Original Article

PGHN

Single Center Experience with Gastrostomy Insertion in Pediatric Patients: A 10-Year Review

Jiyoung Kim, Hong Koh, Eun Young Chang, Sun Yeong Park, and Seung Kim

Department of Pediatrics, Severance Children's Hospital, Yonsei University College of Medicine, Seoul, Korea

Purpose: This study was performed to review the outcomes of gastrostomy insertion in children at our institute during 10 years.
Methods: A retrospective chart review was performed on 236 patients who underwent gastrostomy insertion from October 2005 to March 2015. We used our algorithm to select the least invasive method for gastrostomy insertion for each patient. Long-term follow-up was performed to analyze complications related to the method of gastrostomy insertion.
Results: Out of 236 patients, 120 underwent endoscopic gastrostomy, 79 had laparoscopic gastrostomy, and 37 had open gastrostomy procedures. The total major complication rates for endoscopic gastrostomy insertion, laparoscopic gastrostomy insertion, and open gastrostomy were 9.2%, 8.9%, and 8.1%, respectively. The most common major complication was gastroesophageal reflux requiring Nissen fundoplication (3.8%), and other complications included peritonitis (1.3%), hiatal hernia (1.3%), and bowel perforation (0.8%). Gastrostomy removal was successful in 8.6% and 5.0% of patients in the endoscopic and surgical gastrostomy groups, respectively. Gastrocutaneous fistula occurred in 60% of surgically inserted cases, requiring a second operation.
Conclusion: This retrospective study was performed to review the outcome of gastrostomy insertion, as well as to introduce an algorithm that can be used for future cases. Further studies should be conducted to make a consensus on choosing the most appropriate method for gastrostomy insertion.

Key Words: Gastrostomy, Algorithms, Child, Enterocutaneous fistula

INTRODUCTION

Enteral nutrition is recommended in patients with at least a partially-functioning gastrointestinal (GI) tract when oral intake is no longer possible or adequate. Nasogastric tube insertion is the first intervention to consider for enteral nutrition support (ENS). When patients require long-term ENS, gastrostomy insertion is recommended, because complications associated with nasogastric alimentation

can occur, such as aspiration pneumonia and esophageal mucosal damage caused by mechanical irritation [1,2]. Nowadays, placement of a gastrostomy feeding tube is one of the most commonly performed procedures in pediatric patients.

Over a century has passed since the first introduction of gastrostomy insertion during open surgery in 1894 [3]. In the past 30 years, endoscopic and laparoscopic methods were also introduced [4-6], and comparative research on the outcomes of gastrostomy tube insertion has been thoroughly investigated [7-9]. However, there are few studies that compare all three methods in the pediatric population. The purpose of this study was to review the outcomes of gastrostomy insertion (endoscopic, laparoscopic, and open) in children at a single institute and to introduce an algorithm that we used for choosing the best method of gastrostomy insertion.

