Original Article

# Modified Percutaneous Endoscopic Gastrostomy in Children

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## ABSTRACT

### Background

Gastrostomy is widely used to provide long-term enteral nutrition for children with severe nutritional disorders. However, the optimal method of gastrostomy placement remains controversial, as each method has its advantages and potential complications. In recent years, percutaneous endoscopic gastrostomy (PEG) has gained increasing popularity due to its minimally invasive nature. The aim of this study was to compare the clinical outcomes and complications associated with different gastrostomy techniques and to evaluate the safety of a modified Push-PEG method.

### Methods

A retrospective single-center study included 120 pediatricpatients who underwent gastrostomy placement using four different techniques: open gastrostomy (OG), laparoscopic gastrostomy (LG), standard Push PEG, and modified Push-PEG. Patient demographics, operative time, length of hospital stay, indications for gastrostomy, and postoperative complications were analyzed. Statistical analysis was performed to compare outcomes between the groups.

### Results

The main indication for gastrostomy placement was dysphagia (75%), followed by malnutrition (25%). The overall complication rate was 42.5%. No significant differences were found between the groups in the rate of minor complications ($p = 0.630$). However, significant differences were observed for major complications, with the highest rates seen after open and laparoscopic gastrostomy, and the lowest after the modified Push-PEG technique ($p = 0.001$).

### Conclusions

The modified Push-PEG technique is a safe and minimally invasive alternative to surgical gastrostomy methods, reducing operative time, accelerating recovery, and decreasing the risk of major postoperative complications in pediatric patients.

## Keywords

gastrostomy; dysphagia; PEG; nutritional support.

## INTRODUCTION

Percutaneous endoscopic gastrostomy (PEG) is an established approach for providing long-term enteral nutrition in children with chronic conditions associated with dysphagia or increased nutritional requirements[1–3]. Despite its widespread use, the choice of the optimal gastrostomy technique in pediatric patients remains controversial. Multiple PEG methods have been developed, each characterized by specific advantages and limitations.

For example, the “pull” technique is associated with a higher risk of complications such as buried bumper syndrome and stoma site infections, whereas the “push” technique is more commonly linked to tube dislodgement, perioperative bleeding, pneumoperitoneum, and, less frequently, enteroenteric fistulas. In recent years, growing attention has been directed toward the push-PEG technique and its modifications,

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aiming to minimize infectious complications, reduce procedural invasiveness, and enhance patient comfort.

An additional advantage of the "push" technique is that it does not require repeated endoscopic procedures under general anesthesia following initial placement, and the gastrostomy tube can be replaced at home in a single step by trained caregivers[3–8].

Since 2021, the Scientific Center of Pediatrics and Pediatric Surgery in Almaty has adopted the push-PEG technique as the preferred method for gastrostomy placement, with several technical modifications introduced during its clinical implementation.

The present study aims to evaluate the safety profile and complication rates of the modified push-PEG technique and to compare its outcomes with those of open and laparoscopic gastrostomy using a retrospective analytical approach.

## MATERIALS AND METHODS

*Study Design:* Cross-sectional, retrospective.

*Study Materials:* Medical records of 120 children who underwent gastrostomy placement in the surgery department of JSC "Scientific Center of Pediatrics and Pediatric Surgery" from 2017 to 2025. Gastrostomy was performed using 4 methods: open Kader gastrostomy, laparoscopic Kader gastrostomy, standard push-PEG, and modified push-PEG techniques.

*Surgical Procedure of Modified Push-PEG*

The standard procedural steps were preserved; however, some technical modifications were introduced: (1) the use of two gastropexy fixation devices instead of three; (2) standard placement of the gastrostomy tube in the gastric body; and (3) mandatory submucosal injection of saline at the puncture site to reduce the risk of bleeding. These changes were implemented to enhance procedural safety and standardization while maintaining the basic principles of the original technique (Figure 1).

