

Gastroenterologic and Radiologic Approach to Obscure Gastrointestinal Bleeding: How, Why, and When?¹

ONLINE-ONLY CME

See www.rsna.org/education/lrg_cme.html

LEARNING OBJECTIVES

After reading this article and taking the test, the reader will be able to:

- Discuss obscure gastrointestinal bleeding and its main causes.
- List the diagnostic imaging modalities used to assess obscure gastrointestinal bleeding.
- Describe a diagnostic approach to obscure gastrointestinal bleeding according to the patient's clinical presentation.

*Bruno M. Graça, MD • Paulo A. Freire, MD • Jorge B. Brito, MD
José M. Ilharco, MD • Vitor M. Carneiro, MD • Filipe
Caseiro-Alves, MD, PhD*

Gastrointestinal (GI) bleeding is a common clinical condition that is increasingly seen in an aging population and frequently requires hospitalization and intervention, with significant morbidity and mortality. Obscure GI bleeding (OGIB) is defined as loss of blood with no source identified after upper endoscopy and colonoscopy. Whether an obscure site of bleeding is clinically evident or silent, it constitutes a diagnostic and therapeutic challenge for the clinician. Gastroenterology and radiology provide the essential diagnostic tools used to evaluate suspected OGIB, each with its strengths and weaknesses. Small bowel series and conventional enteroclysis have a limited role in OGIB. Computed tomographic (CT) enterography and CT enteroclysis are noninvasive techniques with promising results in evaluation of small bowel disease and silent OGIB. CT angiography is a useful triaging tool for diagnosing or excluding active GI hemorrhage, localizing the site of bleeding, and guiding subsequent treatment. Tagged red blood cell scanning is the most sensitive technique for detection of active GI bleeding and allows imaging over a prolonged period, making it useful for detecting intermittent bleeding. Capsule endoscopy has emerged as an important tool for investigating OGIB, but it may soon have competition from double-balloon enteroscopy, a diagnostic technique that can also facilitate therapy.

©RSNA, 2010 • radiographics.rsna.org

Abbreviations: GI = gastrointestinal, MIP = maximum intensity projection, OGIB = obscure GI bleeding, RBC = red blood cell

RadioGraphics 2010; 30:235–252 • **Published online** 10.1148/rg.301095091 • **Content Codes:** **CT** **GI** **VI**

¹From the Department of Radiology, Coimbra University Hospital, Praceta Mota Pinto/Av. Bissaya Barreto, 3000-075 Coimbra, Portugal. Presented as an education exhibit at the 2008 RSNA Annual Meeting. Received April 14, 2009; revision requested June 22 and received September 4; accepted September 8. All authors have no financial relationships to disclose. **Address correspondence to** B.M.G. (e-mail: brunomiguel@inbox.com).

The Editor has no relevant financial relationships to disclose.

©RSNA, 2010

Introduction

The management of gastrointestinal (GI) bleeding often involves a multispecialty approach in which radiologists and gastroenterologists play a key role, providing several specialized diagnostic examinations with a variety of imaging modalities as well as therapeutic interventions. The ultimate objective is to localize, characterize, and, when indicated, treat the bleeding lesion.

Obscure GI bleeding (OGIB) refers to bleeding from the GI tract that persists or recurs without an obvious cause after esophagogastroduodenoscopy and colonoscopy. OGIB may be categorized into obscure overt bleeding and obscure silent bleeding on the basis of the presence or absence of clinically evident bleeding. Silent OGIB may manifest as amounts of blood detectable only with chemical tests in the stool or as iron deficiency anemia. Overt OGIB is high-volume bleeding manifesting as hematemesis, melena, or hematochezia without an identified source after initial upper endoscopy and colonoscopy (1,2).

GI bleeding leads to more than 300,000 hospitalizations per year. Approximately 10%–20% of these patients do not have an identified bleeding source, leading to extensive testing (3). In this article, we present an overview of the diagnostic imaging modalities used in OGIB, including small bowel series and conventional enteroclysis, computed tomography (CT), CT enterography and enteroclysis, CT angiography, radionuclide imaging, catheter-directed angiography, wireless capsule endoscopy, and double-balloon enteroscopy. We also describe a rational diagnostic approach in patients with OGIB according to the clinical presentation.

Causes of OGIB

The source of OGIB may be attributable to any of a number of different causes (Table), including missed lesions in the upper and lower GI tract. The age of the patient is an important factor in the differential diagnosis of a small intestinal source of OGIB (5).

Determining the origin of the bleeding source in OGIB is a challenging clinical problem. Approximately 5% of patients presenting with GI bleeding have no source identified at esophagogastroduodenoscopy and colonoscopy; most of these patients will have small bowel disease identified (6,7). Small bowel vascular lesions are the most common cause. The most common pathologic lesions in this group are angiodysplasias, found in 30%–60% of examinations (8). Of unknown cause, these lesions are relatively common throughout the GI tract. Small bowel

Causes of OGIB

Upper GI lesions

- Cameron erosions
- Fundic varices
- Peptic ulcer
- Angiectasia
- Dieulafoy lesion
- Gastric antral vascular ectasia

Middle GI lesions

- In patients <40 years of age
 - Tumors
 - Meckel diverticulum
 - Dieulafoy lesion
 - Crohn disease
 - Celiac disease
- In patients >40 years of age
 - Angiectasia
 - NSAID* enteropathy
 - Celiac disease
- Uncommon lesions
 - Hemobilia
 - Hemosuccus pancreaticus
 - Aortoenteric fistula

Lower GI lesions

- Angiectasia
- Neoplasms

Sources.—References 1 and 4.

*NSAID = nonsteroidal anti-inflammatory drug.

tumors are the next most common small bowel lesion causing OGIB and account for 5%–10% of cases of small bowel bleeding (9). Other less common causes of bleeding include small bowel ulcers (eg, Crohn disease, use of nonsteroidal anti-inflammatory drugs, Meckel diverticulum), vasculitis, small bowel diverticula, aortoenteric fistulas, and caliber-persistent arteries of the stomach (Dieulafoy lesion) (4).

Imaging Techniques

Small Bowel Series and Conventional Enteroclysis

The role of small bowel series and conventional enteroclysis in the evaluation of OGIB has declined substantially with the advent of newer imaging techniques owing to the low diagnostic yield of the former two techniques (10). Available data suggest that unless malignancy or Crohn disease is suspected, small bowel series and conventional enteroclysis have little use in the evaluation of OGIB (4).

Computed Tomography

With the development of multidetector technology with submillimeter collimation and faster scanning speeds, CT now has the potential to

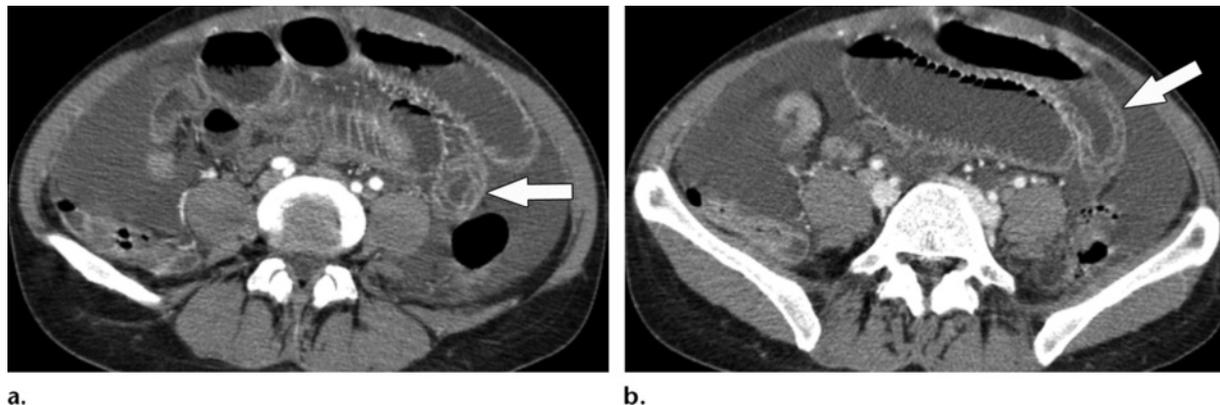


Figure 1. Small bowel involvement in a 34-year-old woman with systemic lupus erythematosus who presented with lower abdominal pain, diarrhea, weight loss, anemia, and positive results from a fecal occult blood test. Axial enteric phase (**a**) and portal venous phase (**b**) CT images show ascites and marked mural thickening and target appearance of a small bowel loop (arrow), findings consistent with small bowel involvement by systemic lupus erythematosus.

play a role in evaluation of patients with GI bleeding. Most of the studies in the literature on the use of CT in evaluation of GI bleeding focused on patients with acute bleeding. In this group of patients, a CT examination with thin collimation, rapid intravenous administration of contrast material, and appropriate scan timing with acquisition of an arterial phase, yielding an angiographic study, may be beneficial in identifying the exact source of the bleeding. In patients with silent OGIB, a standard CT examination of the abdomen and pelvis could demonstrate larger lesions, whereas CT techniques involving small bowel luminal distention, like CT enterography and CT enteroclysis, may be beneficial in identifying small enhancing bowel wall lesions.

These special CT techniques are reviewed in the next sections.

CT Enterography and Enteroclysis

CT examination of the small bowel is a recently developed diagnostic tool for evaluation of small bowel disease. The introduction of neutral oral contrast agents with improved luminal distention and advances in CT technology have converged to provide new CT imaging techniques specific for the small bowel known as CT enterography and CT enteroclysis. Whereas in CT enterography luminal distention is achieved by ingestion (11), in CT enteroclysis contrast medium is administered into the small intestine through a nasojejunal tube under fluoroscopic guidance (12).

