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Is percutaneous radiologic gastrostomy safer than percutaneous endoscopic gastrostomy?

Johnathan Righetti[1], Shane Morris[1], Mehran Fotoohi[1], Danielle La Selva[1], Troy Zehr[1], Richard Kozarek[1]

[1]Digestive Disease Institute, Virginia Mason Medical Center, Seattle, Washington, United States.

***Corresponding author:**
Richard Kozarek,
Digestive Disease Institute,
Virginia Mason Medical Center,
Seattle, Washington,
United States.

richard.kozarek@
virginiamason.org

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ABSTRACT

Objectives: The objectives of the study were to compare the indications, adverse events, removal rates, and mortality of percutaneous endoscopic gastrostomy (PEG) and percutaneous radiologic gastrostomy (PRG) techniques at our tertiary care institution from 2014 to 2019.

Material and Methods: We undertook a 5-year retrospective review of patients who underwent either PEG or PRG at our institution from 2014 to 2019. Common adverse events include tube clogs, leaks, minor bleeds, and wound infections, while more rare major complications include peritonitis, intra-abdominal infection, and major hemorrhage. The procedures were all performed with either conscious sedation or general anesthesia. A total of 789 patients were reviewed, of whom 519 (65.8%) had a PRG and 270 (34.2%) had a PEG. PRGs were more likely to be placed for head-and-neck cancer ($P < 0.0001$) and amyotrophic lateral sclerosis ($P < 0.0001$), while PEGs were more likely to be placed for gastric outlet obstruction (GOO) ($P <.0001$) and malnutrition ($P < 0.0001$).

Results: The rate of major adverse events was similar between the two groups ($P = 0.938$). GI placed gastrostomy tubes were more likely to have a minor adverse event ($P < 0.0001$), however, this was secondary to a significant increase in tube clog in the PEG/J group as compared to PEG ($P < 0.0001$).

Conclusion: The decision to place a PEG or PRG should be individualized to the patient's specific condition and indication. Both procedures have favorable safety profiles, and it is likely that institutional expertise and procedural access will be the primary determinants of the procedural technique chosen for minimally invasive gastrostomy.

Keywords: Percutaneous endoscopic gastrostomy, Percutaneous radiologic gastrostomy, Interlocking PEG with J tube placed through it and into the small bowel, Minimally invasive gastrostomy, Gastrostomy complications

INTRODUCTION

Percutaneous gastrostomy has evolved as the preferred method for patients needing long-term nutritional support.[1,2] Surgical gastrostomy, which was invented in 1837 by a Norwegian surgeon named Egeberg, has been nearly entirely replaced by percutaneous techniques given the risk of laparotomy and general anesthesia.[3] This invasive technique is now reserved for difficult cases in which the percutaneous approach is unsafe.

The percutaneous approach can be achieved endoscopically or radiographically. Percutaneous endoscopic gastrostomy (PEG), which was first introduced in 1979 by Gauderer and Ponsky,

allows for direct visualization of the stomach while the gastrostomy tube is inserted [Figure 1a and b].[4] Shortly thereafter in 1981, a Canadian surgeon, Preshaw, introduced the percutaneous radiologic gastrostomy (PRG), which uses fluoroscopic guidance to visualize an air-inflated stomach [Figure 2a and b].[5] Both techniques have been shown to be effective for long-term nutrition as well as decompression.[3,6]

The indications for gastrostomy are diverse. They include neurologic disorders (e.g., amyotrophic lateral sclerosis (ALS), occlusive stroke, and intracranial hemorrhage), malignancy (e.g., head/neck and esophageal), gastric outlet or small bowel obstruction, malnutrition (e.g., gastroparesis, post-operative, and pancreatitis), as well as numerous other conditions. Gastrostomy can be considered in any situation where long-term enteral nutrition is needed, as loss of nutritional status has been shown to increase mortality as well as length of hospital stays.[7] In most institutions, there are no guidelines for which method of gastrostomy is preferred given a specific condition.

