Communication from the ASGE Technology Committee

TECHNOLOGY STATUS EVALUATION REPORT

Enteral nutrition access devices

The ASGE Technology Committee provides reviews of existing, new, or emerging endoscopic technologies that have an impact on the practice of GI endoscopy. Evidence-based methodology is used, performing a MEDLINE literature search to identify pertinent clinical studies on the topic and a MAUDE (U.S. Food and Drug Administration Center for Devices and Radiological Health) database search to identify the reported complications of a given technology. Both are supplemented by accessing the "related articles" feature of PubMed and by scrutinizing pertinent references cited by the identified studies. Controlled clinical trials are emphasized, but, in many cases, data from randomized, controlled trials are lacking. In such situations, large case series, preliminary clinical studies, and expert opinions are used. Technical data are gathered from traditional and Web-based publications, proprietary publications, and informal communications with pertinent vendors.

Technology Status Evaluation Reports are drafted by 1 or 2 members of the ASGE Technology Committee, reviewed and edited by the committee as a whole, and approved by the ASGE Governing Board. When financial guidance is indicated, the most recent coding data and list prices at the time of publication are provided. For this review, the MEDLINE database was searched through August 2009 for articles related to endoscopy in patients requiring enteral feeding access by using the keywords "endoscopy," "percutaneous," "gastrostomy," "jejunostomy," "nasogastric," "nasoenteric," "nasojejunal," "transnasal," "feeding tube," "enteric," and "button."

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BACKGROUND

Enteral access allows the short- and long-term delivery of nutrients and medications into the GI tract of patients who cannot maintain their needs with oral intake. Enteral nutrition is the preferred means of nutrient delivery for patients with intact and functional GI tracts because it is associated with better clinical outcomes relative to parenteral nutrition, including a lower rate of sepsis.[1,2] In addition to providing enteral nutrition, enteral access may also be used to decompress the upper digestive tract in patients with obstruction not amenable to surgery or refractory gastroparesis.[3]

This review covers the current endoscopic options for enteral access devices including short-term options such as endoscopically placed nasoenteric feeding tubes and long-term solutions such as PEG tubes, PEG with jejunal extension (PEGJ), and direct percutaneous endoscopic jejunostomy (DPEJ) tubes.

TECHNICAL CONSIDERATIONS

Nasoenteric feeding tubes (NETs) are made of silicone or polyurethane. They range from 3.5F to 16F in diameter and 15 to 170 cm in length (Table 1). NETs may be placed unassisted at the bedside or with endoscopic or fluoroscopic guidance. NETs are designed with various features that aid in their placement including removable stylets or guidewires, weighted tips, radiopaque markers, magnets, and suture loops. Double-lumen NETs through which both the stomach and small intestine can be accessed are also available.

There are various endoscopic methods by which NETs can be advanced from the nostril to the small intestine. Some NETs can be placed over a guidewire whereby an endoscope is initially positioned into the jejunum and the guidewire is advanced into the small intestine through the accessory channel. The endoscope is removed leaving the guidewire in place. A thin oronasal transfer tube is placed through a naris into the oropharynx so that one end of the tube exits the mouth and one exits the nose. The guidewire is passed from the mouth up through a naris through the transfer tubing, which is then removed. Finally, the NET is passed over the guidewire into the small intestine.[4] Variations of this technique include first passing the NET into the stomach and advancing it into the jejunum over a guidewire or with a stiffening guidewire in it. The wire is removed once the endoscope is removed from the patient.[5,6]

Alternative methods include the so-called drag and pull method whereby the NET with a suture loop attached at the tip is advanced through a naris into the stomach and dragged into the jejunum with endoscopic forceps. The