Figure 1 shows a schematic description of the sagittal section of gastrostomy placement using the modified Push-PEG method and the external appearance of the final stage.

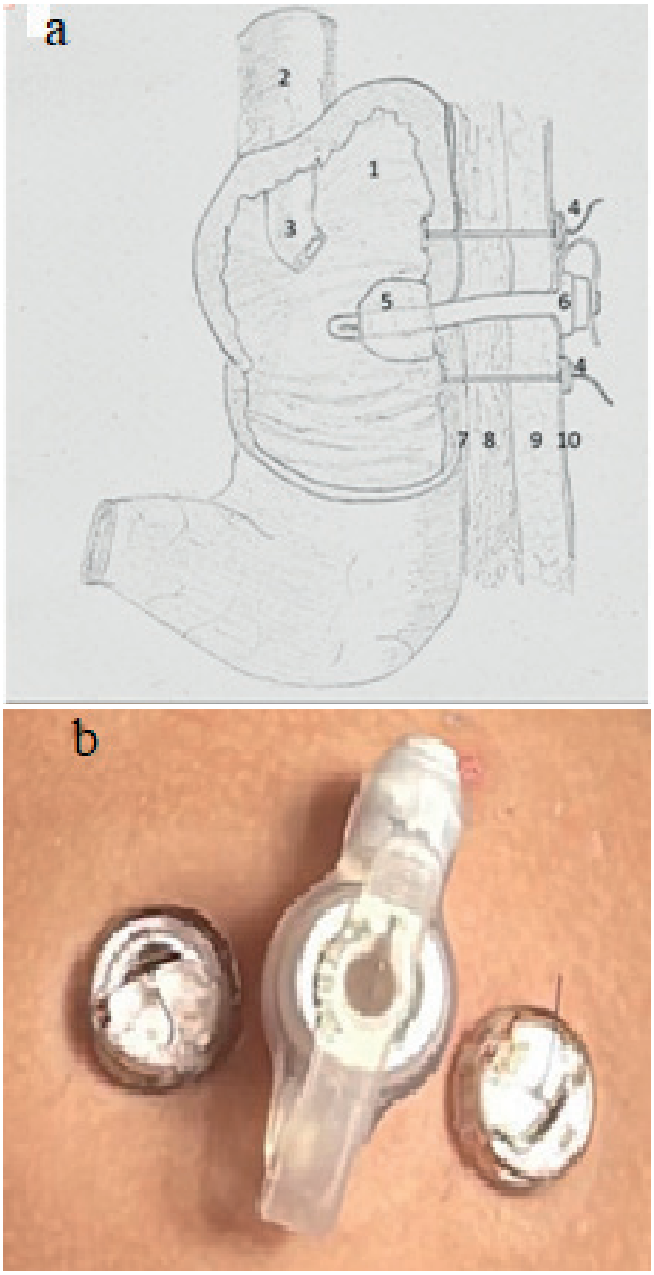


**Figure 1** – Schematic representation of the gastrostomy placement technique using the modified Push-PEG method and the external appearance of the gastrostomy tube with two fixation devices

a) Schematic description of the sagittal section of endoscopically assisted gastrostomy placement: 1. Gastric lumen; 2. Esophagus; 3. Endoscope; 4. Fixation devices (T-fasteners); 5. Internal balloon retainer; 6. Gastrostomy tube; 7. Peritoneum; 8. Muscular layer of the anterior abdominal wall; 9. Subcutaneous adipose tissue; 10. Skin

