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ORIGINAL ARTICLE

64-Slice Multi-detector Computed Tomography for Detection of Acute Gastrointestinal Bleeding

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ABSTRACT

Aim: *To evaluate the usefulness of 64-slice multi-detector computed tomography for the detection of acute gastrointestinal bleeding.*

Patients and Methods: *In this retrospective study, 20 patients presenting with acute gastrointestinal bleeding from 1 October 2005 to 31 October 2006 had undergone digital subtraction angiography. Eleven patients had also undergone 64-slice multi-detector computed tomography and were enrolled in the study.*

Results: *Ten of the 11 patients had positive 64-slice multi-detector computed tomography findings for detection of mass, abnormal vessel, or active contrast extravasation into the bowel lumen. The sensitivity, specificity, positive predictive value, and negative predictive value of 64-slice multi-detector computed tomography with arterial phase to detect acute intestinal bleeding was 100%, 50%, 90%, and 50%, respectively.*

Conclusions: *Despite the limited number of patients, 64-slice multi-detector computed tomography with arterial phase is sensitive for the detection and localisation of bleeding sites in patients with acute gastrointestinal bleeding. Further studies are needed to confirm its role in clinical management.*

Key Words: *Angiography, digital subtraction; Gastrointestinal hemorrhage; Tomography, X-ray computed*

INTRODUCTION

Acute gastrointestinal (GI) bleeding is a common medical emergency. GI bleeding is classified anatomically according to the bleeding source. Bleeding proximal to and distal to the ligament of Treitz is classified as upper and lower gastrointestinal bleeding, respectively. The reported mortality rates for upper and lower GI bleeding are 8% to 14% and 3.6% to 18%, respectively.[1-3] The mortality rate increases to 21% to 40% for massive bleeding, which is defined as bleeding leading to haemodynamic instability or required transfusion of more than 4 units of packed red cells per 24 hours.[4,5]

For upper GI bleeding, endoscopy remains the main diagnostic modality. However, one study has shown that a diagnosis is not possible at first endoscopy for 24% of patients, usually due to excessive blood or clots obscuring the view.[6] For lower GI bleeding, the diagnostic approach is controversial due to the lack of prospective controlled data. Diagnostic modalities include colonoscopy, enteroscopy, capsule endoscopy, visceral angiography, and red blood cell scan.

With the recent introduction of multi-detector computed tomography (MDCT), CT has become a potential diagnostic tool for acute GI bleeding. MDCT enables acquisition of images in the arterial phase with good image quality that allows identification of contrast extravasation into the bowel lumen before being diluted by luminal intestinal fluid.

Use of 64-slice MDCT with the arterial phase has rarely been reported,[7] and no study has been performed in Hong Kong. The purpose of this study was to evaluate the usefulness of 64-slice MDCT for the detection of acute GI bleeding.

PATIENTS AND METHODS

This was a retrospective study of 20 patients presenting with acute GI bleeding who underwent digital subtraction angiography (DSA) from 1 October 2005 to

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31 October 2006. Eleven patients also underwent MDCT and were enrolled in the study.

The clinical data were retrieved from the electronic patient records, and the MDCT and DSA images were retrieved from the picture archiving and communication system (PACS).

MDCT was performed using a 64-slice CT scanner (Somatom Sensation 64; Siemens, Erlangen, Germany) with a gantry rotation speed of 0.5 seconds/rotation. Multi-detector row scans were obtained in the pre-contrast, arterial, and porto-venous phases. Imaging parameters for all phases were slice collimation of 1.2 mm, beam pitch of 1.2, reconstruction interval of 0.6 mm, tube voltage of 120 kV, and tube current of 140 mA. Feeds per rotation for pre-contrast, arterial, and portal venous phases were 34.6 mm, 23.0 mm, and 34.6 mm, respectively. All patients received 100 mL of intra venous contrast agent with 300 mg iodine/mL at an average injection rate of 3 mL/second. A bolus tracking technique with a predefined 100 HU enhancement threshold for triggering data acquisition was used. Scanning in the portal venous phase started with a 75-second delay. Multiplanar reconstruction and maximum intensity projection were used for data processing.