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TABLE 1. Nasoenteric tubes

Manufacturer	Device name	Diameter (F)	Length (cm)	Price($)
Abbott Nutrition (Columbus, Ohio)	Enteral feeding tube	8, 10, 12, 14, 16	91, 114	207.80–267.10/box of 10
Cook Endoscopy (Bloomington, Ind)	NJFT	8, 10	240	111.00/each
Corpak Medical Systems (Wheeling, IL)	CORFLO Anti-IV NG	5,6, 8	38, 56	100.00-155.00/box of 10
	CORFLO Ultra lite NG with stylet	5, 6, 8, 10, 12	56, 91, 109, 140	130.00-200.00/box of 10
	CORFLO Ultra lite NG without stylet	5, 6, 8, 10, 12	38, 56, 91, 109	85.50-95.00/box of 10
	CORFLO Ultra lite Clear NG without stylet	5, 6, 8	56	94.50-96.00/box of 10
	CORFLO Ultra Pedi NG	6, 8	56, 91	163.00/box of 10
	CORFLO Ultra NG with stylet	6, 8, 10, 12	91, 109	163.00-188.00/box of 10
	CORFLO Ultra NG without stylet	8, 10, 12	91, 109	134.00-151.00/box of 10
	CORFLO Ultra Pill NG	8, 10	91	175.00-188.00/box of 10
	CORFLO Ultra 7 NG	8, 10 ,12	91	188.00/box of 10
	CORFLO Controller NG	8, 10	109, 140	175.00-201.50/box of 10
	CORFLO Controller Pill NG	8, 10	109, 140	201.50/box of 10
	CORFLO Controller 7 NG	8, 10, 12	109	188.00/box of 10
	CORFLO ENDO/F	10, 12	152	67.00/individual
	CORTRAK Enteral access system NG*	8, 10	91, 109, 140	450.00-460.00/box of 10
Covidien (Mansfield, Mass)	Purple Argyle Indwell tube with safe enteral connector (pediatric)	3.5, 5, 6.5, 8, 10	31, 51, 91, 107	54.54/case of 10
	Purple Argyle Indwell tube (pediatric)	3.5, 5, 6.5, 8, 10	31, 51, 91, 107	53.00/case of 10
	Argyle PVC tube (pediatric)	3.5, 5, 6.5, 8, 10	31, 41, 91, 107	45.44/case of 10
	Curity PVC tube (pediatric)	5, 8	38, 91, 107	33.31/case of 10
	Kangaroo nonweighted feeding tubes	8, 10, 12, 14	91	93.76/case of 10
	Entriflex nasogastric feeding tubes with safe enteral connections	8, 10, 12	91, 109, 140	85.98-100.68/case of 10
	Dobbhoff nasogastric feeding tubes with safe enteral connections	8, 10, 12	109, 140	90.88-101.13/case of 10
	Endo-Tube feeding tube	12	152	66.83/box of 2
Teleflex Medical (Research Triangle Park, NC)	Triple Port Entube 3	8, 10, 12	45	168.33-182.88/box of 10
	Twin Port Entube	8, 10, 12	45	141.03-186.86/box of 10
	Twin Port Entube Plus	8, 10, 12	45, 55	182.88-192.16/box of 10
	Entube pediatric	6	30	112.46-138.38/box of 10

*Magnetic tracking feature to facilitate jejunal advancement.

tube can then be released, or, alternatively, the tube's position can be secured by ligating the suture loop to the small intestinal mucosa by using an endoscopic clip.[7-11] Another variation of the drag and pull method can be performed by using a specially designed NET with a small magnet within the tip that is then directed into the jejunum by using an external magnet.[12,13] Ultrathin endoscopes can be used for transnasal endoscopic placement of a guidewire and NET,[4,14-16] eliminating the need for an oronasal transfer tube. Placement of NETs has also been described through the biopsy channel of a therapeutic gastroscope. At the completion of the procedure, tubes may be bridled at the nose to prevent dislodgment and tube position confirmed by an abdominal radiograph.[17]

PEG tubes are made of silicone or polyurethane. They range from 12F to 28F in diameter (Table 2). Their position is secured internally on the anterior gastric wall by either a bumper or an inflated balloon and externally on the anterior abdominal wall by a bumper or a bolster. External markings on the tube indicate the length of the transabdominal wall tract. Some PEG tubes are designed so they may be removed with traction pull or endoscopically, based on patient and physician preference, whereas others must be removed endoscopically because of their rigid noncollapsible internal bumper. PEG tubes are usually purchased as part of a kit that includes accessories for skin preparation and wound dressing, but some are also available separately. Replacement PEG tubes include low profile, or button tubes, which are designed to extend only to skin level without tubing external to the abdominal wall, and come in variable diameters and lengths (Table 3).

There has been various terminology used in the literature; however, there are 3 basic techniques for PEG tube placement, the peroral pull technique,[18] the peroral push technique,[19] and the direct percutaneous procedure.[20,21] The initial phase of the procedure is similar for all these techniques. Before placement of a PEG tube, intravenous antibiotics are administered to reduce the rate of wound infections.[22] After performing an upper endoscopy, the stomach is insufflated to help bring the gastric wall in apposition to the abdominal wall. A safe location for PEG tube placement is determined by transillumination on the abdominal wall with the endoscopic light and confirmed by finger indentation (typically in the left upper quadrant). The skin at the identified site is then prepped in a sterile fashion. Local anesthetic is injected with a 22- or 25-gauge needle at the skin and along the proposed tract. Endoscopic visualization of the needle should coincide with air aspiration back into the syringe.[23] Air aspiration before endoscopic visualization of the needle may indicate puncture of an adjacent loop of bowel. A 1-cm skin incision is made at the site. Gastric access is achieved with a larger-bore needle, with or without a catheter, and a wire is passed through the access catheter/needle into the stomach.

The peroral pull and push techniques are the most commonly performed PEGs. For these techniques, the wire placed in the stomach is grasped with a snare or forceps and withdrawn out of the patient's mouth along with the endoscope. Pull-type tubes have a nylon or metal loop at the end, which is knotted to the oral end of the wire. The wire is then pulled from the abdominal access site until the attached tube exits the wound and resistance is felt, indicating that the internal bumper is flush with the anterior gastric wall. For push-type tubes, the guidewire is passed through the central lumen of the entire feeding tube. The tube is advanced over the guidewire while maintaining guidewire control from the patient's mouth until the tube exits the abdominal wound. The tube is pulled into position similar to the pull technique. Many PEG tubes have external centimeter markings indicating the distance from the internal bumper, which further assists with ensuring correct positioning of the tube.

