

Obscure Gastrointestinal Bleeding: Evaluation with 64-Section Multiphase CT Enterography—Initial Experience

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Abstract

This retrospective HIPAA-compliant study was approved by the institutional review board and institutional conflict of interest committee. Patients gave informed consent for use of medical records. The purpose of the study was to retrospectively evaluate the findings depicted at computed tomographic (CT) enterography performed with a 64-section CT system and by using neutral enteric contrast material and a three-phase acquisition in patients with obscure gastrointestinal bleeding (OGIB). Twenty-two outpatients (11 men, 11 women; age range, 37–83 years) with OGIB underwent CT enterography. Findings were compared with capsule and traditional endoscopic, surgical, and angiographic findings. CT enterographic findings were positive for a bleeding source in 10 (45%) of 22 patients. Eight of 10 positive findings at CT enterography were also positive at capsule endoscopy or subsequent clinical diagnosis. CT enterography helped correctly identify three lesions undetected at capsule endoscopy. Study results suggest that multiphase, multiplanar CT enterography may have a role in the evaluation of OGIB.

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Obscure gastrointestinal bleeding (OGIB) is defined as gastrointestinal bleeding with no source identified at upper and lower endoscopy (1).

Despite a thorough endoscopic examination, the origin of the blood loss remains unexplained in up to 52% of patients (1), who are usually treated with iron supplementation and observed for further bleeding.

Should further gastrointestinal bleeding occur, as it does in approximately one-half of patients (2), a second upper and lower endoscopy is generally performed in the hope that its results may reveal abnormalities not discovered at the initial examination. If repeat examination findings are negative, further investigation for a small-bowel bleeding source is usually indicated.

Investigation of the small bowel for a bleeding source can be performed by using several modalities. **Extended endoscopy** may help identify a lesion in about one-third of patients but is often unable to reach the distal small bowel. **Barium small-bowel examinations** have traditionally been a mainstay in the evaluation of small-bowel disease but lack sensitivity in the evaluation of OGIB (3-5).

Recently, **wireless capsule endoscopy** has been effectively used in the evaluation of OGIB. The sensitivity of capsule endoscopy for detection of small-bowel lesions that cause gastrointestinal bleeding ranges from 42% to 80% (6-12). While highly effective in the evaluation of small-bowel disease, capsule endoscopy has technical limitations (13,14) and there is a risk of capsule retention.

Computed tomographic (CT) enterography is a recently developed diagnostic tool for the evaluation of small-bowel disease. This technique uses multidetector CT combined with luminal distention of the small bowel by using neutral enteric oral contrast material. Image acquisition after intravenous contrast material administration is timed to optimize bowel wall enhancement. The ability to exquisitely depict bowel wall abnormalities, as well as extraintestinal disease, has made it an important tool at our institution in the evaluation of small-bowel disease, particularly inflammatory bowel disease (15-18).

Sixty-four-section CT systems permit an increase in both spatial and temporal resolution compared with eight- and 16-section systems. The

32-channel detector and flying focal spot in one system permit a spatial resolution of 0.4 mm in the z-axis—equivalent to the spatial resolution in the transverse plane (19). Additionally, the table speed can be increased, compared with that of most 16-section systems, which permits a volume to be scanned in a more homogeneous vascular phase. These improvements are theoretically important in detecting small vascular lesions, which often have a vascular blush that is visible for only short periods. The potential advantages of this new technology would seem well suited for the investigation of gastrointestinal bleeding. Thus, the purpose of our study was to retrospectively evaluate the findings depicted at CT enterography performed with a 64-section CT system and by using neutral enteric contrast material and a three-phase acquisition in patients with OGIB.

MATERIALS AND METHODS

This retrospective Health Insurance Portability and Accountability Act-compliant study was approved by our institutional review board and institutional conflict of interest committee. All patients consented to the use of their medical records for research purposes. The CT system used in this study was provided through a grant from Siemens Medical Solutions (Malvern, Pa). Two investigators (J.G.F., C.H.M.) received salary support from a grant from Siemens Medical Solutions, but they did not participate in the determination of the final diagnosis for each patient. An additional investigator (J.L.F.) received research support from E-Z-Em (Lake Success, NY). The principal investigator and gastroenterologist collaborator (J.E.H. and J.A.A., respectively) maintained exclusive control of all study data.

