Communication from the ASGE Technology Committee

TECHNOLOGY STATUS EVALUATION REPORT

Enteroscopes

The American Society for Gastrointestinal Endoscopy (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, with a MEDLINE literature search to identify pertinent clinical studies on the topic and a MAUDE (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 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 April 2007 for articles related to endoscopy in patients with enteroscopy by using the keywords "enteroscopy," "enteroscope," "overtube," "intra-operative," "double-balloon," and "push pull" paired with "endoscopy," "small intestine," and "small bowel."

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BACKGROUND

Enteroscopy describes endoscopic examination of the small intestine, extending into the jejunum and/or the ileum. EGD is normally used to describe procedures into the duodenum. Limited terminal ileal examinations are usually included under the term colonoscopy. "Push enteroscopy" (PE) is performed with a specifically designed enteroscope, with or without an overtube, or a colonoscope without an overtube. Double-balloon enteroscopy (DBE) involves a specially coupled enteroscope and overtube apparatus with balloons mounted on the distal ends of each component and is intended for examination of the entire jejunum and the ileum. Single-balloon enteroscopy (SBE) uses a similar concept with an enteroscope and an overtube that contains a balloon on its distal end. Intraoperative enteroscopy (IOE) is a procedure in which an endoscope is inserted orally or via an enterotomy and is manually guided through the small bowel with surgical assistance. Wireless capsule endoscopy (WCE) is a purely diagnostic technology that is used to identify and roughly localize lesions.[1-3] Sonde enteroscopy is also purely diagnostic, and uses a very long small-caliber endoscope that is passed deep into the small bowel by peristalsis over the course of several hours and is then retracted for viewing. Sonde enteroscopy is an obsolete technique and will not be reviewed further.

TECHNICAL CONSIDERATIONS

The technical specifications of the push and double-balloon enteroscopes are shown in Table 1. Push enteroscopes are longer versions of standard videoendoscopes and are compatible with standard processing units. They have a working length of 2200 to 2500 mm, external diameters of 10.5 to 11.7 mm, and channel diameters of 2.2 to 3.8 mm. However, the length of the instrument does not necessarily correlate with deeper insertion or improved diagnostic yield.[4] Prototype variable-stiffness enteroscopes appear to enhance procedural performance and depth of insertion.[5,6] Overtubes have been used to facilitate deeper jejunal intubation during PE.[7] They have an outer diameter of 14.4 mm, a flexible segment at the distal end, and a radiopaque ring at the tip. However, results are mixed, and overtubes are not regularly used because of complications.[8-11]

PE can be accomplished with a pediatric or a standard colonoscope, as well as an enteroscope, and is initially performed like a standard upper endoscopy. The procedure is usually begun in the left lateral decubitus position. The instrument is introduced through the mouth and advanced

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TABLE 1. Technical specifications of dedicated enteroscopes

Make/model	PE or DBE	Length, mm	Outer diameter, mm	Inner channel, mm	Field of view	Overtube	List price, $
Fujinon							
EN-200WM/23	PE	2300	10.7	2.8	120°	No	27,800
EN-410WM5/23*	PE	2300	10.7	2.8	120°	No	34,280
EN-450P5/20	DBE endoscope	2000	8.5	2.2	120°	Required	44,095
TS-12140†	DBE overtube	1350	12.2	10	NA	Overtube	208
EN-450T5	DBE endoscope	2000	9.4	2.8	140°	Required	47,400
TS-13140†	DBE overtube	1350	13.2	10.8	NA	Overtube	208
Olympus							
SIF-140Q	PE	2500	10.5	2.8	140°	Optional	36,700
ST-S2‡	PE	1000	14.4	12.4	NA	Overtube	2234
SIF-Q180*	SBE endoscope	2000	9.2	2.8	140°	Required	37,500
ST-SB1†	SBE overtube	1320	13.2	11.0	NA	Overtube	225
Pentax							
VSB-3430	PE	2200	11.7	3.5	120°	No	34,650
VSB-3430K	PE	2200	11.6	3.8	140°	No	34,755

NA, Not applicable.
*High-resolution video chip.
†Single use.
‡Reusable.

as far as possible into the small bowel until it begins to loop. Clockwise torque and retraction are performed until the loop is straightened and the tip begins to retract. The endoscope is then advanced, and the process is repeated. If the instrument cannot be advanced further, the patient may be moved to the supine, right lateral, and occasionally prone positions. The endoscope maneuvers are then repeated until it is completely inserted or it continues to loop. Abdominal pressure may be helpful as in colonoscopy. The examination should be accomplished during both insertion and retraction, because minor mucosal abrasions can mimic vascular or inflammatory lesions. The examination may be enhanced by administration of glucagon for reduction of bowel motility. If an overtube is used, it is backloaded to the hub of the enteroscope. The enteroscope is inserted into the second or third portion of the duodenum and straightened. The overtube is then advanced to where the tip is in the second or third portion of the duodenum, and the entire apparatus is straightened. The endoscope is then deeply inserted, and the overtube is advanced as deeply as possible. Enteroscope insertion and withdrawal are then performed by using the maneuvers outlined above. Fluoroscopic guidance is occasionally used.

