Usefulness of percutaneous endoscopic gastrostomy for supportive therapy of advanced esophageal cancer

Running title:

Haruei Ogino, Hirotada Akiho

Department of Gastroenterology, Kitakyushu Municipal Medical Center, Kitakyushu 802-0077, Japan

Author contributions:

Correspondence to:

Hirotada Akiho, MD, PhD, Kitakyushu Municipal Medical Center, 2-1-1 Bashaku, Kokura-kitaku, Kitakyushu 802-0077, Japan.

E-mail: akiho@med.kyushu-u.ac.jp

Tel: +81-93-541-1831; Fax: +81-93-533-8691

Abstract

Esophageal cancer is well known to have a poor prognosis. It is often diagnosed in the late stages, with dysphagia being the major symptom. Insufficient nutrition and lack of stimulation of the intestinal mucosa may worsen immune compromise due to toxic side effects. A poor nutritional status is a significant prognostic factor for increased mortality. Therefore, it is most important to optimize enteral nutrition in patients with esophageal cancer before and during treatment as well as during palliative treatment. Percutaneous endoscopic gastrostomy (PEG) may be useful for nutritional support. However, PEG tube placement is limited by digestive tract stenosis and is an invasive endoscopic procedure with a risk of complications. There are three PEG techniques. The pull/push and introducer methods have been established as standard techniques for PEG tube placement. The modified introducer method, namely the direct method, allows for direct placement of a larger button-bumper-type catheter device. PEG tube placement using the introducer method or the direct method may be a much safer alternative than the pull/push method. PEG may be popular in patients with esophageal cancer because of the improved complication rate.

Key words: esophageal cancer, percutaneous endoscopic gastrostomy

Introduction

Tumors of the esophagus and gastroesophageal junction are some of the most malignant cancers with high mortality rates because many patients are diagnosed in the advanced stages[1]. Dysphagia, or difficulty swallowing, is one of the most distressing and debilitating symptoms. Dysphagia leads to nutritional compromise and deterioration of quality of life[2,3]. When the esophageal lumen becomes stenotic to less than 14 mm in diameter, dysphagia generally develops. It first becomes difficult to swallow solid food. Next, it becomes difficult to swallow semisolid food. Finally, fluids and even saliva are difficult to swallow. Patients develop anorexia and significant weight loss secondary to the tumor effects and may present with varying degrees of malnutrition. A poor nutritional status is a significant prognostic factor for increased mortality[4].

Selection of therapy for esophageal cancer is dependent upon the tumor stage, location, and histological type and the physician’s experience and preference. Therapeutic options include surgical resection of the primary tumor, chemotherapy, and radiotherapy. Therapies are sometimes combined, such as chemotherapy plus surgery or chemotherapy and radiotherapy plus surgery. Many of these patients find that their initial dysphagia worsens during this treatment because of side effects such as esophagitis and oral mucositis. Moreover, insufficient nutrition and lack of stimulation of the intestinal mucosa may worsen immune compromise due to toxic side effects[5]. During these periods, it is most important to optimize enteral nutrition. Early enteral nutrition reduces the incidence of life-threatening surgical complications in patients who undergo esophagectomy or esophagogastrectomy for esophageal carcinoma[6-10]. Nutrition is administered through a transnasal feeding tube for short-term feeding when oral intake is not possible. When chemotherapy and/or radiotherapy are intended to be curative, they frequently compromise oral intake for a long period of time. Nasogastric tubes are easy to place, but they are poorly tolerated for prolonged periods of feeding. Percutaneous endoscopic gastrostomy (PEG) may be one of the best options for nutritional support.

A majority of patients are destined to receive palliation only, which is associated with a severely impaired health-related quality of life. These patients require palliative treatment including brachytherapy, chemotherapy, and endoscopic palliation techniques such as esophageal dilatation, intraluminal stents, and laser therapy to relieve progressive dysphagia[11,12]. The two most commonly used strategies for improving swallowing are stent insertion and radiation, including intraluminal brachytherapy. They allow for an almost normal oral intake. Unfortunately, some patients develop restenosis symptoms after palliative therapy, and some develop severe treatment-related side effects such as mucositis from radiation therapy. Stent insertion is difficult in some patients with proximal esophageal cancers. For these patients, PEG or nasal tubes may be the best options for nutritional support.