While both PEG and PRG techniques have been shown to be effective with improved safety compared to surgical techniques, risks from complications remain. Major complications include peritonitis, intra-abdominal infection, hemorrhage requiring transfusion or subsequent interventional procedures, and aspiration.[8-10] Minor complications include tube clogs, leaks, minor bleeds, and wound infections. There is also a theoretical complication of seeding malignancy from the upper digestive tract into the stomach or along the gastrostomy tract.[11-13] Complication rates have been previously described to be relatively common, with rates of total complications generally ranging from 5% to 15%.[14-16]

Several studies have compared the safety of these two percutaneous techniques with mixed results.[1-3,6,17-20] To the best of our knowledge, there have been no randomized controlled trials to compare the two techniques. Even so, over the past 30 years, PEG remains the preferred technique at most institutions with gastroenterologists receiving most of the initial referrals.

This study compares outcomes of patients treated at our tertiary care institution from 2014 to 2019. The data include indications, adverse events, removal rates, and mortality of PEG and PRG.

MATERIAL AND METHODS

This retrospective, single-center study includes 789 patients who were treated at our center from January 2014 to April 2019 and was HIPAA compliant and IRB approved. Patients aged 18–90 who underwent placement of a gastrostomy were eligible for inclusion. Tube placements were identified through billing records and then stratified into PEG and PRG subgroups. PEGs were further stratified into PEG alone or those patients in whom a jejunostomy tube was placed through the PEG and endoscopically manipulated into the jejunum. A single patient in this series underwent a direct endoscopic jejunostomy. Procedural indications, tube removal status, and adverse events for each tube placement were obtained through chart review. Indications were grouped as neurologic, cancer, malnutrition, gastric outlet and small bowel obstruction, and other. Neurologic causes include ALS, ischemic stroke, intracranial hemorrhage, neurologic causes

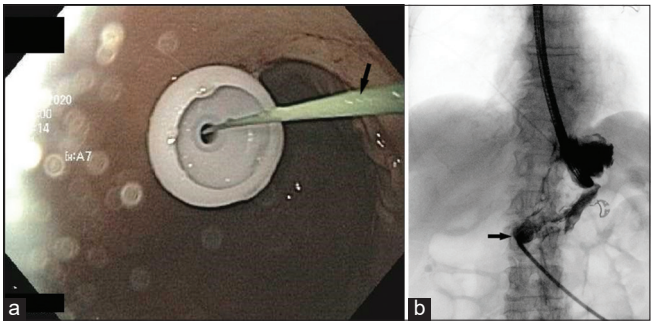

Figure 1: (a) Percutaneous endoscopic gastrostomy (PEG) patient is a 72-year-old male with an acute CVA and recurrent aspiration with oral feedings. PEG was employed because of concomitant nausea and vomiting. Note endoscopic image of the PEG internal bumper pulled in place over a percutaneously placed guidewire (arrow). (b) Contrast injection through the PEG in the patient depicted in Figure 1a to assure absence of leak (arrow).

Figure 2: (a) The patient is a 65-year-old male who presented with upper motor neuron weakness and dysphagia and was subsequently diagnosed with amyotrophic lateral sclerosis requiring enteral nutrition. Fluoroscopic image of the abdomen shows the stomach insufflated with air and a nasogastric tube present in the stomach. "T-fasteners" project over the gastric body (arrows), allowing the stomach to be pinned to the abdominal wall. Contrast opacifies surrounding bowel to avoid a bowel injury. (b) Fluoroscopic image of the abdomen from the patient in Figure 2a demonstrates a gastrostomy tube in place and the balloon inflated within the gastric antrum (arrow). Contrast was injected into the catheter, opacifying the stomach without evidence of a leak.

of chronic aspiration, and other. Cancer causes include head, neck, esophageal, and other. Malnutrition causes included gastroparesis, post-operative, respiratory failure, and severe pancreatitis. Major complications were defined as peritonitis, intra-abdominal infection, hemorrhage requiring transfusion or interventional procedures, or aspiration. Minor complications were defined as tube clogs requiring ED/office visits, tube leak, minor bleeds, and wound infections. Overall mortality was also obtained by chart review and obituary review, if available.

Continuous variables were analyzed using the Student's *t*-test and categorical variables using the χ^2 test or Fisher's exact test, where appropriate. For each calculation, $P < 0.05$ was used as the threshold for statistical significance.

