GI endoscopes

The ASGE Technology Committee provides reviews of existing, new, or emerging endoscopic technologies that have an impact on the practice of GI endoscopy. Evidence-based methodology is used, performing a MEDLINE literature search to identify pertinent clinical studies on the topic and a MAUDE (U.S. Food and Drug Administration Center for Devices and Radiological Health) database search to identify the reported complications of a given technology. Both are supplemented by accessing the "related articles" feature of PubMed and by scrutinizing pertinent references cited by the identified studies. Controlled clinical trials are emphasized, but in many cases data from randomized, controlled trials are lacking. In such 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 September 2010 for articles related to endoscopy by using the key words "gastroscope," "colonoscope," "echoendoscope," "duodenoscope," "choledochoscope," "ultraslim endoscope," "variable stiffness colonoscope," and "wide-angle colonoscope."

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BACKGROUND

GI endoscopes are devices used for the examination and treatment of the GI tract. They have evolved from early rigid designs with limited capabilities to more sophisticated flexible instruments with advanced imaging capabilities, specialized features for advanced therapeutic interventions, and different designs to enable examination of specific areas of the GI tract. This document is an overview of all flexible endoscopes. Separate, more detailed technical reviews are available for echoendoscopes, enteroscopes, ultrathin endoscopes, choledochoscopes, and high-resolution and high-magnification endoscopes.[1-5]

TECHNICAL CONSIDERATIONS

The basic design of a flexible endoscope is similar for all models and consists of 3 main parts: the control section, the insertion tube, and the connector section.

The control section is held in the left hand and has 2 stacked control dials that deflect the instrument tip up/down and left/right. Some endoscopes (eg, some ultrathin endoscopes and choledochoscopes) have only 1 dial for up/down angulation; right/left angulation in these endoscopes is achieved by applying torque to the insertion tube of the instrument. The control dials can be locked into place for prolonged tip deflection. The control section also has separate buttons for suction, air or water insufflation, and image freeze and capture. Some endoscopes have additional programmable buttons for other functions such as image printing and video capture. Finally, the control section has the entry port for inserting accessories through the channel of the instrument. Some specialty endoscopes such as duodenoscopes and echoendoscopes have additional features on the control section, which are discussed separately. Many endoscopes also have controls to activate advanced imaging features, and some colonoscopes have a separate dial encircling the control section that allows the user to change the flexibility of part of the insertion tube.

The insertion tube is a flexible shaft attached to the control section. The insertion tube contains a working channel that allows passage of accessories and enables suction. Some endoscopes have dual working channels that allow full suction when an accessory is in the other working channel; two accessories can also be passed simultaneously in these endoscopes during more complex therapeutic procedures. Channel diameter varies among endoscopes, ranging from 1.2 mm for some choledochoscopes to 6 mm for some therapeutic endoscopes. Some endoscopes have an auxiliary water channel that enables them to be fitted with a foot-controlled water pump for extra flushing capabilities. The shaft also contains angula-

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tion wires to enable deflection of the instrument tip. The degree of angulation of the tip of the insertion tube in an up/down or left/right plane varies among instruments. The tip of the insertion tube of video endoscopes contains a charge-coupled device (CCD) for color image generation, a light guide illumination system, an opening for the air/water channel, a water jet to clear the lens, and an objective lens. The lens may be oriented for forward-viewing, side-viewing, or oblique-viewing, depending on the type of endoscope. Although less commonly used today, some fiberoptic endoscopes are still available. The insertion tube or shaft of these instruments also contains 1 or 2 light guide bundles and an image guide bundle. The length, diameter, and flexibility of the insertion tube vary among endoscope types and manufacturers (see Tables 1-9, available online at www.giejournal.org,).

The connector section attaches the endoscope to an image processor, light and electrical source, air or CO_2 source, and water.

Special features: magnification, high-definition, and enhanced imaging capability

Standard endoscopes magnify the endoscopic image 30 to 35 times at baseline. Endoscopes with the ability to increase magnification are also available. These “zoom” endoscopes optically magnify images up to 150 times by means of a movable optical lens in the endoscope tip to obtain a more detailed image of a target lesion while maintaining high resolution.[5]

High-definition (HD) endoscopes generate images with 850,000 to more than 1 million pixels compared with image signals of 100,000 to 400,000 pixels on standard endoscopes.[5] They require HD-compatible image processors and monitors to produce a true HD image.

Some endoscopes are equipped with enhanced imaging capabilities including narrow-band imaging (NBI) (Olympus Medical Systems, Center Valley, Pa) and multiband imaging (MBI) such as Fujinon Intelligent Color Enhancement (Fujinon, Wayne, NJ) and i-SCAN (Pentax, Montvale, NJ). NBI uses filters to illuminate the tissue at selected wavelengths of blue (415 nm) and green (540 nm), highlighting vascular detail from surrounding mucosa. MBI processes the white-light image digitally, reconstructing it through software rather than a filter to enhance the appearance of the mucosa. MBI can be combined with magnification. These image enhancement techniques are intended to assist in diagnosing and further characterizing lesions in the GI tract, but their utility is not yet defined. A detailed technical review of NBI and MBI is available.[6]

Image processor/light source

Fiberoptic imaging, which is generally obsolete today other than for a few specialty endoscopes (eg, some choledochoscopes), is generated by a coherent bundle of glass fibers that transmit an image from the tip of the endoscope to the eyepiece.

