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Percutaneous radiologic gastrostomy versus percutaneous endoscopic gastrostomy: A comparison of indications, complications and outcomes in 370 patients

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Abstract

Objective: Percutaneous access to the stomach can be achieved by endoscopic or fluoroscopic methods. Our objective was to compare indications, complications, efficacy and outcomes of these two techniques.
Methods: Records of 370 patients with feeding tubes placed either endoscopically by gastroenterology, or fluoroscopically by radiology, at our university-based tertiary care center over a 54-month period were reviewed.
Results: 177 gastrostomies were placed endoscopically and 193 fluoroscopically. Nutrition was the most common indication in each group (94 and 92%), but the most common underlying diagnosis was neurologic impairment in the endoscopic group ($n = 89$, 50%) and malignancy in the fluoroscopic group ($n = 134$, 69%) ($p < 0.001$). Complications in the first 30 days were more common with fluoroscopic placement (23% versus 11%, $p = 0.002$), with infection most frequent. Correlates of late complications were inpatient status (OR 0.26, 95%CI: 0.13–0.51) and a diagnosis of malignancy (OR 2.2, 95%CI: 1.03–4.84). Average follow-up time was 108 days in the fluoroscopic group and 174 days in the endoscopic group.
Conclusions: Both endoscopic and fluoroscopic gastrostomy tube placement are safe and effective. Outpatient status was associated with greater early and late complication rates; minor complications such as infection were greater in the fluoroscopic group, while malignancy was associated with late complications.

Keywords: Percutaneous radiologic gastrostomy; Percutaneous endoscopic gastrostomy; Gastrostomy

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1. Introduction

Gastrostomy tubes are well tolerated for long term nutritional supplementation, generally provide improved quality of life when compared to available alternatives and limit disorders of intestinal motility by maintaining gastrointestinal tract function [1–3]. Gastrostomy tubes can be placed surgically, endoscopically and fluoroscopically; a review of the literature supports radiologic and endoscopic techniques as superior to surgery, requiring less sedation, less invasive placement techniques, having lower complication rates, and less costly [3–6]. Previous studies comparing percutaneous radiologic gastrostomy (PRG) and percutaneous endoscopic gastrostomy (PEG) placement have suffered from small sample sizes and biased patient selection (studies with PRG have typically been done on those patients who previously failed PEG placement) [4–9].

The purpose of this study was to compare percutaneous radiologic and percutaneous endoscopic gastrostomy tube placement in a large-volume, single-center retrospective analysis of 193 PRG tubes and 177 PEG tubes placed over a 54-month period. We evaluated indications, complications and outcomes using medical records and telephone contact.

2. Methods

2.1. Patients

IRB approval was sought and deemed not required for this study at our institution.

A retrospective analysis of 193 gastrostomy tubes placed fluoroscopically and 177 gastrostomy tubes placed endoscopically in a single tertiary care, university-based center from February of 1997 to August of 2001 was performed. A single gastrostomy tube was placed in February of 1997, and all other tubes were placed consecutively from July of 1997 through August 2001. Information was collected from both electronic and paper medical records including operative reports, inpatient and outpatient notes. Additional procedural and follow-up information was obtained via telephone calls to patients, next-of-kin and primary care providers.

Complications were divided into early (occurring within 30 days after placement) and late (occurring after 30 days).

Complications were further subdivided into major and minor categories. Major adverse events were defined as those requiring surgery or hospitalization, causing permanent adverse sequelae, or resulting in death. Minor adverse events were defined as those requiring either minor or no treatment and resulting in no permanent sequelae.

Minor peristomal infections were defined as infections at the gastrostomy tube site which required a course of oral antibiotics without further treatment. Further therapy, such as surgical debridement, was considered major. Leakage of gastric juice was considered minor if it caused the patient to seek medical attention and required specific local treatment. If the tube had to be manually re-positioned by a healthcare provider it was considered a minor complication. If the tube was misplaced and required removal and surgical intervention for repositioning it was considered a major complication. If a tube either fell out or was pulled out and had to be replaced by a healthcare provider it was counted as a minor complication for inadvertent removal. Pain requiring medical attention was considered a minor complication.