MATERIALS AND METHODS

Study population and data collection

A retrospective review was performed on records of all patients under the age of 18 years who underwent placement of a gastrostomy tube at a single tertiary institution from October 2005 to March 2015. No randomization was performed. Patient demographics, method of gastrostomy, hospital course, and outcomes were measured. The method for gastrostomy tube insertion was selected according to an algorithm (Fig. 1). Complications were defined as any disease course-modifying GI event, as well as all immediate post-operative events. All short-term post-operative complications and long-term GI complications were monitored. Short-term complications were defined as complications occurring in ≤4 weeks, whereas long-term complications were defined as complications occurring in ≥4 weeks. Major complications were defined as complications needing surgical intervention or intensive care. Minor complications were defined as any complications
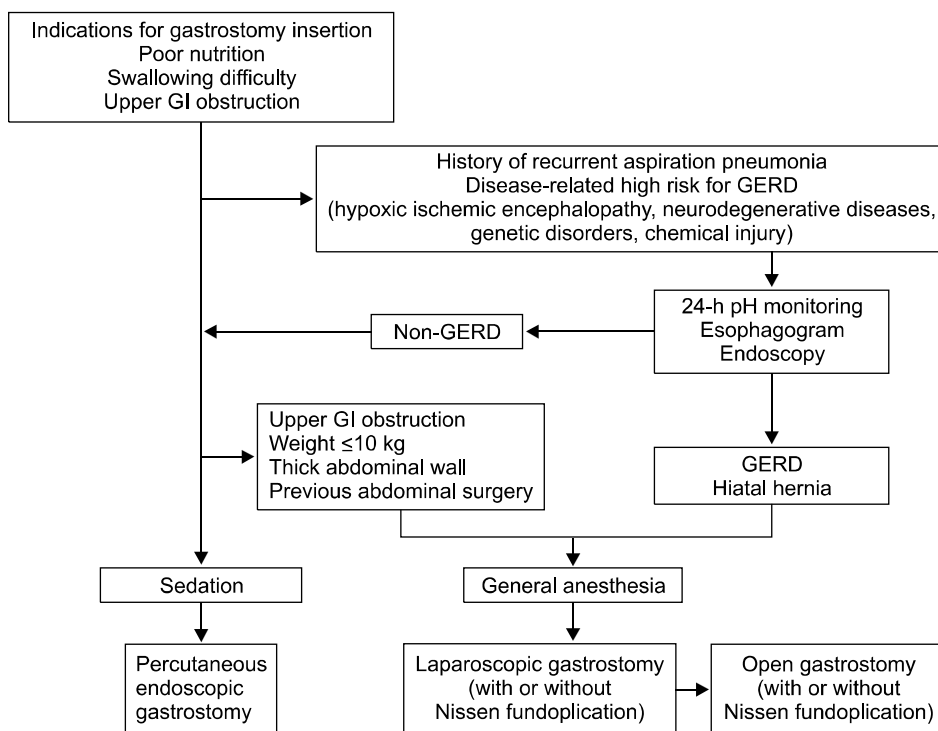

Fig. 1. An algorithm for selecting gastrostomy tube insertion method. GI: gastrointestinal, GERD: gastroesophageal reflux disease.

documented on medical records that either required medication or simple procedures that could be performed in an outpatient setting. The positioning of the gastrostomy tube was compared in endoscopic and surgical cases (Fig. 2). We also separately evaluated patients who underwent removal of gastrostomy and the prognosis after removal. The study protocol was approved by the Institutional Review Board of Severance Hospital (IRB no. 4-2016-0157).

Summary statistics are presented as percentages and mean±standard deviation. The analyses consisted of a descriptive statistical review of all gathered information. IBM SPSS Statistics ver. 20.0 (IBM Co., Armonk, NY, USA) was used for the statistical analysis of data.

Method of gastrostomy insertion

Standard methods for gastrostomy insertion were used [10]. Sedation was used for anesthesia in endoscopic gastrostomy insertion at an outpatient setting, and general anesthesia was used for surgical (open and laparoscopic) gastrostomy insertion in an operating room. Perioperative antibiotics were used in all cases.
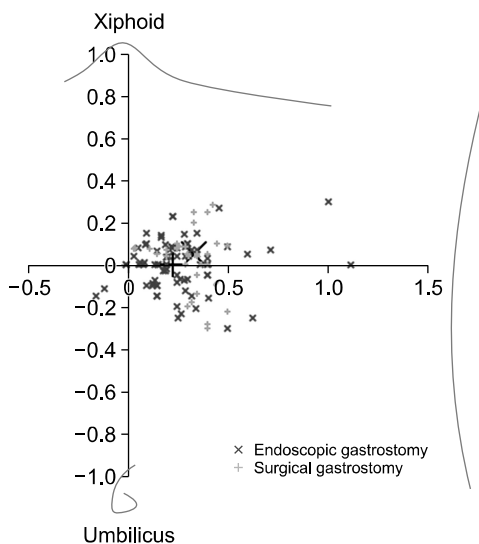
Fig. 2. Comparison of gastrostomy position according to the gastrostomy method.

