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Percutaneous endoscopic gastrostomy in children and adolescents: 15-years' experience of a tertiary center

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ABSTRACT – **Background** – Percutaneous endoscopic gastrostomy (PEG) is an important option for enteral nutrition for both children and adults. It is considered a safe, effective, and advantageous technique in comparison to other complementary feeding routes. It allows continuous feeding, the feeding of patients with swallowing disorders due to neurological causes or others, and the administration of non-palatable diets or medications, all with low rates of complications and mortality. **Objective** – This study aimed to evaluate the main indications and complications of PEG in pediatric patients. In addition, the impact on the nutritional status of patients undergoing PEG was also compared with weight, body mass index (BMI), and height according to references from the World Health Organization. **Methods** – This observational and retrospective study included 152 children and adolescents who underwent PEG between January/2003 and December/2018. Patients up to 18 years of age at the time of the procedure were included. Complications related to the procedure were classified as minor or major. Patients with PEG indication for nutritional supplementation were evaluated for weight gain, height, and BMI, using the Z score at the day of the procedure and six months, 1 year, and 2 years after the procedure. **Results** – Indications for PEG were: swallowing disorder of neurological cause (67.1%), need for nutritional supplementation (25%), swallowing disorder of mechanical origin (6.6%), and indication of gastric decompression (1.3%). Minor complications occurred in 57.8% of patients and major complications in 9.8% of patients. The traction technique corresponded to 92.1% and puncture to 7.9%. The death rate was 1.3%. Thirty-eight patients had an indication for nutritional supplementation. In these patients, there was a gradual increase in both BMI and weight, reaching statistically significant differences (P=0.0340 and P= 0.0105, respectively). These differences were more evident in chronic renal disease patients. Height did not vary significantly (P=0.543). **Conclusion** – PEG proved to be an advantageous option as an auxiliary feeding method in pediatric patients. Dysphagia of neurological origin was the main indication followed by the need for nutritional supplementation. PEG has low frequency of major complications and mortality. This study also showed the importance of PEG in patients who need nutritional supplementation, as it enabled patients to move from undernutrition to normal weight ranges.

Keywords – Percutaneous endoscopic gastrostomy; indications; complications; nutritional supplementation.

INTRODUCTION

Percutaneous endoscopic gastrostomy (PEG) is a safe, effective and advantageous technique that creates a gastric access for enteral nutrition in children and adults. This alternative feeding route allows continuous feeding and administration of non-palatable diets, enabling safe and effective nutritional support with low mortality rates[1-4].

There are two main techniques to PEG implantation, traction (or pull) and puncture (or push). Each technique exhibits advantages and disadvantages. Pull technique is more used in children, being safe and effective and having success rates above 90%[5-8]. The main indication for PEG is oropharyngeal dysphagia or neurological swallowing disorder, but other indications include mechanical swallowing disorders, the need for nutritional supplementation, and gastric decompression[8-10].

Complications are divided according to severity into minor ones, such as leakage through the orifice of the tube, granuloma, skin infection, and obstruction of the tube, and major complications, including early exit of the tube, gastrocolocutaneous fistula, and buried bumper syndrome[11-14]. The rate of fundoplication in patients who had already undergone PEG ranges from 7.2% to 16%[15-17].

Considering that chronic diseases such as cystic fibrosis, chronic kidney disease, and congenital heart malformations can cause an increase in energy expenditure due to the patients' catabolic status, it seems necessary to evaluate the nutritional supplementation strategies in order to avoid malnutrition that may adversely affect the treatment, recovery, or quality of life of these patients[18-20]. There is also a need for improvement of nutritional status in patients with short bowel syndrome, malabsorption syndrome, and Crohn's disease[21]. In all of these cases, PEG presents itself as a beneficial method to ensure long-term enteral nutritional support. PEG is capable of improving nutritional status and quality of life by allowing weight gain and adequate development of pediatric patients[18,22,23].

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The objective of this study was to evaluate the main indications and complications of pediatric patients who underwent PEG at the Alfa Institute of Gastroenterology (IAG) at Hospital das Clínicas, UFMG. Moreover, we aimed to assess the impact on the nutritional status of patients that had undergone PEG for nutritional supplementation, by comparing weight, body mass index (BMI), and height with the references of the World Health Organization (WHO) in sequential dates after the procedure.

