through which to place the PEG-J (39,79). A NJT may also be placed having placed by the endoscopic direct vision a guidewire into the jejunum and then blindly passing the NJT over the guidewire—subsequent radiological position confirmation may be used.

Direct jejunostomy or a variation utilising a Roux-en-Y loop have been attempted previously but were abandoned due to high complication rates. A newer combined laparoscopic/endoscopic technique similar to PEG placement has gained favour. Once the duodeno-jejunal flexure is identified the laparoscopist clamps the small bowel in the proximal jejunum in order to prevent subsequent endoscopic small bowel insufflation limiting the laparoscopic field of vision. A dual channel gastroscope or variable-stiffness colonoscope is preferred due to greater stiffness and the absence of gastric loop formation. CO_2 can be used for endoscopic insufflation. The procedure then follows the same technique as a standard PEG, leaving the 12FG tube in the duodenum. After 3 months this can be changed by simple endoscopy for a low-profile device (80–84).

STATEMENTS

NJ tubes can be correctly inserted by radiological or direct-vision endoscopic means and provide short-term proof of the efficacy and safety of this enteral feeding route.

PEG-J tubes and direct PEJ tubes can be endoscopically placed and provide a longer-term solution to the patient requiring this enteral feeding route.

RECOMMENDATIONS

LAPEJ is a more permanent method of transpyloric feeding than PEG-J.
Direct jejunostomy is no longer recommended due to the higher rate of complications.

REMOVAL OF GASTROSTOMY DEVICE

Removal of the PEG tube should be considered when the tube is not used for a few months even for rehydration or giving medications; however, there are no paediatric guidelines/recommendations on when tube feeding may stop nor on the timing of subsequent PEG removal. The European Society for Parenteral and Enteral Nutrition (ESPEN) Guidelines on home enteral nutrition for adults propose to terminate tube feeding when the desired weight has been reached and the patient's oral intake matches his/her maintenance needs but without giving recommendations when the feeding tube can be removed (85). Forbes et al comment that stopping tube feeding is more difficult than starting it, but the issue is beyond the scope of this paper (86).

The way to remove the PEG tube will depend on the device in place. For the classical bumper-type PEG, removal is performed by endoscopic polyp snare retrieval of the inner bumper (1). For some other primary tube types, the bumper can be collapsed and pulled out of the stomach through the stoma tract without general anaesthesia (1). The ''cut and push'' method consisting of cutting and pushing the internal bumper into the intestinal lumen allowing a spontaneous migration can be performed in adults (85) but is not recommended in children due to the theoretical increased risk of mechanical ileus especially in younger children (87). For the PEG retained by a water-filled balloon, the water has to be removed from the balloon before removing the tube.

St-Louis et al performed in 2018 a systematic review and meta-analysis of the epidemiology and treatment options of gastrocutaneous fistulae (GCF) in children. Persistent GCF after tube removal occurred in approximately one-third of paediatric patients, but the definition of GCF regarding the time of spontaneous non-closure of the stoma tract differed in the studies. It ranged from 2 to 12 weeks, but most studies defined persistent GCF when one month of non-closure after tube removal had occurred. There was no significant difference in GCF incidence between the PEG and surgical techniques. The only risk factor identified was the duration of the gastrostomy tube in place before removal. The described cut-off duration values varied between 6 and 18 months. Other possible risk factors for GCF were age at insertion, open technique and fundoplication. Although surgical repair is the standard treatment for persistent GCF, multiple non-operative therapeutic approaches have been described including systemic, local and endoscopic therapies – most recently the Over-The-Scope-Clip (OTSC). The OTSC permanently close the fistula according to limited reports in adults (88,89). Therapy with ranitidine and proton pump inhibitors, local therapies with 2-octylcyanoacrylate glue application and extraperitoneal closure have been used in children with success rates of 58, 100 and 95%, respectively. Endoscopic approaches with banding, cauterization and clipping, or clipping alone were used in children with success rates of 75, 63–67 and 55–83%, respectively. The limitations of the systematic review were the low number and quality of the studies, significant heterogeneity, none was randomized, most of the observational studies had a small sample size and an important risk-of-bias assessment (90). Denning et al later in the same year reported that curettage and cautery of a persistent GCF under general anaesthesia is a safe technique with a success rate of 67% in children (91).

STATEMENT

Several non-operative techniques and surgery can be used to close a fistula post-removal after one month of non-closure.