RESULTS

A total of 236 patients underwent gastrostomy tube placement at our institute during the study period. The time interval between disease onset and gastrostomy insertion ranged from 1 day to ≥8 years. The mean length of follow-up was 45 months. Mean ages were 5.5±3.94, 3.38±3.92, and 0.35±0.94 years for the endoscopic, laparoscopic, and open gastrostomy insertion groups, respectively. The disease entities of the patients were as follows; neurological disorder, congenital malformation (traceho-esophageal fistula), genetic disorder (i.e., mucopolysaccharidosis, Tay-Sach's disease, Charge shyndrome), chemical injury, congenital heart disease, and oncological disease. The indication for gastrostomy insertion was categorized into three groups: poor nutrition, swallowing difficulty, and upper GI obstruction. We used an algorithm to choose the best method for gastrostomy insertion (Fig. 1). In our algorithm, percutaneous endoscopic gastrostomy was considered the first-choice method. Surgical approach was used in patients needing Nissen fundoplication due to medication refractory gastroesophageal reflux disease (GERD) (72 patients), anatomically contraindicated patients in whom the endoscopic tube could not be advanced (18 patients), patients weighing ≤10 kg (13 patients) with limitations for endoscopic access, and patients scheduled for other interventions needing general anesthesia (5 patients). On short-term follow-up (1 month), only one major complication was observed in the endoscopy and laparoscopy groups. On long-term follow-up, however, major complications occurred even 4 years after the insertion. The overall rates of major complication were 9.2%, 8.9%, and 8.1% in the endoscopic gastrostomy insertion, the laparoscopic, and the open gastrostomy groups, respectively. The demographics and complication rates of each procedure are listed in Table 1.

Major complications needing re-operative procedures were recorded as the following categories (Table 2); GERD refractory with medicine needing operation for Nissen fundoplication, gastrostomy

Table 1. Basic Characteristics, Demographics, Indications, and Complication Rates according to the Gastrostomy Method

Variable	Endoscopy (n=120)	Laparoscopy (n=79)	Open (n=37)
Age (y)	5.50±3.94	3.38±3.92	0.35±0.94
Sex			
Male	67 (55.8)	49 (62.0)	17 (45.9)
Female	53 (44.2)	30 (38.0)	20 (54.1)
Underlying disease			
Neurological disorder	103 (85.8)	64 (81.0)	19 (51.4)
Congenital malformation	0 (0)	3 (3.8)	13 (35.1)
Genetic disorder	6 (5.0)	9 (11.4)	3 (8.1)
Chemical injury	0 (0)	2 (2.5)	0 (0)
Congenital heart disease	1 (0.8)	1 (1.3)	1 (2.7)
Oncological disease	8 (6.7)	0 (0)	0 (0)
Other	2 (1.7)	0 (0)	1 (2.7)
Indication			
Poor nutrition	81 (67.5)	64 (81.0)	21 (56.8)
Swallowing difficulty	39 (32.5)	12 (15.1)	5 (13.5)
Upper GI obstruction	0 (0.0)	3 (3.8)	11 (29.7)
Acute complications			
Major	1 (0.8)	1 (1.3)	0 (0)
Minor	6 (5.0)	8 (10.1)	4 (10.8)
Total complications			
Major	11 (9.2)	7 (8.8)	3 (8.1)
Minor	47 (39.2)	37 (46.8)	22 (59.5)

Values are presented as mean±standard deviation or number (%).
GI: gastrointestinal.

Table 2. Major Complication Rates according to the Gastrostomy Method

Variable	Endoscopy (n=120)	Laparoscopic (n=79)	Open (n=37)
Total	11 (9.2)	7 (8.9)	3 (8.1)
GERD needing Nissen fundoplication	7 (5.8)	1/27 (3.7)	1/15 (6.7)
Gastrostomy dislodgement with peritonitis	3 (2.5)	4 (5.0)	1 (2.7)
Hiatal hernia	1 (0.8)	2 (2.5)	0 (0)
Transverse volvulus	0 (0)	1 (1.3)	1 (2.7)
Small-bowel strangulation	0 (0)	1 (1.3)	0 (0)

Values are presented as number (%).
GERD: gastroesophageal reflux disease.

dislodgement with peritonitis, symptomatic hiatal hernia, transverse volvulus, and small-bowel strangulation. When surgical gastrostomy insertions with co-operative Nissen fundoplication were excluded, 4.5% and 5.8% of patients with surgical (laparoscopic and open) and endoscopic gastrostomy insertions, respectively, needed a second operation for Nissen fundoplication. The long-term complication rates were considerably high in all three groups, similar to the results of recent studies (3-17.5%) [11].

