

Percutaneous endoscopic gastrostomy tube placement is safe and effective in children when compared to the laparoscopic technique

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Abstract

Introduction: We compare our experience of percutaneous endoscopic gastrostomy (PEG) and laparoscopic technique (LapGT) at a tertiary care pediatric hospital.

Methods: All PEGs and LapGT placements were reviewed at our institution from August 2016 through January 2018. Demographics, procedure time, operative charges, and 30-day complications were reviewed for patients who had either PEG or LapGT. Means of quantitative values were compared using the student's t test. Categorical values were compared using the X^2 test.

Results: Over 18 months, 93 isolated gastrostomy tubes were placed in children aged 2 weeks to 19 years. There were 56 PEGs (60%) and 37 LapGTs (40%). There was no significant difference in gender, age, or weight between the two groups. Operative time for PEG was 59% shorter (14 vs. 33 minutes, $p < 0.001$). Operating room charges averaged \$4,500 less in the PEG group (\$11,400 vs. \$15,900, $p < 0.001$). Neither group had complications requiring a return to the operating room within 30 days postoperatively. In two cases, PEGs were converted to LapGTs because safety criteria for PEG were not met.

Conclusions: Our experience with PEGs and LapGTs has found that the PEG technique, when used with clearly defined safety criteria, decreases operative time and cost without compromising safety.

Level of evidence: level III

Highlights

- Retrospective comparison of percutaneous and laparoscopic gastrostomy, both using fixation of the stomach to the abdominal wall, Seldinger technique and MIC gastrostomy tubes.
- Percutaneous gastrostomy has decreased cost, shorter operative times, and no difference in major complications.
- Percutaneous endoscopic gastrostomy is safe and effective in children compared to laparoscopic gastrostomy.

Introduction

Gastrostomy tube placement is a necessary procedure for children requiring long-term enteral feeding access for a host of medical conditions. The techniques for gastrostomy tube placement have undergone many iterations from the centuries old Stamm procedure and percutaneous endoscopic gastrostomy (PEG), first described in 1980, to the more recent laparoscopic gastrostomy (LapGT) and fluoroscopic techniques [1, 2].

In previous studies comparing PEGs and LapGTs, there has been heterogeneity between the two techniques that makes comparison flawed. For the most part, these investigations compare the pull or push technique of PEG insertion with LapGT [3, 4, 5, 6, 7, 8, 9, 10]. This inconsistency is also seen in

systematic reviews comparing PEGs and LapGTs [11, 12, 13]. This is an imperfect comparison, given that the push and pull techniques involve gastrostomy tubes with semi-rigid internal bumpers and no fixation of the stomach to the abdominal wall, while contemporary LapGT technique employs gastrostomy tubes with balloons as well as transcutaneous sutures that fix the stomach to the abdominal wall.

At our children's hospital, the PEG is performed exclusively using a Seldinger technique which includes transabdominal-transgastric T-fasteners. Our PEG and LapGT techniques, therefore, have in common the use of a MIC balloon gastrostomy tube, the principles of the Seldinger technique and fixation of the stomach to the abdominal wall, allowing more exact comparison. The aim of this study is to compare our recent experience utilizing PEGs or LapGTs at a busy tertiary care pediatric hospital, focusing on operating room (OR) time, operative charges, morbidities requiring a return to the OR and mortality. We hypothesized that our current PEG method was not only safe, but also quick and cost effective.

Methods

IRB approval was obtained to conduct an investigator initiated, single site, non-randomized retrospective chart review on patients undergoing either PEG or LapGT from August 2016 through January 2018. Electronic medical records were accessed to collect data on sex, age at time of surgery, weight, indication for feeding access, procedure duration, total time in OR, operative charges, and 30-day morbidity and mortality. To be included in the study, patients must have undergone PEG or LapGT in isolation of other procedures during the study period. Subjects were excluded from analysis if they underwent gastrostomy placement via an alternate method or if the gastrostomy placement was performed in conjunction with another surgery. The method of gastrostomy was left to each of the four attending surgeons. One surgeon exclusively performed LapGTs, while two surgeons planned PEGs for all patients, and a final attending allowed the pediatric surgery fellow to choose the technique.