Miscellaneous minor complications included tube migration (e.g. through the pylorus), bleeding which did not require interventions such as suturing or transfusion, tube malfunction and aspiration.

2.2. Procedure

2.2.1. Percutaneous radiologic gastrostomy

Contraindications to PRG placement included ascites, intra-abdominal tumor displacing the stomach, or altered gastric anatomy secondary to past history of resection or stapling. Informed written consent was obtained from the patient or proxy.

Preprocedure sonographic examination of the abdomen performed for left liver edge localization.

Gastric insufflation was achieved either by having the patient swallow effervescent crystals (EZEm Inc.; Westbury, NY) or by advancing a five French Berenstein catheter (Boston Scientific, Natick, MA) into the stomach under fluoroscopic guidance via nasal approach. Effervescent crystals were not used in patients with aspiration risks.

The abdomen was prepped and draped in sterile fashion. Local anesthesia was administered to the abdominal wall. Conscious sedation was administered using a combination of intravenous versed and fentanyl in all suitable patients.

The access site was localized via fluoroscopic examination of the insufflated stomach. Where necessary, in patients with tumoral implants or altered anatomy, CT guidance was used to guide stomach access. Two to three T-fastener gastropexy sutures were placed percutaneously to bring the anterior stomach wall into contact with the anterior abdominal wall. An 18-gauge needle was used to access the gastric lumen. Placement was confirmed with air aspiration and contrast injection. A 0.035 heavy-duty guidewire was advanced through the needle into the stomach, the needle was withdrawn and the tract dilated. The gastrostomy tube was advanced into the stomach over the wire and the wire was withdrawn. The pigtail locking mechanism was deployed and contrast was injected via the tube for final placement confirmation. Catheters were not sutured in place. Tubes were not used for 24 h following placement, to deter against possible risk of cutaneous and intraperitoneal leakage. Prophylactic antibiotics were not routinely administered [10].

Gastropexy sutures were removed at 10 days, at which time the access site was evaluated. The patient was then followed regularly by the ostomy care nurses and referring team.

Ostomy nurses taught gastrostomy care to outpatients before the tube was placed. If inpatients were physically capa-

ble and neurologically intact, they were taught by the floor nurses.

2.2.2. Percutaneous endoscopic gastrostomy

At our institution, PEG tubes are placed using the "pull" technique, which was first described by Gauderer et al. in 1980 [11].

Preprocedure, outpatients were admitted through the same-day program. Assuming no drug allergies, Cefotetan 1 g was given intravenously on call to the procedure. Once the patient was in the Endoscopy Suite, the upper endoscope was passed from the mouth into the stomach, which was inflated with air to allow the anterior wall to meet the abdominal wall. The abdominal wall was transilluminated with light from the endoscope. The site of maximal transillumination was chosen as the insertion site. The site was marked, the abdominal wall was cleaned and draped in a sterile fashion, and local anesthesia with 1% lidocaine was instilled. A small incision was made in the skin over the site. A sheathed needle was passed percutaneously into the stomach and a suture was threaded through the catheter once the needle was removed. The suture was grasped with a snare through the endoscope and drawn back through the mouth. The percutaneous gastrostomy tube was attached to the thread and pulled through the mouth, down the esophagus, into the stomach, and through the abdominal wall, after which it was secured with a plastic bolster. The endoscope could then be reinserted to check for positioning, and to be certain that the tension on the tube was not excessive. Feeding through the gastrostomy tube could begin after 24 h. If the patient was an inpatient, the gastroenterology fellow checked the tube the next day. Care instructions were provided to the nursing staff and referring team. If the patient was an outpatient, care instructions were provided upon discharge, and often the patient was seen in the Gastroenterology outpatient clinic 7–10 days later for a tube check and consideration of loosening the bolster. Long-term follow-up of PEG tubes at our institution was done on an as-needed basis with the ostomy nurses, or in the gastroenterology clinic.

All attempts at gastrostomy tube placement were technically successful.

2.3. Statistical analysis

Comparisons in patient characteristics and complications between those receiving PRG and PEG were made using chi-square tests and *t*-tests. To identify factors associated with early and late complications, multivariable logistic regression analyses were undertaken. Adjusted odds ratios for complications and 95% confidence intervals are reported for factors identified as statistically significant ($p < 0.05$) in these analyses. All statistical analyses were performed using STATA, Version 7 (STATA Corporation, College Station, TX).