b) Final stage, external view

**Table 1.** Demographic data and indications for surgery broken down by group

| | Total (n=120) | OG (n=20) | LG (n=30) | Push PEG (n=20) | Modified Push PEG (n=50) | p-value |
|---|---|---|---|---|---|---|
| Male | 62 (51.6%) | 10 (50%) | 11 (36.6%) | 9 (45%) | 32 (64%) | 0.107 |
| Female | 58 (48.4%) | 10 (50%) | 19 (63.4%) | 11 (55%) | 18 (36%) | 0.107 |
| Age (years) | 3.7 (SD=3.6) | 4.2 (SD=3.5) | 3.6 (SD=2.4) | 4.8 (SD=5.1) | 3.1 (SD=3.5) | 0.281 |
| Weight (kg) | 13.0 (SD=6.9) | 16.2 (SD=8.1) | 14.0 (SD=2.7) | 13.7 (SD=10.5) | 10.89 (SD=5.8) | **0.017** |
| Operation Time (min) | 27.1 (SD=20.3) | 48.75 (SD=16.0) | 50.0 (SD=6.9) | 11.28 (SD=1.17) | 11.15 (SD=1.42) | **0.001** |
| Hospital Stay (days) | 10.95 (SD=8.6) | 17.1 (SD=8.0) | 19.5 (SD=8.8) | 6.1 (SD=3.0) | 5.2 (SD=2.2) | **0.001** |
| **Indications for Gastrostomy** | | | | | | |
| Neurological disease | 55 | 2 | 2 | 16 | 35 | **0.001** |
| Mechanical dysphagia | 35 | 16 | 5 | 3 | 11 | **0.001** |
| Nutritional support | 30 | 2 | 23 | 1 | 4 | **0.001** |

Sex distribution was nearly equal: 62 boys (51.6%) and 58 girls (48.4%). No statistically significant differences were found between the groups regarding sex ($p > 0.05$), indicating the comparability of the cohorts for this parameter.

*Statistical analysis* The collected data formed our database and were analyzed using IBM SPSS Statistics software (version XX, IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using the Shapiro–Wilk test and visual analysis of histograms and Q–Q plots. Normally distributed data were presented as mean ± standard deviation (SD) and compared between the four independent groups using one-way analysis of variance (ANOVA). Categorical variables are presented as absolute values and percentages. The $\chi^2$ test was used to compare complication rates between groups. In cases where the expected cell count in contingency tables was less than 5, Fisher's exact test was used. Differences were considered statistically significant at $p < 0.05$.

## Ethical Clearance

This clinical case was described in accordance with all ethical standards and principles provided by the Declaration of Helsinki. Informed consent was obtained from the patient's parents for publication and use of medical information for scientific analysis and dissemination. The patient's personal information was completely anonymized, excluding the possibility of

identification. The study did not involve interventions beyond standard medical care and did not require separate approval from an ethics committee.

## RESULTS

During the study period, a total of 120 gastrostomies were performed. The mean follow-up period was 21 months. All complications were documented within the first 6 months after gastrostomy placement.

The distribution of surgical methods used for gastrostomy was as follows: open gastrostomy was performed in 20 cases (16.7%), laparoscopic gastrostomy in 30 cases (25%), Push PEG in 20 cases (16.7%), and modified Push PEG in 50 cases (58.4%). Patient characteristics and comparison of surgical techniques are shown in Table 1.

The mean age of participants was 3.7 ± 3.6 years (range 3 months – 16 years). Although patients in the standard push PEG and OG groups were somewhat older, differences between groups did not reach statistical significance ($p > 0.05$).

The mean patient weight was 13.0 ± 6.9 kg. Intergroup analysis revealed that the lowest body weight was in the Push-PEG group, whereas the highest was in the OG group. Differences between groups were statistically significant ($p = 0.017$).

The mean operative time for the entire cohort was 27.1 ± 20.3 min. The shortest operative time was recorded for modified Push-PEG (11.15 min), followed by standard Push-PEG (11.28 min), whereas OG and LG were characterized by significantly longer intervention times (48.75 and 50.0 minutes, respectively). These differences were statistically significant ($p = 0.001$). A similar trend was observed when analyzing the length of hospitalization. The minimum number of hospital days was noted in the modified Push-PEG group (5.2 days), while the maximum length of stay was recorded after LG (19.5 days). Differences between groups were statistically significant ($p = 0.001$).