METHODS

This was an observational and retrospective study carried out with children and adolescents who underwent PEG. The procedure was performed at the Alfa Institute of Gastroenterology (AIG) of Hospital das Clínicas, Federal University of Minas Gerais, Belo Horizonte, between January 2003 and December 2018. Patients under 18 years of age at the time of the procedure were included in the evaluation. Those over 18 and whose data were not found in the medical records were excluded.

Medical records and upper gastrointestinal endoscopy reports were revised for data collection. Patients who underwent the procedure, regardless of the PEG technique used, underwent fasting that varied according to the age group and diet used[24]. Patients were submitted to laboratory tests including blood count, platelets, coagulation tests, and serum levels of albumin[25]. All patients received antibiotic prophylaxis with cefazolin 50 mg/kg (maximum 1 g) at a single dose, one hour before the procedure[26]. It was observed that, until 2011, the only technique used was traction or pull. After that year, some patients were submitted to the puncture or push technique.

Following the procedure, the external piece was adjusted close to the skin. In addition, before the first diet, passage of 0.9% saline solution or double-distilled water in volume according to gastric capacity by age group and weight was recommended to check the permeability of the tube. This step was also performed after each diet to avoid deterioration or obstruction of the tube. The daily care included turning the tube clockwise and counterclockwise, cleaning the ostomy area with soap and water, and avoiding buried bumper syndrome[27].

The complications related to the procedure were divided into minor, which were those treated conservatively, and major, when hospitalization, endoscopic, or surgical procedures were required[7].

Patients with indication of PEG for nutritional supplementation were assessed for weight gain, height, and BMI, using the Z score of the WHO references at the day of the procedure, and six months, 1 year, and 2 years after.

For the analysis of each patient, Z scores were mapped for BMI, weight, and height. A Z score of weight below -2 was considered as the definition of malnutrition, and Z score between -2 and +2 as appropriate weight for age and Z score between -2 and +1 of BMI for age as eutrophic, according to WHO reference.

Statistical analysis

Patient data were collected using a specific protocol. The database was developed and analyzed using IBM SPSS Statistics 20® (IBM, Armonk, NY, USA) and GraphPad Prism® (GraphPad Software, San Diego, CA, USA) software. The studied group was characterized by descriptive analysis, including means, medians, standard deviations, intervals, and percentages. Continuous variables without normal distribution were as medians and interquartile ranges 25–75% (IQ25–75%) and compared using the non-parametric Mann-Whitney test.

The variables studied were gender, age, medical indication for PEG, systemic underlying disease, and complications secondary to the procedure. The following aspects were analyzed: indications for endoscopic gastrostomy, minor and major complications after the procedure, and weight and height of patients with gastrostomy indication due to nutritional supplementation before and after the procedure.

Anthropometric data evaluations were obtained using the WHO software WHO Anthros plus 2®, with Z-scores for weight/age, BMI/age, and height/age.

The results obtained from the Z scores of the anthropometric measurements of each patient were evaluated over time and compared using the ANOVA (parametric variables) or Kruskal-Wallis (non-parametric variables) tests. The probability of significance was considered significant when the value was less than 0.05 (P<0.05).

Ethical aspects

The Ethics and Research Committee of our institution approved this study under the protocol No. 2,690,470.

RESULTS

During the study period, 167 gastrostomies were performed and 15 were excluded due to lack of data. One hundred and fifty-two patients who underwent PEG were included. Among them, 57.9% were male (n=88) and 42.1% were female (n=64). The patients' ages ranged from 30 days to 16 years and 9 months, with a median of 3.08 years (Q25: 0.75; Q75: 7.58).

One hundred and two (67.1%) patients underwent PEG due to neurological dysphagia, 38 (25%) due to nutritional supplementation, 10 (6.6%) due to mechanical dysphagia, and 2 (1.3%) due to indication of gastric decompression.