DSA was performed by 2 radiologists, including 1 senior medical officer or consultant with special interest in interventional and vascular radiology. Coeliac and superior mesenteric angiography using a power injector was performed for a clinical diagnosis of upper GI bleeding. Inferior mesenteric angiography using a power injector was added if there was clinical suspicion for lower GI bleeding.

The methods for interpretation of 64-slice MDCT and DSA included review of the formal reports and images by a radiologist with 4 years' experience in MDCT inter-pretation. If there was discrepancy between the reports and the imaging findings, a consultant radiologist made the final diagnosis. The reviewers were not blinded to the DSA findings.

DSA was used as the gold standard for comparison. For the purposes of statistical analysis, a true-positive finding was defined as a positive finding on MDCT when DSA was positive. A false-positive finding was defined as a positive finding on MDCT that was not detected on DSA. A true-negative finding was defined as the lack of detection of a bleeding focus on MDCT when DSA was negative. A false-negative finding was defined as MDCT with a negative result despite a positive DSA.

RESULTS

Twenty patients underwent DSA for acute GI bleeding during the study period, after the 64-slice MDCT scanner was installed. Eleven patients had undergone both MDCT and DSA. Six patients presented with acute upper GI bleeding and 5 patients presented with lower GI bleeding.

Emergency MDCT and DSA were performed for these patients. However, information on the severity of bleeding such as number of transfusions given or haemodynamic instability was not fully documented in the electronic clinical records.

Ten patients had positive MDCT findings and the results are summarised in Table 1. MDCT detected a mass or haematoma in 5 patients (patients 1, 2, 7, 8, and 9; Figure 1), abnormal vascularity in 3 patients (patients 3, 4, and 6; Figure 2), and active contrast extravasation in 2 patients (patients 10 and 11; Figure 3). The DSA findings of 9 patients correlated with the MDCT findings. One patient had negative DSA findings, and 1 patient had both negative MDCT and DSA findings (patient 5). No patients had negative CT findings and positive DSA findings.

One patient (patient 4) had recurrent GI bleeding within 5 days. This patient had positive MDCT findings but negative DSA findings on 2 occasions. This patient had operative and pathological findings of cytomegalovirus-related small bowel ulcers that can correspond to MDCT-detected enhancing nodules in the small bowel (Figure 4).

As well as review of the arterial phase MDCT images, the portal venous phase images were reviewed. No arterial phase MDCT diagnosis was missed by portal venous phase MDCT, but the findings were more conspicuous on the arterial phase images. No diagnosis was made solely by the portal venous phase images. The portal venous phase confirmed the diagnosis made by the arterial phase.

The sensitivity, specificity, positive predictive value, and negative predictive value of 64-slice MDCT with arterial phase to detect acute GI bleeding was 100%, 50%, 90%, and 50%, respectively (Table 2).

Table 1. Summary of 64-slice multi-detector computed tomography and digital subtraction angiography findings.