Double-balloon enteroscopes

Double-balloon enteroscopes are available in a general use version (EN-450P5; Fujinon, Saitama, Japan) and a therapeutic version (EN-450T5; Fujinon). Both have a 200-cm-long working length. The EN-450P5 is 8.5 mm in diameter, with a 2.2-mm working channel; the EN-450T5 is 9.4 mm in diameter with a 2.8-mm channel. Both endoscopes contain a port for balloon inflation and deflation. A disposable 1-mm-thick latex balloon must be mounted on the tip before each procedure and removed afterward. The flexible single-use overtubes are matched to the caliber of the endoscopes. Dimensions are provided in Table 1. The accompanying overtubes are 1350-mm long, have a 1-mm-thick latex balloon permanently fixed to the distal end, and a port for balloon inflation and deflation. An external air pump is attached to the balloon ports of the endoscope and the overtube. A control box for activation of balloon inflation and deflation is connected to the pump by a wire. Automated pressure control assures that the balloon-inflation pressure does not exceed 45 mm Hg. The overtubes contain a port for water instillation to activate a hydrophilic coating on the inner surface that minimizes friction with the endoscope. A stiffening wire is available to minimize looping.

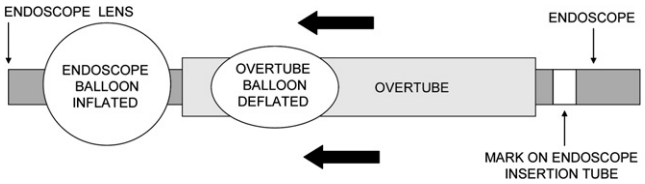

Figure 1. Double-balloon enteroscope. In this diagram, the endoscope is secured in the small intestine with its balloon inflated. The overtube is advanced over the endoscope with its balloon deflated in the direction of the arrows. To prevent damage to the endoscope balloon, a mark is revealed on the endoscope insertion tube as the overtube passes over, indicating that the overtube tip is near the endoscope balloon.

DBE requires an endoscopist and an assistant to operate the system and to manipulate the endoscope and the overtube. Mucosal examination and therapy are performed during both insertion and retraction. When the apparatus is assembled, the balloons are deflated to begin the procedure. For the oral approach, the patient is fasted, but no other preparation is required. The endoscope and the overtube are inserted into the duodenum, and the balloon on the overtube is inflated to maintain a stable position. With its balloon deflated, the endoscope is inserted up to 40 cm beyond the overtube, the endoscope balloon is reinflated, the overtube balloon is deflated, and the overtube is advanced to the tip of the endoscope. The overtube balloon is then reinflated, so that the entire apparatus is secured in the intestine with both balloons inflated. The entire endoscope-overtube apparatus is then retracted, which pleats the intestine along the overtube like a compressed concertina. This procedure is repeated, and the device is advanced through the intestine in increments of up to 40 cm. When the desired insertion distance is achieved, the intestine is marked with a tattoo if there is suspicion of more distal lesions. Withdrawal is initiated with the endoscope balloon inflated, and the overtube balloon is deflated. The overtube is retracted and then the overtube balloon is reinflated. Endoscope retraction is always performed with the overtube secured by its balloon to prevent uncontrolled loss of depth.[12,13] A circumferential white mark on the endoscope insertion tube 140 cm proximal to the balloon represents a stopping point beyond which the overtube should not be advanced or the endoscope withdrawn. This prevents the overtube from shearing off the endoscope balloon, as shown in Figure 1. DBE is usually performed with fluoroscopic guidance.

A colonoscopy preparation is required for performance of DBE via the anal approach. The endoscope and the overtube are advanced to the cecum, either directly or with the double-balloon push-pull system. With the overtube balloon inflated, the endoscope is advanced across the ileocecal valve and its balloon is inflated within the ileum. The overtube is then advanced along the endoscope and into the ileum and the push-pull procedure continued.[12,13]

A recently developed SBE (SIF-Q180; Olympus America Inc, Center Valley, Pa) has been approved by the U.S. Food and Drug Administration based on preliminary studies[14-16] but was not yet available for purchase at the time of this writing. It uses a disposable 140-cm-long, 13.2-mm outer-diameter, silicone (nonlatex) sheath (ST-SB1; Olympus), with a balloon at its distal end, which is loaded much like an overtube onto the enteroscope, with a working length of 200 cm and an outer diameter of 9.2 mm. The total length of the enteroscope is 234 cm, and it has a 2.8-mm working channel to permit therapeutic maneuvers with devices that are at least 240 cm in length. The balloon is inflated and deflated by an electronic inflation-control device, with automatic pressure control to standardize balloon-inflation pressures. The balloon is inflated and deflated by pressing buttons on the inflation-control unit or the included remote-control unit. The internal surface of the balloon overtube is hydrophilic, and lubrication between the outer sheath of the endoscope and the inner surface of the overtube is facilitated by flushing the internal surface of the overtube with water. The initial process of insertion into the small bowel is similar to the double-balloon system, with the insertion of the endoscope system as far as possible in the deflated position. The balloon is then inflated, and the entire system is withdrawn to promote backloading of the small bowel onto the outer surface of the overtube. The endoscope is then advanced while the balloon is inflated, holding the proximal small bowel in the retracted position. When the endoscope cannot be advanced further, the balloon is deflated and the balloon sheath is advanced over the scope to the tip of the endoscope. This sequence is repeated until the endoscope cannot be advanced further. The tip of the balloon sheath is radiopaque to facilitate fluoroscopic imaging localization relative to the endoscope. Unlike the double-balloon system, there is no second balloon on the tip of the endoscope to secure the position while the sheath is inserted to meet the distal aspect of the endoscope. Whether this compromises insertion depth has not been defined in comparative studies. The disposable overtube balloon device does eliminate the need for special processing while the endoscope is reprocessed similar to standard endoscopes.