Patients

Twenty-two consecutive patients with OGIB who were referred by gastroenterologists at our institution for clinically indicated triple-phase CT enterography were included in this study. The study group consisted of 11 men and 11 women (mean age, 55.4 years; age range, 37–83 years) seen during an 8-month period. Nine patients had an overt type of OGIB (defined as the presence of hematochezia and/or melena, negative results at upper and lower endoscopy, and with or without iron deficiency anemia), while 13 patients had an occult type of OGIB

(positive fecal occult blood test result and/or iron deficiency anemia, negative result at upper and lower endoscopy, and no melena and hematochezia) (1). All patients were outpatients, and none had clinical signs of active bleeding at CT examination. Comorbid conditions included single cases of colectomy for ulcerative colitis, portal hypertension secondary to portal vein thrombosis, history of resection of periampullary gangliocytic paraganglioma, and von Willebrand disease.

When we first began use of triple-phase CT enterography at our institution, it was performed within an institutional review board-approved protocol and was approved by our Radiation Safety Committee.

Patient informed consent was obtained. This technique has since become clinically accepted and part of our clinical imaging procedures and has been requested by our referring clinicians.

All patients underwent prior conventional upper and lower endoscopy performed by one of eight staff gastroenterologists (including J.A.A.; each with 1–20 years of endoscopic experience). Fifteen patients underwent at least one additional prior upper and lower endoscopic examination. All endoscopic results were negative for an upper gastrointestinal or colonic source of bleeding. In two patients, fresh blood was seen in the terminal ileum orifice at colonoscopy. Incidental endoscopic findings thought by the endoscopist to be unrelated to recent gastrointestinal bleeding were found in 11 patients and included the following: mild esophagitis, $n = 2$; hiatal hernia, $n = 1$; colonic diverticulosis, $n = 2$; both hiatal hernia and colonic diverticulosis, $n = 1$; small gastric polyp, $n = 1$; small colon polyp, $n = 3$; and postoperative changes in the duodenum secondary to prior periampullary tumor resection, $n = 1$. In the remaining nine patients, endoscopic findings were negative.

Capsule endoscopy was performed in 13 (59%) of 22 patients. Capsule endoscopic findings were abstracted from clinical records by the gastroenterologist author (J.A.A.). The presence of intraluminal blood, mass, or vascular lesion was noted.

Triple-Phase CT Enterographic Technique

After a 4-hour fast, patients were given a total of 1800 mL of 0.1% (weight per volume) barium sulfate suspension (Volumen; E-Z-Em) divided into four 450-mL oral doses given every 20 minutes, beginning 60 minutes prior to scanning. The last dose was administered with the patient on the CT table just prior to scanning. All patients successfully ingested the required 1800 mL of enteric contrast material. Glucagon (Glucagen; Bedford Laboratories, Bedford, Ohio) (0.5 mg) was administered intravenously just before intravenous contrast material injection to minimize bowel motion artifact. One hundred fifty milliliters of iohexol (Omnipaque 300; GE Healthcare, distributed by Amersham Health, Princeton, NJ) was power injected intravenously at a rate of 4 mL/sec through an antecubital catheter. Scanning was performed by using a 64-section CT system (Sensation 64; Siemens Medical Solutions) from the diaphragm to the symphysis pubis during each of the following three phases: (a) a bolus-triggered arterial phase, (b) 20–25 seconds after the beginning of the arterial phase acquisition (enteric phase, during maximal bowel wall enhancement), and (c) 70–75 seconds after the beginning of the arterial phase acquisition (delayed phase).

Bolus triggering was performed by the CT technologist by using software (Care Bolus; Siemens Medical Solutions). A region-of-interest cursor was placed over the descending aorta 2 cm above the diaphragm. The region-of-interest trigger threshold was set at 150 HU, with scanning initiated 6 seconds later. Patients were scanned at 120 kVp and at a quality reference milliampere-seconds of 350 (effective). Collimation was 32 detector rows and 0.6-mm section thickness, with use of z-flying focal spot, resulting in 64 0.6-mm-wide projections that overlapped by 0.3 mm. Transverse images were reconstructed at a 2-mm section width and a 1-mm interval. Coronal multiplanar images were reconstructed from the retroperitoneal border to the anterior abdominal wall at a 2-mm section width and a 1-mm interval. Additional images, including three-dimensional, maximum intensity projection, and volume-rendered image reconstructions of data sets, were obtained at each radiologist's discretion but were not routinely used for primary interpretation.

