injected during fluoroscopic imaging to visualize the vessel's lumen. Visceral angiography is used to evaluate mesenteric vessels in the setting of GI bleeding or suspected mesenteric ischemia. For GI bleeding, angiography is sensitive enough to detect blood loss of as little as 1 to 1.5 mL/minute. Once the site of bleeding has been localized, the radiologist can infuse vasopressin (a vasoconstrictor) or embolize the vessel using tiny coals or gelatin sponges to ensure hemostasis. In the setting of mesenteric ischemia, angiography permits localization of a vascular stenosis or obstruction, followed by possible therapeutic interventions such as balloon angioplasty, stent placement, or infusion of vasodilators and thrombolytics. Other indications for angiography include the placement of transjugular intrahepatic portosystemic shunts (TIPS) in cirrhotic patients with intractable variceal bleeding or refractory ascites and the chemoembolization of liver tumors.

Radionuclide Imaging

Technetium-99m (^{99m}Tc) is currently the major radionuclide used in GI imaging. Its 6-hour half-life and ready availability make it ideal for clinical use. ^{99m}Tc can be used to label various substances for use in several imaging techniques. ^{99m}Tc-sulfur colloid scanning and ^{99m}Tc-labeled red blood cell scanning are two distinct methods that can be used to detect active GI bleeding. The latter uses the patient's own blood cells to carry the radionuclide throughout the body. These methods can detect as little as 0.05 to 0.4 mL/minute of blood loss. However, localization of the site of bleeding is less accurate than with angiography. ^{99m}Tc scans are often performed before angiography to document ongoing bleeding before subjecting a patient to the more invasive, less sensitive study. A ^{99m}Tc-labeled red blood cell scan can also be used to diagnose hepatic hemangioma with an almost 100% positive predictive value.

Cholescintigraphy using ^{99m}Tc-iminodiacetic acid (IDA) analogues is the most commonly performed liver study in nuclear medicine. The radionuclide is taken up by the liver, is excreted into bile, and passes through the biliary tree into the gallbladder and duodenum. Failure to visualize the gallbladder during a hepatobiliary IDA scan may indicate cholecystitis secondary to cystic duct obstruction by a gallstone. Meckel's diverticulum can be a source of abdominal pain and bleeding, but it may be difficult to visualize with standard endoscopic and radiographic imaging. The agent ^{99m}Tc-pertechnetate has a high affinity for gastric mucosa and is therefore used to demonstrate the presence of this congenital anomaly.

Gastric emptying studies are useful for the evaluation of suspected gastroparesis. Patients are given a ^{99m}Tc-sulfur colloid–labeled standardized meal (consisting of liquid egg whites, toast, jam or jelly, and water) and are imaged at 0, 1, 2 and 4 hours after meal ingestion. Gastric retention of more than 10% of contents at 4 hours is highly sensitive and specific for delayed gastric emptying.

PROSPECTUS FOR THE FUTURE

Through continued technologic advances, endoscopic and radiologic image quality and resolution will also continue to improve. In addition, the GI lumen will no longer be regarded as a boundary to therapeutic endoscopy. Examples of expected innovations include the following.

- *The implementation of natural orifice transluminal, endoscopically guided surgical procedures.* With the use of recently introduced instruments, an endoscopist will be able to incise the GI tract wall, advance an endoscope into the peritoneal cavity, and then perform surgical procedures such as cholecystectomy. Endoscopic bariatric procedures for the treatment of obesity are also on the horizon and are likely to be in high demand given the obesity epidemic. A new field of *endosurgery* will develop to accompany these advances and will require training in both surgical principles and gastroenterology.
- *Commercial availability of new endoscopic imaging methods, such as confocal microscopy and fluorescence endoscopy.* Confocal microscopy allows an endoscopist to obtain magnified endoscopic images similar to those seen with a low-power microscope. Fluorescence endoscopy entails the use of special wavelengths of light to excite naturally occurring fluorophores in benign and neoplastic tissue. These fluorophores, such as collagen and nicotinamide adenine dinucleotide plus hydrogen (NADH), then fluoresce in a predictable manner, providing a means of identifying, by endoscopy, otherwise microscopic changes (e.g., dysplasia) without the need for a biopsy.
- *Video capsule endoscopes with advanced diagnostic and possibly therapeutic capabilities.* Through further advances in nanotechnology, video capsule endoscopes will be able to sample GI secretions, measure intraluminal pressures, take biopsy samples, and perhaps even provide focal ablation of lesions using thermal energy or radiofrequency ablation.

For a deeper discussion on this topic, please see Chapter 134, "Gastrointestinal Endoscopy," in Goldman-Cecil Medicine, *25th Edition.*

SUGGESTED READINGS

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