The PEG technique began with upper endoscopy. A gastroscope was inserted into the mouth, advancing through the esophagus and into the stomach. The stomach was distended with carbon dioxide (CO₂) to oppose the stomach to the abdominal wall. The position of the stomach against the abdominal wall was confirmed with: (1) distinct transillumination of the endoscopic light across the abdominal wall and (2) by clear transmission of focal finger indentation through the abdominal wall as seen with the gastroscope. In the rare case that these two criteria could not be met, the technique was abandoned, and LapGT was performed. After performance of the safety measures and with the stomach insufflated with CO₂, three T-fasteners were placed under direct vision of the gastroscope in a triangular configuration around the chosen gastrostomy site—identified with continuous finger indentation—and tightened down to hold the stomach to the abdominal wall (Avanos Medical Introducer Kit). The stomach was decompressed between each step to avoid over inflation of the bowel. A transverse skin incision was made between the T-fasteners, a finder needle was placed into the stomach through the incision and a wire passed through the needle. This was all performed under gastroscopic surveillance. The needle was removed, and using Seldinger technique, the tract was serially dilated (Avanos Medical Introducer Kit) to accept an introducer sheath of a diameter 4-French greater than the chosen tube being placed. A MIC

gastrostomy tube (Avanos Medical) was then placed through the sheath and into the stomach, and the balloon inflated to the manufacturer's recommended volume with sterile water once the sheath was peeled away.

In the LapGT technique, the surgeon started by making a 3mm or 5mm incision in the umbilicus and inserting the corresponding trocar and laparoscope. A transverse incision was then made at a predetermined location in the left upper quadrant. Using a laparoscopic grasper via the left upper quadrant incision, with or without a trocar, the anterior body of the stomach was grasped along the greater curve and brought up to the abdominal wall. Two transcutaneous monofilament sutures were placed through the stomach on each side of the grasper to hold it up to the abdominal wall. The tract was then created using Seldinger technique: a finder needle was placed through the left upper quadrant incision into the gastric lumen, a wire passed through the needle into the stomach, and then the needle removed. Serial dilations were undertaken over the wire to reach the desired tract diameter (Cook Medical Dilator Set or Avanos Medical Introducer Kit). Once the tract was dilated to a diameter 4-French greater than the size of the desired tube, the MIC gastrostomy tube (Avanos Medical) was passed over the wire and into the stomach. The balloon was inflated to the recommended volume with sterile water. If a sheath was used, it was removed together with the wire. The external retention ring of the gastrostomy was secured to the abdominal wall by threading the previously placed transcutaneous sutures through it and tying them down.

All procedures were performed in the operating room under general endotracheal anesthesia. In both techniques, the temporary gastric fixation sutures were cut in 3–5 days.

The primary objective of our study is to identify which of the two gastrostomy techniques had the lowest major complication rate, identified by the need to return to the OR or death within 30 days postoperatively. Additional outcomes included procedure time, length of time in the operating room, and operating room charges. We also evaluated the rate of gastroesophageal reflux disease requiring fundoplication after gastrostomy. Demographics including age at time of surgery, weight, sex, and indication for enteral feeding access were compared between the two groups to control for potential confounders. Means of quantitative values were compared using the student's t test and reported with ranges or standard deviation (SD). Categorical values were compared using the X^2 test. Means and ratios are reported to the nearest whole number.

Results

During the 18-month period reviewed for this study, a total of 93 primary gastrostomy tubes were placed. Of these, 56 (60%) were PEGs and 37 (40%) were LapGTs. Of those undergoing PEG, 43% were female while 62% were female in the LapGT cohort ($p = 0.06$). Mean patient age was 48 months in the PEG cohort (range = 1–225 months) and 36 months in the LapGT cohort (range = 1–238 months) ($p = 0.16$). There was also no difference in the mean patient weight between the two groups (PEG 13 kg vs LapGT

10 kg, p = 0.09). Demographic information is listed in Table 1. Indications for enteral feeding access were similar between the two groups and are shown in Table 2.

Table 1
Demographic data. Means reported with ranges.

	PEG	LapGT	P-value
Number of Cases	56/93 (60%)	37/93 (40%)	NA
% Female	62	43	0.06
Mean Age (months)	48 (range 1–225)	36 (range 0.5–238)	0.16
Mean Weight (kg)	13 (range 3–50)	10 (range 1–50)	0.09

Table 2
Indications for feeding access reported as percent of each gastrostomy technique.

Indication for Feeding Access	PEG	LapGT
Failure to thrive	41%	43%
Feeding Difficulties	52%	46%
Gastric Volvulus	0%	3%
Hypoglycemia	2%	3%
Ketogenic diet	4%	5%
Medication administration	2%	0

There was no difference between PEGs and LapGTs in the primary outcome of the study, with neither group experiencing a mortality or complication that required a return to the operating room within 30-days of the initial operation (Table 3).

