Journal of Pediatric Gastroenterology and Nutrition, Publish Ahead of Print

DOI : 10.1097/MPG.0000000000003207

Percutaneous endoscopic gastrostomy in children: an update to the ESPGHAN position paper

Matjaž Homan[a *], Bruno Hauser[b], Claudio Romano[c], Christos Tzivinikos[d], Filippo Torroni[e], Frédéric Gottrand[f], Iva Hojsak[g], Luigi Dall'Oglio[e], Mike Thomson[h], Patrick Bontems[i], Priya Narula[h], Raoul Furlano[j], Salvatore Oliva[k], Jorge Amil-Dias[l *]

[a] Faculty of Medicine, University Children's Hospital, University of Ljubljana, Ljubljana, Slovenia

[b] KidZ Health Castle UZ Brussel, Brussels, Belgium

[c] Department of Human Pathology in Adulthood and Childhood "G. Barresi"- University of Messina, Italy

[d] Al Jalila Children's Specialty Hospital , Dubai , UAE

[e] Digestive Endoscopy and Surgery Unit, Bambino Gesù Children's Hospital IRCCS, Rome. Italy

[f] Univ. Lille, CHU Lille, Infinite U1286, Lille, F-59000, France

[g] Children's Hospital Zagreb, University of Zagreb School of Medicine, Zagreb Croatia, University J.J. Strossmayer, School of Medicine, Osijek, Croatia

[h] Sheffield Children's Hospital NHS Foundation Trust, Sheffield, South Yorkshire, UK

[i] Université Libre de Bruxelles, Hôpital Universitaire des Enfants Reine Fabiola, Belgium

[j] University Children's Hospital Basel, Division of Pediatric Gastroenterology & Nutrition, University of Basel, Switzerland

[k] Maternal and Child Health Department, Sapienza, University of Rome, Italy

[l] Centro Hospitalar S. João, Porto, Portugal

* Contributed equally

Funding sources

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

Abstract

Background: The 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 change to low-profile devices, management of any complications, and optimal timing of removal of the PEG.

Keywords: gastrostomy, children, complications, feeding tube, enteral feeding, nutrition, PEG, balloon device

Abbreviations:

ESPGHAN: European Society for Paediatric Gastroenterology, Hepatology, and Nutrition

GB: skin-level gastrostomy button

LAPEJ: laparoscopic assisted endoscopic jejunostomy

MDT: Multidisciplinary team

NGT: nasogastric tube

NJT: naso-jejunal tube

PEG: percutaneous endoscopic gastrostomy

PEG-J: percutaneous endoscopic gastro-jejunostomy

PEJ: percutaneous endoscopic jejunostomy tube

GERD: gastroesophageal reflux disease

Synopsis of all recommendations is presented in Table 1.

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 which 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 OTSC placed by endoscopy.

Introduction

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 (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 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 1st, 2014 and September 1st, 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 i.e. naso-gastric (NG) or naso-jejunal (NJ) or via a stoma created percutaneously with endoscopic assistance i.e. 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 i.e. surgical gastrostomy or jejunostomy. (7-13) . Main indications that may require temporary or permanent enteral feeding are presented in Table 2.

Indications for PEG

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 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 PEG

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 prior to 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. 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). Ventriculo-peritoneal (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.

Patient Preparation prior to PEG 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 prior to 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 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 (e.g. 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 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 prior to 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 in order 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 e.g. superior mesenteric artery (SMA) syndrome (29).

Antibiotic prophylaxis

Lack of pre-operative antibiotics were 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 does 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*., 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 (34). Therefore, it remains advisable to use prophylactic antibiotics for PEG insertion.

Statements:

An 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 GERD is not usually necessary.

Recommendation:

Antibiotic prophylaxis to prevent PEG site infection is recommended.

PEG 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, prior to 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 PEG

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 3 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.

PEG-J 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 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.

PEG care

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. 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 to 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 to 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.

