



Single-Step Method for Pull-Type Gastrostomy Tube Placement

Shawn Ma, BA, Nicole A. Lamparello, MD, Helen Paik, MD, Gregory Nadolski, MD, William Stavropoulos, MD, David Tischfield, MD, Terence Gade, MD, and Richard D. Shlansky-Goldberg, MD

ABSTRACT

Single-step pull-type gastrostomy tube (PGT) placement is a method involving gastric puncture with a curved 18-gauge trocar needle allowing retrograde cannulation of the gastroesophageal junction without use of a sheath or snare. This retrospective review of 102 patients who underwent single-step PGT placement demonstrated 91% success in advancing the wire up the esophagus using only the curved trocar. Successful placement of a gastrostomy tube was 100%. Two major and 2 minor complications occurred within 30 days, all unrelated to the single-step technique. Mean fluoroscopy time for all patients was 5.1 min (range, 1.5–19.2 min). Single-step PGT placement is an effective, safe, fast, and equipment-sparing method for gastrostomy placement.

ABBREVIATIONS

GE = gastroesophageal, PGT = pull-type gastrostomy tube, RIG = radiographically inserted gastrostomy

Radiographically inserted gastrostomy (RIG) is divided into 2 classes, push-type and pull-type. Although push-type gastrostomy is the more conventional approach, recent data suggest that pull-type gastrostomy tube (PGT) placement has similar technical success rates with potentially reduced complication rates (1–3). Traditional pull-type gastrostomy placement uses an introducer needle for a single percutaneous gastric puncture, followed by placement of a sheath over a stiff guide wire. The guide wire is used in conjunction with a guiding catheter to facilitate retrograde cannulation of the gastroesophageal (GE) junction. The wire is then directed up the esophagus and out of the oropharynx or the wire is snared out of the mouth. A large-bore bumper-retained or mushroom-retained catheter is then attached and advanced antegrade down the esophagus and into the

stomach (1,4). A simplified single-step PGT technique was developed that uses a curved 18-gauge trocar needle shaped into an esophageal cannula to directly engage the GE junction, avoiding the need for additional equipment. The purpose of this retrospective study was to evaluate success rate, complications, 30-day outcomes, and inventory cost of single-step PGT placement.

MATERIALS AND METHODS

Data Collection and Patients

The study was approved by the institutional review board. This retrospective study included all single-step PGT placement procedures performed between October 2012 and August 2018 at 2 academic medical centers. Determination of single-step methodology was accomplished by examining records using an interventional radiology database (HI-IQ; ConexSys, Lincoln, Rhode Island) and cross-referencing these records with an electronic inventory database (QSight; Owens & Minor, Mechanicsville, Virginia). Single-step PGT placement was identified by the use of a specific 20-cm 18-gauge trocar needle (Cook, Inc, Bloomington, Indiana), which was not used in other gastrostomy techniques. Electronic medical record procedure notes confirmed a single-step technique. The inventory database, procedural reports, and medical record were also evaluated for single-step success, fluoroscopy time, and 30-day complications and mortality. Failure of single-step PGT placement was defined by the use of equipment besides the

From the Division of Interventional Radiology (S.M., H.P., G.N., W.S., D.T., T.G., R.D.S.-G.), Department of Radiology, Hospital of the University of Pennsylvania, 1 Silverstein, 3400 Spruce Street, Philadelphia, PA 19104; and Interventional Radiology (N.A.L.), Weill Cornell Imaging at New York-Presbyterian, New York, New York. Received March 30, 2019; final revision received May 20, 2019; accepted May 21, 2019. Address correspondence to R.D.S.-G.; E-mail: shlanskr@uphs.upenn.edu

None of the authors have identified a conflict of interest.

From the SIR 2019 Annual Scientific Meeting.