Among the 102 patients with neurological dysphagia, 31 (30.4%) were diagnosed with a genetic syndrome; 35 (34.3%) had cerebral palsy related to hypoxic-ischemic encephalopathy; 15 (14.7%) had malformation of the central nervous system (CNS) such as hydrocephalus or microcephaly, with no association with genetic syndrome; 9 (8.8%) had chronic epileptic encephalopathies; and the remaining 12 (11.7%) had CNS tumors.

Thirty-one patients presented genetic syndromes: Down syndrome in 3 (9.7%) patients, neuromuscular syndrome in 3 (9.7%) patients, Dandy-Walker syndrome in 2 (6.5%) patients, and the remaining 23 syndromes include Arnold-Chiari, Mucoplissacaridosis type IIIB, Bartter, Opitz Tay-Sachs, Batten, Moebius, Aicardi, and Pierre-Robin (74.2%).

In 15 patients diagnosed with CNS malformations not associated with any syndrome, 6 (40%) patients had hydrocephalus, 4 (26.7%) had microcephaly, 3 (20%) had holoprosoencephaly, and the remaining 2 (13.3%) had hydroanencephaly and lysoencephaly.

Tumors of the CNS occurred in 12 patients. Four (33.3%) patients were diagnosed with medulloblastoma, 2 (16.7%) with astrocytoma, 1 (8.3%) with craniopharyngioma, and 5 (41.7%) with other diagnoses, such as primitive neuroectodermal tumor (PNET), ependymoma, posterior fossa tumor, xanthoastrocytoma, and pineal tumor.

Regarding the 10 patients with swallowing disorder of mechanical origin, lymphangioma (three patients) and esophageal strictures were the main indications (three patients). The remaining 4 (40%) patients had adenobucodystrophy, a cervical tumor to be clarified, hemangioma, and neurofibromatosis. In regard to the indication

for gastric decompression, the two patients were diagnosed with visceral myopathy.

About the techniques employed, it is emphasized that only traction (or pull) and puncture (or push) techniques were applied during the research period. The traction technique was performed on 140 (92.1%) patients, while the puncture technique was performed on 12 (7.9%) patients.

The procedure occurred without complications in 147 (96.7%) patients. In the remaining cases, the following complications were reported: laceration of the esophagus (three patients), vagal reflex associated with desaturation and need for intubation and interruption of the procedure (one patient), and bradycardia in a cardiac patient after sedation requiring intubation and referral to the ICU. A total of eleven complications occurred, with minor complications occurring 96 times in 88 patients and major complications occurring in 15 patients.

It is important to note that none of the patients who underwent PEG due to esophageal stenosis had esophageal laceration during the procedure. Lacerations occurred in three patients with chronic neurological diseases and dysphagia (Medulloblastoma, Moebius syndrome, and Alobar Holoprosencephaly) and was related to excessive traction of the internal shield or use of a tube greater than appropriate for the patient. The minor and major complications are described in TABLE 1.

TABLE 1. Minor and major complications related to the PEG procedure.

Complications number (n=111)	Complications types	Number of episodes	Percentage of the total complications (%)
Minor complications (n=96)	Granuloma	33	29.8
	Ostomy leak	31	27.9
	Damaged tube	18	16.2
	Infection	14	12.6
Major complications (n=15)	Buried bumper syndrome	5	4.5
	Gastrocolocutaneous fistulae	4	3.6
	Early tube exit	2	1.8
	Bleeding	2	1.8
	Periostomy cellulite	1	0.9
	Pressure ulcer	1	0.9

Three (1.9%) patients needed fundoplication after PEG due to persistent vomiting and failure of the clinical treatment of severe gastroesophageal reflux disease. Among these three patients, two had a genetic syndrome and one had congenital liver fibrosis and polycystic kidneys and needed nutritional supplementation. Fundoplication was performed 8, 23, and 32 months after endoscopic gastrostomy. The upper endoscopy was normal in all these patients during the performance of the PEG.

Two deaths associated with the procedure were identified among the patients analyzed, reaching a death rate of 1.3%. One of them died during the procedure due to an important tearing of the esophagus after the passage of the internal shield. The other patient died after 17 days due to a gastrocolocutaneous fistula and post-surgery complications.

