Role of multislice computed tomography angiography in the diagnosis of clinically suspected acute mesenteric ischemia

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Background
The study aims to determine the accuracy of computed tomography angiography (CTA) in the diagnosis of cases of acute mesenteric ischemia (AMI).

Patients and methods
Fifty patients clinically suspected to have AMI were included and evaluated by multislice computed tomography (MSCT) abdominal angiography to detect the sensitivity, specificity, and diagnostic accuracy of the procedure.

Results
The final diagnosis confirmed mesenteric vascular occlusion (MVO) in 29 (58%) patients; of the 29 patients with MVO, 10 (34.5%) patients had arterial occlusion and 19 (65.5%) had venous occlusion. MSCT showed MVO in 28 (56%) patients; of the 28 patients with MVO, 10 (35.7%) patients had arterial occlusion and 18 (64.3%) patients had venous occlusion. As regards the 28 patients diagnosed by MSCT as MVO, the final diagnosis approved MVO in 27 of them while one patient was negative. CTA showed a sensitivity of 93.1%, specificity of 95.24%, and an overall accuracy of 94%.

Conclusion
CTA is an accurate tool that helps in the diagnosis of bowel ischemia with high accuracy in diagnosis. This supports the role of CTA as the ideal first-step imaging procedure in cases suspected to have AMI.

Keywords:
abdominal angina, mesenteric ischemia, multislice computed tomography angiography

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Background

Acute mesenteric ischemia (AMI) is a life-threatening disease having a high rate of mortality [1,2]. Although AMI represents less than 0.001 hospital admissions, its mortality rate is high reaching up to 90% [3]. Arterial embolism is the most common cause of AMI; the second common cause is arterial thrombosis, followed by nonocclusive ischemia, and lastly venous thrombosis [3].

Accurate diagnosis and rapid successful treatment of AMI are the cornerstones to improve its outcome and the delayed diagnosis contributes to the continued high mortality rate [4].

However, the variable presentations and different causes of AMI make its diagnosis a major challenge [4,5]. Patients' presentations ordinarily are vague abdominal symptoms and nonspecific laboratory findings, leading to a delay in the diagnosis [5–10]. Therefore, imaging diagnosis has considered one of the most decisive components in suspected AMI diagnostic workup [11,12].

Recently, advanced modalities are raising the role of computed tomography angiography (CTA) to be the modality of choice in suspected cases with AMI. CTA is a fast and noninvasive diagnostic modality for assessing both intestinal vascularity and loops [11,13]. CTA allows earlier diagnosis and differentiation between occlusive and nonocclusive causes, which are important to effective therapeutic management [14,15]. So, a combination of assessment of both vascular and bowel findings resulted in better diagnostic accuracy [13,16–18].

Knowledge of the alternative diagnoses in cases diagnosed as non-AMI have a very important role in proper patient care. CTA allows the diagnosis of variable acute alternative diagnoses that help in improving the clinical outcomes of those patients [19].

Aim

Our study aims to determine the diagnostic accuracy of CTA in the diagnosis of AMI.

Patients and methods

Patients

Our study performance was between May 2018 and May 2019 on 50 consecutive patients with clinical suspicion of AMI. They were referred from the emergency department and the outpatient clinics of general surgery and general medicine departments of Assiut University Hospitals.

Inclusion criteria

High clinical suspicion of AMI based on the evaluation of physicians during 48 h of acute manifestation.

The clinical suspicion of mesenteric ischemia was based on the following findings: pain disproportionate to the clinical signs, postprandial abdominal pain, loss of weight, and history of previous abdominal angina, history of previous mesenteric ischemia, atrial fibrillation, severe vascular disease, and hypercoagulable states.

Exclusion criteria

Those patients with known renal impairment or allergic to iodinated contrast media were excluded.

The study protocol was approved and monitored by the Medical Ethics Committee, Assiut Faculty of Medicine and written consent was taken from all patients (IRB: 17100956). Patients signed an informed consent.

Protocol of computed tomography angiography

Multislice computed tomography (MSCT) imaging was performed using either 16- detector (GE [bright speed, GE healthcare 16 slice, Boston, USA]), 64-detector (Toshiba [Aquilion 64, Toshiba Medical Systems, Nasu, Japan]), or 128-detector (Siemens [SOMATOM 128 detectors, Siemens, Forchheim, Germany]) MSCT scanners for CTA in the arterial and portovenous phases with a tube voltage equal 120 kV and automated range of effective tube current between 100 and 400 mA. Nonionic contrast material was used with at a dose of 100–120 ml according to the body built (1.5 ml/kg body weight) intravenously at a rate of 3–4 ml/s by an automatic injector, through an 18-G antecubital intravenous line. The cuts were taken from the xiphoid process down to the symphysis pubis with a slice thickness of 0.5 mm.