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 patency of the track in case of accidental removal. Empowering staff nurses with 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 in order 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 how to use and manage the inserted device before discharge from 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 (e.g. 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, 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 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 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 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 found that the same patient cohort had elevated risk for wound infection (58).

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.

PEG 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 h 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 h vs 12 h post-PEG procedure was safe, well tolerated and led to a shortened hospitalization stay (64). Two other prospective randomized trials in children compared early (3h) vs late 6h (65) or 8h (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 3 paediatric randomized controlled trials evaluated introduction of early feeds after pull PEG placement technique. These 3 studies were recently recognized in a meta-analysis confirming that early feeding after PEG placement may be a safe alternative to delayed feeding, although 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 a first choice. In case of severe gastro-oesophageal reflux disease or if bolus feeding is not tolerated continuous feeding can be used as alternative (7). Regardless of the mode of the delivery (bolus or continuous) excessive feeds may lead to abdominal discomfort and distension or ‘‘dumping.’’ Therefore, 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 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.

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 stoma tract is completely matured in one 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 0.8-10 cm, but usually between 0.8 to 4.5cm) 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 e.g. 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 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 to 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 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 out 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/child who will need long term enteral nutrition to improve quality of life.

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

NJ tube, PEG-J, laparoscopic assisted endoscopic jejunostomy (LAPEJ)

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 SMA syndrome.

In some of these circumstances, and mainly in the 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 with jejunal extension (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 in order 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 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 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 gastro-cutaneous 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 prior to 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 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-occtylcyanoacrylate 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 the 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 interfered 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 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.

DISCLAIMER

"ESPGHAN is not responsible for the practices of physicians and provides guidelines and position papers as indicators of best practice only. Diagnosis and treatment is at the discretion of physicians".

REFERENCES

1 Heuschkel RB, Gottrand F, Devarajan K, et al. ESPGHAN position paper on management of percutaneous endoscopic gastrostomy in children and adolescents. J Pediatr Gastroenterol Nutr 2015;60(1):131-41.

2 Löser C, Aschl G, Hébuterne X, et al. ESPEN guidelines on artificial enteral nutrition--percutaneous endoscopic gastrostomy (PEG). Clin Nutr 2005;24(5):848-61.

3 Arvanitakis M, Gkolfakis P, Despott EJ, et al. Endoscopic management of enteral tubes in adult patients - Part 1: Definitions and indications. European Society of Gastrointestinal Endoscopy (ESGE) Guideline. Endoscopy 2021;53(1):81-92.

4 Bawazir OA Percutaneous endoscopic gastrostomy in children less than 10 kilograms: A comparative study. Saudi J Gastroenterol 2020;26(2):105-10.

5 Daveluy W, Guimber D, Uhlen S, et al. Dramatic changes in home-based enteral nutrition practices in children during an 11-year period. J Pediatr Gastroenterol Nutr 2006;43(2):240-4.

6 Cederholm T, Barazzoni R, Austin P, et al. ESPEN guidelines on definitions and terminology of clinical nutrition. Clin Nutr 2017;36(1):49-64.

7 Braegger C, Decsi T, Dias JA, et al. Practical approach to paediatric enteral nutrition: a comment by the ESPGHAN committee on nutrition. J Pediatr Gastroenterol Nutr 2010;51(1):110-22.

8 Irving SY, Lyman B, Northington L, et al. Nasogastric tube placement and verification in children: review of the current literature. Nutr Clin Pract 2014;29(3):267-76.

9 Metheny NA, Krieger MM, Healey F, et al. A review of guidelines to distinguish between gastric and pulmonary placement of nasogastric tubes. Heart Lung 2019;48(3):226-35.

10 Frohlich T, Richter M, Carbon R, et al. Review article: percutaneous endoscopic gastrostomy in infants and children. Aliment Pharmacol Ther 2010;31(8):788-801.

11 Khalil ST, Uhing MR, Duesing L, et al. Outcomes of Infants With Home Tube Feeding: Comparing Nasogastric vs Gastrostomy Tubes. JPEN J Parenter Enteral Nutr 2017;41(8):1380-85.