Patient	Sex	Age (years)	Clinical history	64-Slice multi-detector computed tomography		Digital subtraction angiography	
				Findings	Contrast extravasation	Findings	Contrast extravasation
1	M	75	Recurrent cholangiocarcinoma Haematemesis	Mass at first and second part of duodenum	No	Tumour staining at T12	No
2	F	41	Duodenal carcinoma Haematemesis	Mass in upper abdomen	No	Hypovascular mass in upper abdomen	No
3	F	83	Fresh melaena	Dilated vessels in caecum	No	Angiodysplasia in caecum	No
4	M	65	Fresh melaena	Suspected enhancing nodules in mid–small bowel	No	Negative	No
5	M	70	Fresh melaena	Negative	No	Negative	No
6	F	61	Fresh melaena	Bleeding from side branch of first jejunal artery	No	Side branch of first jejunal artery with abnormal vascularity and staining	No
7	M	36	Pancreatitis Haematemesis	Gas-containing mass in pancreatic head	No	Hypervascular mass supplied by gastroduodenal artery	No
8	M	61	Nasopharyngeal carcinoma Haematemesis	Haematoma in gastric antrum and duodenum	No	Small extravasation from gastroduodenal artery	Yes (at screening only)
9	F	43	Haematemesis Tumour at third part of duodenum	Vascular tumour at third part of duodenum	No	Tumour staining at third part of duodenum	No
10	M	39	Pancreatitis Fresh melaena	Haemorrhagic pancreatitis Haematoma at tail of pancreas	Yes	Extravasation from branch of marginal artery of Dummond	Yes
11	M	73	Duodenal carcinoma Haematemesis	Active contrast extravasation in second part of duodenum	Yes	Active contrast extravasation in second part of duodenum	Yes

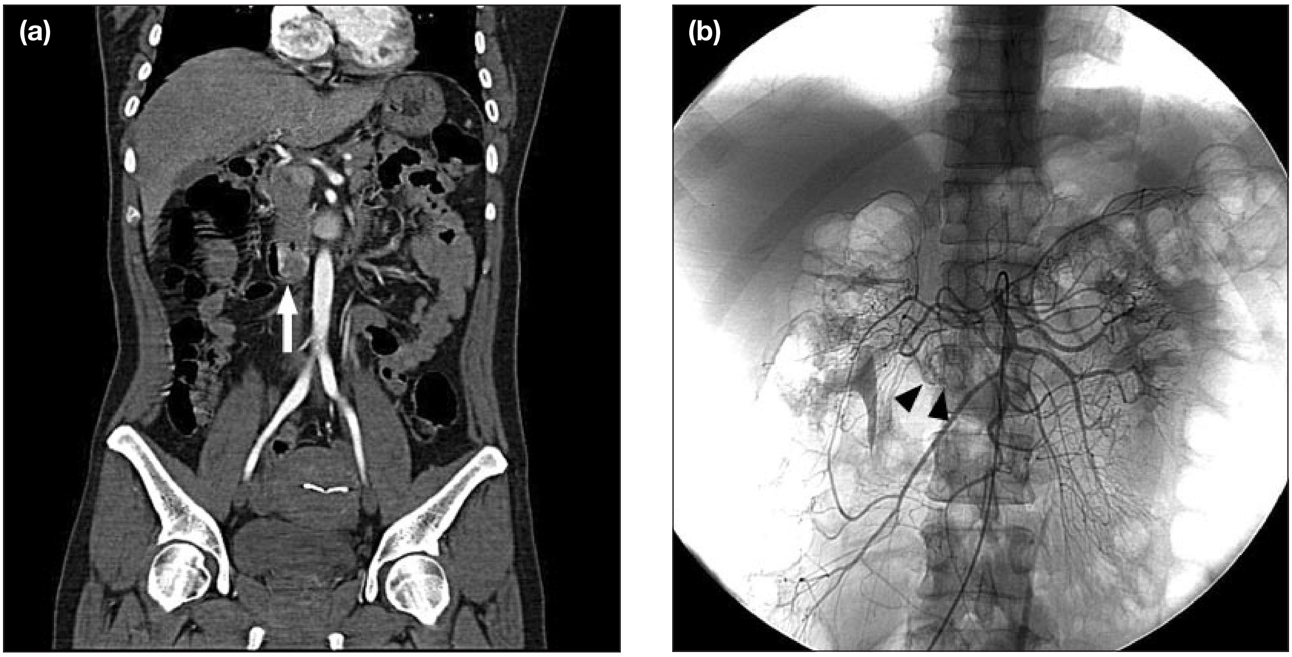

Figure 1. A patient presenting with haematemesis. (a) Multi-detector computed tomography scan (coronal reformatted image) showing a vascular tumour (white arrow) at the third part of the duodenum, compatible with gastrointestinal stromal tumour; and (b) corresponding coeliac angiography showing tumour staining (black arrowheads) at the third part of the duodenum.

