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Safety of the One Step Percutaneous Endoscopic Gastrostomy (Push-PEG) Button in Pediatric Patients

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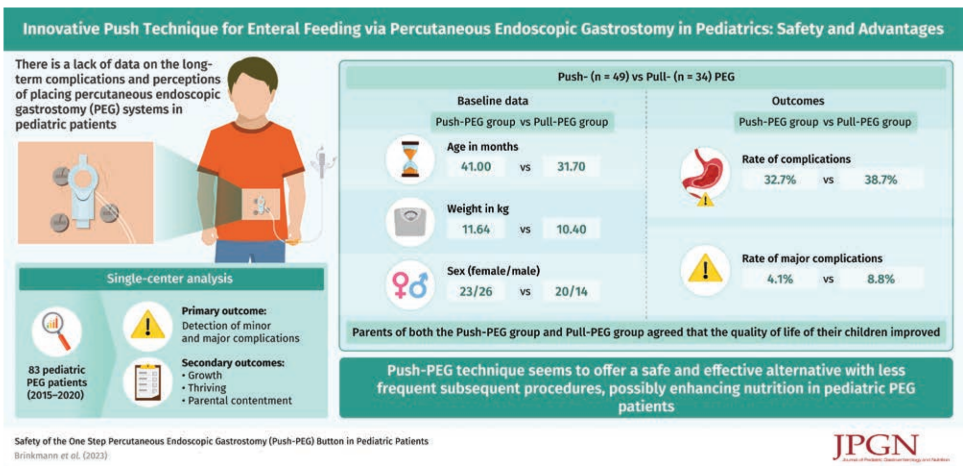

ABSTRACT

Objectives: Percutaneous endoscopic gastrostomy (PEG)-systems are essential tools for enteral feeding in a broad variety of pediatric patients. The One Step ("Push-PEG") technique allows the direct introduction of a PEG-Button. The aim of the study was to investigate the safety and parental view of the Push-PEG technique.

Methods: We conducted a single-center retrospective data and questionnaire (SDC, http://links.lww.com/MPG/D296) based study including all pediatric patients receiving a PEG via push or pull technique between 2015 until end of 2020 and compared these 2 groups. The primary outcome was the detection of minor and major complications. Secondary outcomes were growth, thriving, and parental contentment using a Likert-scaled questionnaire.

Results: Eighty-three patients were included in the analysis. There were no significant differences in the basic data regarding age, weight, or diagnosis category. Overall complication rate was 34.9%. The Push-PEG group showed a lower rate of complications (32.7% vs 38.7%) and a lower rate of major complications (4.1% vs 8.8%), although the difference is not significant. Thirty-four families completed the questionnaire (SDC, http://links.lww.com/MPG/D296) (response rate 40%). There were no significant differences between the 2 groups regarding answers of the Likert-scaled questions.

Conclusion: Push-PEG placement seems to be as safe as placement via traditional pull technique, even in small infants more than 2.8 months and 4 kg. As Push-PEG placement requires less follow-up interventions it may show significant advantages and could be the method of first choice in many cases.

Key Words: complications, enteral, feeding, quality-of-life

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Meeting the need for fluids and nutrients is essential for health. Not only does adequate nutrition counteract feelings of hunger and thirst, it is also important for homeostasis, growth, and thriving, especially in pediatric patients (1). Following the feeding via nasogastric tubes, percutaneous endoscopic gastrostomy (PEG) tubes were introduced in 1979 by Gauderer and Ponsky to improve care of patients with inadequate oral intake. It has been shown that PEG tubes improve the outcome of patients with chronic diseases (2). Common underlying conditions that lead to PEG placement are swallowing disorders in the context of congenital malformations and neuromuscular disorders, or chronic disorders with increased need of calorie intake, psychiatric eating disorders, and challenged intake of medication (3). Moreover

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What Is Known

- Percutaneous endoscopic gastrostomy (PEG) placement is necessary in a variety of pediatric patients.
- Conventional placement via pull-technique is feasible and safe but follow-up interventions are needed for replacement or explantation.
- With the one-step placement (push-technique), less follow-up interventions are needed.

What Is New

- This study brings further evidence to the feasibility and safety of the one-step PEG placement in children and small infants.
- The method of PEG placement does not seem to influence risk of complications.