Table 3

Comparison of complications, procedure time, total OR time, and charges between PEG and LapGT. Means reported with standard deviation. SD: Standard Deviation. OR: Operating Room. USD: United States Dollar.

	PEG	LapGT	P-value
Major Complications	0/56	0/37	NA
Fundoplication Rate	0.05	0.05	0.99
Conversions to LapGT	2/58	NA	NA
Mean Procedure Time	14 (SD 9)	33 (SD 11)	< 0.01
Mean OR Time	51 (SD 22)	85 (SD 25)	< 0.01
Mean OR Charges (USD)	11,400 (SD 922)	15,900 (SD 1,100)	< 0.01

Certain differences between the two groups were noted in the additional outcomes measured (Table 3). Mean procedure time for PEGs was 14 minutes (min) compared to 33 min for LapGTs ($p < 0.001$). Additionally, the average time in the OR for PEG patients was 51 min versus 85 min for LapGT patients ($p < 0.001$). Operating room charges were also consistently lower for PEGs, at an average charge of \$11,400, compared to \$15,900 in the LapGT group ($p < 0.001$). Fundoplication rate after initial gastrostomy was identical in the two groups, at 5% each ($P = 0.99$).

Two PEGs were converted to LapGTs when they did not meet safety criteria. In one patient, transillumination and finger indentation were not clear. On conversion to laparoscopy, the patient was found to have a dilated colon overlying the left upper quadrant, and the stomach was not visualized. The stomach was identified after a rectal tube was placed for decompression, an additional 5mm trocar was placed to aid in retraction, and the stomach was distended with air via a nasogastric tube. Procedure time was 147 min, and total OR time was 186 min. The second conversion to LapGT occurred after transillumination showed the stomach to be superior to the costal margin, transilluminating under the rib cage. Upon conversion to laparoscopy, the stomach was brought below the costal margin and the gastrostomy was completed laparoscopically. Procedure time was 41 min and total OR time was 80 min, the former slightly longer and the latter slightly shorter than the average LapGT times. No data is available to compare how much time was spent in endoscopic and laparoscopic modes during these two cases. These two cases were not included in the analysis for either group. No case required conversion to an open procedure.

Discussion

Since the introduction of the laparoscopic technique for gastrostomy tube placement in the 1990s, there have been comparisons made between percutaneous and laparoscopic techniques. Unfortunately, these studies have suffered from heterogeneity in the principles of the PEG and LapGT methods as well as in the materials used for each. Most recent comparison studies describe PEGs placed using the pull or push

technique, leaving gastrostomy tubes with semi-rigid internal retention bumpers and no fixation of the stomach to the abdominal wall. These aspects differ greatly from the laparoscopic technique and may account for the increased complications noted with PEGs in these studies [3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13]. At our institution, both PEGs and LapGTs employ similar mechanics, using gastrostomy tubes with internal retention balloons, inserted by way of Seldinger technique and stabilized with temporary fixation of the stomach to the abdominal wall. These parallel placement techniques allow more fundamental comparison of the endoscopic versus laparoscopic methods.

The push and pull PEG techniques require pulling wires and tubes back and forth across the abdominal wall, stomach and esophagus, an action that can be traumatic to tissue, especially in the neonatal population or patients with head and neck pathologies. In our PEG technique, the MIC gastrostomy tube is placed directly into the stomach via a percutaneous sheath, which prevents unnecessary trauma.

The semi-rigid retention bumpers used in the pull and push technique are also associated with an increased risk of buried bumper syndrome [14]. This is a serious complication in which the internal retention device of the gastrostomy tube migrates through the gastrostomy tract and outside of the stomach. This complication often requires surgical intervention in the OR and may help account for the increase in major complications noted with the PEG technique in earlier studies.

The transcutaneous gastric fixating sutures in our PEG and LapGT techniques give time for the stomach to adhere to abdominal wall and for the tract to form and may prevent dislodgements and other major complications [15, 16].

As in our study, Koh et al. found the initial PEG procedure to be a quicker operation than LapGTs [10]. Yet, with the pull technique used in their study, patients in the PEG group returned to the OR for tube changes leading to no difference in utilization of the operating room between the two groups. By using MIC gastrostomy tubes that have an inflatable internal retention balloon in both our PEGs and LapGTs we find common ground between the two techniques. Exchanges of this type of gastrostomy tube are done exclusively at the bedside or in the office, which greatly reduces the time and cost associated with gastrostomy tube exchange and thus preserves the savings in operative time that we see in the PEG technique at our institution.