Permanent removal of the tube was possible in 10 (6.5%) patients who had good tolerance to oral diet. The tube removal time varied from 5 months to 5 years and 7 months after the procedure (average of 3.1 years, SD: ±1.8 years). The main groups that carried out the permanent removal of the tube were those with neurological causes who evolved with improvement of dysphagia by means of physical therapy training, totaling 6 (60%) patients, and nutritional supplementation, in 4 (40%) patients. The diagnosis of these patients were: (1) neurological disorders, four patients; (2) ischemic hypoxic syndrome and prematurity, two patients; (3) chronic renal disease, two patients; and (4) hematological disease, two patients.

PEG for nutritional supplementation

PEG was performed in 38 patients due to the indication of nutritional supplementation: 14 patients had cystic fibrosis, nine patients had chronic kidney disease, five had congenital heart disease, three had immunodeficiency, two had pulmonary diseases, two had an inborn error of metabolism, one had sickle cell disease, one had gastrosquize, and one had congenital liver fibrosis and polycystic kidneys.

The graphs in FIGURE 1 show the variation of the median in relation to the BMI, weight, and height of the patients during all the pre-established dates.

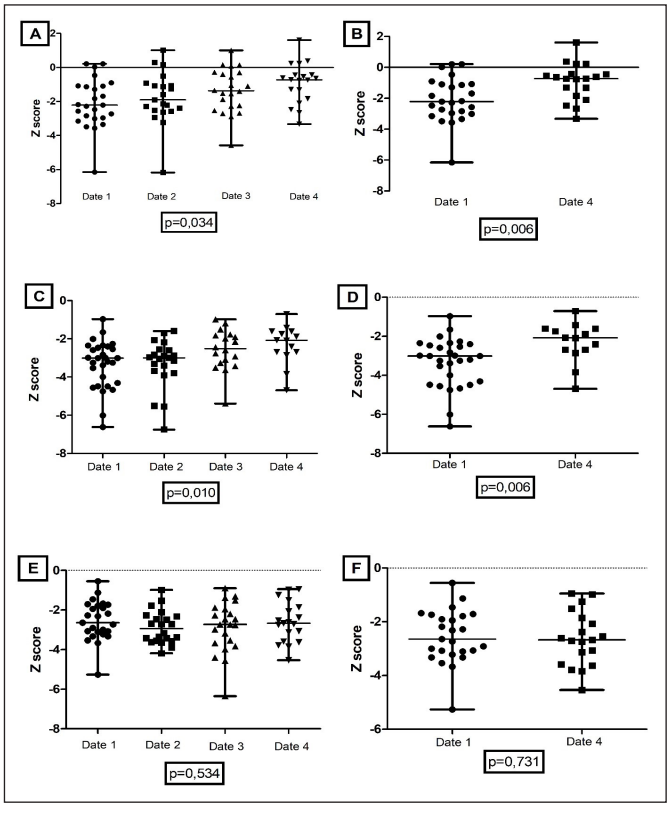

FIGURE 1. Evolution of Z scores according to the WHO classification for BMI, weight and height after endoscopic gastrostomy. **A.** Evolution of BMI Z score in all evaluated dates; **B.** Evolution of BMI Z score from date 1 (procedure day) and after 2 years (date 4); **C.** Evolution of weight Z score in all evaluated dates; **D.** Evolution of weight Z score from date 1 (procedure day) and after 2 years (date 4); **E.** Evolution of height Z score in all evaluated dates; **F.** Evolution of height Z score from date 1 (procedure day) and after 2 years (date 4). Data presented as median and IQ range 25–75%.

In relation to BMI, it was observed that at the time of PEG (date 1) the median Z score was -2.21 (Q25% -2.21; Q75% -1.09) and, gradually, there was an increase in the median until 2 years after the procedure (date 4), which had a Z score of -0.73 (Q25% -1.84; Q75% -0.44). There was, therefore, a significant variation (P=0.034). The same analysis was performed in relation to the patients' median weight at the day of PEG and 2 years after the procedure. It is observed that, as well as the BMI, the patients exhibited weight gain over time, changing the median of the Z score of -3.01 (Q25% -4.40; Q75% -2.44) to -2.08 (Q25% -2.73; Q75% -1.62) (P=0.0105). The median height evolution of patients over time did not vary significantly (P=0.534), as shown in TABLE 2.

