Communication from the ASGE Technology Committee

TECHNOLOGY STATUS EVALUATION REPORT

Enteroscopy

Prepared by: ASGE TECHNOLOGY COMMITTEE

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This document was reviewed and approved by the Governing Board of the American Society for Gastrointestinal Endoscopy.

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 adverse events 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 cases, 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 Governing Board of the ASGE. 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 October 2014 for articles related to endoscopy in patients by using the key words "enteroscopy," "enteroscope," "overtube," "double-balloon," "single-balloon," "spiral," "intraoperative," and "push pull" paired with "endoscopy," "small intestine," and "small bowel."

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BACKGROUND

Enteroscopy refers to endoscopic examination of the small intestine. Although limited small-bowel evaluation is undertaken during EGD and is possible during colonoscopy, enteroscopy typically refers to more extensive endoscopic examination of the small intestine, extending into the jejunum and/or ileum. Diagnostic evaluation of the small bowel can be performed by noninvasive imaging (CT or magnetic resonance enterography) or by wireless capsule endoscopy (WCE). Whereas these modalities currently lack therapeutic ability, they often precede and serve to guide and direct therapy via enteroscopy. WCE was discussed in a previous ASGE Technology Committee document.[1] This document will focus on endoscopes, devices, and techniques used for enteroscopy and represents an update of a previous ASGE Technology Status Evaluation Report titled "Enteroscopes."[2]

TECHNOLOGY UNDER REVIEW

Push enteroscopy

This procedure may be performed with a specifically designed enteroscope or by using a colonoscope with or without an overtube. Typically evaluation is limited to the proximal jejunum.

Device-assisted enteroscopy

Deeper evaluation of the small bowel can be accomplished with enteroscopes coupled with a specialized overtube apparatus. The procedure can be performed via an antegrade approach (via the mouth) or via a retrograde approach (via the anus). In the United States, current options for device-assisted enteroscopes include double-balloon enteroscopy (DBE), single-balloon enteroscopy (SBE), and spiral enteroscopy. A newer through-the-scope

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TABLE 1. Technical specifications of enteroscopes

Endoscope make/model	Type	Length, mm	Outer diameter, mm	Working inner channel, mm	Field of view	Overtube required	List price, $
Fujinon							
EN-450T5	DBE scope	2300	9.4	2.8	140°	Yes	55,250
EN-450T5/W	DBE scope	2300	9.4	2.8	140°	Yes	Not available in the U.S.
EN-450P5/20	DBE scope	2300	8.5	2.2	120°	Yes	51,350
EC-450BI5	DBE scope	1820	9.4	2.8	140°	Yes	37,900
Olympus							
SIF-Q180	SBE scope	2000	9.2	2.8	140°	Yes	46,400
Pentax							
VSB-3430K	PE	2200	11.6	3.8	140°	No	41,400

DBE, Double-balloon enteroscopy; *SBE*, single-balloon enteroscopy.

balloon-assisted device that allows "on-demand" enteroscopy is also available.

Intraoperative enteroscopy

This is a technique in which an endoscope is inserted orally or via an enterotomy and is guided through the small bowel with surgical assistance.

TECHNICAL CONSIDERATIONS

Certain general principles and techniques applicable to all forms of enteroscopy deserve consideration. Foremost, mucosal inspection should be accomplished during both insertion and withdrawal because minor mucosal abrasions caused by instrumentation can mimic vascular or inflammatory lesions. Second, the use of fluoroscopy to assess enteroscope and/or overtube position, and advancement varies and depends on many factors including the type of enteroscopy being performed, the approach (antegrade vs retrograde), the indication, and endoscopist preference. Although fluoroscopy was widely used previously, many endoscopists currently perform enteroscopy without fluoroscopic guidance. Finally, an important variable is the use of CO_2 for insufflation rather than air because studies specific to enteroscopy have shown enhanced insertion depth and better patient tolerance with CO_2 insufflation.[3-6] The technical specifications of push and device-assisted enteroscopes and overtubes are listed in Tables 1 and 2.

Push enteroscopes

Push enteroscopy may be performed with dedicated enteroscopes or by using colonoscopes. Push enteroscopes are longer versions of standard endoscopes with a working length of 200 to 250 cm, external diameters of 10.5 to 11.7 mm, and channel diameters of 2.8 to 3.8 mm. However, the length of the instrument does not necessarily correlate with deeper insertion or improved diagnostic yield.[7] The use of overtubes has been proposed to allow for greater insertion depth during push enteroscopy; however, it is again unclear whether this results in a greater diagnostic yield.[8-10] Overtubes are not routinely used because of greater patient discomfort and reported adverse events related to their use.[9-12] Overtubes have been detailed in a separate ASGE Technology Committee document.[13]

Technique. The endoscope is introduced through the mouth and advanced into the small bowel as far as possible until looping limits forward progression. Torque and withdrawal are performed to reduce loops, and the endoscope is then re-advanced and the process is repeated. If the endoscope cannot be advanced further with these maneuvers, patient position can be changed and abdominal pressure can be applied. If a variable-stiffness colonoscope is used, stiffening of the instrument may allow further advancement. In procedures in which an overtube is used, it is backloaded up to the hub of the endoscope before insertion. The endoscope is then advanced to the second or third portion of the duodenum, and loop reduction is then performed. The overtube is then advanced to the level of the tip of the endoscope, and the endoscope is then re-advanced further. Fluoroscopy may guide loop reduction, assessment of endoscope position, and advancement.

Device-assisted enteroscopy

Double-balloon enteroscopes. DBE was first introduced in 2001 and was developed for evaluation of the entire jejunum and ileum. DBE uses a specially coupled enteroscope and overtube apparatus with latex balloons mounted on the distal ends of each component. The balloons are intended to anchor the endoscope in position during insertion to allow for pleating of the bowel over the endoscope shaft, reducing loop formation and allowing for greater insertion depth. Three DBE systems are currently available. The most commonly used system is an enteroscope with a 9.4-mm diameter, a 2.8-mm working channel, and a 200-cm working length (EN-450T5; Fujinon, Saitama, Japan). DBE systems designed with a smaller

TABLE 2. Technical specifications of enteroscope overtubes

Overtube make/model	Type	Length, mm	Outer diameter, mm	Inner diameter, mm	Balloon diameter, mm	Scope compatibility	List price, $
Fujinon							
TS-12140	DBE overtube	1450	12.2	10	40	EN-450P5/20	226.50
TS-13140	DBE overtube	1450	13.2	10.8	40	EN-450T5, EN-450T5/W	226.50
TS-13101	DBE overtube	1050	13.2	10.8	40	EC-450BI5	226.50
Olympus							
ST-SB1	SBE overtube	1320	13.2	11	40	SIF-Q180	276.50
Spirus Medical		Total length/spiral length, mm		Spiral height, m			
Endo-Ease Discovery Standard profile	Spiral enteroscopy	1180/220	14.5	9.8	5.5	SIF-Q180 EN-450T5 EN-450T5/W EN-450P5/20 EC-450BI5	495
Endo-Ease Discovery low profile	Spiral enteroscopy	1180/220	14.5	9.8	4.5	SIF-Q180 EN-450T5 EN-450T5/W EN-450P5/20 EC-450BI5	495
Endo-Ease Vista Retrograde	Spiral enteroscopy	1000/220	17.4	13	5	Pediatric colonoscope	395

DBE, Double-balloon enteroscopy; *SBE*, single-balloon enteroscopy.

diameter (EN-450P5/20) and shorter length (EC-450BI5) are detailed in Table 1. The smaller diameter system may be used for pediatric patients and for diagnostic procedures in adults. The shorter length system has been used to perform ERCP in patients with postsurgical anatomy.

