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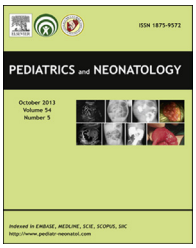

ORIGINAL ARTICLE

Long-term Outcome After Percutaneous Endoscopic Gastrostomy in Children

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Key Words
endoscopy;
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Background: Percutaneous endoscopic gastrostomy (PEG) is widely accepted as the preferred procedure to establish long-term enteral feeding.
Objective: To learn the long-term outcomes of the patients who have undergone PEG placement, we reviewed our experience with children who underwent this procedure in our institute.
Methods: A total of 83 pediatric patients (42 males and 41 females), who were aged from 3 months to 20 years, underwent PEG insertion in National Taiwan University Hospital from January 2000 to April 2011. The underlying diseases of the patients receiving PEG were neurological dysfunction ($n = 67$), metabolic disorders ($n = 9$), gastrointestinal disease ($n = 2$), and congenital heart disease ($n = 1$). This procedure was performed under intravenous sedation or under general anesthesia. Prophylactic antibiotics were administered for 1 day. Tube feeding began 24 hours after the PEG placement. The body weight of the patients was recorded 1 day before PEG placement and at least 6 months after PEG placement.
Results: The weight-for-age Z-score before and at 6 months after PEG placement were -1.5 ± 2.0 and -0.9 ± 2.1, respectively, which was statistically significant (paired t test, $p = 0.006$). The catch-up growth was recorded after PEG placement. Complications of PEG in our patients included cellulitis at the gastrostomy wound ($n = 14$), dislodgement of the tube ($n = 17$), and persistent gastrocutaneous fistula ($n = 3$). The PEG tube was removed permanently in seventeen patients because they resumed an adequate oral intake. During the follow-up period, 14 patients died of an underlying disease or infection.
Conclusion: Our experience confirmed that PEG placement is a good long-term route for nutritional supply with no serious complications in children.

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1. Introduction

Children may require enteral tube feeding when they are unable to swallow because of neurological or neuromuscular disorders or when they cannot maintain adequate caloric intake because of congenital heart disease or oncologic disease.[1] Nasogastric (NG) tube feeding is frequently employed under such conditions. However, the long-term use of a NG tube may result in local nasopharyngeal irritation and excess secretion production, thereby increasing the risk of aspiration pneumonia. Other drawbacks of NG feeding are easy dislocation with repeated reinsertions of the tube, erosions and bleeding resulting from trauma by the NG tube tips, and possible social stigma. Since its introduction in 1980, percutaneous endoscopic gastrostomy (PEG) has been widely accepted as the preferred route for enteral nutrition.[2] It is relatively noninvasive and less expensive than surgical gastrostomy. The use of PEG can improve the nutritional status of patients[3] and improve the quality of life of their caregivers.[4,5] In this article, we reviewed the long-term outcomes of 83 children who underwent PEG placement in the Department of Pediatrics in a tertiary hospital in Taiwan.

2. Methods

We performed a retrospective chart review of 83 patients who underwent PEG placement in the Department of Pediatrics of the National Taiwan University Hospital from January 1, 2000 to April 30, 2011. Informed consent was obtained.

The indications for PEG placement in the patients were approved by multidisciplinary approaches. Before PEG insertion, patients received serial evaluations such as an upper gastrointestinal barium study, ^{99m}Tc gastric empty time, and 24-hour esophageal pH monitoring (the multichannel intraluminal impedance was added in January 2010). Percutaneous endoscopic gastrostomy is the preferred method for establishing an enteral nutrition route in patients, except for patients who fit the exclusion criteria, which includes severely prolonged gastric empty time (i.e., more than 85% of the tracer remains in the stomach after 1 hour), severe gastroesophageal reflux (defined as a DeMeester score greater than 14.72), unfavorable gastrointestinal anatomy, and limited life expectancy. Under the aforementioned conditions, a surgeon may shift to laparoscopic gastrostomy or abort this procedure.

