



CONSENSUS STATEMENT

ESPEN guidelines on artificial enteral nutrition—Percutaneous endoscopic gastrostomy (PEG)

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Introduction

Since the first published report of a percutaneous endoscopic gastrostomy (PEG) in 1980 by Gauderer and Ponsky,¹ the procedure has been modified and improved several times. It has now replaced the surgical gastrostomy (Witzel gastrostomy, Stamm gastrostomy, Janeway gastrostomy) which was associated with a markedly higher rate of complications.^{2,3} Placement of a PEG/PEJ (percutaneous endoscopic jejunostomy) tube is simple, safe and well-tolerated by patients.^{4,5} There is a wide range of diets and nutrient preparations suitable for tube feeding currently available. Modern PEG tube systems made of polyurethane or silicone rubber are easy to insert and well-tolerated. Clinicians

have a broad spectrum of low risk, practicable, patient-orientated forms of enteral nutritional therapy available. PEG-feeding, therefore, has rapidly spread to become routine practice worldwide and is currently the method of choice for medium- and long- term enteral feeding.

Recent studies have provided new information on the benefits and drawbacks of PEG-feeding. We have a clearer appreciation of ethical issues surrounding artificial enteral feeding. Since we started placing percutaneous enteral tube systems by endoscopic techniques nearly 25 years ago¹ our attitude towards this method has changed in many ways: in the early days PEG-tubes were often used in patients in the advanced state of predominantly malignant diseases; this is now regarded as an inappropriate indication in most cases being too late to offer adequate clinical benefits to the patients in terms of nutritional status and quality of life. Data from a large number of recently

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published clinical studies has modified our views on a variety of issues: on the benefits and disadvantages of the PEG feeding; on more distinct clinical indications with regard to important outcome parameters (i.e. maintenance and improvement of nutritional status and quality of life); on ethical aspects; and on contraindications, for example in patients with advanced dementia or during terminal stages of incurable diseases. In many ways our modern point of view has shifted towards an earlier individual consideration of additional supplementary feeding via PEG tube in appropriate patients, when special nutritional advice and supplementary drinks are not effective.

Guidelines issued by various specialist authorities have been modified in the light of recently published clinical studies and the recommended procedures have been markedly simplified in many respects.⁶⁻⁹ With this background, ESPEN asked a multidisciplinary group (nutritionists, gastroenterologists, nurses, and medical practitioners) with special expertise in the field to prepare guidelines and a consensus report on current clinical aspects of artificial enteral nutrition via PEG-tubes in adults and children. In the following, matters relevant to clinical practice are summarized and discussed on the basis of the currently available scientific information.

Enteral tube systems

In general, tube systems for artificial enteral nutrition can be placed by nasal insertion, guided percutaneous application, or surgical techniques. The superiority of percutaneously placed gastrostomies compared to former surgical gastrostomy procedures (i.e. Witzel, Stamm, Janeway technique) has been shown clearly in many clinical studies.^{2,3} If it is to be expected that the patient will require artificial enteral nutrition for a longer period after abdominal surgery, it is advisable to prepare for subsequent jejunal feeding by preparation of a fine needle catheter jejunostomy (NCJ) towards completion of the surgical procedure. This intraoperative technique enables the use of clinically effective early postoperative enteral nutrition in patients who are not able to eat sufficient amounts for a prolonged period after major abdominal surgery. Today, various techniques and modifications are available.¹⁰⁻¹²

Several studies compared the various clinical effects of PEG tube feeding and feeding via nasogastric tubes.¹³⁻¹⁷ While nasogastric tube feeding was found to have a higher rate of

discomfort and complications (irritations, ulceration, bleeding, dislocation, clogging), PEG feeding proved to have higher subjective and social acceptance, being less stigmatizing, and had reduced rates of oesophageal reflux and aspiration pneumonia.¹³⁻¹⁷ Interestingly it was clearly shown that with regard to nutritional efficacy PEG feeding was superior too.^{14,17} Therefore, in our present understanding, feeding via PEG should be preferred if it can be expected that the patient's nutritional intake is likely to be inadequate and supplementary artificial enteral nutrition is necessary for a period exceeding 2-3 weeks. Figure 1 shows the decision tree that can be used in clinical practice to select the tube system for enteral nutrition most appropriate to the requirements of the individual case. Evidence from research with parents suggests that decision making in children is difficult and emotionally laden; there is a special need for information and individual support in these cases.