PEG can be used to avoid complications like pneumonia via food aspiration (4). European Society for Paediatric Gastroenterology, Hepatology, and Nutrition guideline and other international guidelines suggest PEG placement in pediatric patients who need assisted enteral feeding for more than 3–6 weeks (5,6). The original technique (pull-technique) is still widely used but also newer techniques like PEG buttons, introduced by the push-technique, were developed (7).

While some studies have highlighted the complications and side-effects for certain techniques and groups of patients, there is still a lack of information regarding the long-term complications of PEG placement in children (8,9). In addition, there is very limited information about the parents' and caregivers' view on PEG tubes in pediatric patients.

Operative Techniques

In the pull technique (9), anatomic conditions are identified under endoscopic control and a needle (21G)/cannula is used to place a thread into the stomach. This is grasped endoscopically with forceps and then withdrawn from the patient's mouth. After the PEG tube is attached to the suture, it is pulled into the stomach and through the gastrostomy outlet. The internal holding plate and external fixation result in gastropexy (10).

In the Push technique, a gastropexy is first created with 3 special needles (Avanos Medical Inc., Mic-Key SAF-T-PEXY T-Fastener, 18 Fr). Through these Pexy needles, T-fasteners are inserted into the stomach to fix it in the shape of a triangle on the anterior abdominal wall. A guide wire is inserted via a cannula in the center of the triangle, which is then used to gradually dilate the outlet with an 18 Ch dilator. Finally, the button is placed over a withdrawal sleeve and filled with sterile water.

There is some evidence, albeit few for children, that the push-technique reduces some risks (10). Mainly, the pull-technique inherently has a higher risk for buried bumper syndrome and for infections at the PEG exit, while the push-technique mainly causes tube dislodgement, perioperative bleeding, pneumoperitoneum, or rarely enteroenteric fistulas (11–13). In contrast to the pull technique, the push technique has the additional advantage that it does not require further endoscopic interventions under general anesthesia (GA) after initial implantation and can be changed at home in a 1-step technique by trained caregivers.

Several studies show that both procedures have a good safety profile in adults, despite method-inherent risks (14,15). Several studies suggest antibiotic prophylaxis to prevent the risk of infection (10,16).

Caregivers acceptance, resources, and perspective are crucial to successful long-term use of enteral feeding assistance; there is limited data concerning caregivers' views on this topic (17–20). Brotherton et al explored the psychosocial dimensions of PEG placement through interviewing caregivers and discovered 9 topics on which parents expressed different opinions regarding, for example, missing the opportunity to breastfeed (21). Åvitsland et al (22) described that parents were generally accepted the PEG well while Bozzetti (23) demonstrated that for elderly patients the loss of social interaction and gustatory deprivation severely limited the quality of life for these patients.

At the children's hospital of the University Hospital of Cologne, the Push-PEG was the preferred method to place a PEG since 2015 and in most cases replaced the Pull-PEG.

The study aims to assess the feasibility, safety, and acceptance of the Push-PEG in comparison to the Pull-PEG in pediatric patients by retrospective data analysis of the patient's outcome and by using a questionnaire (SDC, *http://links.lww.com/MPG/D296*) to measure the contentment of parents and caregivers towards the PEG.

METHODS

We performed a retrospective and observational cross-sectional cohort study of all patients who underwent PEG placement at the Children's Hospital of the University Hospital of Cologne. The primary outcome compared was short- and long-term complications. Secondary outcomes were growth, thriving, and parental opinion, which were assessed by a questionnaire (SDC, *http://links.lww.com/MPG/D296*). Approval was obtained from the local ethics committee.

All PEG procedures performed at the Center for Pediatric Gastroenterology and Hepatology at the University Hospital of Cologne from 2015 until end of 2020 were screened and patients who received a PEG were included. Patients 18 years of age or older were excluded. Patients characteristics were extracted from the digital reports. The principal diagnosis leading to PEG tube placement was categorized and included gastroenterological, nephrological, neurological, oncological, cardiac or muscular diseases, prematurity, cystic fibrosis, and complex syndromic diseases. All visits of all included patients were reviewed and assessed for complications/adverse events.

For complications, any complication that did not require GA was classified as minor and any complication that required GA was classified as major. We also distinguished complications into short-term and long-term complications (less than 30 days and greater than or equal to 30 days after placement).