Technique.—Recently, a multiphase CT enterography-enteroclysis protocol has been introduced for evaluation of OGIB (13). Because of the requirement for rapid, multiphase imaging, this technique should be performed on at least a 16-row multidetector scanner. After a 6-hour

fast, patients are given a total of 1200–1600 mL of neutral oral contrast agent, either through a tube at a rate of 60–120 mL/min (CT enteroclysis) or divided into four oral doses given every 20 minutes, beginning 60 minutes before scanning; the last dose is administered with the patient on the CT table just before scanning (CT enterography). Intravenous administration of a spasmolytic drug is essential before image acquisition to minimize patient discomfort and bowel motion artifact (11–13).

During intravenous injection of 150 mL of iodinated contrast material at a rate of 4 mL/sec through an antecubital catheter, bolus triggering is performed by placing a region-of-interest cursor over the descending aorta 2 cm above the diaphragm. The region-of-interest trigger threshold is set at 150 HU, with scanning initiated 6 seconds later. Scanning is performed from the diaphragm to the symphysis pubis during each of three phases: (*a*) a bolus-triggered arterial phase, (*b*) at 20–25 seconds (enteric phase), and (*c*) at 70–75 seconds (delayed phase) after the beginning of the arterial phase acquisition. Axial images are reconstructed with a 2-mm section width and 1-mm interval. Coronal images are reformatted from the retroperitoneal border to the anterior abdominal wall with a 2-mm section width and 1-mm interval.

Identification of the Bleeding Cause.—The isotropic spatial resolution provided with newer multidetector CT systems allows us to visualize small vascular lesions responsible for bleeding in multiple orthogonal planes. The use of neutral enteric contrast material provides a background against which enhancing bowel wall lesions (Figs 1–5) and active bleeding can be detected (13).

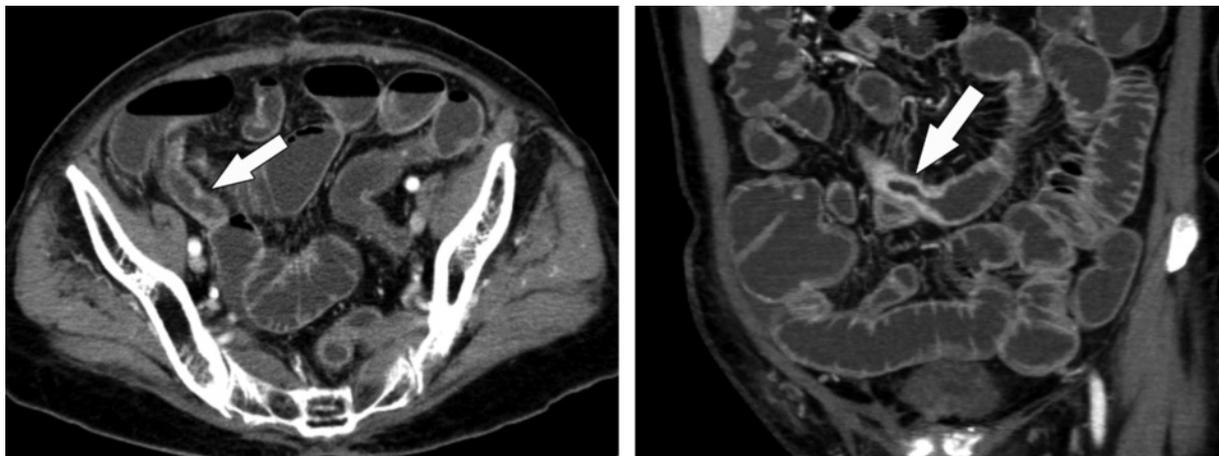


Figure 2. Radiation enteritis in a 72-year-old woman with colicky abdominal pain and unexplained anemia. She had undergone external-beam radiation therapy to the pelvis for cervical carcinoma. Axial (**a**) and coronal (**b**) maximum intensity projection (MIP) enteric phase images from CT enterography show ileal luminal narrowing and a thickened enhanced bowel wall (arrow), findings consistent with radiation enteritis.



Figure 3. Polypoid jejunal lesion in a 53-year-old man with positive results from a fecal occult blood test. Coronal (**a**) and sagittal (**b**) MIP enteric phase images from CT enterography show a hyperattenuating polypoid lesion (arrow) in the jejunum.

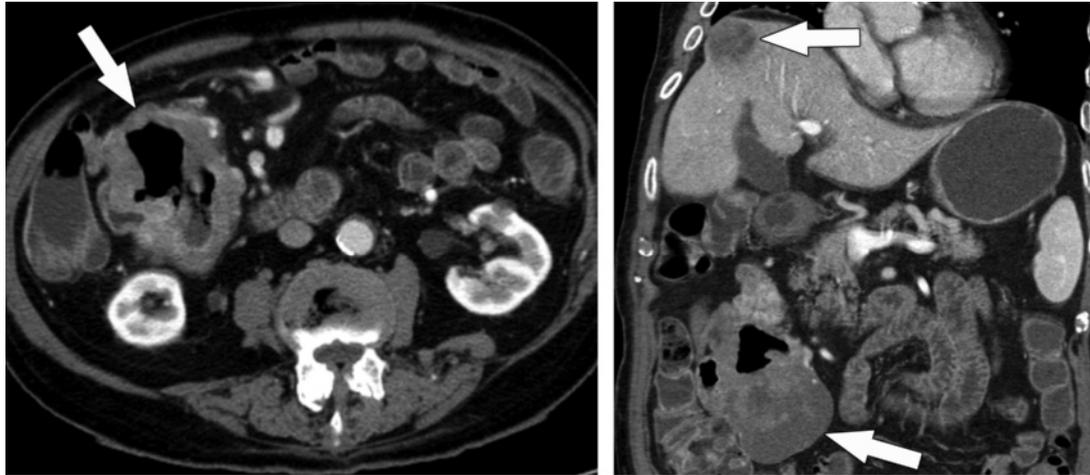
Indications and Advantages.—CT enterography and enteroclysis improve visualization of the small bowel mucosa and wall in comparison with traditional CT and fluoroscopic studies by distending the small bowel. Although CT enterography is performed with oral hyperhydration, CT enteroclysis requires placement of an enteroclysis tube, often in patients who are unable to orally consume that amount of liquid. When tolerated, CT enterography is often preferred owing to its lack of invasiveness.

In patients with OGIB, these techniques may help determine the cause of the bleeding lesion,

allowing improved interventional planning and lesion-directed planning. Similarly to other CT techniques, another advantage is the possibility of depicting extraintestinal disease (Figs 1, 4) (13–15). **CT enterography and enteroclysis are indicated in silent OGIB, with no data favoring one technique over the other (15,16).** The long and relatively complex preexamination preparation precludes the use of these techniques in clinically overt OGIB (13).

Disadvantages.—The three-phase acquisition results in substantial patient radiation exposure. Another major limitation of CT enterography-en-

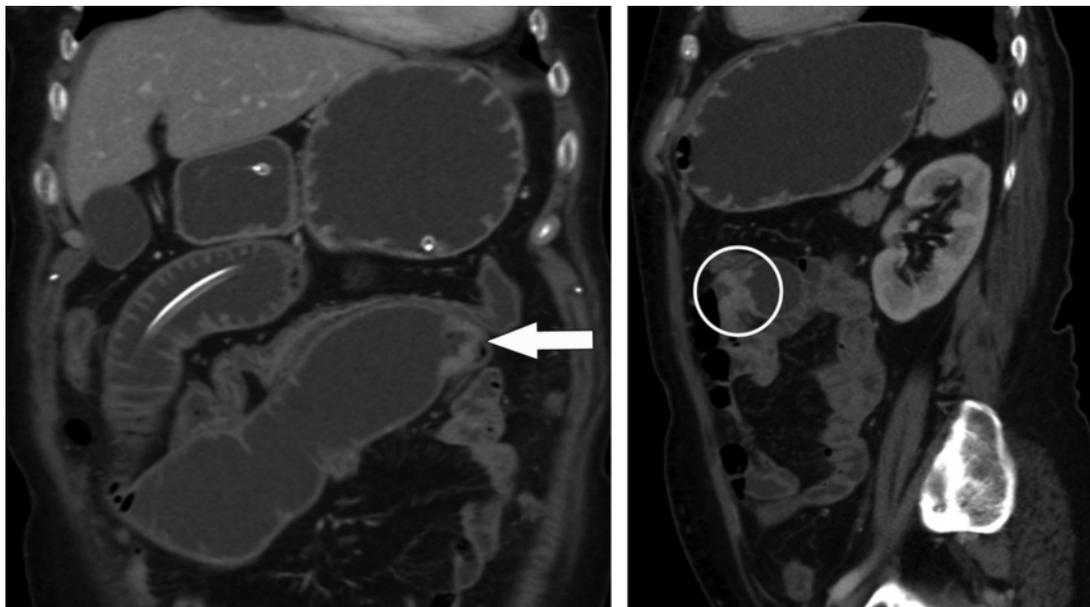
Teaching
Point



a.

b.

Figure 4. Gastrointestinal stromal tumor in a 92-year-old man with anemia and positive results from a fecal occult blood test. **(a)** Axial enteric phase CT image shows aneurysmal dilatation of the terminal ileum (arrow). **(b)** Coronal MIP enteric phase image from CT enteroclysis shows aneurysmal dilatation of the terminal ileum by an exophytic mass (bottom arrow). There is one hepatic metastasis (top arrow). The surgical specimen revealed a gastrointestinal stromal tumor.



a.