3. Results

3.1. Patient demographics and follow-up time

Mean (±S.D.) age of PEG patients was 68 (±15); mean age of PRG patients was 63 (±14). One hundred (56.5%) male PEG patients and 114 (59.1%) male PRG patients. Follow-up to death or discontinuation of the tube for PRG patients averaged 108 days (range 3–376 days). Average follow-up time for PEG patients was 174 days (range 4–877 days).

3.2. Indications

One hundred sixty-seven (94%) PEG tubes were placed for nutrition and 10 (6%) for decompression; 177 (92%) PRG tubes were placed for nutrition and 16 (8%) for decompression. Dysphagia was the underlying problem for 120 (67.8%) of the PEG tubes placed, but for only 88 (45.6%, $p < 0.001$) of PRG tubes. Forty-nine (25.4%) of the PRG tubes were placed in anticipation of (or for the purpose of) ongoing radiation therapy, in comparison to only 7 (4%, $p < 0.001$) of the PEG tubes. The most common underlying diagnosis in the PEG group was neurologic impairment (cerebrovascular accidents, intracranial hemorrhage, mental retardation, hypoxic–ischemic brain injury and cerebral palsy) ($n = 89$, 50.3%), while the most common underlying diagnosis in the PRG group was malignancy (typically head and neck cancer) ($n = 134$, 69.4%) ($p < 0.001$). One hundred sixty-one (91.0%) endoscopic procedures and 133 (68.9%, $p < 0.001$) fluoroscopic procedures were performed on inpatients (Table 1).

3.3. Major complications

Mortality was not significantly different between the two groups (4.5% in PEG versus 3.1% in PRG) at 30 days, and no deaths attributable to feeding tube placement were observed.

In the PRG group, three major complications occurred early, and one major complication occurred late. Major complications affected 2.1% of the PRG patients overall.

The first early major complication involved an outpatient with stage IV squamous cell cancer of the tongue who presented with shortness of breath and cellulitis around the G tube site 7 days post-placement. Exploratory laparotomy diagnosed previously unknown gastric implant; anterior wedge gastrectomy and abdominal wall debridement performed; jejunostmy tube placed and intravenous antibiotics administered. The second early major complication was in an outpatient with stage III squamous cell cancer of the tonsil. Three days following placement he was admitted for extensive cellulitis of the anterior abdominal wall. The tube was removed and treatment with intravenous antibiotics instituted. The infection resolved, and another PRG tube was placed without complication. The third early major complication was in a patient with severely impaired cognition and agitation. Five days after the tube was placed, she presented with fever and abdominal discomfort and presumed infection. Exploratory

Table 1
Patient characteristics and indications for receiving gastrostomy

	Endoscopic placement (PEG), $n = 177$, n (%)	Fluoroscopic placement (PRG), $n = 193$, n (%)	p-value
Age (mean ± S.D.)	68 (±15)	63 (±14)	0.001
Gender male	100 (56.5)	114 (59.1)	0.617
Indication			
Nutrition (overall)	167 (94.4)	177 (91.7)	0.321
Dysphagia	120 (67.8)	88 (45.6)	<0.001
XRT	7 (4.0)	49 (25.4)	<0.001
FTT	24 (13.6)	20 (10.4)	0.343
Other	16 (9.0)	20 (10.4)	0.668
Decompression	10 (5.7)	16 (8.3)	0.321
Diagnosis			<0.001
Neuro impairment	89 (50.3)	37 (19.2)	<0.001
Malignancy	41 (23.2)	134 (69.4)	<0.001
Other	47 (26.6)	22 (11.4)	<0.001
Inpatient status (yes)	161 (91.0)	133 (68.9)	<0.001

Comparisons between endoscopic and fluoroscopic placement were made using *t*-tests for continuous variables and chi-square tests for categorical variables.

laparotomy demonstrated that the gastrostomy tube had migrated out of the stomach, and was free in the peritoneal cavity. The tube was removed, the peritoneal cavity irrigated and a jejunostomy tube was placed.