© SIR, 2019

J Vasc Interv Radiol 2020; 31:473–477

<https://doi.org/10.1016/j.jvir.2019.05.022>

Table 1. Patient Demographics and Procedure Indications

	No. Patients*
Patient demographics	
Male	47
Female	55
Age, y, mean (range)	62.9 (20–89)
Procedure indications	
Cerebrovascular accident	36
Peritoneal carcinomatosis	18
Other cancers	10
Dysphagia NOS	9
Failure to thrive	6
Aspirations/reflux	4
Infectious	4
Other conditions (stricture, trauma, genetic)	4
Dementia/neurodegenerative	3
Other neurologic disorder	3
Pulmonary disease	2
Seizures/altered mental status	2
Neuromuscular disorder	1
Total	102

NOS = not otherwise specified.

*Except for age, as indicated.

curved trocar needle to cannulate the GE junction or retrieve the wire from the esophagus or oropharynx. Gastrostomy tube exchanges and procedures with incomplete documentation were excluded. No selection bias was noted because all procedures with incomplete documentation were successful using the single-step method. Three fellowship-trained interventional radiologists with a mean of 17.7 years (range, 6–27 y; G.N., W.S., R.S.G.) of operator experience performed the procedures in an inpatient fluoroscopy suite with or without the aid of a fellow or resident.

Between October 2012 and August 2018, 102 patients, 47 men and 55 women with a mean age of 62.9 years (range, 20–89 y), underwent single-step PGT placement. The most common indications for gastrostomy were cerebrovascular accident (35%) and peritoneal carcinomatosis requiring decompression of the stomach and/or small intestine (18%). Other common indications included nonspecified dysphagia, other cancer, and failure to thrive requiring supplemental nutrition. Complete demographics and procedural indications are summarized in **Table 1**. Patients with head and neck tumors were excluded owing to the risk of tract seeding of tumor.

Gastrostomy Placement

Patients did not eat or drink for at least 6 hours before PGT placement. Coagulopathic patients (prothrombin time > 17 s or international normalized ratio > 1.92) or thrombocytopenic patients (platelet count < 50,000/ μ L blood) received blood products to achieve a platelet count > 50,000/ μ L and a target international normalized ratio of 1.5. All patients

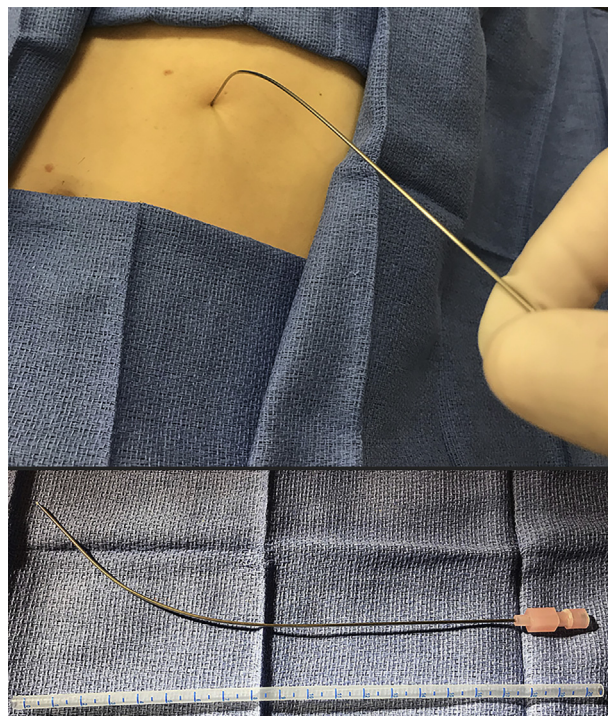


Figure 1. A 20-cm 18-gauge trocar needle is bent with a gentle curve after applying povidone-iodine (Betadine) ointment to the stylet to create the esophageal cannula. The petroleum lubricant in the povidone-iodine provides for easy removal of the bent stylet. The curve at the tip of the trocar needle allows for optimal interrogation of the GE junction. After the wire is advanced into the midesophagus, the curved trocar is positioned in the distal esophagus to support the wire as it is advanced into the proximal esophagus and out of the mouth. During the initial puncture, the hub of the trocar is angled down so that the proximal curved tip is at a near right angle to the puncture site to allow for advancement into the needle.

