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A Literature Review of Percutaneous Endoscopic Gastrostomy

Dealing With Complications

ABSTRACT

Sufficient energy and essential nutrients are vital for normal growth and development in childhood. Ideally, nutrition should be provided orally. However, if the gastrointestinal system is functional, enteral tube feeding can be used when nutritional requirements cannot be provided orally, thus providing nutritional benefits and enabling positive disease management in pediatric patients. Postoperative care in children allows monitoring of the position and functionality of the tube; performing nutrition intolerance, growth, hydration, and nutritional assessments; and performing metabolic and complication follow-ups. Tube feeding in pediatric patients is beneficial and has positive effects in controlling and managing diseases and providing appropriate nutrition in children. However, in postoperative patients, it is important to prevent potential complications, which can be classified into 5 groups: mechanical, gastrointestinal, metabolic, infectious, and pulmonary complications. Important points for managing complications include having enteral nutrition practices based on evidence-based guidelines, sharing outcomes with nurses working in clinical settings, creating enteral feeding guides in clinical settings, providing patients/patients' family with training in line with these guides, and maintaining follow-ups at home. This literature review discusses complications and practices regarding the management of complications after percutaneous endoscopic gastrostomy.

Providing sufficient energy and the basic nutritional requirements to children is of utmost importance to sustain normal growth and development. Ideally, nutrition should be provided orally. However, when energy sources and nutritional requirements cannot be administered orally, enteral feeding with a tube is used in patients with a functional gastrointestinal system (Braegger et al., 2010; Löser et al., 2005). The major factor in deciding the route of enteral feeding is the duration for which the patient will receive enteral nutrition. Enteral feeding is performed with a nasogastric (NG) or nasoenteric tube if it is to be provided for less than 6 weeks and via a stoma if it is to be provided for more than 6 weeks. If a child's condition can be expected to last more than 1–3 months, placement of a gastrostomy tube should be considered to avoid complications of NG tube feeding (Ackroyd, Saincher, Cheng, & El-Matary, 2011; Braegger et al., 2010; Löser et al., 2005; Puntis, 2009; Volkert et al., 2006).

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Background

It is generally preferred that enteral feeding products are delivered through the stomach. Feeding through the stomach is easy, safe, and physiological at the same time. It is possible to benefit from the anti-infectious effect of the stomach acid and the peristaltic movements and mixing function of the stomach. Moreover, pancreatic enzymes function normally as the passage to duodenum is controlled. Also, feeding through a gastrostomy tube has some advantages compared with NG tube feeding.

Nasogastric tubes are recommended to be replaced once a month, but percutaneous endoscopic gastrostomy (PEG) tubes can be used for longer periods. Problems of displacement or dislocation are not

encountered. Also, breathing does not create a problem. Feeding through a stoma can also be achieved comfortably in situations that can create problems in NG tubes such as nose anomalies and chronic sinusitis. Psychological trauma that can develop in children during the placement or displacement of an NG catheter and rejection to eat accompanying this trauma are prevented with gastrostomy (Ackroyd et al., 2011; Puntis, 2009; Volkert et al., 2006). A retrospective review of 121 children undergoing PEG found a high rate of parental and caregiver satisfaction with the procedure (Avitsland et al., 2006).

The most common indications of feeding with a gastrostomy tube include neurological diseases, which impair functions such as sucking, chewing, and swallowing, followed by oncological problems associated with malnutrition and other clinical entities leading to malnutrition such as chronic kidney failure, cystic fibrosis, metabolic disorders, cardiac diseases, short-bowel syndrome, and Crohn disease (Braegger et al., 2010; Goldberg, Barton, Xanthopoulos, Stettler, & Liacouras, 2010; Löser et al., 2005; Szlagatys-Sidorkiewicz et al., 2010).

