focal masses or cysts, ascites, biliary ductal dilation, gallstones, and large vessel thromboses. It may detect thickening of the gut wall and areas of intussusception. Ultrasound is also used to guide needle placement for biopsies or fluid aspiration. Ultrasound cannot penetrate bone or air, preventing its use as a more general diagnostic tool for the GI tract.

Computed Tomographic Methods

Computed tomography (CT) uses computer-aided reconstruction of multiple radiographic images obtained in a circular or helical course around a patient's vertical axis. Internal organs are visualized based on their inherent tissue densities compared with their surroundings. The GI lumen is usually opacified by having the patient drink an oral contrast agent. In addition, intravenous contrast agents can be administered to highlight regions with increased blood flow, thereby improving detection of pathologic lesions such as tumors and areas of active inflammation.

CT can detect parenchymal lesions, such as tumors, cysts, and abscesses, and can define the size, shape, and characteristics of organs such as the liver and spleen. Vascular abnormalities (e.g., perigastric varices, large vessel thromboses) and intra-abdominal fluid (e.g., ascites) can also be seen with CT. The caliber and contour of the GI tract wall are demonstrated by CT, aiding in the diagnosis of inflammatory lesions such as colitis, diverticulitis, and appendicitis. CT may also be used to guide needle biopsies of abdominal masses and to place electrodes into tumors for ablative therapies such as radiofrequency ablation. The use of CT to guide placement of drainage catheters has made possible the percutaneous treatment of intra-abdominal abscesses, pseudocysts, and pancreatic necrosis.

CT enteroclysis and *CT enterography* are two emerging techniques that were developed to provide better images of the small intestine. CT enteroclysis uses a nasojejunal tube to deliver contrast material into the small intestine, whereas CT enterography uses an orally ingested low-density intraluminal contrast agent to distend the lumen and highlight the small intestinal mucosa (Fig. 34-7). With the advancement of this technology and its ability to reconstruct images in multiple planes, both luminal and extraluminal information can be obtained.

CT can also be used to obtain high-resolution images of the colon. CT colography, or *virtual colonoscopy*, makes use of special image reconstruction software to create accurate visualization of the colonic lumen, provided that the patient has completed a bowel-cleansing regimen identical to that used for colonoscopy (although techniques that do not require such preparation are being developed). These CT images are 70% to 90% sensitive for detecting polyps or masses within the colon, helping to determine which patients need therapeutic colonoscopy. Virtual colonoscopy is being used in some centers to complete colonic visualization in the setting of an incomplete colonoscopy.

FIGURE 34-7 Computed tomography enterography. A long segment of inflamed terminal ileum is demonstrated in this patient with Crohn's disease. (Courtesy Christopher S. Huang.)

Magnetic Resonance Methods

Similar to CT, magnetic resonance imaging (MRI) provides multiple cross-sectional images of the abdomen and pelvis. These images are created using powerful field magnets to orient small numbers of nuclei within the body in such a way as to produce a measurable magnetic moment. MRI avoids radiation exposure but requires the patient to lie almost motionless, often within a small enclosed tube, for prolonged periods. MRI can visualize parenchymal lesions such as masses and cysts and may better characterize abnormalities seen on CT, such as hemangiomas, hepatic focal nodular hyperplasia, and fatty liver. MRI is also helpful in better characterizing perirectal abscesses and fistulas in patients with Crohn's disease. Special rectal MRI probes or coils can provide detailed images of rectal cancer used for tumor staging and can evaluate anal sphincters in patients with fecal incontinence.

MRI of the biliary and pancreatic ducts (*magnetic resonance cholangiopancreatography*, or MRCP) is a noninvasive method that can detect ductal dilation, strictures, stones (Fig. 34-8), pancreatic parenchymal changes in chronic pancreatitis, and congenital ductal abnormalities such as pancreas divisum. *Magnetic resonance angiography* is a magnetic resonance method for visualizing blood vessels that serves as an important noninvasive tool in patients with suspected mesenteric ischemia, vasculitis, or other vascular anomalies.

Visceral Angiography

Angiography is an invasive technique whereby a catheter is introduced into a blood vessel and intravascular contrast material is

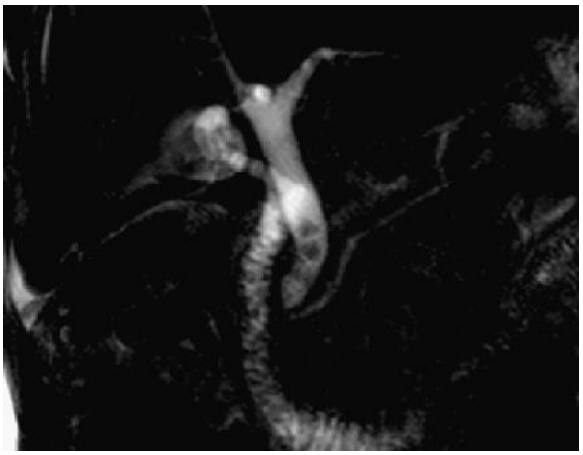

FIGURE 34-8 Magnetic resonance cholangiopancreatography. Several stones are visualized within the common bile duct, appearing as hypointense filling defects on T2-weighted images. (Courtesy Christopher S. Huang.)