The percutaneous direct technique uses a tract dilator and introducer tube that is advanced percutaneously over the guidewire into the stomach while the endoscope is maintained in the stomach for visualization and air insufflation. The apposition of the stomach to the abdominal wall can be further secured by using T fasteners, which are placed through separate percutaneous needle punctures of the stomach. The PEG tube is then advanced into the stomach through this introducer, which is then removed before the tube is secured.[21] Low-profile or button tubes are placed in a manner similar to that of the direct percutaneous method. When placing low-profile devices, it is important to measure the distance from the skin to the anterior gastric wall (the tract length) to choose the correct length tube. For challenging cases, PEG tubes can also be placed in combination with laparoscopy.[24,25]

Once the PEG tube is in place, note is made of its position at the skin and an external bolster is placed to the level of the skin. The tube is then trimmed to an appropriate length (typically 15-20 cm) and adaptors are placed on the end of the tube to facilitate connection with the source feeding tubing or syringe. Postplacement endoscopy to confirm adequate PEG tube placement may be performed for pull and push type PEG tubes according to physician preference.[26,27]

PEG tubes can be converted to PEGJ tubes for jejunal feeding. Jejunal extension tubes are inserted through certain larger diameter PEG tubes (Table 4).[28-30] These PEGJ tubes are available as a single kit. Extension tubes are also available individually. Extension jejunal tubes measure 9F to 12F in diameter and are approximately 60 cm in length. The extension tube is grasped endoscopically with a forceps or a snare and dragged into the jejunum[31] or advanced over an endoscopically placed guidewire or stiffening catheter.[32,33] An ultrathin endoscope (either through a 28F PEG tube or through a mature abdominal wall tract) can also be used to

place the guidewire into the jejunum.[34,35] Endoscopic clips have been used to anchor the tubes and prevent retrograde migration.[7,36] Fluoroscopy may be used to aid with tube and guidewire positioning. The final tube position is usually confirmed with abdominal radiographs.

DPEJ tubes are another endoscopic alternative for jejunal feeding.[37] DPEJ tubes are actually PEG tubes that are placed in the jejunum. A pediatric colonoscope or enteroscope is advanced into the small bowel. As with PEG tube placement, a safe jejunal access site is identified by both endoscopic visualization of finger indentation and adequate skin transillumination. Once a site has been identified, a small-gauge needle can be passed into the lumen and secured with a snare to prevent migration of the jejunal loop away from the abdominal wall and to aid with insertion of a larger needle or trocar immediately adjacent to the anchoring needle. A guidewire, with adequate length to accommodate the increased distance from the jejunum to the mouth, is then inserted through the larger needle. Subsequent steps are similar to pull PEG tube placement.

INDICATIONS

Enteral feeding tubes are primarily used in patients with intact GI tracts who are unable to maintain appropriate oral caloric intake and need short-term (eg, NETs) or long-term (eg, PEG, PEGJ, DPEJ) nutrition support. The indications for enteral feeding tube placement include impaired swallowing caused by neurologic conditions or head/facial trauma, luminal obstruction from malignancy or other strictures, motility disorders such as gastroparesis, and hypercatabolic states such as cystic fibrosis, extensive burn injury, and Crohn's disease. Jejunal feeding tubes are primarily used to provide postpyloric nutrition to minimize aspiration of gastric contents or when obstruction or motility disorders prevent gastric feeding. Enteral tubes are also used for hydration and medication administration, and PEG tubes may also be used for gastric decompression in the setting of severe gastroparesis or nonoperable intestinal obstruction.[38]

CLINICAL EFFICACY AND EASE OF USE

PEG tube placement is a part of the standard endoscopic training and widely performed. Current guidelines specify that at least 15 procedures be performed before assessing competence.[39] Training in the placement of NET, PEGJ, and DPEJ may be variable depending on the staff experience and resources, and there are insufficient data to specify the minimum procedure volume before competence assessment. DPEJ tubes should be limited to individuals with substantial enteroscopy and gastrostomy experience.[40] Technical challenges with placement of these tubes are primarily identifying safe access sites rather than the use of the tubes themselves.

The success rate of endoscopic transnasal and transoral NET feeding tube placement ranges from 86% to 97%.[4,10,11,14,15,41] Procedure times range from 12 to 40 minutes.[43,43] Insertion success rate and procedure times seem to improve with experience,[15] although this is not uniformly true.[44] Endoscopic placement requiring oronasal transfer tubing can be cumbersome and time-consuming.[45] The reported average length of time that NETs stay in place is 7 to 24 days, with a reported range of 1 to 94 days.[4,14-16,41,46-48] Successful placement may be limited by anatomic features such as the size of the nares[45] and pyloric and duodenal abnormalities, particularly when transnasal endoscopy is used.[4] For instance, insufficient stiffness of ultrathin endoscopes may prevent jejunal intubation in patients with pyloric stenosis.[4] Accidental or purposeful tube dislodgment is common, particularly in the very young, elderly, or disoriented,[41,49] and the need for repeated insertion of tubes can be demanding for caregivers.[47] Bridling the tube to the nose may help prevent dislodgment.[43] Finally, small-caliber tubes are also prone to clogging or kinking.[41,45,47,48]