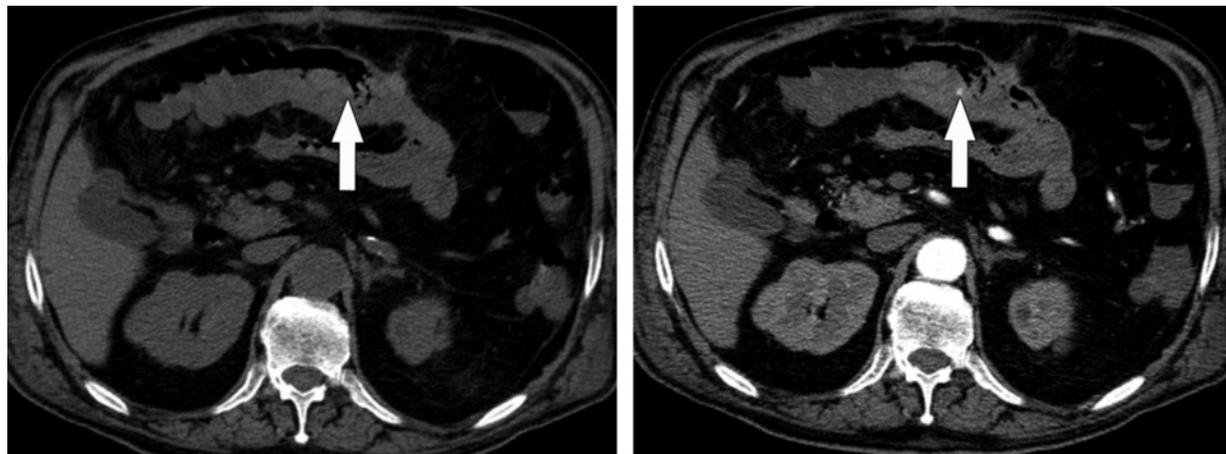
b.

Figure 5. Adenocarcinoma in a 60-year-old man with anemia and subacute bowel obstruction. Coronal **(a)** and sagittal **(b)** MIP portal venous phase images from CT enteroclysis show parietal thickening and enhancement of the proximal jejunum (arrow in **a**, circle in **b**), resultant marked stenosis, and dilatation of the proximal small bowel. The surgical specimen revealed adenocarcinoma.

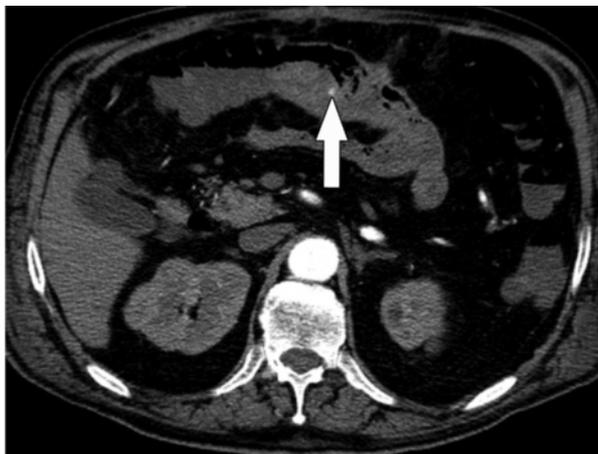
teroclysis is the impossibility of performing therapeutic maneuvers. These techniques do not allow prolonged imaging times, which are necessary for detection of intermittent bleeding. Preexisting high-attenuation material within the bowel may limit the detection of active bleeding.

CT Angiography

Recent advances in CT technology have greatly expanded the diagnostic role of CT angiography for various pathologic processes. Although still



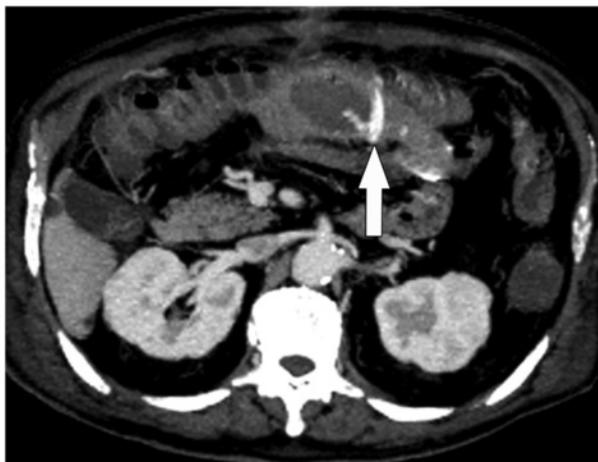
a.



b.



c.



d.

Figure 6. Active colonic bleeding in a 69-year-old man with massive hematochezia from an ileotransversostomy. (a) Axial unenhanced CT image shows a fluid-filled transverse colonic loop (arrow). (b, c) Axial arterial phase (b) and portal phase (c) CT images, obtained at the same level, show highly attenuating extravasated contrast material (arrow) in the lumen of the transverse colon. (d, e) Axial (d) and coronal (e) MIP CT images show active bleeding into the transverse colon (arrow).



e.

undergoing study, CT angiography seems to be a promising noninvasive diagnostic tool in the evaluation of OGIB, particularly the overt variant.

Technique.—CT angiography requires no special preparation. The acquisition technique is similar to that of CT enterography-enteroclysis, only differing in the choice of scanning phases. In patients with overt OGIB, an unenhanced CT scan should be obtained immediately before CT angiography to identify any preexisting hyperattenuating areas

within the bowel lumen that could be confused with hemorrhage. After administration of intravenous contrast material, enteric phase images should be obtained (17).

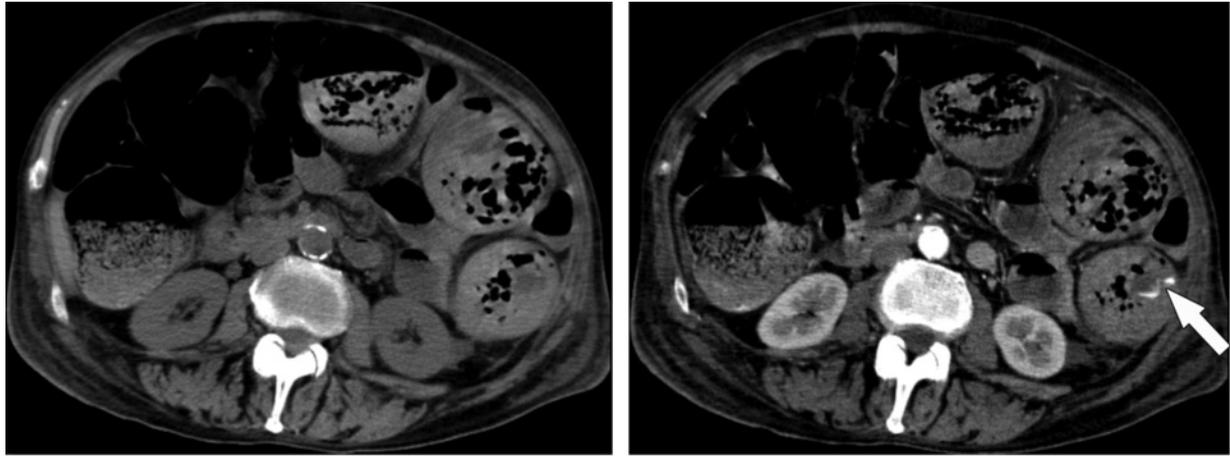


Figure 7. Large vascular lesion in a 71-year-old man with massive hematochezia. (Results of colonoscopy were inconclusive owing to excess fluid and massive hemorrhage.) **(a)** Axial unenhanced conventional CT image shows fluid-filled colonic loops. **(b)** Axial enteric phase conventional CT image, obtained at the same level, shows highly attenuating extravasated contrast material (arrow) in the lumen of the descending colon. The patient underwent surgical treatment, which confirmed the presence of a large vascular lesion.

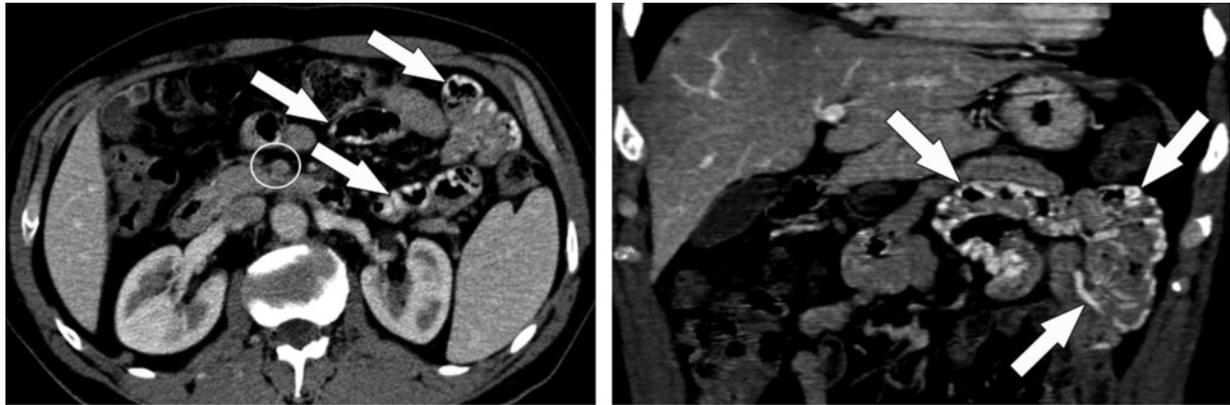


Figure 8. Jejunal varices in a 59-year-old man with melena and anemia. **(a)** Axial portal venous phase conventional CT image shows thrombosis of the superior mesenteric vein (circle) and high-attenuation dilated and tortuous variceal structures along the jejunal wall (arrows). **(b)** Coronal MIP portal venous phase CT image shows high-attenuation dilated and tortuous variceal structures along the jejunal wall (arrows), findings indicative of jejunal varices.

Identification of the Bleeding Cause.—The CT angiographic diagnosis of active GI bleeding is made when hyperattenuating extravasated contrast material not present at unenhanced CT is seen within the bowel lumen (Figs 6, 7) (18). Evaluation of GI bleeding with CT angiography may also provide etiologic information in many cases, especially with lower GI bleeding, as has been demonstrated in the evaluation of colonic vascular lesions, with a sensitivity of 70% and specificity of 100% when compared with colonoscopy and conventional angiography (19).