The main indication for gastrostomy placement was swallowing difficulty (75%). The most common cause of dysphagia was neurological diseases such as cerebral palsy, hydrocephalus, and stroke. Mechanical difficulty in food passage through the oropharynx or esophagus due to structural changes or lumen narrowing accounted for about 39% of dysphagia causes. Patients with post-burn stenosis and congenital esophageal malformations constituted this group. In 25% of cases, gastrostomy was performed for malnutrition with the aim of nutritional support. This group included patients with severe protein-energy malnutrition due to congenital heart defects, lung, liver, and kidney diseases.

Overall, 81 postoperative complications occurred in 51 (42.5%) patients. Twenty-two patients (18.3% of all patients and 27.1% of patients with complications) had more than one complication. Complications occurred early (within 30 days of surgery) in 48 patients (40%) and late (later than 30 days after surgery) in 16 patients (13.3%). Minor complications occurred in 42 (35%), major complications in 39 (32.5%) (Table 2).

Intergroup analysis revealed no statistically significant differences in the frequency of minor complications ($p = 0.630$). Minor complications were somewhat more frequent with more invasive gastrostomy methods, such as open and laparoscopic gastrostomy; however, a comparable rate of minor complications was also noted with the use of percutaneous techniques. These complications resolved with conservative treatment.

At the same time, analysis of major complications revealed statistically significant differences between the study groups ($p = 0.001$). The highest number of severe complications was observed after laparoscopic gastrostomy and the standard Push-PEG technique, somewhat less frequently after open gastrostomy. The lowest rate of major complications was recorded with the modified Push-PEG technique.

A more detailed analysis of the complication structure revealed that labiform gastrocutaneous fistulas formed more often after open gastrostomy. In the laparoscopic gastrostomy group, conversion of access was necessary in some cases due to intraoperative bleeding. After the standard Push-PEG technique, bleeding from the gastric mucosa was most frequently recorded. The only major complication observed after the modified Push-PEG technique was buried bumper syndrome.

**Table 2** - Comparison of complications in patients undergoing gastrostomy

| | OG (n=20) | LG (n=30) | Push PEG (n=20) | Modified push PEG (n=50) | Total | p-value |
|---|---|---|---|---|---|---|
| **Minor Complications** | | | | | | **0.630** |
| Pneumoperitoneum | 0 | 2 | 3 | 4 | 9 | |
| Peristomal infection | 4 | 4 | 4 | 2 | 14 | |
| Leakage of gastric contents | 5 | 2 | 1 | 2 | 10 | |
| Granulation tissue | 6 | 5 | 2 | 1 | 14 | |
| **Major Complications** | | | | | | **0.001** |
| Gastric bleeding | 4 | 5 | 9 | - | 18 | |
| Buried bumper syndrome | 0 | 0 | 0 | 1 | 1 | |
| Gastrocutaneous fistula | 5 | 3 | 2 | - | 10 | |
| Peristomal bleeding | 0 | 3 | 0 | 0 | 3 | |
| Conversion of access | 0 | 2 | 0 | 0 | 2 | |

The overall complication rate was higher in the laparoscopic gastrostomy (LG) group, accounting for 32% of all complications, followed by open gastrostomy (OG) — 29.6% and the standard Push-PEG technique — 26%. The lowest complication rate was observed with the modified Push-PEG method, accounting for 12.4%.

## DISCUSSION

Despite the widespread use of gastrostomy as a method of long-term enteral support, the question of choosing the optimal technique for its performance remains debatable, as none of the existing methods is without complications. Nevertheless, in recent decades, PEG has become widespread and, in many clinical situations, is considered the preferred method for providing long-term enteral nutrition. This is due to several advantages of this technique, including less invasiveness, reduced operative time, shorter hospital stay, and the absence of necessity for a laparotomic or laparoscopic incision. Furthermore, PEG is characterized by faster postoperative patient recovery and less tissue trauma, which is particularly important in pediatric practice [9].