PEG tube placement has a success rate as high as 99.5% (range 76%-100%).[50-52] Reasons for failure include inadequate transillumination, complete oropharyneal or esophageal obstruction, and gastric resections. The success rate for low-profile PEG tube placement is reported to be lower.[53] The procedure is generally performed by two or more physicians, although the procedure has been reported to be safe with 1 physician[54] and with nurse assistants.[48] Simulator training does not seem to improve PEG tube insertion rates.[55] PEG tube placement is generally done safely as an outpatient procedure,[56] and the average life span of tubes is 1 to 2 years, with tube degradation being the most common reason for tube replacement.[57]

PEGJ tubes have a high success rate, as high as 93%.[9,58] In one study, the mean functional duration of the tubes was 55 days.[9] Unfortunately, retrograde dislodgment of the jejunal extension tube is common and can occur in 33% of cases.[58] Securing the jejunal tube with endoscopic clips may help prevent displacement.[9] In children, PEGJ tubes have been used with success but require frequent tube changes (mean 2.2 per patient [range 1-14]).[59,60] In one study, the tubes had a median functional duration of 39 days with a range of 2 to 474 days. The most common reasons for tube changes were displacement (31%) and tube obstruction or mechanical failure (41%).[59]

Although considered to be a modification of PEG tubes, DPEJ tubes are considerably more challenging to place.[37,61,62] Technical success ranges from 68% to 98%.[37,58,61-64] Success has been reported to be higher in patients with altered surgical anatomy.[58,63,65] In addition, use of an access wire, selective use of fluoroscopic guidance, use of general anesthesia, and placement in patients

TABLE 2. PEG tubes and replacement PEG tubes

Manufacturer	Device name	Diameter (F)	Internal Bumper	Price ($)
Abbott Nutrition	Easy-Feed gastrostomy tube	16, 18, 20, 22	Balloon	29.94/each
	Gastrostomy tube	20	Balloon	69.00/each
	Magna-Port gastrostomy tube	14, 16, 18, 20, 22, 24, 26	Balloon	38.42/each
Applied Medical Technology (Cleveland, Ohio)	Balloon gastrostomy tube	12, 14, 16, 18, 20, 24	Balloon	26.25/each
	Suture Monarch nonballoon replacement gastrostomy tube	12, 14, 18, 20	Bumper	63.00/each
	Capsule Monarch nonballoon replacement gastrostomy tube	12, 14, 18, 20	Bumper	72.50/each
Bard Access Systems (Salt Lake City, Utah)	Ponsky PEG, safety deluxe kit, pull	20	Bumper	410.00/case
	Ponsky PEG, safety deluxe kit, push	20	Bumper	431.00/case
	Ponsky PEG, nonsafety deluxe kit, pull	20	Bumper	378.00/case
	Ponsky PEG, nonsafety deluxe kit, push	20	Bumper	399.00/case
	Ponsky PEG, safety deluxe kit, pull	28	Bumper	420.00/case
	Ponsky PEG, safety deluxe kit, push	28	Bumper	441.00/case
	Ponsky PEG, nonsafety standard kit, pull	20	Bumper	357.00/case
	Ponsky PEG, nonsafety standard kit, push	20	Bumper	378.00/case
	Ponsky-Gauder PEG, nonsafety standard kit, pull	20	Bumper	347.00/case
	Ponsky PEG, nonsafety standard kit, push	20	Bumper	378.00/case
	Bard Trifunnel replacement gastrostomy tube	12, 14, 16, 18, 20, 22, 24	Balloon	110.00/case
Boston Scientific (Natick, Mass)	EndoVive safety PEG	20, 24	Bumper	80.00
	EndoVive standard PEG	20, 24	Bumper	80.00
Conmed (Utica, NY)	Entake PEG safety, push	14, 18, 20, 24	Bumper	225.00/each
	Entake PEG safety, pull	14, 18, 20, 24	Bumper	225.00/each
	Entake PEG standard, push	14, 18, 20, 24	Bumper	170.00/each
	Entake PEG standard, pull	14, 18, 20, 24	Bumper	170.00/each
	Entake Trifunnel replacement gastrostomy tube	14, 18, 20, 24	Balloon	56.00/each
Cook Medical	Flow 20 pull method	18.61	Bumper	295.00/box of 2
	Flow 20 pull method, safety sharps kit	18.61	Bumper	205.00/box of 2
	Flow 20 push method	18.61	Bumper	295.00/box of 2
	Flow 20 push method, safety sharps kit	18.61	Bumper	205.00/box of 2
	PEG 24 pull	24	Bumper	295.00/box of 2
	PEG 24 pull, safety sharps kit	24	Bumper	205.00/box of 2
	PEG 24 push	24	Bumper	295.00/box of 2
	PEG 24 push, safety sharps kit	24	Bumper	205.00/box of 2
	Balloon replacement gastrostomy tube	14, 18, 24		226.00/box of 5

TABLE 2. (continued)