received preprocedural antibiotics (1 g ampicillin sodium/500 mg sulbactam sodium or 1 g ceftriaxone unless allergic). Intravenous midazolam and fentanyl citrate were used for sedation and analgesia. Patients were monitored by an advanced cardiac life support–certified radiology nurse with critical care credentials. After successful placement, the catheters were placed to gravity drainage overnight. Water boluses were started that evening or the following day depending on the attending physician's preference.

Single-Step Method for Pull-Type Gastrostomy

The single-step technique used a curved needle to engage the GE junction, which was then advanced into the mid-esophagus, eliminating the need for other devices. Similar to traditional pull-type catheter placement, the stomach was first insufflated with a nasogastric tube, and local anesthetic was administered at the site of planned puncture. The 20-cm 18-gauge trocar needle (Cook, Inc) was gently curved 45° in the distal 4 cm manually by the operator. The modification allowed for direct cannulation of the GE junction after

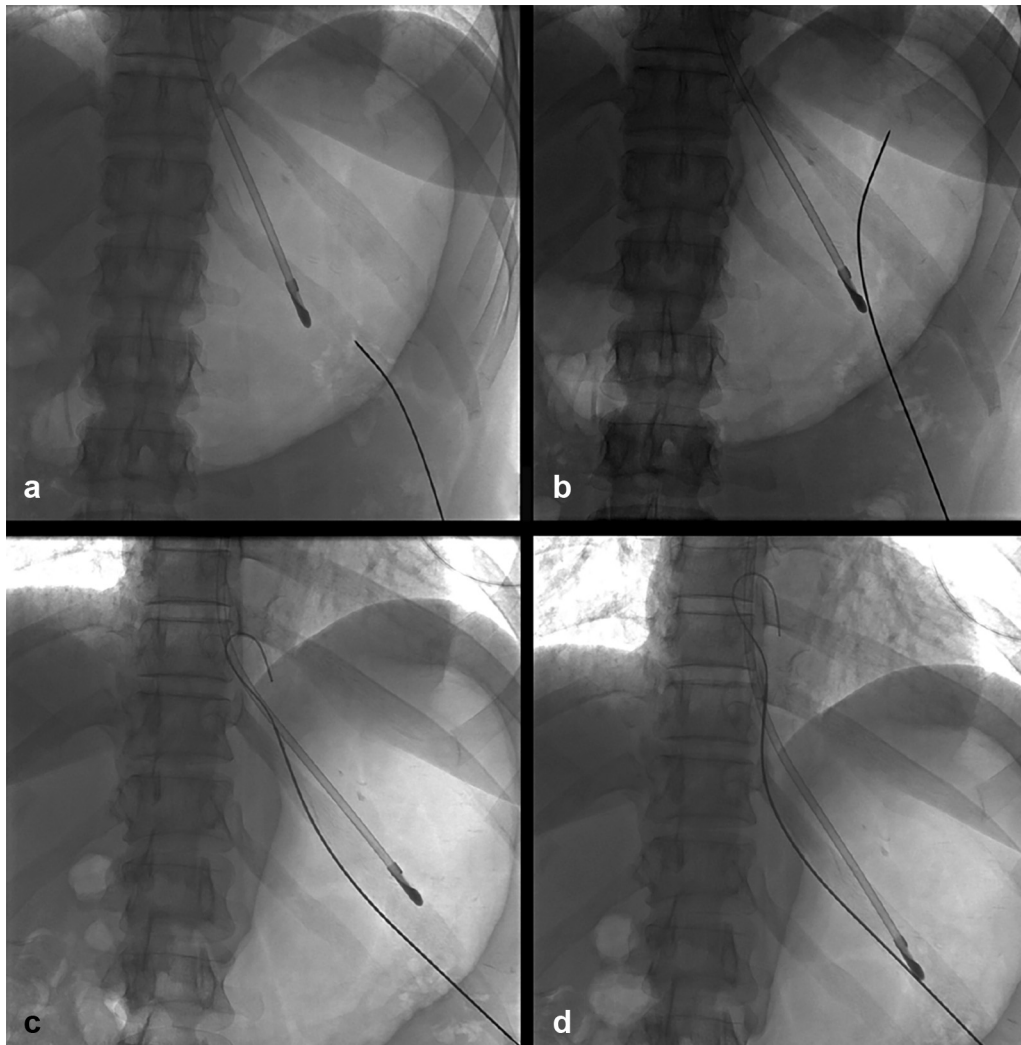


Figure 2. Fluoroscopic images using an 18-gauge trocar needle shaped into an esophageal cannula to perform pull-type gastrostomy. **(a)** The curved trocar needle is used to puncture the stomach after air insufflation. **(b)** The curved trocar is directed posteriorly to catheterize the esophagus at the GE junction. **(c)** The GE junction is engaged with the curved trocar allowing the wire to be advanced into the distal esophagus. **(d)** The curved trocar is advanced into the distal esophagus, which prevents the wire from coiling in the stomach and allows it to be advanced up the esophagus and out of the mouth.

gastric puncture. The needle was curved with the internal stylet in place after it was lubricated with the povidone-iodine petroleum ointment included in the 20-F PGT kit (Halyard Health, Alpharetta, Georgia) that was used (Fig 1). After gastric puncture, the stylet was removed so that the blunt tip could be used to interrogate the GE junction. The image intensifier was placed