A gastrostomy tube can be inserted using endoscopic, surgical, or radiological methods. The most common method of gastrostomy tube application in children is PEG, which was defined by Gauderer in 1980 and since then has become the preferred method of application in enteral nutrition for medication, liquid, and food intake in children without adequate oral intake (Ackroyd et al., 2011; Puntis, 2009). Percutaneous endoscopic gastrostomy has some advantages such as the lack of need for laparotomy, shorter duration of anesthesia and surgery, reduced postoperative pain, shorter duration of hospitalization, and lack of exposure to radiation (Puntis, 2009; Rahnemai-Azar, Rahnemaiazar, Naghshizadian, Kurtz, & Farkas, 2014). On the contrary, PEG is contraindicated when the endoscope cannot be passed through the esophagus (stenosis, anomaly) and in conditions such as gastric varices, massive ascites, portal hypertension, coagulopathy, severe hepatomegaly, previous surgery, and positional anomalies of the gastrointestinal system (Löser et al., 2005; Puntis, 2009).

Some situations must be considered before the placement of a PEG tube. For example, diagnosis, prognosis, the expected feeding duration, the patient's request, and the effect of the PEG tube on the patient's quality of life are among the important points to be considered before the placement of a PEG tube (Canadian Clinical Practice Guidelines, 2013; Malhi & Thompson, 2014; Width & Reinhard, 2009).

The most widespread indication for feeding with a PEG tube is in cases of neurological diseases in which functions such as sucking, swallowing, and chewing are disrupted (Braegger et al., 2010; Goldberg et al., 2010; Löser et al., 2005; Szlagatys-Sidorkiewicz et al., 2010). Although a PEG tube is commonly used in children and is considered safe, it may lead to some undesirable results; peristomal skin infections are the most common, minor complication after a PEG procedure. In studies involving the use of a PEG tube in children, peristomal skin infections that impair peristomal skin integrity and the formation of granulation tissue are found to be the most common complications (Ackroyd et al., 2011; Braegger et al., 2010; Crosby & Duerksen, 2005; Friedman, Ahmed, Connoley, Chait, & Mahant, 2014; Goldberg et al., 2010).

During a PEG procedure, some major and minor complications can develop. The frequency of minor complications including tube blockage, tube dislocation, and peristomal skin infections is 2%–55%. On the contrary, the frequency of major complications such as aspiration, peritonitis, bleeding, and pneumoperitoneum is 5%–25%. Therefore, major complications are seen less frequently than minor complications (Fortunato et al., 2010; Park, Rhie, & Jeong, 2011; Pedrón-Giner et al., 2013). These complications can be classified into five categories: mechanical, gastrointestinal, metabolic, infectious, and pulmonary complications. This literature review highlights the complications observed in children after the placement of a PEG tube, the studies in which these complications have been examined, and the suggestions made to prevent these complications.

Mechanical Complications

Tube obstruction, leakage from the tube edges, hypergranulation, and buried bumper syndrome (BBS) are the most common mechanical complications after PEG tube placement. In a retrospective study by Crosby and Duerksen (2005) conducted in Canada, the complications in children nourished using the gastrostomy tube were assessed through phone calls. The most frequently observed complications were hypergranulation (67%) and leakage from the tube edges (60%).

In a prospective study conducted in America, patients were followed up for 2 years and interviews were carried out every 4 months on the phone or in a clinic. In the hospital where the study was conducted, clindamycin was used as antibiotic prophylaxis prior to the PEG procedure. The wound site infection was evaluated by the primary investigator, who was the gastroenterology department nurse, and the presence of erythema and purulent drainage was used to diagnose wound site infection. Wound site infection developed in the first 15 days, and infection was observed in 37% of patients whereas granulation tissue developed in 68% of patients. In that study, the wound site infection was treated with a cream containing antibiotics (for 5–7 days) and granulation tissue was treated with steroid cream and silver nitrate (Goldberg et al., 2010).

In a study by Zopf et al. (2008) in Germany, 390 patients who had undergone a PEG procedure using the

pull technique were followed up in outpatient clinics as controls; peristomal skin infection was assessed by the nurse and the physician using a scoring system measuring purulent drainage and erythema. Erythema was found in 54% of patients, purulent drainage in 36.9% of patients, and skin infection in 33.6% of patients.

These results reveal that mechanical complications such as hypergranulation tissue and leakage may lead to infectious complications. To prevent the complications such as discharge and hypergranulation tissue that can develop depending on the excessive movement of the tube, it is suggested that the tube be fixed appropriately to the abdomen (Friedman et al., 2014; Goldberg et al., 2010; Löser et al., 2005).