RESULTS

During the study period, 789 gastrostomy tubes were placed. Of these cases, 519 (65.8%) gastrostomy tubes were placed with interventional radiology techniques and 270 (34.2%) by endoscopic techniques. PRGs were more likely to be placed for head-and-neck cancer (242 vs. 10, $P < 0.0001$) and ALS (91 vs. 1, $P < 0.0001$), while PEGs were more likely to be placed for GOO (54 vs. 12, $P < 0.0001$) and malnutrition (113 vs. 64, $P < 0.0001$). No significant difference was seen for patients with chronic aspiration (13 vs. 22, $P = 0.717$). Tube removal rates were comparable between PRGs and PEGs (36 vs. 39.3%, $P = 0.393$). PRGs were more likely to be placed for a longer duration of time (245 days vs. 173 days, $P = 0.009$). PEGs were more likely to require additional intervention such as repositioning or replacement (22.6% vs. 13.5%), and PEG tubes were more likely to be manipulated earlier (62 days vs. 145 days, $P < 0.0001$). The rate of major adverse events was similar between the two groups (1.3 vs. 3%, $P = 0.938$).

While the rate of minor adverse events showed that patients with PEGs were statistically more likely to have a minor adverse event (10.0% vs. 19.6%, $P < 0.0001$) [Table 1], this was explained by subanalysis that showed a statistically significant difference in minor adverse events in patients receiving PEG-J tubes compared to a simple PEG (37.5% vs. 9.8%, $P < 0.0001$) [Table 2]. This was secondary to a statistically significant difference in tube clogs between the PEG and PEG-J groups (23 vs. 3, $P < 0.0001$). The rates of minor bleed, leak, and wound infection requiring antibiotics had no statistical difference between the PRG and PEG groups.

DISCUSSION

Percutaneous gastrostomy is the standard procedure to facilitate long-term nutrition when enteral feeding is required. The previous studies have reported discordant

Table 1: Indications and outcomes: PEG versus PRG.

	PEG (*n*=270)	PRG (*n*=519)	*P*
Age, m±SD	63.0±15.0	64.1±12.6	0.259
Sex, % male	49.6	65.5	<0.001
Inpatient, *n* (%)	231 (85.6)	377 (72.6)	<0.001
Indications			
Neurologic – overall, *n* (%)	52 (19.3)	177 (34.1)	<0.001
ALS, *n* (%)	1 (0.4)	91 (17.5)	<0.001
CVA, *n* (%)	15 (5.6)	38 (7.3)	0.373
ICH, *n* (%)	8 (3.0)	17 (3.3)	0.981
Other, *n* (%)	15 (5.6)	9 (1.7)	0.004
Cancer – overall, *n* (%)	34 (12.6)	251 (48.2)	<0.001
Head and neck, *n* (%)	10 (3.7)	242 (46.6)	<0.001
GI, *n* (%)	13 (4.8)	4 (0.8)	<0.001
Other, *n* (%)	11 (4.1)	5 (1.0)	0.006
Chronic aspiration, *n* (%)	13 (4.8)	22 (4.2)	0.717
Malnutrition, *n* (%)	113 (41.9)	64 (12.3)	<0.001
GOO, *n* (%)	54 (20.0)	12 (2.3)	<0.001
Other, *n* (%)	25 (9.3)	20 (3.9)	0.003
Adverse events			
Major* adverse event, *n* (%)	8 (3.0)	7 (1.3)	0.938
Minor** adverse event, *n* (%)	53 (19.6)	52 (10.0)	<0.001
Hematoma/minor bleed, *n* (%)	4 (1.5)	6 (1.2)	0.742
Leak	10 (3.7)	16 (3.1)	0.676
Tube clog req. replacement or office/ED visit	26 (9.6)	17 (3.3)	<0.001
Wound infection requiring antibiotics	13 (4.8)	13 (2.5)	0.095
Subsequent procedures			
Additional interventions, *n* (%)	61 (22.6)	70 (13.5)	0.002
Tube replacement as intervention, *n* (%)	48 (17.8)	67 (12.9)	0.071
Days between tube placement/manipulation, m±SD	62.1 ± 98.1	145.6±147.8	<0.001
Tube removal, *n* (%)	106 (39.3)	187 (36.0)	0.393
Tube days, m±SD	172.5±355.4	244.7±293.7	0.009
Mortality			
Overall mortality, *n* (%)	130 (48.1)	232 (44.7)	0.367
Died with tube, *n* (%)	91 (33.7)	159 (30.6)	0.42
Days between tube placement and death m±SD	229.0±332.3	360.4±346.1	<0.001