All video endoscopes have a black and white, solid-state image sensor called a CCD mounted at the tip of the endoscope, which allows an image to be transmitted via an electronic signal to a video processor for display on 1 or more video monitors. This signal is converted to a color image by 1 of 2 systems: a red green blue (RGB) sequential system or a color CCD system. The RGB system uses a xenon lamp to arc white light through a rotating RGB filter located between the lamp and the light guide; this results in bursts of red, green, and blue light to create a visual strobe effect. When tissue is illuminated, the reflected red, green, and blue images are sent through a CCD in the instrument tip and transmitted to the image processor. The color CCD system differs in that a micro-mosaic color filter is mounted over the CCD chip itself. Whitelight illumination is provided by the xenon lamp, and reflected color images on the CCD surface are processed by circuitry in the image processor.

The front panel of the image processor contains the receiver for the endoscope connector section, air and water pump control buttons, and light adjustment controls. Some image processors incorporate the light source into the same chassis, but others separate these devices. Light is provided by a 100- to 300-W xenon lamp. Some light sources also have a 75-W halogen lamp for backup. Endoscopes are compatible only with image processors from their manufacturers, and RGB type endoscopes are not compatible with CCD-type image processors. A variety of image displays and monitors are available. Tables 8 and 9 (available online at www.giejournal.org) list available video processors and US processors.

CATEGORIES OF ENDOSCOPES AND INDICATIONS

Gastroscopes

Gastroscopes are forward-viewing endoscopes with relatively short insertion tubes designed primarily for use in the esophagus, stomach, and duodenum. Gastroscopes have variable insertion tube lengths (925-1100 mm), insertion tube diameters (4.9-12.8 mm), and channel sizes (2.0-3.8 mm). Gastroscopes are available in standard adult, pediatric, and therapeutic models. Some therapeutic gastroscopes have dual working channels for more complex interventions. Another type of gastroscope is an ultrathin variety in which the insertion tube diameter is 6 mm or less. These endoscopes may be used for unsedated peroral or transnasal esophagoscopy or upper endoscopy or to traverse narrow areas (eg, tight strictures) in the GI tract. Ultrathin endoscopes may have 2-way or 4-way tip deflection, insertion tube diameters between 4.9 and 6 mm, and small instrument channels (1.5-2 mm).[7] They are otherwise similar in design to gastroscopes. Table 1 (available online at www.giejournal.org) lists available gastroscopes and specifications.

Duodenoscopes

Duodenoscopes are side-viewing endoscopes designed primarily for ERCP. They are available in standard and therapeutic versions and have variable insertion tube lengths (1235-1250 mm), insertion tube diameters (7.5-12.1 mm), and channel sizes (2.0-4.8 mm). The tip of the duodenoscope has an elevator that raises accessories passed through the working channel into the field of view to facilitate cannulation of the papilla and other interventions. The elevator is operated by the endoscopist via a small lever on the control section. One available duodenoscope (V-Scope; Olympus) also has a V-shaped groove at its tip to facilitate locking of guidewires passed through the instrument channel. Duodenoscopes with a large working channel (≥4.2 mm) enable passage of a choledochoscope. Table 2 (available online at www.giejournal.org) lists available duodenoscopes and their specifications.

Enteroscopes

Enteroscopes are forward-viewing endoscopes similar to gastroscopes in design but with a much longer insertion tube used for examination of the duodenum, jejunum, and, in some cases, the ileum. They have working lengths ranging from 1520 to 2200 mm, channel diameters of 2.2 mm to 3.8 mm, and insertion tube diameters of 9.2 to 11.6 mm.[8] Overtubes are sometimes used with these endoscopes to decrease gastric looping and enable deeper insertion. Single-balloon (Olympus) and double-balloon (Fujinon) enteroscopes are also available. These devices have a specialized disposable overtube with an inflatable balloon that anchors the instrument in place during shortening maneuvers. Double-balloon enteroscopes have a second balloon on the endoscope insertion tube. Enteroscopy can be performed via the oral or anal approach, depending on the indication and lesion site. Table 3 (available online at www.giejournal.org) lists available enteroscopes and specifications.

Sigmoidoscopes

Sigmoidoscopes are relatively short forward-viewing endoscopes designed for examination of the distal colon. They have variable insertion tube lengths (700-790 mm), insertion tube diameters (11.3-12.8 mm), and channel sizes (3.2-4.2 mm). Rigid sigmoidoscopes are used primarily by surgeons when evaluating malignancy of the rectum and distal colon or for foreign-body retrieval. Table 4 (available online at www.giejournal.org) lists available sigmoidoscopes and their indications.

