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ORIGINAL RESEARCH

Multidetector computed tomography in acute lower gastrointestinal bleeding

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Background: The aim of this study is to evaluate multidetector computed tomography (MDCT) in acute massive lower gastrointestinal bleeding, with endoscopy and surgery as reference examinations.

Methods: A single-center retrospective study involving 34 patients with acute massive lower gastrointestinal bleeding was carried out. All patients were evaluated by MDCT scan then endoscopic or surgical examinations. Sensitivity, specificity, and positive and negative predictive values of MDCT scan were calculated using the extravasation of the contrast agent as the main criterion.

Results: Extravasation of the contrast agent was found in 30 of 34 patients (88%). The bleeding site seen on CT was always the same as on endoscopic or surgical examinations (100%). Sensitivity of MDCT scan was 94%, specificity 100%, positive predictive value 100%, and negative predictive value 50% ($P < 0.001$). Twelve diverticulum bleedings were seen on MDCT scan compared with 13 (92%) on endoscopic or surgical examinations. Angiodysplasia was overestimated by MDCT scan.

Conclusion: MDCT scan appears to be an excellent tool to find and localize the bleeding site in cases of acute massive lower gastrointestinal disease.

Keywords: MDCT, acute lower gastrointestinal bleeding, extravasation, contrast agent

Introduction

If management algorithms are relatively widely accepted for acute upper gastrointestinal (GI) bleeding, with upper endoscopy as the first test to depict and treat the bleeding site and for treatment at the same time, the management of lower GI bleeding is still controversial.[1–3] The major issue, after the acute management of the bleeding, is the detection of the bleeding site. 99mTc-labeled red blood cell scintigraphy,[4–8] colonoscopy,[9–15] and angiography[16–26] are the tests usually performed to reach this objective.[27] Scintigraphy is sensitive but is of poor positive predictive value in determining the precise site of bleeding, and is also rarely available in an emergency. Colonoscopy and angiography are still controversial; they require a high level of expertise and are invasive. The potential role of multidetector computed tomography scan (MDCT scan) in acute lower GI bleeding has been emphasized recently.[28–31] Nevertheless, its use in a clinical scenario remains rarely described. The purpose of our study was to illustrate the potential role of MDCT scan in acute massive lower GI bleeding experienced by a large cohort of patients, with endoscopy and surgery as reference examinations.

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Material and methods
Study group

This retrospective study was approved by the Human Research Committee of our institution in March 2007. We performed research using our clinical database records for a 51-month period (January 2005 to March 2007) that was available for retrospective review and revealed 34 patients with acute massive bleeding who underwent emergency MDCT scan. This study group included 12 women (average age: 68 years ± 18) and 22 men (average age: 73 years ± 13). Patient ages ranged from 23 to 95 years (mean, 71 years ± 15).

CT examination and interpretation of results

MDCT scan was performed with a commercially available multidetector row CT unit (Somatom Plus 10 Volume Zoom; Siemens, Erlangen, Germany) by using the following scanning parameters: 10 × 2.5 mm collimation (four detector rows and 2.5-mm section thickness), 120 kVp, 165 mAs, and 12.5-mm table speed/gantry rotation. Images were reconstructed at 3-mm intervals with a b30 soft-tissue algorithm and 1.5 mm image reconstruction.

The average time between patients' admission in the hospital and the start of the MDCT scan was between 1 and 12 h. One of the contraindications of contrast-enhanced MDCT is severely impaired renal function with no possibility of hemodialysis.

In our study, although the mean age was more than 70, we had no patient with severe clinical renal dysfunction. At the start of the procedure, 120 mL of nonionic iodinated contrast media (CM) (Iomeron 400; Altana, Milan, Italy) was injected intravenously through a 20-gauge cannula at a rate of 4 mL/s using an automated power injector (Medex, Carlsbad, CA). After a nonenhanced acquisition, multidetector row scans were obtained during the arterial phase and the portal phase, to help identify active extravasation of CM within the bowel lumen. Both arterial and portal phases are useful to increase the sensibility in the depiction of an extravasation of the CM. The delay between the start of administrating the CM and the start of scanning was 30 sec for the injected at the arterial time and 60 sec for the portal time. Images were obtained from the dome of the liver to the lower margin of the symphysis pubis during a single breath-hold. The evaluation of MDCT scan was based on the detection, the site, and the etiology of extravasation of the iodinated CM. Extravasation was defined by the accumulation of CM within a digestive lumen and by it being in linear or nodular appearance. For the accuracy of MDCT scan in depicting acute lower GI bleeding, the lower GI tract was classified according to eight anatomic locations: small bowel, cecum, right colon, transverse colon, left colon, sigmoid, rectum, and anal canal. Presence or absence of extravasation was recorded for each anatomic location in each patient. One radiologist with 6 years of experience in abdominal CT imaging was blinded from any clinical findings. Axial transverse MDCT scan images were reviewed on a workstation while using an archiving system (Impax; AGFA, Mortsel, Belgium), allowing multiplanar reconstructions. In terms of etiology, diagnosis of hemorrhagic diverticula was defined if the extravasation of CM was definitely arising from a single diverticulum. The presence of diverticulosis was insufficient for the final diagnosis. Angiodysplasia was considered if the extravasation of CM was arising from a segment of bowel without any thickening or irregularity. Diagnosis of tumoral bleeding was defined if the extravasation was arising from an obvious intraluminal mass. The other etiologies were classified as having various causes such as acute hemorrhagic colitis (extravasation of CM arising from a thickened segment of bowel) or postoperative bleeding (extravasation of CM arising from a postoperative site). In the absence of extravasation, the MDCT scans were considered negative.