Minor complications after gastrostomy insertion were defined as any complications documented on medical records that required minor outpatient procedures or medication (Table 3). They were categorized as granulation, gastrostomy dislodgement without peritonitis, tube leakage, GI bleeding due to tube irritation, gastritis/duodenitis, discharge, tube damage, GERD controlled with medication, tube obstruction, pneumonia, and infection. The results of overall minor complications (39.2% in endoscopic

Table 3. Minor Complication Rates according to the Gastrostomy Method

Variable	Endoscopy (n=120)	Laparoscopy (n=79)	Open (n=37)
Total	47 (39.2)	37 (46.8)	22 (59.5)
Granulation	31 (25.8)	25 (31.6)	10 (27.0)
Gastrostomy dislodgment without peritonitis	6 (5.0)	6 (7.6)	5 (13.5)
Tube leakage	5 (4.2)	8 (10.1)	4 (10.8)
PEG irritation (GI bleeding)	4 (3.3)	4 (5.1)	2 (5.4)
Ulcer/gastritis/duodenitis	5 (4.2)	3 (3.8)	1 (2.7)
Discharge	5 (4.2)	1 (1.3)	2 (5.4)
Tube damage	6 (5.0)	1 (1.3)	1 (2.7)
GERD (medication)	5 (4.2)	2 (2.5)	0 (0)
Tube obstruction	0 (0)	3 (3.8)	2 (5.4)
Pneumonia	0 (0)	4 (5.1)	0 (0)
Infection	0 (0)	1 (1.3)	0 (0)

Values are presented as number (%).
PEG: percutaneous endoscopic gastrostomy, GI: gastrointenstinal, GERD: gastroesophageal reflux disease.

gastrostomy insertion, 46.8% and 59.5% in laparoscopic and open gastrostomy insertion) were similar to those reported in previous studies (2-43%) [12-14]. Post-operative pneumonia occurred in only 4 patients in the surgical gastrostomy insertion group.

Positioning of the gastrostomy tube was measured and compared according to the gastrostomy method (Fig. 2). We measured the distance from the xiphoid process to the umbilicus in centimeters, and standardized each patient by calculating the ratio from −1 (umbilicus) to +1 (xiphoid process). We then measured and calculated the position of the gastrostomy tube according to its ratio. Most of the gastrostomy tubes were positioned in the first quadrant, with no significant difference found in the positioning of the gastrostomy tube between endoscopic and surgical (laparoscopic and open) gastrostomy methods.

Long-term clinical follow-up showed that 8.6% and 5% of patients who underwent surgical and endoscopic gastrostomy insertions eventually had their gastrostomy tubes removed to prevent disease progression and to recover from underlying disease. The mean time intervals from insertion to removal were 1.23 years in the surgical group and 0.83 years in the endoscopic group. We also monitored the complications after gastrostomy tube removal. Enterocutaneous fistula that lasted ≥1 month after removal was noted in six of 10 patients (60%) who underwent

surgical gastrostomy insertion, and this was statistically significant (p=0.0338), compared with the endoscopic insertion group.

DISCUSSION

Gastrostomy tube insertion is an effective method for enteric feeding in children. There are many methods for inserting a gastrostomy tube, and the laparoscopic gastrostomy insertion is emerging as the new less-invasive method. The endoscopic approach is a preferable method since it can be performed with minimal anesthesia, and patients can anticipate fast recovery. Choosing the right method of gastrostomy insertion and pre-insertion evaluation may be the keys to a successful, minimal-risk insertion of a gastrostomy tube, so the selection should be made carefully on a case-by-case basis. Many previous studies have either compared the methods of gastrostomy insertion or described complications resulting from gastrostomy tube insertion. While a guideline for choosing an optimal method of gastrostomy insertion exists for the adult and geriatric population [15,16], an algorithm still needs to be specified for the pediatric population.