Given this trend, in recent years, the Push-PEG technique has become the method of choice in our center. However, the relatively high incidence of gastric mucosal bleeding observed at the beginning of the method's implementation prompted a modification of the procedure technique. Specifically, before placing the gastrostomy tube, submucosal infiltration of saline was performed to reduce the risk of bleeding. This technical maneuver was adapted from endoscopic methods for preventing and stopping bleeding used in the endoscopic treatment of gastric peptic ulcers[10-11]. The gastrostomy tube was placed exclusively in the gastric body area, which is closer to the natural physiology of digestion, as the gastric body serves as the main reservoir of the stomach and ensures more natural mixing and gradual emptying compared to placement in the fundus[12,17,18]. Furthermore, we used two T-fasteners for gastropexy instead of three, which reduced the invasiveness of the procedure and clinically decreased the severity of postoperative pain associated with local inflammation and expected adhesion.

In the presented study, the main indication for gastrostomy placement was swallowing disorders (75%), which aligns with current literature where dysphagia is considered the leading cause for establishing indications for long-term enteral support in children [13-20]. Neurological diseases predominated in the structure of dysphagia causes, reflecting the high prevalence of neurogenic swallowing disorders in the pediatric population. Mechanical dysphagia is also a common indication for gastrostomy in childhood. Patients with severe protein-energy disorders due

to congenital malformations, lung, kidney, and liver diseases constituted the remaining proportion of patients.

Complications were observed in 42.5% of patients, which is comparable to data from international studies, where the complication rate after gastrostomy varies widely depending on the intervention method and follow-up duration[3-8]. In our cohort, LG had the highest number of complications, followed by OG, then the percutaneous gastrostomy techniques. Intergroup analysis showed no statistically significant differences in the rate of minor complications ($p = 0.630$). At the same time, analysis of major complications revealed statistically significant differences between the groups ($p = 0.001$). The highest rate of severe complications was observed after open and laparoscopic gastrostomy, as well as after the standard Push-PEG technique. In the modified Push-PEG group, only one case of major complication was recorded ($p=0.001$). The results of our study demonstrate the advantages of percutaneous endoscopic gastrostomy, primarily associated with reduced operative time. This indicator has important clinical significance, especially in pediatric practice, where the duration of anesthesia is an independent risk factor for the development of postoperative complications. A shorter intervention potentially reduces the anesthetic burden and may decrease the risk of intraoperative and early postoperative complications. A similar trend was observed when analyzing the length of hospitalization. Patients after Push-PEG placement had a significantly shorter hospital stay compared to patients who underwent laparotomy or laparoscopy. A shorter hospitalization period may reflect less surgical trauma, faster recovery of gastrointestinal function, and a lesser need for postoperative monitoring. Besides clinical significance, reducing the length of hospitalization also has organizational and economic implications, as it allows for optimizing the use of hospital resources and reducing the burden on surgical departments.

The totality of the obtained data suggests that the modified Push-PEG technique is characterized by a more favorable safety profile regarding severe postoperative complications. Furthermore, this method is associated with shorter operative time and faster postoperative patient rehabilitation.

It should be noted that the presented study has several limitations. First, the analysis was retrospective, which could potentially lead to incomplete recording of some postoperative complications. Second, the study covers a fairly long time period during which interventions were performed by various surgeons, which could have influenced the choice of operation technique and the complication rate. Third, the study was conducted in a single center, which may limit the ability to extrapolate the obtained results to a broader patient population. Additionally, the relatively small sample size in some subgroups could have reduced the statistical power of the analysis.

Despite these limitations, the obtained results can serve as a basis for further prospective multicenter studies.

## CONCLUSION

When appropriate indications are present, the modified Push-PEG technique can be considered a less invasive alternative to surgical gastrostomy methods. The use of this approach allows for reduced operative time, shortened hospital stay, and decreased risk of severe postoperative complications.

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