The single late major complication occurred in an outpatient 4 months after her gastrostomy tube was removed. PRG originally placed for nutritional supplementation while she was on a ventilator for a prolonged period following open cardiac surgery. Twenty-five days after the gastrostomy tube was placed, it was removed, as she was able to maintain adequate oral intake. A draining tract and hematoma persisted at the gastrostomy tube site. The tract was excised and it was discovered that the tube had passed through the left lobe of the liver. The hematoma was evacuated and the fistula oversewn.

In the PEG group there were two early major complications. The first involved a 72-year-old female who suffered acute inferior wall myocardial infarction. PEG was placed after a month-long, complicated hospitalization. Post-placement, she developed bradycardia and hypotension requiring fluids, dopamine, and temporary pacing for 24 h. The second early major complication in the PEG group occurred in a 78-year-old man who attempted suicide by caustic ingestion. Initial EGD revealed stage III alkaline injury to the esophagus and scattered gastric fundal erosions. Seven days after admission, a PEG was placed without incident. Eleven days after the procedure, he complained of abdominal pain. CT scan of the chest and abdomen was obtained, demonstrating that the PEG had migrated out of the stomach, and that the internal bolster was lodged between the stomach and abdominal walls. Surgical repair for gastric perforation was performed without sequelae.

3.4. Minor complications

Complications within the first 30 days (Table 2) were more common with PRG tubes (22.8% versus 10.8%, $p = 0.038$), with infections requiring antibiotics ($n = 17$) and inadvertent tube removal ($n = 14$) the most frequent. Four patients (2.1%) in the PRG group experienced minor periprocedure complications. One patient had an episode of decreased consciousness and required chemical reversal of conscious sedation. This patient did not experience any further problems. Another patient had some shoulder pain after the procedure and was found to have symptomatic iatrogenic pneumoperitoneum that required only pain medication and resolved spon-

Table 2
Complications in patients receiving gastrostomy

	Endoscopic placement (PEG), n (%)	Fluoroscopic placement (PRG), n (%)
Early complications		
Overall	19 (10.8)	44 (22.8)[a]
Major	2 (1.1%)	3 (1.6%)
Minor		
Infection	3 (1.7)	14 (7.3)[b]
Tube fell/pulled out	4 (2.3)	10 (5.2)
Pain	4 (2.3)	6 (3.1)
Procedural problem	2 (1.1)	4 (2.1)
Other	6 (3.4)	10 (5.2)
Late complications		
Overall	17 (10.1)	46 (23.8)[a]
Major		1 (0.5%)
Minor		
Infection	4 (2.3)	10 (5.2)
Tube fell/pulled out	2 (1.1)	12 (6.2)[b]
Leakage	1 (0.6)	10 (5.2)[b]
Pain	3 (1.7)	3 (1.6)
Other	7 (4.0)	11 (5.7)
Mortality within 7 days	8 (4.5)	6 (3.1)

Comparisons between endoscopic and fluoroscopic placement were made using chi-square tests with Fisher's exact when needed.

[a] p-values for the overall comparison between endoscopic and fluoroscopic placement complications were 0.038 for early and 0.002 for late complications.

[b] In spite of small numbers, several p-values for individual comparisons were significant: early infection p-value = 0.012, late tube fell/pulled out $p = 0.012$, late leakage $p = 0.011$.

taneously. The third patient had a hypotensive episode immediately following the procedure treated successfully with rapid intravenous infusion of 300cc of Lactated Ringers. The last patient had a 16 French 3 cm Mic-Key tube placed de novo, which was inadvertently not placed within the gastric lumen. It was removed immediately, and replaced by a 12 French intragastric tube, with no further difficulties.

Two PEG patients (1.1%) experienced minor periprocedural complications. One was a 76-year-old man with dysphagia secondary to tumoral obstruction of the mid esophagus. During the procedure he developed transient hypotension and bleeding. A small intramucosal hematoma developed at the PEG site, which resolved spontaneously, and hypotension was treated with 0.4 mg of Narcan without sequelae. The second patient was an 82-year-old woman with cerebral palsy, who received a PEG for failure to thrive. The intubation of the endoscope through the pharynx was difficult, requiring initial passage of a Maloney bougie. The esophagus was normal, but endoscopy of the stomach and duodenum revealed a large hiatal hernia and many non-bleeding superficial duodenal ulcers. Four unsuccessful attempts were made to pass an angiocath through the abdominal and gastric walls. The procedure was aborted and the patient was sent to interventional radiology, where a PRG tube was placed successfully.