IOE

IOE requires a push enteroscope, a colonoscope, and an endoscope light source and video processor in the operating room. In the anesthetized patient, the endoscope is passed orally or through an enterotomy. IOE is performed in a darkened operating room while the endoscopist views the endoscopic image and the surgeon watches the transilluminated intestine. The surgeon pleats segments of intestine over the endoscope via a laparotomy or with laparoscopic techniques. An inspection is performed upon insertion of the endoscope, because the inevitable mucosal trauma may mimic vascular lesions seen

during withdrawal. Vascular lesions and polyps may be endoscopically treated or marked with a suture for resection.[17-24]

A variety of 300-cm-long endoscopic accessories suitable for use with PE and DBE are commercially available, including biopsy forceps, injection needles, snares, thermal and ionized argon probes, a stiffening wire, and cleaning brushes. A limited selection of 300-cm-long ERCP accessories is also available, including cannulas, sphincterotomes, stone-extraction balloons, and dilation balloons.

INDICATIONS

The most common indication for all varieties of enteroscopy is diagnosis and/or therapy of acute, chronic, or occult intestinal bleeding without an etiology found with standard EGD and colonoscopy.[7] Other indications include small-bowel Crohn's disease, strictures, ulcers, polyps, masses, foreign bodies, lymphoma, other infiltrative diseases, and imaging abnormalities.[25-31] PE and DBE are also appropriate for evaluation of celiac disease and malabsorption, gastrostomy placement and performance of ERCP in patients with altered surgical anatomy, placement of jejunal feeding tubes, and treatment of early postoperative small-bowel obstruction.[7,25-35] PE, DBE, and IOE all have therapeutic capabilities, but Sonde and capsule enteroscopy are only diagnostic. DBE and IOE are usually performed after a presumptive diagnosis is made with prior imaging and/or WCE or when the need for therapy is clear.

EFFICACY AND COMPARATIVE STUDIES

PE

The average depths of intubation at PE can be estimated from disparate reports without standardized methodologies. Jejunal intubation is reported to be about 45 to 60 cm beyond the ligament of Treitz with a colonoscope, 25 to 63 cm with a bare enteroscope, and 46 to 80 cm with an enteroscope through an overtube.[4,8,36-43] Variable stiffness enteroscopes appear to facilitate the procedure but are only available as prototypes.[5,6] Overall, among multiple studies, PE yielded a diagnosis in 53% of patients, generating a change in medical management in 45%.[4,6,36,42-59] A diagnosis was made more frequently in patients with acute bleeding than for other indications. However, in 36% of patients, the detected lesions were within the reach of a standard gastroscope.[36,44,47-50,54] The most commonly seen lesions were vascular ectasias, erosions, ulcers, Crohn's disease, Cameron's lesions, polyps, tumors, gastric antral vascular ectasias, esophagitis, varices, and jejunal diverticula. Endoscopic therapy, including thermal coagulation and ablation and polypectomy, was successfully performed in about 20% of procedures. However, bleeding recurred in about 25% of patients who were endoscopically treated and 50% of patients who were not treated.[37,41,51,53,54] In 1 series, PE was thought to be helpful in patient management in 55% of cases.[46]

Several studies compared PE to WCE or radiography. In compiled comparative studies that involved 216 patients with bleeding of unknown origin or suspected small-bowel disease, a diagnosis was made with PE in 29% and with WCE in 68% of patients.[39-41,60-62] Clinical management was changed in 9% and 39% of patients diagnosed by PE and WCE, respectively.[40,41,60] In 2 series, all lesions diagnosed by PE were seen on WCE, but most of the lesions seen by WCE and not PE were distal to the reach of the enteroscope.[40,60] However, in a study that involved patients with familial adenomatous polyposis, PE detected many more polyps than WCE, even though the latter examined far more of the intestine. Lesions missed by WCE included the ampullae of Vater in all cases, many polyps larger than 10 mm, and large tattoos.[63] In a separate study with a follow-up of 1 year or more after diagnosing small-bowel disease, the sensitivity and specificity for PE was 48% and 80%, respectively, and, for WCE, it was 92% and 69%, respectively ($P < .01$).[64] A diagnosis was made in 16% of 75 patients with PE compared with 7% with enteroclysis or barium small-bowel follow-through radiographic series. All lesions found on radiographic examinations were also detected by PE.[37,58] Meta-analysis data also showed that WCE is superior to PE for the diagnosis of small-bowel pathology, with a 35% to 40% incremental yield and a number needed to treat of 3.[65,66]

DBE

From a compilation of uncontrolled DBE series, the mean insertion depth via the oral route was about 233 cm beyond the ligament of Treitz and when inserted via the anal route about 135 cm proximal to the ileocecal valve.[12,25,43,67-69] In a Japanese series reported by the inventor of this apparatus, it was estimated that about two thirds of the small bowel can be examined from either end and that complete visualization was achieved in 86% of patients undergoing dual examinations.[70] However, similar results have not been achieved in Western series.[12,25,67-69] A diagnosis was made with DBE in 60% of reported cases with similar etiologies to those listed for PE. Endoscopic biopsies and/or therapies were performed in 31% of procedures, including ionized argon coagulation, injection for hemostasis, polypectomy, balloon dilation, and foreign-body removal.[25,67-73]