Colonoscopes

A colonoscope is a forward-viewing endoscope designed for examination of the entire colon and terminal ileum. Colonoscopes are available in pediatric and adult models and have variable insertion tube lengths (1330-1700 mm), diameters (11.1-15 mm), channel sizes (2.8-4.2 mm), and channel number (1 or 2).

Standard colonoscopes have varying degrees of flexibility throughout the length of the insertion tube.[9] The distal portion of the tube is more flexible to allow the endoscopist to negotiate angulated areas of the colon, and the more proximal shaft is stiffer to provide column strength and reduce looping of the bowel. This varying flexibility is achieved by alterations in the resin polymer that constitutes the outer layer of the endoscope. The distal 40 cm of the tube is covered with a softer resin that is gradually replaced with a harder resin more proximally.[10]

One company (Olympus) also produces adult and pediatric colonoscopes that can be further stiffened as needed by the endoscopist. These variable-stiffness (VS) colonoscopes were designed to improve ease of insertion by reducing looping in more mobile sections of bowel with the ability to maintain flexibility in more fixed sections. They have an adjustable tensioning coil that extends down the length of the insertion tube. An internal wire is attached to the coil and can be stiffened by rotating a dial on the control section of the endoscope. The proximal 40 to 50 cm of the insertion tube is the only section that has varying stiffness capabilities; the distal 25 cm of the insertion tube and tip are unaffected. The stiffness control dial can be rotated from position 0 to 3, allowing incremental increase in stiffness of the proximal shaft.[10]

Another colonoscope modification is a wide-angle field of view of 170 degrees versus the standard 140-degree field of view (Olympus). Table 5 (available online at www.giejournal.org) lists available colonoscopes and device specifications.

Echoendoscopes

Echoendoscopes are forward- or oblique-viewing endoscopes fitted with an US transducer on the tip. These endoscopes are designed to allow US examination of layers of the GI wall and extraluminal structures. Radial echoendoscopes produce an US image that is perpendicular to the axis of the insertion tube, and the image is generally 360 degrees. Curvilinear echoendoscopes produce an image that is parallel to the axis of the insertion tube and is usually a 100- to 180-degree image.[11] Curvilinear echoendoscopes allow tissue sampling via needle aspiration[11]; diagnostic and therapeutic models are available. US transducers were previously available in mechanical versions, which use a rotating electrical element in the tip to create an US image. These are being replaced by electronic US transducers that use a series of nonrotating electrical elements to produce an image. Electronic echoendoscopes have Doppler capabilities. Acoustic coupling between the US transducer and the mucosa is via a water-filled balloon on the instrument tip. Echoendoscopes are available in a variety of lengths and insertion tube diameters (Table 6 [available online at www.giejournal.org] lists available echoendoscopes and device specifications).

Choledochoscopes

Choledochoscopes are forward-viewing miniature endoscopes designed for examination of the bile or pancreatic ducts. They can be passed through a therapeutic duodenoscope or percutaneously into the biliary system. Completely reusable and partially disposable fiberoptic choledochoscopes are available in the United States, with working lengths of 1870 to 1900 mm, insertion tube diameters of 3.1 to 3.4 mm, and a channel diameter of 1.2 mm. The completely reusable models have controls for up/down tip deflection, buttons for air/water insufflation and suction, and 1 instrument channel. The partially disposable choledochoscope (Spyglass; Boston Scientific, Natick, Mass) has controls for 4-way tip deflection. The insertion tube is a disposable catheter with steering wires, an irrigation port, and a 1.2-mm accessory channel. Miniaturized accessories are available for use through this choledochoscope, such as biopsy forceps. Choledochoscope use requires a separate light source and image processor. Table 7 (available online at www.giejournal.org) lists available choledochoscopes and device specifications.

Comparative studies

There are no published studies comparing endoscopes made by different manufacturers. Detailed reviews of comparative studies of enteroscopes, choledochoscopes, echoendoscopes, and HD/high-magnification endoscopes are available.[1-5]

The single-balloon enteroscope was compared with the double-balloon enteroscope in an ongoing trial published in abstract form of patients randomized to examination with either endoscope for a variety of indications, most commonly obscure GI bleeding.[12] Procedure time, depth of insertion, and diagnostic yield were similar between the 2 endoscopes, although total setup time was significantly longer for the double-balloon enteroscope (12 minutes for double-balloon enteroscope vs 3 minutes for single-balloon enteroscopy, $P < .005$).