The soft overtube of the most commonly used DBE system (EN-450T5; Fujinon) has a length of 145 cm, an outer diameter of 13.2 mm, and a specifically designed pump for inflating and deflating the latex balloon at its tip. Additional available overtubes used with the smaller diameter and shorter length DBE enteroscopes are detailed in Table 2.

A balloon pump controller (PB-20; Fujinon) controls the internal dilation pressure of both enteroscope and overtube balloons, monitoring it and setting it at 5.6 kPa. Increased pressure within the balloon triggers an alarm. If the alarm is not acknowledged and silenced by the endoscopist or assistant, autodeflation of both balloons occurs.

Technique. DBE is a 2-person procedure, requiring an endoscopist and an assistant. After the overtube is loaded onto the enteroscope, a soft latex balloon is attached to the tip of the enteroscope. The balloons are deflated at the initiation of the procedure. For the antegrade approach, the endoscope and overtube are advanced to the duodenum past the major papilla, and the overtube balloon is inflated to maintain a stable position. The enteroscope is then advanced up to 40 cm distal to the overtube tip, and its balloon is inflated to anchor the enteroscope. The overtube balloon is then deflated, and the overtube is advanced toward the tip of the enteroscope. The overtube balloon is then reinflated such that the entire apparatus is secured to the intestine with both balloons inflated. The enteroscope-overtube apparatus is then retracted simultaneously so as to pleat the intestine along the overtube like an accordion. This sequence is repeated, and the device is advanced through the intestine in 40-cm increments (Fig. 1). When the desired or maximum insertion distance is reached, a submucosal tattoo is often placed to mark the distal extent of the evaluation.

Withdrawal of the apparatus is generally performed in short segments to allow for careful mucosal inspection. Withdrawal is initiated with the endoscope balloon inflated and the overtube balloon deflated. After withdrawal of the overtube, the overtube balloon is reinflated. Endoscope retraction is always performed with the overtube secured by its inflated balloon to prevent uncontrolled loss of depth of insertion.[14,15] A circumferential white marking on the enteroscope 140 cm proximal to the balloon represents a marker beyond which the overtube should not be advanced or the enteroscope withdrawn. This is to prevent the overtube from shearing off the enteroscope balloon during insertion or withdrawal (Fig. 2). DBE was often performed previously with fluoroscopic guidance, although this is currently less commonly used.

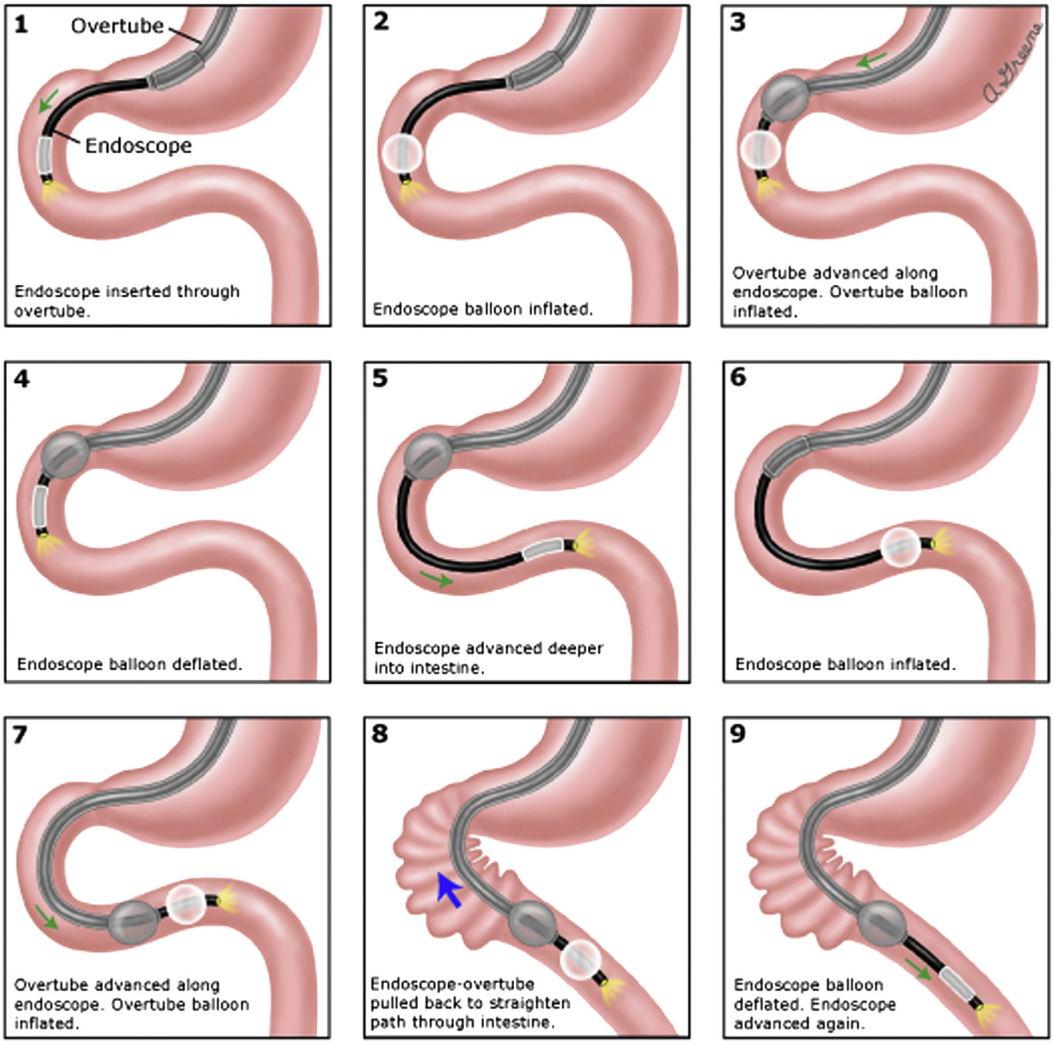

Figure 1. Double-balloon enteroscopy technique. (Reproduced with permission from Kita H. Overview of deep small bowel enteroscopy. In: UpToDate, Post TW (Ed), UpToDate, Waltham, Mass. (Accessed on April 29, 2014.) Copyright © 2015 UpToDate, Inc. For more information, visit www.uptodate.com.