*Defined as peritonitis, major bleed requiring transfusion, aspiration, or intra-abdominal infection, **defined as tube clog requiring ED/office visit, tube leak, minor bleed/hematoma, or wound infection requiring oral antibiotics. PEG: Percutaneous endoscopic gastrostomy, PRG: Percutaneous radiologic gastrostomy, ALS: Amyotrophic lateral sclerosis, CVA: Cerebrovascular accident, ICH: Intracerebral hemorrhage, GI: Gastrointestinal, GOO: Gastric outlet obstruction, ED: Emergency department, SD: Standard deviation

Table 2: Indications and outcomes: PEG* versus PEG-J+PEJ.

	PEG* (*n*=174)	PEG-J+PEJ (*n*=96)	*P*
Age, m±SD	65.6±13.9	58.1±15.6	<0.001
Sex, % male	50.6	47.9	0.704
Inpatient, *n* (%)	148 (85.1)	83 (86.5)	0.857
Indications			
Neurologic – overall, *n* (%)	45 (25.9)	7 (7.3)	<0.001
ALS, *n* (%)	1 (0.6)	0 (0.0)	0.935
CVA, *n* (%)	13 (7.5)	2 (2.1)	0.093
ICH, *n* (%)	14 (8.0)	1 (1.0)	0.022
Other, *n* (%)	6 (3.4)	2 (2.1)	0.715
Cancer – overall, *n* (%)	28 (16.1)	6 (6.3)	0.021
Head and neck, *n* (%)	10 (5.7)	0 (0.0)	0.015
GI, *n* (%)	10 (5.7)	2 (2.1)	0.222
Other, *n* (%)	8 (4.6)	4 (4.2)	0.869
Chronic aspiration, *n* (%)	11 (6.3)	2 (2.1)	0.146
Malnutrition, n (%)	58 (33.3)	55 (57.3)	<0.001
GOO, *n* (%)	31 (17.8)	23 (24.0)	0.266
Other, *n* (%)	18 (10.3)	7 (7.3)	0.512
Adverse events			
Major** adverse event, *n* (%)	3 (1.7)	5 (5.2)	0.137
Minor*** adverse event, *n* (%)	17 (9.8)	36 (37.5)	<0.001
Hematoma/minor bleed, *n* (%)	2 (1.1)	2 (2.1)	0.617
Leak	5 (2.9)	5 (5.2)	0.334
Tube clog req. replacement or office/ED visit	3 (1.7)	23 (24.0)	<0.001
Wound infection requiring antibiotics	7 (4.0)	6 (6.3)	0.553
Subsequent procedures			
Additional interventions, *n* (%)	19 (10.9)	42 (43.8)	<0.001
Tube replacement as intervention, *n* (%)	17 (9.8)	31 (32.3)	<0.001
Days between tube placement/manipulation, m±SD	104.6±128.7	43.5±73.8	0.027
Tube removal, *n* (%)	51 (29.3)	55 (57.3)	<0.001
Tube days, m±SD	174±331.6	174.6±408.4	0.962
Mortality			
Overall mortality, *n* (%)	101 (58.0)	35 (36.5)	<0.001
Died with tube, *n* (%)	69 (39.7)	22 (22.9)	0.007
Days between tube placement and death m±SD	210.6±322.9	280.6±351.9	0.294