Among the mechanical causes of complications, tube obstruction is observed with all types of feeding tubes and quite frequently. Besides the diameter, length, and the composition of material of the tube, the administration rate of the enteral products, the type of product/medication given via the tube, and the quality of tube care are the main factors affecting tube obstruction. The risk of obstruction is highest in silicon tubes with small diameters (El-Matary, 2008; Goldberg et al., 2010; Itkın et al., 2011). Slow infusion of products with high calories or high-fiber contents, and administration of blended foods via tubes, increases the risk of obstruction. Furthermore, the administration of drugs without grinding and dissolving them well significantly increases the incidence of tube obstruction (Avitsland et al. 2006; Bankhead et al., 2009; El-Matary, 2008; Goldberg et al., 2010; Socia & Friedman, 2011).

Regular irrigation is recommended to prevent tube obstruction. The irrigation procedure must be applied once every 4–8 hours in situations of continuous infusion and before and after each feeding in bolus feedings. The tube must be irrigated prior to and following drug administration. In case of any obstruction, irrigation with lukewarm water and consecutive application of mild pressure and aspiration can be performed. The guiding wires, cytology brushes, and an endoscopic retrograde cholangiopancreatography (ERCP) tube can also be used to open the obstruction (Bankhead et al., 2009; Friedman et al., 2014; Goldberg et al., 2010; Socia & Friedman, 2011). However, the level of evidence for these studies is not high and mostly consists of expert opinion. Also of note, when using mechanical instruments (such as pancreatic enzyme mixtures) to unclog a tube, the potential complications may include perforation of the intestine.

Leakage at the tube site is more commonly seen in patients with malnutrition, in cases of rapid weight loss, and during immunosuppression with delayed wound healing. The ostomy site must be initially evaluated in terms of infection and granulation tissue. Whether the tube is fixed too loosely or tightly must also be evaluated. In tubes with a balloon, the volume of the balloon must be controlled. It is critical to fix the tube to the abdomen not too loosely or tightly to prevent complications. For example, the periphery of the stoma can be sutured during PEG placement. A successful outcome may sometimes be obtained by placing a tube that is a size larger; however, consecutive applications of larger sized tubes may cause dilation of the stoma and eventually more leakage (El-Matary, 2008; Friedman et al., 2014; Mahan, Jovcevska, & Cohen, 2011; Socia & Friedman, 2011). Zopf et al. (2008) investigated the risk factors for peristomal skin infections and found that children with a larger sized (15 Fr) gastrostomy tube had higher levels of peristomal skin infection than children with smaller tubes (9 Fr).

The risk factors for granulation tissue development are friction of the dressing around the tube, a hypermobile tube, catheter misplacement, use of an inappropriate tube, and improper application of the wound dressing. To prevent these complications, it is essential to fix the external fixator material to the skin to keep the site of the stoma clean and dry, use a soft sponge that does not shed fibers, and apply the dressing via the proper protocol. Application of a cream containing hydrocortisone and cauterization with silver nitrate are recommended for the management of hypergranulation (Friedman et al., 2014; Goldberg et al., 2010). However, it has been highlighted in some studies in the literature that the use of silver nitrate leads to an increase in leakage in the stomal area. If the application of silver nitrate is not done by an experienced person, the healthy tissue around the granulation tissue may also be harmed (Goldberg et al., 2010; Malhi & Thompson, 2014; Warriner & Spruce, 2012).

The risk factors for BBS, a rare mechanical complication, include extremely tight internal and external fixators, bad wound healing, excessive weight gain, and improper application of the wound dressing. The prevalence of BBS is approximately 2.3% after PEG in children (Kohler, Lang, & Behrens, 2008). To prevent this complication, the tube must be rotated 180° during each dressing change (Ackroyd et al., 2011; Löser et al., 2005; Puntis, 2009). The tube can be rotated only if the external bumper is not sutured and if it is a gastric tube, not a postpyloric tube.

Gastrointestinal Complications

Gastrointestinal complications are the second most common complications of using PEG tubes. The most common complications are nausea, vomiting, increased gastric residues, abdominal distention, and diarrhea. The study conducted by Park et al. (2011) revealed 6.3% of vomiting complications. In the study by Peters, Baldyck, and Nour (2010), 16 of 114 children with a PEG tube developed reflux.