Meanwhile, besides the standard endoscopic procedure, many modifications and other techniques for adequate percutaneous placement of enteral tube systems were established and proven in clinical practice. In the hands of an experienced endoscopist it should be possible to place percutaneous tube systems in nearly all cases either by endoscopic, laparoscopic, sonographic, or fluoroscopic means. The gastric and jejunal tube systems currently available for enteral feeding are outlined in Fig. 2. Artificial enteral nutrition should either be given into the stomach or beyond the ligament of Treitz, there are no medical reasons for any kind of duodenal feeding. In cases in which endoscopic insertion of a tube is not technically possible, gastric (PLG) and jejunal (PLJ) enteral tube systems can also be placed using laparoscopic

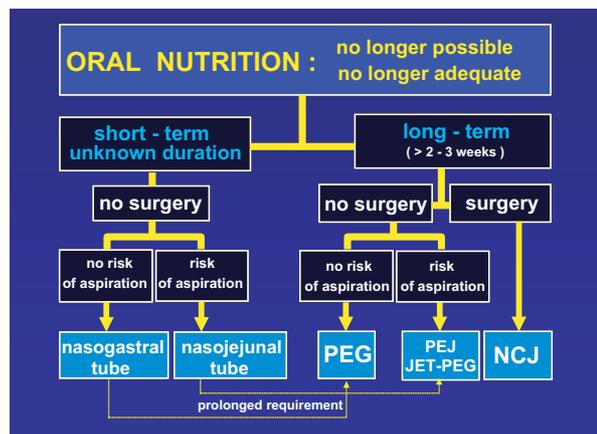


Figure 1 Decision tree for the selection of the appropriate tube system for enteral nutrition (for explanation, see text).

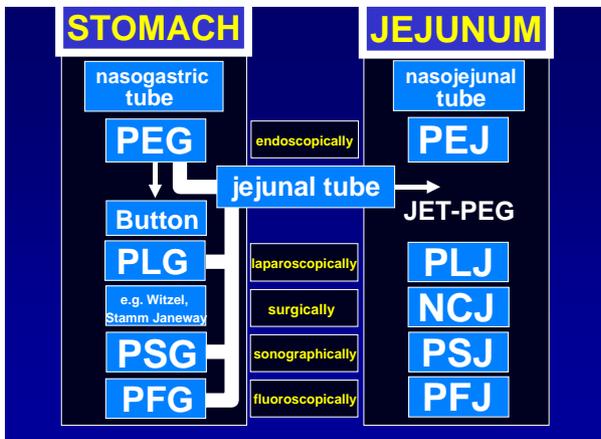


Figure 2 General techniques and modified methods of placement of enteral tube systems for gastric and jejunal nutrition: PEG, Percutaneous Endoscopic Gastrostomy; PLG, Percutaneous Laparoscopic Gastrostomy; PSG, Percutaneous Sonographically Guided Gastrostomy; PFG, Percutaneous Fluoroscopically Guided Gastrostomy; PEJ, Percutaneous Endoscopic Jejunostomy; JET-PEG, Jejunal Tube PEG; PLJ, Percutaneous Laparoscopic Jejunostomy; NCJ, Fine Needle Catheter Jejunostomy; PSJ, Percutaneous Sonographically Guided Jejunostomy; PFJ, Percutaneous Fluoroscopically Guided Jejunostomy.

techniques.^{18–20} In those rare situations in which there is a stenosis of the oesophagus which is resistant to bougienage and prevents passage of an endoscope, a gastric or jejunal feeding tube can be inserted with the aid of sonographic^{21,22} or fluoroscopic^{22–24} guidance. Once a stable stoma has formed at least 4 weeks after insertion of the PEG system, a changeover to use of a button system may be conducted for cosmetic reasons, at the request of the patient.^{25–28} Although, primarily placed button procedures are published in the literature,^{29,30} it is generally recommended that buttons are placed secondarily after initial PEG placement with a mature established stoma canal. Since button systems are much more expensive and have to be routinely exchanged approximately every 6 months because of material fatigue—which is not necessary for PEG-tubes—these systems are usually only indicated for cosmetic reasons in socially fully integrated younger patients. In cases of gastroduodenal motility problems, pyloric stenosis or aspiration, a jejunal catheter can be placed through the PEG and endoscopically guided further into the jejunum beyond the ligament of Treitz (JET-PEG, jejunal tube PEG) or a PEJ can be performed as the initial procedure.^{12–33} Tube dysfunction and the need for reinterventions are significantly lower in direct PEJ compared to JET-PEG, therefore direct PEJ should be preferred if long-term jejunal feeding is indicated. There are

conflicting data in the recent literature about whether or not jejunal feeding via PEJ or JET-PEG definitely reduces the rate of reflux and aspiration.^{33–35}

Indications

As a general rule, PEG feeding should be considered if it is expected that the patient's nutritional intake is likely to be qualitatively or quantitatively inadequate for a period exceeding 2–3 weeks. Prior to the insertion of an enteral feeding tube, each case should be considered on its own merits, taking into account the clinical situation, diagnosis, prognosis, ethical issues, the expected effect on the patient's quality of life and the patient's own wishes.^{36–41} The central question to be answered is whether PEG feeding is likely to improve or maintain the patient's quality of life? Percutaneous insertion of an enteral feeding tube should not be a terminal or even symbolic measure in patients with an unfavourable prognosis or an incurable disease and is—according to our present knowledge and understanding—very rarely indicated in patients with short-life expectancy or advanced dementia. Placement of a PEG-tube should always be for medical reasons and not for administrative convenience—saving time, money or manpower—nor is a PEG tube a substitute for good nursing care. Ethical considerations have to be taken into account before the placement of PEG-tubes: decision-making should always be individualized rather than the result of a general algorithm.^{36–41} It is important to try supplementary oral nutrition by special drinks and individual nutritional and swallowing advice first; but if this does not stabilize or improve the patients' situation additional enteral nutrition via PEG should be considered early in ongoing diseases in order to stop the deterioration of the nutritional status and consecutively to stabilize and even improve individual quality of life.