In a prospective paired-design series of 52 patients with bleeding, jejunal intubation was achieved to means of 230 cm and 80 cm ($P < .0001$), and a diagnosis was made in 63% and 44% ($P < .0001$), with the orally passed DBE and PE with an overtube, respectively. However, DBE

required longer procedures (68 vs 21 minutes, $P < .001$), significantly larger sedative doses, and more fluoroscopy exposure, and more personnel than DBE.[43] A retrospective comparison of 118 patients with a variety of indications demonstrated that intubation to about 92 cm beyond the ligament of Treitz was achieved with DBE but only to 22 cm when using PE with an overtube ($P < .0001$).[74] DBE required significantly more time than did PE (67 vs 36 minutes, $P < .006$); however, there were no statistically significant differences in the yield for bleeding (40% vs 36%) and nonbleeding (64% vs 82%) lesions. In a prospective study among patients with a prior diagnosis by WCE, DBE detected 93% of lesions, and they were biopsied or treated in 79% of procedures.[1] In other combined series that compared DBE with WCE, total small-bowel visualization was achieved in 63% and 91%, and a diagnosis was made in 53% and 74% of patients, respectively.[2,75] However, endoscopic biopsies and/or therapies were performed via DBE in 65% of patients, and this is not possible with WCE. Similar to results that compared WCE with PE, WCE missed polyps and underestimated polyp counts within the reach of DBE but visualized polyps beyond the reach of the orally inserted double-balloon enteroscope.[29,63]

SBE

The single-balloon enteroscope system had not been released in clinical practice at the time of writing, and all published reports are limited to abstracts of limited numbers of patients. Overall diagnostic yields are reported in the 47% to 69% for small-bowel diseases, primarily obscure GI bleeding.[14-16] Larger prospective comparisons with DBE and WCE are needed.

IOE

IOE has long been considered the criterion standard for the diagnosis and treatment of small-bowel lesions. With oral intubation or enterotomy, most of the small bowel can be examined. In a series of 23 patients examined with oral endoscope insertion and laparotomy, the ileocecal valve was visualized in 13, the distal ileum in 7, and the proximal ileum in 3.[76] The diagnostic yield has been reported to be about 86% and ranges from 58% to 100%.[17-24] Intraoperative Sonde enteroscopy has been reported in 16 patients with total small-bowel visualization in all and a definitive diagnosis in 14.[77] For occult GI bleeding, surgical resection, and/or endoscopic therapy is usually performed when the source is identified, with infrequent relapses in treated patients, but recurrent bleeding is common when no source is identified.[18-24,76] In a comparative study that involved 47 patients with bleeding, a diagnosis was made in 72% with IOE and 74% with a single WCE.[78]

EASE OF USE

PE

PE when using a colonoscope is similar to, but somewhat more difficult than, other standard forms of endoscopy and requires no special training. Use of an enteroscope and overtube makes the procedure yet more difficult. Fine maneuvering of the tip is more cumbersome, air insufflation may be compromised by leakage through the an overtube, and there can be spatter of fluid from the proximal hub around the enteroscope. The procedure requires about 32 minutes of endoscopy time.[4,36,37] It may require more sedation and analgesia than EGD or colonoscopy, but general anesthesia is not routinely needed. PE can be done in a standard endoscopy unit or an ambulatory surgical center. Fluoroscopy is not generally used when a colonoscope is used but may be very helpful when using an overtube. A caveat is that these long endoscopes are often in a very tortuous position when inserted. This makes passing instruments difficult, and 1-to-1 transmission of torque is lost. Inadvertent falling back of many centimeters frequently occurs. The patient is recovered in a standard unit, and the instruments are processed in a routine fashion.

DBE

DBE is a moderately difficult procedure, with technical nuances that require some specialized training. Technical proficiency assessed by procedure and fluoroscopy duration is significantly improved after performing 10 oral procedures but not for anal procedures.[79] The procedures are lengthy, uncomfortable for the patient, and may be fatiguing for the endoscopist. Many authorities prefer general anesthesia, set time limits of 1 to 2 hours for the examinations, and the use of fluoroscopy. It is not feasible to do a total enteroscopy in a single procedure, and it is not recommended that procedures be performed from the oral and anal approach on the same day.[69] The mean duration of an oral DBE is 73 minutes and 78 minutes for an anal approach.[1,13,25,67-70] Ileal intubation is often challenging.

SBE

SBE has similar challenges to DBE but is conceptually less complicated, given that only 1 balloon must be inflated and deflated. Early reports suggest shorter procedure times of 55 to 68 minutes, with adequate completion by using only moderate sedation.[15,16]

IOE

IOE is a major surgical and endoscopic procedure that is the ultimate diagnostic and therapeutic modality for small-bowel disorders. However, it can be tedious, time consuming, and logistically difficult.

TABLE 2. CPT codes for enteroscopy*†

Code	Procedure	RVU
44360	Small intest endo beyond 2nd part of duodenum not including ileum with/without brush wash	2.59
44361	Small intest endo beyond 2nd part of duodenum not including ileum with biopsy	2.87
44363	Small intest endo beyond 2nd part of duodenum not including ileum with foreign-body removal	3.49
44364	Small intest endo beyond 2nd part of duodenum not including ileum with snare removal polyps	3.73
44365	Small intest endo beyond 2nd part of duodenum not including ileum with hot biopsy/bipolar	3.31
44366	Small intest endo beyond 2nd part of duodenum not including ileum with control of bleeding	4.4
44369	Small intest endo beyond 2nd part of duodenum not including ileum with ablation	4.51
44370	Small intest endo beyond 2nd part of duodenum not including ileum with transendoscopic stent	4.70
44372	Small intest endo beyond 2nd part of duodenum not ileum with percutaneous jejunostomy	4.4
44373	Small intest endo beyond 2nd part of duodenum not ileum with conversion PEG to jejunostomy	3.49
44376	Small intest endo beyond 2nd part of duodenum including ileum with/without brush wash	5.25
44377	Small intest endo beyond 2nd part of duodenum including ileum with biopsy	5.52
44378	Small intest endo beyond 2nd part of duodenum including ileum with control of bleeding	7.12
44379	Small intest endo beyond 2nd part of duodenum including ileum with transendoscopic stent	7.46
44380	Ileoscopy through stoma with/without brushing or washing	1.05
44382	Ileoscopy through stoma with biopsy	1.27
44383	Ileoscopy through stoma with transendoscopic stent placement	2.94
44385	Endoscopic evaluation of small intest pouch with/without brushing or washing	1.82
44386	Endoscopic evaluation of small intest pouch with biopsy	2.12

intest, Intestinal; *endo,* endoscopy.