Arterial phase imaging was acquired using bolus tracking of the contrast material at the abdominal aorta to determine the arrival of the bolus of contrast material. The portal phase was imaged either 70–80 s postinjection or 50–60 s after bolus tracking. The venous phase was imaged either 100-s postinjection or 80 s after bolus tracking.

Multislice computed tomography postprocessing techniques

Data were acquired in 0.5 mm slice thickness and intervals, and images were reconstructed and viewed on a workstation (via GE workstation, Vitrea, Siemens Syngo), which provide multiplanar 'axial, sagittal, oblique and coronal' reformatted and volume rendering images including the small and large bowel. Maximum intensity projection, three-dimensional volume rendering, multiplanar reformatted images, and curved planar reconstruction were done from the arterial phase volume.

Image interpretation

MSCT images were analyzed to diagnose AMI depending on vascular MSCT findings such as arterial occlusion 'embolism or thrombus,' stenosis, arterial dissection, or mesenteric venous thrombosis. Other MSCT findings were analyzed to detect abnormal bowel wall thickening of more than 3 mm in noncollapsed bowel, mucosal attenuation in precontrast scans, mucosal enhancement pattern in postcontrast CT scans, mesenteric fat stranding, free fluid collection, air density within the bowel wall, superior mesenteric vein, or portal vein. The impressed MSCT diagnosis for each patient was compared with the reported final clinical diagnosis.

The final clinical diagnosis

The close follow-up of the patients to determine the final clinical diagnosis was based on emergency department evaluation, laboratory, surgical, pathological, and follow-up imaging reports. The determined final clinical diagnosis for each patient was used as the standard reference including patients with delayed diagnoses and interventions.

Statistical analysis

Data was collected and analyzed using the Statistical Package for the Social Sciences (version 20; IBM, Armonk, New York, USA). Continuous data were expressed in the form of mean ± SD or median (range), while nominal data were expressed in the form of frequency (percentage). χ^2 test was used to compare the nominal data and the Student's *t* test was used to compare continuous variables. Diagnostic performance of CTA including sensitivity, specificity, predictive values, and accuracy were calculated. *P* value was considered significant if less than 0.05.

Results

In this study, 50 patients with clinical suspicion of AMI have been examined using CTA including 34 (68%) men and 16 (32%) women. The mean ± SD age of the examined patients was 50.86 ± 12.74 years with a range between 18 and 75 years.

As regards the risk factors for AMI in the studied patients, liver cirrhosis (18%) and atrial fibrillation (12%) were the most frequent risk factors, followed by previous intestinal ischemia (6%) and malignant diseases (4%).

Acute abdomen was the most frequent clinical presentation in 20 (40%) patients. Constipation, repeated vomiting, gastrointestinal bleeding, and fever were present in 14 (28%), seven (14%), six (12%), and two (4%) patients, respectively.

Among the studied patients, MSCT showed mesenteric vascular occlusion (MVO) in 28 (56%) patients, while in the remaining 22 (44%) patients, non-MVO has been encountered. Of the 28 patients with MVO, 10 (35.7%) had arterial occlusion and 18 (64.3%) had venous occlusion (Figs. 1–3).

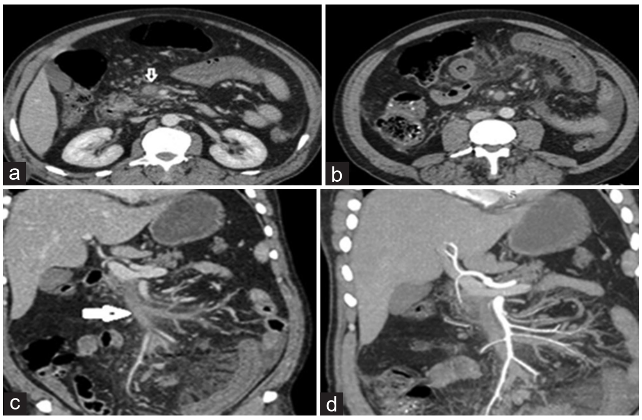
Among the studied patients, the final diagnosis showed MVO in 29 (58%) patients while in the remaining 21 (42%) patients, non-MVO has been encountered.