Reference examinations

After the MDCT scan interpretation, patients were systematically examined either by an endoscopy (rectoscopy or colonoscopy) or by a surgery. The site and etiology of acute lower GI bleeding were identified. The lower GI tract was classified according to the same eight anatomic locations used for MDCT scan interpretations. In case of surgery, the site of the hematochezia was defined by pathological interpretation. Etiologies were classified as either diverticulosis, angiodysplasia, tumors, miscellaneous causes, or undetermined causes. The accuracy of MDCT scan in identifying the site of acute lower GI bleeding was assessed by comparing its ability to locate extravasation for each patient with that by surgery or endoscopy. Likewise, the accuracy of MDCT scan for identifying the cause of acute lower GI bleeding was also assessed by comparing it with the etiologies of bleeding identified by surgery or endoscopy (diverticulosis, angiodysplasia, tumors, various causes, and undetermined).

Analysis of clinical data

Active massive hematochezia at the time of MDCT scan noted by the physician, relapse of hematochezia, admission of the patient to intensive care unit before or after imaging, hemodynamic status of the patient at the time of MDCT scan, medical history, prescribed coagulation medication, red blood cell units transfused before MDCT scan, and hemoglobin rates were all retrospectively recorded for each patient. Clinical follow-up data were collected and reviewed independently from MDCT scan examinations. In all cases, the lower GI bleeding was estimated as massive by the clinicians.

Statistical analysis

Sensitivity, specificity, accuracy, and positive and negative predictive values for detecting acute lower GI bleeding with MDCT scan were calculated on the basis of a per-patient analysis in relation to the results of endoscopy or surgery. For the purposes of statistical analysis, a true-positive finding was defined when MDCT scan depicted the presence of extravasation at the same site identified by endoscopy or surgery. A false-positive finding was defined when MDCT scan showed the presence of active bleeding which was not found even in a different location, by reference examinations. A true-negative finding was defined when a bleeding focus was not identified by both MDCT scan and reference examinations. A false-negative finding was defined as the absence of active bleeding depicted on MDCT scan despite the presence of bleeding being found by reference examinations. Accuracy was defined as the ratio of the number of cases of acute lower GI bleeding that were correctly diagnosed in our study population to the total number of patients investigated. Etiologies were classified and further analyzed according to their histopathological diagnosis and/or endoscopic identification.

Results

The final diagnosis of lower GI tract bleeding (n = 34) was diverticulosis (n = 13), angiodysplasia (n = 2), tumors (n = 3), postoperative hemorrhage (n = 5), rectal ulcer (n = 5), colitis (n = 2), hemorrhoids (n = 1), nonspecific hemorrhagic changes (n = 1), and undetermined cause (n = 2). Table 1 summarizes the location of etiologies by surgery or endoscopy.

Table 1 Etiologies by location on reference examination

Location	Etiology
Small bowel (n = 4)	Diverticula (n = 1)
	Tumor (n = 2)
	Various (n = 1)
	Postoperative
Cecum (n = 7)	Diverticula (n = 2)
	Angiodysplasia (n = 1)
	Tumor (n = 1)
	Various (n = 3)
	Postoperative
	Colitis
	Nonspecific
Right colon (n = 3)	Diverticula (n = 1)
	Various (n = 2)
	Postoperative
Transverse colon (n = 2)	Diverticula (n = 1)
	Angiodysplasia (n = 1)
Left colon (n = 3)	Diverticula (n = 3)
Sigmoid (n = 5)	Diverticula (n = 5)
Rectum (n = 7)	Various (n = 7)
	Ulcer (n = 5)
	Postoperative (n = 1)
	Rectocolitis (n = 1)
Anal canal (n = 1)	Various (n = 1)
	Hemorrhoids
Undetermined (n = 2)	