Flexible sigmoidoscopy using a standard sigmoidoscope was compared with examination using an upper endoscope in 2 randomized trials of colon cancer screening in an average-risk population. In 1 study of 160 women, unsedated examination with an upper endoscope was significantly less painful than with the sigmoidoscope.[13] Pain scores were likewise lower in the upper endoscope group in a randomized study of 81 screening patients, and more examinations reached the splenic flexure (76% with an upper endoscope vs 35%, $P = .001$).[14]

The standard pediatric colonoscope was compared with the standard adult colonoscope in a nonblinded trial that randomized 100 women with a history of hysterectomy to colonoscopy with either instrument. Cecal intubation rates were higher in the pediatric colonoscope group (96.1% vs 71.4%, $P < .001$) and success increased to 89.9% in the group with failed examination by switching to the pediatric instrument.[15] In another trial, 918 outpatients were randomized to screening colonoscopy with a long pediatric colonoscope or an intermediate-length adult colonoscope.[16] Overall, there were no differences in cecal intubation rates or need for abdominal pressure or position change. Time to cecal intubation was shorter in the adult colonoscope group (5.75 ± 3.18 minutes vs 6.26 ± 3.30 minutes, $P = .02$), and significantly shorter in the subgroup of male patients. These trials suggest that use of a pediatric colonoscope may be preferable in patients suspected of having a fixed sigmoid colon and otherwise may be used according to individual endoscopist preference.

Endoscope length was examined as a factor for colonoscopy completion in a trial randomizing 998 examinations with an adult colonoscope with 168-cm working length compared with a 133-cm device.[17] The shorter endoscope was associated with lower mean cecal intubation times (4.14 ± 0.13 minutes vs 5.16 ± 0.13 minutes, $P = .000$). Complete colonoscopy can sometimes be achieved with a gastroscope. Colonoscopy with a standard adult colonoscope was compared with examination with a gastroscope in a randomized trial of 622 patients.[18] There was no difference in cecal intubation rates, but time to cecal intubation was prolonged in the gastroscope group (8.7 ± 2.4 minutes vs 8.2 ± 2.3 minutes, $P = .006$).

A meta-analysis of multiple randomized trials found that compared with the standard adult colonoscope, use of the VS colonoscope resulted in higher cecal intubation rates (odds ratio 2.08; 95% CI, 1.29-3.36), less abdominal pain, and decreased need for sedation, but cecal intubation times were similar.[19] A later randomized, controlled trial (RCT) compared a pediatric VS colonoscope, a standard pediatric colonoscope, and an adult colonoscope for cecal intubation times, completeness of the examination, patient tolerance, use of abdominal compression, and endoscopists' assessment of procedure difficulty.[20] No significant differences were found among any of the colonoscopes. Another study evaluated whether use of the VS colonoscope decreased the amount of sedation necessary for an examination. This trial randomized 355 patients into 3 groups based on the type of colonoscope used (standard adult colonoscope of intermediate and regular lengths of 1.3 and 1.6 m and VS adult colonoscope).[21] The patients underwent colonoscopy using a mixture of propofol and alfentanil delivered by a patient-controlled pump. Patients in the VS colonoscope group used significantly less propofol compared with the other 2 groups, and mean pain scores were lower. In summary, study results are somewhat conflicting comparing VS colonoscopes with conventional colonoscopes but suggest that there may be a modest positive effect on cecal intubation rates and patient tolerability, with no difference in time to cecal intubation. Their use may be based on endoscopist preference.

The wide-angle colonoscope has been compared with the standard colonoscope for polyp detection rates and efficiency. Two studies used 170-degree wide-angle instruments and standard 140-degree view colonoscopes to conduct back-to-back, same-day colonoscopies. In 1 randomized study of 50 patients, use of a prototype wide-angle colonoscope was associated with a reduced time to the cecum (2.09 minutes vs 2.53 minutes, $P = .002$), reduced time for examination during withdrawal (4.98 minutes vs 5.74 minutes, $P < .0001$), and similar missed polyp rates (19% vs 27%, $P = .19$) compared with the standard colonoscope.[22] A similar study showed lower miss rates for all polyps with the wide-angle instrument (20% vs 31%, $P = .046$) with a shorter mean examination time (6.75 minutes vs 7.64 minutes total; $P = .0005$),[23] indicating a potential impact on colonoscopy efficiency. Another multicenter RCT showed that the wide-angle colonoscope reduced withdrawal time compared with the standard colonoscope (4.9 minutes vs 5.4 minutes, $P = .0001$) without compromising adenoma detection rates.[24]