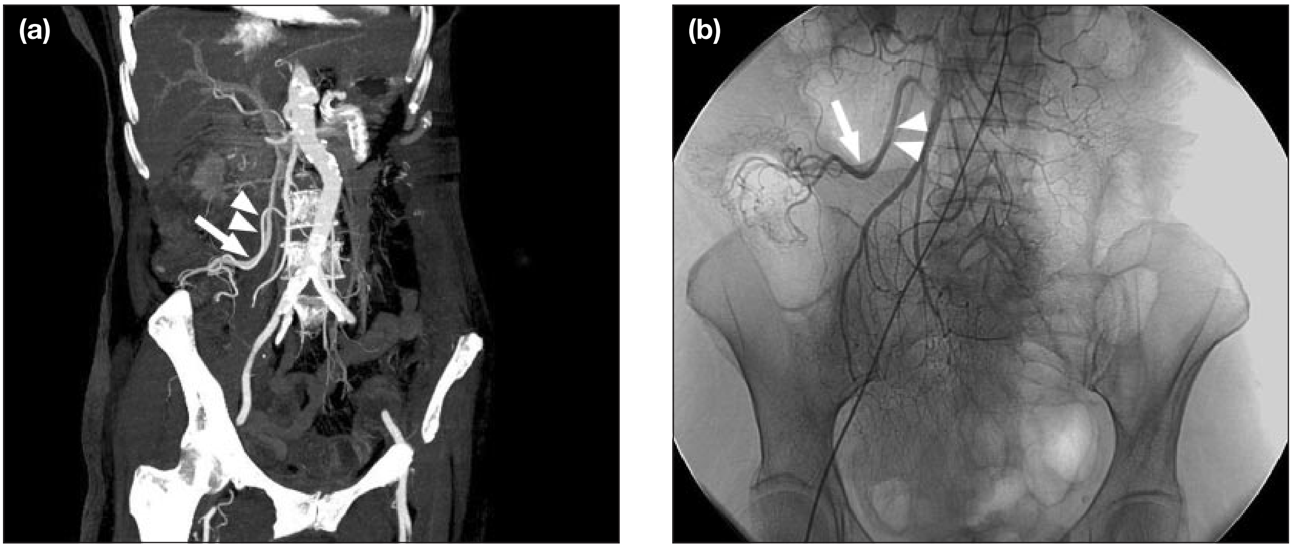

Figure 2. A patient presenting with fresh per rectal bleeding. (a) Multi-detector computed tomography scan (coronal reformed image with maximum intensity projection) showing a dilated artery (white arrowheads) and vein (white arrow) in the caecum; and (b) corresponding superior mesenteric angiogram showing an abnormal dilated artery (white arrowheads) with an early draining vein (white arrow) in the caecum, compatible with angiodysplasia.