In addition, complications were categorized according to the Clavien-Dindo-Classification-system (24):

Grade 1: Any deviation from the normal postoperative course without the need for pharmaceutical treatment or surgical, endoscopic, and radiological interventions.
Grade 2: Requiring pharmaceutical treatment.
Grade 3: Requiring surgical, endoscopic, or radiological intervention.
Grade 3a: Intervention under regional/local anesthesia.
Grade 3b: Intervention under GA.
Grade 4: Life-threatening complication requiring intensive care treatment.
Grade 5: Death of the patient.

Baseline demographic data were extracted using the electronic patient management software Orbis (Agfa HealthCare,

Mortsel, Belgium). Patient growth and thriving were assessed by extracting height and weight during visits at baseline and 3 and 12 months after PEG placement. Percentiles and body mass index were calculated using a freely available online tool [Ped(z) Kinderarzt Rechner, Krohmeyer-Hauschild] (25).

The primary endpoint was defined as complication rate (see above). Secondary outcomes were defined as weight and height at 3 and 12 months after the procedure, time in GA, and parental (or caregivers') contentment with their child's PEG.

In our center, families were informed on both techniques and participated in the decision of the method of choice. To assess the parents' opinion about the PEG procedure, all families included in the retrospective analysis were asked to complete a questionnaire (SDC, *http://links.lww.com/MPG/D296*). The questionnaire consists of 16 questions in German language with a Likert-5-point-scale. Parents were contacted during their hospital appointment or the questionnaire was sent to them by mail. All questions were translated into English for publication.

Statistical Analysis

The collected data were analyzed using SPSS (Version 29.0.1.0 241). The demographic and clinical data were tabulated and presented as percentages and absolute numbers. Questionnaire (SDC, *http://links.lww.com/MPG/D296*) answers were described with median, minimum, maximum, and mean values. Continuous variables were described with mean, interquartile range, standard deviation, median, minimum, and maximum value. Significant differences between pull- and push-technique were determined with the Mann-Whitney *U* test and Fisher exact or Chi-square test. Exact *P* values for the Mann-Whitney *U* test and the Fisher exact test are reported to the nearest 0.001; significance was assumed at $P < 0.05$. Likert-Scale questions were compared with the polychromatic-C test. Binomial confidence intervals have been calculated using a freely available online tool (26).

RESULTS

Ninety-four children with PEG were identified by screening and treated in our center between January 2015 and December 2020. Eleven patients were excluded from the analysis. Four patients received their PEG outside our institution and 3 were placed by a different team at the University Hospital (pediatric surgery). Two were 18 years of age or older at the time of PEG placement and information on the type of PEG was not available for 2.

Baseline Data

Of the 83 patients analyzed, 49 patients received a PEG via the push-technique and 34 patients via the pull-technique. There were no significant differences in age, sex, and weight between the 2 groups. The average follow-up time of patients was 2.97 years, with a minimum of 0.03 years and a maximum of 5.97 years. The most common underlying condition for Push-PEG placement was neurological disease (39%), complex syndromic disease (31%), and nephrological disease (18%). For the Pull-PEG, the same categories were found in a comparable distribution (41% neurological diseases, 21% nephrological diseases, 21% complex syndromic diseases, see Tables 1 and 2). For the Pull-PEG group 9 out of 34 patients and for the Push-PEG group 24 out of 49 patients received only a PEG implantation during GA, while others received additional interventions.

For the Pull-PEG group mean duration of anesthesia was 00:48:53 hours (h) [standard deviation (SD) 00:13:10 h], with a minimum of 00:25:00 h and maximum of 01:05:00 h, and for the Push-PEG group, the mean duration was 00:55:52 h (SD 00:12:47 h) with a minimum of 30 minutes and a maximum of 01:20:00 h.

Age, Growth, and Thriving

Among patients in the push-PEG group, the mean age at PEG placement was 3.4 years (40.8 months; median 22.18 months), the youngest patient was 2.8 months old, and the oldest patient was 17 years (208.8 months) old. The Push-PEG group contained 12 infants younger than 1 year of age. The mean body weight was 11.6 kg (median 9.0 kg; range 4.0–51.0 kg). At 1-year follow-up, mean body weight was 14.6 kg (median 10.98 kg; range 8.0–67.0 kg). Weight percentiles increased from P9 to P13.

The mean age of patients in the Pull-PEG group was 2.7 years (32.4 months; median 15.93 months), the youngest patient was 0.9 months old, and the oldest 13.5 years (162.3 months). The Pull-PEG group contained 14 infants younger than 1 year of age.