Examination Interpretation and Comparison

Scans were interpreted by one of four gastrointestinal radiologists (J.E.H., J.G.F., J.L.F., and S.S.B., each with 8 years or more of experience interpreting CT studies of the gastrointestinal tract) who were blinded to clinical history and endoscopic and surgical findings. Primary image data consisted of three sets of transverse and coronal images with up to 500 images per set. Images were reviewed on workstations (Advantage Workstation, version 4.2; GE Healthcare, Piscataway, NJ).

Effective radiation dose to each patient was 59 mSv. Effective doses were calculated by the physicist author (C.H.M.) with scanner-specific published Monte Carlo organ dose coefficients ([20](#)), a software-based (Excel; Microsoft, Redmond, Wash) calculation tool ([21](#)), and the effective dose organ weighting factors established by the International Commission on Radiological Protection ([22](#)).

The demonstration of active bleeding (progressive accumulation of intraluminal contrast material) or abnormal bowel wall enhancement was considered a positive finding for gastrointestinal bleeding. Radiologists evaluated imaging findings by examining all three phases of enhancement simultaneously. Each radiologist noted (*a*) the presence and location of focal, abnormal enhancement; (*b*) scan phase in which enhancement was present; (*c*) the presence or absence of masses; (*d*) early draining veins; (*e*) evidence of active bleeding (progressive intraluminal contrast material accumulation); and (*f*) presumptive diagnosis. If abnormal enhancement was seen, the enhancement intensity was ranked as no visible enhancement (–), just visible (+), moderate intensity (++), or marked intensity (+++). One author (J.E.H.) compared the imaging findings with reports of capsule and conventional endoscopic results, surgical and angiographic findings, and clinical follow-up. The gastroenterologist author (J.A.A.), who did not participate in CT interpretation, determined the final diagnosis for each patient.

RESULTS

Twenty-one (95%) of 22 patients underwent technically successful triple-phase enterography. Failure to acquire the delayed phase occurred in one patient (patient 7) for technical reasons (Table 1).

Table 1.

Clinical, Capsule Endoscopic, and CT Enterographic Findings in Patients with Positive CT Enterographic Results

Patient No.	Clinical Finding	Capsule Endoscopic Finding	CT Enterographic Finding	Abnormal Focal Increased Enhancement*			Final Diagnosis	Reference Standard
				Arterial Phase	Enteric Phase	Delayed Phase		
1	IDA, hematochezia	Not performed	Meckel diverticulum (blind pouch in distal small bowel with prominent mucosal enhancement)	—	+	+	Meckel diverticulum	Surgery
2	Hematochezia	Negative	Cecal AVM (vascular tuft in cecum with early draining vein)	++	+	—	Cecal angiodysplasia	Conventional angiography
3	IDA, melena	Fresh blood in small bowel	Active bleeding in ascending colon (focal contrast material pooling over time)	+	++	+++	Actively bleeding colonic angiodysplasia	Colonoscopy
4	Melena	Negative	Vascular lesion (6-mm focal enhancement in jejunum)	++	+	—	Unknown vascular small-bowel lesion	CT findings duplicated at two follow-up CT examinations
5	IDA (transfusion dependent), melena	Negative	Active bleeding in distal ileum	—	+	+	Gastric antral vascular ectasia at repeat upper endoscopy	Normal small bowel at intraoperative endoscopy
6	IDA, positive FOBT result	Fresh blood in cecum	Focal enhancement in cecum	+	+	+	Negative	Colonoscopy
7	Hematochezia	Negative	Vascular mass in jejunum	+	++	Failed	Jejunal gastrointestinal stromal tumor	Surgery
8	Hematochezia, portal hypertension	Two small-bowel angiodysplasias	Segmental jejunal enhancement	+	+	+	Portal hypertension-associated enteropathy	Colonoscopy
9	IDA	Jejunal AVM	Vascular mass in jejunum	—	+	++	Jejunal submucosal cavernous hemangioma	Surgery
10	IDA, von Willebrand disease	Fresh blood in small bowel	Active bleeding in jejunum	+	+	++	Multiple jejunal angiodysplasias	Surgery

- Note.—AVM = arteriovenous malformation, FOBT = fecal occult blood test, IDA = iron deficiency anemia.
- *The interpreting radiologist ranked focal, increased abnormal enhancement when present as follows: — = no visible enhancement; + = abnormal focal enhancement present; ++ = abnormal focal enhancement present and more conspicuous than in another phase; and +++ = abnormal focal enhancement present and more conspicuous than in other two phases. Two or more phases of enhancement could demonstrate focal abnormal enhancement of equal conspicuity, in which case, both phases were rated as +.