The primary aim of enteral tube feeding is to avoid further loss of body weight, to correct significant nutritional deficiencies, to rehydrate the patient, to promote growth in children with growth retardation, and to stop the related deterioration of the quality of life of the patient due to inadequate oral nutritional intake. With this aim in view, the range of indications for the use of a PEG tube is wide.^{4–8,42,43}

- *Oncological disorders* (stenosing tumours in the ear, nose and throat region or the upper

gastrointestinal tract; PEG tubes may be used palliatively in inoperable cases or placed prior to surgery, radiotherapy or chemotherapy and removed when the patient has recovered and has a reliable and adequate oral intake).

- *Neurological disorders* (dysphagic states after cerebrovascular stroke or craniocerebral trauma, and in patients with cerebral tumours, bulbar paralysis, Parkinson's disease, amyotrophic lateral sclerosis, cerebral palsy).
- *Other clinical conditions* (wasting in AIDS, short bowel syndrome, reconstructive facial surgery, prolonged coma, polytrauma, Crohn's disease, cystic fibrosis, chronic renal failure, congenital abnormalities, e.g. tracheo-oesophageal fistula).

Another indication for use of a PEG system is the palliative drainage of gastric juices and secretions in the small intestine in the presence of a chronic gastrointestinal stenosis or ileus. In non-selected patients less than 40% of patients with a PEG tube have a malignant underlying disorder.⁴ According to the recent literature, the main therapeutic indications are benign neurological disorders (almost 50% of cases) and ENT disorders—usually malignant (approximately 30% of cases).⁴

Aggressive cancer treatment (chemotherapy, radiotherapy) definitely requires an adequate individual nutritional strategy. With the likelihood of transient catabolic metabolism in this situation and the related increased risk of weight loss, PEG tubes can be used liberally; it has been demonstrated clearly that early and appropriate supplementary enteral nutrition via a PEG system is more effective than oral nutrition alone in those cases in which the patient undergoes several weeks of chemotherapy/radiotherapy.^{44,45} In critically ill patients suffering from major head trauma, persistent or slow recovering vegetative state, or long-term intensive care stay: PEG should be considered early in order to ensure an adequate nutritional support and to prevent the well-known drawbacks of prolonged nasogastric tube feeding.⁴⁶ Enteral feeding can easily be terminated after such therapy if patients have recovered and have a stable, adequate oral food intake. Furthermore, prospective clinical studies clearly reveal, that in most cases supplementary PEG feeding can prevent ongoing weight loss and maintain nutritional status while full reversal of weight loss is rare even in benign diseases (Fig. 3).^{4,44} These clinical data have led us to a more generous and a much earlier individual discussion on the benefits of additional feeding via PEG in appropriate patients. Figure 3 from a prospective clinical study in 210 consecutive

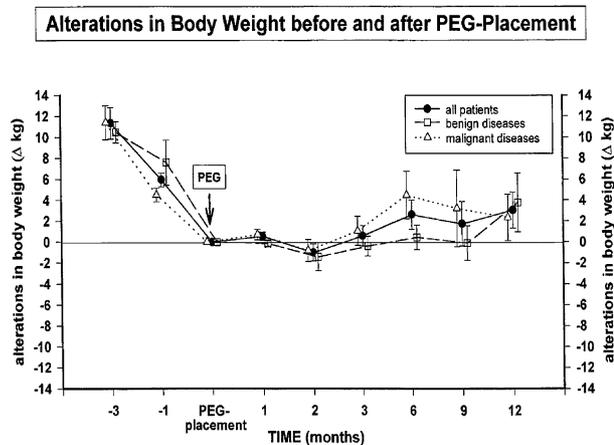


Figure 3 Time-course of body weight in all patients (n = 210) and separately in patients with benign or malignant underlying disease retrospectively for 3 months before and prospectively 12 months after PEG placement (Löser et al., Dig Dis Sci 1998; 43: 2549-2557; for comments, see text).

patients depicts the two major problems: (I) on average adult patients lose about 12 kg body weight within the last 3 months before PEG placement is considered (and this is found for patients with malignant as well as benign underlying disease in precisely the same way!) and (II) this significant deterioration of nutritional status can be halted in most cases but, even in patients with benign diseases, it is very rare to fully regain lost weight and return to the former nutritional status.^{4,44} Though, a timely PEG placement is beneficial in most cases a general statement concerning optimal timing is difficult and primarily depended on the individual conditions.

HIV/AIDS

PEG placement may help to improve medication compliance in children and significantly increases nutritional status in AIDS patients with wasting syndrome.^{47,48}

Cystic fibrosis

There appears to be a consensus stating that nocturnal PEG feeding of malnourished patients with cystic fibrosis improves nutritional status, stabilizes lung function, is superior to the use of nasogastric tubes, and is without major side effects.⁴⁹ Since the long-term benefit depends on pre-gastrostomy pulmonary function, with better outcome observed with good pulmonary function,⁵⁰

PEG insertion should be performed early in the course of the disease.