PEG procedure

There are three PEG tube insertion methods. The pull/push and introducer methods have been established as standard techniques for PEG tube placement. In the pull/push method, the feeding tube is introduced through the mouth, and thus requires a reasonably patent esophagus. In the introducer method, balloon-type catheter feeding tubes can be inserted directly into the stomach through the abdominal wall. The third method is the modified introducer method (i.e., direct method). The direct method involves fixation of the gastric wall to the abdominal wall using a gastropexy device followed by dilation of the hole using a dilator, which allows for direct placement of a larger button-bumper-type catheter device. Use of the direct method is spreading in Japan, but it is not yet used worldwide[13]. Each method has advantages and disadvantages.

Pull/push method

The pull/push PEG technique is based on the standard Ponsky technique, in which a guidewire is inserted through the abdominal wall under endoscopic guidance, grasped by a snare through a port on the endoscope, and subsequently advanced in a retrograde manner through the patient’s mouth. The remaining end exits the patient through the anterior abdominal wall. A 20-French Ross Flexiflo Inverta-PEG tube (Abbott Laboratories, Columbus, OH) is then secured to the transoral end of the patient’s mouth and abdominal wall by pulling the extra-abdominal end of the wire to advance the gastrostomy tube[14].

Introducer method

The introducer PEG technique is based on the Russell introducer method of PEG placement. After the endoscope is inserted and the PEG site is marked, four T-fasteners are placed before gastrostomy tube insertion to secure the stomach to the anterior abdominal wall. This prevents gastric wall displacement while inserting the gastrostomy tube. Using the Seldinger technique, a short guidewire is then passed transabdominally under endoscope visualization. Serial dilators are passed over the guidewire to create a stoma tract; the endoscope remains in place for visualization and verification of gastrostomy tube placement. An 18-French Ross Flexiflo gastrostomy tube (Abbott Laboratories) is then inserted or pushed over the guidewire, directly through the anterior abdominal wall[15].

Direct method

The direct method is a modified version of the introducer method (Direct Ideal PEG kit; Olympus Corp., Tokyo, Japan). Using this method, the anterior wall of the stomach is sutured with two nylon sutures using an endoscope for ease of PEG catheter insertion. The stomach is punctured using a double-lumen gastropexy device. An approximately 10-mm incision is made between these two sutures on the anterior abdominal wall. A needle with an outer plastic sheath (18-French) is introduced into the stomach under endoscopic visualization. The needle is removed, the guidewire is replaced, and the skin incision is dilated by passing a dilator percutaneously into the stomach over the guidewire under endoscopic visualization. After the dilator is removed, a measuring device is inserted over the guidewire to determine the length of the button, followed by insertion of a 24-French PEG tube using an obturator[13] (Fig. 1).

Outcomes of PEG

PEG in patients with esophageal cancer

PEG tube feeding is the preferred method with which to provide long-term tube feeding, and its use is currently widespread. A few studies have examined usefulness of PEG for cancer of the esophagus. In 2001, Stockeld et al. inserted a PEG tube into patients with esophageal cancer in all stages and locations including 37% of patients who had undergone oncological treatment with curative intent[16]. In 2010, Rabie et al. performed PEG in patients with esophageal cancer with different indications, including chemotherapy[17]. In 2011, Yagishita et al. performed PEG tube placement in patients with esophageal cancer and head and neck cancer with advanced-stage malignancies and oral intake difficulties for the purpose of nutritional support. Prophylactic gastrostomy was performed in 33% of patients who had undergone elective chemoradiotherapy[18]. Also in 2011, Dyck et al. and Zuercher reported PEG tube placement in patients with esophageal cancer, including those who had undergone chemoradiotherapy[19,20]. In 2012, Grilo et al. inserted PEG tubes into patients with upper esophageal cancer who had undergone palliative chemotherapy or radiation[21]. Radiation therapy is frequently associated with mucositis, dysphagia, loss of taste, and anorexia. Chemoradiation therapy and hyperfractionated radiation therapy are usually associated with even more severe treatment-related side effects and greater impairment of swallowing function. These radiation and chemoradiation treatments are long-term. Therefore, during these periods, PEG tube insertion may be one of the best options for nutritional support if the complication and mortality rates of PEG are low. Nasogastric tubes are easy to place, but they are poorly tolerated for prolonged periods of feeding because they are associated with frequent ulceration, esophageal reflux, and general discomfort. PEG tubes are better tolerated, but they must be used selectively in patients who can be predicted to have a long-term need for nutritional support[22].