Distinguishing diverticular from angiodysplastic bleeding (when possible) is important because of the prognostic differences between these two lesions. CT angiography can also help accurately diagnose neoplasms and colitis, the third and fourth most common causes of lower GI bleeding, respectively (17). Rare causes of OGIB, like jejunal varices (Fig 8) and aortoenteric fistula (Fig 9), can also be found.

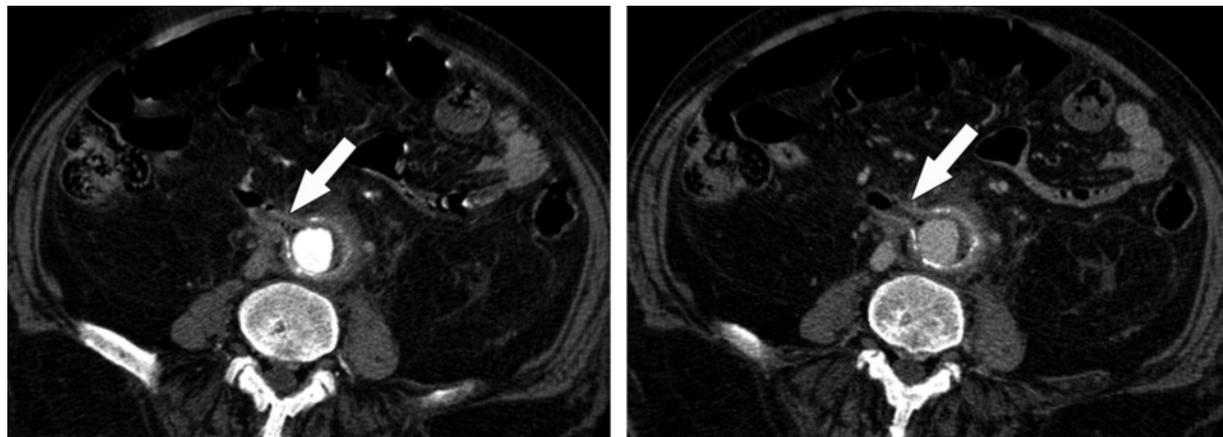
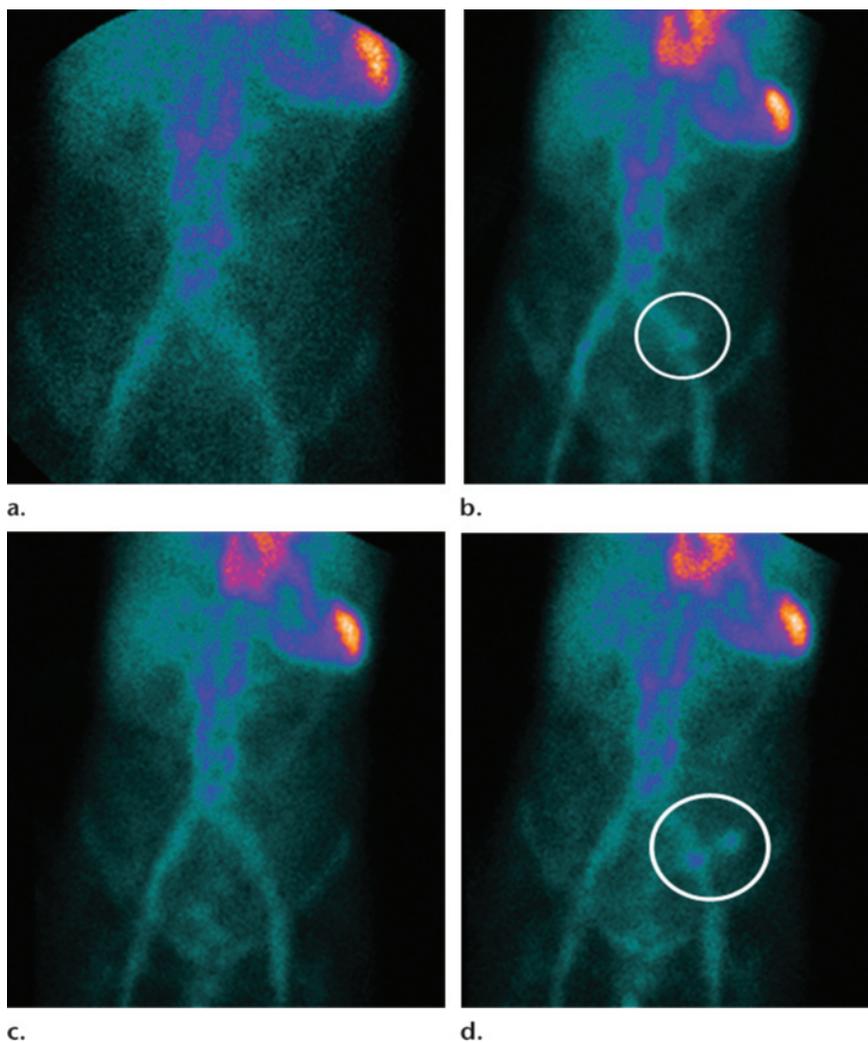


Figure 9. Aortoenteric fistula in a 73-year-old man with a history of aortic repair who presented with acute anemia and melena. Axial arterial phase (**a**) and portal venous phase (**b**) conventional CT images show inflammatory alterations and gas surrounding the aortic graft. The fourth portion of the duodenum is closely adjacent to the aorta, with a fistulous tract (arrow) between the two structures.

Figure 10. Intraluminal accumulation of radiotracer activity in a 75-year-old man who presented with intermittent bright rectal bleeding. Dynamic radionucleide images of the abdomen, obtained 30 minutes (**a**), 2 hours (**b**), 3 hours (**c**), and 4 hours (**d**) after intravenous administration of ^{99m}Tc -labeled RBCs, show a focus of intermittent bleeding (circle in **b** and **d**) in the left lower quadrant. The bleeding was from a distal small bowel source.



Indications and Advantages.—Strengths of this technique include noninvasiveness and sensitivity for low rates of bleeding (0.5 mL/min) (20).

CT angiography is rapid and easy to perform in comparison with conventional angiography.

Yoon et al (17) conducted a CT angiographic study of 26 consecutive patients with acute GI

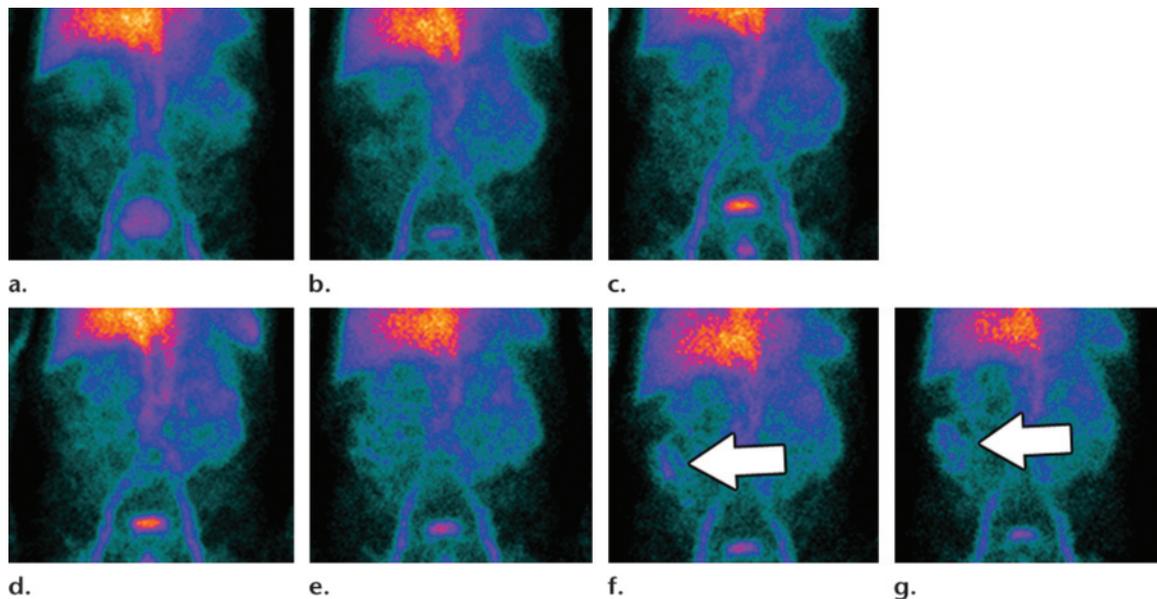


Figure 11. Increasing intensity of intraluminal radiotracer activity over time in a 79-year-old woman who presented with melena. Dynamic radionuclide images of the abdomen, obtained 1 hour (a), 2 hours (b), 3 hours (c), 4 hours (d), 5 hours (e), 6 hours (f), and 7 hours (g) after intravenous administration of ^{99m}Tc -labeled RBCs, show a focus of bleeding (arrow in f and g) in the ileum. The bleeding focus is apparent beginning at 5 hours.

bleeding. Their preliminary study demonstrated good overall location-based sensitivity, specificity, accuracy, positive predictive value, and negative predictive value for CT angiography in detection and localization of GI bleeding (17).

In the setting of acute lower GI bleeding, we find CT angiography a useful triaging tool to (a) obviate an angiographic examination with negative findings, (b) localize the site of bleeding, (c) determine whether surgery or embolization should be the next treatment, (d) discover abnormal vascular anatomy that may preclude or modify the approach to angiography, and (e) obtain additional information about the pathologic condition and the prognosis for the cause of bleeding.