Crohn's disease

Despite fears of complications such as fistula formation, recently published studies reveal that PEG placement is safe with no higher rate of complication in patients with Crohn's disease.^{51–54} Furthermore, supplementary feeding via PEG proved to be highly effective even in children with severe growth retardation which nowadays makes supplementary feeding via PEG the most reliable nutritional measure available in malnourished patients with Crohn's disease, where supplementary nutritional drinks are not effective.

Small children

In experienced hands PEG-tubes can be placed safely in low weight infants and neonates, even in those weighing less than 3 kg.⁵⁵

Mentally and physically retarded children

Feeding via PEG is able to substantially improve nutritional status and quality of life in mentally retarded children and adults.⁵⁶ However, due to physical deformities (severe kyphoscoliosis), placement is often complicated but feasible in experienced hands. As the placement is sometimes impossible, the procedure should be performed under general anaesthesia in the operation room, and proceed with a minilaparotomy if the anatomical situation prohibits endoscopic positioning. The surgeon punctures the stomach helped by the minilaparotomy, and the endoscopic procedure then follows as usual.

Stroke, neurological dysphagia

Dysphagic states in neurological disorders are the most common and established indications for artificial enteral nutrition via PEG.^{4,6,7,42,43} The assessment of safe swallow and adequacy of nutritional assessment are crucial in determining which patients with neurological dysphagia should be referred for PEG. Especially in stroke patients with dysphagia and inadequate oral food intake early feeding via PEG is helpful and highly effective, and in contrast to nasogastric tube feeding allows in parallel adequate training to re-enable swallowing. In stroke patients PEG can be removed when the ability to swallow recovers and

adequate oral food intake is possible without complications.

Amyotrophic lateral sclerosis

Most of these patients will receive a PEG. The decision for PEG placement should be made early in the course of the disease as restricted pulmonary function will reduce the chance of successful placement.⁵⁷ Pulmonary function with a vital capacity of more than 50% of the predicted capacity is recommended, but in experienced hands, PEG placement is feasible in patients with a VC of 1 l and a PCO_2 of less than 45 mm Hg (6.5 pKa). Sedation is critical and the stomach should actively be desufflated after the procedure as patients cannot lower the raised diaphragm themselves.

Dementia

The most controversial area regarding PEG placement concerns patients with dementia. Stated aims of tube feeding in advanced dementia include improving functional status, avoiding hunger, improving comfort, preventing nutritional decline and its consequences, preventing aspiration and reducing the incidence of pressure sores and infections. Although there are no randomized controlled studies, recent reviews conclude that there is no published evidence that these aims are achieved.^{58–61} Overall published data support an individualized but critical and restrictive approach to PEG feeding in elderly demented patients.^{36,37,39,41}

Contraindications

Serious coagulation disorders (INR > 1.5, Quick < 50%, PTT > 50 s platelets < 50,000/mm³), interposed organs (e.g. liver, colon), marked peritoneal carcinomatosis, severe ascites, peritonitis, anorexia nervosa, severe psychosis and a clearly limited life expectancy are contraindications for the use of PEG/PEJ systems.^{6–8} Though clinical studies are not available taking of low dose aspirin is not established as a contraindication for PEG-placement. Nowadays, the lack of diaphanoscopy (transillumination of the endoscopic light through the abdominal wall) at the puncture area is no longer a contraindication; a negative needle aspiration test (using a syringe containing 5 ml saline solution, puncture under continuous aspiration towards the air-filled stomach without prior air aspiration)

proved to be even safer than an adequate diaphanoscopy.⁶² It has been shown in clinical studies that the presence of mild to moderate ascites⁶³ and/or a ventriculoperitoneal shunt system⁶⁴ are no longer contraindications for the insertion of a PEG/PEJ tube, as an increased rate of complications has not been demonstrated under these circumstances. Peritoneal dialysis treatment is also not a contraindication for the use of a PEG tube. Particularly, in the paediatric field, good results have been reported for the use of PEG tubes or button systems being placed prior to the start of peritoneal dialysis.^{65,66} Case reports confirm that even in pregnancy PEG tubes can be inserted successfully with no increased complication rate.⁶⁷

Oesophageal stenoses are not a contraindication, providing these can be passed by a very thin endoscope (direct puncture technique) or can be treated with endoscopic dilatation (pull technique). It may be necessary to consider placing an oesophageal tube or stent (to improve quality of life by allowing swallowing of saliva, drinking at will, tasting food, etc.), and to simultaneously insert a PEG tube for adequate supplementary nutrition—which is hardly possible in these cases just by the oral route. In order to exclude the possibility of local contraindications, gastroscopy is routinely conducted prior to insertion of a PEG/PEJ tube. Severe erosive gastritis or ulcer should be healed before an enteral feeding tube is inserted. Extensive tumour infiltration in the area of the puncture site also represents a local contraindication. Previous gastrointestinal surgery (such as Billroth I or II resection or total gastrectomy) is no longer considered a contraindication for the use of PEG/PEJ tube systems. Although, the primary success rate for endoscopic placement of enteral feeding tubes is somewhat lower in patients who have undergone previous gastrointestinal surgery, the procedure can be carried out without a significant increase in risk if diaphanoscopy is successful and/or the needle aspiration test is negative.