There are more reports of patients with head and neck cancer than patients with esophageal cancer. One of the reasons for this is that stent insertion and brachytherapy are the first-choice palliative treatments in patients with middle and low esophageal cancers in many institutions. In terms of nutritional support, the most important factor is maintenance of oral food intake, which should stabilize or even improve quality of life. Dysphagia improves more rapidly after stent placement[11,12], and long-term relief of dysphagia is better after brachytherapy[23,24]. Therefore, stent placement may be reserved for patients with severe dysphagia in combination with a short life expectancy who need more rapid relief of dysphagia and for patients with persistent or recurrent tumor growth after brachytherapy[11,12]. When these modalities are technically not possible, nutritional support with a nasoenteric feeding tube or PEG tube should be considered to maintain adequate calorie intake. Grilo et al. suggests that PEG should be considered as a nutritional support method in patients with upper esophageal cancer that is unsuitable for esophageal stenting[21]. For patients who suffer from restenosis symptoms after palliative therapy or who have proximal esophageal cancers, PEG may be one of the best options for nutritional support. However, studies on this topic have weaknesses typical to retrospective studies. Nugent and Locher reported that there is no sufficient evidence to determine the optimal method of enteral feeding for patients with head and neck cancer receiving radiotherapy and/or chemoradiotherapy[25,26]. Larger studies of enteral feeding in patients with esophageal cancer are needed.

Complications

PEG tube placement is an invasive endoscopic procedure with a risk of complications. Minor complications resulting from PEG tube placement include cellulitis, ileus, peristomal leakage, extrusion, tube obstruction, and gastric wall hematoma formation. Major complications include peritonitis, hemorrhage, airway aspiration, peristomal wound infection, buried bumper syndrome, and gastrocolic fistula[27] (Table 1).

The major complications of the standard pull/push method, which requires an esophageal lumen sufficient to pass a standard endoscope[28], include peristomal wound infections presumably resulting from contamination of the gastrostomy catheter as it passes through the oral cavity[13,29] and tumor implantation at the PEG site[30]. In the literature on patients with cancer, the overall complication and mortality rates of the pull/push method in patients with head and neck cancer are 10.9–42% and 0–5%, respectively[14,16,17,19-21,31-34].

An overall complication rate of 0–11% and mortality rate of 0% have been reported with the introducer method[14,15,35,36] compared with the pull/push method in patients with cancer. In the pull/push method, one reason for the high complication rate may be that it is necessary to dilate the lumen before treatment when the stenosis caused by the tumor is severe. In many patients, PEG tube placement can be limited by digestive tract stenosis. PEG tube placement using an introducer is the safest alternative in this group of patients, but use of the available devices is difficult to implement.

In the past, the introducer technique was technically more demanding and associated with a lower success rate. This problem was solved by the use of T-fasteners to secure the anterior stomach to the abdominal wall[37,38]. Therefore, recent data on the introducer method using T-fasteners show low complication rates of less than 11% and no mortality[36,39-43]. However, Dyck’s study shows that severe short-term complications may occur in patients with esophageal or head and neck tumors after placement of the introducer PEG tube with T-fasteners, leading to urgent surgical intervention and even death in a substantial number of patients[19]. Why the complication and mortality rates were high in Dyck’s study is unclear. Selection bias may be one reason. Dyck et al. reported that better follow-up of PEG tube daily care might be necessary. In almost all studies, the complication and mortality rates were low. Larger studies on the introducer method in patients with esophageal cancer are needed.

One disadvantage of the introducer method is that only small-diameter balloon-type catheters are available and the requirement for frequent catheter changes when long-term tube feeding is needed[40,41]. The modification of the PEG device using the introducer technique is improved in this respect. It allows for the use of a larger-caliber tube with low complication rates and no procedure-related mortality. The direct method reduces the incidence of catheter changes compared with the 20-French catheter in the standard pull/push method. It is also feasible, safe, and efficient in outpatients with obstructive head and neck cancer. However, procedure-related severe bleeding associated with the direct method has been reported[44].