12 Mahant S, Cohen E, Nelson KE, et al. Decision-making around gastrostomy tube feeding in children with neurologic impairment: Engaging effectively with families. Paediatr Child Health 2018;23(3):209-13.

13 Ricciuto A, Baird R, Sant'Anna A A retrospective review of enteral nutrition support practices at a tertiary pediatric hospital: A comparison of prolonged nasogastric and gastrostomy tube feeding. Clin Nutr 2015;34(4):652-8.

14 Romano C, van Wynckel M, Hulst J, et al. European Society for Paediatric Gastroenterology, Hepatology and Nutrition Guidelines for the Evaluation and Treatment of Gastrointestinal and Nutritional Complications in Children With Neurological Impairment. J Pediatr Gastroenterol Nutr 2017;65(2):242-64.

15 Szczesniak R, Su W, Clancy JP Dynamics of Disease Progression and Gastrostomy Tube Placement in Children and Adolescents with Cystic Fibrosis: Application of Joint Models for Longitudinal and Time-to-Event Data. Intern Med Rev (Wash D C) 2016;2(9).

16 Ricci MF, Alton GY, Ross DB, et al. Gastrostomy Tube Feeding after Neonatal Complex Cardiac Surgery Identifies the Need for Early Developmental Intervention. J Pediatr 2016;169(160-5 e1.

17 Sochet AA, Grindy AK, Son S, et al. Percutaneous Endoscopic Gastrostomy After Cardiothoracic Surgery in Children Less Than 2 Months Old: An Assessment of Long-Term Malnutrition Status and Gastrostomy Outcomes. Pediatr Crit Care Med 2020;21(1):50-58.

18 Sienna JL, Saqan R, Teh JC, et al. Body size in children with chronic kidney disease after gastrostomy tube feeding. Pediatr Nephrol 2010;25(10):2115-21.

19 McGrath KH, Hardikar W Gastrostomy tube use in children with cancer. Pediatr Blood Cancer 2019;66(7):e27702.

20 Findlay SM, Toews H, Grant C Use of gastrostomy tubes in children and adolescents with eating disorders and related illnesses. J Adolesc Health 2011;48(6):625-9.

21 Poskanzer SA, Hobensack VL, Ciciora SL, et al. Feeding difficulty and gastrostomy tube placement in infants with Down syndrome. Eur J Pediatr 2020;179(6):909-17.

22 Al-Attar H, Shergill AK, Brown NE, et al. Percutaneous gastrostomy tubes in children with Pierre Robin sequence: efficacy, maintenance and complications. Pediatr Radiol 2012;42(5):566-73.

23 Cairns A, Geraghty J, Al-Rifai A, et al. Percutaneous endoscopic gastrostomy and ventriculoperitoneal shunts: a dangerous combination? Dig Endosc 2009;21(4):228-31.

24 Kim JS, Park YW, Kim HK, et al. Is percutaneous endoscopic gastrostomy tube placement safe in patients with ventriculoperitoneal shunts? World J Gastroenterol 2009;15(25):3148-52.

25 Fraser JD, Aguayo P, Sharp SW, et al. The safety of laparoscopy in pediatric patients with ventriculoperitoneal shunts. J Laparoendosc Adv Surg Tech A 2009;19(5):675-8.

26 Abbas PI, Naik-Mathuria BJ, Akinkuotu AC, et al. Routine gastrostomy tube placement in children: Does preoperative screening upper gastrointestinal contrast study alter the operative plan? J Pediatr Surg 2015;50(5):715-7.

27 Aumar M, Lalanne A, Guimber D, et al. Influence of Percutaneous Endoscopic Gastrostomy on Gastroesophageal Reflux Disease in Children. J Pediatr 2018;197(116-20.

28 Franken J, Stellato RK, Tytgat S, et al. Gastro-esophageal Reflux After Laparoscopic Gastrostomy Placement in Children. J Pediatr Gastroenterol Nutr 2020;70(2):e41-e47.