Initial examination and informed consent

As the endoscopic insertion of an enteral feeding tube represents an elective invasive procedure and physical injury from the legal point of view, it is essential to obtain legally valid consent.⁴¹ The nature and scope of the information to be given to the patient and the related documentation should follow the general guidelines for obtaining informed consent from patients prior to endoscopic

procedures and minimal invasive surgery. In the case of patients with reduced legal capacity who as yet have no legal guardian, consent must be obtained from the local magistrates court prior to endoscopic placement of an enteral feeding tube in most European countries, as is the case prior to other invasive, elective procedures. Nevertheless, in this regard the law is clearly different in different European countries and the special local legal provisions have to be taken into account. In those cases in which there is no recent documentation of the patient's will to undergo the procedure, it is not sufficient from the legal point of view to merely obtain consent from close relatives.

The preparatory measures required prior to endoscopic tube insertion are outlined in Table 1. An indwelling venous catheter should first be inserted. This allows for appropriate sedation for the procedure with a short acting benzodiazepine derivative (such as midazolam, 3–5 mg i.v.). The patient should be fasted for at least 8 h prior to the PEG procedure. If there is extensive hair growth on the abdomen, the epigastric region should be shaved above the umbilicus. It should be ensured that the current coagulation status is as follows: INR < 1.5, Quick > 50%, partial thromboplastin time < 50 s and platelet count > 50,000/mm³. Aspirin can be stopped five days prior to PEG-placement, but—though it is not yet investigated in clinical studies—clinical practice reveals that PEGs can be placed in patients taking low dose aspirin medication without increased risk of complications. There is no evidence that discontinuation of drugs which influence gastric acid secretion, such as H₂ receptor antagonists or proton pump inhibitors, is necessary prior to insertion of a PEG tube. Children tend to have a general anaesthetic and a shorter period of starvation.

Preparation, antibiotic prophylaxis

The adult patient should be fasted for at least 8 h prior to the procedure for insertion of a PEG system, or longer in cases in which there is evidence of impairment of gastric motility. Currently, there is a controversial debate in the literature as to whether a single dose of an antibiotic (e.g. 2 g of a cephazolin i.v.), as a general prophylaxis, provides effective protection against inflammatory complications (for an overview, see).^{68,69} At present, there are more published studies in which a clinical benefit of a single administration of an antibiotic has been demonstrated,^{70–75} while there are two studies in

Table 1 Preparations and aftercare prior to and after endoscopic placement of an enteral tube system.

Preparation	Aftercare
Exclusion of contraindications	Allow external fixation plate to adapt over night with low traction (avoid tension!)
Current coagulation status (INR < 1.5, Quick < 50%, PTT < 50 s, platelets > 50,000/mm ³)	Ensure tube has sufficient free movement > 5 mm after first change of dressing next morning
Written informed consent (see text)	Sterile Y-compress under the external fixation plate
Indwelling venous catheter	Cleansing and sterile renewal of dressings initially on a daily basis (later every 2–3 days) (see text)
Patient fasting overnight (8 h)	Nutrients can be delivered via the tube 1 h after uncomplicated PEG placement
Antibiotic prophylaxis (2 g cephazolin i.v.) (see text)	Individual nutritional schedule (calories, fluids, etc.)
Shave the epigastric region above the umbilicus if necessary	Training of patients and relatives
Analgesia/sedation (e.g. midazolam i.v.), general anaesthetic for children	Organization of further aftercare and nutritional supply
Placement of tube system under sterile surgical conditions	Social support for patient and his family

which no advantage in respect of the prevention of wound infection was found.^{76,77} Additionally, one recently published meta-analysis⁶⁹ confirmed the clinical benefits of a single-shot antibiotic prophylaxis. In view of the various criticized inadequacies and obvious methodological flaws of the published studies, it is not possible to draw a definite conclusion at present. There is no consensus as to the general benefit of prophylactic use of antibiotics, so that in the late 1990s many experienced centres started to provide antibiotic prophylaxis only in patients with a particularly high-risk profile. The German Association of Gastroenterology (DGVS) no longer recommends a general antibiotic prophylaxis in their revised new guidelines from 2002.⁷⁸ On the other hand, official guidelines of European and American Societies of Gastrointestinal Endoscopy have recommended the use of a single intravenous dose of antibiotics for all patients undergoing PEG insertion,^{79,80} which is in line with most of the published studies.^{69–75}

In summary we recommend that, in experienced hands under established hygienic conditions, routine antibiotic prophylaxis is not mandatory for PEG placement. However, in case of doubt or outside experienced centres a generous decision in favour of antibiotic prophylaxis is recommended. It is not necessary to give a single, prophylactic dose of an antibiotic if the patient is already receiving antibiotic therapy.

A gastroscopy should be performed as a routine measure prior to insertion of the PEG tube. The appropriate preparations for this procedure must also be taken. The examination should be conducted with the patient supine and the patient's

head turned to the side. An aspirator should be available in cases where there is extensive formation of mucus or other secretions. The PEG insertion procedure is conducted using standard surgical procedures under sterile conditions (skin disinfection, sterile surgical drapes, sterile gloves for the PEG insertion, sterile dressing, etc.).