Positive Results at Triple-Phase CT Enterography

Ten of 22 multiphase CT enterographic examinations showed positive findings—demonstrating abnormal bowel wall enhancement (compatible with a bleeding source) or evidence of active bleeding (Table 1). Seven of 10 patients with positive CT enterographic results had an overt type of OGIB. Capsule endoscopic results were positive in five of 10 patients with positive CT enterographic results. Capsule endoscopic and CT enterographic findings were in agreement in four cases, two of which were subsequently confirmed—a jejunal cavernous hemangioma (Fig 1) and active bleeding from jejunal angiodysplasia (Fig 2). In the third case, both capsule endoscopic and CT enterographic findings were falsely positive, each suggesting active cecal bleeding in a patient with negative colonoscopic results on two subsequent occasions. In the fourth case, with a final diagnosis of portal hypertensive enteropathy, both studies had positive findings in the jejunum. In a final case, CT enterographic and capsule endoscopic results were both positive but were not in agreement on the bleeding source. CT enterography accurately depicted active bleeding from a cecal angiodysplasia, while capsule endoscopic results suggested a small-bowel source (Fig 3). Subsequent repeat colonoscopic results confirmed a cecal angiodysplasia, which was treated with endoscopically guided laser ablation.

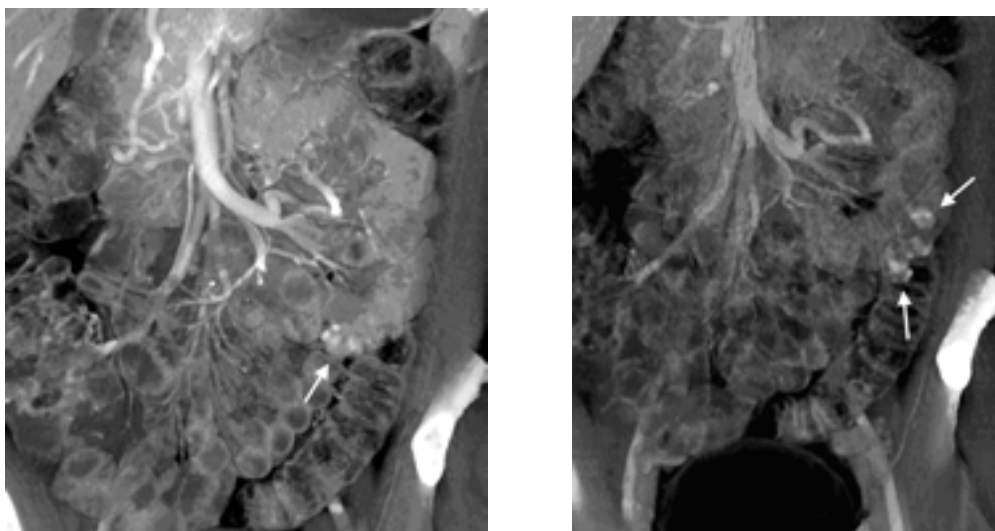


Figure 1: Patient 9.

CT images in 38-year-old woman with iron deficiency anemia. Capsule endoscopic results demonstrated submucosal vascular malformation in jejunum. Volume-rendered

coronal maximum intensity projection images with clip plane applied at (a) enteric phase and (b) delayed phase demonstrate gradual accumulation of contrast material (arrows) within a jejunal hemangioma.