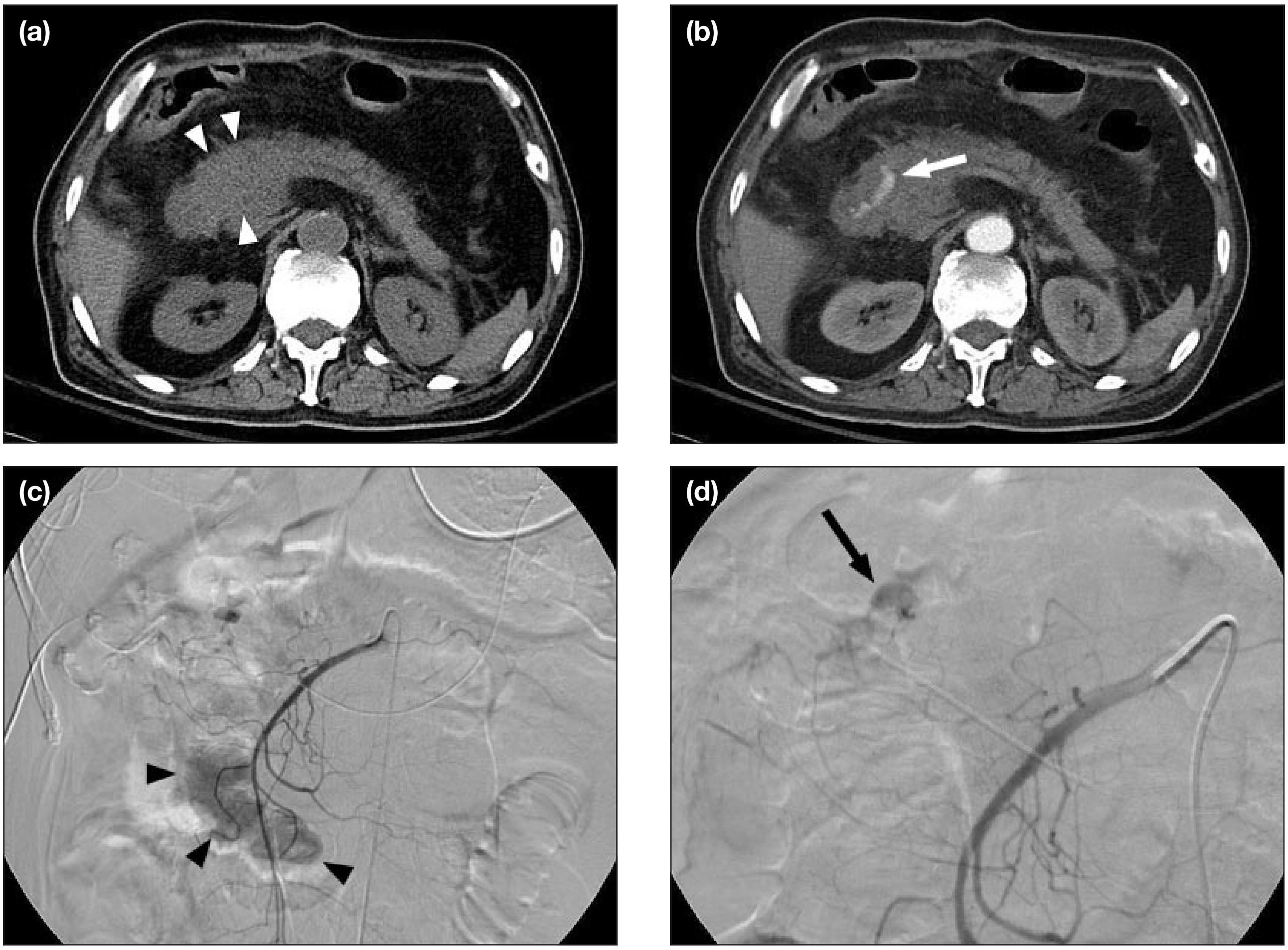

Figure 3. A patient presenting with haematemesis. Multi-detector computed tomography scan (without contrast) showing a haematoma in the duodenum (white arrowheads); (b) corresponding multi-detector computed tomography scan (with contrast) showing active contrast extravasation (white arrow) into the duodenal haematoma; (c) corresponding angiogram from the gastroduodenal artery showing active contrast extravasation (black arrowheads) into the duodenal lumen; and (d) corresponding superior mesenteric angiogram showing active contrast extravasation (black arrow) in the region of the duodenum.

Figure 4. A patient presenting with fresh per rectal bleeding. Multi-detector computed tomography scan (with contrast) showing enhancing nodules (white arrowheads) in a segment of the mid–small bowel.