Manufacturer	Device name	Diameter (F)	Internal Bumper	Price ($)
Corpak Medical Systems	CORFLO Max PEG kit, conical, pull	20*	Inflatable bumper (cone)	264.00/box of 2
	CORFLO Max PEG kit, basic components tray, conical, pull	20	Inflatable bumper (cone)	232.00/box of 2
	CORFLO Max safety PEG kit, conical, pull	20	Inflatable bumper (cone)	284.00/box of 2
	CORFLO Max Safety PEG kit, conical, push	20	Inflatable bumper (cone)	284.00/box of 2
	CORFLO Max PEG kit, conical, push	20*	Inflatable bumper (cone)	264.00/box of 2
	CORFLO Max PEG kit, ring, pull	12,* 16, 20*	Inflatable bumper (ring)	264.00/box of 2
	CORFLO Max PEG kit, basic components tray, ring, pull	12, 16, 20	Inflatable bumper (ring)	232.00/box of 2
	CORFLO Max Safety PEG kit, ring, pull	12, 16	Inflatable bumper (ring)	284.00/box of 2
	CORFLO Max PEG kit, ring, push	12, 16, 20*	Inflatable bumper (ring)	264.00/box of 2
	CORFLO dual gastrostomy tube	12, 14, 16, 18, 20, 22, 24	Balloon	118.00/box of 2
	CORFLO triple gastrostomy tube	16, 18, 20, 22, 24	Balloon	124.00/box of 2
Covidien	Dobbhoff percutaneous endoscopic gastrostomy safety PEG kit, pull	16, 20	Bumper	222.75-317.73/box of 2
	Entristar percutaneous endoscopic gastrostomy safety PEG kit, pull	16, 20	Bumper	200.48/box of 2
	Entristar percutaneous endoscopic gastrostomy safety kit, push	20	Bumper	244.63/box of 2
	Kangaroo gastrostomy feeding tubes with Y ports		Balloon	93.76/box of 2
Kimberly-Clark Health Care (Roswell, Ga)	MIC gastrostomy feeding tubes	12, 14, 16, 18, 20, 22, 24, 26, 28, 30	Balloon	47.25/each
	MIC bolus gastrostomy feeding tubes	12, 14, 16, 18, 20, 22, 24	Balloon	47.25/each
	MIC PEG feeding tube kit, push method	14, 20, 24	Balloon	108.05/each
	MIC PEG feeding tube kit, pull method	14, 20, 24	Balloon	108.05/each
	MIC safety PEG feeding tube/kit, push method	14, 20, 24	Balloon	148.84/each
	MIC safety PEG feeding tube/kit, pull method	14, 20, 24	Balloon	148.84/each
Teleflex Medical	Twin port Gilsdorf gastrostomy tube	12, 14, 46, 18, 20, 22, 24	Balloon	140.11/box of 5
	Triple port gastrotomy tube	12, 14, 46, 18, 20, 22, 24	Balloon	172.86/box of 5
US Endoscopy (Mentor, Ohio)	Safety PEG	20	Bumper	350.00/box of 2
	Pull PEG	20, 24	Bumper	250.00/box of 2
	Guidewire PEG	20	Bumper	250.00/box of 2
	Nonballoon replacement PEG	20	Bumper	90.00/box of 2

*Available with a prepackaged snare for an additional $4.00.

Table 3. Low-profile systems

Manufacturer	Product	Diameter (F)	Internal bumper	Length (cm)	Price ($) (each)
Abbott Nutrition	Hide-a-Port Flush Tip Low Profile gastrostomy kit	16, 18, 20, 24	Balloon	1.5, 1.7, 2.0, 2.7, 3.0, 3.5	85
Applied Medical Technology	Mini Classic balloon button	12, 14, 16, 18, 20, 24	Balloon	0.8, 1.0, 1.2, 1.5, 1.7, 2.0, 2.3, 2.5, 2.7, 3.0, 3.5, 4.0, 4.4, 5.0, 5.5, 6.0, 6.5	90
	Mini ONE balloon button	12, 14, 16, 18, 20, 24	Balloon	0.8, 1.0, 1.2, 1.5, 1.7, 2.0, 2.3, 2.5, 2.7, 3.0, 3.5, 4.0, 4.4, 5.0, 5.5, 6.0, 6.5	90
	Mini ONE Nonballoon Button	14, 18, 20, 24	Bumper	1.0, 1.2, 1.5, 1.7, 2.0, 2.5, 3.0, 3.4, 4.4	145
	Mini ONE Capsule nonballoon button	14, 18, 20, 24	Capsule	1.0, 1.2, 1.5, 1.7, 2.0, 2.5, 3.0, 3.4, 4.4	165
	Nonballoon button (Bard equivalent)	18, 24	Bumper	1.2, 1.5, 1.7, 2.4, 2.8, 3.4, 4.3, 4.4, 5.4	132
Bard Access System	Bard button gastrostomy tube	18, 24	Bumper	1.2, 1.7, 2.4, 3.4, 4.4	216
		28	Bumper	1.5, 2.7, 4.3	216
Boston Scientific	EndoVive Low Profile PEG	18, 24	Bumper	1.2, 1.7, 2.4, 3.4, 4.4	80
Cook Endoscopy	Passport-24	24	Bumper	1.2, 1.7, 2.4, 3.4, 4.4	197
	Passport-20	20	Bumper	1.2, 1.7, 2.4, 3.4, 4.4	197
Corpak Medical Systems	CORFLO-cuBBy	12, 14, 16, 18, 20, 24	Balloon	1, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5	204
Covidien	NutriPort skin level gastrostomy kits with safe enteral connections	12, 14, 16, 18, 20, 24	Balloon	0.8, 1, 1.2, 1.5, 1.7, 2.0, 2.3, 2.5, 2.7, 3.0, 3.5, 4.0. 4.5, 5.0	89.10
Kimberly-Clark	MIC-KEY Low profile gastrostomy feeding tube/kit	12, 14, 16, 18, 20, 24	Balloon	0.8, 1, 1.2, 1.5, 1.7, 2.0, 2.3, 2.5, 2.7, 3.0, 3.5, 4.0	109