Technique

A variety of insertion techniques and a wide range of commercially available PEG systems, currently allow the experienced endoscopist to achieve a success rate greater than 99% for the procedure and a method-related mortality rate close to 0%.^{4,31,81–83} Such success depends on meeting established technical standards and observing the well-known contraindications.^{4,29,81–85} In patients who have undergone prior gastric surgery (Billroth I- or II-resection, total gastrectomy, etc.) the success rate is only slightly reduced.^{81,86} A PEG tube can be placed using either the pull through method ("pull" technique), the Seldinger technique ("push" technique) or by direct puncture. The thread pull through technique is the simplest and safest technique and has become the most frequently used in clinical practice, followed by the direct puncture method. As a general rule it is advisable to use PEG tubes with a large lumen (at least 15 Charrière)—even in children—as smaller diameter tubes are associated with higher rates of clogging.

According to prospective studies PEG placement using the standard pull through method takes approximately 12 min.⁴ In the thread pull through method, the puncture site is marked with gastroscopic monitoring of the anterior gastric wall in the region of the distal corpus by means of diaphanoscopy or the needle aspiration test (see above) and, after adequate local anaesthesia (-in children long acting local anaesthetics e.g. bupivacaine should be preferred to improve local pain relief post insertion-) and an appropriate (~8 mm, depending on the tube size-) initial incision, the puncture cannula is inserted under endoscopic control into the stomach which has been previously fully dilated with air. As stated above, lack of diaphanoscopy in the region of the puncture site is no longer considered a contraindication for the procedure, assuming that there are no problems during needle puncture (without prior air aspiration) using a syringe containing 5 ml saline solution during gastric aspiration (needle aspiration test).⁶² A suture thread or guide wire is passed through the cannula sheath into the stomach, grasped using the biopsy forceps by the endoscopist and drawn out through the mouth together with the gastroscope. The thread loop is fastened tightly to the external end of the PEG tube and, while applying continuous traction, is drawn down through the oesophagus and stomach and out through the puncture site until the internal fixation plate has drawn the anterior wall of the stomach against the abdominal wall. To avoid causing damage to the mucosa while pulling the thread or wire, it must be ensured that the cannula sheath remains in the puncture canal during the positioning phase until the conical tip of the tube is locked in its intragastric end. Provided that positioning of the PEG tube has been conducted without complications, it is unnecessary to confirm appropriate placement by means of further gastroscopy or X-ray.⁸⁷

In order to avoid the most commonly occurring complication, i.e. wound infection, it is important that the following general measures are taken and these should be followed as a part of routine practice: it should be ensured that the incision at the puncture site is sufficiently large (8 mm) so that the tube does not cause pressure-related lesions in the skin area with subsequent ischaemia; a Y-compress should be used to avoid the formation of a moist cavity under the external fixation plate and, furthermore, to cushion movements; to ensure that local ischaemia is not induced, the external fixation plate should retain the tube but not exert any tension on the stoma canal and allow free movement of the tube of at least 5 mm.

Aftercare

On the basis of our current experience, there is no longer any justification for the previously recommended procedure of application of traction to the freshly inserted PEG system for the initial 24 h to achieve better adaptation of the gastric to the abdominal wall. On the contrary, if the tension applied is too great and is maintained for too long, there is the possibility of ischaemia and thus wound healing complications and an increased risk of infection. In order to achieve appropriate adaptation, the external fixation plate should be initially subjected to very low traction, without tension, overnight. It must thereafter be ensured that the tube has at least 5 mm of free movement when the Y-compress is inserted under the external fixation plate (Table 1).

The first change of dressing should be performed the morning after PEG placement. Until granulation of the stoma canal has taken place it is advisable to change the sterile dressing daily and provide local disinfection (usually day 1–7). Dressings should be removed and the fixation plate opened and the tube removed from the groove. Then gloves are disposed of, hands disinfected and new gloves applied. The wound area is inspected (bleeding, erythema, secretion, induration, allergic skin reaction etc.), cleaned, disinfected and dried completely. In order to avoid adhesions (buried bumper syndrome, see below) the tube should be pushed approximately 2–3 cm ventrally and carefully pulled back up to the resistance of the internal fixation flange. Then a Y-compress is applied under the tube and the external fixation plate is secured with free movement of at least 5 mm and a sterile dressing is applied.

After initial wound healing wound cleansing and dressing should be performed every 2–3 days. Dressing with a simple plaster around the wound is possible. Washing with soap and water or showering is possible after initial wound healing (1–2 weeks after insertion of PEG); dressings should always be removed before washing, residual soap rinsed away and the tube dried well before a new dressing is applied.

After feed or medication administration the tube should be flushed with about 40 ml of drinking or still mineral water.