Mean body weight at PEG-placement was 10.4 kg (median 8 kg; range 2.9–27 kg) and increased to 13.46 kg (median 10.65 kg; range 5–48.5 kg) at 1-year follow-up. Weight percentiles decreased from P15 at time of implantation to P13 at the 1-year-follow-up.

There was no significant difference between groups in regard to age at PEG-placement, proportion of infants, weight at PEG-placement, and weight gain 1 year after PEG-placement.

Complications

Of all 83 patients studied, 54 patients (65%) experienced no complications. Twenty-nine patients (35%) had 1 or more complications. A total of 40 complications were observed (see Table 3). In the Push-PEG group, complications occurred in 16 of 49 patients (complication rate 32.7%, 95% CI: 0.20–0.48). In the Pull-PEG group, the complication rate was 38.2% (13/34 patients, 95% CI: 0.22–0.56, see Table 2). There was no statistical difference ($P = 0.263$).

Classification of Complications

Pull-PEG

During the first 30 days after PEG-placement, 5 minor complications (3 CD1 and 2 CD2) and no major complications were observed.

For long-term complications (>30 days), 13 minor complications (2 CD1 and 11 CD2) in 4 patients (2 patients had 2 consecutive complications and 1 patient had 3 consecutive complications) and 3 major complications (CD3b) were observed.

Push-PEG

In the first 30 days after placement, 2 minor complications (CD2) and 1 major complication (CD3b) were observed. Beyond 30 days, 14 minor complications (8 CD1, 6 CD2) and 2 major complications (1 CD3 and 1 CD3b) were observed.

Questionnaire

Thirty-four questionnaires were completed, 3 had to be excluded. The participation rate was 40%. The families of 20 Push-PEG patients and 11 Pull-PEG patients completed the questionnaire (SDC, *http://links.lww.com/MPG/D296*).

Parents of both groups were satisfied overall with the PEG of their child. When asked whether the parents would choose the corresponding PEG again or whether they would recommend the corresponding PEG to others, both answered positively (see Table 4).

DISCUSSION

The push-technique is used more and more as the method of choice for the placement of a PEG already in infancy. Data on

TABLE 1. Basic information/demographics

	Push-PEG (n = 49)	Pull-PEG (n = 34)	*p*, M-W
Age, mo			
Mean (±SD)	41.0 (49.16)	31.7 (41.3)	0.088
Median (IQR)	22.18 (12.0–41.4)	15.93 (6.6–36.9)	–
Min/max	2.8/208.8	0.9/162.3	–
Sex			
Female/male	23/26	20/14	0.290
Weight at implantation, kg			
Mean (±SD)	11.64 (9.54)	10.4 (6.3)	0.497
Median (min/max)	9.0 (4.0/51.0)	8.0 (2.9/27.0)	–
Percentile, mean (*z* value)	9 (−2.44)	15 (−1.71)	0.236
Weight 3 months post implantation, kg			
Mean (±SD)	12.84 (10.75)	10.47 (6.23)	0.216
Median (min/max)	9.0 (5.8/55)	8.5 (4.1/28.0)	–
Percentile, mean (*z* value)	8 (−2.38)	13 (−2.05)	0.960
Weight 12 months post implantation, kg			
Mean (±SD)	14.61 (12.39)	13.26 (10.5)	0.519
Median (min/max)	10.98 (8.0/67.0)	10.65 (5.0/48.5)	–
Percentile, mean (*z* value)	13 (−2.00)	14 (−1.97)	0.928
Diagnosis category			
Neurological disease; n (%)	19 (39)	14 (41)	
Syndromal disease; n (%)	15 (31)	7 (21)	
Nephrologic disease; n (%)	9 (18)	7 (21)	
Cystic fibrosis; n (%)	2 (4)	–	
Gastroenterologic disease; n (%)	2 (4)	–	
Cardiological disease; n (%)	1 (2)	2 (6)	
Oncological disease; n (%)	1 (2)	2 (6)	
Premature birth; n (%)	–	2 (6)	

IQR = interquartile range; M-W = Mann-Whitney U test; PEG = percutaneous endoscopic gastrostomy; SD = standard deviation.

safety, also in comparison to the pull-technique, are not uniform. The results of our study support the good feasibility and safety of the push-technique even in infants of more than 2.8 months of age and 4 kg of body weight.