In our study, we used an algorithm to choose the best method of gastrostomy tube insertion during the past 10 years. The algorithm was based on our

clinical experience with decision making and the accessibility of each method at our institute. Percutaneous gastrostomy insertion was considered the first choice in all cases, if applicable, due to the lesser burden associated with anesthesia in pediatric patients. Nissen fundoplication, anatomical and weight related contraindications for endoscopic access, and patients scheduled for other interventions needing general anesthesia were reserved for surgical approach. Laparoscopic intervention was attempted in all surgical cases. Patients who had abdominal anatomical abnormalities, a thick abdominal wall, or had multiple adhesions due to previous operations were indications for open gastrostomy insertion (Fig. 1).

Children with a high suspicion for gastroesophageal reflux were evaluated before undergoing gastrostomy insertion, and fundoplication was concurrently done in reflux cases. This was because (1) the majority of pediatric patients at our institute had neurological deficits and high levels of coexisting GERD occurrence, and (2) general anesthesia for a second GERD surgery came with high risks due to underlying comorbidities. Even with these precautions, a second operation for Nissen fundoplication was needed for medication-refractory GERD and in our study, this was considered a major complication. This may have been due to the placement of the gastrostomy tube itself, or the disease progression of the patient [17-19]. We believe that the disease etiology may be a risk factor for GERD after gastrostomy insertion. If the disease etiology related to GERD can be defined, earlier intervention with Nissen fundoplication while inserting the gastrostomy tube may result in fewer events of general anesthesia.

Cases that had morbid major complications (pan-peritonitis, transverse colon volvulus around the gastrostomy tube site, and bowel perforation) include patients who underwent previous abdominal surgeries or ventriculoperitoneal (VP) shunt. When we compared patients with VP shunts using gastrostomy method, their complication rates were similar and relatively high; 20.0% in the surgical insertion

group and 21.1% in the endoscopic insertion group. "Complicated shunts" such as recurrent VP shunt malfunction or recurrent peritonitis could be considered for open gastrostomy insertion.

In some cases (5-9%), the gastrostomy tube was successfully removed with adequate oral nutrition. After removal, a enterocutaneous fistula persisted in 60% of patients in the surgical (laparoscopic and open) insertion group needing a second surgery. Previous studies have mentioned the incidence of enterocutaneous fistula after the removal of gastrostomy tubes (16%), and there was no difference according to method of insertion [20]; however, in our study all cases were associated with surgical insertion. Further studies are needed to clarify the relation between method of gastrostomy insertion and occurrence of gastrocutenous fistula.

Our study was limited by its retrospective single-center design. The cases were not randomized, and the p-value could not be assessed due to selection bias. Moreover, we did not take into account the variability nor the experience of each gastroenterologist or surgeon. Despite such limitations, this study compares the complications of gastrostomy insertion according to three methods, and introduces an algorithm that can be used in the pediatric population.

This retrospective study was performed to review the outcome of gastrostomy insertion, as well as to introduce an algorithm that can be used for future cases. The algorithm that we used prioritized the least invasive endoscopic gastrostomy over surgical gastrostomy insertion. Under general anesthesia, laparoscopic insertion was considered the first-choice method, while open surgery was used in limited cases. Possibility of gastroesophageal reflux was meticulously reviewed before performing gastrostomy insertion, and co-operative Nissen fundoplication was done to minimize the risk for a secondary operation. We suggest that our algorithm can be used as a guide and can be modified to be used at other institutes. Future studies on choosing the most appropriate method for gastrostomy insertion is needed.

REFERENCES

1. Braegger C, Decsi T, Dias JA, Hartman C, Kolacek S, Koletzko B, et al. Practical approach to paediatric enteral nutrition: a comment by the ESPGHAN committee on nutrition. J Pediatr Gastroenterol Nutr 2010;51: 110-22.