Timing of PEG tube placement

Cady et al. reported that patients who require therapeutic PEG tube placement in response to significant weight loss during treatment suffer greater morbidity than do patients who receive PEG tubes prophylactically[45]. Patients who have a PEG tube at treatment initiation experience less overall weight loss and fewer hospitalizations and toxicity-related treatment interruptions. However, Locher et al. reported that systematic evidence assessing both the benefits and harm associated with prophylactic PEG tube placement in patients undergoing treatment for head and neck cancer is weak, and the benefits and potential for harm have not been established[26].

Conclusions

An optimal supportive treatment for esophageal carcinoma is not yet available. PEG has many advantages for esophageal cancer, although there is insufficient evidence to determine the optimal method of enteral feeding. Enteral nutrition by the introducer method or the direct method must be studied with an emphasis on the long-term effectiveness and safety of supportive therapy of the esophagus.

References

1. **Pisani P**, Parkin DM, Bray F, Ferlay J. Estimates of the worldwide mortality from 25 cancers in 1990. *Int J Cancer* 1999; **83**: 18-29.
2. **Javle M**, Ailawadhi S, Yang GY, Nwogu CE, Schiff MD, Nava HR. Palliation of malignant dysphagia in esophageal cancer: A literature-based review. *J Support Oncol* 2006; **4**: 365-373.
3. Conigliaro R, Battaglia G, Repici A, De Pretis G, Ghezzo L, Bittinger M, Messmann H, Demarquay JF, Togni M, Blanchi S, Filiberti R, Conio M. Polyflex stents for malignant oesophageal and oesophagogastric stricture: a prospective, multicentric study. Eur J Gastroenterol Hepatol. 2007;19:195-203.
4. Miyata H, Yano M, Yasuda T, Hamano R, Yamasaki M, Hou E, Motoori M, Shiraishi O, Tanaka K, Mori M, Doki Y. Randomized study of clinical effect of enteral nutrition support during neoadjuvant chemotherapy on chemotherapy-related toxicity in patients with esophageal cancer. Clin Nutr. 2012 ;31:330-6.
5. Motoori M, Yano M, Yasuda T, Miyata H, Peng YF, Yamasaki M, Shiraishi O, Tanaka K, Ishikawa O, Shiozaki H, Doki Y. Relationship between immunological parameters and the severity of neutropenia and effect of enteral nutrition on immune status during neoadjuvant chemotherapy on patients with advanced esophageal cancer. Oncology. 2012;83:91-100.
6. Gabor S, Renner H, Matzi V, Ratzenhofer B, Lindenmann J, Sankin O, Pinter H, Maier A, Smolle J, Smolle-Jüttner FM. Early enteral feeding compared with parenteral nutrition after oesophageal or oesophagogastric resection and reconstruction. Br J Nutr. 2005 ;93:509-13.
7. Fujita T, Daiko H, Nishimura M. Early enteral nutrition reduces the rate of life-threatening complications after thoracic esophagectomy in patients with esophageal cancer. Eur Surg Res. 2012;48:79-84.
8. Bozzetti F, Braga M, Gianotti L, Gavazzi C, Mariani L. Postoperative enteral versus parenteral nutrition in malnourished patients with gastrointestinal cancer: a randomised multicentre trial. Lancet 2001;358:1487-92.
9. Wu GH, Liu ZH, Wu ZH, Wu ZG. Perioperative artificial nutrition in malnourished gastrointestinal cancer patients. World J Gastroenterol 2006;12:2441-4.
10. Braga M, Gianotti L, Gentilini O, Parisi V, Salis C, Di Carlo V. Early postoperative enteral nutrition improves gut oxygenation and reduces costs compared with total parenteral nutrition. Crit Care Med 2001;29:242-8.
11. Siersema PD. New developments in palliative therapy. Best Pract Res Clin Gastroenterol. 2006;20:959-78.
12. Homs MY, Kuipers EJ, Siersema PD. Palliative therapy. J Surg Oncol. 2005;92:246-56.
13. Horiuchi A, Nakayama Y, Tanaka N, Fujii H, Kajiyama M. Prospective randomized trial comparing the direct method using a 24 Fr bumper-button-type device with the pull method for percutaneous endoscopic gastrostomy. Endoscopy 2008;40:722-6.
