

## 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 il-

eum. 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.<sup>1-3</sup> 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.<sup>4</sup> Prototype variable-stiffness enteroscopes appear to enhance procedural performance and depth of insertion.<sup>5,6</sup> Overtubes have been used to facilitate deeper jejunal intubation during PE.<sup>7</sup> 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.<sup>8-11</sup>

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

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							
VSF-3430	PE	2200	11.7	3.5	120°	No	34,650
VSF-3430K	PE	2200	11.6	3.8	140°	No	34,755

NA, Not applicable.

\*High-resolution video chip.

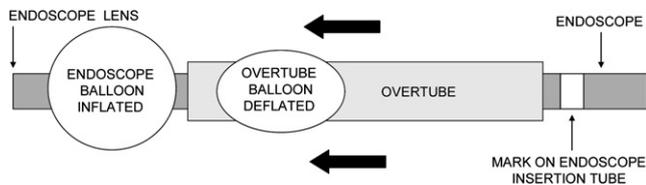
†Single use.

‡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.<sup>12,13</sup> 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.<sup>12,13</sup>

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<sup>14-16</sup> 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.<sup>17-24</sup>

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.<sup>7</sup> Other indications include small-bowel Crohn's disease, strictures, ulcers, polyps, masses, foreign bodies, lymphoma, other infiltrative diseases, and imaging abnormalities.<sup>25-31</sup> 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.<sup>7,25-35</sup> 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.<sup>4,8,36-43</sup> Variable stiffness enteroscopes appear to facilitate the procedure but are only available as prototypes.<sup>5,6</sup> Overall, among multiple studies, PE yielded a diagnosis in 53% of patients, generating a change in medical management in 45%.<sup>4,6,36,42-59</sup> 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.<sup>36,44,47-50,54</sup> 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 polypec-

tomy, 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.<sup>37,41,51,53,54</sup> In 1 series, PE was thought to be helpful in patient management in 55% of cases.<sup>46</sup>

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.<sup>39-41,60-62</sup> Clinical management was changed in 9% and 39% of patients diagnosed by PE and WCE, respectively.<sup>40,41,60</sup> 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.<sup>40,60</sup> 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.<sup>63</sup> 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 ( $P < .01$ ).<sup>64</sup> 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.<sup>37,58</sup> 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.<sup>65,66</sup>

### 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.<sup>12,25,43,67-69</sup> 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.<sup>70</sup> However, similar results have not been achieved in Western series.<sup>12,25,67-69</sup> 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.<sup>25,67-73</sup>

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.<sup>43</sup> 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 ( $P < .0001$ ).<sup>74</sup> 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.<sup>1</sup> 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.<sup>2,75</sup> 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.<sup>29,63</sup>

## 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.<sup>14-16</sup> 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.<sup>76</sup> The diagnostic yield has been reported to be about 86% and ranges from 58% to 100%.<sup>17-24</sup> Intraoperative Sonde enteroscopy has been reported in 16 patients with total small-bowel visualization in all and a definitive diagnosis in 14.<sup>77</sup> 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.<sup>18-24,76</sup> In a comparative study that involved 47 patients with bleeding, a diagnosis was made in 72% with IOE and 74% with a single WCE.<sup>78</sup>

## 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.<sup>4,36,37</sup> 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.<sup>79</sup> 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.<sup>69</sup> The mean duration of an oral DBE is 73 minutes and 78 minutes for an anal approach.<sup>1,13,25,67-70</sup> 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.<sup>15,16</sup>

### 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 including ileum with percutaneous jejunostomy	4.4
44373	Small intest endo beyond 2nd part of duodenum not including 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.<sup>7</sup> 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.<sup>36-38,42,44-59</sup> Complications of DBE occurred in 2.3% of cases with sedation

and cardiorespiratory events, pain, fever, vomiting, perforation, and pancreatitis being most common.<sup>1,12,25,68,70,72,80,81</sup> 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.<sup>21,24</sup> There were no serious complications in a series that used the small-caliber Sonde enteroscope for IOE.<sup>77</sup>

## 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.

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