3.5. Complications after adjustment

Logistic regression (Table 3) revealed that correlates of short-term complications were inpatient status (OR 0.35, 95%CI: 0.17–0.72) and radiologic placement (OR 2.15, 95%CI: 1.10–4.20). These held true regardless of patient age or other characteristics. Correlates of late complications in the multivariate analysis (Table 3) were inpatient status (OR 0.26, 95%CI: 0.13–0.51) and underlying malignancy (OR 2.2, 95%CI: 1.03–4.84). Although late complications (Table 2) were more common in the PRG group (23.8% versus 10.1%, $p = 0.002$), following adjustments shown in Table 3, no significant difference remained between endoscopic and fluoroscopic placement.

Table 3
Factors associated with early and late complications shown as adjusted odds ratios and 95% confidence intervals

	Adjusted odds ratio[a]	95% Confidence interval
Early complications		
Method of placement		
Endoscopic (PEG)	1.0	
Fluoroscopic (PRG)	2.15	1.10, 4.20
Hospitalization status		
Outpatient	1.0	
Inpatient	0.35	0.17, 0.72
Late complications		
Hospitalization status		
Outpatient	1.0	
Inpatient	0.26	0.13, 0.51
Diagnosis		
Neurological impairment	1.0	
Malignancy	2.2	1.03, 4.84

[a] Logistic regression models included age, method of placement, hospitalization status, and diagnosis.

4. Discussion

Major PRG and PEG complication rates reported in the literature range from 2.2 to 22.5% [4,12,13] and 12.9 to 17% [3,5] respectively as compared to our population rates of 2.1 and 1.1% for PRG and PEG procedures. Major complication rates, early and late, did not significantly differ between PRG and PEG patients.

As supported in the literature, most major PRG complications involved infection [3–5,14,15].

Early and late minor complication rates occurred in 22.8 and 23.8% of PRG patients respectively, in keeping with reported minor PRG complication rates of 2.9–36% [3,12,16]. Early and late minor PEG complication rates of 10.8 and 10.1% concurred with reported rates ranging from 8.3 to 65% [5,17]. Overall, in our study, radiologic placement was associated with significantly more early complications, but following adjustment, there was no difference in late complications between PRG and PEG.

Fewer minor complications were observed among inpatients, perhaps because inpatients might have benefitted from educated and experienced healthcare providers caring for new gastrostomy tubes and possibly supplemental teaching from ostomy nurses. The patients who went home following gastrostomy placement may have been less likely to receive this same quality of care, or equal education opportunities.

In our institution, prophylactic antibiotics were routinely administered to PEG recipients but not so for PRG patients. Routine antibiotic prophylaxis for PRG tube placement has not been described as documented infectious complications following PRG have been infrequent [10,18]. Malignancy predominated among PRG patients (69.4%) and is a well-known risk factor for infections as well as other complications [19,17,20–22]; neurologic impairment predominated among PEG patients (50.3%) while only 23.3% of PEG patients had underlying malignancy. Malignancy among the PRG may have predisposed this population to increased infection risk. Given the lack of described infectious complications among patients receiving PRG in the literature, treating all patients with prophylactic antibiotics may predispose resistance in this group [20,23]. Multivariate analysis showed that a diagnosis of malignancy was a statistically significant correlate of late complications. 87% of the patients who got local infections had a cancer diagnosis, as compared to 69.4% of the total study population. Even though patients with underlying diagnoses of cancer had higher infection rates, Pickhardt argues for radiologic gastrostomy tube placement in this population to avoid direct tumor metastatic implantation in patients with malignancies of the upper aerodigestive tract [24].