DISCUSSION

The use of CT to detect acute gastrointestinal bleeding was first reported in 1997 by Ettorre et al.[8] These researchers enrolled 18 consecutive patients with acute GI bleeding who underwent catheterisation of the abdominal aorta followed by single-detector helical CT angiography after intra-arterial injection of contrast through the angiographic catheter placed near the origin of the coeliac trunk. Helical CT revealed the site of contrast material extravasation in 13 patients (72%). The bleeding site was revealed at DSA for 2 of 5 patients who had negative helical CT angiography results. In 2003, Ernst et al reported that single-detector row helical contrast-enhanced CT identified the site of bleeding in 15 of 19 patients with acute lower GI bleeding (79%).[9] Three of the 15 patients showed extravasation of contrast, implying limited clinical usefulness of single-detector row helical CT for the clinical management of acute GI bleeding. In 2004, Tew et al published a retrospective study of 13 patients with acute lower GI bleeding who underwent multi-detector row CT with a 4-detector row scanner before angiography.[10] Multi-detector CT depicted the site of bleeding in 7 patients (54%), with all sites correlated by DSA. A recent prospective study using 4-slice MDCT shows promising results, with a high sensitivity of 90.9% (20 of 22 patients), specificity of 99.1% (107 of 108 patients), accuracy of 97.6% (127 of 130 patients), positive predictive value of 95.2% (20 of 21 patients), and negative predictive value of 98% (23 of 26 patients).[11] However, to the authors' knowledge, there are no published data on the use of 64-slice MDCT for detection of acute GI bleeding.

The aim of this study was to evaluate the usefulness of 64-slice MDCT for detection of acute GI bleeding. This technology has the advantages of better spatial resolution, faster scanning time, and better temporal resolution. The quality of the arterial phase images is expected to be better than with other imaging modalities, especially for critically ill patients who cannot hold their breath during scanning.

The results of this study indicate that 64-slice MDCT is sensitive for the detection and localisation of acute GI bleeding. For this indication, 64-slice MDCT has a sensitivity, specificity, positive predictive value, and negative predictive value of 100%, 50%, 90%, and 50%, respectively. The bleeding sites detected by 64-slice MDCT corresponded well with the bleeding sites detected by DSA. This information is important for interventional radiologists who perform selective angiography and subsequent embolisation for critically ill patients. The detailed vascular anatomy demonstrated on the arterial phase images assists interventional radiologists in planning vascular intervention.

There are several limitations to this study. Firstly, this was a retrospective study. Secondly, only 11 patients underwent both DSA and CT. This relatively small number of patient limits the statistical significance of the results. Thirdly, there was incomplete information on the severity of GI bleeding in these patients. Finally,

Table 2. Sensitivity, specificity, positive predictive value, and negative predictive value of 64-slice multi-detector computed tomography with arterial phase to detect acute gastrointestinal bleeding.

	Calculation	Result
True positive	Positive MDCT and positive DSA	9
False positive	Positive MDCT and negative DSA	1
True negative	Negative MDCT and negative DSA	1
False negative	Negative MDCT and positive DSA	0
Sensitivity	TP/(TP + FN) = 9/(9 + 0)	100%
Specificity	TN/(TN + FP) = 1/(1 + 1)	50%
Positive predictive value	TP/(TP + FP) = 9/(9 + 1)	90%
Negative predictive value	TN/(TN + FN) = 1/(1 + 1)	50%

Abbreviations: DSA = digital subtraction angiography; FN = false negative; FP = false positive; MDCT = 64-slice multi-detector computed tomography; TN = true negative; TP = true positive.

there was bias in the case selection, in that patients were required to have undergone both MDCT and DSA.

In conclusion, 64-slice MDCT with arterial phase is sensitive for detection and localisation of GI bleeding sites in the acute setting. The technology provides detailed vascular anatomy and information on the site of the bleeding to assist interventional radiologists with vascular intervention. Further studies are required to establish the role of 64-slice MDCT in clinical management.

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