2. Maitines G, Ugenti I, Memeo R, Clemente N, Iambrenghi OC. Endoscopic gastrostomy for enteral nutrition in neurogenic dysphagia: application of a nasogastric tube or percutaneous endoscopic gastrostomy. Chir Ital 2009;61:33-8.

3. Stamm M. Gastrostomy by a new method. Med News 1894;65:324-6.

4. Gauderer MW, Ponsky JL, Izant RJ Jr. Gastrostomy without laparotomy: a percutaneous endoscopic technique. J Pediatr Surg 1980;15:872-5.

5. Rothenberg SS, Bealer JF, Chang JH. Primary laparoscopic placement of gastrostomy buttons for feeding tubes. A safer and simpler technique. Surg Endosc 1999;13:995-7.

6. Georgeson KE. Laparoscopic fundoplication and gastrostomy. Semin Laparosc Surg 1998;5:25-30.

7. Grant JP. Comparison of percutaneous endoscopic gastrostomy with Stamm gastrostomy. Ann Surg 1988; 207:598-603.

8. Zamakhshary M, Jamal M, Blair GK, Murphy JJ, Webber EM, Skarsgard ED. Laparoscopic vs percutaneous endoscopic gastrostomy tube insertion: a new pediatric gold standard? J Pediatr Surg 2005;40:859-62.

9. Liu R, Jiwane A, Varjavandi A, Kennedy A, Henry G, Dilley A, et al. Comparison of percutaneous endoscopic, laparoscopic and open gastrostomy insertion in children. Pediatr Surg Int 2013;29:613-21.

10. Gray BW, Ruzic A, Mychaliska GB. Gastrostomy in pediatric patients. In: Kohout P, ed. Gastrostomy. Rijeka, Croatia: INTECH, 2011:17-24.

11. Vervloessem D, van Leersum F, Boer D, Hop WC, Escher JC, Madern GC, et al. Percutaneous endoscopic gastrostomy (PEG) in children is not a minor procedure: risk factors for major complications. Semin Pediatr Surg 2009;18:93-7.

12. Gauderer MW. Percutaneous endoscopic gastrostomy: a 10-year experience with 220 children. J Pediatr Surg 1991;26:288-92; discussion 292-4.

13. Beasley SW, Catto-Smith AG, Davidson PM. How to avoid complications during percutaneous endoscopic gastrostomy. J Pediatr Surg 1995;30:671-3.

14. Cosentini EP, Sautner T, Gnant M, Winkelbauer F, Teleky B, Jakesz R. Outcomes of surgical, percutaneous endoscopic, and percutaneous radiologic gastrostomies. Arch Surg 1998;133:1076-83.

15. Herrmann M. Algorithm for techniques of gastrostomy tube placement. Surg Endosc 2000;14:970-1; author reply 972-3.

16. Rabeneck L, McCullough LB, Wray NP. Ethically justified, clinically comprehensive guidelines for percutaneous endoscopic gastrostomy tube placement. Lancet 1997;349:496-8.

17. Heine RG, Reddihough DS, Catto-Smith AG. Gastro-oesophageal reflux and feeding problems after gastrostomy in children with severe neurological impairment. Dev Med Child Neurol 1995;37:320-9.

18. Samuel M, Holmes K. Quantitative and qualitative analysis of gastroesophageal reflux after percutaneous endoscopic gastrostomy. J Pediatr Surg 2002;37:256-61.

19. Hament JM, Bax NM, van der Zee DC, De Schryver JE, Nesselaar C. Complications of percutaneous endoscopic gastrostomy with or without concomitant antireflux surgery in 96 children. J Pediatr Surg 2001;36: 1412-5.

20. El-Rifai N, Michaud L, Mention K, Guimber D, Caldari D, Turck D, et al. Persistence of gastrocutaneous fistula after removal of gastrostomy tubes in children: prevalence and associated factors. Endoscopy 2004;36:700-4.