RECOMMENDATIONS

The decision to permanently remove PEG tube should be broadly discussed and agreed between the parents, the child and the and the health team providing care.

QUALITY OF LIFE OF CHILDREN WITH GASTROSTOMY AND JEJUNAL TUBES

PEG is a reliable and successful method in infants, children and adolescents allowing a nutritional and growth catch-up in the long term (92). PEG has however an influence on the quality of life (QoL) of children and their caregivers through physical, psychological and social effects on their lives. QoL is one of the patient-related outcomes that should be monitored to evaluate the effects of treatments, ideally at the beginning and periodically thereafter to evaluate the impact of this intervention (85).

A systematic review of family experiences with gastrostomy tubes in children with neurologic impairment showed that gastrostomy tubes affect the lives of children, parents, and family cohesion in many ways, both positively and negatively. Improvements and challenges were described for children's health and happiness, for parental caregiving and stress, and for logistics and bonding with family. Gastrostomy tube feeding also changed relationships within the family, between the family and the medical system, and between the family and the outside world. Furthermore, experiences varied, with different families framing similar concepts as positive and negative (93). Glasson et al looked at the QoL of 21 children with intellectual disability and marked feeding difficulties that underwent a gastrostomy placement to assist with their nutritional and medication needs and QoL of their families. They used a QoL framework relevant to children with intellectual disabilities and their families. For children, the impacts of gastrostomy for the physical health domain were predominant, supplemented by experiences of value for emotional well-being, social interactions, leisure activities and independence. For families, gastrostomy was integrated into multiple aspects of QoL relating to family interactions, parenting, resources and support, health and safety, and advocacy support for disability. Shortcomings related to difficulties with equipment and complications looked at the QoL in 50 children with a gastrostomy tube including paediatric patients referred for laparoscopic gastrostomy using the validated PedsQoL questionnaire before and 3 months after surgery (94). The total QoL did not increase but the psychosocial health significantly increased, and this was mainly owing to an improvement in social QoL. QoL both before and after gastrostomy placement was significantly lower in children with neurologic impairment but this latter did not influence the effect of surgery on QoL. A low preoperative body mass index was a predictor for improvement of QoL after gastrostomy placement (95) The QoL was also studied in 128 children referred for a laparoscopic gastrostomy using PedsQL before and after a mean follow-up of 4 years after surgery. The study showed that children

with severe feeding difficulty, who had undergone a gastrostomy placement, had significantly lower QoL compared to a healthy paediatric population. Neurologic impairment, cardiac disease, a history of gastrointestinal surgery, older age, and the need for jejunal feeding through the gastrostomy were predictive of even lower QoL (96). The QoL of 30 major caregivers of children with cerebral palsy and gastrostomy tube feeding was assessed using validated questionnaires. They showed that the QoL from these caregivers was below the average of the general population (moderate hopelessness in 20%, moderate and severe anxiety in 33.3% and moderate and severe depression in 46.7%); however, their results were very similar to those found in other studies that evaluated caregivers of paediatric patients with cerebral palsy that were not using gastrostomy tube feeding, suggesting that the presence of the gastrostomy did not negatively interfere with the caregiver's QoL (97). The importance of gastrostomy tube feeding education in mothers of children with a gastrostomy may increase positive and decrease negative outcomes for these caregivers during the first 3 months post gastrostomy placement using validated questionnaires (98).

STATEMENT

Gastrostomy has an effect on the physical, psychological and social quality of life of children and their caregivers.

RECOMMENDATION

Quality of life using validated questionnaires should be monitored at the beginning and periodically thereafter to evaluate the impact of PEG.

CONCLUSIONS

Instrumental creation of a direct access to the stomach or jejunum to provide nutritional support is important to manage chronic diseases in children of all ages. Knowledge of indications, available techniques and devices helps physicians to provide assistance and guidance to caregivers, avoiding the added burden of progressive malnutrition to other ongoing diseases and to improve prognosis.

A multidisciplinary approach is mandatory for the best possible treatment of children with gastrostomy tubes. Morbidity and mortality are minimized through team decisions on various subjects, such as indication for insertion, adequate planning and preparation before the procedure, following up patients, changing to a low-profile tube, managing complications, and optimal time for permanent removal of the gastrostomy tube.

Monitoring the quality of life of children and care givers with respect to enteral tube feeding should be implemented as part of the holistic approach to chronic disease.

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