Location-based analysis

Arterial phase MDCT scan depicted active extravasation of CM in 30 of 34 patients. With MDCT scan, CM extravasation was identified in the small bowel (n = 3), in the cecum (n = 7), in the right colon (n = 3), in the transverse colon (n = 2), in the left colon (n = 2), in the sigmoid (n = 5), in the rectum (n = 7), and in the anal canal (n = 1) (Table 2). Among these patients with CM extravasation depicted by MDCT scan, findings were then assessed by surgery or endoscopy and acute lower GI bleeding was confirmed in all patients. Twenty-two patients (65%) underwent surgery, seven patients (20%) underwent rectoscopy, and five patients (15%) underwent a colonoscopy. In all patients who underwent rectoscopy, a positive rectal source was always identified, and the endoscopist was confident in determining the rectum as the source of bleeding.

In two patients, reference examinations revealed a bleeding site not detected with MDCT scan (false-negative MDCT scan findings). Of these patients, one presented an infra-cm GIST (gastrointestinal stromal tumor) located at the proximal ileum. The lesion was identified by MDCT scan without extravasation. Bowel resection was performed and the follow-up confirmed the role of the lesion in the active bleeding. In the other patient, arterial phase MDCT scan failed to reveal active bleeding in a diverticulum although active bleeding was identified when a colonoscopy was performed a few hours later. Overall, patient-based accuracy of MDCT scan in the detection of acute massive lower GI bleeding was 88% (n = 30/34). The overall sensitivity, specificity, and positive and negative predictive values for the detection of hematochezia with MDCT scan were 93.8% (30 of 32), 100% (2 of 2), 100% (30 of 30), and 50% (2 of 4), respectively. MDCT scan had an accuracy of 100% for locating acute massive lower GI bleeding. The site of CM

Table 2 Etiologies by location on MDCT

Location	Etiology
Small bowel (n = 3)	Diverticula (n = 1)
	Tumor (n = 1)
	Various (n = 1)
	Postoperative
Cecum (n = 7)	Diverticula (n = 2)
	Angiodysplasia (n = 3)
	Tumor (n = 1)
	Various (n = 1)
	Colitis
Right colon (n = 3)	Diverticula (n = 1)
	Angiodysplasia (n = 1)
	Various (n = 1)
	Postoperative
Transverse colon (n = 2)	Diverticula (n = 1)
	Angiodysplasia (n = 1)
Left colon (n = 2)	Diverticula (n = 2)
Sigmoid (n = 5)	Diverticula (n = 5)
Rectum (n = 7)	Angiodysplasia (n = 6)
	Various (n = 1)
	Rectocolitis
Anal canal (n = 1)	Various (n = 1)
	Hemorrhoids
Undetermined (n = 4)	

extravasation on MDCT scan images corresponded exactly with the location of bleeding assessed by reference examinations in all patients.

Etiology-based analysis

The overall etiology-based accuracy of MDCT scan in acute lower GI bleeding was 65% (22 of 34). The MDCT scan detected 12 hemorrhagic diverticula (92%) (Figures 1–3). The diagnosis of angiodysplasia was made in 11 cases using MDCT scan. Only two cases of angiodysplasia (Figure 4) were assessed by reference examinations (6%). The misdiagnoses with MDCT scan were postoperative hemorrhage in three cases (Figure 5), rectal ulcer in five cases (Figure 6), and nonspecific hemorrhagic changes in one case. MDCT scan correctly identified two tumors. The missed case concerns a patient with an ileal GIST. The tumor was shown with MDCT scan, but without extravasation of CM. MDCT scan correctly identified 100% of cases of colitis (n = 2).

Figure 2 A 70-year-old female with acute lower GI bleeding. MDCT scan demonstrated an extravasation arising from a diverticulum of the sigmoid (arrow). Hartman procedure was performed for life-threatening hemorrhage.

Analysis of clinical data

In 32 cases (94%), the hematochezia were considered as active at the time of MDCT scan. In the remaining cases, the hematochezia had stopped at least 12 h before MDCT scan. In 32 cases (94%), the hematochezia had relapsed. Analysis of clinical data demonstrated that bleeding was considered active in 100% of the cases with presence of extravasation and in 25% of the cases with absence of extravasation. Thus, an extravasation of CM was visible on 30 of the 31 MDCT scans performed during a

Figure 1 A 72-year-old male with acute lower GI bleeding. MDCT scan demonstrated an extravasation arising from a diverticulum of the left colon (arrow). Left hemicolectomy was performed for life-threatening hemorrhage.