with a lower body mass index have all been associated with higher success rates.[64,66,67] Obesity (body mass index ≥30) and an abdominal wall thickness greater than 3 cm on CT are associated with lower success rates of placement and increased morbidity.[67-69] Inability to transilluminate or bypass luminal obstructions are also associated with placement failure.[37,58,61-64] Physician experience may also play a role in the success rate,[58] although this has not been uniformly true.[63] Placement of DPEJ tubes seems to be feasible and well tolerated in children,[70] but current data are limited.

COMPARATIVE DATA

Placement options for NETs include blind placement at the bedside or placement by fluoroscopy or endoscopy. There is no comparison of endoscopic NET and blind placement, which has a very low success rate for jejunal

Table 4. Gastrojejunal tubes and jejunonstomy extension tubes

Manufacturer	Name	Diameter (F)	Length (cm)	Price($)
Cook Endoscopy	PEGJ	12, 24	60, 95	221.00/box of 2
Covidien	EntriStar™ Gastro-jejunostomy tubes	20, 9(jej)	89	143.43/box of 2
	Dobbhoff™ Jejunal feeding/gastric decompression system	22, 24, 9 (jej)	89	175.00 - 177.00/box of 2
Kimberly-Clark	MIC Transgastric-jejunal feeding tubes	16, 18, 22	15, 22, 30, 45	219.08/each
	MIC-KEY low-profile transgastric-jejunal tubes kit	16, 18, 22	15, 22, 30, 45	331.43/each
	MIC Gastro-enteric feeding tubes	16, 18, 20, 22, 24, 26, 28, 30	25.4, 57.9	168.53/each
Jejunal extensions				
Abbott Nutrition	Over-the-Guidewire Jejunal tube	8, 12	60	63.49/each
Bard Access	Jejunal feeding/gastric decompression tube- pull (through Bard PEGs)	9, 12	69	208.00/case
	Jejunal feeding/gastric decompression tube- push (through Bard PEGs)	9, 12	89	275.00/case
ConMed	Entake™ J-tube Pull	9, 12	89	56.00/each
	Entake™ J-tube Push	9, 12	89	56.00/each
Cook Endoscopy	Flow 20® Jejnual	9	60	221.00/box of 2
	PEG 24® jejunal	12	60	221.00/box of 2
Corpak Medical Systems	CORFLO®-ULTRA Jejunal tubes (use for 20Fr CORFLO-MAX PEG)	6, 8, 10	91	275.00/box of 5
Kimberly-Clark	MIC-Key Low-Profile Jejunal feeding tubes	14, 18	22-45	168.53/each
	MIC jejunal feeding tube	12, 14, 16, 18, 20, 22, 24	25.4-57.9	129.20/each

jej, Jejunal portion; *PEGJ*, PEG with jejunal extension.

access.[71] Two prospective, randomized studies comparing transnasal endoscopic and fluoroscopic nasoenteric tube placement found equal success with both techniques (≥90%) but had conflicting results about which procedures were shorter in duration.[15,42] A prospective, randomized study of 160 patients compared transnasal ultrathin endoscopy and standard endoscopy.[16] Transnasal procedures required less time and less sedation and had fewer cardiopulmonary events. Although a previous study found it may occasionally be difficult to advance an ultrathin endoscope through the pylorus and duodenum, this study found no difference in jejunal access (86% vs 82%).[4,16]

A randomized trial compared 2 common polyurethane NETs (which differed in weighted tip and general stiffness) placed endoscopically by dragging the tube from the esophagus into the small intestine. The stiffer tube was placed in the jejunum more frequently, although the difference was not statistically significant. The more flexible tube required a significantly longer procedure time and had a lower nursing satisfaction because of more frequent leaking and dislodgment.[44]

With regard to aspiration risk, a retrospective study suggested that NET placement may be associated with a higher incidence of pneumonia relative to PEG tube placement.[72] However, a prospective study showed equal rates of aspiration pneumonia with NET postpyloric and intragastric feeding.[73]