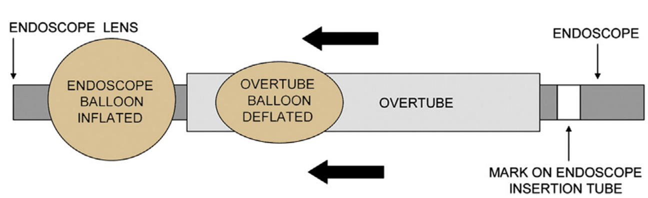

Figure 2. Double-balloon enteroscopy. (Reprinted from ASGE Technology Committee, DiSario JA, Petersen BT, Tierney WM, et al.[2])

For retrograde DBE, a colonoscopy preparation is required. The enteroscope and overtube are advanced to the cecum either directly or by using the previously described push-pull technique. With the overtube balloon inflated, the enteroscope is advanced across the ileocecal valve and its balloon inflated within the ileum. The overtube is then advanced into the ileum with its balloon deflated. Subsequently, the advancement steps are identical to those of the antegrade DBE technique previously described. DBE may allow *complete enteroscopy*, defined as endoscopic evaluation of the entire small bowel with a single approach or by combining antegrade and retrograde approaches.

Single-balloon enteroscopes. SBE was introduced in 2007, and it uses an enteroscope with an overtube (SIF-Q180; Olympus America Inc, Center Valley, Pa) and an electronic balloon inflation control device that allows automatic pressure control. In contrast to DBE, only the disposable overtube has a nonlatex balloon at its distal end. The enteroscope has a working length of 200 cm, an outer diameter of 9.2 mm, and a 2.8-mm diameter working channel. The overtube (ST-SB1; Olympus) is 140 cm long with a 13.2-mm outer diameter, and its distal end has an inflatable silicone balloon. The balloon is controlled by pressing buttons on the front panel of the Olympus balloon control unit or on a remote control. The balloon pressure is regulated to 5.4 kPa. The internal surface of the overtube is hydrophilic, and lubrication between the outer surface of the enteroscope and the inner surface of the overtube is facilitated by flushing the internal surface of the overtube with water.

Technique. The technique for SBE is similar to that for DBE. The overtube is backloaded onto the enteroscope, and the enteroscope is advanced as far as possible into the small bowel, then anchored by using its flexible tip (as opposed to enteroscope tip balloon-assisted anchoring used in DBE). Subsequently, the overtube is advanced with its balloon deflated to the tip of the enteroscope. The overtube balloon is then inflated while keeping the enteroscope tip flexed. The entire apparatus is then withdrawn to allow pleating of the small bowel over the enteroscope and overtube. The enteroscope is then re-advanced while keeping the overtube balloon inflated to prevent slippage of the proximal bowel that has been pleated on the overtube. When the enteroscope cannot be advanced further, its tip is again flexed to anchor the enteroscope. The overtube balloon is then deflated, and the overtube is again advanced to the tip of the enteroscope. This sequence is repeated until the apparatus has advanced to the maximal, or to the desired extent within the small intestine (Fig. 3). The point of final enteroscope advancement can be marked with a submucosal tattoo.

Spiral enteroscopes. Spiral enteroscopy was developed in 2007 potentially to provide a simpler and faster technique compared with balloon-assisted enteroscopy. It uses a disposable overtube with a soft raised spiral ridge that is designed to pleat the small bowel. The overtube is 118 cm long with soft raised spiral helix at its distal end that is either 4.5 mm (low profile) or 5.5 mm (standard profile) in height. The overtube is compatible with enteroscopes that are 200 cm in length and between 9.1 and 9.5 mm in diameter. Two different overtubes are available for antegrade (Endo-Ease Discovery SB; Spirus Medical Inc, Stoughton, Mass) or retrograde (Endo-Ease Vista; Spirus Medical Inc) examinations. The overtube has a coupling device on its proximal end that affixes itself to the enteroscope. This allows for free rotation of the overtube independent of the enteroscope but prevents independent movement of the enteroscope (advancement or withdrawal) relative to the overtube. When the overtube is uncoupled, the enteroscope can then be advanced or withdrawn independent of the overtube. A motorized spiral enteroscopy system is in development.

Technique. Two operators are required to perform the procedure: an endoscopist and an assistant to operate the overtube. Before insertion, the inner lining of the overtube is generously lubricated with the proprietary lubricant supplied with the device. The overtube is then backloaded onto the enteroscope so that about 20 cm of the enteroscope protrudes past the distal tip of the overtube. When the overtube and enteroscope are coupled, the overtube should be rotated clockwise for advancement and counterclockwise for withdrawal. For antegrade examination, the overtube and enteroscope are advanced slowly with clockwise rotation of the overtube until the enteroscope tip ideally reaches the ligament of Treitz. It is important to minimize insufflation of air or CO_2, which decreases the chance of loop formation in the stomach and allows for better contact of the spiral helix to the small intestine to initiate movement and pleating of the intestine onto the overtube. Resistance to rotation of the overtube is usually due to loop formation in the stomach. This can be countered by continued slow clockwise rotation of the overtube while gently pulling back (withdrawing) the overtube. This reduction maneuver along with application of external abdominal pressure or splinting can be used to advance the overtube-enteroscope unit into the small intestine. When resistance to further clockwise overtube rotation is encountered and deeper advancement is not thought to be possible, the enteroscope can be uncoupled from the overtube and further advanced to its maximal depth. Withdrawal of the enteroscope is performed by pulling back the enteroscope so that its tip is 20 cm distal to the overtube tip. At this point, it is recoupled, and further withdrawal is done by counterclockwise rotation of the overtube. For retrograde examinations, the technique is similar to antegrade examination.

On-demand enteroscope. The NaviAid (SMART Medical Systems Ltd, Ra'anana, Israel) is a newer device that consists of a disposable balloon component that is advanced through the working channel of an endoscope or colonoscope (NaviAid AB and NaviAid ABC) and an air supply unit. The NaviAid AB has a working length of 350 cm with a balloon diameter of 40 mm. The minimum endoscope working channel diameter needed for passage of the device is 3.8 mm. The inflation/deflation of the balloon is controlled by an air supply unit, and balloon pressure is regulated at 6 kPa. The balloon device can be advanced through the instrument channel of the endoscope only when deep enteroscopy is needed. It does not require any specific premounting or preprocedural preparation.

Technique. The procedure technique is conceptually similar to balloon-assisted enteroscopy with an overtube. The balloon is advanced beyond the tip of the endoscope through its instrument channel and inflated to anchor itself to the small intestine. Subsequently, repetitive push-pull maneuvers are performed with the endoscope sliding over the catheter as a rail until it reaches the inflated balloon distally. The balloon catheter can be removed to allow for therapeutic interventions as needed and reinserted for further advancement.