CT angiography can also assist in determining the endoscopic approach, especially when clinical localization of bleeding to the upper or lower GI tract is difficult or unreliable. This situation may occur because endoscopy often fails to depict the exact focus of bleeding when massive bleeding (>1 mL/min) occurs, since excessive blood or clots in the gastroduodenal tract impair the endoscopic view (21). Conversely, localization of bleeding within the small bowel may prevent unnecessary endoscopic examinations while expediting endovascular or surgical interventions.

Disadvantages.—As with all CT, CT angiography results in substantial patient radiation exposure, although this disadvantage is mitigated by the fact that most patients are elderly and their disease may be life-threatening in the short term. CT angiography does not permit therapeutic ma-

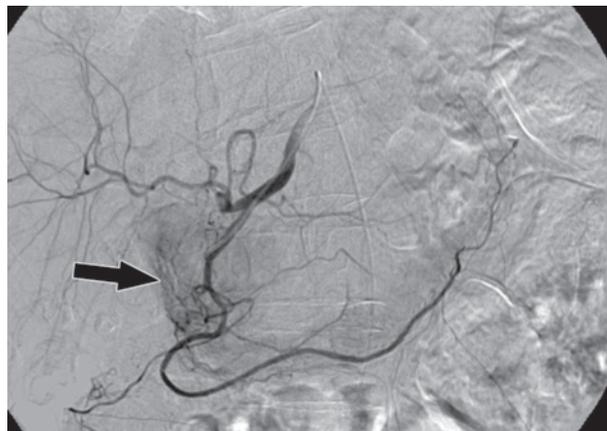
neuvors nor prolonged imaging times, which are necessary for detection of intermittent bleeding. Preexisting high-attenuation material within the bowel may also limit detection of active bleeding.

Radionuclide Imaging

Scintigraphy of GI bleeding is most commonly performed with technetium 99m (^{99m}Tc)-labeled red blood cells (RBCs); this technique allows acute and delayed imaging owing to the persistence of labeled RBCs in the circulation. Tagged RBC scanning is considered to be the standard of reference for detection of active lower GI bleeding, as it reportedly allows detection of active bleeding at a rate of 0.10 mL/min (22).

Technique.—Twenty mL of RBCs are tagged with technetium and then reinjected into the patient. In general, images are obtained every 3 seconds for the first minute, every 5 minutes for the next 45 minutes, and then every 15–60 minutes according to the clinical setting (22).

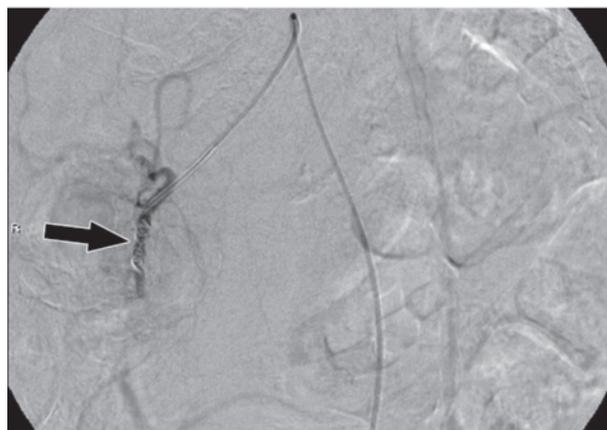
Identification of the Bleeding Cause.—Criteria for identifying the site of GI bleeding include intraluminal accumulation of radiotracer activity (Fig 10), increasing intensity of intraluminal activity over time (Fig 11), and movement of the radiotracer on successive images, a finding consistent with intraluminal transit. In this way, it is possible to determine the presence or absence of bleeding and, where appropriate, the most likely source of the bleeding (23).



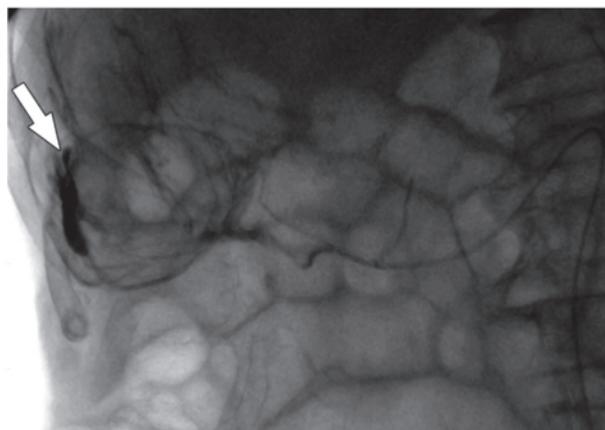
12a.



13a.



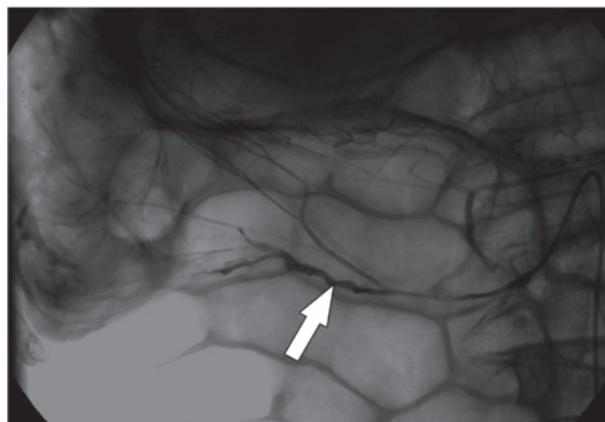
12b.



13b.



12c.



13c.

Figures 12, 13. (12) Active GI hemorrhage in a 67-year-old woman with melena and bleeding that obscured endoscopic findings. (a) Selective angiogram of the gastroduodenal artery shows contrast material extravasation into the duodenal lumen (arrow). (b, c) Gastroduodenal artery (b) and celiac trunk (c) angiograms, obtained after coil embolization (arrow), show stoppage of the GI bleeding. (13) Active GI hemorrhage in an 82-year-old man with hematochezia. (a) Colonoscopic image of the right colon shows a large quantity of blood, which obscures the colonoscopic findings. (b) Selective angiogram of the ileocolic artery shows contrast material extravasation into the colonic lumen (arrow). (c) Ileocolic artery angiogram obtained after coil embolization (arrow) shows stoppage of the GI bleeding.

Teaching Point

Indications and Advantages.—Tagged RBC scanning is the most sensitive technique for detecting active GI bleeding and offers advantages in being noninvasive, not requiring special preparations for the patient, and allowing detection of both arterial and venous bleeding sites, whereas catheter-directed angiography allows detection of only arterial bleeding. Moreover, tagged RBC scanning offers the capability of imaging over a prolonged period, making it useful for detecting intermittent bleeding (Fig 10). Because of its mode of action, radionuclide scanning of bleeding is not useful in the setting of silent OGIB.

Disadvantages.—In patients with OGIB, there are several drawbacks to nuclear scanning. First, the ability to localize the source of bleeding with radionuclide scanning, especially in the foregut, has been repeatedly demonstrated to be poor; even a positive scan does not allow determination of the cause of the bleeding. In addition, because nuclear scanning is not therapeutic, a follow-up study, such as catheter-directed angiography or endoscopic examination, must be subsequently performed (24).

Catheter-directed Angiography

Catheter-directed angiography is more likely to demonstrate an exact location of the bleeding if the rate is greater than 0.5 mL/min (25). In addition, it allows identification of nonbleeding lesions (eg, vascular ectasias, tumors, and inflammatory lesions) on the basis of their vascular patterns. Interventional radiologists may also administer specific embolization therapy if the lesion is amenable to such therapy.

If results of standard angiography are negative, provocative angiography may be considered. In this type of study, anticoagulants, vasodilators, and thrombolytics are used to provoke bleeding and increase the likelihood that a bleeding source will be found (26). Because these tests could initiate uncontrolled bleeding, they are rarely used and are usually not recommended.

Technique.—Catheter-directed angiography for GI bleeding is usually performed from a common

femoral artery access with the Seldinger technique. Upper extremity arterial access can be used when femoral access is not possible; upper extremity access may even be necessary, as it often provides better angles for catheterization of mesenteric vessels relative to the abdominal aorta. A 4-F or 5-F cobra or Simmons catheter is typically chosen for selection of the superior mesenteric artery, and diagnostic angiography is performed with 30–35 mL of nonionic contrast material injected at a rate of 5–6 mL/sec. For selection of the inferior mesenteric artery, a 5-F Simmons II catheter is typically chosen, and diagnostic angiography is performed with 15–20 mL of nonionic contrast material injected at 2–3 mL/sec.

Selective catheterization for upper GI bleeding includes the celiac and superior mesenteric arteries; for lower GI bleeding, selective catheterization includes the superior and inferior mesenteric arteries. The initial artery catheterized is the one most suspected of bleeding on the basis of prior imaging or endoscopic results; this would of course be the celiac artery for upper GI bleeding. For lower GI bleeding, if bleeding from the descending and sigmoid colon is suspected, then inferior mesenteric angiography should be performed initially, before the bladder is filled with contrast material, to maximize detection of small lesions (27).

Identification of the Bleeding Cause.—Contrast material extravasation into the bowel lumen is the definitive angiographic sign of active GI hemorrhage (Figs 12, 13), but for extravasation to be visualized, bleeding must be active at a minimum rate of 0.5 mL/min (25). Indirect signs of bleeding include contrast material filling of spaces outside the bowel lumen (diverticula), vascular tufts (Fig 14) and early draining veins (angiodyplasia), hyperemia (colitis), neovascularity (tumor), pseudoaneurysm, or arteriovenous fistula (28).