Nausea, vomiting, abdominal distention, and increased gastric residues occur in cases of impaired motility in the upper gastrointestinal system and delayed gastric emptying. Their causes are multifactorial (i.e., inflammation, electrolyte abnormalities, medications, and hypoperfusion); however, these causes may be associated with the increased caloric concentration and osmolality, as well as the extremely rapid administration of enteral formula. To prevent these complications, it is essential to regulate the administration rate of the nutritional formula to reach the target dose in several days, apply continuous infusion, prevent contamination, and administer the product at 68°F-75°F (20°C–24°C) (El-Matary, 2008; Friedman et al., 2014; Mahan et al., 2011).

Diarrhea is another frequent gastrointestinal complication. Several factors including food intolerance, inflammatory bowel disease, short-bowel syndrome, and malnutrition may lead to the development of diarrhea. Other causes such as hyperosmolar product, rapid infusion, and deficiency of micro-food are related to nutrition, as well as other factors such as antibiotic use, medications, and enteral product or tube contamination. To prevent diarrhea, it is essential to use a formula specific to the disease (i.e., the use of a product containing short-chain fatty acids in patients with short-bowel syndrome); to administer the drugs via an intravenous route, where possible; to not administer the formula very rapidly when the complication is due to the medications; to not use a formula with an extremely high osmolarity; and to maintain the hygiene and safety of the enteral products, tube, and the sets.

If diarrhea develops, the osmolarity, content, and the infusion rate of the enteral product must be reconsidered. In cases of severe diarrhea, other situations that may lead to diarrhea must be investigated. The stool culture, stool microscopy, stool pH, fecal occult blood, and fecal reducing substance must be analyzed, particularly in hospitalized patients. If the patient receives a fibrous product, it must be replaced with a product not containing fiber, and feeding by infusion is recommended (Ackroyd et al., 2011; Crosby & Duerksen, 2005; Friedman et al., 2014; Löser et al., 2005; Mahan et al., 2011; Puntis, 2009; Socia & Friedman, 2011).

In the literature, there is no evidence of the need for measuring gastric residual volume (GRV) other than in critical patients. Moreover, the matter is controversial and there are no specific recommendations for children (McClave et al., 2005; Mentec et al., 2001; Metheny, Schallom, Oliver, & Clouse, 2008). A study revealed that gastroesophageal reflux (GER) could be seen in patients despite low GRV values (McClave et al., 2005). There are also no commonly accepted GRV and high GRV values in the guidelines. The acceptable GRV value in adults has been determined to be 500 ml by the American Society for Parenteral and Enteral Nutrition (McClave et al., 2009) and 250–500 ml by the Canadian Clinical Practice Guidelines (2013). Clinical procedures related to high GRV values also differ. A study conducted on 2,298 intensive care nurses revealed that a high GRV value was accepted as 200 ml by 36.5% of nurses, 250 ml by 25% of nurses, and 500 ml by 12.6% of nurses (Metheny, Mills, & Stewart, 2012).

Mentec et al. (2001) reported that patients with high GRV values have statistically significantly higher vomiting rates. Montejo et al. (2010) found that feeding intolerance was significantly more common in the group with a GRV value of 200 ml than in the group with a GRV value of 500 ml. No statistically significant difference was found regarding the rate of vomiting or feeding intolerance in the groups with and without GRV measurements in this study. Poulard et al. (2010) and Reignier et al. (2013) reported that feeding intolerance was significantly more common in the GRV measurement group than in the no-measurement group. The lack of a cutoff point indicating the presence of a vomiting risk can also suggest that the GRV value is not a suitable parameter to determine feeding intolerance. Ozen et al. (2016) found that feeding targets were reached quicker in the group without GRV monitoring ($n = 26$), with no increase in the complication rate ($p < .05$). No significant relationship was observed between measuring GRV and GER in the group with GRV monitoring ($n = 25$) ($p > .05$). However, these studies and guidelines are not specific to child patients; these are adult studies. A recent study conducted with children's nurses in the UK aimed to explore the decision-making processes of pediatric intensive care nurses surrounding this practice. In this study, the 3 main reasons for stopping or withholding enteral feeds were the volume of GRV obtained (67%), the appearance of this gastric aspirate (40%), and the overall clinical condition of the child (23%). Most nurses reported checking GRV primarily to determine 'feed tolerance' (97%) as well as to confirm the feeding tube position (94%). Nurses' perceived harms from high GRV were: the risk of pulmonary aspiration (44%), malabsorption of feeds (20%), and the risk of vomiting (19%). GRV was measured frequently in the PICU in that study; 58% of nurses measured GRV before every feed, 27% measured it every 4 h, and 17% measured it every 6 h. Most nurses (84%) stated they would be "worried" or "very worried" if they could not routinely measure GRV (Tume, Latten, & Kenworthy, 2017).