Intraoperative enteroscopy. Intraoperative enteroscopy is the most invasive of the enteroscopy techniques but can allow for complete evaluation of the small intestine. Due to significant advancements in noninvasive imaging and device-assisted enteroscopy, it is performed less

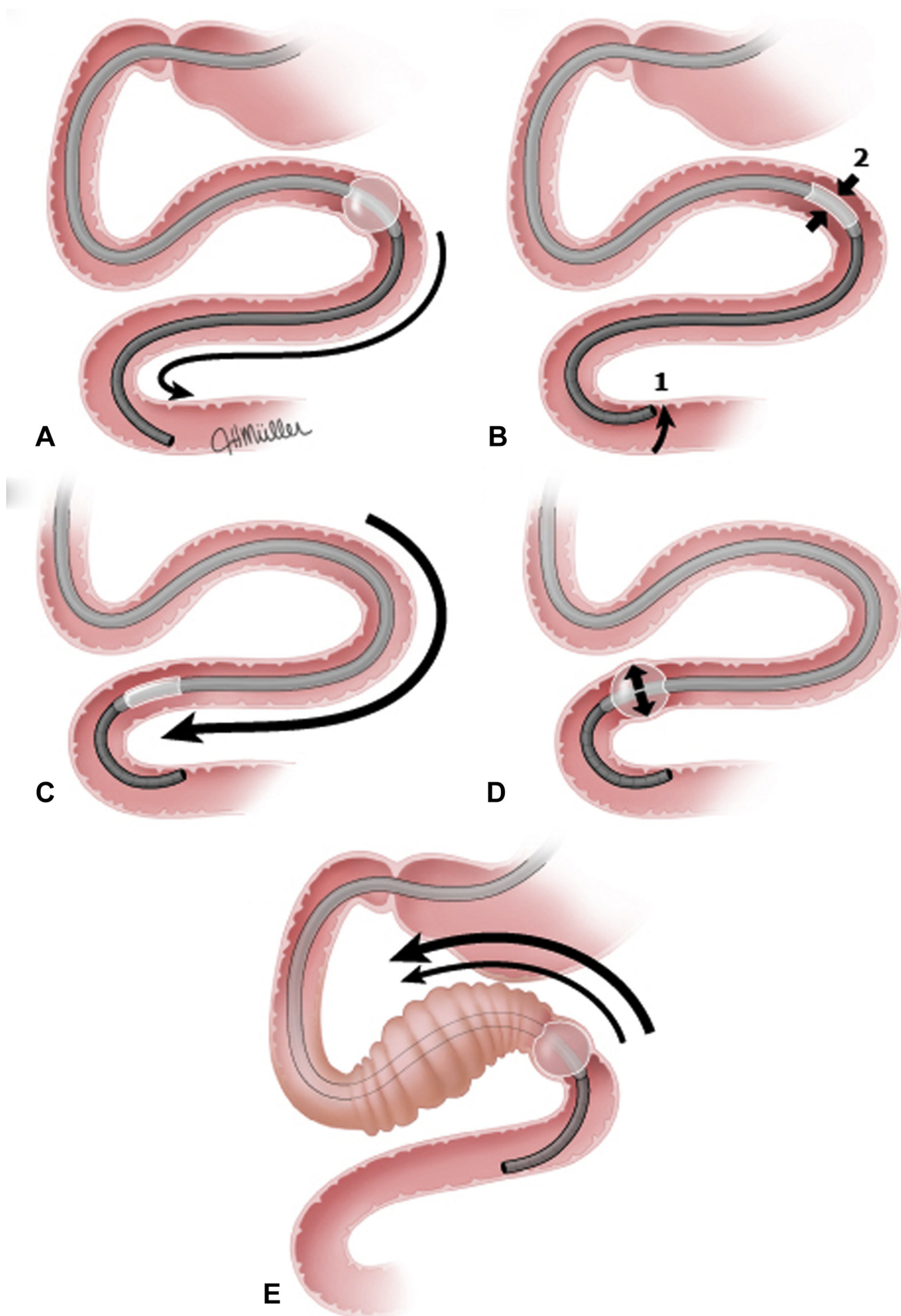

Figure 3. Single-balloon enteroscopy technique. **A**, With the balloon at the tip of the overtube inflated to anchor the small bowel, the enteroscope is advanced as deeply into the small bowel as possible (except for the initial insertion, when the enteroscope is advanced with the overtube balloon deflated). **B**, Once forward motion is no longer possible, the tip of the enteroscope is agulated to create a "hook" (*1*) that will help anchor the enteroscope. Once the small bowel is anchored by the tip of the enteroscope, the overtube balloon is deflated (*2*). **C**, The overtube is advanced to the end of the enteroscope. **D**, The overtube balloon is inflated to anchor the small bowel. **E**, Both the enteroscope and the overtube are gently withdrawn to pleat the small bowel onto the overtube. The enteroscope is then advanced as in **A**, and the process is repeated until forward progress with the enteroscope is no longer possible or the area of interest within the small bowel is reached. (Reproduced with permission from Kita H. Overview of deep small bowel enteroscopy. In: UpToDate, Post TW (Ed), UpToDate, Waltham, Mass. (Accessed on April 29, 2014.) Copyright © 2015 UpToDate, Inc. For more information, visit www.uptodate.com.)

frequently. The technique can be quite variable with regard to the location of endoscope insertion, the type of endoscope used, and the approach to intra-abdominal access (laparotomy vs laparoscopy). It is performed in the operating room with the assistance of a surgical team while the endoscopist performs the enteroscopy. The surgeon pleats segments of intestine over the enteroscope via a laparotomy or with laparoscopic techniques. Lesions can be treated endoscopically or marked for surgical resection.[16-23]

INDICATIONS

The most common indication for all types of enteroscopy is the diagnosis and/or therapy of obscure overt or occult intestinal bleeding, ie, bleeding without an etiology found on standard upper endoscopy and colonoscopy with terminal ileoscopy.[8] Other indications include evaluation of imaging abnormalities raising concern for small-bowel Crohn's disease, strictures, ulcers, celiac disease, malabsorption, polyps, masses, lymphoma, and other infiltrative diseases.[24-30] Therapeutic indications in addition to hemostasis include polypectomy, retrieval of foreign bodies, enteral stricture dilation, placement of jejunal feeding tubes, treatment of early postoperative small-bowel obstruction, and performance of ERCP in patients with postsurgical anatomy.[8,24-34]

EFFICACY AND COMPARATIVE STUDIES

Push enteroscopy

Push enteroscopy offers the advantage of wide availability because it does not require specialized equipment or training. Currently, it is usually performed for investigation of upper small-bowel lesions up to the proximal jejunum as determined by previous imaging or not within reach of standard EGD. The average depth of intubation at push enteroscopy can be estimated from reports without standardized methodologies. The extent of jejunal intubation has been reported to be approximately 45 to 60 cm beyond the ligament of Treitz with a colonoscope, 25 to 63 cm with an enteroscope, and 46 to 80 cm with an enteroscope through an overtube.[7,9,35-42] The diagnostic yield of push enteroscopy for obscure GI bleeding ranges from 20% to 80%.[43] However, many lesions found during push enteroscopy are within reach of a standard gastroscope,[44] and the true diagnostic yield of push enteroscopy may be more in the 15% to 40% range.[45] Overt bleeding has been found to be predictive for positive findings at push enteroscopy, which can change management in 40% to 75% of patients in this setting.[46-51] Studies evaluating long-term outcomes of patients undergoing push enteroscopy have shown conflicting results. One study indicated that recurrent rebleeding occurs in 33% of patients, with a trend toward frequent rebleeding in patients with angioectasias.[52] Some studies indicate that therapy of angioectasias can reduce transfusion requirements and improve quality of life,[50,53-55] but others have not shown similar results.[56,57]