Several studies compared the performance of pull and direct percutaneous PEG tubes. Three studies (N = 340) had equal success rates[74-76] and procedure length,[74,76] but the incidence of peristomal infections was significantly lower for the direct method as opposed to the pull method.[74,76] This was true for procedures performed without antibiotic prophylaxis as well.[77] The visual analogue pain scores were also lower for the direct method.[76]

In children, low-profile PEG tubes may yield some advantages relative to standard PEG tubes. A retrospective review of 223 children showed no difference between operative time, intraoperative complications, clogging,

breakage, infections, emergency department visits, or hospital readmissions between the 2 PEG tubes. However, pediatric patients with low-profile PEG tubes were more likely to have shorter hospital stays and fewer tube dislodgments than those with standard PEG tubes.[78]

Several reports compared techniques of PEG tube insertion. Two randomized trials comparing surgical gastrostomy tube placement with PEGs (pull) demonstrated equal success rates for placement.[79,80] A more recent study demonstrated that the PEG group had a shorter average procedure duration (15 minutes vs 35 minutes, $P < .001$) and a decreased rate of complications (42.9% vs 74.3%) compared with the surgical group.[80] The 30-day mortalities were not statistically different.[79,80] A systematic review comparing PEG with radiologic gastrostomy tube placement (N = 2379) in head and neck cancer patients observed a similar pooled fatality rate (2.2% vs 1.8%) between the 2 groups and a slight increase in major complications (7.4% vs 8.9%) for the radiologic group.[52] Another meta-analysis evaluating the effectiveness and safety of radiologic, endoscopic, and surgical gastrostomies described higher success rates with radiologic techniques relative to endoscopic procedures (99.2% vs 95.7%, $P < .001$) and equal success rates with radiologic and surgical techniques (99.2% vs 100%).[81] Major complications occurred less frequently after radiologic gastrostomies than PEG or surgical gastrostomy (5.9% vs 9.4% PEG group vs 19.9% surgical group, $P < .001$). The 30-day mortality rate was highest for surgery (2.5% vs 0.3% radiologic group and 0.53% PEG group, $P < .001$).

Comparisons between DPEJ and PEGJ tube placement show a lower success rate for DPEJ tubes (65.4%-73% vs 89.7%-95%).[58,82] Tube dislocation occurred significantly more often with the PEGJ tube.[82] Although there was no difference in the incidence of short-term complications, DPEJ tube was associated with fewer long-term complications and longer tube patency.[82]

SAFETY

Complications related to NETs include patient discomfort, sinusitis, epistaxis, tube malposition, reflux esophagitis, esophageal injury including pressure ulcers, and diarrhea.[83-85] Aspiration pneumonia may occur in as many as 89% of patients, and studies have shown no clear advantage with nasoenteric feeds when compared with nasogastric feeds.[5,14,73,86-89]

For PEG, there is roughly a 0.5% procedure-related death rate and overall 16.7% complication rate.[77,90,91] The complication rate has been reported to be higher in patients with head and neck cancer than with patients without cancer. The difference is thought to be caused by airway compromise,[52,92] which can be prevented by a tumor assessment protocol.[92] Mortality often is related to comorbidities rather than the placement of the PEG tube itself.[93,94] There seems to be no difference in complication rates between patients on steroids and those not on steroids.[95] In the pediatric population, there seems to be equal short-term safety for endoscopic PEGs and surgical gastrostomies with or without fundoplication.[96] There are conflicting data regarding the safety and an increased complication rate of PEG tube placement in children with ventriculoperitoneal shunts.[97,98] Case reports have described the safe use of PEG and PEGJ tubes in pregnant women.[99-101]

Complications associated with PEG tube placement include wound infections, injury to adjacent organs, gastrocolonic fistula, and bleeding. Postprocedure pneumoperitoneum has a reported incidence of 5.4%, but most cases are benign and not considered a complication. Clinical signs of peritonitis require surgical exploration.[102] Other clinical predictors of the need for laparotomy include higher body mass index (>30) and low serum albumin (<2.5 g/dL). The combination of these 2 factors increases the likelihood of laparotomy by 25-fold.[103] Wound infections at the PEG site are common. A recent multicenter study identified 4 independent risk factors for peristomal infections including clinical institutionalization, size (15F > 9F), experience of the endoscopist (<100 procedures), and the existence of an underlying malignant disease.[104] Other risk factors include excessive traction on the tube.[105] Antibiotics have been shown to reduce the frequency of infection.[106,107] Injuries to adjacent organs associated with PEG tube placement are rare and include enterocutaneous and gastrocolonic fistulae, small-bowel or gastric volvulus, small-bowel obstruction, liver injury, and splenic laceration.