Metabolic Complications

Metabolic complications may exist in relation to insufficient nutrition (deficiency of energy and protein intake, deficiency of micro-food, hyponatremia, hypokalemia, hypophosphatemia, hypoglycemia) and

excessive nutrition (refeeding syndrome). The delay in the evaluation of nutritional status or the erroneous calculation of the requirement, fluid limitation, use of the vasoactive drugs and muscle relaxants, problems associated with the feeding tube, fasting before and after the interventional procedures, suspected intolerance, GRV, and severe diarrhea/nausea/constipation may also cause insufficient enteral nutrition.

In the case of refeeding syndrome due to excessive feeding, an electrolyte and fluid imbalance exists after long-term fasting (Crosby & Duerksen, 2005; El-Matary, 2008; Fröhlich, Richter, Carbon, Barth, & Köhler, 2009; Mahan et al., 2011; Socia & Friedman, 2011). Children with severe chronic weight loss are at the highest risk (e.g., anorexia nervosa, cancer cachexia), with the greatest risk being during the first week of feeding. However, refeeding syndrome is a potential complication of nutritional support in any malnourished patient. Because the nature of refeeding precludes randomized trials of treatment, recommendations are derived from expert opinion. The following is a strategy for reducing the risk of refeeding syndrome: Before starting nutritional support, assess nutritional status and hydration, serum electrolytes, magnesium, and phosphate; monitor electrolytes, phosphate, magnesium, calcium urea, and creatinine daily; and assess cardiac status (pulse, heart failure, electrocardiogram, ultrasonographic scan) (Afzal et al., 2002; Aissaoui, Hammi, Tagajdid, Chkoura, & Boughalem, 2016).

Dumping syndrome is another common metabolic complication. In patients with jejunostomy or gastrostomy with a feeding tube placed in the distal antrum, the administration of enteral products with a high volume or high osmolarity by rapid infusion may lead to dumping syndrome. Nausea, vomiting, distention, cramps, and diarrhea can be seen. This complication can be prevented by reducing the administration rate and osmolarity of the enteral product and by providing feeding with continuous infusion (El-Matary, 2008; Fröhlich et al., 2009). In the study conducted by Madre et al. (2010), 17 children were followed for 5 years and metabolic complications including dumping syndrome and chronic digestive malabsorption were observed in 8 children.

Pulmonary Complications

Pulmonary complications are among the most serious and life-threatening complications of feeding with a tube. The severity of complications related to aspiration is closely associated with the aspiration volume, the pH and content of the aspirate, the presence of microorganisms, and the overall clinical status of the patient. While lying in the supine position, swallowing difficulties, delayed gastric emptying time, and reflux can also contribute to pulmonary complications. The patient with a mechanical ventilator, neuromuscular diseases, and the aspiration of gastric acid are the main causes of pulmonary complications. Gastrointestinal obstruction and bolus administration or rapid infusion of the enteral products of high osmolarity may increase the risk of vomiting and aspiration.

Elevating the head 30°–45° during feeding, using prokinetic drugs in patients with delayed gastric emptying time, feeding with continuous infusion, and postpyloric placement of the tube (which decreases the risk of aspiration but does not completely eliminate it) are required for the prevention of these complications. The administration of water after feeding (the pressure in the lower esophagus decreases by washing with 10 ml of water within 15 minutes following feeding) is also essential (Crosby & Duerksen, 2005; El-Matary, 2008; Fröhlich et al., 2009; Mahan et al., 2011; Soscia & Friedman, 2011; Width & Reinhard, 2009). It has been demonstrated that compared with the supine position during gastric feeding, the elevation of the head of the bed by 45° is associated with reduced reflux of gastric contents into the esophagus and pharynx, thereby reducing the risk of aspiration pneumonia. The incidence of mortality has also been shown to decrease in this position. Therefore, it is recommended to feed the patient after elevating the bedhead by 30°–45° (Heyland et al., 2010) and to keep the patient in this position for 1 hour after feeding to reduce the risk of aspiration (Gavi, Hensley, Cerva, Nicastri, & Fields, 2008).