Embolization of the bleeding vessel (Figs 12, 13) is the mainstay of transcatheter treatment of nonvariceal GI bleeding, and high technical and

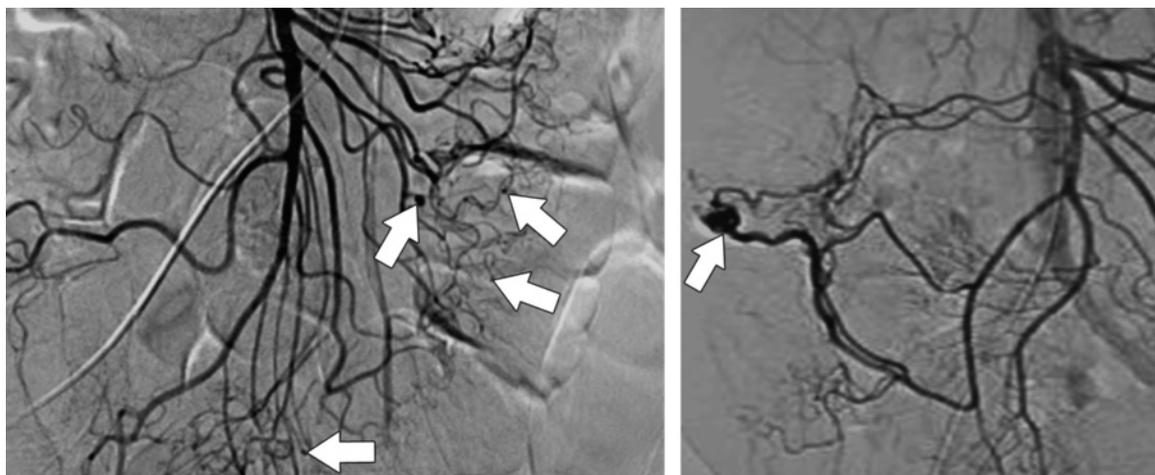


Figure 14. Hereditary hemorrhagic telangiectasia (Osler-Weber-Rendu syndrome) in a 45-year-old man with anemia, epistaxis, and oral telangiectases. Images from catheter-directed angiography of the mesenteric vessels show small telangiectases in the dependence of the colon (arrows in **a**) and a larger vascular malformation in the wall of the left colon (arrow in **b**).



a.
Figure 15. Close-up (**a**) and panoramic (**b**) photographs of a wireless capsule endoscope (PillCam; Given Imaging, Yoqneam, Israel).



b.

clinical success rates have been reported (29). Microcoil embolization is typically preferred within the lower GI tract (30), whereas controversy exists about the optimal agent within the upper GI tract. Common embolic agents include microcoils, polyvinyl alcohol particles, Gelfoam (absorbable gelatin sponge; Pharmacia & Upjohn, Kalamazoo, Mich), *n*-butyl cyanoacrylate glue, and enbucrilate tissue adhesive.

Indications and Advantages.—Catheter-directed angiography seems to be useful in patients with overt OGIB. Ideally, these patients should first be evaluated with CT angiography, to localize the bleeding lesion and plan the approach to catheter-directed angiography. Patients with early positive nuclear scans, postoperative patients, and patients with severe bleeding not diagnosed or unable to be treated with endoscopy are also

suitable to be studied preferentially with catheter-directed angiography. Catheter-directed angiography is generally reserved for specific situations in which other modalities have failed. One of its greatest advantages is the ability to localize the bleeding site and perform therapeutic interventions upon detection. This technique is not useful in patients with silent OGIB because the blood loss is often too low to be detected (4).

Disadvantages.—In patients with OGIB, the major drawbacks to catheter-directed angiography are the invasive nature of the procedure; the associated risks related to vascular access and other catheter-related complications (the most feared by far has been bowel ischemia); the risk of contrast material reactions; and the impossibility of achieving prolonged imaging times, preventing the detection of intermittent bleeding (25,27–30).

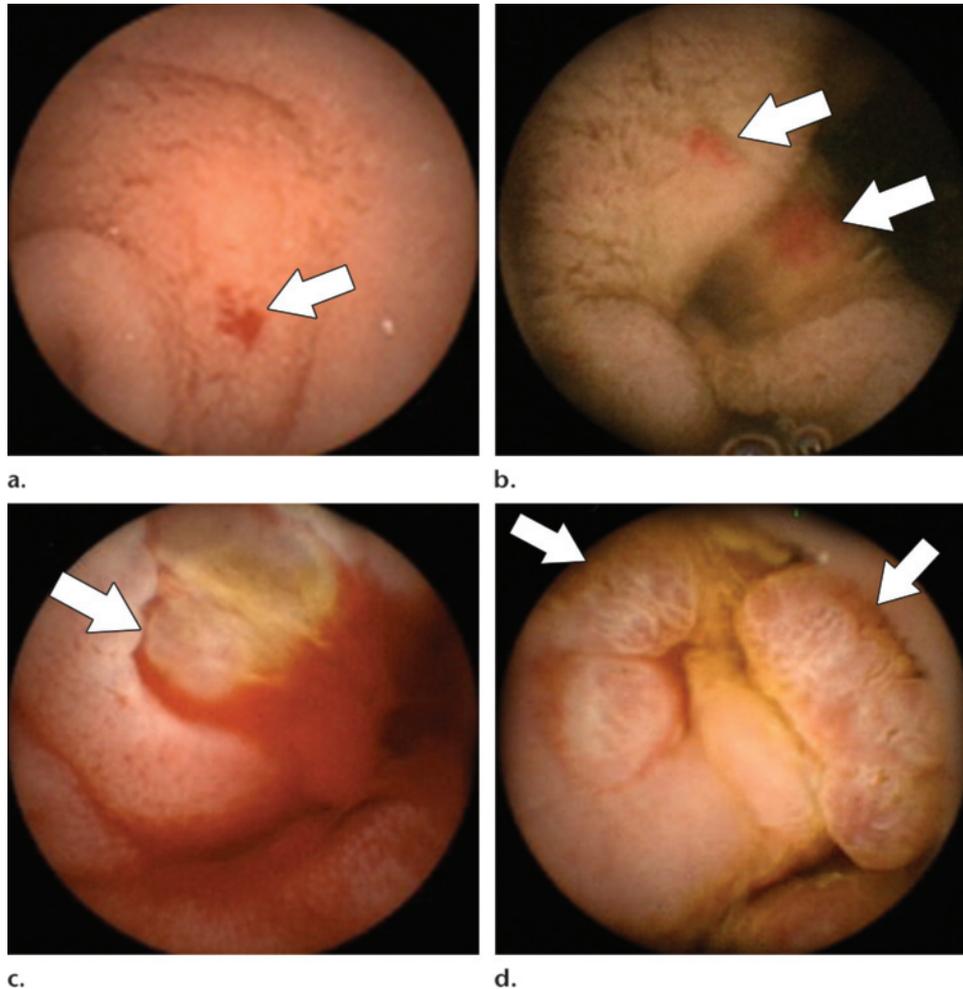


Figure 16. Results of wireless capsule endoscopy in four patients with OGIB. Images from capsule endoscopy show small bowel lesions suspected of being responsible for bleeding: angiodysplasias (arrows in **a** and **b**), bleeding ileal ulceration (arrow in **c**), and a jejunal tumor (arrows in **d**).

Wireless Capsule Endoscopy

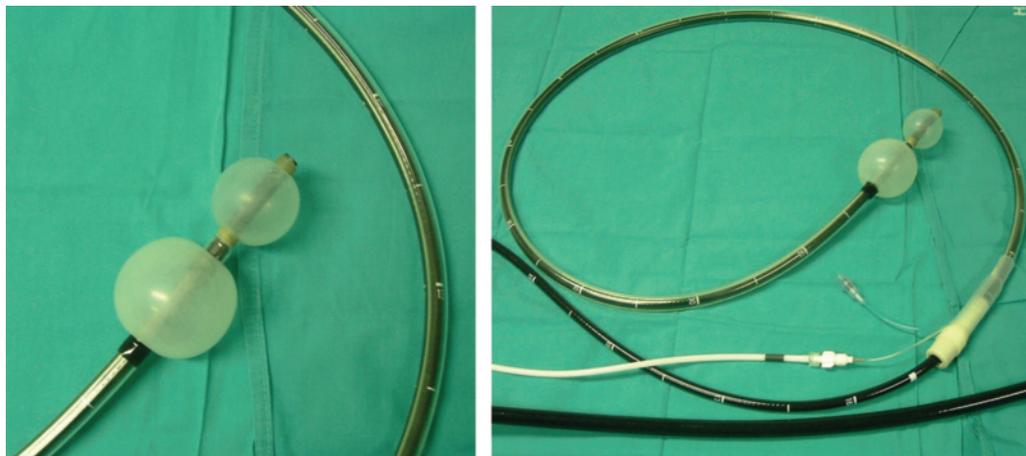
The development of capsule endoscopy has permitted direct visualization of the small bowel mucosa. So far, OGIB is the main clinical indication for capsule endoscopy; about 70%–80% of patients undergoing capsule endoscopy have OGIB (31,32).

Technique.—Capsule endoscopy uses a 26 × 11-mm plastic capsule (Fig 15), which contains four light-emitting diodes, a lens, a camera, two batteries, and a radiofrequency transmitter. Patients typically undergo preprocedure preparation (ranging from simple fasting to cathartic cleansing) to clear the GI tract (32).

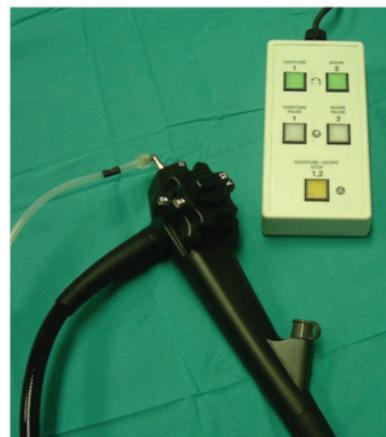
After the patient swallows the capsule, it is passively propelled by peristalsis and captures images of the entire length of the small intestine, transmitting the data to a recording device worn

by the patient. Images are transmitted by radio-frequency to an eight-point abdominal sensory array taped to the patient's abdomen and recorded on a portable digital recorder worn on a belt. The images are viewed with dedicated software after downloading to a computer workstation. The procedure is completely ambulatory. The patient is not confined to a medical institution and is allowed to continue daily activities (32).