In case of patients with cystic fibrosis undergoing PEG due to the need for nutritional supplementation, it was observed that there was no statistically significant difference for weight, height and BMI over time. The median age of this group was 9 years old (Q25% 3 years; Q75% 14 years). Despite this fact, these patients had evolved from low weight and malnutrition according to medians of weight and BMI, to adequate weight for age and eutrophic BMI (TABLE 3).

Unfortunately, it was not possible to analyze the functional classification of neurological patients. In addition, some genetic disorders found in our patients certainly resulted in weight loss due to the evolution of the disease, which can interfere with nutritional assessment. Despite of that, we still found a nutritional improvement by means of nutritional support via gastrostomy in the individual monitoring of each patient.

Conversely, when assessing the data of chronic renal disease patients over time, there was a statistically significant difference in values for weight and BMI (FIGURE 2). The median age of this group was 7 years old (Q25% 2.5 years; Q75% 11 years). The median weight Z-score for age on the day of the procedure (date 1) increased from -3.4 (Q25%: -4.4; Q75%: -3.0) to -2.7 (Q25%: -2.9; Q75%: -2.1) in 2 years after the procedure (date 4) with P=0.048. The median value of the Z-score for BMI also increased over the 2-year period, from -2.6 (Q25%: -3.1; Q75%: -2.2) on date 1 to -0.64 (Q25%: 0.73; Q75%: -0.61), with a P-value of 0.031. However, there was no significant difference in height (FIGURE 2 and TABLE 4).

In patients with congenital heart disease undergoing PEG for nutritional supplementation, it was not possible to assess whether there was a significant difference due to the very limited amount of data.

TABLE 2. Median of Z score for weight, height, and BMI of all patients evaluated over time.

	D1	D2	D3	D4	*P* value
Z score/weight					
Median	-3.01	-3.00	-2.52	-2.08	0.010
(IQ range 25–75%)	(-4.4 to -2.4)	(-3.7 to -2.6)	(-3.3 to -1.8)	(-2.7 to -1.6)	
Z score/height					
Median	-2.64	-2.95	-2.73	-2.67	0.534
(IQ range 25–75%)	(-3.2 to -1.7)	(-3.6 to -2.3)	(-3.7 to -1.9)	(-3.6 to -1.9)	
Z score/BMI					
Median	-2.21	-1.90	-1.38	-0.73	0.034
(IQ range 25–75%)	(-2.9 to -1.1)	(-2.6 to -0.9)	(-2.3 to -0.3)	(-1.8 to -0.4)	

D1: procedure date; D2: 6 months after PEG; D3: 12 months after PEG; D4: 24 months after PEG. IQ range: interquartile range. The first quartile corresponds to 25% and the third quartile corresponds to 75%.

TABLE 3. Median of Z score for weight, height, and BMI of patients with cystic fibrosis that undergone PEG due to the need for nutritional supplementation.

	D1	D2	D3	D4	*P* value
Z score/weight					
Median	-2.7	-2.7	-2.0	-1.8	0.188
(IQ range 25–75%)	(-3.2 to -2.1)	(-3.0 to -1.8)	(-2.6 to -1.5)	(-2.5 to -1.2)	
Z score/height					
Median	-2.8	-3.0	-2.7	-2.7	0.851
(IQ range 25–75%)	(-3.2 to -2.2)	(-3.6 to -2.3)	(-3.6 to -2.0)	(-3.8 to -1.8)	
Z score/BMI					
Median	-2.0	-2.2	-1.8	-0.8	0.747
(IQ range 25–75%)	(-3.0 to -0.9)	(-2.6 to -0.5)	(-2.7 to -0.08)	(-2.5 to -0.4)	

D1: procedure date; D2: 6 months after PEG; D3: 12 months after PEG; D4: 24 months after PEG. IQ range: interquartile range. The first quartile corresponds to 25% and the third quartile corresponds to 75%.