Several studies compared push enteroscopy with WCE. In compiled comparative studies that included 216 patients with bleeding of unknown origin or suspected small-bowel disease, a diagnosis was made with push enteroscopy in 29% of patients and with WCE in 68% of patients.[38-40,58-60] Clinical management was changed in 9% and 39% of patients diagnosed with push enteroscopy and WCE, respectively.[39,40,58] In 2 series, all lesions diagnosed by push enteroscopy were also seen by WCE, but most of the lesions seen by WCE and not by push enteroscopy were distal to the reach of the enteroscope.[39,58] However, in a study of patients with familial adenomatous polyposis, push enteroscopy detected many more polyps than WCE, even though the latter examined far more of the intestine. WCE did not visualize the ampulla of Vater in all patients and missed many polyps larger than 10 mm as well as large submucosal tattoos.[61] In a separate study with follow-up of 1 year or more after diagnosing small-bowel disease, the sensitivity and specificity of push enteroscopy were 48% and 80%, respectively, and for WCE, they were 92% and 69%, respectively ($P < .01$).[62] Meta-analysis data also indicate that capsule endoscopy is superior to push enteroscopy for the diagnosis of small-bowel pathology, with a 35% to 40% incremental yield and a number needed to treat of 3.[63,64]

Double-balloon enteroscopy

Most published data on balloon-assisted enteroscopy come from DBE studies. Most studies have focused on patients with obscure GI bleeding, but a few have compared DBE with other small-bowel imaging modalities.[14,15,24,28,42,65-73] The mean reported procedure times range from 73 to 123 minutes.[24,65,71,74,75] The estimated depth of insertion for the antegrade approach is reported to be between 220 to 360 cm and for the retrograde approach between 124 to 183 cm.[24,65,71,74,75] Reported rates of complete enteroscopy vary widely. Whereas Japanese studies have reported complete enteroscopy rates in the 70% to 86% range, Western series have generally reported lower rates.[14,65,74-80] Reported diagnostic yields have ranged from 40% to 80%, with therapeutic yields of 15% to 55%.[24,65,71,74,75,81] A large study of 2245 DBEs performed in 1765 patients revealed that diagnostic yield varied with the indication. Rates were highest for patients with Peutz-Jeghers syndrome and lowest when the indication for the procedure was diarrhea.[79] In patients with angioectatic lesions, DBE has been shown to allow effective treatment, although recurrent bleeding is common.[82,83] In 1 study of 50 patients, 88% of whom were treated for angioectasias and followed for a mean duration of 55 months, mean hemoglobin levels increased from a pretreatment level of 7.6 to 11.0 g/dL after treatment. There was an associated significant decrease in transfusion requirements. However, the rebleeding rate was 48% in patients treated with argon plasma coagulation.[82] In another study of 98 patients with treated angioectasias, rebleeding occurred in 46% of patients at 36 months. Factors associated with increased rates of rebleeding were the presence of a larger number of angioectasias and underlying cardiac disease.[83]

Some studies compared DBE with capsule endoscopy and push enteroscopy. A comparative meta-analysis of DBE and capsule endoscopy indicated a similar yield of clinically significant small-bowel findings (60% and 57%).[84] Comparison of DBE and push enteroscopy indicates a superior diagnostic yield with DBE that is thought to be related to higher rates of complete small-bowel visualization.[42,66]

Single-balloon enteroscopy

The efficacy of SBE is generally similar to that of DBE. Reported diagnostic yields have ranged from 41% to 65% and therapeutic yields from 7% to 50%.[85-94] The reported range for depth of insertion is 133 to 270 cm for antegrade examinations and 73 to 199 cm for retrograde examinations.[86,89,91,92,94] Studies suggest that the rate of total enteroscopy with SBE may be lower than that with DBE by 0% to 24%.[86-88,93] This may be because of the difficulty in maintaining enteroscope position in the small bowel as the overtube is advanced due to lack of a specific anchoring mechanism for the SBE enteroscope.

Spiral enteroscopy

Reports on spiral enteroscopy suggest decreased procedure times compared with balloon-assisted enteroscopy.[92,95-99] Data from 3 studies including a total of 183 patients (of whom 171 successfully underwent the procedure) indicated mean depths of insertion ranging from 175 to 262 cm, mean procedure times of 34 to 37 minutes, and diagnostic yields of 12% to 59%.[95-97] With regard to diagnostic yield, in 1 of these studies, the primary indication was diarrhea; hence, the diagnostic yield was low at 12%.[96] The other 2 studies indicated diagnostic yields of 33% and 59%.[95,97]

A comparison study of WCE and spiral enteroscopy in 56 patients who had positive capsule findings indicated that the yield of spiral enteroscopy was 54%. The type of finding on capsule endoscopy was associated with reproducibility on spiral enteroscopy, with fresh bleeding being the most reproducible, followed by angioectasias.[100] Another study that examined long-term outcomes in 78 patients who underwent spiral enteroscopy for obscure GI bleeding found that deep small-bowel spiral enteroscopy was safe and effective and led to a statistically significant reduction in the incidence of overt bleeding from 62% to 26%.[101]

On-demand enteroscopy

Preliminary studies of the on-demand enteroscopy system report mean antegrade insertion depths of 120 to 190 cm with mean procedure times of 15.5 to 52 minutes.[102-105] Data on retrograde examinations revealed a mean depth of insertion of 89 to 110 cm.[103,105] Only 1 study reported the mean procedure time for retrograde examinations, which was 31 minutes.[103] The mean diagnostic and therapeutic yield for antegrade examinations is reported to be 45% and 36%, respectively, and for retrograde examinations, 59% and 47%, respectively.[103]

Intraoperative enteroscopy

With oral intubation or enterotomy, most of the small bowel can be examined. In a series of 23 patients examined with oral endoscope insertion with surgical assistance via a laparotomy, the ileocecal valve was visualized in 13, the distal ileum in 7, and the proximal ileum in 3 patients.[106] The diagnostic yield for intraoperative enteroscopy has been reported to be approximately 86% and ranges from 58% to 100%.[16-23] For occult GI bleeding, surgical resection and/or endoscopic therapy are usually performed when the source is identified.[17-23,106] In a comparative study that included 47 patients with bleeding, a diagnosis was made in 72% with intraoperative enteroscopy and in 74% with WCE.[107]

Comparative studies of device-assisted enteroscopy

Few studies have directly compared DBE, SBE, and spiral enteroscopy. Parameters evaluated have included depths of insertion, rates of complete enteroscopy, procedure times, clinical outcomes, learning curves, and safety.[80,87,92-94,108-112] Currently, there are no comparative data for the on-demand enteroscopy system. Procedure-related data and clinical outcomes from studies comparing DBE, SBE, and spiral enteroscopy are summarized in Tables 3 and 4.