Of the 29 patients with MVO, 10 (34.5%) had arterial occlusion and 19 (65.5%) had venous occlusion.

Of the 28 patients diagnosed by MSCT as MVO, the final diagnosis confirmed MVO in 27 of them while in one patient there was no MVO. Of the 22 patients diagnosed by MSCT such as non-MVO, the final diagnosis confirmed non-MVO in 20 of them while in two patients there was MVO (Table 1).

It was noticed that CTA had 93.1% sensitivity and 95.24% specificity for the prediction of MVO in patients with acute abdomen (Table 2).

Figure 1



(a) Axial CT portal phase shows thrombosis of SMV 'arrows;' (b) axial CT portal phase showing dilated bowel loops with thickened edematous mildly enhancing walls; (c) coronal reconstructed CT image portal phase shows SMV thrombosis extending to its tributaries 'arrows;' (d) coronal CT arterial phase showing normal SMA. CT, computed tomography; SMA, superior mesenteric artery.

Discussion

Mesenteric ischemia is a rare disease affecting the small and large intestine resulting from reduced blood flow of the intestine. The disease has a high death rate in an acute stage in spite of advances in management options [3,20–22].

Table 1 Cross-tabulation between final and multislice computed tomography diagnosis of the studied patients

MSCT diagnosis	Final diagnosis		Total
	MVO	Non-MVO	
MVO	27	1	28
Non-MVO	2	20	22
Total	29	21	50

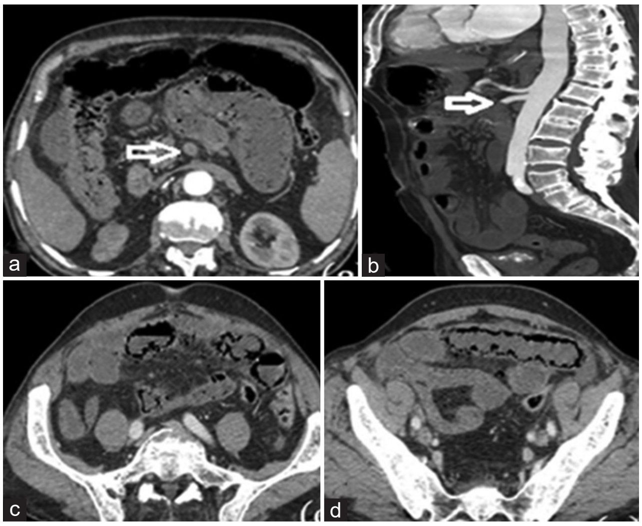
MSCT, multislice computed tomography; MVO, mesenteric vascular occlusion.

Table 2 Accuracy of computed tomography angiography in diagnosing mesenteric vascular occlusion

	Value (%)
Sensitivity	93.1
Specificity	95.24
Positive predictive value	96.4
Negative predictive value	90.9
Diagnostic accuracy	94
P	<0.001

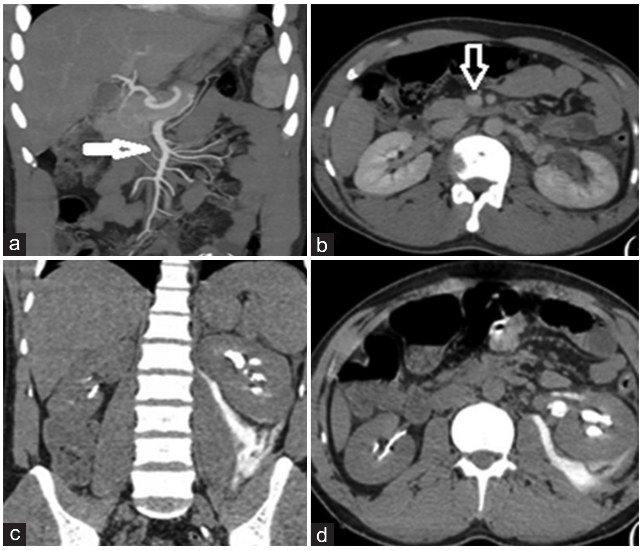
P<0.05.

Figure 2



(a) Axial CT image of the arterial phase shows thrombosed SMA 'arrows;' (b) sagittal reformatted MIP CT image of the thrombosed SMA 'arrows;' (c and d) axial CT images showing dilated loops with thickened nonenhanced walls and pneumointestinalis. CT, computed tomography; MIP, maximum intensity projection; SMA, superior mesenteric artery.