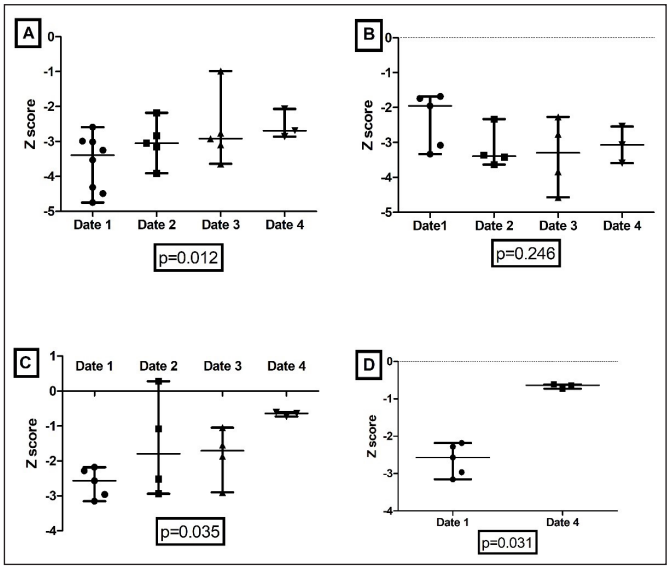

FIGURE 2. Evolution of Z scores for weight, height and BMI of patients with chronic kidney disease undergoing gastrostomy due to the need for nutritional supplementation. **A.** Evolution of weight Z score in all evaluated dates; **B.** Evolution of height Z score in all evaluated dates; **C.** Evolution of BMI Z score in all evaluated dates; **D.** Evolution of BMI Z score from date 1 (procedure day) and after 2 years (date 4). Data presented as median and IQ range 25–75%.

DISCUSSION

Percutaneous endoscopic gastrostomy is a safe alternative for pediatric patients who have neurological dysphagia, who need nutritional supplementation, who have dysphagia due to mechanical causes or who need gastric relief for various reasons[4-6]. The results supported that PEG is an extremely advantageous and effective option for supplementary feeding route. In addition, the study reinforced how safe the procedure is for pediatric patients of all age groups, with low mortality rate of approximately 1%[6,11,12].

In the sample presented, the main indications for PEG were dysphagia of neurological cause and the need for nutritional supplementation due to catabolic conditions (cystic fibrosis, kidney disease, congenital heart disease). Similar studies have reported that patients with severe neurological sequelae and swallowing disorders are the main indication of PEG, being cerebral palsy the most common isolated indication among neurological conditions[28,29]. In the present study, cerebral palsy was the second most common indication. The main cause of cerebral palsy was hypoxic-ischemic encephalopathy. Hospital das Clínicas at UFMG is a reference center for fetal medicine and for high-risk newborns, justifying the greater number of these patients among those who needed PEG.

Before the advent of PEG, gastrostomy was performed surgically. Therefore, simultaneous fundoplication was common, as it was believed that gastrostomy worsened or led to the development of gastroesophageal reflux disease. Since the introduction of PEG as a gastrostomy method, the context of fundoplication has changed. Studies in the literature have shown that the rate of fundoplication after PEG ranges from 7.2% to 16%[15-17]. In the present study, the fundoplication rate was 1.9%. The probable causes of this difference are the fact that the data from studies in the literature had a longer follow-up time for patients in relation to this study. In any case, the results show that the need for fundoplication after PEG is not frequent, and the optimization of the clinical treatment of gastroesophageal reflux disease can be satisfactory for the control of the disease[16,17,30].

In agreement with the available literature, minor complications occurred more frequently when compared to major ones[11-14]. The rate of minor complications varies from 16.4% to 55%[11-13]. Balogh et al.[12] reviewed 18 articles with a total of 4,631 patients undergoing gastrostomy from 1994 to 2017, with an average age of 3 years (0–26 years), and found as the main complications minor granuloma (10.3%), local infection (8.3%), leakage (6.0%), and local infection (4.1%)[12]. In the present study, the complication rate of 57.8% was similar to that found in the literature, also presenting granuloma, leakage, and local infection as the most frequent.