Although the use of prokinetic agents is recommended for the prevention of aspiration, this is controversial and some adverse effects may be observed in children (Width & Reinhard, 2009). Results of a meta-analysis in which 13 randomized controlled studies conducted with adults were examined showed that prokinetic agents reduced the high gastric volume risk (Lewis et al., 2016); however, no conclusive studies conducted with children are available. Also, some recent studies have indicated that aspiration risk does not decrease with postpyloric feeding. It was revealed in a meta-analysis study that examined 17 randomized controlled studies conducted with children that postpyloric feeding has no role in preventing the development of pneumonia and aspiration (Zhang, Xu, Ding, & Ni, 2013).

Infectious Complications

Peristomal infections are the main infectious complications. The mucosa is prone to infections in patients fed with a tube due to the mechanical trauma and irritation caused by gastric or intestinal fluids. Several studies have shown that the most common minor complication is peristomal infection in children in whom a gastrostomy/jejunostomy tube is inserted (Crosby & Duerksen, 2005; Goldberg et al., 2010; Löser et al., 2005; Pars, 2016; Rahnemai-Azar et al., 2014).

In their study of 239 children with a PEG tube, Fascetti-Leon et al. (2012) found a major complication in 3.3% of patients, hypergranulation tissue in 14.2% of patients, and wound site infection in 2.5% of patients. In their study, patients were followed up in the first, third, sixth, and 12th months; the rate of complications seen in the first month decreased toward the 12th month, and no patient had wound site infection at the end of the 12th month. In a study conducted by Wu, Wu, and Ni (2012) of 83 pediatric patients with a PEG tube, 18.1% had a major complication, 20% had tube dislocation, and 15% had a wound site infection. In a study conducted on 198 children with a PEG tube by McSweeney, Kerr, Jiang, and Lightdale (2015), at least one major complication occurred in 10.5% of children whereas at least one minor complication occurred in 16.4% of children. In a study conducted by Fortunato et al. (2010) on 760 children with a PEG tube, 20% of students developed complications and wound site infection and hypergranulation tissue occurred in 8% and 9% of children, respectively. As seen in the studies conducted so far, following the PEG insertion, the most common complications are the ones that impair peristomal skin integrity.

To assess peristomal skin integrity, comprehensive evaluation of peristomal skin (color, moisture, odor, erythema, temperature increase, maceration, and lesion) and stoma care using the correct care product are necessary (Goldberg et al., 2010; Rahnemai-Azar et al., 2014; Zulkowski, Ayello, & Stelton, 2014). According to the literature, it is advisable to change the sterile dressing daily until granulation of the stoma canal has taken place, provide local disinfection (usually Days 1–7), and clean the site with additive-free pH 5.5 soap (Braegger et al., 2010; Itkın et al., 2011; Löser et al., 2005; Pedrón-Giner et al., 2013; Socia & Friedman, 2011). Some sources have also recommended cleaning the site using saline solution following the sterile dressing (Andrews, 2013; Duarte, Santos, Capela, & Fonseca, 2012). In contrast, the use of glycerin hydrogel in PEG stoma care in addition to the standard dressing was examined as a new approach in recent years; it was reported that glycerin hydrogel might remain for up to 7 days at the stoma site, offering a high antimicrobial effect on the site, decreasing the maceration risk by ensuring oxygenation of the wound site and cell feeding, and accelerating the wound healing process (Aschl et al., 2008; Blumenstein et al., 2012; Borger, Marcel, & Shastri, 2008). However, the studies conducted on these care products offering better protection in preventing peristomal skin problems among the patients with gastrostomy remain limited.