Figure 3



(a) Coronal reformatted MIP CT image shows normal SMA 'arrows;" (b) axial CT image portal phase showing normal SMV 'arrowed;' (c and d) coronal and axial CT images at a delayed phase shows left extrarenal contrast leakage due to ruptured left renal calyx. CT, computed tomography; MIP, maximum intensity projection; SMA, superior mesenteric artery.

The causes of ischemia include arterial embolism or thrombosis, venous thrombosis, or vasoconstriction of blood vessels. There is increased prevalence in the older population and nonspecific clinical symptoms and signs leading to delayed diagnosis causing the high death rate. Mostly mesenteric ischemia is due to an acute insult that leads to the diminished blood supply to the intestine [20].

AMI is most commonly caused by acute embolism to the superior mesenteric artery (SMA), which accounts for about half of all episodes, then acute thrombosis of mesenteric artery mesenteric ischemia, followed by nonocclusive mesenteric ischemia and mesenteric and portal venous thrombosis, the least common cause.

CTA can be helpful in detecting the grades of arterial stenosis and in differentiating between patients who would benefit from angiographic management and those who need surgical intervention.

Abdominal MSCT imaging also helps in the assessment of the entire gastrointestinal and genitourinary tract, excluding other differential diagnoses as causes of acute abdominal pain including pancreatitis, appendicitis, cholelithiasis, nephrolithiasis, and diverticulitis [23].

The etiology of mesenteric ischemia determines the outcome of the patient and if thromboembolic occlusion of the SMA is the cause of AMI fatality, occurring in up to 95% of cases [23]. It is important to detect intestinal ischemia before infarction of intestinal wall results to get better outcomes [23].

Our study confirmed that AMI is mainly an abdominal emergency condition in the older patients. We found only one (0.03%) young patient aged 32 years old with ischemia, among the 29 patients with a proven diagnosis of AMI. This is in keeping with Henes *et al.* [19] who stated that there is a significant increase in the prevalence of AMI in patients of age more than 35 years.

The major risk factors in patients with AMI in our study were liver cirrhosis, and atrial fibrillation followed by previous intestinal ischemia and malignant diseases. Other risk factors included old age and hypovolemia. This matched with Hemat *et al.* [24] who stated that advanced age, atherosclerosis, recent MI, arrhythmias, valvular disease, CHF hypovolemia, and intra-abdominal malignancy are the major risk factors for AMI.

Abdominal pain disproportionate to physical signs and examination is the most common clinical presentations followed by constipation, repeated vomiting, and gastrointestinal bleeding. Less common presentations were fever and shock. This was going with the same findings as Owens and Ronan-Bentle [25] which stated that AMI is mostly presented by abdominal pain disproportionate to physical examination with a history of cardiovascular affection. Patients may have variable other presentations including projectile vomiting, bloody diarrhea, fever, and lastly infarction of the bowel wall that makes the patient vitally unstable.

Our study showed that 10 (34.5%) patients from those with MVO had SMA occlusion; six patients had complete occlusion of the artery while four patients had partial occlusion.

The other 19 (65.5%) patients with MVO had superior mesenteric vein thrombosis. Twelve patients from those with SMV thrombosis had also portal vein thrombosis.

On the other side, Fidelman *et al.* [26] reported a higher incidence of AMI due to SMA embolism or thrombosis in comparison to mesenteric venous thrombosis. This may be contributed to our sample size and the increased incidence of liver diseases in Egypt.

On comparing CTA findings with endoscopic, surgical, and follow up of the patients, we found that CTA has accurately diagnosed AMI in 27/29 patients and was false negative in two patients, resulting in a sensitivity of 93.1%. The two false-negative cases were diagnosed as minor branch AMI and the other as mesenteric ischemia of the nonocclusive type.

CTA correctly excluded AMI in 20/21 patients and was false positive in one patient, resulting in a specificity of 95.24%. The accuracy of CTA in the diagnosis of mesenteric ischemia was 94%. That was in keeping with Kanasaki *et al*. [27] which stated that the diagnostic accuracy of CTA for detection of AMI is high with a sensitivity of 64–96% and a specificity of 92–100%.

In another study, Menke *et al*. [28] showed a sensitivity of 93.3% and specificity of 95.9% contrast-enhanced MSCT in the detection of primary AMI.

Conclusion

In conclusion, CTA is an accurate tool that allows for the detection of bowel ischemia with high diagnostic performance. This highly supports the role of CTA as the ideal first-step imaging procedure to confirm or rule out AMI in cases suspected to have the disease.

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Conflicts of interest

There are no conflicts of interest.

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