Identification of the Bleeding Cause.—The most common findings include vascular lesions, small bowel malignancies, and small bowel ulcerations (Fig 16). Several studies have further supported the role of capsule endoscopy in the evaluation of OGIB, with an overall diagnostic yield between 50% and 70% (33–35).



a.
b.
Figure 17. Double-balloon enteroscope. **(a)** Close-up photograph shows the insufflated latex balloons at the distal end of the enteroscope. **(b, c)** Photographs show an overall view **(b)** and the controller mechanisms **(c)** of the enteroscope.



c.

Indications and Advantages.—Capsule endoscopy is currently the preferred test for mucosal imaging of the entire small intestine and seems to be most useful in patients with a history of recent active bleeding (33). Subgroup analysis shows that the diagnostic yield is much higher in patients with ongoing overt OGIB than in those with silent OGIB. Current data suggest that the timing of the procedure is very important in optimizing the yield of capsule endoscopy in OGIB (36). The International Conference on Capsule Endoscopy consensus meeting on OGIB recommended that capsule endoscopy should be performed early (preferably within 2 weeks) in the work-up of patients with OGIB (37).

Disadvantages.—The main limitations of capsule endoscopy are the lack of air insufflation, the unavailability of rinsing, and the inability to perform biopsies or treat lesions (31,33,34). As with conventional endoscopy of the upper and lower GI tract, the presence of massive hemorrhage can obscure the bleeding site (21).

There is a risk of retention of the endoscopic capsule, estimated at less than 1% and generally related to the presence of endoluminal narrowing.

To reduce this risk, patients with high suspicion of bowel narrowing (history of nonsteroidal anti-inflammatory drug use, Crohn disease, occlusive symptoms, or ischemic bowel disease) should undergo capsule endoscopy only after undergoing other techniques, such as CT enterography-enteroclysis, small bowel series, or exploration with a patency capsule (38).

Double-Balloon Enteroscopy

Yamamoto et al (39) established a new double-balloon insertion method for enteroscopy. This method enables endoscopic inspection of the entire small bowel with interventional capabilities.

Technique.—The double-balloon enteroscopy system (Fig 17) consists of a high-resolution video endoscope with a working length of 200

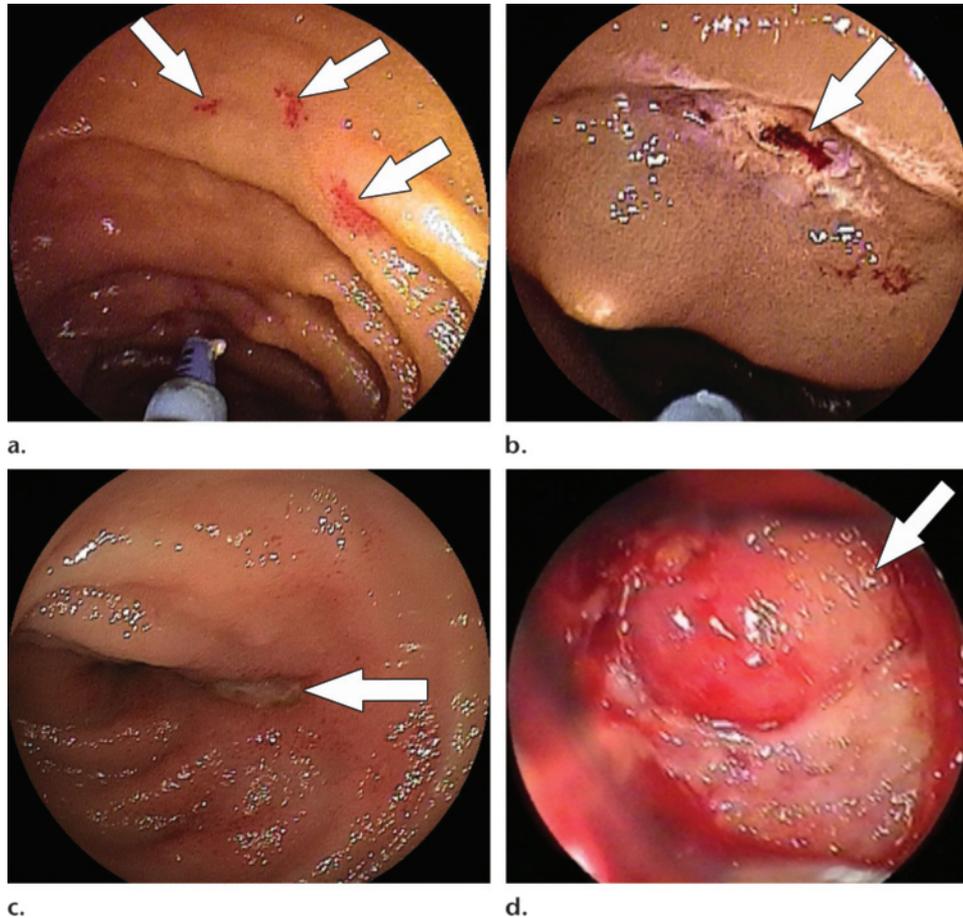


Figure 18. Results of double-balloon enteroscopy in four patients with OGIB. Images from double-balloon enteroscopy show small bowel lesions suspected of being responsible for bleeding: angiodysplasias (arrows in **a** and **b**), ileal ulceration (arrow in **c**), and jejunal adenocarcinoma (arrow in **d**). Arrow in **b** = angiodysplasia treated with argon plasma.

cm. Latex balloons are attached at the tip of the enteroscope, and the overtube is inflated and deflated with air. The scope can be advanced by mouth or per anus by using the balloons in a pushing and pulling manner to pleat the small bowel over the scope and visualize the small intestine. This method allows insertion deep into the small bowel in steps of 20 cm on average and is also known as push-and-pull enteroscopy. Endoscope insertion to the distal small intestine is generally carried out from an anal approach.

As preparation for double-balloon enteroscopy, the patient must fast overnight for the oral approach; for the anal approach, preparation is the same as for colonoscopy. For all lesions observed with double-balloon enteroscopy, biopsy specimens are obtained and the lesion is treated as necessary (39).

Identification of the Bleeding Cause.—Diagnostic or therapeutic success is achieved in 55%–75% of examinations, a result comparable to those of other diagnostic modalities in the small bowel. This method is likely to be one of the better techniques for detection and treatment of mucosal lesions. The most common findings include small bowel vascular lesions followed by ulcerations and malignancies (Fig 18) (40).

Indications and Advantages.—One of the main advantages of double-balloon enteroscopy is that it not only allows confirmation of the diagnosis suspected with capsule endoscopy or radiologic examination, but also allows biopsy and therapeutic approaches in most patients with OGIB.

Teaching
Point



Figure 19. Algorithm for the imaging work-up of patients with OGIB. *DB* = double-balloon, *Mes* = mesenteric.

Endoscopic therapeutic treatment may be by injection (epinephrine, alcohol) or may be thermal (Fig 18a, 18b) (heater probe, electrocoagulation, laser) (40).

Disadvantages.—In patients with OGIB, the major limitations to double-balloon enteroscopy are the impossibility of visualizing the entire small bowel in one examination; limited availability; the presence of massive hemorrhage, which can obscure the bleeding site; and the associated risks of pancreatitis and visceral perforation (41).

Clinical Scenarios and Diagnostic and Therapeutic Approach

The diagnostic and therapeutic approach to patients with OGIB will vary according to the clinical presentation of the bleeding. Figure 19 offers a suggested systematic approach to diagnosis and treatment of OGIB according to the clinical presentation. This guideline has not been clinically validated.

Silent OGIB

Patients presenting with silent OGIB who have previously undergone upper endoscopy and colonoscopy should undergo repeat upper endos-

copy or colonoscopy (4). A significant number will have an identifiable lesion found with these procedures. If no lesions are seen, the patient should undergo CT enterography-enteroclysis. Although there are no data favoring CT enterography over CT enteroclysis in this clinical situation, the former is often preferred due to its lack of invasiveness. CT enteroclysis is reserved for patients who are unable to orally consume the required amount of liquid.

If a lesion is visualized with CT enterography-enteroclysis, the patient should be treated accordingly. If that study shows no lesion, the next step will be capsule endoscopy. If a lesion is detected, double-balloon enteroscopy should be performed with diagnostic and therapeutic intentions. Catheter-directed angiography should be reserved for the selected rare cases of silent OGIB where no diagnosis is obtained. If no lesions are seen, efforts to control the OGIB with pharmacologic therapy should be considered.

Overt OGIB

If the patient is in hemodynamically stable condition, we recommend repeating upper endoscopy and colonoscopy (4). If results are negative, tagged RBC scanning is our next diagnostic step. If results of radionuclide scanning are positive, the following step should be catheter-directed angiography with

therapeutic intentions. If the patient is actively bleeding and in unstable condition or results of radionuclide scanning are negative, CT angiography is indicated, followed by catheter-directed angiography if a bleeding source is identified. When significant bleeding is ongoing despite a thorough evaluation with negative results, laparotomy and intraoperative enteroscopy should be performed. If the patient is in stable condition and results of all these studies are negative, the OGIB is reclassified to the silent type.

Conclusions

OGIB is a relatively common problem facing internists, gastroenterologists, and surgeons in a typical clinical practice. There are multiple imaging modalities that are currently being used in the evaluation of OGIB. To optimize patient care, the radiologist must be familiar with the common causes of OGIB and the strengths and weaknesses of the various available imaging examinations.

Recognition of the cause and site of OGIB is instrumental to guide treatment planning, and the various imaging approaches should be tailored according to the clinical scenario.