In our cohort, 32.7% of patients in the Push-PEG group and 38.2% of patients in the Pull-PEG group showed at least 1 complication. Comparable proportions were found for severe complications (more severe than CD3: 4.1% vs 8.8%). In particular, late CD3b complications occurred more frequently in the Pull-PEG group. Procedure-related complications such as a buried bumper in the Pull-PEG group or a dislocated button in the Push-PEG group occurred. One case of severe peritonitis occurred in the Push-PEG group, and a gastrojejunal fistula was observed in the pull-PEG group. In contrast to the difficulties reported in a retrospective study by Kvello et al (27), no complications with the T-fasteners occurred during our observation period. In our experience, a too tight fixation must be avoided to prevent necrosis and migration through the abdominal wall with possible gastric perforation. Regarding minor complications, more CD2 complications occurred in the Pull-PEG group whereas more CD1 complications—mainly granuloma formation—occurred in the Push-PEG group. More local infections occurred in the Pull-PEG group (n = 13; 68.4% of total complications) than in the Push-PEG group (n = 8; 38.1% of total complications). Three patients in the Pull-PEG group had repeated local infections, whereas only 1 patient in the Push-PEG group had 2 separate infections. Results of a retrospective survey by Demirel et al and a prospective study by Jacob et al in pediatric patients found both higher (28), as well as lower (29) complication rates for Push-PEG. Kvello et al observed 54 complications in 41 pediatric patients (47%) in the first 30 days after Push-PEG placement with T-fastener fixation. Peristomal infections were the most common. Tube dislocation occurred in 9 patients (10%). Late gastrostomy-related complications occurred in 33 patients (38%). T-fasteners caused early and late complications in 9 (10%) and 11 patients (13%), respectively. Of these, 4 patients (5%) had subcutaneously migrated T-fasteners that were removed under GA (27). Jacob et al described the outcome of the Push-PEG technique in 183 children, stating that this technique was safe and had lower infection rates compared with placement using the pull-technique (Push-PEG group 10.6% vs Pull-PEG group 29.0%) (28).

Our data support the latter, that infection rates are lower with the push technique. Out of 34 patients, 13 infections occurred in the Pull-PEG group, whereas the Push-PEG group had 8 infections in 49 patients (in regard to infections: Pull-PEG group 38.2%, 95% CI: 0.22–0.56 vs Push-PEG group 16.3%, 95% CI: 0.07–0.30).

It was hypothesized that Pull-PEG may be associated with more frequent procedure-related infections because intestinal bacteria can more easily contact the iatrogenic wound (9). This could

TABLE 2. All cases with detected complications

Case	Age (y)	Diagnosis	Early complication (≤30 d)	Late complication (>30 d)	Procedure/treatment
Push-PEG					
1	3.2	Wolf-Hirschhorn syndrome		Inflammation (CD1)	Local disinfection
2	1.9	Epileptic encephalopathy		Inflammation (CD1)	Local disinfection
3	1.5	Perinatal asphyxia		Granuloma (CD1)	Topic silver nitrate
4	3.0	Metachromatic adrenoleukodystrophy		Granuloma (CD1)	Topic corticosteroids
5	2.6	IVH with cerebellar atrophy		Granuloma (CD1)	Topic silver nitrate
6	2.7	West syndrome with hydrocephalus		Granuloma (CD1)	Topic corticosteroids
7	1.7	IUGR, multiple renal failures		Granuloma (CD1)	Topic corticosteroids
8	0.5	Moebius syndrome		Infection (CD2)	Topic antibiotics and antimycotics
9	3.9	Cystic fibrosis	Infection (CD2)		Oral antibiotics
10	0.4	Neurogenerative disease with dystonia	Infection (CD2)		Intravenous antibiotics
11	5.9	Epilepsy syndrome		Infection (CD2)	Intravenous antibiotics
12	17.3	Duchenne muscular dystrophy		Infection (CD2)	Oral antibiotics
13	3.1	Gangliosidosis		Abscess (CD2)	Intravenous antibiotics
14	1.8	Chronic kidney disease	Dislocation of Button (CD3b)	Peritonitis (CD2)	Surgical revision, intravenous antibiotics
15	3.4	Lower urinary tract obstruction		Prolaps (CD3b)	Surgical revision
16	1.1	Jacobsen syndrome, dystonia		Granuloma (CD1), infection (CD2), abscess (CD3)	Topic corticosteroids, intravenous antibiotics, surgical revision
Pull-PEG					
17	1.6	Aicardi-Goutieres syndrome, microcephaly	Inflammation (CD1)		Local disinfection
18	1.2	Neonatal dysphagia	Minor bleeding (CD1)		Bandaging
19	1.5	Extremely low birthweight infant		Granuloma (CD1)	Topic corticosteroids
20	0.8	Chromosomal anomaly with cerebral palsy	Infection (CD2)		Intravenous antibiotics
21	2.1	Microcephaly with spastic quadriplegia		Infection (CD2)	Intravenous antibiotics
22	9.0	Cerebral palsy, dystonia		Infection (CD2)	Topic antimycotics
23	.1	Asphyxia and hypoxic-ischemic encephalopathy		Infection (CD2)	Intravenous antibiotics
24	11.4	Chronic kidney disease in Joubert-Syndrome		2× Infection (CD2)	Intravenous antibiotics, oral antibiotics
25	1.2	Chronic kidney disease in renal tubular acidosis, IVH		3× Infection (CD2, CD3b)	Intravenous and oral antibiotics, topic antimycotics, explantation
26	.5	Chronic kidney disease		3× Infection (CD2)	Intravenous and oral antibiotics
27	.7	Chronic kidney disease (polycystic dysplastic kidneys)	Small esophageal lesion (CD2)		Intravenous antibiotics
28	1.3	Chronic kidney disease (polycystic dysplastic kidneys)	Granuloma (CD1)	Burried bumper (CD3b)	Topic silver nitrate, surgical revision
30	.2	Chronic kidney disease (polycystic dysplastic kidneys)		Granuloma (CD1), infection (CD2), gastrojejunal fistula (CD3b)	Intravenous and intraperitoneal antibiotics, surgical revision