*PEG group excludes PEG-J and PEJ, **defined as peritonitis, major bleed requiring transfusion, aspiration, or intra-abdominal infection, ***defined as tube clog requiring ED/office visit, tube leak, minor bleed/hematoma, or wound infection requiring oral antibiotics. PEG: Percutaneous endoscopic gastrostomy, PRG: Percutaneous radiological gastrostomy, ALS: Amyotrophic lateral sclerosis, CVA: Cerebrovascular accident, ICH: Intracerebral hemorrhage, GI: Gastrointestinal, GOO: Gastric outlet obstruction, ED: Emergency department, SD: Standard deviation

results about whether the PEG or PRG approach is safer or more effective. One of the most recent reviews on this subject reported that PEG is associated with a significantly lower risk of inpatient adverse events (including hemorrhage and infection) and mortality compared to PRG.[21] Additional previous studies have demonstrated mixed results in terms of complications rates with one meta-analysis showing major complications more frequent with PEG than PRG (9.4% vs. 5.9%).[16] However, an additional meta-analysis of head-and-neck cancer patients showed higher rates of complications in PRG when compared to PEG.[10] Furthermore, there are studies that do not show any difference between the two techniques.[2,6] These studies are all retrospective and contain various definitions of major and minor adverse events. While both practices remain safe, a randomized controlled trial is needed to sufficiently determine which procedure, if either, is safer.

Even though endoscopic techniques had been favored for decades at our institution and remain the favored technique at many institutions, only one-third of non-surgically placed gastrostomy tubes were placed endoscopically at our tertiary care institution during this study period.[22,23] This is likely due to several factors. Both ALS patients and those with head-and-neck malignancies made up a substantial majority of gastrostomies placed through PRG, and these indications made up a large percentage of the overall gastrostomies in this study. ALS patients have increased risk of aspiration with general anesthesia, and therefore, the PRG technique is favored as it can be done with moderate sedation.[24-26] In addition, head-and-neck malignancies have a theoretical risk of seeding tumor into the gastrointestinal or PEG tract with PEG, and therefore, recommendations suggest avoiding this technique when possible.[11] PEG still has several indications in which it is the preferred method including gastric outlet obstruction and malnutrition. In addition, if patients have other indications for endoscopy (diagnosis, biopsy, or additional treatment), PEG should be the preferred technique for gastrostomy placement. Removal rates, as well as 30-day and overall survival, were similar between the 2 groups. This is consistent with prior studies that have shown no significant difference between the two groups in overall survival.[4,20] This confirms that these procedures are safe and that their placement is rarely the cause of increased mortality.

There were significantly fewer minor adverse events with PRG as opposed to PEG, however, there were similar rates of major adverse events. This was a result of a statistically significant difference in tube clogs requiring replacement or office/ED visit in the PEG group as compared to the PRG. However, when analyzing the data further, a statistically significant amount of the tube clogs occurred in patients who received PEG-J tubes. As explained by Hagen–Poiseuille law (flow in a tube is inversely proportional to length and directly proportional to the square of the tube radius), the

longer and smaller diameter jejunostomy tubing results in the tube clogs rather than the gastrostomy procedure itself. Moreover, although PEJ can be done directly, all but one patient in this study had a direct PEG with a standard 20 Fr tube and subsequently had a 9 Fr tube placed through this and directed into the small bowel. Not only does this reduction in radius decrease flow 5-fold which predisposes patients to early tube occlusion, it was also associated with J tube migration proximally into the stomach in patients with recurrent nausea and vomiting.

This is further evident when analyzing PRG tubes that had tube clogs. There were 15 tube clogs after placement with standard gastrostomy techniques, while only one tube clog occurred when placed with the low profile ("button") technique. The other minor adverse events, including tube leak, wound infection, and hematoma/minor bleed, did not show a statistically significant difference between the two groups.

There is an inevitable selection bias in our study, and our findings may not be generalizable to other institutions with different skillsets or those which treat all patients with either a PEG or PRG regardless of the indication for placement or clinical status of the patient. As such, it is likely that institutional expertise and procedural access will be the primary determinants of the procedural technique chosen for minimally invasive gastrostomy. Data in the current review suggest that patients can benefit from "individualized," patient-centered, decision-making in terms of choosing the technique best suited for gastrostomy.

CONCLUSION

Two thirds of non-surgical gastrostomies were placed radiologically in our tertiary care institution, most frequently for ALS and head and neck cancer. Both techniques were safe and effective, although placement of small diameter J-tubes through a PEG led to a significantly higher re-intervention rate.

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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