The delayed complications associated with PEG tube use include peristomal pain, necrotizing fasciitis, buried bumper syndrome, peristomal leakage, GI bleeding and ulceration, gastric outlet obstruction, ileus, gastroparesis, bowel volvulus, PEG tube dislodgment, diarrhea, and tumor seeding. Buried bumper, retraction of the internal bumper into the tract with complete or partial closure of the luminal portion of the tract, occurs in 2% to 6% of patients.[108] Patients with a buried bumper usually present with the inability to infuse through the tube, leakage, and abdominal pain. The migrated PEG should be removed and replacement can be performed through the existing tract.[108] A combination push-pull technique has been proposed for this complication in children.[109] Abdominal wall and stoma metastases have been reported after pull-type or push-type PEG tube placement in patients with oropharyngeal and esophageal cancers. Risk factors include large tumor size, poorly differentiated tumors, advanced tumor stage, and squamous cell histology.[110]

In addition to those related to PEG tubes, complications of PEGJ tubes include those associated with the jejunal extension tubes. The most common is retrograde tube migration.[59,60] Others include tube obstruction, tube fracture, perforation, peristomal leakage, diarrhea, and small-bowel intussusceptions.[60,111,112] Feeding through a PEG or a PEGJ tube does not reduce the incidence of aspiration.[113-115] Aspiration is thought to be related to intragastric pressure.[116]

For DPEJ, complications have been reported in 19% to 95% of patients.[63,65,117,118] In the largest reported case se-

ries, severe perioperative complications occurred in 4.2% of all cases and included bowel perforations, bleeding, jejunal volvulus, and aspiration.[63] Three of these complications occurred at the time of tube removal. There was 1 DPEJ tube–related death caused by hemorrhage. Four other deaths in the study were thought to be possibly related to the DPEJ tube. Moderate complications defined as nonurgent endoscopy or surgery and/or hospitalization occurred in 5.9% of patients.[63] These included enterocutaneous fistulae, pain, site infections, hematoma, aspiration pneumonia, and partial buried bumper.[63] Minor adverse events occurred in 14% of patients and included site infections, pain, and adverse response to sedation.[63] Among the long-term complications related to DPEJ, tube failure (blockage, breakage, leaking) is the most commonly reported.[117,119] Other complications include abdominal pain, peristomal infection, fever, ileus, enteric ulcers bleeding, abdominal wall abscess, and colon perforations.[61,118] The incidence of aspiration pneumonia may decrease in high-risk patients after DPEJ tube placement.[120]

FINANCIAL CONSIDERATIONS

For NET, endoscopy is more cost-effective than blind placement when postpyloric feeding is the goal.[121] Procedure-related costs related to endoscopic gastrostomy placement are 10-fold more than costs related to nasogastric tubes[122] and 44% more than those related to radiologic placement,[123] but less than the costs of surgical placement.[79,124] Antibiotics given before PEG tube placement have been shown to be cost-effective.[125] No cost-effective analyses have been published for DPEJ or PEGJ. Device costs are listed in Tables 1 through 4.

Table 5 lists appropriate CPT (Current Procedural Terminology)* coding related to endoscopic enteric feeding tube placement.

TABLE 5. CPT codes for enteral feeding tubes

CPT code	Description
Primary tube placement, endoscopic procedures	
43241	EGD with transendoscopic intraluminal tube or catheter placement (including nasoenteric tube)
43246	EGD with directed placement of percutaneous gastrostomy tube
44372	Small intestinal endoscopy beyond duodenum with placement of percutaneous jejunostomy tube
44373	Small intestinal endoscopy with conversion of percutaneous gastrostomy tube to percutaneous jejunostomy tube
Tube changes and repositionings, nonendoscopic	
43760	Change of gastrostomy tube, percutaneous without imaging or endoscopic guidance
43761	Repositioning gastric tube to duodenum (if PEG performed same day, report with 43246 and report 43761-59) (report 76000 for imaging guidance, if performed)
Tube placement and repositionings, with fluoroscopy	
43752	Naso- or orogastric tube placement requiring physician skill, includes fluoroscopy
49440	Insertion of gastrostomy tube percutaneously under fluoroscopic guidance
49441	Insertion of duodenostomy or jejunostomy tube, percutaneously under fluoroscopic guidance
49446	Conversion of gastrostomy tube to gastrojejunostomy tube, percutaneously under fluoroscopic guidance
49450	Replacement of gastrostomy tube, percutaneously under fluoroscopic guidance
49451	Replacement of duodenostomy or jejunostomy tube, percutaneously under fluoroscopic guidance
49452	Replacement of gastrojejunostomy tube, percutaneously under fluoroscopic guidance
Other	
49460	Mechanical removal of obstructive material from gastrostomy, duodenostomy, or jejunostomy (or other enteric tube) by any method under fluoroscopic guidance
E&M codes	Unclogging tube at bedside, no fluoroscopy; removal of tube at bedside, no replacement; troubleshooting tube malfunction

E&M, Evaluation and management.

AREAS FOR FUTURE RESEARCH

Studies to clarify risk stratification and predictors of morbidity or mortality would help physicians and patients choose the most appropriate route of enteral access. Improved techniques to establish and maintain jejunal access as well as clarification of the role of jejunal feeding tubes in preventing aspiration are also needed.

SUMMARY

Multiple endoscopic techniques are available for enteral access and feeding. There are significant differences in the success rates, complication rates, and costs of various routes and devices used for enteral feeding. The choice and route should be individualized according to

the patient's clinical condition, comorbidities, prognosis, and physician preference.

Abbreviations: DPEJ, direct percutaneous endoscopic jejunostomy; NET, nasoenteric feeding tube; PEGJ, PEG with jejunal extension.

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