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*From Center for Medicare Services. Available at: http://www.cms.hhs.gov. Accessed March 16, 2007.

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SAFETY

Endoscopic enteroscopy appears to be very safe.[7] From a compilation of the literature that involved 1881 patients, PE appears to have associated complications in about 1%, including cardiorespiratory events, mucosal lacerations, bleeding, perforation, and pancreatitis.[36-38,42,44-59] Complications of DBE occurred in 2.3% of cases with sedation

and cardiorespiratory events, pain, fever, vomiting, perforation, and pancreatitis being most common.[1,12,25,68,70,72,80,81] IOE is a major procedure, with complications in about 34% of cases, which are often caused by intestinal and mesenteric trauma from passage of large endoscopes. They include prolonged ileus, perforation, mucosal and serosal lacerations, superior mesenteric vein avulsion, ischemic-bowel necrosis, and obstruction.[21,24] There were no serious complications in a series that used the small-caliber Sonde enteroscope for IOE.[77]

FINANCIAL CONSIDERATIONS

All enteroscopic procedures can be done with the processing units used for standard endoscopy. These procedures are lengthy, with associated costs of professional and unit time. PE and IOE can be done with a colonoscope at no additional investment to the unit or with a dedicated enteroscope and its associated costs. Special accessories must be purchased for enteroscopes. DBE requires a specific endoscope/overtube combination, is time consuming, and may require additional personnel during the procedure. It may also require fluoroscopy suites with associated costs. IOE is very expensive because of the required resources, personnel, and morbidity, but it is the ultimate intervention.

The manufacturers' list prices for enteroscopes and overtubes are shown in Table 1. Standard push enteroscopes can be used with compatible processing units. Additional costs for the double-balloon system include the balloon pump controller ($18,015), replacement tube kits (about $70), replacement trap bottle sets (about $170), disposable overtubes ($208), and disposable balloons ($25). DBE systems complete with a video processor and light source, 1 enteroscope, a leak tester, and supplies outlined above have list prices of $95,095 to $98,275. Special 300-cm-long accessories must be purchased. A stiffening wire costs about $700. Sonde enteroscopes are no longer commercially available.

Current Procedural Terminology (CPT) codes 43235 through 43259 are used for most diagnostic and therapeutic upper endoscopy and state ''upper gastrointestinal endoscopy including esophagus, stomach and either the duodenum and/or jejunum as appropriate …'' These codes are also used for jejunal examinations in persons with surgically altered anatomy, such as gastrojejunostomy, Roux-en-Y, and Billroth II. CPT codes 44360 through 44373 encompass ''small intestinal endoscopy, enteroscopy beyond the second portion of the duodenum, not including the ileum …'' and 44376 through 44397 refer to ''small intestinal endoscopy, enteroscopy, beyond the second portion of duodenum, including ileum …'' and are used in cases of native anatomy.

For transoral PE or DBE, one may use the jejunal codes (44360 through 44373) or the ileal codes (44376 through 44397) in conjunction with the standard codes for EGD (43235 through 43259) if the EGD is necessary for more than transit to the jejunum or the ileum (eg, biopsy, ablation, polypectomy). For a transanal procedure with deep ileal intubation, ileal codes (44376 through 44397) can be combined with the colonoscopy codes (45378 through 45385) if the colonoscopy entailed more than transit to the ileum. The code with the highest relative value units (RVU) is used as the primary code, coupled with a 59 modifier for others. A 22 modifier may be attached to the primary CPT code for unusual procedural services (duration), and the reason must be specified with times and usual comparisons included. If fluoroscopy is used, 76003 (fluoroscopic guidance for needle placement [eg, biopsy, aspiration, injection, localization device]) with a 26 modifier can also be included. The CPT codes used for enteroscopy are outlined in Table 2.

SUMMARY

The various enteroscopic procedures have individual strengths and limitations, and are generally complementary rather than exclusive. WCE is an important modality for making an initial diagnosis and directing subsequent studies to an appropriate area of the intestine. PE can be done in almost any department with a colonoscope, however, somewhat better results may be obtained with an enteroscope. Sonde enteroscopy is an obsolete technology and has little utility at present. DBE appears to be effective for the diagnosis and treatment of a variety of diseases throughout the small bowel. WCE is generally performed before DBE to help identify whether to start from above or below. IOE is the ultimate small-bowel intervention but is not available in all centers. It should be reserved for cases that cannot be managed with other modalities because of the difficulties of the procedure and significant associated morbidity.

Abbreviations: ASGE, American Society for Gastrointestinal Endoscopy; CPT, Current Procedural Terminology; DBE, double-balloon enteroscopy; IOE, intraoperative enteroscopy; PE, push enteroscopy; SBE, single-balloon enteroscopy; RVU, relative value units; WCE, wireless capsule endoscopy.

REFERENCES

1. Gay G, Delvaux M, Fassler I. Outcome of capsule endoscopy in determining indication and route for push-and-pull enteroscopy. Endoscopy 2006;38:49-58.
2. Hadithi M, Heine GD, Jacobs MA, et al. A prospective study comparing video capsule endoscopy with double-balloon enteroscopy in patients with obscure gastrointestinal bleeding. Am J Gastroenterol 2006;101:52-7.
3. Lewis BS. Enteroscopy: endangered by the capsule? Endoscopy 2002;34:416-7.
4. Benz C, Jakobs R, Riemann JF. Does the insertion depth in push enteroscopy depend on the working length of the enteroscope? Endoscopy 2002;34:543-5.