All patients received intravenous sedation or general anesthesia during the procedure. We used a commercialized PEG kit with the Ponsky Pull PEG kit (Bard Access Systems, Inc, Salt Lake City, Utah, USA) or MIC PEG kit (Kimberly-Clark, Roswell, Georgia, USA) with a Ponsky-pull technique.[6] After performing a diagnostic esophagogastroduodenoscopy, the stomach was fully inflated to push the liver, spleen, and colon away from the gastrostomy puncture site. The ideal position of gastrostomy is the anterior wall of the middle or lower body. A dose of prophylactic antibiotics, generally first generation cephalosporin, was administered 30 minutes before the procedure. Three doses were subsequently administered. Twenty-four hours after the insertion of the PEG tube, the newly inserted gastrostomy tube was used for clean water feeding and later for a liquid diet, if there were no complications.

Body weight was recorded 1 day before PEG tube placement and at least 6 months after the insertion (6—9 months). The Z-score is the number of standard deviations by which a weight differs from the mean weight at a specific age. The weight-for-age Z-score was calculated with WHO Anthro v.3.2.2 software (World Health Organization, Geneva, Switzerland) in patients who were younger than 5 years old and with WHO AnthroPlus v.1.0.4 software (World Health Organization, Geneva, Switzerland) in patients who were 5—10 years old. An increase in the weight-for-age Z-score indicates "catch-up growth."

The PEG was replaced with a low profile button device (LPBD) or tube gastrostomy when long-term feeding support was indicated. The tube gastrostomy that we used was the CLINY flat balloon type (Create Medic Co., Hokkaido, Japan), and the LPBD that we used was either the Bard button device (Bard Access Systems, Inc, Salt Lake City, Utah, USA) or the Cook low profile gastrostomy set (Wilson-Cook Medical, Inc, Winston-Salem, North California, USA). Patients received gastrostomy replacement at least 3 months after the PEG insertion. The chosen type was decided after discussions with the caregivers, and the size of PEG tube used was based on the patient's body size.

Major events were recorded and included PEG tube removal, PEG tube dislodgement, peristomal infection, and mortality. The major complications were those that required a surgical or endoscopic procedure, use of nonprophylactic antibiotics, blood transfusion, or complications leading to death.[7]

3. Results

Eighty-three patients underwent PEG insertion from January 1, 2000 to April 30, 2011. There were 42 males and 41 females. The mean follow-up period was 6.8 years per person (range, 1—12.3 years). The mean age at gastrostomy insertion was 4.6 years (range, 3 months to 20 years), and 14 (16.9%) patients were younger than 1 year old. The mean weight at PEG insertion was 13.9 kg (range, 3.5—66.8 kg). Sixty-seven (80.7%) of 83 patients were partially or fully dependent on NG tube feeding at the time of PEG insertion. Table 1 lists the underlying diseases of the patients.

The weight-for-age Z-score was -1.5 ± 2.0 just before PEG placement and -0.9 ± 2.1 at 6 months later (paired t test, $p = 0.006$). There was an increase in the weight-for-age Z-score after PEG placement, which indicates catch-up growth after gastrostomy feeding.

The PEG was permanently removed from 17 (20.5%) of 83 patients in this study. The mean time interval between insertion and removal was 1.42 years (range, 1.2 months to 2.6 years). The children who had the gastrostomy removed were younger (mean age, 4 years) than children who remained on PEG feeding (mean age, 4.7 years). Twelve of the 17 patients showed improved oral intake ability and the PEG tube was to be removed. The other five patients either had an uncontrolled PEG wound infection ($n = 4$) or an unexpected gastrocutaneous tract closure due to prolonged PEG dislodgement ($n = 1$). After observation for a period of

Table 1 Underlying diseases of patients undergoing percutaneous endoscopic gastrostomy insertion ($N = 83$) and permanent removal ($N = 17$).