14. Tucker AT, Gourin CG, Ghegan MD, Porubsky ES, Martindale RG, Terris DJ. 'Push' versus 'pull' percutaneous endoscopic gastrostomy tube placement in patients with advanced head and neck cancer. Laryngoscope. 2003;113:1898-902.
15. Foster JM, Filocamo P, Nava H, Schiff M, Hicks W, Rigual N, Smith J, Loree T, Gibbs JF. The introducer technique is the optimal method for placing percutaneous endoscopic gastrostomy tubes in head and neck cancer patients. Surg Endosc. 2007 ;21:897-901.
16. Stockeld D, Fagerberg J, Granström L, Backman L. Percutaneous endoscopic gastrostomy for nutrition in patients with oesophageal cancer. Eur J Surg. 2001;167:839-44.
17. Rabie AS. Percutaneous endoscopic gastrostomy (PEG) in cancer patients; technique, indications and complications. Gulf J Oncolog. 2010;(7):37-41.
18. Yagishita A, Kakushima N, Tanaka M, Takizawa K, Yamaguchi Y, Matsubayashi H, Ono H. Percutaneous endoscopic gastrostomy using the direct method for aerodigestive cancer patients. Eur J Gastroenterol Hepatol. 2012 ;24:77-81.
19. Van Dyck E, Macken EJ, Roth B, Pelckmans PA, Moreels TG. Safety of pull-type and introducer percutaneous endoscopic gastrostomy tubes in oncology patients: a retrospective analysis. BMC Gastroenterol. 2011 ;11:23.
20. Zuercher BF, Grosjean P, Monnier P. Percutaneous endoscopic gastrostomy in head and neck cancer patients: indications, techniques, complications and results. Eur Arch Otorhinolaryngol. 2011;268:623-9.
21. Grilo A, Santos CA, Fonseca J. Percutaneous endoscopic gastrostomy for nutritional palliation of upper esophageal cancer unsuitable for esophageal stenting. Arq Gastroenterol. 2012 ;49:227-31.
22. Corry J, Poon W, McPhee N, Milner AD, Cruickshank D, Porceddu SV, Rischin D, Peters LJ. Randomized study of percutaneous endoscopic gastrostomy versus nasogastric tubes for enteral feeding in head and neck cancer patients treated with (chemo) radiation. J Med Imaging Radiat Oncol. 2008;52:503-10.
23. Sur R, Donde B, Falkson C, Ahmed SN, Levin V, Nag S, Wong R, Jones G. Randomized prospective study comparing high-dose-rate intraluminal brachytherapy (HDRILBT) alone with HDRILBT and external beam radiotherapy in the palliation of advanced esophageal cancer. Brachytherapy. 2004;3:191-5.
24. Homs MY, Eijkenboom WM, Coen VL, Haringsma J, van Blankenstein M, Kuipers EJ, Siersema PD. High dose rate brachytherapy for the palliation of malignant dysphagia. Radiother Oncol. 2003;66:327-32.
25. Nugent B, Lewis S, O'Sullivan JM. Enteral feeding methods for nutritional management in patients with head and neck cancers being treated with radiotherapy and/or chemotherapy. Cochrane Database Syst Rev. 2013;1:1-18
26. Locher JL, Bonner JA, Carroll WR, Caudell JJ, Keith JN, Kilgore ML, Ritchie CS, Roth DL, Tajeu GS, Allison JJ. Prophylactic percutaneous endoscopic gastrostomy tube placement in treatment of head and neck cancer: a comprehensive review and call for evidence-based medicine. JPEN J Parenter Enteral Nutr. 2011;35:365-74.
27. Lin HS, Ibrahim HZ, Kheng JW, Fee WE, Terris DJ. Percutaneous endoscopic gastrostomy: strategies for prevention and management of complications. Laryngoscope. 2001;111:1847-52.
28. Ferguson DR, Harig JM, Kozarek RA, Kelsey PB, Picha GJ Placement of a feeding button ("one-step button") as the initial procedure. Am J Gastroenterol. 1993 ;88:501-4.
29. Maetani I, Tada T, Ukita T, et al. PEG with introducer or pull method: a prospective randomized comparison. Gastrointest Endosc 2003;57:837-41.
30. Brown MC. Cancer metastasis at percutaneous endoscopic gastrostomy stomata is related to the hematogenous or lymphatic spread of circulating tumor cells. Am J Gastroenterol 2000;95:3288-91.