5. Harewood GC, Gostout CJ, Farrell MA, et al. Prospective controlled assessment of variable stiffness enteroscopy. Gastrointest Endosc 2003; 58:267-71.
6. Keizman D, Brill S, Umansky M, et al. Diagnostic yield of routine push enteroscopy with a graded-stiffness enteroscope without overtube. Gastrointest Endosc 2003;57:877-81.
7. Eisen GM, Dominitz JA, Faigel DO, et al. Enteroscopy. Gastrointest Endosc 2001;53:871-3.
8. Benz C, Jakobs R, Riemann JF. Do we need the overtube for push-enteroscopy? Endoscopy 2001;33:658-61.
9. Taylor AC, Chen RY, Desmond PV. Use of an overtube for enteroscopy: does it increase depth of insertion? A prospective study of enteroscopy with and without an overtube. Endoscopy 2001;33:227-30.
10. Gay G, Loudu P, Bichet G, et al. Parotid gland and submaxillary enlargement after push video enteroscopy. Endoscopy 1996;28:328.
11. Landi B, Cellier C, Fayemendy L, et al. Duodenal perforation occurring during push enteroscopy. Gastrointest Endosc 1996;43:631.
12. May A, Nachbar L, Wardak A, et al. Double-balloon enteroscopy: preliminary experience in patients with obscure gastrointestinal bleeding or chronic abdominal pain. Endoscopy 2003;35:985-91.
13. Mönkemüller K, Weigt J, Treiber G, et al. Diagnostic and therapeutic impact of double-balloon enteroscopy. Endoscopy 2006;38:67-72.
14. Vargo JJ, Upchurch B, Dumot JA, et al. Clinical utility of the Olympus single balloon enteroscope: The initial U.S. experience [abstract]. Gastrointest Endosc 2007;65:AB90.
15. Forman JS, Karp BJ, Uradomo LT, et al. Single balloon enteroscopy of the small bowel: diagnostic and therapeutic yield in patients with obscure gastrointestinal bleeding [abstract]. Gastrointest Endosc 2007; 65:AB172.
16. Kawamura T, Yasuda K, Cho E, et al. Clinical evaluation of newly developed single balloon enteroscopy [abstract]. Gastrointest Endosc 2007; 65:AB173.
17. Ress AM, Benacci JC, Sarr MG. Efficacy of intraoperative enteroscopy in diagnosis and prevention of recurrent, occult gastrointestinal bleeding. Am J Surg 1992;163:98–4.
18. Esaki M, Matsumoto T, Hizawa K, et al. Intraoperative enteroscopy detects more lesions but is not predictive of postoperative recurrence in Crohn's disease. Surg Endosc 2001;15:455-9.
19. Kim J, Kim YS, Chun HJ, et al. Laparoscopy-assisted exploration of obscure gastrointestinal bleeding after capsule endoscopy: the Korean experience. J Laparoendosc Adv Surg Tech A 2005;15:365-73.
20. Esaki M, Matsumoto T, Hizawa K, et al. Preventive effect of nutritional therapy against postoperative recurrence of Crohn's disease, with reference to findings determined by intra-operative enteroscopy. Scand J Gastroenterol 2005;40:1431-7.
21. Edwards DP, Khosraviani K, Stafferton R, et al. Long-term results of polyp clearance by intraoperative enteroscopy in the Peutz-Jeghers syndrome. Dis Colon Rectum 2003;46:48-50.
22. Kendrick ML, Buttar NS, Anderson MA, et al. Contribution of intraoperative enteroscopy in the management of obscure gastrointestinal bleeding. J Gastrointest Surg 2001;5:162-7.
23. Douard R, Wind P, Panis Y, et al. Intraoperative enteroscopy for diagnosis and management of unexplained gastrointestinal bleeding. Am J Surg 2000;180:181-4.
24. Zaman A, Sheppard B, Katon RM. Total peroral intraoperative enteroscopy for obscure GI bleeding using a dedicated push enteroscope: diagnostic yield and patient outcome. Gastrointest Endosc 1999;50: 506-10.
25. Heine GD, Hadithi M, Groenen MJ, et al. Double-balloon enteroscopy: indications, diagnostic yield, and complications in a series of 275 patients with suspected small-bowel disease. Endoscopy 2006;38:42-8.
26. Sunada K, Yamamoto H, Kita H, et al. Clinical outcomes of enteroscopy using the double-balloon method for strictures of the small intestine. World J Gastroenterol 2005;11:1087-9.
27. Ohmiya N, Taguchi A, Shirai K, et al. Endoscopic resection of Peutz-Jeghers polyps throughout the small intestine at double-balloon enteroscopy without laparotomy. Gastrointest Endosc 2005;61:140-7.