IVH = intraventricular hemorrhage; IUGR = intrauterine growth retardation.

also account for the fact that patients with Pull-PEG may experience infections with intestinal bacteria that are more difficult to treat, whereas Push-PEG procedurally reduces this risk. McSweeney et al point out that various preexisting conditions significantly affect outcomes. Neurologic status, a higher ASA score (American Society of Anesthesiologists score for assessing the fitness of patients before surgery) (29), and the presence of a ventriculoperitoneal shunt appeared to negatively influence complication rates (30). When considering alternative procedures, Demirel et al suggest that laparoscopic placement of PEGs should be used in special

cases because it may lead to a reduction in severe complications in complex patients (28).

The comparatively rather low complication rate of Push-PEG in our heterogeneous patient cohort should not protect against always making an individual decision on the possibly superior procedure for the respective patient (6). Considering that the push technique does not require a second endoscopy and GA for change or removal, this may be an argument in favor of the push technique. Also, it should not be ignored that many families prefer the primary placement of a button for cosmetic and practical reasons. With regard to other parameters such as anesthesia duration, both groups were comparable with each other and with published data (27). The shortest overall anesthesia duration for PEG implantation was 25 (Pull-PEG) and 30 minutes (Push-PEG), indicating that both procedures can be performed quickly. In some cases, long operation times of up to 4 hours are the result of multiple surgical procedures performed in 1 session.

TABLE 3. Comparison of complication rate by category (Clavien-Dindo-Classification)

		Push-PEG (95% CI)	Pull-PEG (95% CI)	*p* (F-E)
≤30 days	CD1	–	8.8% (1.9–23.7)	0.065
	CD2	4.1% (0.1–14.0)	5.9% (0.7–19.7)	1
	CD3	–	–	–
	CD3b	2.0% (0.0–10.9)	–	1
>30 days	CD1	16.3% (7.3–29.7)	5.9% (0.7–19.7)	0.180
	CD2	12.2% (4.6–24.8)	32.4% (17.4–50.5)	0.220
	CD3	2.0% (0.0–10.9)	–	1
	CD3b	2.0% (0.0–10.9)	8.8% (1.9–23.7)	0.302

F-E = Fisher exact test.

Nutrition and weight gain are also important issues, as PEG placement is usually performed to ensure caloric and fluid intake and thus promote physical development. Our patients showed a discrete weight gain from weight percentile 11 (17.95 SD) to 13.6 (15.81 SD) 1 year after PEG placement. Group comparison showed that patients in the Push-PEG group increased by 4 percentage points from 9th to 13th weight percentiles, whereas patients in the Pull-PEG group decreased by 2 percentage points from 15th to 13th weight percentiles. This difference is not statistically significant; in terms of patients' ability to be fed, the 2 systems appear comparable.