References

1. American Gastroenterological Association medical position statement: evaluation and management of occult and obscure gastrointestinal bleeding. *Gastroenterology* 2000;118(1):197–201.
2. Gralnek IM. Obscure-overt gastrointestinal bleeding. *Gastroenterology* 2005;128(5):1424–1430.
3. Thompson JN, Salem RR, Hemingway AP, et al. Specialist investigation of obscure gastrointestinal bleeding. *Gut* 1987;28(1):47–51.
4. Raju GS, Gerson L, Das A, Lewis B; American Gastroenterological Association. American Gastroenterological Association (AGA) Institute technical review on obscure gastrointestinal bleeding. *Gastroenterology* 2007;133(5):1697–1717.
5. Leighton JA, Goldstein J, Hirota W, et al. Obscure gastrointestinal bleeding. *Gastrointest Endosc* 2003;58(5):650–655.
6. Szold A, Katz LB, Lewis BS. Surgical approach to occult gastrointestinal bleeding. *Am J Surg* 1992;163(1):90–92, discussion 92–93.
7. Chong J, Tagle M, Barkin JS, Reiner DK. Small bowel push-type fiberoptic enteroscopy for patients with occult gastrointestinal bleeding or suspected small bowel pathology. *Am J Gastroenterol* 1994;89(12):2143–2146.
8. Thompson JN, Hemingway AP, McPherson GA, Rees HC, Allison DJ, Spencer J. Obscure gastrointestinal haemorrhage of small-bowel origin. *Br Med J (Clin Res Ed)* 1984;288(6431):1663–1665.
9. Adler DG, Knipschild M, Gostout C. A prospective comparison of capsule endoscopy and push enteroscopy in patients with GI bleeding of obscure origin. *Gastrointest Endosc* 2004;59(4):492–498.
10. Malik A, Lukaszewski K, Caroline D, et al. A retrospective review of enteroclysis in patients with obscure gastrointestinal bleeding and chronic abdominal pain of undetermined etiology. *Dig Dis Sci* 2005;50(4):649–655.
11. Raptopoulos V, Schwartz RK, McNicholas MM, Movson J, Pearlman J, Joffe N. Multiplanar helical CT enterography in patients with Crohn's disease. *AJR Am J Roentgenol* 1997;169(6):1545–1550.
12. Maglinte DD, Bender GN, Heitkamp DE, Lappas JC, Kelvin FM. Multidetector-row helical CT enteroclysis. *Radiol Clin North Am* 2003;41(2):249–262.
13. Huprich JE, Fletcher JG, Alexander JA, Fidler JL, Burton SS, McCullough CH. Obscure gastrointestinal bleeding: evaluation with 64-section multiphase CT enterography—initial experience. *Radiology* 2008;246(2):562–571.
14. Paulsen SR, Huprich JE, Fletcher JG, et al. CT enterography as a diagnostic tool in evaluating small bowel disorders: review of clinical experience with over 700 cases. *RadioGraphics* 2006;26(3):641–657, discussion 657–662.
15. Filippone A, Cianci R, Milano A, Valeriano S, Di Mizio V, Storto ML. Obscure gastrointestinal bleeding and small bowel pathology: comparison between wireless capsule endoscopy and multidetector-row CT enteroclysis. *Abdom Imaging* 2008;33(4):398–406.
16. Huprich JE. Multi-phase CT enterography in obscure GI bleeding. *Abdom Imaging* 2009;34(3):303–309.
17. Yoon W, Jeong YY, Shin SS, et al. Acute massive gastrointestinal bleeding: detection and localization with arterial phase multi-detector row helical CT. *Radiology* 2006;239(1):160–167.
18. Laing CJ, Tobias T, Rosenblum DI, Banker WL, Tseng L, Tamarkin SW. Acute gastrointestinal bleeding: emerging role of multidetector CT angiography and review of current imaging techniques. *RadioGraphics* 2007;27(4):1055–1070.
19. Junquera F, Quiroga S, Saperas E, et al. Accuracy of helical computed tomographic angiography for the diagnosis of colonic angiodysplasia. *Gastroenterology* 2000;119(2):293–299.
20. Kuhle WG, Sheiman RG. Detection of active colonic hemorrhage with use of helical CT: findings in a swine model. *Radiology* 2003;228(3):743–752.
21. Vreeburg EM, Snel P, de Bruijne JW, Bartelsman JF, Rauws EA, Tytgat GN. Acute upper gastrointestinal bleeding in the Amsterdam area: incidence, diagnosis, and clinical outcome. *Am J Gastroenterol* 1997;92(2):236–243.
22. Zuckier LS. Acute gastrointestinal bleeding. *Semin Nucl Med* 2003;33(4):297–311.

23. Holder LE. Radionuclide imaging in the evaluation of acute gastrointestinal bleeding. *RadioGraphics* 2000;20(4):1153–1159.
24. Howarth DM, Tang K, Lees W. The clinical utility of nuclear medicine imaging for the detection of occult gastrointestinal haemorrhage. *Nucl Med Commun* 2002;23(6):591–594.
25. Nusbaum M, Baum S, Blakemore WS. Clinical experience with the diagnosis and management of gastrointestinal hemorrhage by selective mesenteric catheterization. *Ann Surg* 1969;170(3):506–514.
26. Bloomfeld RS, Smith TP, Schneider AM, Rockey DC. Provocative angiography in patients with gastrointestinal hemorrhage of obscure origin. *Am J Gastroenterol* 2000;95(10):2807–2812.
27. Kuo WT. Transcatheter treatment for lower gastrointestinal hemorrhage. *Tech Vasc Interv Radiol* 2004;7(3):143–150.
28. Lee EW, Laberge JM. Differential diagnosis of gastrointestinal bleeding. *Tech Vasc Interv Radiol* 2004;7(3):112–122.
29. Schenker MP, Duszak R Jr, Soulen MC, et al. Upper gastrointestinal hemorrhage and transcatheter embolotherapy: clinical and technical factors impacting success and survival. *J Vasc Interv Radiol* 2001;12(11):1263–1271.
30. Funaki B. Superselective embolization of lower gastrointestinal hemorrhage: a new paradigm. *Abdom Imaging* 2004;29(4):434–438.
31. Tatar EL, Shen EH, Palance AL, Sun JH, Pitchumoni CS. Clinical utility of wireless capsule endoscopy: experience with 200 cases. *J Clin Gastroenterol* 2006;40(2):140–144.
32. Mazzarolo S, Brady P. Small bowel capsule endoscopy: a systematic review. *South Med J* 2007;100(3):274–280.
33. Pennazio M, Santucci R, Rondonotti E, et al. Outcome of patients with obscure gastrointestinal bleeding after capsule endoscopy: report of 100 consecutive cases. *Gastroenterology* 2004;126(3):643–653.
34. Sturniolo GC, Di Leo V, Vettorato MG, et al. Small bowel exploration by wireless capsule endoscopy: results from 314 procedures. *Am J Med* 2006;119(4):341–347.
35. Triester SL, Leighton JA, Leontiadis GI, et al. A meta-analysis of the yield of capsule endoscopy compared to other diagnostic modalities in patients with obscure gastrointestinal bleeding. *Am J Gastroenterol* 2005;100(11):2407–2418.
36. Bresci G, Parisi G, Bertoni M, Tumino E, Capria A. The role of video capsule endoscopy for evaluating obscure gastrointestinal bleeding: usefulness of early use. *J Gastroenterol* 2005;40(3):256–259.
37. Pennazio M, Eisen G, Goldfarb N, ICCE. ICCE consensus for obscure gastrointestinal bleeding. *Endoscopy* 2005;37(10):1046–1050.
38. Fritscher-Ravens A, Swain CP. The wireless capsule: new light in the darkness. *Dig Dis* 2002;20(2):127–133.
39. Yamamoto H, Sekine Y, Sato Y, et al. Total enteroscopy with a nonsurgical steerable double-balloon method. *Gastrointest Endosc* 2001;53(2):216–220.
40. Manabe N, Tanaka S, Fukumoto A, Nakao M, Kamino D, Chayama K. Double-balloon enteroscopy in patients with GI bleeding of obscure origin. *Gastrointest Endosc* 2006;64(1):135–140.
41. Mensink PB, Haringsma J, Kucharzik T, et al. Complications of double balloon enteroscopy: a multicenter survey. *Endoscopy* 2007;39(7):613–615.

Gastroenterologic and Radiologic Approach to Obscure Gastrointestinal Bleeding: How, Why, and When?

Bruno M. Graça, MD, et al

RadioGraphics 2010; 30:235–252 • Published online 10.1148/rg.301095091 • Content Codes: **CT** **GI** **VI**

Page 238

CT enterography and enteroclysis are indicated in silent OGIB, with no data favoring one technique over the other (15,16).

Page 243

CT angiography can also assist in determining the endoscopic approach, especially when clinical localization of bleeding to the upper or lower GI tract is difficult or unreliable. This situation may occur because endoscopy often fails to depict the exact focus of bleeding when massive bleeding (>1 mL/min) occurs, since excessive blood or clots in the gastroduodenal tract impair the endoscopic view (21).

Page 245

Tagged RBC scanning is the most sensitive technique for detecting active GI bleeding and offers advantages in being noninvasive, not requiring special preparations for the patient, and allowing detection of both arterial and venous bleeding sites, whereas catheter-directed angiography allows detection of only arterial bleeding. Moreover, tagged RBC scanning offers the capability of imaging over a prolonged period, making it useful for detecting intermittent bleeding (Fig 10).

Page 248

Capsule endoscopy is currently the preferred test for mucosal imaging of the entire small intestine and seems to be most useful in patients with a history of recent active bleeding (33).

Page 249

One of the main advantages of double-balloon enteroscopy is that it not only allows confirmation of the diagnosis suspected with capsule endoscopy or radiologic examination, but also allows biopsy and therapeutic approaches in most patients with OGIB.