28. May A, Nachbar L, Ell C. Extraction of entrapped capsules from the small bowel by means of push-and-pull enteroscopy with the double-balloon technique. Endoscopy 2005;37:591-3.
29. Matsumoto T, Esaki M, Moriyama T, et al. Comparison of capsule endoscopy and enteroscopy with the double-balloon method in patients with obscure bleeding and polyposis. Endoscopy 2005;37:827-32.
30. Pennazio M, Rossini FP. Small bowel polyps in Peutz-Jeghers syndrome: management by combined push enteroscopy and intraoperative enteroscopy. Gastrointest Endosc 2000;51:304-8.
31. Cellier C, Cuillerier E, Patey-Mariaud de Serre N, et al. Push enteroscopy in celiac sprue and refractory sprue. Gastrointest Endosc 1999;50:613-7.
32. Gersin KS, Ponsky JL, Fanelli RD. Enteroscopic treatment of early postoperative small bowel obstruction. Surg Endosc 2002;16:115-6.
33. Shetzline MA, Suhocki PV, Workman MJ. Direct percutaneous endoscopic jejunostomy with small bowel enteroscopy and fluoroscopy. Gastrointest Endosc 2001;53:633-8.
34. Ross S, Semrad C, Alverdy J, et al. Use of double-balloon enteroscopy to perform PEG in the excluded stomach after Roux-en-Y gastric bypass. Gastrointest Endosc 2006;4:797-800.
35. Baron TH. Double-balloon enteroscopy to facilitate retrograde PEG placement as access for therapeutic ERCP in patients with long-limb gastric bypass. Gastrointest Endosc 2006;64:973-4.
36. Sharma BC, Bhasin DK, Makharia G, et al. Diagnostic value of push-type enteroscopy: a report from India. Am J Gastroenterol 2000;95: 137-40.
37. Foutch PG, Sawyer R, Sanowski RA. Push-enteroscopy for diagnosis of patients with gastrointestinal bleeding of obscure origin. Gastrointest Endosc 1990;36:337-41.
38. Taylor AC, Buttigieg RJ, McDonald IG, et al. Prospective assessment of the diagnostic and therapeutic impact of small-bowel push enteroscopy. Endoscopy 2003;35:951-6.
39. Ell C, Remke S, May A, et al. The first prospective controlled trial comparing wireless capsule endoscopy with push enteroscopy in chronic gastrointestinal bleeding. Endoscopy 2002;34:685-9.
40. Mata A, Bordas JM, Feu F, et al. Wireless capsule endoscopy in patients with obscure gastrointestinal bleeding: a comparative study with push enteroscopy. Aliment Pharmacol Ther 2004;20:189-94.
41. Adler DG, Knipschield M, Gostout C. A prospective comparison of capsule endoscopy and push enteroscopy in patients with GI bleeding of obscure origin. Gastrointest Endosc 2004;59:492-8.
42. Chong J, Tagle M, Barkin JS, et al. Small bowel push-type fiberoptic enteroscopy for patients with occult gastrointestinal bleeding or suspected small bowel pathology. Am J Gastroenterol 1994;89:2143-6.
43. May A, Nachbar L, Schneider M, et al. Prospective comparison of push enteroscopy and push-and-pull enteroscopy in patients with suspected small-bowel bleeding. Am J Gastroenterol 2006;101:2016-24.
44. Nguyen NQ, Rayner CK, Schoeman MN. Push enteroscopy alters management in a majority of patients with obscure gastrointestinal bleeding. J Gastroenterol Hepatol 2005;20:716-21.
45. Lepere C, Cuillerier E, Van Gossum A, et al. Predictive factors of positive findings in patients explored by push enteroscopy for unexplained GI bleeding. Gastrointest Endosc 2005;61:709-14.
46. Bezet A, Cuillerier E, Landi B, et al. Clinical impact of push enteroscopy in patients with gastrointestinal bleeding of unknown origin. Clin Gastroenterol Hepatol 2004;2:921-7.
47. Romelaer C, Le Rhun M, Beaugerie L, et al. Push enteroscopy for gastrointestinal bleeding: diagnostic yield and long-term follow-up. Gastroenterol Clin Biol 2004;28:1061-6.
48. Lara LF, Bloomfeld RS, Pineau BC. The rate of lesions found within reach of esophagogastroduodenoscopy during push enteroscopy depends on the type of obscure gastrointestinal bleeding. Endoscopy 2005;37:745-50.
49. Parry SD, Welfare MR, Cobden I, et al. Push enteroscopy in a UK district general hospital: experience of 51 cases over 2 years. Eur J Gastroenterol Hepatol 2002;14:305-9.
50. Lin S, Branch MS, Shetzline M. The importance of indication in the diagnostic value of push enteroscopy. Endoscopy 2003;35:315-21.