31. Baredes S, Behin D, Deitch E. Percutaneous endoscopic gastrostomy tube feeding in patients with head and neck cancer. Ear Nose Throat J. 2004;83:417-9.
32. Hujala K, Sipilä J, Pulkkinen J, Grenman R. Early percutaneous endoscopic gastrostomy nutrition in head and neck cancer patients. Acta Otolaryngol. 2004;124:847-50.
33. Ehrsson YT, Langius-Eklöf A, Bark T, Laurell G. Percutaneous endoscopic gastrostomy (PEG) - a long-term follow-up study in head and neck cancer patients. Clin Otolaryngol Allied Sci. 2004;29:740-6.
34. Chandu A, Smith AC, Douglas M. Percutaneous endoscopic gastrostomy in patients undergoing resection for oral tumors: a retrospective review of complications and outcomes. J Oral Maxillofac Surg. 2003;61:1279-84.
35. Saunders JR Jr, Brown MS, Hirata RM, Jaques DA. Percutaneous endoscopic gastrostomy in patients with head and neck malignancies. Am J Surg. 1991;162:381-3.
36. Giordano-Nappi JH, Maluf-Filho F, Ishioka S, Hondo FY, Matuguma SE, Simas de Lima M, Lera dos Santos M, Retes FA, Sakai P. A new large-caliber trocar for percutaneous endoscopic gastrostomy by the introducer technique in head and neck cancer patients. Endoscopy. 2011 ;43:752-8.
37. Endoscopy. 2011 ;43:752-8. Brown AS, Mueller PR, Ferrucci JT Jr. Controlled percutaneous gastrostomy: nylon T-fastener for fixation of the anterior gastric wall. Radiology. 1986 ;158:543-5.
38. Robertson FM, Crombleholme TM, Latchaw LA, Jacir NN. Modification of the "push" technique for percutaneous endoscopic gastrostomy in infants and children. J Am Coll Surg. 1996;182:215-8.
39. Wejda BU, Deppe H, Huchzermeyer H, Dormann AJ: PEG placement in patients with ascites: a new approach. Gastrointest Endosc 2005,61:178-180.
40. Dormann AJ, Glosemeyer R, Leistner U, et al. Modified percutaneous endoscopic gastrostomy (PEG) with gastropexy: early experience with a new introducer technique. Z Gastroenterol 2000;38:933-8.
41. Dormann AJ, Wejda B, Kahl S, et al. Long-term results with a new introducer method with gastropexy for percutaneous endoscopic gastrostomy. Am J Gastroenterol 2006;101:1229-34.
42. Shastri JM, Hoepffner N, Tessmer A, Ackermann H, Schroeder O, Stein J: New introducer PEG gastropexy does not require prophylactic antibiotics: multicenter prospective randomized double-blind placebo controlled study. Gastrointest Endosc 2008, 67:620-628
43. Shigoka H, Maetani I, Tominaga K, Gon K, Saitou M, Takenaka Y. Comparison of modified introducer method with pull method for percutaneous endoscopic gastrostomy: prospective randomized study. Dig Endosc. 2012 ;24:426-31.
44. Koide T, Inamori M, Kusakabe A, Uchiyama T, Watanabe S, Iida H, Endo H, Hosono K, Sakamoto Y, Fujita K, Takahashi H, Yoneda M, Tokoro C, Yasuzaki H, Goto A, Abe Y, Kobayashi N, Kubota K, Saito S, Nahajima A. Early complications following percutaneous endoscopic gastrostomy: results of use of a new direct technique. Hepatogastroenterology. 2010;57:1639-44.
45. Cady J. Nutritional support during radiotherapy for head and neck cancer: the role of prophylactic feeding tube placement. Clin J Oncol Nurs. 2007;11:875-80.

Figure Legends

Figure 1

Direct method

1: The transilluminated area on the abdominal wall was pushed with a finger.

2, 3: The stomach was punctured using a double-lumen gastropexy device.

4: A needle with an outer plastic sheath (18-French) was introduced into the stomach under endoscopic control.

5: The needle was removed and the guidewire was replaced.

6, 7: The skin incision was dilated by passing a dilator percutaneously into the stomach over the guidewire under endoscopic visualization.

8: After the dilator was removed, a 24-French PEG tube using an obturator was inserted over the guidewire.

Table 1

Comparison of the advantages and disadvantages of the pull, introducer, and direct PEG placement methods