Other studies compared the wide-angle colonoscope with the addition of HD capabilities with the standard-view colonoscope for polyp detection. In 1 RCT of 390 patients, the overall polyp detection rate was higher for the wide-angle HD instrument (1.76 ± 2.31 vs 1.31 ± 1.90, $P = .03$).[25] However, there were no significant differences between the 2 groups with respect to adenoma detection rate; the major difference was in the detection of small hyperplastic polyps. Another RCT of 620 patients showed no difference in the overall detection of polyps and no difference in polyp detection rates based on size or histology.[26] A third case-control study found no difference in overall polyp detection rate, adenoma detection rate, or insignificant lesion detection rate between HD/wide-angle and conventional colonoscope groups.[27] A multicenter RCT compared the wide-angle colonoscope with a standard adult colonoscope for withdrawal times; endoscopists were asked to withdraw the endoscope as quickly as they could while carefully completing examinations.[28] Of 710 procedures, the mean withdrawal time was significantly shorter in the wide-angle group (4.9 minutes vs 5.9 minutes, $P = .0001$), with no difference in adenoma detection. Finally, a prospective cohort study compared 130 patients who had colonoscopy performed with optimized withdrawal technique (time >6 minutes, reexamination of flexures and folds) with either the HD colonoscope or the adult colonoscope; no differences in polyp detection or adenoma detection were found.[29] Taken together, these studies suggest a minimal, if any, effect on polyp detection with use of the wide-angle and HD instruments compared with the standard colonoscope, with a possible small positive impact on colonoscopy efficiency because of the ability to decrease withdrawal times without compromising efficacy.

SAFETY

Upper and lower endoscopy is safe. Cardiorespiratory events, both major and minor, related to sedation are the most common adverse event, occurring in 0.03% to 20%.[30,31] Adverse events at 30 days from diagnostic and therapeutic colonoscopy include bleeding (0.2%-2.1%), perforation (≤0.1%), abdominal discomfort (5.4%), and infection (0.2%).[32,33] Other rare events such as splenic rupture are reported. Therapeutic maneuvers such as stricture dilation and polypectomy with cautery increase some risks. Death from diagnostic endoscopy is rare. Epistaxis (0.85%-2%) and vasovagal events (0.3%) have been reported with unsedated transnasal endoscopy using the ultrathin endoscope.[34,35] Pancreatitis has been reported from balloon enteroscopy and push enteroscopy with an overtube in less than 1%; double-balloon enteroscopy is associated with a 2.3% rate of adverse events.[9] Diagnostic EUS is generally as safe as EGD, although the risk of cervical esophagus perforation is reportedly increased (0.03%)[36] because of the long rigid portion of the insertion tube tip. The echoendoscope is oblique-viewing, and this may also increase the risk of duodenal perforation. It is imperative that users follow manufacturer-specific recommendations for reprocessing of endoscopes to avoid infection risk to patients.

FINANCIAL CONSIDERATIONS

List prices for endoscopes and processors are shown in Table 1 (available online at www.giejournal.org). Medical-grade image display monitors are also necessary and are not included in the processor price. Specialty endoscopes such as echoendoscopes require special processors. Mechanical radial endoscopes require separate US processors from linear array echoendoscopes, but newer fully electronic radial and linear array echoendoscopes can use the same US processor. Peroral cholangioscopy requires an additional processor and image display monitor separate from the duodenoscope setup.

AREAS FOR FUTURE RESEARCH

Direct comparisons of different enteroscopes are necessary to define the optimal instrument for deep enteroscopy. New innovations in endoscopic technology aimed at improving the detection and characterization of neoplastic lesions are needed. Some areas for future improvement in endoscopic design include self-propelled (partial/complete) endoscopes, improved choledochoscope platforms, and a larger suction channel–to–outer diameter ratio. A better ergonomic endoscope design and smaller processors are other areas of potential improvement.

SUMMARY

A variety of endoscopes for GI use are available. Special features such as magnification/HD, enhanced imaging, and wide-angle view have recently evolved. Procedure-specific endoscopes are required to enhance diagnostic and therapeutic success.

DISCLOSURES

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Abbreviations: CCD, charge-coupled device; HD, high-definition; MBI, multiband imaging; NBI, narrow-band imaging; RCT, randomized controlled trial; RGB, red green blue; VS, variable stiffness.