29 Livingston MH, Shawyer AC, Rosenbaum PL, et al. Fundoplication and gastrostomy versus percutaneous gastrojejunostomy for gastroesophageal reflux in children with neurologic impairment: A systematic review and meta-analysis. J Pediatr Surg 2015;50(5):707-14.

30 Osei H, Munoz-Abraham AS, Kim JS, et al. Perioperative Antibiotics Are Independent Predictors for Major Complications in Pediatric Patients Undergoing Gastrostomy Placement. J Laparoendosc Adv Surg Tech A 2019;29(10):1259-63.

31 Lipp A, Lusardi G Systemic antimicrobial prophylaxis for percutaneous endoscopic gastrostomy. Cochrane Database Syst Rev 2013;2013(11):CD005571.

32 Rawat D, Srivistava A, Thomson M Antibody prophylaxis for children undergoing percutaneous endoscopic gastrostomy. J Pediatr Gastroenterol Nutr 2005;40(2):234-5.

33 van Els AL, van Driel JJ, Kneepkens CF, et al. Antibiotic prophylaxis does not reduce the infection rate following percutaneous endoscopic gastrostomy in infants and children. Acta Paediatr 2017;106(5):801-05.

34 Alessandri F, Strisciuglio C, Borrazzo C, et al. Antibiotic Prophylaxis for Percutaneous Endoscopic Gastrostomy in Children: A Randomised Controlled Trial. Journal of Pediatric Gastroenterology and Nutrition 2021;72(3):366-71.

35 Blumenstein I, Shastri YM, Stein J Gastroenteric tube feeding: techniques, problems and solutions. World J Gastroenterol 2014;20(26):8505-24.

36 Gauderer MW, Ponsky JL, Izant RJ, Jr. Gastrostomy without laparotomy: a percutaneous endoscopic technique. J Pediatr Surg 1980;15(6):872-5.

37 Gershman G, Thomson M Practical Pediatric Gastrointestinal Endoscopy. Wiley-Blackwell Ltd; 2021.

38 Winter H, Murphy MS, Mougenot JF, et al. Pediatric gastrointestinal endoscopy. PMPH USA, Ltd; 2021.

39 Michaud L, Robert-Dehault A, Coopman S, et al. One-step percutaneous gastrojejunostomy in early infancy. J Pediatr Gastroenterol Nutr 2012;54(6):820-1.

40 Gothberg G, Bjornsson S One-Step Insertion of Low-Profile Gastrostomy in Pediatric Patients vs Pull Percutaneous Endoscopic Gastrostomy: Retrospective Analysis of Outcomes. JPEN J Parenter Enteral Nutr 2016;40(3):423-30.

41 Jacob A, Delesalle D, Coopman S, et al. Safety of the One-Step Percutaneous Endoscopic Gastrostomy Button in Children. J Pediatr 2015;166(6):1526-8.

42 Abdelhadi RA, Rahe K, Lyman B Pediatric Enteral Access Device Management. Nutr Clin Pract 2016;31(6):748-61.

43 Blumenstein I, Borger D, Loitsch S, et al. A glycerin hydrogel-based wound dressing prevents peristomal infections after percutaneous endoscopic gastrostomy (PEG): a prospective, randomized study. Nutr Clin Pract 2012;27(3):422-5.

44 Pars H, Cavusoglu H Effects of 3 Different Methods of Care on the Peristomal Skin Integrity of Children with Percutaneous Endoscopic Gastrostomy Tubes: A Prospective Randomized Controlled Trial. Adv Skin Wound Care 2018;31(4):172-81.

45 León AH, Hebal F, Stake C, et al. Prevention of hypergranulation tissue after gastrostomy tube placement: A randomised controlled trial of hydrocolloid dressings. Int Wound J 2019;16(1):41-46.