When comparing different surgical techniques for the same operation, one must consider which adds more value. The value of a surgical procedure can be influenced in two ways, quality (i.e., complications) and cost. Our study saw zero major complications after 30 days in both the PEG (0/56) and LapGT (0/37) groups, a stark difference not readily seen in previous studies and meta-analyses where LapGTs were often found to be safer. We postulate that this may be due, in part, to the differences in PEG technique applied in this study as compared to the technique employed in previous analyses.

Overall operative charges were significantly less for the PEG group compared to the LapGT group, with an average savings of \$4,500 per patient ($p < 0.001$). This reported monetary benefit is significantly underestimated, as the private-practice anesthesia billing was not included in the savings calculation.

Both procedure time and total time spent in the OR were significantly less in the PEG group, a point seen in some previous studies [4, 5, 6, 7, 8, 9, 11]. Since OR and anesthesia services are billed in half-hour increments, mean OR times become important, in terms of cost-effectiveness, when they cross 30 min thresholds. By keeping average OR time for PEGs under an hour, considerable cost savings are realized when compared to LapGTs that have an average OR time of 85 min. Shorter OR times add value to the patient by saving in anesthesia and operative charges and by minimizing intubation and anesthesia time in this fragile cohort. They additionally benefit the hospital and anesthesia practice by improving OR efficiency.

If safety criteria were not met during upper endoscopy for a planned PEG, then a LapGT was performed. We do not see this as a failure of PEG, but rather proof that the safety criteria helped prevent misplaced gastrostomy tubes during the study period. In our report, two planned PEGs were changed to the LapGT, technique, representing a conversion rate of 3.5%. Although low, the possibility of PEG failure makes us recommend the presence of laparoscopy equipment readily available, but unopened, in the OR suite to minimize OR time if change to the LapGT technique is required.

Although the quantity of time spent on the endoscopic and laparoscopic portions of the two converted cases was not recorded, we can gather a sense of how time was used from the operative notes. For the patient in whom the area of transillumination was above the costal margin, procedure time and OR time were 41 min and 80 min, similar to the average LapGT times. In the patient with a distended colon who required an additional trocar and maneuvers to identify the stomach, procedure and OR times were longer (147 min and 186 min, respectively). We hypothesize that outlier operative times for this child were secondary to the difficult anatomy and would have occurred with or without the addition of the endoscopy at the start of the case.

This study is limited by the potential effects of confounding and bias inherent to retrospective study designs. The smaller sample size characteristic of a single center study may miss small differences between two groups. Additionally, the decision to proceed with PEG or LapGT was based on surgeon preference. This preference is no doubt influenced by the surgeon's skill and experience with their technique of choice. Complications were assessed and reported in the 30-day postoperative period, and therefore lack long term follow up data. We also recognize that surgeon comfort with upper endoscopy is not uniform across institutions. It should be noted that pediatric surgeons at our institution perform their own upper endoscopies, and as such did not require intraoperative assistance from gastroenterology colleagues. Therefore, we did not analyze how the addition of a gastroenterologist to the PEG procedure would change operative cost or outcomes.

Conclusion

The last decade has seen a growing consensus toward using LapGT over PEG due to safety concerns. However, in these studies, PEGs and LapGTs did not utilize the same type of gastrostomy tubes or employ similar principles of insertion. In our institution, where both PEGs and LapGTs use a Seldinger

approach with MIC gastrostomy tubes, the PEG technique decreased operative time and cost without compromising safety. With such wide variation in operative modality and technique between PEGs and LapGTs in the literature, consensus will most likely not be achieved without a large multicenter prospective randomized study using standardized materials and techniques.

Abbreviations

PEG

percutaneous endoscopic gastrostomy

LapGT

laparoscopic gastrostomy

OR

operating room

CO₂

carbon dioxide

Min

minutes

SD

standard deviation

Declarations

Author Contributions: Conceptualization: Kyle J. Glithero and Cathy A. Burnweit Methodology: Kyle J. Glithero Formal analysis and investigation: Kyle J. Glithero and Matthew T. Hey Writing - original draft preparation: Kyle J. Glithero and Matthew T. Hey Writing - review and editing: Kyle J. Glithero, Matthew T. Hey, Juan L. Calisto, Fuad Alkhoury, Leopoldo Malvezzi, Cathy A. Burnweit Supervision: Cathy A. Burnweit

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Ethics Approval: This research study was conducted retrospectively from data obtained for clinical purposes. An IRB official waiver of ethical approval was granted from the IRB of Nicklaus Children's Hospital.

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