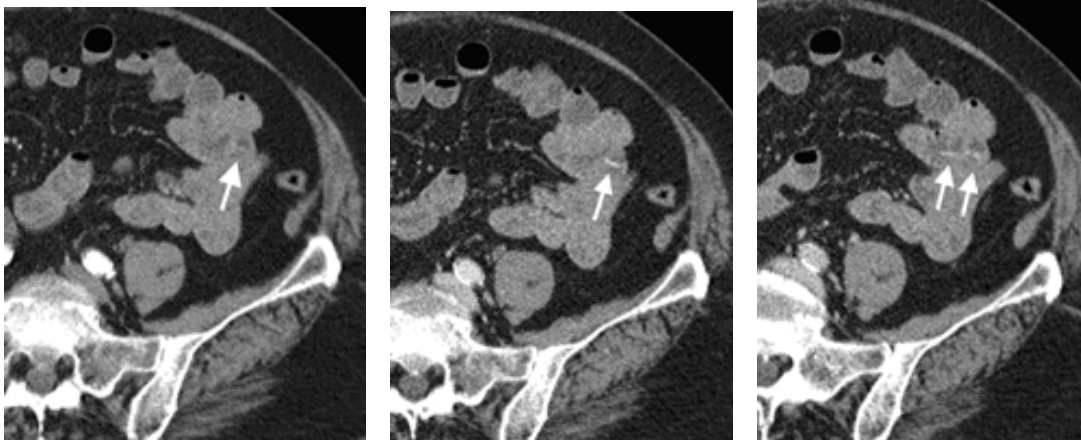


Figure 2: Patient 10.

CT images in 76-year-old woman with iron deficiency anemia and von Willebrand disease. (a) Transverse arterial phase image demonstrates focal accumulation of contrast material (arrows) in jejunal lumen, which increases during (b) enteric and (c) delayed phases. At surgery, multiple jejunal angiodysplasias were found, many of which were undetected at CT enterography and capsule endoscopy.

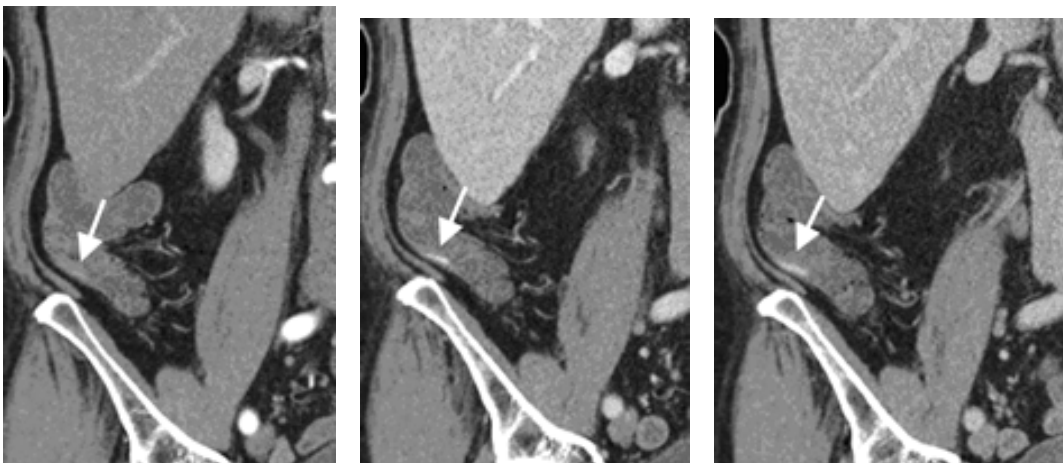


Figure 3: Patient 3.

CT images in 82-year-old man with melena and iron deficiency anemia. Coronal multiplanar reformatted (a) arterial, (b) enteric, and (c) delayed phase images demonstrate gradual intraluminal accumulation of contrast material (arrow) in

ascending colon, consistent with active bleeding. An **angiodysplasia** was found and treated at repeat colonoscopy.

Capsule endoscopic results were negative in four of the 10 patients with positive findings at CT examination. In three of these patients, capsule endoscopic results were falsely negative, with CT enterography depicting angiodysplasia of the cecum with an early draining vein ([Fig 4](#)); a jejunal stromal tumor; and an enhancing jejunal wall mass ([Fig 5](#)), which was confirmed at two subsequent CT enterographic examinations. In a fourth patient with a negative capsule endoscopic result, CT enterography falsely depicted small-bowel bleeding. At subsequent repeat conventional endoscopy, gastric antral vascular ectasia was found to be the source of gastrointestinal bleeding. One patient with a Meckel diverticulum detected at CT enterography did not undergo capsule endoscopy.