in a right posterior oblique position, and the existing nasogastric tube was followed under fluoroscopy to the GE junction. After GE junction cannulation, the steel guide wire from the PGT kit, with a bend at the tip to facilitate exiting the oropharynx, was directly inserted into the esophagus. The needle was completely advanced with the wire into the midesophagus allowing the wire to be supported through the stomach and midesophagus so it could be manipulated out of the oropharynx (Fig 2a–d). Similar procedural steps as traditional PGT placement were then used to pull the gastrostomy tube down the esophagus into the stomach.

Table 2. Single-Step PGT Average Fluoroscopy Time

	No. Patients	Minutes
Successes	93	4.2
Failures	9	12.4
Total	102	5.1

PGT = pull-type gastrostomy tube.

Cost Analysis

Inventory costs for single-step PGT placement and conventional push-type gastrostomy placement were calculated by summing the list prices of the necessary equipment for the 2 techniques. Only equipment needed for uncomplicated procedures was included. The push-type technique analyzed here was the most common method for gastrostomy placement at the 2 centers in this study.

Table 3. Equipment List Prices for Push-Type and Single-Step PGT Placement

	Manufacturer	Product Type	Catalog No.	Quantity	List Price (\$)
PGT	Cook, Inc	Fixation device	GIAS-SRM-ADJ-2	1	144.00
	Terumo Medical Corp	Introducer/sheath	RSS905	1	37.95
	Boston Scientific*	Amplatz guide wire	M001465241	1	44.00
	Cook, Inc	Introducer/sheath	PLVW-22.0-38	1	105.00
	Avanos Medical [†]	Feeding tube	0110-18	1	71.48
	Cook, Inc	Dilator	JCD14.0-38-20-HC	1	23.00
	Cook, Inc	Dilator	JCD16.0-38-20-HC	1	20.00
	Cook, Inc	Dilator	JCD18.0-38-20-HC	1	20.00
Total cost					465.43
Single-Step PGT	Cook, Inc	Needle	DTN-18-20.0	1	28.00
	Avanos Medical [†]	Feeding tube kit	7150-20	1	158.67
	Total cost				186.67

PGT = pull-type gastrostomy tube.

*Marlborough, Massachusetts.

[†]Alpharetta, Georgia.

Statistical Analysis

Data are reported as mean \pm SD or as ratio with confidence interval. *t* tests were used to determine the statistical significance of these data.