In a systematic review on patients with stoma (PEG, colostomy, and ileostomy), among the studies involving intervention in peristomal skin care, only two related to PEG stoma care were found (Tam et al., 2014). In a study by Aschl et al. (2008), 48 patients were placed in a soapy water group and 50 patients were placed in a hydrogel group in terms of the peristomal skin integrity; the number of patients with wound site infection was found to be higher in the soapy water group, although the difference was not statistically significant. In a study conducted by Blumenstein et al. (2012), 68 patients (34 in the soapy water group and 34 in the hydrogel group) were followed up and the peristomal skin infection rate was found to be higher in the soapy water group than in the hydrogel group. The difference was found to be statistically significant. However, these studies were conducted on adult patients and there are no studies on pediatric patients.

In the management of peristomal skin complications, which are important situations negatively affecting the enteral nourishment process and quality of life in children, the wound care nurses and home care team have important responsibilities. In addition to nurses having important responsibilities in preventing post-PEG complications, complications can arise due to different risk factors. A study examining the risk factors leading to peristomal skin infections determined that an environment where a PEG tube was placed with the pull technique was a risk factor, and a significant difference was observed in terms of peristomal skin infection among the hospitals where the study was conducted (Zopf et al., 2008). The difference between hospitals in terms of the findings that impair peristomal skin integrity may be associated with the differences in experience, technique, and procedures used by the clinicians who carried out the PEG operation.

Other studies have also highlighted the effect of procedural differences in determining the location and technique of PEG tube placement on emerging complications (Beres, Bratu, & Laberge, 2009; Gauderer, 1991; Okutani, Kotani, & Makihara, 2008; Rolstad & Erwin-Toth, 2004). In their study on the prevention and management of peristomal skin complications, Rolstad and Erwin-Toth (2004) highlighted that the location of the stoma, surgical techniques such as suturing the stoma, and the team that carries out the procedure have a critical role in preventing peristomal skin infections.

Moreover, the studies conducted so far have revealed that the use of antibiotic prophylaxis (Arora, Rockey, & Gupta, 2013; Johnston, Tham, & Mason, 2008; Lucendo & Friginal-Ruiz, 2014), immunodeficiency, having a malignant illness (Arora et al., 2013; Johnston et al., 2008; Lucendo & Friginal-Ruiz, 2014; Mcsweeney et al., 2015; Zopf et al., 2008), being diagnosed with diabetes, having a ventriculoperitoneal shunt placement (Lee et al., 2002; Mcsweeney et al.,

2015; Parbhoo, Tiedemann, & Catto-Smith, 2011), having a neurological illness (Fortunato et al., 2010), the technique used by the team that places the PEG tube, and the environment where the PEG tube is placed (Lucendo & Friginal-Ruiz, 2014; McClave & Neff, 2006; Rolstad & Erwin-Toth, 2004) are risk factors in terms of the complications that may occur after the placement of a PEG tube. However, these studies were mainly conducted on adults as studies on children are fairly limited; thus, the risk factors leading to complications after PEG tube placement in children have not yet been explored fully.

Identifying risk factors and complications is important in determining the interventions that can be used to prevent and manage the complications that can occur after the placement of a PEG tube (Zulkowski, Ayello, & Stelton, 2014). Therefore, we need more studies that determine the frequency of and the reason behind complications in children with a PEG tube. There is also a need for a high level of evidence (i.e., randomized controlled studies) in setting out the initiatives to prevent these complications after PEG tube placement.

Conclusion

The insertion of feeding tubes into pediatric patients is an extremely useful procedure that positively affects the management of disease and keeps children at a proper nutritional status. Nurses play a key role in implementing the nutritional plan of care for patients, including advocating for early commencement of enteral nutrition, assessment of calorie requirements, and initiating, titrating, and administering the feed. To sustain this important treatment successfully, a gastroenterology nurse should effectively manage the therapeutic processes and postoperative care, recognizing possible complications. This may lead to the prevention and management of problems properly, and the nutrition process can be maintained successfully.

The following are key steps in the postoperative care of children with gastrostomy: the application of nursing practices in accordance with evidence-based guidelines, sharing of study results in the literature with nurses in clinical practice to ensure that the proven results of enteral feeding applications be applied in practice, preparing the enteral feeding care guidelines in accordance with proven studies for the use by nurses in clinics, allowing nurses to share this knowledge with patients' parents during hospitalization and discharge, and enabling follow-up at home. Moreover, more detailed, randomized controlled studies on this subject should be conducted in the future, particularly in the pediatric population. ✪

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