Diagnosis	Insertion *N* (%)	Removal *N* (%)
Neurological dysfunction	67 (81)	9 (53)
Cerebral palsy	36	3
Hypoxic encephalopathy	8	1
Central nervous system infection	6	1
Seizure disorders	4	
Metachromatic leukodystrophy	3	
Mitochondria disease	2	
Congenital varicella syndrome	1	
de Lange syndrome	1	1
Ceroid lipofuscinosis	1	
Encephalopathy with acute psychosis	1	1
Neuromuscular disease	1	
Intracerebral hemorrhage	1	1
Neurodegenerative disease	1	1
Congenital myopathy	1	
Metabolic disorder	9 (11)	5 (29)
Niemann-Pick disease	2	1
Persistent hyperinsulinemic hypoglycemia of infancy	2	2
Protein-induced hyperinsulinemic hypoglycemia	1	1
Mucopolysaccharidosis	1	
Nonketotic hyperglycinemia	1	
Succinic semialdehyde dehydrogenase deficiency	1	1
Maple syrup urine disorder	1	
Gastrointestinal disease	2 (2)	2 (12)
Organoaxial gastric volvulus	1	1
Ineffective esophageal motility disorder	1	1
Congenital heart disease	1 (1)	
Coarctation of aorta, right pulmonary artery hypoplasia	1	
Others	4 (5)	1 (6)
Chromosome anomaly	2	
Goldenhar syndrome	1	1
Neck lymphangioma	1	

time, the patients achieved a fair oral intake, and the PEG tube could be removed permanently. Of the 17 patients, nine patients [13.4% (9/67)] had a neurological dysfunction; two patients had gastrointestinal diseases (1 patient with gastric volvulus and 1 patient with ineffective esophageal motility disorder); five patients had metabolic disorders (2 patients had persistent hyperinsulinemic hypoglycemia of infancy; 1 patient had protein-induced hyperinsulinemic hypoglycemia; 1 patient had Niemann-Pick disease; 1 patient had succinic semialdehyde dehydrogenase deficiency) (Table 1). The patients with underlying gastrointestinal disease had the highest chance of having the PEG removed [100% (2/2)]. By contrast, most patients with a neurological disorder needed lifelong enteral nutritional support. Three (17.6%) of the 17 patients received operative gastrostomy wound closure because of persistent gastrocutaneous fistula. The mean time from PEG insertion until PEG removal was 2.19 years (range, 1.96—2.62 years) for the three patients who experienced delayed closure of the gastrocutaneous fistula and 0.88 years (range, 0.1—1.44 years) for patients with spontaneous closure of the fistula. The patients who had PEG placement for more than 1.5 years seemed to have a greater likelihood of delayed closure of the gastrocutaneous fistula.

Fifty-four patients received either a button type or a balloon type gastrostomy tube replacement at least 3 months later. Manual traction was performed in all patients for PEG removal. Two patients experienced bumper separation and the inner dome remained in the stomach during this procedure. A few days later, the dome passed uneventfully in both patients.

During the follow-up period, 20.5% (17/83) of patients experienced gastrostomy tube dislodgement. The mean duration between placement and dislodgement was 90 days (range, 5—350 days). One patient had gastrocutaneous tract stenosis and needed gastrostomy revision. Two patients had the complication of peritonitis and received systemic antibiotics treatment. None of the patients presented with buried bumper syndrome.

Peristomal infection occurred in 14 patients with 22 episodes (0.12 episodes/1000 days of use) at a median interval of 85.5 days (range, 3 days to 7.3 years) after PEG placement. The most common pathogens from pus cultures were mixed flora ($n = 13$), followed by *Pseudomonas aeruginosa* ($n = 4$), *Candida* species ($n = 2$), *Staphylococcus aureus* ($n = 2$), and *Enterobacter cloacae* ($n = 1$). The mixed flora included *Acinetobacter baumannii* and *Viridans streptococci* in one culture; *S. aureus* and *P. aeruginosa* in three cultures; *Klebsiella pneumoniae* with *E. cloacae* in one culture; *K. pneumoniae* with *Serratia marcescens* in one culture; *K. pneumoniae* with *S. aureus* in one culture; yeast-like organism with *Escherichia coli* in three cultures, yeast-like organism with *E. cloacae* in one culture; yeast-like organism with *A. baumannii* in one culture, and yeast-like organism with *Proteus* in one culture. No peristomal infection was associated with a positive blood culture. The gastrostomy was removed in 3 patients because of significant peristomal infection.