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Table 1.1. Gastroscopes

Manufacturer	Model #	Insertion tube length/ Diameter (mm)	Image type	Image characteristic	Compatible processor	Biopsy channel #/Diameter (mm)	List price ($)	Comments	
OLYMPUS	GIF-H180J	1030/9.9	Video	Color CCD	CV-180/160/140/92	1/2.8	36,500	Standard adult with forward water jet (HD)	
	GIF-H180	1030/9.8	Video	Color CCD	CV-180/160/140/93	1/2.8	35,700	Standard adult (HD)	
	GIF-Q180	1030/8.8	Video	Color CCD	CV-180/160/140/94	1/2.8	31,875	Standard adult (high resolution)	
	GIF-N180	1100/4.9	Video	Color CCD	CV-180/160/140/95	1/2.0	28,950	Ultrathin	
	GIF-XP180N	1100/5.5	Video	Color CCD	CV-180/160/140/96	1/2.0	30,500	Ultrathin	
	GIF-2TH180	1030/12.6	Video	Color CCD	CV-180/160/140/97	2/2.8,3.7	36,500	Dual-channel therapeutic (HD)	
	GIF-1TQ160	1030/11.3	Video	Color CCD	CV-180/160/140/98	1/3.7	34,300	Therapeutic	
	GIF-XTQ160	1030/12.9	Video	Color CCD	CV-180/160/140/99	1/6.0	31,750	Therapeutic (large channel)	
	GIF-Q160Z	1030/10.9	Zoom Video	Color CCD	CV-180/160/140/100	1/2.8	32,075	115x zoom (with 20-in monitor)	
FUJINON	EG-530WR	1100mm/9.3	Video	HD	EPX-4400HD/EPX-2500	1/2.8mm	$27,035	Standard	
	EG-450PE5	1100mm/8.1	Video	HD	EPX-4400HD	1/2.2mm	$26,650	Slim	
	EG-530N	1100mm/5.9	Video	HD	EPX-4400HD/EPX-2500	1/2.0mm	$26,800	Ultra Slim	
	EG-530NP	1100mm/4.9	Video	HD	EPX-4400HD/EPX-2500	1/2.0mm	$26,700	Ultra Slim	
	EG-450CT5	1100mm/10.8	Video	HD	EPX-4400HD	1/3.8mm	$26,780	Treatment	
	EG-450D5	1090mm/11.5	Video	HD	EPX-4400HD	2/3.8mm, 2.8mm	$27,515	Dual Channel	
	EG-590WR	1100mm/9.6	Video	HD (Super CCD)	EPX-4400HD	1/2.8mm	$29,285	Standard	
	EG-590ZW	1100mm/9.8	Video	HD (Super CCD)	EPX-4400HD	1/2.8mm	$30,330	Optical Magnification	
PENTAX (VIDEO)	EG-2790i	1050/9.0	Video	HD	EPK-i	1/2.8	$31,500		$31,500.00
	EG-2990i	1050/9.8	Video	HD	EPK-i	1/2.8	$31,500		$31,500.00
	EG-1690K	1050/5.4	Video	Std	EPK-I, EPK1000	1/2.0	$26,500		$26,500.00
	EG-2490K	1050/8.0	Video	Std	EPK-I, EPK1000	1/2.4	$28,500		$28,500.00
	EG-2790K	1050/9.0	Video	Std	EPK-I, EPK1000	1/2.8	$27,500		$27,500.00
	EG-2990K	1050/9.8	Video	Std	EPK-I, EPK1000	1/2.8	$27,500		$27,500.00
	EG-3490K	1050/11.6	Video	Std	EPK-I, EPK1000	1/3.8	$28,500		$28,500.00
	EG-3470ZK	1050/11.6	Video	Std	EPK-I, EPK1000	1/2.8	$24,650		$24,650.00
	EG-3890TK	1050/12.8	Video	Std	EPK-I, EPK1000	2/3.8 & 2.8	$30,500		$30,500.00

Table 1.2. Sigmoidoscopes

Manufacturer	Model #	Insertion tube length/Diameter (mm)	Image type	Image characteristic	Compatible processor	Biopsy channel #/Diameter (mm)	List price ($)	Comments
OLYMPUS	OSF-V60	730/11.3	Video	Color CCD	CV-60	1/3.2	10,300	Standard adult
	OSF-4	700/11.8	Fiber	Coherent bundle	CLK-4	1/3.2	8,200	
FUJINON	ES-450WE5	790mm/12.8	Video	HD	EPX-4400HD	1/3.8mm	$19,030	Standard
PENTAX (VIDEO)	ES-3870K	700/12.8	Video	Std	EPK-I, EPK-1000	1/4.2	$16,800	
PENTAX (FIBER)	FS-34V	700/11.5	Fiber	Coherent Bundle	LH-150 PC	1/3.5	$5,775	