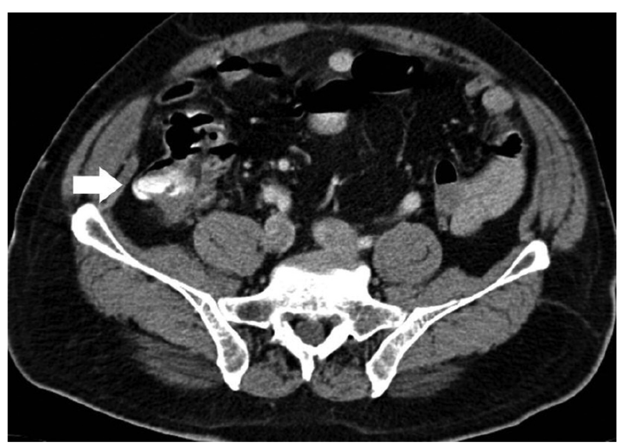

Figure 3 A 60-year-old female with acute lower GI bleeding. MDCT scan demonstrated an extravasation arising from a diverticulum of the cecum (arrow). Ileocolectomy was performed for life-threatening hemorrhage.

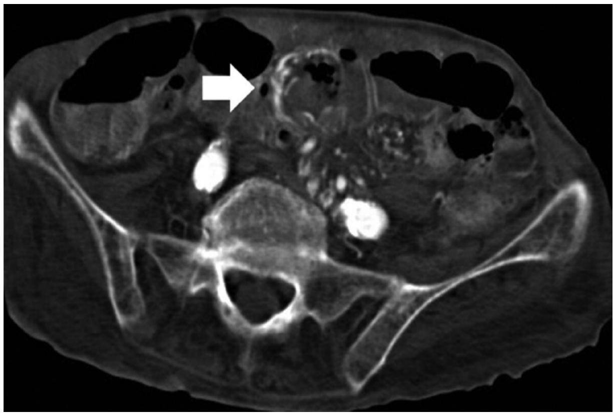

Figure 4 An 80-year-old female with acute lower GI bleeding. MDCT scan demonstrated an extravasation arising from the transverse colon (arrow). MDCT scan was in keeping with the diagnosis of hemorrhagic angiodysplasia, which was confirmed with a colonoscopy.

Figure 6 A 77-year-old male with acute lower GI bleeding. MDCT scan demonstrated an extravasation arising from the rectum (arrow). MDCT scan was in keeping with the diagnosis of hemorrhagic angiodysplasia. Rectoscopy demonstrated a lateral rectal ulcer, which was successfully treated at the same time.

hemorrhagic period (97%). Small bowel resection occurred in four cases, ileocolectomy in four cases, right colectomy in six cases, transverse colectomy in two patients, left colectomy in three cases, Hartman procedure in three cases, endoscopic clip in three patients, and switching in five cases. Two patients died during their hospitalization. Of these two patients, one presented a hemorrhage following a polypectomy. This patient presented severe cardiac dysfunction and died from a heart attack. The second patient presented a rectal ulcer. The death was attributed to severe acute renal failure.

Discussion

Because bleeding can occur anywhere along the bowel tract, lower GI bleeding remains a clinical challenge.[1–3] The major issue, after the acute management of the bleeding, is the detection of the bleeding site. Many studies discuss the respective role of 99mTc-labeled red blood cell scintigraphy,[4–8] colonoscopy,[9–15] and angiography[16–26] for that purpose.[27] The last two have the advantage of simultaneous treatment but require high expertise and are invasive, while the first is rarely available in an emergency, even if it is highly sensitive. The use of MDCT scan in acute lower GI bleeding has been rarely described in the literature. Some recent studies emphasize its possible role in the accurate detection of the bleeding site.[28–30] Ettorre et al performed CT angiography with direct SMA catheterization, which is an invasive technique with good results when depicting extravasation of CM.[32] Ernst et al found MDCT scan to be of intermediate sensitivity for acute lower GI bleeding,[33] but their study focused on many different signs ranging from stranding to active evidence of bleeding. The prospective study by Yoon et al demonstrates high sensitivity and specificity of MDCT scan compared to angiography.[34] In our series, the bleeding site found with MDCT scan was in 100% of cases concordant with the site of bleeding identified by reference examinations, with only four patients with no extravasation identified by MDCT scan. The overall patient-based accuracy of MDCT scan in detecting acute lower GI bleeding was 88%, with use of CM extravasation as the only criterion for the presence of active bleeding and for locating the bleeding site, which is a good result compared to those from other retrospective studies (3 of 17 for Ernst et al,[33] and 7 of 13 for Tew et al[35])[33–35] and in concordance with the prospective study by Yoon et al.[34] This is also higher than what was found in the recent prospective study by Zink et al.[31] A note must be made that our population presented severe bleeding at the time of MDCT scan. We are in agreement with their findings of a higher accuracy of MDCT in cases of active bleeding at the time of the acquisition. Contrary to the study by Yoon et al, our series involved a majority of patients with