Fourteen (16.9%) of 83 patients died at a mean period of 3.43 years (range, 1.9 months to 9.9 years) after PEG insertion. They died of underlying diseases that were complicated by respiratory failure or septic shock. No death was associated with the procedure.

The total major complication rate was 18.1%, according to the previously mentioned definition.

4. Discussion

According to the previous literature, PEG shortens the hospital stay and it costs less than operative gastrostomy (OG).[8] The postoperative morbidity and severe gastroesophageal reflux were less frequent after PEG than after OG in neurologically impaired children.[9] Therefore, in 1994 we began performing PEG, rather than OG, in our institution when there were no contraindications.[10] In infants and children, PEG could be a safe method to establish enteral

feeding.[1,11] In our experience, the youngest patient was a 3-month-old girl with an atrial septal defect, supravavular pulmonary stenosis, and organo-axial gastric volvulus. She received laparoscopic-assisted PEG successfully. However, the gastrostomy dislodged 5 days later because of poor wound healing. After intensive wound care the gastrostomy was reinserted 1 week later and thereafter remained in place uneventfully. In adults with head and neck malignancies, PEG is widely used for nutritional support; however, its use in children with malignancies is more limited, possibly because of the increased risk of local infection and poor wound healing if a child has a neutropenic status.[12]

Improvement in the nutritional status of patients receiving PEG placement has been well established.[3,12–14] Anthropometric measurements such as height, weight, body mass index (BMI), triceps skin fold thickness (TSFT), and mid-upper arm circumference (MAC) are the more practical indices.[14] Most of our patients have neurological dysfunction and are bedridden, so height could not be measured accurately. The weight-for-age is an ideal and easy parameter. Our study showed an increase in the weight-for-age Z-score after PEG placement, which indicates catch-up growth after gastrostomy feeding.

Long-term NG tube use may interfere with the training of the swallowing ability; therefore, PEG could be used as a temporary route of enteral feeding during a rehabilitation program. In this study, PEG was permanently removed from 17 (20.5%) of 83 patients. A persistent gastrocutaneous fistula is a fistula between the stomach and the skin that has not closed by one month after the removal of the gastrostomy tube. The medical literature indicates that the time between the insertion and the removal of the gastrostomy is the only factor that determines whether a gastrocutaneous fistula will persist. Our results were compatible with previous findings. In our experience, the patients who had PEG placement for more than 1.5 years seemed to have a greater likelihood of delayed closure of the gastrocutaneous fistula and therefore surgical closure may be expected. The age of a patient at the time of PEG insertion, the underlying disease, and the type of gastrostomy tube showed no conclusive correlation with the persistence of gastrocutaneous fistula.[15,16]

Stoma-related complications were common and included infection, granulation, and leakage. The complication rate was high, but most complications were minor and easy to treat.[5] The prophylactic use of antibiotics could prevent the complication of peristomal infection. However, the type of prophylactic antibiotics used and the number of doses needed showed no significant differences.[1]

A previous report showed that the rate of major complications was approximately 12.6–17.5% for complications requiring an unexpected surgical or endoscopic procedure, nonprophylactic antibiotics use or blood transfusion, and complications leading to death.[7] Percutaneous endoscopic gastrostomy procedure-related mortality is rare. The incidence is 0.5–1.2%, according to the medical literature.[1] In our experience, the rate of major complications was 18.1%, and most (16.9%) of these complications were peristomal infections that necessitated antibiotics use. No procedure-related mortality occurred in our study group. In conclusion, our experience suggested that PEG is a safe procedure that can provide long-term nutritional support with acceptable complication rates in children.

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