RESULTS

Single-Step Success Rate

In 93 of the 102 (91%) (95% confidence interval, 84%–96%) single-step PGT placements, the GE junction was successfully cannulated using only the curved trocar needle. In the 9 failures, the additional equipment used to facilitate cannulation included introducer sheaths (8-F TIF TIP Introducer Sheath [Terumo Medical Corp, Tokyo, Japan]; 9-F, 10-F, and 11-F PINNACLE Introducer Sheaths [Terumo Medical Corp]; 11-F AVANTI+ Sheath Introducer [Cordis, Miami Lakes, Florida]), endobronchial forceps (grasping forceps; LYMOL Medical, Woburn, Massachusetts), endovascular snares (ONE Snare Endovascular Snare; Merit Medical Systems, Inc, South Jordan, Utah), and angiographic catheters (5-F Cobra 2; Cook, Inc). Successful placement of a gastrostomy tube was achieved in all patients regardless of single-step success or failure.

Fluoroscopy Time and Inventory Cost

Mean fluoroscopy time for all patients was 5.1 minutes (range, 1.5–19.2 min). Mean fluoroscopy time for successes was 4.2 minutes (range, 1.5–12.2 min) and for failures was 12.4 minutes (range, 5.5–19.2 min), which was a significant difference between the single-step successes and failures ($P < .001$) (Table 2). The total list price was \$186.67 for successful single-step PGT placement and \$465.43 for uncomplicated push-type tubes performed at the 2 institutions (Table 3).

Complications

Two major (2%) and 2 minor (2%) complications occurred within 30 days of tube placement, based on Society of Interventional Radiology (SIR) criteria. The major complications were tube malposition (transhepatic course) and aspiration during gastric insufflation causing respiratory compromise. There was 1 death within 30 days unrelated to tube placement. The 2 minor complications were emesis during gastric insufflation and tube dislodgment owing to patient removal.

DISCUSSION

RIG has been established as a safe and effective procedure for obtaining enteric access (5,6). Studies comparing the 2 methods of RIG have suggested that pull-type gastrostomy has similar technical success with fewer complications, specifically reduced obstruction and dislodgment (4,7,8). Limited prospective randomized control trial data also seem to support these findings (8). However, pull-type tubes are advanced from the oral cavity, which can limit their feasibility in patients with obstructive head and neck or esophageal cancer.

In 1989, Cope (9) described his gastrojejunal cannula for catheterizing the duodenum from the stomach. It had a malleable portion that was bent to the appropriate angle to facilitate cannulation of the duodenal bulb while placing a transgastric jejunal tube. This concept was used in developing the curved trocar needle to cannulate the GE junction. This study introduces the single-step method for PGT placement, which reduces the necessary equipment and steps to traverse the esophagus in performing a pull-type RIG. Success in placing a gastrostomy tube in this study was 100%, in line with other reported success rates (6,7,10,11). Also, the simplified technique did not increase

the need for image guidance relative to traditional PGT placement. The average fluoroscopy time of 5.1 minutes in this study is on the lower end of reported PGT fluoroscopy times (range, 4.8–8.7 min) (7,11,12). Fluoroscopy times for gastrostomy placement with failed single-step technique were higher because alternative techniques were then used to traverse the esophagus or conventional push-type gastrostomy was performed.

The major and minor complication rates of the single-step method were both 2.0%. A large 2018 retrospective review of RIG reported a 2.0% major complication rate and 1.7% minor complication rate in 402 PGTs (6). The 30-day mortality was 0.47%, comparable to the 30-day mortality in this study (0.98%) (95% confidence interval, 0.03%–5.3%). Other, smaller studies had similar or higher complication rates and 30-day mortality (10,11). None of the major or minor complications in this study were related to the single-step technique. In aggregate, these results suggest that single-step PGT placement is equivalently safe compared with RIG overall and traditional PGT placement in particular.

