

The most invasive approach for visualization of the entire small bowel is intraoperative enteroscopy. In this procedure, a surgeon makes an incision in the patient's abdomen and then pleats the small bowel onto the enteroscope while the endoscopist visualizes the lumen. Once a lesion has been identified, the surgeon may elect to proceed directly to a resection of the affected segment of small intestine if the lesion is not amenable to endoscopic treatment.

### Video Capsule Endoscopy

The desire to obtain visualization of the GI lumen in the least invasive way has resulted in the development of video capsule endoscopy, in which the patient swallows a pill-sized wireless camera (E-Fig. 34-1; Video 34-1). Capsule endoscopes are now available for evaluation of the esophagus and small intestine, and development of colon capsule endoscopes is underway. Capsules are 11 × 26 mm and can transmit images wirelessly to a data recorder as they travel through a patient's GI tract, without the need for sedation. At the end of the study, the stored images are uploaded into a computer for viewing while the capsule is ultimately passed in the patient's stool.

The esophageal capsule is helpful in patients being screened for esophageal varices and in those with suspected complications of acid reflux, such as reflux esophagitis or Barrett's esophagus. The small bowel capsule has become the "gold standard" for visualization of the small intestine, most commonly for the purpose of investigating obscure GI bleeding (E-Figs. 34-2 and 34-3; Videos 34-2 and 34-3) or suspected inflammatory bowel disease (E-Figs. 34-4 and 34-5). Retention of the capsule within the small bowel, usually at a site of pathology, occurs rarely but is the main potential complication of capsule endoscopy.

### Sigmoidoscopy and Colonoscopy

Flexible sigmoidoscopy allows visualization of the rectum, sigmoid colon, and descending colon to the level of the splenic flexure. Enemas are given before the procedure to clear stool from the distal colon. Because sigmoidoscopy is quick (<10 minutes) and not particularly painful, sedation typically is not necessary, making it a convenient tool for colorectal cancer screening. Sigmoidoscopy may also be useful for evaluating chronic diarrhea and rectal bleeding suspected to arise from the distal colon or rectum and for assessing response to therapy in patients with inflammatory bowel disease involving the rectosigmoid colon.

Colonoscopy allows direct visualization of the entire large bowel and the terminal ileum. Bowel cleansing for colonoscopy requires the ingestion of osmotically active solutions, such as polyethylene glycol, coupled with a clear liquid diet for 24 hours before the procedure. Colonoscopy can be more uncomfortable for the patient than sigmoidoscopy due to stretching and distention of the colon, so sedation and analgesia are typically provided. In recent years, colonoscopy has become widely performed as a first-line colorectal cancer screening test. Other indications for colonoscopy include evaluation of chronic diarrhea, iron deficiency anemia, and overt or occult GI blood loss, as well as assessment of inflammatory bowel disease, including surveillance for dysplasia. Therapeutic interventions that can be performed during colonoscopy include polypectomy, thermal ablation of vascular ectasias, decompression of colonic dilation associated

with pseudo-obstruction, stenting of malignant obstruction, and control of lower GI bleeding.

### Endoscopic Retrograde Cholangiopancreatography

Endoscopic retrograde cholangiopancreatography (ERCP) is a combined endoscopic and radiographic procedure for imaging the biliary and pancreatic ducts. A *duodenoscope* is an instrument specially designed for use during ERCP that includes an imaging lens oriented on the side of the endoscope's tip, allowing a direct view of the ampulla of Vater on the medial wall of the second portion of the duodenum. An adjustable instrument *elevator* located at the tip of the duodenoscope helps the endoscopist guide a catheter into the duct of interest. Contrast material is then injected through the catheter, filling the duct, and fluoroscopic images are obtained (Fig. 34-3).

Indications for ERCP include evaluation and treatment of bile duct obstruction due to benign or malignant causes (e.g., bile duct stones, strictures, bile duct or pancreatic malignancies), cholangitis, postoperative or traumatic bile leaks and pancreatic duct leaks, drainage of pseudocysts, and evaluation of idiopathic pancreatitis. With the use of a special manometry catheter, sphincter of Oddi pressures can be measured in cases of suspected sphincter of Oddi dysfunction. Therapeutic interventions that are possible during ERCP include sphincterotomy (an incision through the sphincter of Oddi using a catheter with an electrocautery cutting wire), removal of bile duct stones, and placement of biliary or pancreatic duct stents to alleviate signs and symptoms of obstruction or to promote healing of duct leaks. ERCP carries a significant (5%) risk for complications, including pancreatitis, postsphincterotomy bleeding, and perforation. Therefore, ERCP should be performed only if therapeutic benefits are anticipated.

*Choledochoscopy* and *pancreatoscopy* are techniques in which an endoscope 3 mm or less in diameter is passed through the accessory channel of a duodenoscope and into the bile or pancreatic duct. The use of this small endoscope permits direct visualization of ductal abnormalities, guides electrohydraulic lithotripsy of large stones, and allows for direct sampling of ductal lesions.

### Endoscopic Ultrasound

Endoscopic ultrasound (EUS), or endosonography, is performed with an endoscope containing an ultrasound transducer in its tip. Because this transducer can be placed within the GI lumen, high-resolution images of the bowel wall can be obtained, revealing distinct layers that correspond to the mucosa, submucosa, muscularis propria, and serosa (Fig. 34-4). This technique allows the endoscopist to stage tumor depth and determine the layer of origin of a subepithelial mass. In addition, EUS can penetrate the luminal wall, providing sonographic images of adjacent structures within the mediastinum and upper abdomen, including the pancreas, liver, gallbladder, mesenteric vessels, and adrenal glands. High-frequency EUS catheter probes can be passed through the accessory channel of a duodenoscope and into the biliary or pancreatic duct to provide sonographic images of small tumors and stones. They can likewise be used through a standard endoscope to evaluate diminutive subepithelial lesions and to stage obstructing esophageal cancers.