46 Bennell J Buried bumper syndrome: do we have enough evidence? Br J Community Nurs 2018;23(Sup7):S28-s30.

47 Kirk L, Shelley A, Battles M, et al. Educating parents on gastrostomy devices: necessary components to achieve success. J Pediatr Nurs 2014;29(5):457-65.

48 Hucl T, Spicak J Complications of percutaneous endoscopic gastrostomy. Best Pract Res Clin Gastroenterol 2016;30(5):769-81.

49 Molina Villalba C, Vazquez Rodriguez JA, Gallardo Sanchez F Percutaneous endoscopic gastrostomy. Indications, care and complications. Med Clin (Barc) 2019;152(6):229-36.

50 Lucendo AJ, Friginal-Ruiz AB Percutaneous endoscopic gastrostomy: An update on its indications, management, complications, and care. Rev Esp Enferm Dig 2014;106(8):529-39.

51 Balogh B, Kovacs T, Saxena AK Complications in children with percutaneous endoscopic gastrostomy (PEG) placement. World J Pediatr 2019;15(1):12-16.

52 Pih GY, Na HK, Ahn JY, et al. Risk factors for complications and mortality of percutaneous endoscopic gastrostomy insertion. BMC Gastroenterol 2018;18(1):101.

53 Sandberg F, Viktorsdottir MB, Salo M, et al. Comparison of major complications in children after laparoscopy-assisted gastrostomy and percutaneous endoscopic gastrostomy placement: a meta-analysis. Pediatr Surg Int 2018;34(12):1321-27.

54 Schrag SP, Sharma R, Jaik NP, et al. Complications related to percutaneous endoscopic gastrostomy (PEG) tubes. A comprehensive clinical review. J Gastrointestin Liver Dis 2007;16(4):407-18.

55 Thomson M, Rao P, Rawat D, et al. Percutaneous endoscopic gastrostomy and gastro-oesophageal reflux in neurologically impaired children. World J Gastroenterol 2011;17(2):191-6.

56 Di Leo G, Pascolo P, Hamadeh K, et al. Gastrostomy Placement and Management in Children: A Single-Center Experience. Nutrients 2019;11(7).

57 McSweeney ME, Jiang H, Deutsch AJ, et al. Long-term outcomes of infants and children undergoing percutaneous endoscopy gastrostomy tube placement. J Pediatr Gastroenterol Nutr 2013;57(5):663-7.

58 Fortunato JE, Troy AL, Cuffari C, et al. Outcome after percutaneous endoscopic gastrostomy in children and young adults. J Pediatr Gastroenterol Nutr 2010;50(4):390-3.

59 McSweeney ME, Kerr J, Jiang H, et al. Risk factors for complications in infants and children with percutaneous endoscopic gastrostomy tubes. J Pediatr 2015;166(6):1514-9 e1.

60 Vervloessem D, van Leersum F, Boer D, et al. Percutaneous endoscopic gastrostomy (PEG) in children is not a minor procedure: risk factors for major complications. Semin Pediatr Surg 2009;18(2):93-7.

61 Kaur S, Ceballos C, Bao R, et al. Percutaneous endoscopic gastrostomy tubes in pediatric bone marrow transplant patients. J Pediatr Gastroenterol Nutr 2013;56(3):300-3.

62 Fascetti-Leon F, Gamba P, Dall'Oglio L, et al. Complications of percutaneous endoscopic gastrostomy in children: results of an Italian multicenter observational study. Dig Liver Dis 2012;44(8):655-9.

63 Stein J, Schulte-Bockholt A, Sabin M, et al. A randomized prospective trial of immediate vs. next-day feeding after percutaneous endoscopic gastrostomy in intensive care patients. Intensive Care Med 2002;28(11):1656-60.

64 Islek A, Sayar E, Yilmaz A, et al. Percutaneous endoscopic gastrostomy in children: Is early feeding safe? J Pediatr Gastroenterol Nutr 2013;57(5):659-62.

65 Corkins MR, Fitzgerald JF, Gupta SK Feeding after percutaneous endoscopic gastrostomy in children: early feeding trial. J Pediatr Gastroenterol Nutr 2010;50(6):625-7.