Table 1.3. Colonoscopes

Manufacturer	Model #	Insertion tube length/ Diameter (mm)	Image type	Image characteristic	Compatible processor	Biopsy channel #/Diameter (mm)	List price ($)	Comments
OLYMPUS	CF-H180AL	1680/12.8	Zoom Video	Color CCD	CV-180/160/140/96	1/3.7	41,200	Standard adult (HD)
	CF-H180AI	1330/12.8	Zoom Video	Color CCD	CV-180/160/140/97	1/3.7	41,200	Standard adult (HD)
	CF-Q180AL	1680/12.8	Zoom Video	Color CCD	CV-180/160/140/98	1/3.7	36,950	Standard adult (high resolution)
	CF-Q180AI	1330/12.8	Zoom Video	Color CCD	CV-180/160/140/99	1/3.7	36,950	Standard adult (high resolution)
	CF-Q160ZL	1680/12.8	Zoom Video	Color CCD	CV-180/160/140/100	1/3.7	37,900	150x zoom (with 20-in monitor)
	CF-Q160ZI	1330/12.8	Zoom Video	Color CCD	CV-180/160/140/101	1/3.7	37,900	150x zoom (with 20-in monitor)
	CF-H180DL	1680/13.2	Zoom Video	Color CCD	CV-180/160/140/102	1/3.7	42,500	For use with ScopeGuide (endoscope position detecting unit) (HD)
	CF-2T160L	1680/13.7	Zoom Video	Color CCD	CV-180/160/140/104	2/3.7,3.2	34,500	Dual-channel therapeutic
	CF-2T160I	1330/13.7	Zoom Video	Color CCD	CV-180/160/140/105	2/3.7,3.2	34,500	Dual-channel therapeutic
	CF-Q160ZL	1680/15.0	Zoom Video	Color CCD	CV-180/160/140/107	1/3.7	37,900	150x zoom (with 20-in monitor)
	PCF-H180AL	1680/11.8	Zoom Video	Color CCD	CV-180/160/140/108	1/3.2	42,000	Pediatric (HD)
	PCF-H180AI	1330/11.8	Zoom Video	Color CCD	CV-180/160/140/109	1/3.2	42,000	Pediatric (HD)
	PCF-Q180AL	1680/11.5	Zoom Video	Color CCD	CV-180/160/140/110	1/3.2	37,595	Pediatric (high resolution)
	PCF-Q180AI	1330/11.5	Zoom Video	Color CCD	CV-180/160/140/111	1/3.2	37,595	Pediatric (high resolution)
FUJINON	EC-530HL	1690mm/12.8	Video	HD	EPX-4400HD/EPX-2500	1/4.2mm	$29,925	Standard
	EC-530LS	1690mm/11.5	Video	HD	EPX-4400HD/EPX-2500	1/3.8mm	$29,925	Slim
	EC-450LP5	1690mm/11.1	Video	HD	EPX-4400HD	1/3.2mm	$28,610	Super Slim
	EC-450DL5	1690mm/12.8	Video	HD	EPX-4400HD	1/3.8mm	$29,235	Dual Channel
	EC-590ZW/L	1690mm/12.8	Video	HD (Super CCD)	EPX-4400HD	2/3.8mm, 2.8mm	$32,915	Optical Magnification/Zoom
PENTAX (Video)	EC-3490Li	1700/11.6	Video	HD	EPK-i	1/3.2	$37,850	
	EC-3890Li	1700/13.2	Video	HD	EPK-i	1/3.8	$36,950	
	EC-3490LK	1700/11.6	Video	Std	EPK-I, EPK1000	1/3.8	$33,000	
	EC-3890LK	1700/13.2	Video	Std	EPK-I, EPK1000	1/4.2	$32,250	
	EC-3890TLK	1700/13.2	Video	Std	EPK-I, EPK1000	2/3.8 & 2.8	$33,000	
	EC-3872LZK	1700/13.2	Video	Std	EPK-I, EPK1000	1/3.8	$26,775	
PENTAX (Fiber) V-series	FC-38LV	1700/12.8	Fiber	Coherent bundle	All EPK, EPM	1/3.8	$15,540	

Table 1.4. Duodenoscopes

Manufacturer	Model #	Insertion tube length/Diameter (mm)	Image type	Image characteristic	Compatible processor	Biopsy channel #/Diameter (mm)	List price ($)	Comments
OLYMPUS	TJF-Q180V	1240/11.3	Video	Color CCD	CV-180/160	1/4.2	$40,000	Therapeutic (replaces TJF-160F)
	JF-140F	1240/11	Video	Color CCD	CV-180/160/140	1/3.2	$33,950	Diagnostic
	PJF-160	1235/7.5	Video	Color CCD	CV-180/160	1/2.0	$37,000	Pediatric
FUJINON	ED-530XT	1250mm/11.5	Video	HD	EPX-4400HD	1/4.2	$32,895	Therapeutic
	ED-450XL5	1250mm/11.8	Video	HD	EPX-4400HD	1/3.2	$29,840	Standard
PENTAX	ED-3270K	1250/10.8	Video	Std	EPK-I, EPK1000	1/3.2	$28,700.00	
	ED-3490TK	1250/11.6	Video	Std	EPK-I, EPK1000	1/4.2	$34,500.00	
	ED-3670TK	1250/12.1	Video	Std	EPK-I, EPK1000	1/4.8	$31,710.00	

Table 1.5. Choledochoscopes

Manufacturer	Model #	Insertion tube length/Diameter (mm)	Image type	Image characteristic	Biopsy channel #/Diameter (mm)	List price ($)	Comments
OLYMPUS	CHF-BP30	1870/3.4	Fiber optic	Coherent bundle	1/1.2	$25,500	Requires large - channel duodenoscopes.
PENTAX	FCP-9P	1900/3.1	Fiber optic	Coherent bundle	1/1.2	24,885	
BOSTON SCIENTIFIC	SPYGLASS	reusable probe: 3000/0.77	Fiber optic		1.2/0.6/0.6	21,475	
		single use catheter: 2200/3.4				4,850	disposable probe