51. Chen RY, Taylor AC, Desmond PV. Push enteroscopy: a single centre experience and review of published series. ANZ J Surg 2002;72:215-8.
52. Linder J, Cheruvattath R, Truss C, et al. Diagnostic yield and clinical implications of push enteroscopy: results from a nonspecialized center. J Clin Gastroenterol 2002;35:383-6.
53. Molina Perez E, Lamas Garcia D, Perez-Cuadrado Martinez E. Push-enteroscopy series: diagnostic and therapeutic efficacy. Rev Esp Enferm Dig 2002;94:259-68.
54. Hayat M, Axon AT, O'Mahony S. Diagnostic yield and effect on clinical outcomes of push enteroscopy in suspected small-bowel bleeding. Endoscopy 2000;32:369-72.
55. Zaman A, Katon RM. Push enteroscopy for obscure gastrointestinal bleeding yields a high incidence of proximal lesions within reach of a standard endoscope. Gastrointest Endosc 1998;47:372-6.
56. Willis JR, Chokshi HR, Zuckerman GR, et al. Enteroscopy-enteroclysis: experience with a combined endoscopic-radiographic technique. Gastrointest Endosc 1997;45:163-7.
57. Schmit A, Gay F, Adler M, et al. Diagnostic efficacy of push-enteroscopy and long-term follow-up of patients with small bowel angiodysplasias. Dig Dis Sci 1996;41:2348-52.
58. Harris A, Dabezies MA, Catalano MF, et al. Early experience with a video push enteroscope. Gastrointest Endosc 1994;40:62-4.
59. Barkin JS, Chong J, Reiner DK. First-generation video enteroscope: fourth-generation push-type small bowel enteroscopy utilizing an overtube. Gastrointest Endosc 1994;40:743-7.
60. Chong AK, Taylor A, Miller A, et al. Capsule endoscopy vs. push enteroscopy and enteroclysis in suspected small-bowel Crohn's disease. Gastrointest Endosc 2005;61:255-61.
61. Saurin JC, Delvaux M, Gaudin JL, et al. Diagnostic value of endoscopic capsule in patients with obscure digestive bleeding: blinded comparison with video push-enteroscopy. Endoscopy 2003;35:576-84.
62. Van Gossum A, Hittelet A, Schmit A, et al. A prospective comparative study of push and wireless-capsule enteroscopy in patients with obscure digestive bleeding. Acta Gastroenterol Belg 2003;66:199-205.
63. Wong RF, Tuteja AK, Haslem DS, et al. Video capsule endoscopy compared to standard endoscopy for the evaluation of small bowel polyps in persons with familial adenomatous polyposis. Gastrointest Endosc 2006;6:530-7.
64. Saurin JC, Delvaux M, Vahedi K, et al. Clinical impact of capsule endoscopy compared to push enteroscopy: 1-year follow-up study. Endoscopy 2005;37:318-23.
65. Triester SL, Leighton JA, Leontiadis GI, et al. A meta-analysis of the yield of capsule endoscopy compared to other diagnostic modalities in patients with obscure gastrointestinal bleeding. Am J Gastroenterol 2005;100:2407-18.
66. Triester SL, Leighten JA, Leontaidis GI, et al. A meta-analysis of the yield of capsule endoscopy compared to other diagnostic modalities in patients with non-stricturing small bowel Crohn's disease. Am J Gastroenterol 2006:954-64.
67. Di Caro S, May A, Heine DG, et al. The European experience with double-balloon enteroscopy: indications, methodology, safety, and clinical impact. Gastrointest Endosc 2005;62:545-50.
68. Ell C, May A, Nachbar L, et al. Push-and-pull enteroscopy in the small bowel using the double-balloon technique: results of a prospective European multicenter study. Endoscopy 2005;37:613-6.
69. May A, Nachbar L, Ell C. Double-balloon enteroscopy (push-and-pull enteroscopy) of the small bowel: feasibility and diagnostic and therapeutic yield in patients with suspected small bowel disease. Gastrointest Endosc 2005;62:62-70.
70. Yamamoto H, Kita H, Sunada K, et al. Clinical outcomes of double-balloon endoscopy for the diagnosis and treatment of small-intestinal diseases. Clin Gastroenterol Hepatol 2004;2:1010-6.
71. Manabe N, Tanaka S, Nakao M, et al. Double-balloon enteroscopy in patients with GI bleeding of obscure origin. Gastrointest Endosc 2006;64:135-40.
72. Oshitani N, Yukawa T, Yamagami H, et al. Evaluation of deep small bowel involvement by double-balloon enteroscopy in Crohn's disease. Am J Gastroenterol 2006;101:1484-9.
73. Sun B, Rajan E, Cheng S, et al. Diagnostic yield and therapeutic impact of double-balloon enteroscopy in a large cohort of patients with obscure gastrointestinal bleeding. Am J Gastroenterol 2006;101:2011-5.
74. Matsumoto T, Moriyama T, Esaki M, et al. Performance of antegrade double-balloon enteroscopy: comparison with push enteroscopy. Gastrointest Endosc 2005;62:392-8.
75. Nakamura M, Niwa Y, Ohmiya N, et al. Preliminary comparison of capsule endoscopy and double-balloon enteroscopy in patients with suspected small-bowel bleeding. Endoscopy 2006;38:59-66.
76. Lewis BS, Wenger JS, Waye JD. Small bowel enteroscopy and intraoperative enteroscopy for obscure gastrointestinal bleeding. Am J Gastroenterol 1992;86:171-4.
77. Lopez MJ, Cooley JS, Petros JG, et al. Complete intraoperative small-bowel endoscopy in the evaluation of occult gastrointestinal bleeding using the Sonde enteroscope. Arch Surg 1996;131:272-7.
78. Hartmann D, Schmidt H, Bolz G, et al. A prospective two-center study comparing wireless capsule endoscopy with intraoperative enteroscopy in patients with obscure GI bleeding. Gastrointest Endosc 2005;61:826-32.
79. Mehdizadeh S, Ross A, Gerson L, et al. What is the learning curve associated with double-balloon enteroscopy? Technical details and early experience in 6 U.S. tertiary care centers. Gastrointest Endosc 2006;64:740-50.
80. May A, Nachbar L, Schneider M, et al. Push-and-pull enteroscopy using the double-balloon technique: method of assessing depth of insertion and training of the enteroscopy technique using the Erlangen Endo-Trainer. Endoscopy 2005;37:66-70.
81. Honda K, Itaba S, Mizutani T, et al. An increase in serum amylase in patients after peroral double-balloon enteroscopy: an association with the development of pancreatitis. Endoscopy 2006;38:1040-3.

Prepared by:
ASGE TECHNOLOGY COMMITTEE
James A. DiSario, MD
Bret T. Petersen, MD, Chair
William M. Tierney, MD
Douglas G. Adler, MD
Bipan Chand, MD
Jason D. Conway, MD
Joseph M.B. Coffie, MD
Daniel S. Mishkin, MD
Raj J. Shah, MD
Lehel Somogyi, MD
Louis Michel Wong Kee Song, MD

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