Depth of insertion. Assessment of depth of insertion has been limited by varying definitions and methodology for measurement of insertion depth in different studies. One DBE simulator study estimated the efficacy of each push and pull maneuver and compared it with overtube insertion length. It was estimated that every 5 cm of overtube advancement was equivalent to 40 cm of small-bowel visualization.[78] In a randomized, controlled trial of 66 DBEs and 53 SBEs, the mean insertion depth was 234.1 cm and 203.8 cm, respectively, via the antegrade approach ($P = .0176$). For the retrograde approach, the mean insertion depths were 75.5 cm and 72.1 cm for DBE and SBE, respectively ($P = .0835$).[108] Another multicenter randomized, controlled trial compared 65 DBE and 65 SBE procedures. The study indicated similar mean depths of insertion for DBE and SBE for both antegrade (253 cm vs 258 cm) and retrograde (107 cm vs 118 cm) approaches.[94] A retrospective study comparing DBE with SBE indicated that although mean insertion depths for the antegrade approach were higher for DBE (245 cm vs 218 cm, $P < .001$), they were similar for the retrograde approach.[112]

TABLE 3. Comparative device-assisted enteroscopy procedure-related data

Author	Design	Patient no.	Depth of insertion (cm), antegrade vs retrograde		Procedure time (min), antegrade vs retrograde		Overall adverse event rate, %
DBE vs SBE							
Efthymiou et al[108] (2012)	RCT	66 vs 53	234 vs 204	75 vs 72	60 vs 60		1.5 vs 1.8
Domagk et al[94] (2011)	RCT	65 vs 65	253 vs 258	107 vs 118	105 vs 96		0
May et al[87] (2010)	RCT	50 vs 50	–	–	67 vs 54	62 vs 60	4 vs 8
Lenz et al[112] (2013)	Retrospective	1052 vs 515	245 vs 218	–	50 vs 40	55 vs 46	0
DBE vs spiral							
Rahmi et al[109] (2013)	Prospective	191 vs 50	200 vs 220	–	60 vs 55	–	24 vs 18
Messer et al[80] (2013)	RCT	13 vs 13	346 vs 268	209 vs 78	60 vs 43	76 vs 52	23 vs 23 (1 perforation in retrograde spiral)
May et al[110] (2011)	RCT	10 vs 10	310 vs 250	–	65 vs 43	–	–
Frieling et al[111] (2010)	Prospective	17 vs 18	260 vs 250	–	42 vs 47	–	0
SBE vs spiral							
Khashab et al[92] (2010)	Retrospective	52 vs 53	222 vs 301	–	53 vs 47	–	3.8 vs 1.9 (1 perforation in single-balloon)

DBE, Double-balloon enteroscopy; *SBE*, single-balloon enteroscopy; *RCT,* randomized, controlled trial; –, data not reported.

TABLE 4. Comparative device-assisted enteroscopy clinical outcomes

Author	Design	No. of procedures	Diagnostic yield, %	Therapeutic yield, %
DBE vs SBE				
Efthymiou et al[108] (2012)	RCT	66 vs 53	53 vs 57	26 vs 32
Domagk et al[94] (2011)	RCT	65 vs 65	43 vs 37	9 vs 5
Takano et al[93] (2011)	RCT	20 vs 18	50 vs 61	35 vs 27.8
May et al[87] (2010)	RCT	50 vs 50	52 vs 42	72 vs 48
Lenz et al[112] (2013)	Retrospective	1052 vs 515	48.2 vs 61.7	–
DBE vs spiral				
Messer et al[80] (2013)	RCT	13 vs 13	46 vs 69	92
Frieling et al[111] (2010)	Prospective	17 vs 18	47.1 vs 33.4	–
SBE vs spiral				
Khashab et al[92] (2010)	Retrospective	52 vs 53	59.6 vs 43.4	33 vs 15

DBE, Double-balloon enteroscopy; *SBE*, single-balloon enteroscopy; *RCT,* randomized, controlled trial; –, data not reported.

With respect to comparing insertion depth of DBE and spiral enteroscopy, results have been inconsistent, likely related to the small size of some of the studies. A prospective, randomized, controlled trial of 10 patients each in DBE and spiral enteroscopy groups showed greater insertion depth for DBE compared with spiral enteroscopy (310 cm vs 250 cm, $P = .004$).[110] Another small randomized, controlled trial of 13 patients each in DBE and spiral enteroscopy groups again indicated superiority of DBE over spiral enteroscopy for antegrade and retrograde approaches. The antegrade insertion depths were 346 cm for DBE and 268 cm for spiral enteroscopy ($P = .006$). Retrograde insertion depths were 209 cm and 78 cm for DBE and spiral enteroscopy, respectively ($P = .001$).[80] However, in a larger prospective comparative study of 191 patients undergoing DBE and 50 patients undergoing spiral enteroscopy, the mean antegrade insertion depths were similar (200 cm for DBE and 220 cm for spiral enteroscopy, $P = .13$).[109]

A retrospective study comparing 52 patients undergoing SBE with 53 patients undergoing spiral enteroscopy indicated that the antegrade insertion depth in the SBE group was much lower than that in the spiral enteroscopy group (222 cm vs 301 cm, $P < .001$).[92]

Despite findings of the aforementioned studies, a systematic review indicated that the depth of insertion with the antegrade approach for all 3 types of device-assisted enteroscopy is similar (DBE, 239 ± 24.3 cm; SBE, 233 ± 31 cm; spiral enteroscopy, 236 ± 23 cm).[113]

Complete enteroscopy

The rates of complete enteroscopy have also been used as a metric to compare device-assisted enteroscopy platforms. A prospective study comparing DBE and SBE for achieving complete enteroscopy as a primary outcome reported 57% and 0% rates of complete enteroscopy for DBE and SBE, respectively. Despite the widely different rates of complete enteroscopy, no differences were noted in the diagnostic and therapeutic yield in both groups.[93] A further prospective study comparing DBE and SBE with 50 patients in each group also indicated that the rate of complete enteroscopy was significantly higher in the DBE group compared with the SBE group (66% vs 22%, $P < .0001$). However, this study also indicated a higher therapeutic yield with DBE compared with SBE (72% vs 48%, $P = .025$).

A small prospective study compared DBE and spiral enteroscopy in 26 patients. DBE achieved complete enteroscopy in 92% of patients compared with only 8% in the spiral enteroscopy group ($P < .05$).[80]

In general, the clinical impact of complete small-bowel visualization has remained controversial[113-115] because diagnosis and therapy can often be accomplished without the need for complete enteroscopy. Furthermore, using complete enteroscopy as a comparative parameter for device-assisted enteroscopy studies is problematic because it is not always clear whether complete enteroscopy was attempted in studies or whether it was a primary measure of outcome. Nevertheless, it appears that complete enteroscopy rates are highest with DBE compared with SBE and spiral enteroscopy.[113] However, whether or not this metric reliably reflects increased diagnostic or therapeutic yields remains debatable.[114,116]

Procedure times

The duration of enteroscopy can be affected by many issues including patient factors such as obesity, surgical history, and intra-abdominal adhesions, and technical factors such as endoscopist expertise. Few studies have directly compared procedure times for device-assisted enteroscopy methods. A retrospective study comparing SBE and spiral enteroscopy reported no significant differences in procedure times (53 minutes for SBE vs 47 minutes for spiral enteroscopy, $P = .2$).[92] A systematic review of device-assisted enteroscopy studies reported mean antegrade procedure times for DBE, SBE, and spiral enteroscopy to be 72 minutes, 60 minutes, and 41 minutes, respectively, and mean retrograde procedure times to be 85 minutes, 69 minutes, and 46 minutes, respectively.[113] Thus, procedure times appear to be shorter for spiral enteroscopy compared with the 2 balloon-assisted methods.