In our sample, the rate of major complications was 9.8%, similar to data in the literature, which ranged from 3.3% to 10.5%[11-13]. Regarding the distribution of major complications, the study of Balogh et al.[12] identified mainly cellulite (1.5%), peritonitis (1.5%), sepsis or dehiscence of the surgical wound (1.5%), buried bumper syndrome (1.0%), severe pneumoperitoneum (0.7%), and gastrocolic fistula (0.45%)[12]. The most common major complications in our case were buried bumper syndrome, gastrocolic fistula, early exit of the tube, bleeding, and periostomy cellulitis, similar to that found in the literature, varying only the distribution.

TABLE 4. Median of Z score for weight, height, and BMI of patients with chronic kidney disease undergoing PEG due to the need for nutritional supplementation.

	D1	D2	D3	D4	*P* value
Z score/weight					
Median	-3.4	-3.1	-2.9	-2.7	0.012
(IQ range 25–75%)	(-4.4 to -3.0)	(-3.5 to -2.5)	(-3.4 to -1.9)	(-2.9 to -2.1)	
Z score/height					
Median	-2.0	-3.4	-3.3	-3.1	0.246
(IQ range 25–75%)	(-3.2 to -1.7)	(-3.6 to -2.6)	(-4.4 to -2.4)	(-3.6 to -2.5)	
Z score/BMI					
Median	-2.6	-1.8	-1.7	-0.64	0.035
(IQ range 25–75%)	(-3.1 to -2.2)	(-2.8 to -0.06)	(-2.6 to -1.2)	(-0.7 to -0.6)	

D1: procedure date; D2: 6 months after PEG; D3: 12 months after PEG; D4: 24 months after PEG. IQ range: interquartile range. The first quartile corresponds to 25% and the third quartile corresponds to 75%.

However, regarding complications, it is worth mentioning that laceration of the esophagus by the internal shield can occur in up to 3.3% of cases[7]. One of the deaths in this study was due to this complication. Thus, the importance of choosing an adequate material is emphasized, observing the ideal tube size for the patient's age, in addition to delicately traction of the gastrostomy tube during its insertion and manipulation. In our study, there were no lacerations related to the technical procedure in patients diagnosed with esophageal stricture. We believe that this is related to the fact that the puncture technique was performed with an ultra-fine device, with a minor risk of laceration.

When analyzing the 38 patients who underwent PEG due to the need for nutritional supplementation, weight gain, height, and an increase in BMI were observed over time. These findings are consistent with those described in the literature regarding the benefits of PEG for patients needing nutritional supplementation, especially those with diseases that increase total energy expenditure due to catabolic state. Cystic fibrosis, chronic kidney disease, and congenital heart malformations are examples of such conditions[18-20]. Several studies have already demonstrated a significantly greater weight gain in patients treated with PEG than in those in a control group[18-20]. The importance of improving patients' nutritional status is directly related to preventing complications, promoting better quality of life, and increasing patient survival[30,31]. The differences in relation to height, however, were not significant during the study period, since height is an anthropometric data that takes more time to recover in chronic malnutrition.

In patients with cystic fibrosis, data in the literature are conflicting. Best et al.[32], for example, observed a significant increase in BMI in 46 patients followed up for 2 years before PEG and 1.2 and 4 years after the procedure. The authors showed that there was a continuous increase in BMI with a statistically significant difference between the first and the last measurement at 4 years[32]. Khalaf et al.[18], however, when comparing 20 cystic fibrosis patients who underwent PEG with 40 who did not, observed an increase in the percentage of BMI per month in the group of patients that underwent PEG. However, there was no significant difference between the groups[18].

In the present study, patients with cystic fibrosis who underwent PEG showed significant improvement in relation to weight, BMI, and height; however, there was no statistically significant difference between the time-points evaluated. It should be mentioned that the small number of patients in our study might be a limiting factor for the interpretation of the results as well as the short period of follow-up. Other issues that might have contributed to this result were the phenotypic factors of the disease itself, which carry severe conditions in relation not only to malnutrition, but also to the type of pulmonary bacterial colonization, the number of pulmonary exacerbations, or an existing pulmonary infection. Therefore, it is hypothesized that these patients gained weight, but very slowly, or at least did not lose weight after PEG. In future studies, it should be investigated whether patients with cystic fibrosis face more severe malnutrition if the PEG is not performed, as to find if the nutritional support by PEG works as a preventive measure to avoid weight loss and BMI reduction.