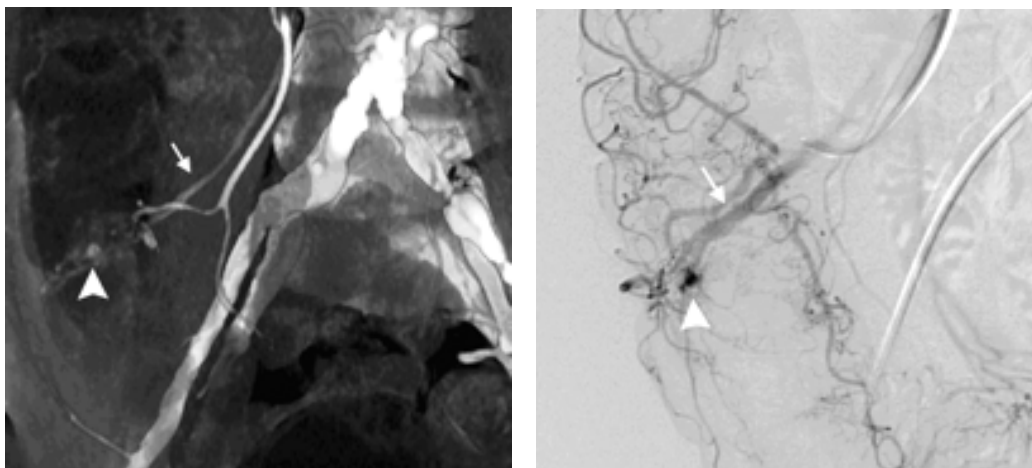


Figure 4: Patient 2.

Images in 69-year-old woman with multiple episodes of hematochezia. **(a)** Coronal volume-rendered CT image demonstrates enhancing vascular tuft (arrowhead) within wall of cecum and an early draining vein (arrow). **(b)** Angiogram obtained prior to therapeutic embolization the next day shows corresponding findings.

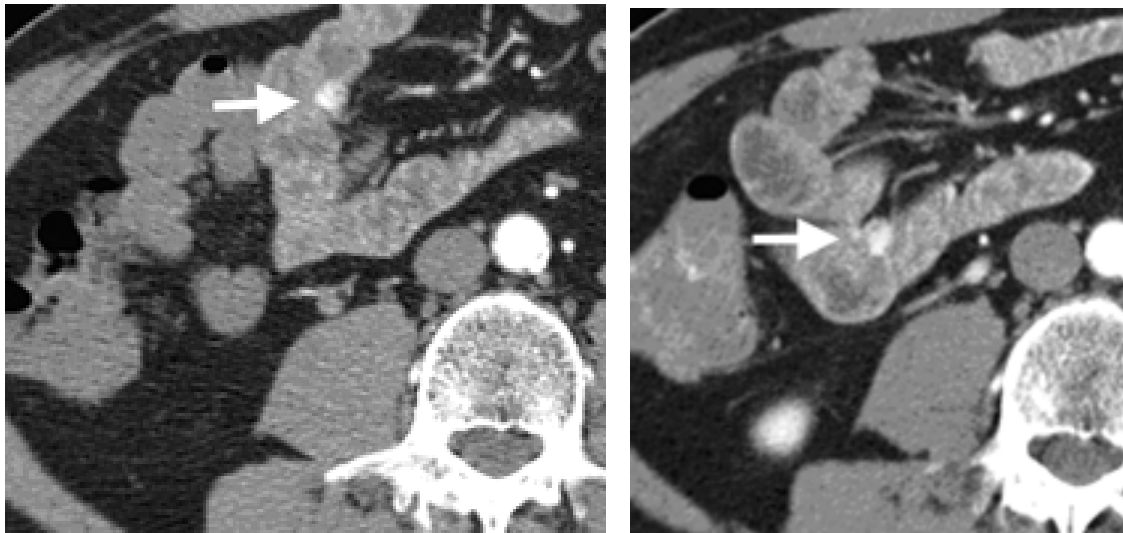


Figure 5: Patient 4.

CT images in 64-year-old man with episodic melena. (a) Transverse arterial phase image demonstrates 5-mm focal area of enhancement (arrow) in wall of jejunum. (b) Repeat CT enterogram 6 months later again demonstrates lesion (arrow).

CT findings at each of the eight CT enterographic examinations with true-positive findings were visible during at least two of the three phases ([Table 1](#)), with the arterial or delayed phases depicting these lesions or a bleeding source in seven cases each. Progressive increase in attenuation within the lesion during each of the three phases was seen in six patients (patients 1, 3, 5, 7, 9, and 10). Increasing dispersion of contrast material in the dependent portion of the bowel lumen was interpreted as evidence of active bleeding and was seen in three patients. (One case was false positive.)