As part of the further care of a patient with a PEG system, preparation of an individual nutrition plan (calculation of the patient's daily calorie and fluid requirement, choice of the appropriate nutrient preparations, etc.) is required, and, where necessary, the patient and his/her relatives may need to be trained in care of the tube and administration of

the feed. Meanwhile, measures for the future treatment and home care of the patient must be organized and coordinated. For patients with cerebrovascular disease routine follow-up for example by speech and language therapists might improve the identification of patients whose swallowing has improved sufficiently to allow full oral feeding and removal of the PEG tube, which occurs in about 25% of stroke patients requiring initial PEG feeding.

To prevent material fatigue, the C-clamp should be repositioned daily or preferably left open if not needed. The tube tip should be cleaned daily using water and a small brush. Common errors made during enteral tube feeding that can cause considerable discomfort for the patient include too rapid build up of enteral nutrition in a patient who has received total parenteral nutrition over a prolonged period, delivery of an excessive volume as a bolus, delivery of the nutrient preparation at too high or too low temperatures, fluid deficiency, insufficient supply of dietary fibre and the use of nutrient preparations which are inadequate for the individual patient.

Complications

The rate of complications after endoscopic placement of enteral feeding tubes is estimated in the available literature to be in the range 8–30%, depending on the very different definitions of what actually constitutes a complication. Serious complications requiring treatment occur in approximately 1–4% of cases.^{4,29,34,43,81–83,85,88–90} Acute and severe complications, such as perforation, serious abdominal haemorrhage or peritonitis, which require surgical intervention, occur in far fewer than 0.5% of cases, provided that the above-mentioned contraindications are observed.

The most frequent complication is the occurrence of local wound infection (in approximately 15% of cases). Less than 5 mm of reddening around the outer stoma canal is frequent. It is largely induced by movement and is not necessarily a sign of wound infection. During initial daily change of dressing the wound should be inspected and reddening should be carefully noted. Most of the peristomal forms of infection can be readily treated by means of antiseptic measures and daily change of dressings under sterile conditions. After taking a swab for microbiological examination, persistent local infections should additionally be treated by antibiotics. Radiological evidence of pneumoperitoneum is very frequently observed after placement of a PEG system. It is reported in the

literature^{91–93} that pneumoperitoneum after insertion of a PEG tube may occur in more than 50% of cases; nevertheless, a pneumoperitoneum is not regarded as a complication since there is no clinical evidence of adverse consequences. Even in cases of pneumoperitoneum and abdominal pain the patients first should be treated conservatively since severe cases are definitely rare and many unnecessary exploratory investigations have been described.^{43,91–93}

In the initial days after endoscopic placement of an enteral feeding tube, patients may complain of peristomal abdominal pain, fever (in some instances with transient leukocytosis) or occasionally transient leakage of the stomach contents from the granulating puncture canal. If gastric contents are leaking skin protection for example using a hydrocolloid wafer as a keyhole dressing is an important issue. The possible long-term complications after placement of a PEG tube include occlusion of the tube, tube porosity and fracture with subsequent leakage from the tube or the tube connection, development of cellulitis, eczema or hypergranulation tissue (proud flesh). The development of most of these potential long-term complications is exclusively dependent on the quality of aftercare given to the tubing system, and can be effectively avoided if the proper measures are taken. In association with the use of the thread pull through method, 16 cases of contact cancer at the puncture site due to the presence of occluding proximal tumours have been reported worldwide, although in none of these very rare cases did this prove to be a life-limiting factor.⁹⁴

Buried bumper syndrome is a rare complication and to the best of our knowledge can be avoided by adequate aftercare treatment (see above). Nevertheless, if a buried bumper syndrome occurs it is removable in nearly all cases by endoscopic means using a needle knife sphincterotome.^{89,95,96}

Removal of a PEG system

We now frequently use PEG tubes as a prophylactic or temporary measure so the task of removing the tube is more common. In some centres up to 20–30% of the PEG tubes are removed.⁴ Although, it has been demonstrated in clinical studies that PEG systems can be removed by simply cutting away the external catheter and allowing the internal fixation plate to pass from the body by the natural route without complications in adults,^{97,98} it is still recommended to remove the fixation plate endoscopically by catching it with a snare, since there

are several reports of subsequent ileus, need for operation, and even fatal outcome.^{99,100} In children, PEG-tubes must be removed by endoscopic means in any way. Recent investigations have shown that patients can ingest nutrients orally immediately after removal of a PEG system and that the puncture canal heals rapidly, when covered externally with a sterile compress. It is recommended not to remove PEG tubes within the first ten days after initial placement because of a possibly higher risk of local complications as for example peritonitis during this period.

In the meantime, there are now commercially available PEG systems with internal fixation plates which can be released from the outside so that these tube systems can be simply removed percutaneously without further endoscopy. Such PEG systems are particularly suitable and clinically indicated in cases where it can be anticipated that there will only be a temporary requirement for additive enteral nutrition via a tube system, e.g. as is frequently the case during planned chemotherapy or radiation therapy in patients with critical baseline nutritional status.

The durability of a PEG tube system is primarily linked to its careful handling. There is no need to exchange a tube system at regular intervals. In case of adequate handling PEG tubes can stay in situ for many years exceeding even 10 years and more.