Table 1.6. Echoendoscopes

Manufacturer	Model #	Insertion tube length/Diameter (mm)	US orientation/Scanning degrees/# frequency (MHz)	Image type/View angle/Degree
OLYMPUS	GF-UE160-AL5	1250/11.8	electronic radial 360/ 4,(5,6,7.5,10)	video, oblique (55)
	GF-UM160	1,250/10.5	mechanical radial 360/ 4,(5,7.5,12,20)	video, oblique (50)
	GF-UCT140P-AL5	1,250/11.8	curvilinear (100)/4,(5,6,7.5,10)	video oblique (55)
	GF-UCT140-AL5	1,250/12.6	curvilinear (180)/4,(5,6,7.5,10)	video, oblique (55)
	GF-UCT180	1,250/12.6	curvilinear (180)/4,(5,6,7.5,10)	video, oblique (55)
	GF-UCT160-OL5	1,250/12.6	curvilinear (150)/1, (7.5)	video, oblique (55)
	GF-UC160P-OL5	1,250/11.8	curvilinear (150)/1, (7.5)	video, oblique (55)
PENTAX	EG-3670URK	1250/12.1	electronic radial 360/ 3 (5,7.5,10)	video, forward
	EG-3630UR	1250/12.1	electronic radial 270	video, forward
	EG-3830UT	1250/12.8	longitudnal 120/3(5,7.5,10)	video, oblique (50)
	EG-3870UTK	1250/12.8	longitudnal 120/3 (5,7.5,10)	video, oblique (50)

Table 1.7. Enteroscopes

Manufacturer	Model #	Insertion tube length/ Diameter (mm)	Image type	Image characteristic	Compatible processor	Biopsy channel #/Diameter (mm)	List price ($)	Comments
OLYMPUS	SIF-Q180	2000/9.2	Video	Color CCD	CV-180/160/140	1/2.8	$45,000	Replaces SIF-Q-140
FUJINON	EN-450T5	2000mm/9.4	Video	HD	EPX-4400HD	1/2.8mm	$50,290	DBE Therapeutic
	EN-450P5/20	2000mm/8.5	Video	HD	EPX-4400HD	1/2.2mm	$46,785	DBE Standard
	EC-450BI5	1520mm/9.4	Video	HD	EPX-4400HD	1/2.8mm	$34,480	DBE Colon standard
PENTAX	VSB-3430K	2200/11.6	Video	Color CCD	EPK-I, EPK1000	1/3.8	$34,755	

TABLE 1.8. Video endoscope processors/Light sources

Manufacturer	Model #	Color system	Lamp (watt)	Compatibility	Cost ($)	Comments
OLYMPUS	CV-180	Color CCD	N/A	100 series endoscopes	23,500	Digital video processor with Narrow Band Imaging (NBI)
	CV-60	Fiber	N/A	Fiber Optic (OSF-V60)	7,300	Combed video processor, light source and air pump
	CLV-180	Light Source	Xenon (300)	CV-180	13,400	Light source for color CCD with Narrow Band Imaging (NBI)
	CLK-4	Light Source	Halogen (150)	Fiber Optic (OSF-4)	1,165	Simplified light source
FUJINON	EPX-2500	HD	N/A	EG,EC, series	$20,870	Digital Video Processor and Lightsource
	EPX-4400HD	HD	N/A	EG,EC,EN,ES,ED series	$34,500	Digital Video Processor and Lightsource, with FICE
						Note: HD is ONLY available from DVI/HD-SDI output of EPX-4400HD and DVI output of EPX-2500
						FICE: Flexible spectral Imaging Color Enhancement
PENTAX	EPK-i	Color CCD	Xenon (300)	Fiber, 30K, 70K, 90K, 90i series	$36,750	Software upgradeable, iScan, HD video system
	EPK-1000	Color CCD	Xenon (100)	Fiber, 30K, 70K, 90K series	$24,255	Standard Definition video system
	LH-150PC	Light Source	Halogen (150)	Fiber	$1,268	

Please note that all PENTAX video processors include an integrated light source.
Please note that all PENTAX video processors and endoscopes have FULL SCREEN image.

TABLE 1.9. US processors

Manufacturer	Model #	Scanning type/ Frequency (MHz)	Scanning orientation	Endoscope compatibility	Cost ($)	
OLYMPUS	EU-ME1	Mechanical & Electronic	Radial/Longitudinal	All Olympus EUS/EBUS scopes and probes	$79,900	
	SSD-a10	Electronic	Radial/Longitudinal	All Olympus Electronic EUS/ EBUS scopes	$214,450	
					???	
PENTAX	HI VISION 5500		Radial/Longitudinal	All PENTAX Ultrasound Endoscopes	$82,500	
	HI VISION 900		Radial/Longitudinal	All PENTAX Ultrasound Endoscopes	$175,000	includes Sonoelastography
	HI VISION 900b		Radial/Longitudinal	All PENTAX Ultrasound Endoscopes	$150,000	NO Sonoelastography