Negative Results at Triple-Phase CT Enterography

Twelve of 22 patients had negative findings at CT enterography ([Table 2](#)). Ten (83%) of 12 patients with negative CT enterographic results had an occult type of OGIB. Only four (33%) of 12 patients underwent capsule endoscopy. Capsule endoscopic results were positive in two cases: a patient with a jejunal lymphangioma (confirmed at surgery) and a patient with bleeding from an ulcer within a hiatal hernia (confirmed at repeat conventional endoscopy). In both cases, capsule endoscopic results revealed the presence of small-bowel blood but did not detect the offending lesion. No corresponding CT abnormalities could be seen

in retrospect. Of the remaining 10 patients with negative results at CT enterography, four patients ceased bleeding, four continued to bleed, and two were lost to follow-up.

Table 2.

Clinical and Capsule Endoscopic Findings in Patients with Negative CT Enterographic Results

Patient No.	Clinical Finding	Capsule Endoscopic Finding	Follow-up
11	IDA, positive FOBT result	Fresh blood in jejunum	Jejunal lymphangioma resected
12	IDA, positive FOBT result	Altered blood in jejunum	Cameron ulcer in hiatal hernia at repeat upper endoscopy
13	IDA, positive FOBT result	Not performed	Persistent IDA
14	Hematochezia	Not performed	Persistent IDA
15	IDA, positive FOBT result	Negative	No follow-up
16	IDA	Not performed	No follow-up
17	IDA	Not performed	IDA resolved
18	IDA	Not performed	Persistent IDA
19	IDA	Not performed	IDA resolved
20	IDA, negative FOBT result	Negative	Gastric antral vascular ectasia cauterized at repeat endoscopy; IDA persists
21	Intermittent hematochezia	Not performed	Hemorrhoids, IDA resolved
22	IDA	Not performed	IDA resolved

- Note.—FOBT = fecal occult blood test, IDA = iron deficiency anemia.

DISCUSSION

Reports of the usefulness of CT in evaluating gastrointestinal bleeding are numerous (23–32). In general, only patients with acute, life-threatening lower gastrointestinal bleeding with no source found at endoscopy (ie, overt OGIB) have been described previously (23–26,28,29,32). In contradistinction, all of our patients were outpatients without clinical evidence of substantial acute blood loss. Triple-phase CT enterographic results demonstrated true-positive findings in eight (36%) of 22 patients that were confirmed with endoscopy, surgery, or conventional angiography, including four vascular malformations, one neoplasm (jejunal gastrointestinal stromal tumor), one Meckel diverticulum, and two other lesions. Two of the four vascular malformations demonstrated active bleeding at CT. Considering the substantial differences between our group of patients and those reported in previous articles, one might postulate a greater sensitivity with this technique in a group with patients with more severe bleeding.

CT techniques used in previous studies varied and included single-phase (23,26,27,30) or dual-phase (24,28,29,31,32) acquisitions with single (29,32,33) or multichannel (23,24,27,28,30) spiral CT systems. All studies included intravenous contrast material administration except one (33) that included arterial contrast material injection. Either no oral contrast material or neutral enteric contrast material was used in all studies. Section thickness varied from 1.25 to 10 mm. Sensitivity varied from 67% to 79% for detection of active bleeding or specific bowel wall abnormality.

The method of examination used in our study differed from that in previous studies in several ways. All of the patients in our study were examined after ingestion of large volumes of neutral enteric contrast material to distend the bowel lumen and separate the bowel walls, a factor that likely facilitated the detection of extravasated intraluminal contrast material. The use of neutral enteric contrast material not only produces excellent luminal distention but also provides a canvas on which enhancing bowel wall lesions and active bleeding can be detected. All 22 patients in our study were able to successfully ingest 1800 mL of low-concentration barium solution, which parallels the experience in several other CT enterographic studies employing large volumes of oral contrast material (34–36).

The isotropic spatial resolution provided with our 64-section CT system allows us to visualize small vascular lesions responsible for bleeding in multiple orthogonal planes. The increased temporal resolution permits image acquisition in each of three vascular phases without sacrificing spatial resolution.

Our three-phase acquisition protocol is designed to optimize detection of the most common causes of OGIB (angiodysplasia and small-bowel neoplasms) (37) and to depict active bleeding. Data from angiographic studies suggest that arterial-phase imaging, as well as delayed acquisitions, is necessary to detect small-bowel angiodysplasias—the most common abnormality causing OGIB (37). Boley et al (38) reported angiographic findings in 25 patients with gastrointestinal bleeding

secondary to right colonic angiodysplasia. Findings included prolonged opacification of a dilated intramural vein (92%), visualization of a vascular tuft (68%), and visualization of an early filling vein in the arterial phase (56%). Bowel wall neoplasms account for 5%–15% of OGIB. Gastrointestinal stromal tumors make up a large portion of neoplasms causing OGIB (37). Most of these tumors enhance substantially during the portal venous phase but may also be positive on earlier acquisitions if they are highly vascular (39).