Clinical value, quality of life

PEG feeding has a distinct clinical value in the treatment of patients with either malignant disease or benign conditions. In the case of patients who will be able to ingest considerably less than their full daily fluid and calorie requirement for the foreseeable future (for a period exceeding 2–3 weeks), nutritional support by means of a PEG system provides the energy required for recovery from the disorder and allows patients to feed orally as far as they are able, but without the need to feel forced to eat or drink without appetite or a safe swallow. In patients choking in their meals due to muscle fatigue or weakness, additional PEG-feeding decreases the urgency to eat adequately. It is essential to provide an adequate nutritional regime for patients with borderline or poor nutritional status who are receiving radiotherapy/chemotherapy. In order to increase the patient's tolerance of the treatment, reduce the complication and hospitalization rate, and to maintain the patient's quality of life, temporary supplementary feeding via an enteral tube should be considered in the

individual case.^{44,45} For the patients who did not reach their nutritional requirements in the weeks before PEG insertion, nutritional support should be initiated in a stepwise fashion together with a monitoring of biochemical parameters to prevent refeeding syndrome. Prospective clinical studies clearly prove the inability to regain nutritional status in most patients after severe loss of body weight even in those with benign underlying disorders (Fig. 3)^{4,44}; therefore, an early individual consideration for supplementary enteral nutrition via PEG is important.

Long-term prospective clinical studies have demonstrated that the patient's subjective acceptance and tolerance of enteral nutrition using a PEG system is excellent.^{4,5} In a prospective study 3 months after insertion of the PEG system, more than 80% of patients gave the standard PEG tube method of nutrition the highest score on a four-point scale.⁴ Prospective clinical studies have also demonstrated that enteral nutrition via a PEG tube significantly improves the quality of life of the patients.^{5,101,102} In a prospective long-term study in 155 non-selected, consecutive patients, a significant improvement in quality of life was found after nutrition via PEG for patients both with benign and malignant underlying disorders as well as conscious and unconscious patients.⁵ On the other hand, studies from nursing homes and in older adults paint a picture of frailty and dependency amongst tube fed patients.^{101,103}

As already pointed out earlier it is important to carefully select patients being suitable for PEG feeding on the basis of established medical and ethical indications and contraindications. The individual benefits with regard to quality of life is expected to be lower in older patients and patients with complex and severe co-morbidity and therefore individual indications for feeding via PEG-tubes should be considered more critically in these patients.^{101,103}

Recent developments

In addition to the routine endoscopic technique for percutaneous placement of an enteral nutrition tube, there are now many alternative, well-standardized installation methods and techniques: laparoscopic (PLG, PLJ), sonographic (PSG, PSJ), fluoroscopic (PFG, PFJ) and surgical (NCJ; Witzel or Stamm fistula) (Fig. 2). Over the past few years, many of the different steps of the procedure have fortunately been simplified or even omitted on the basis of results obtained in clinical studies: after

complication-free placement of a PEG system, radiological or endoscopic control is no longer required on a routine basis; delivery of nutrients via the tube can commence within 1–2 h after placement of a PEG system^{104–107}; routine antibiotic prophylaxis is not obligatory in all cases; gastric acid secretion inhibitors do not necessarily have to be discontinued prior to placement of a PEG system; after endoscopic removal of a PEG tube, the patient can eat immediately; the durability of a PEG system is primarily dependent on the quality of aftercare given to the tubing system; and routine removal and replacement of a PEG tube is not necessary as patients have used the same PEG system for more than 10 years without complications.

Contraindications applicable to date such as lack of diaphanoscopia, mild to moderate ascites, Crohn's disease, ventriculoperitoneal shunt, peritoneal dialysis or concomitant administration of immunosuppressants, can no longer be considered contraindications. On the contrary, Crohn's disease in young patients with malnutrition and retardation of growth is now an established indication for targeted, long-term nutritional therapy via a PEG tube if oral measures are not successful.

Concluding remarks

Based on many recently published clinical studies our earlier view of PEG being primarily linked to advanced stages of mainly malignant diseases has switched to support for earlier decision making in a large variety of potential patients with different underlying diseases. Patients with advanced cancer, end-stage diseases or advanced dementia are not usually considered appropriate candidates for artificial feeding via PEG tubes. Overall published data support an individualized but critical and restrictive approach to PEG feeding in such patients. In experienced hands PEG placement and feeding is a safe and highly effective procedure if modern devices are used and established standards are adhered to. Nevertheless, decision making is still difficult in many cases having always an individual character. Prospective clinical studies have shown, that guidelines help to improve the appropriateness of patients selection and play a proactive role in the decision making for medically adequate PEG insertion with a consecutively improved outcome.¹⁰⁸

Enteral nutrition via a tube system inserted with endoscopic guidance is an efficient, highly effective and easy to use technique, associated with a

low rate of complications, which allows the maintenance of adequate enteral nutrition of patients who are unable to ingest sufficient nutrients orally. Clinical studies have demonstrated the high level of acceptance by patients and the marked improvement in nutritional status and general well being of such patients. In order to prevent deterioration of nutritional status and to improve their overall quality of life, the decision whether or not to use an enteral tube system for feeding should be taken at a much earlier stage and should be more frequently positive in appropriate patients who fulfil the above mentioned and discussed criteria.

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