66 Wiernicka A, Matuszczyk M, Szlagatys-Sidorkiewicz A, et al. Tolerability and safety of early enteral nutrition in children after percutaneous endoscopic gastrostomy placement: A multicentre randomised controlled trial. Clin Nutr 2019;38(4):1544-48.

67 Bury KD, Jambunathan G Effects of elemental diets on gastric emptying and gastric secretion in man. Am J Surg 1974;127(1):59-64.

68 Ellis ZM, Tan HSG, Embleton ND, et al. Milk feed osmolality and adverse events in newborn infants and animals: a systematic review. Arch Dis Child Fetal Neonatal Ed 2019;104(3):F333-F40.

69 Maxwell CI, Hilden K, Glasgow RE, et al. Evaluation of gastropexy and stoma tract maturation using a novel introducer kit for percutaneous gastrostomy in a porcine model. JPEN J Parenter Enteral Nutr 2011;35(5):630-5.

70 Buderus S, Adenaeuer M, Dueker G, et al. Balloon gastrostomy buttons in pediatric patients: evaluation with respect to size, lifetime in patients, and parent acceptance. Klin Padiatr 2009;221(2):65-8.

71 Bhambani S, Phan TH, Brown L, et al. Replacement of Dislodged Gastrostomy Tubes After Stoma Dilation in the Pediatric Emergency Department. West J Emerg Med 2017;18(4):770-74.

72 Michaud L, Guimber D, Blain-Stregloff AS, et al. Longevity of balloon-stabilized skin-level gastrostomy device. J Pediatr Gastroenterol Nutr 2004;38(4):426-9.

73 Hajjat T, Rahhal RM Differences in Durability, Dislodgement, and Other Complications With Use of Low-Profile Nonballoon Gastrostomy Tubes in Children. Nutr Clin Pract 2017;32(2):219-24.

74 Vermilyea S, Goh VL Enteral Feedings in Children: Sorting Out Tubes, Buttons, and Formulas. Nutr Clin Pract 2016;31(1):59-67.

75 Showalter CD, Kerrey B, Spellman-Kennebeck S, et al. Gastrostomy tube replacement in a pediatric ED: frequency of complications and impact of confirmatory imaging. Am J Emerg Med 2012;30(8):1501-6.

76 Alerhand S, Tay ET Point-of-care ultrasound for confirmation of gastrostomy tube replacement in the pediatric emergency department. Intern Emerg Med 2020;15(6):1075-79.

77 Egnell C, Eksborg S, Grahnquist L Jejunostomy enteral feeding in children: outcome and safety. JPEN J Parenter Enteral Nutr 2014;38(5):631-6.

78 Smith D, Soucy P Complications of long-term jejunostomy in children. J Pediatr Surg 1996;31(6):787-90.

79 Bobowicz M, Makarewicz W, Polec T, et al. Totally laparoscopic feeding jejunostomy - a technique modification. Wideochir Inne Tech Maloinwazyjne 2011;6(4):256-60.

80 Belsha D, Thomson M, Dass DR, et al. Assessment of the safety and efficacy of percutaneous laparoscopic endoscopic jejunostomy (PLEJ). J Pediatr Surg 2016;51(3):513-8.

81 Denzer U, Mergener K, Kanzler S, et al. Mini-laparoscopically guided percutaneous gastrostomy and jejunostomy. Gastrointest Endosc 2003;58(3):434-8.

82 Rumalla A, Baron TH Results of direct percutaneous endoscopic jejunostomy, an alternative method for providing jejunal feeding. Mayo Clin Proc 2000;75(8):807-10.

83 Shike M, Latkany L, Gerdes H, et al. Direct percutaneous endoscopic jejunostomies for enteral feeding. Gastrointest Endosc 1996;44(5):536-40.

84 Virnig DJ, Frech EJ, Delegge MH, et al. Direct percutaneous endoscopic jejunostomy: a case series in pediatric patients. Gastrointest Endosc 2008;67(6):984-7.