From the questionnaire (SDC, *http://links.lww.com/MPG/D296*), it can be concluded that in most cases the families were satisfied with the feeding and the shortening of the feeding time.

Overall, the results of the questionnaire show that both push and pull techniques were generally rated very positively, with no differences between Push- and Pull-PEG. Families agreed that quality of life improved, and the majority would recommend the type of PEG their child received.

Limitations

Our study has several limitations. Data collection on PEG placement and follow-up was retrospective, for that complications may be underreported and there was no randomization between the 2 groups. The irregularity of clinic appointments made it challenging to record the development of thriving and growth exactly. This resulted in incomplete calculations for both groups.

In addition, it should be noted that families may have visited their general pediatrician for minor complications and follow-up and did not present to the hospital, so events may not have been captured for this analysis.

In designing the questionnaire, some questions specifically asked about negative outcomes (eg, the PEG feels uncomfortable for my child), whereas other questions asked about positive outcomes, possibly leading to confusion. Although the questions were

TABLE 4. Answers from the quality-of-life questionnaire

	Push-PEG; mean (± SD)	Pull-PEG; mean (± SD)	*p* (*t* test)	*p* (estimated via polychromatic-C)
Q1 I am overall satisfied with my child's PEG.	1.71 (0.72)	1.42 (0.52)	0.217	0.3
Q2 The PEG feels uncomfortable for my child	2.43 (0.81)	2.17 (1.03)	0.425	−0.238
Q3 The PEG restricts my child's physical activity.	2.29 (0.78)	1.8 (0.63)	0.098	−0.366
Q4 Woundhealing after PEG placement was unproblematic.	2.29 (0.78)	2.45 (1.13)	0.707	0.154
Q5 The PEG has helped my child to a positive weight development.	1.9 (1.18)	1.42 (0.79)	0.212	−0.154
Q6 I am satisfied with the quality of my child's sleep after the PEG insertion.	1.95 (0.81)	2.08 (1.17)	0.705	0.107
Q7 I am satisfied with the feeding compared to the time before the PEG	1.9 (1.09)	1.45 (0.93)	0.255	0.136
Q8 The time needed for feeding my child has been reduced by the PEG	2.29 (1.27)	1.73 (1.01)	0.217	−0.186
Q9 The PEG makes feeding less stressful for me and my child.	1.9 (1.14)	1.45 (0.68)	0.24	−0.133
Q10 My child still eats by mouth despite being fed via the PEG tube.	2.71 (1.62)	2.83 (1.59)	0.839	0.067
Q11 Feeding through the PEG reduces the amount of normal eating that is required.	2.38 (1.07)	2.27 (0.79)	0.77	0.026
Q12 The PEG allows more social activities with my family compared to the period before PEG insertion.	2.44 (0.97)	2 (0.78)	0.331	−0.217
Q13 I find the PEG stigmatizing for my child, for example, because it makes it visible to others that my child as limitations.	2.48 (0.98)	2.17 (1.27)	0.439	−0.273
Q14 I consider the PEG to be an increase in the QoL for my child.	1.62 (0.74)	1.67 (0.79)	0.863	0.048
Q15 I would decide to have a PEG again.	1.67 (1.01)	1.33 (0.14)	0.297	−0.053
Q16 I would recommend the type of PEG to other parents.	1.62 (0.74)	1.58 (0.19)	0.891	−0.028

PEG = percutaneous endoscopic gastrostomy; QoL = quality-of-life.

phrased in an easy-to-understand manner, it cannot be excluded that some parents misunderstood their answers due to the question design. However, given the results, this seems unlikely due to the homogeneity of variances between the answers. Furthermore, since we retrospectively analyzed patients from 2015 onwards until December 2020, several years may have passed between implantation and answering the questionnaire which also made it more unlikely to receive a greater number of questionnaires. The participation rate of 40% may also be a limitation to the accuracy of results.

CONCLUSIONS

The results of our study show that PEG placement using the push technique is feasible and safe in infants and children weighing more than 4 kg and has a very high acceptance rate. Minor complications were mostly limited to granulomas and infections. Major complications rarely occurred. Considering the advantages of Push-PEG placement (less frequent subsequent procedures, less frequent serious complications), this technique could be considered more frequently as an alternative in suitable patients.

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