Peristomal infection is a well-known problem with percutaneous gastrostomy tube placement [3,4]. Three recent randomized clinical trials of prophylactic antibiotic use with PEG placement have demonstrated a significantly decreased rate of infection in the short-term [17,21,22]. Without antibiotic prophylaxis, local wound infection was nine times more common among PEG patients than PRG patients [25]. Administration of prophylactic antibiotics has been proven to be effective in reducing infections during PEG placement and should be considered for routine use in PRG placement, especially in high-risk patients such as those with malignancy [17,21,22]. Although our study did not show an effect of malignancy on early complications, other studies [19] have attributed early infections to the prevalence of malignancy.

Another important difference in minor complications between the two groups was inadvertent tube removal. This was possibly secondary to differences in anchoring devices between PRG and PEG tubes. PRG tubes either have locking pigtail or inflatable balloon retention mechanisms while PEG tubes have small internal plastic discs and external plastic bolsters. Similar results have been reported in the literature. Cosentini et al. reported 18% of PRG cohort and 8% PEG cohort experienced dislodged tubes [3].

The lower rate of leakage in the PEG group (5.2% versus 0.6%) is also likely a reflection of the difference in gastrostomy devices, as well as patient education. Inpatient status was related to fewer complications, possibly because patients and caregivers were taught stoma surveillance and care during the hospitalization. Leakage of gastric contents causes painful irritation and infection of the peristomal skin. Excessive leakage can be a sign that the tube has clogged, kinked or migrated. Prevention of leakage and associated complications can be accomplished with good skin care, regular tube changes and patient education [26].

Durability of the tubes was not statistically different for the two groups.

The percentage of patients with pain and other problems during the procedure was similar in both groups. Most PRG patients who experienced early pain reported marked improvement once the gastropexy sutures were removed. Gastropexy sutures however are an integral part of PRG placement technique and help to reduce the incidence of technical complications such as failed tube placement secondary to inadequate retention of the anterior gastric wall [27]. Two of the three PRG patients who experienced pain as a late complication were concurrently frequently vomiting due to chemotherapy; when vomiting ceased, so did their pain. Another cause of pain was excessive granulation tissue around the stoma tract. Local therapy with silver nitrate improved the situation in all cases.

Four PEG patients experienced early pain and two, late pain. Five of these six patients improved after loosening the bolster. Possibly, once weight gain was established, the abdominal subcutaneous fat increased in thickness causing tightening of the bolster against the abdominal wall.

Catheter migration was infrequently reported in our study though this potential complication is noteworthy to observe as two cases of death after delayed recognition of PEG tube migration and peritonitis have been reported in the literature [28].

Four patients (2.1%) in the PRG group and two PEG patients (1.1%) experienced periprocedural complications. All were treated promptly without delayed sequelae.

Disparity in indications is likely a reflection of referral patterns of the oncology and neurology staff at our center. Of the PRG patients, greater than two thirds were diagnosed with head and neck cancer (AJCC stage III or higher), while less than a third of the PEG group had a malignancy. Fewer than 20% of the PRG patients had neurologic impairment, whereas half of the PEG patients had neurologic impairment.

Patients who require gastroenteric access through the anterior abdominal wall are likely to have worse pathology and a poorer prognosis than any disease-matched control group [19]. Digital medical records system and rural location of our center allowed for close patient follow-up over a prolonged period. Close patient follow-up, as compared to prior studies, may have led to the discovery of more disease which may, in turn, have caused inflation of our complication rates in comparison with other study populations [3,5,7,12,29,30].

5. Conclusion

Percutaneous gastrostomy tube placement is an excellent alternative to parenteral and nasogastric feeding for patients unable to maintain adequate oral nutrition. Both endoscopic and radiologic techniques are safe for placement and long term use, with few major complications and minor complications that were, for the most part, readily treated.

Statistically significant correlations for early minor complications included percutaneous fluoroscopic placement and inpatient status. Early infections prevalent among PRG patients may be attributed to lack of antibiotic prophylaxis. Routine antibiotic coverage for PRG placement should be considered, especially for high-risk patients, such as those with malignancy.

Educating both patients and healthcare providers about gastrostomy tube and stoma care may prevent pain and inadvertent removal. Regularly scheduled tube changes may decrease the amount of tube leakage, peristomal pain and local infection.

Both PRG and PEG are safe and effective. The differences in outcomes between them appear to be minor and relate largely to routine antibiotic use at the time of placement and may be, at least in part, attributed to underlying diagnoses among referred patients.

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