85 Bischoff SC, Austin P, Boeykens K, et al. ESPEN guideline on home enteral nutrition. Clin Nutr 2020;39(1):5-22.

86 Forbes D, Grover Z Tube feeding: stopping more difficult than starting. J Paediatr Child Health 2015;51(3):245-7.

87 Thomas H, Yole J, Livingston MH, et al. Replacing gastrostomy tubes with collapsible bumpers in pediatric patients: Is it safe to "cut" the tube and allow the bumper to pass enterally? J Pediatr Surg 2018;53(5):942-45.

88 Heinrich H, Gubler C, Valli PV Over-the-scope-clip closure of long lasting gastrocutaneous fistula after percutaneous endoscopic gastrostomy tube removal in immunocompromised patients: A single center case series. World J Gastrointest Endosc 2017;9(2):85-90.

89 Singhal S, Changela K, Culliford A, et al. Endoscopic closure of persistent gastrocutaneous fistulae, after percutaneous endoscopic gastrostomy (PEG) tube placement, using the over-the-scope-clip system. Therap Adv Gastroenterol 2015;8(4):182-8.

90 St-Louis E, Safa N, Guadagno E, et al. Gastrocutaneous fistulae in children - A systematic review and meta-analysis of epidemiology and treatment options. J Pediatr Surg 2018;53(5):946-58.

91 Denning NL, Abd El-Shafy I, Hagen J, et al. Outpatient curettage and electrocautery as an alternative to primary surgical closure for pediatric gastrocutaneous fistulae. J Surg Res 2018;229(96-101.

92 Lalanne A, Gottrand F, Salleron J, et al. Long-term outcome of children receiving percutaneous endoscopic gastrostomy feeding. J Pediatr Gastroenterol Nutr 2014;59(2):172-6.

93 Nelson KE, Lacombe-Duncan A, Cohen E, et al. Family Experiences With Feeding Tubes in Neurologic Impairment: A Systematic Review. Pediatrics 2015;136(1):e140-51.

94 Glasson EJ, Forbes D, Ravikumara M, et al. Gastrostomy and quality of life in children with intellectual disability: a qualitative study. Arch Dis Child 2020;105(10):969-74.

95 Franken J, Stellato RK, Tytgat S, et al. The Effect of Gastrostomy Placement on Health-Related Quality of Life in Children. J Pediatr Surg 2019;54(11):2268-73.

96 Franken J, Stellato RK, Tytgat S, et al. Health-related quality of life in children after laparoscopic gastrostomy placement. Qual Life Res 2020;29(1):171-78.

97 Figueiredo AA, Lomazi EA, Montenegro MA, et al. Quality of Life in Caregivers of Pediatric Patients with Cerebral Palsy and Gastrostomy Tube Feeding. Arq Gastroenterol 2020;57(1):3-7.

98 Suluhan D, Yildiz D, Surer I, et al. Effect of Gastrostomy Tube Feeding Education on Parents of Children with Gastrostomy. Nutr Clin Pract 2020.

Table 1 – List of Statements and Recommendations

Statements
A multi-disciplinary team 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 GERD is not necessary.
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.
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.
PEGJ tubes and direct PEJ tubes can be endoscopically placed and provide a longer-term solution to the patient requiring this enteral feeding route.
Several non-operative techniques and surgery can be used to close a fistula post-removal after one month of non-closure.
Gastrostomy has an effect on the physical, psychological and social quality of life of children and their caregivers.
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.
Antibiotic prophylaxis to prevent PEG site infection is recommended.
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.
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 hours 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 six months, but buttons can be replaced annually.
LAPEJ is a more permanent method of transpyloric feeding than PEGJ.
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.

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's 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)

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/mm3)**		
Clear interposition of enlarged organs **(eg, liver, colon)**		
Frank peritonitis		

Table 4 - Early and 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	Malpositioning of the gastrostomy catheter within

pseudoaneurysm	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

Table 5 - Major and minor 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		