Clinical outcomes

The components of clinical outcomes reported include diagnostic and therapeutic yields. In 4 randomized, controlled trials comparing DBE and SBE, the diagnostic yield for both groups ranged from 40% to 60%.[87,93,94,108] The therapeutic yield for both methods was similar in 3 studies,[93,94,108] but the fourth study indicated a higher therapeutic yield for DBE compared with SBE (72% vs 48%, $P = .025$).[87] Comparison of DBE and spiral enteroscopy in small studies has shown no difference in diagnostic and therapeutic yields.[80,111] Similarly, the only study comparing SBE with spiral enteroscopy indicated similar diagnostic and therapeutic yields.[92] The results of these studies are summarized in Table 4. Systematic reviews of all 3 device-assisted enteroscopy methods indicated similar diagnostic and therapeutic yields and similar clinical outcomes.[113,117]

Learning curve. No studies have directly compared the 3 device-assisted enteroscopy modalities. Improvements in procedural times and extent of visualized small bowel have been reported after the initial 10 to 15 procedures in studies of balloon-assisted enteroscopy.[75,118] Spiral enteroscopy may have the shortest learning curve because of its relative ease of use and reported effective operation after performing as few as 5 training cases.[96]

Enteroscopy-assisted ERCP

ERCP in postsurgical anatomy poses a special challenge for endoscopists. With the advent of device-assisted enteroscopy, several studies have evaluated the utility of enteroscopy in facilitating ERCP.[119-124] Whereas a complete discussion of this topic is beyond the scope of this document, a systematic review of 945 procedures (DBE, SBE, and spiral enteroscopy–assisted ERCP) in 679 patients reported an overall ERCP success rate ranging from 70% to 90%.[125] The success rates were highest in patients with Billroth II anatomy and lowest in patients with Roux-en-Y gastric bypass anatomy. The overall ERCP success rate for all procedures was reported to be 74%.[125]

EASE OF USE

Push enteroscopy

Push enteroscopy by using a colonoscope offers the advantages of ready availability and ease of use because it requires no special training. In addition, it is well tolerated with moderate conscious sedation and does not require general anesthesia routinely. Use of a dedicated push enteroscope and overtube makes the procedure more cumbersome. Fine maneuvering of the tip of the enteroscope is more difficult, air insufflation may be compromised by air escaping through the overtube, and there can be spillage of fluid from the proximal overtube hub around the enteroscope. Average reported procedure times are approximately 30 minutes.[7,35,36] Inadvertent loss of position occurs frequently.

Double-balloon enteroscopy

DBE has technical nuances that require specialized training. Furthermore, 2 operators are required for the procedure. The procedures are lengthy and potentially uncomfortable for the patient and may be fatiguing for the operators. Many endoscopists prefer general anesthesia for the procedure and set time limits for the duration of the examination. It is not recommended that both antegrade and retrograde approach procedures be performed on the same day.[67] Antegrade examinations are thought to be easier than retrograde examinations because of difficulty in intubating the terminal ileum via the retrograde approach. Failure rates of ileal intubation range from 7% to 30%.[71,75,81] Previous abdominal surgery and resultant adhesions can make the procedure more difficult. The learning curve for DBE is reported to be approximately 10 cases for antegrade examinations and 20 to 30 cases for retrograde examinations.[126,127] However, to develop expertise, 100 to 150 cases may be required.[74] The learning curve for DBE was evaluated in a multicenter study including 188 patients, of whom two-thirds of the procedures were antegrade. After performing 10 antegrade cases, the mean procedure times decreased thereafter. However, a similar decrease in mean procedure time was not observed with retrograde cases, and in 31% of patients undergoing retrograde DBE, the ileum was not reached.[75]

Single-balloon enteroscopy

SBE is associated with challenges similar to those of DBE but overall is less complicated given that only 1 balloon must be inflated and deflated. However, it has been suggested that, due to a lack of an anchoring mechanism on the enteroscope, there can be difficulty in maintaining the enteroscope position in the small bowel as the overtube is advanced. Similar to DBE, retrograde ileal intubation during SBE can be challenging. The procedure times for antegrade and retrograde approaches are similar, and the overall procedure times are comparable to those of DBE. In a single-center study evaluating the learning curve for antegrade and retrograde approaches, the antegrade approach had a higher success rate and a shorter learning curve.[118]

Spiral enteroscopy

Two operators are required for spiral enteroscopy. Conceptually, spiral enteroscopy was developed as a faster and simpler method to perform deep small-bowel enteroscopy. The procedure times for spiral enteroscopy are the shortest of the 3 device-assisted enteroscopy techniques.[113,116] However, failure rates can be higher compared with balloon-assisted enteroscopy, especially in cases where the spiral overtube does not adequately engage the small bowel. For retrograde examinations, advancement of the overtube into the ileum can be problematic and is occasionally not possible. In such cases, the overtube is used only to prevent colonic loop formation, and the enteroscope is uncoupled from the overtube and then advanced independently into the ileum.[128] It has been suggested that the overtube designed for antegrade procedures (Endo-Ease Discovery SB) may be easier to advance through the ileocecal valve compared with the overtube for retrograde procedures (Endo-Ease Vista).[128] The learning curve for spiral enteroscopy appears to be the shortest and can be performed after 5 training cases.[96] A motorized spiral enteroscopy system is in development, and preliminary reports in abstract form suggest that complete enteroscopy is possible with this system.[129,130]

On-demand enteroscopy

There are very few reports of this newer system, but the theoretical advantage appears to be that no special preloading or preparation is needed before procedure initiation. No special endoscopes are needed, and the device can be inserted via the endoscope instrument channel, if and when the clinical need arises, allowing for “impulse” or on-demand enteroscopy. Furthermore, the balloon can be removed, allowing for the advancement of therapeutic devices through the endoscope instrument channel.

Intraoperative enteroscopy

Intraoperative enteroscopy is tedious, time-consuming, resource intensive, and logistically difficult. Given the significant advances in noninvasive imaging and device-assisted enteroscopy, intraoperative enteroscopy is less-frequently performed, and careful patient selection is critical before undertaking this invasive procedure.