Single-step PGT placement is differentiated from other methods of RIG placement by its inventory cost. Successful single-step PGT placement, which was achieved in 91% of cases, does not require sheaths or catheters compared with traditional PGT techniques. The total list price of uncomplicated balloon-retained push-type gastrostomy, the most common method of gastrostomy placement at the 2 centers, was \$465.43, nearly 150% more than the total list price of successful single-step PGT placement. The cost differential is partly due to the fact that the pull-type kit contains all necessary components except for the trocar needle, whereas there is no single kit for the push-type technique, which consists of several individual components, such as gastric anchors.

This study has several limitations. First, this was a retrospective study of only 3 operators. Also, the choice of single-step PGT placement versus push-type gastrostomy was determined on a case-by-case basis, potentially contributing to patient selection bias. These factors may

limit the generalizability of the single-step technique for all patients requiring gastrostomy tubes.

In conclusion, the single-step method for PGT placement is a fast, effective, and safe option with similar fluoroscopy time, success rates, and complication rates compared with other RIG methods, including traditional PGT placement. In addition, this technique may simplify and reduce the inventory cost of gastrostomy placement.

REFERENCES

1. Yang Y, Schneider J, Düber C, Pitton M. Comparison of fluoroscopy-guided pull-type percutaneous radiological gastrostomy (pull-type-PRG) with conventional percutaneous radiological gastrostomy (push-type-PRG): clinical results in 253 patients. *Eur Radiol* 2011; 21:2354–2361.
2. Ahmed O, Jilani D, Sheth S, Giger M, Funaki B. Radiologically guided placement of mushroom-retained gastrostomy catheters: long-term outcomes of use in 300 patients at a single center. *Radiology* 2015; 276: 588–596.
3. Currie B, Getrajdman GJ, Covey AM, et al. Push versus pull gastrostomy in cancer patients: a single center retrospective analysis of complications and technical success rates. *Diagn Interv Imaging* 2018; 99:547–553.
4. Szymiski GX, Albazzaz AN, Junaki B, et al. Radiologically guided placement of pull-type gastrostomy tubes. *Radiology* 1997; 205:669–673.
5. Wollman B, D'Agostino HB, Walus-Wigle JR, Easter DW, Beale A. Radiologic, endoscopic, and surgical gastrostomy: an institutional evaluation and meta-analysis of the literature. *Radiology* 1995; 197:699–704.
6. Tischfield DJ, Nadolski GJ, Hunt SJ, et al. Retrospective comparison of outcomes and associated complications between large bore radiologically inserted gastrostomy tube types. *Abdom Radiol* 2018; 44: 318–326.
7. Han K, Kim MD, Kwon JH, et al. Randomized controlled trial comparing radiologic pigtail-retained gastrostomy and radiologic mushroom-retained gastrostomy. *J Vasc Interv Radiol* 2017; 28:1702–1707.
8. Laasch HU, Wilbraham L, Bullen K, et al. Gastrostomy insertion: comparing the options—PEG, RIG or PIG? *Clin Radiol* 2003; 58:398–405.
9. Cope C. Directable cannula for gastrojejunal catheterization. *AJR Am J Roentgenol* 1989; 152:1346.
10. Busch JD, Herrmann J, Adam G, Habermann CR. Radiologically inserted gastrostomy: differences of maintenance of balloon- vs. loop-retained devices. *Scand J Gastroenterol* 2016; 51:1423–1428.
11. Bernstein OA, Campbell J, Rajan DK, et al. Randomized trial comparing radiologic pigtail gastrostomy and peroral image-guided gastrostomy: intra- and postprocedural pain, radiation exposure, complications, and quality of life. *J Vasc Interv Radiol* 2015; 26:1680–1686.
12. Haber ZM, Charles HW, Gross JS, Pflager D, Deipolyi AR. Percutaneous radiologically guided gastrostomy tube placement: comparison of ante-grade transoral and retrograde transabdominal approaches. *Diagn Interv Radiol* 2017; 23:55–60.