The detection of active bleeding with CT requires sufficient delay after intravenous contrast material injection to allow accumulation of extravasated contrast material within the bowel lumen. The evidence therefore suggests that the best chance to visualize lesions responsible for OGIB requires three separate acquisitions: (a) arterial phase (ie, maximum mesenteric arterial attenuation) to detect early draining veins and vascular tufts, (b) during maximum bowel wall enhancement (enteric phase) to detect neoplasms, and (c) delayed phase to detect prolonged opacification of intramural veins and luminal extravasation of contrast material due to active bleeding. The evolving appearance of the offending lesion at successive phases provides clues to its nature and increases diagnostic certainty.

Two previous studies compared the results of capsule endoscopy with those of CT. Voderholzer et al (40) compared capsule endoscopic results with CT enteroclysis results in eight patients with gastrointestinal bleeding. Capsule endoscopy depicted abnormalities in four of eight patients, while CT enteroclysis findings were positive in only one of eight patients. Hara et al (41) compared capsule endoscopic findings with findings of CT and barium studies in a retrospective study of 52 patients. The majority of subjects (83%) were being evaluated for OGIB. Only 19 patients underwent both capsule endoscopy and CT. A routine abdominal CT technique was utilized in all but four patients (5-mm section width, acquisition 70 seconds after injection). Overall, CT demonstrated small-bowel findings in only 21% of patients, compared with 63% at capsule endoscopy. By contrast, by utilizing a multiphase, high-spatial-resolution technique, we were able to identify abnormalities in five (71%) of seven patients with positive findings at

capsule endoscopy, as well as detecting abnormalities in three additional patients who had negative findings at capsule endoscopy. Furthermore, two of 22 patients with initial negative findings at colonoscopy were found to have cecal angiodysplasia at triple-phase CT enterography, with both cases confirmed at repeat colonoscopy. These findings are not entirely unanticipated because the ability of endoscopy to help identify causes of gastrointestinal bleeding depends, in part, on active bleeding and other factors, with clinical recommendations for repeat endoscopy in selected cases underscoring the limited sensitivity of endoscopy in this challenging subset of patients (2).

Three-phase acquisition results in substantial patient radiation exposure (effective dose of 59 mSv per examination). The need for this examination must therefore be carefully weighed against the potential benefits of successful diagnosis. While early mortality is usually not an issue with OGIB, delay in diagnosis, the need for multiple blood transfusions, and repeated diagnostic studies are commonly encountered in these patients. In one study (42), the median delay in diagnosis of overt OGIB was 2 years. Furthermore, mortality related to radiation-induced cancer decreases considerably after age 40 (43), and most OGIB occurs in older patients (mean age, 55 years in our series). In the future, dose-minimizing techniques for image acquisition or reconstruction will likely reduce radiation dose. Additionally, results of multireader studies may suggest that only two phases are required.

Our study had several limitations. The small sample size precluded findings of statistical significance. In addition, patients were included on the basis of referral from one of several sources, and selection bias may have existed. Furthermore, images were reviewed only by one of four radiologists, so reader bias may exist. A lack of pathologic diagnosis and limited clinical follow-up made estimation of the clinical importance of our findings difficult. Additionally, because vascular lesions in the bowel are often multiple and may not be associated with bleeding, it is difficult in a study like this to define true- and false-positive findings. However, when all the clinical data were evaluated, CT enterographic findings were thought to accurately demonstrate evidence of

gastrointestinal bleeding in eight of 10 patients. Furthermore, CT was able to depict lesions not depicted by using other means.

The results of this preliminary study suggest a possible role for multiphasic CT enterography in the evaluation of OGIB. Several factors, including luminal bowel distention with large volumes of enteric contrast material, multiphase imaging with bolus-tracking software, and the improved spatial and temporal resolution of modern 64-section CT systems, likely facilitated the identification of mass lesions and active small-bowel bleeding. Results of this study suggest a complimentary role for CT enterography and capsule endoscopy in the evaluation of OGIB. In our opinion, a larger prospective study comparing this technique with other diagnostic methods, including capsule endoscopy, is warranted.