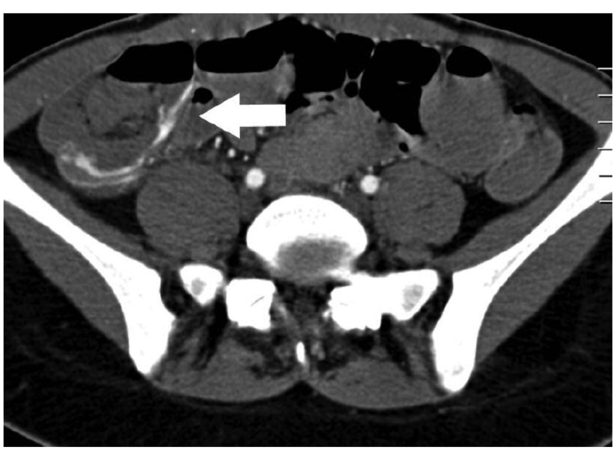

Figure 5 An 18-year-old female with acute lower GI bleeding. MDCT scan demonstrated an extravasation arising from the cecum (arrow). MDCT scan was in keeping with the diagnosis of hemorrhagic angiodysplasia. In fact, the patient had an appendectomy 10 days prior, and an ileocolectomy was performed for life-threatening hemorrhage.

acute bleeding from diverticula, which represents the most frequent cause for recurrent hematochezia. This point is very important because the depiction of the involved diverticulum is one key in deciding the management of the bleeding, from conservative treatment to surgery in the case of ongoing life-threatening bleeding.[3,10,36,37]

In our study, MDCT scan correctly identified 12 diverticulum bleedings of the 13 identified from reference examinations. Our study comprised only a small number of angiodysplasia, what can be related to that bleeding from angiodysplasia are more prone to resolve without recurrence.[3,38–40] Because our study was blinded from clinical settings, the rate of angiodysplasia was overestimated. The majority of small bowel or colonic bleeding was thought to be from angiodysplasia or from postoperative bleeding. The clinical scenario would have easily corrected the diagnosis, improving the overall etiology-based accuracy of 65%. MDCT scan appears as an effective tool in identifying the site of postoperative bleeding, excluding bleeding from other sources. A large number of patients in our study demonstrated bleeding from the rectum. In those cases, a rectal ulcer was the most common cause. This condition must be suggested to elderly patients with numerous comorbidities.[41,42] MDCT scan enabled the elimination of other possible sites of bleeding, which provided patients with a more positive outcome after endoscopic treatment.[42] Our study comprised significant limitations. Its retrospective nature limited its statistical impact. To limit recruitment bias, we included all patients with acute lower GI bleeding from our surgical emergency department who benefited from MDCT scan at their admission. The major limitation was the heterogeneity of the tools used as gold standard. Because it is a retrospective clinical study, we had no choice other than including the different examination used at the time of the clinical onset. This bias is especially important when considering a patient who only received a rectoscopy. For the seven patients who demonstrated active bleeding at the rectum and an actively bleeding rectal source at the rectoscopy, the endoscopist was confident in determining the rectum as the source of the bleeding, but another bleeding source was not completely ruled out. There is also a reading bias, because the reader was aware of the presence of intestinal bleeding. We believe that it allows a better understanding of the value of MDCT scan in this specific clinical scenario, because a reader will especially look for an active extravasation in such a case. A case-control study, although allowing stronger statistical implications, would not correspond to the reality of the radiological assessment in emergency situations. There is an evident population bias. The clinical presentation demonstrated that most patients had severe bleeding. So, we believe that our findings are only relevant for patients with massive hematochezia. This is in fact the case in almost all studies. Nevertheless, it corresponds to the correct clinical scenario, in which the correct bleeding site must be known in an emergency. Chronic or subacute bleeding is in fact not included in this discussion and is relieved of different explorations. In conclusion, our findings suggest that MDCT scan is accurate for the depiction and localization of sites of bleeding in patients with acute massive lower GI bleeding and is good at identifying the diverticulum as the source of bleeding.

Disclosure

The authors report no conflicts of interest in this work.

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