SAFETY

Overall, enteroscopy appears to be a very safe procedure.[8] Adverse events of push enteroscopy with colonoscopes are rare, and those noted from the use of dedicated push enteroscopes are usually attributed to overtubes.[131,132] Reported adverse events have included mucosal stripping, parotid gland swelling, cardiorespiratory events, pancreatitis, and perforations.[133-135] However, the overall adverse event rate is reported to be only 1%.[2]

Most data on adverse events of device-assisted enteroscopy are compiled from DBE studies. The most commonly reported adverse events with DBE include pancreatitis, bleeding, and perforation with an overall rate ranging between 1.2% and 1.6%.[79,136,137] Specifically, the rate of pancreatitis is reported to be 0.3% and that of perforation to be between 0.3% and 0.4%.[136-138] Of note, the perforation risk seems to be higher in patients with surgically altered anatomy, and caution is advised in such cases.[138] Adverse events reported with SBE are also rare and include abdominal pain, fever, mucosal tears, pancreatitis, and perforation.[85-89,92,139,140] After spiral enteroscopy, postprocedure sore throat and mucosal tears and abrasions

TABLE 5. CPT codes and RVUs for enteroscopy

CPT code	Procedure	RVUs 2014
44360	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, not including ileum; diagnostic, including collection of specimen(s) by brushing or washing, when performed (separate procedure)	4.64
44361	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, not including ileum; with biopsy, single or multiple	5.1
44363	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, not including ileum; with removal of foreign body	6.08
44364	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, not including ileum; with removal of tumor(s), polyp(s), or other lesion(s) by snare technique	6.49
44365	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, not including ileum; with removal of tumor(s), polyp(s), or other lesion(s) by hot biopsy forceps or bipolar cautery	5.76
44366	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, not including ileum; with control of bleeding (eg, injection, bipolar cautery, unipolar cautery laser, heater probe, stapler, plasma coagulator)	7.62
44369	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, not including ileum; with ablation of tumor(s), polyp(s), or other lesion(s) not amenable to removal by hot biopsy forceps, bipolar cautery or snare technique	7.8
44370	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, not including ileum; with transendoscopic stent placement (includes predilation)	8.43
44372	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, not including ileum; with placement of percutaneous jejunostomy tube	7.56
44373	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, not including ileum; with conversion of percutaneous gastrostomy tube to percutaneous jejunostomy tube	6.06
44376	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, including ileum; diagnostic, with or without collection of specimen(s) by brushing or washing (separate procedure)	8.93
44377	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, including ileum; with biopsy, single or multiple	9.43
44378	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, including ileum; with control of bleeding (eg, injection, bipolar cautery, unipolar cautery laser, heater probe, stapler, plasma coagulator)	12.1
44379	Small intestinal endoscopy, enteroscopy beyond second portion of duodenum, including ileum; with transendoscopic stent placement (includes predilation)	12.88

RVUs, Relative value units.
From Center for Medicare Services. Available at: http://www.cms.hhs.gov. Accessed September 23, 2014.

may be common.[95] The perforation rate is reported to be 0.3%.[141] Although postprocedure hyperamylasemia has been reported, there have been no reports of pancreatitis.[132,142] Preliminary studies of the on-demand enteroscopy system have not reported any serious adverse events.[103,105]

Adverse event rates for intraoperative enteroscopy are higher because it is a major surgical procedure and they have ranged from 0% to 52%.[143] These have included mucosal laceration, intramural hematomas, mesenteric hemorrhage, perforation, prolonged paralytic ileus, intestinal ischemia, intestinal obstruction, wound infection, and postoperative pulmonary infection.[106,107,144-146] Mortality due to intraoperative enteroscopy is very rare but in older reports it has been reported to be as high as 11%, either because of the procedure itself or because of postoperative adverse events.[106,144]

Finally, with regard to ERCP performed with all device-assisted enteroscopy systems (DBE, SBE, and spiral enteroscopy), a systematic review reported an overall major adverse event rate of 3.4%.[125]

FINANCIAL CONSIDERATIONS

The costs associated with enteroscopy will vary based on the type of enteroscopy performed. For push enteroscopy or intraoperative enteroscopy, there is little additional investment required other than the cost of the endoscope. Because the endoscope used to perform push enteroscopy is frequently a colonoscope, there will be no additional cost to the endoscopy unit. At this time, only Pentax makes a dedicated push enteroscope (Table 1), although enteroscopes from other manufacturers designed for SBE and DBE may also be used for push enteroscopy. It is important to note that enteroscopy necessitates the purchase of accessory devices that are long enough to pass through the enteroscope (eg, biopsy forceps, polyp snares, injection needles, clips, and bipolar probes). Keeping a supply of enteroscopy tools available will add some additional cost.

SBE and DBE both require the purchase of a specialized enteroscope as well as its compatible overtube. Tables 1 and 2 outline currently available SBE and DBE enteroscopes and overtubes with list prices. In addition, both SBE and DBE systems require the capital purchase of their respective balloon insufflation device. The SBE Olympus balloon control unit costs $18,100 and the Fujinon DBE PB-20 balloon-pump controller costs $21,750. Spiral enteroscopy requires the purchase of an enteroscope. The technical specifications and cost of the Endo-Ease overtubes are listed in Table 2. In addition, the spiral enteroscopy overtubes require the purchase of Endo-Ease medical lubricant. A box of 4 lubricant-filled syringes costs $110.

Current Procedural Terminology codes for diagnostic and therapeutic enteroscopy (44360-44379) can be found in Table 5. Enteroscopy codes are based on the therapy provided and the distance traversed in the small bowel. The codes are divided based on the distance traversed distal to the pylorus (must traverse >50 cm beyond pylorus to report enteroscopy) and either including or not including the ileum. CPT codes 43235 through 43270 should be used in the case of surgically altered gastric anatomy where the examination of the jejunum is limited to just distal to the anastomosis (eg, gastric bypass and gastroenterostomy [Billroth II]). For a retrograde approach enteroscopy, one should use the appropriate colonoscopy codes plus the unlisted procedure code 44799 (unlisted procedure, intestine) because there is no separate CPT code to indicate a retrograde approach. Medicare for 2015 requires use of G code G6021 for the unlisted procedure, intestine code.

FUTURE RESEARCH AND DEVELOPMENT

1. The relative advantages of each device-assisted enteroscopy system should be further evaluated.
2. Improved technology for determination of the location of lesions noted on WCE would be advantageous and would allow endoscopists to select the appropriate enteroscopy system as well as approach (antegrade or retrograde) specific to each case.
3. Technology development that would eliminate the need for 2 operators, reduce procedure times, and enhance procedural efficiency is needed. This may promote widespread adoption of device-assisted enteroscopy in community settings as well as in academic centers.
4. Newer therapeutic devices compatible with currently available enteroscopy platforms should be developed.

SUMMARY

Noninvasive imaging with CT and magnetic resonance enterography or direct visualization with wireless capsule endoscopy can provide valuable diagnostic information and direct therapy. Enteroscopy technology and techniques have evolved significantly and allow diagnosis and therapy deep within the small bowel, previously attainable only with intraoperative enteroscopy. Push enteroscopy, readily available in most endoscopy units, plays an important role in the evaluation and management of lesions located up to the proximal jejunum. Currently available device-assisted enteroscopy systems, DBE, SBE, and spiral enteroscopy each have their technical nuances, clinical advantages, and limitations. Newer, on-demand enteroscopy systems appear promising, but further studies are needed. Despite slight differences in parameters such as procedural times, depths of insertion, and rates of complete enteroscopy, the overall clinical outcomes with all overtube-assisted systems appear to be similar. Endoscopists should therefore master the enteroscopy technology based on institutional availability and their level of technical expertise.

DISCLOSURE

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Abbreviations: DBE, double-balloon enteroscopy; SBE, single-balloon enteroscopy; WCE, wireless capsule endoscopy.

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