When assessing patients with chronic kidney disease, the findings of the present investigation were similar to those of a study including 82 pediatric patients with chronic kidney disease followed for 5 years after the implantation of PEG (with a mean age of implantation of 1.7 years). There was a significant increase in the Z-score weight for age (P<0.01) and BMI for age (P<0.03), but there was no difference in height for age[33].

Although age may be a factor influencing the absence of height increase, in these two groups, the patients had median ages of 9 and 7 years, respectively. At these ages, there is still potential for growth. Thus, we did not considered age as a relevant factor.

CONCLUSION

PEG has been shown to be an advantageous option as an auxiliary nutritional support route for pediatric patients with neurological dysphagia and patients in need of nutritional supplementation. These two conditions are the most frequent indications, and our patients have low rates of major complications and mortality.

The present study, in agreement with the literature, also showed the importance of PEG in patients needing nutritional supplementation. PEG enabled patients to move from undernutrition to normal weight ranges. This change is extremely important because, in future, it can allow clinical and quality of life improvements.

Authors' contribution

All authors equally contributed to this article. Franco Neto JA, Liu PMF, Carvalho SD collected the data, analyzed and wrote the text. Bittencourt PFS and Ferreira AR conceptualized the study, made general supervision and revised the manuscript. Liu PMF submitted the final version of the manuscript, which was approved by all authors.

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RESUMO – **Contexto** – A gastrostomia endoscópica percutânea (GEP) é uma importante opção de nutrição enteral para crianças e adultos, sendo considerada uma técnica segura, eficaz e vantajosa em comparação às outras vias de alimentação complementar. Permite a alimentação contínua, a alimentação em pacientes com distúrbios de deglutição de causa neurológica ou outros, a administração de dietas ou medicamentos não palatáveis, todos com baixos índices de complicações e mortalidade. **Objetivo** – Avaliar as principais indicações e complicações de pacientes pediátricos submetidos à GEP e o impacto no estado nutricional de pacientes submetidos à GEP para suplementação nutricional, comparando peso, índice de massa corporal (IMC) e estatura com referências da Organização Mundial de Saúde. **Métodos** – Estudo observacional e retrospectivo de 152 crianças e adolescentes submetidos à GEP, no período de janeiro/2003 a dezembro/2018. Foram incluídos pacientes até 18 anos de idade na época do procedimento. As complicações relacionadas ao procedimento foram divididas em menores e maiores. Pacientes com indicação de GEP para suplementação nutricional foram avaliados quanto ao ganho de peso, altura e IMC, por meio do escore Z no dia do procedimento e 6 meses; 1 ano; e 2 anos após o procedimento. **Resultados** – As indicações para GEP foram distúrbio de deglutição de causa neurológica (67,1%), necessidade de suplementação nutricional (25%), distúrbio de deglutição de origem mecânica (6,6%), e indicação de descompressão gástrica (1,3%). Complicações menores ocorreram em 57,8% dos pacientes e complicações maiores em 9,8%. A técnica de tração correspondeu a 92,1% e a punção, 7,9%. A taxa de mortalidade foi de 1,3%. Trinta e oito pacientes tinham indicação de suplementação nutricional. Nestes, houve aumento gradativo tanto do IMC quanto do peso, com variação estatisticamente significativa da mediana P=0,0340 e P=0,0105, respectivamente, mais evidente nos pacientes renais crônicos. A altura não variou significativamente (P=0,543). **Conclusão** – A GEP mostrou-se uma opção vantajosa como forma auxiliar de alimentação em pacientes pediátricos, tendo como principais indicações a disfagia de causa neurológica e a necessidade de suplementação nutricional, com baixa prevalência de complicações maiores e mortalidade. Este estudo também mostrou a importância da GEP em pacientes com necessidade de suplementação nutricional, possibilitando a passagem dos pacientes desnutridos para escores nutricionais de peso adequados à idade.

Palavras-chave – Gastrostomia endoscópica percutânea; indicações; complicações; complementação nutricional.

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