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Computed tomography versus digital subtraction angiography for the diagnosis of obscure gastrointestinal bleeding

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ABSTRACT

Purpose: The diagnostic yield of computed tomography angiography (CTA) compared to digital subtraction angiography (DSA) for major obscure gastrointestinal bleeding (OGIB) is not known. Aim of the study was to prospectively evaluate the diagnostic yield of CTA versus DSA for the diagnosis of major OGIB.
Material and methods: The institutional review board approved the study and informed consent was obtained from each patient. Patients with major OGIB were prospectively enrolled to undergo both CTA and DSA. Two blinded radiologists each reviewed the CTA and DSA images retrospectively and independently. Contrast material extravasation into the gastrointestinal lumen was considered diagnostic for active bleeding. Primary end point of the study was the diagnostic yield, defined as the frequency a technique identified an active bleeding or a potential bleeding lesion. The diagnostic yield of CTA and DSA were compared by McNemar's test.
Results: 24 consecutive patients (11 men; median age 64 years) were included. CTA and DSA identified an active bleeding or a potential bleeding lesion in 92% (22 of 24 patients; 95% CI 72%–99%) and 29% (7 of 24 patients; 95% CI 12%–49%) of patients, respectively ($p < 0.001$). CTA and DSA identified an active bleeding in 42% (10 of 24; 95% CI 22%–63%) and 21% (5 of 24; 95% CI 7%–42%) of patients, respectively ($p = 0.06$).
Conclusion: Due to the lower invasiveness and higher diagnostic yield CTA should be favored over DSA for the diagnosis of major OGIB.

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1. Introduction

Obscure gastrointestinal bleeding (OGIB) is defined as bleeding of unknown origin that persists or recurs after negative endoscopy (colonoscopy and/or upper endoscopy) [1]. The small bowel is usually considered the source of bleeding and several approaches are available to identify the exact site and cause of bleeding [2–4].

For several decades, mesenteric angiography was considered the most accurate modality for the diagnosis of OGIB [5–8]. However, the procedure is often unsatisfactory due to its variable diagnostic yield [6,9]. Scintigraphy proves active bleeding into the gastrointestinal lumen with high sensitivity but often lacks specificity for the site and cause of bleeding [10]. The implementation of capsule endoscopy and double balloon enteroscopy has revolutionized the diagnostic approach [1,11,12]. However, in actively bleeding patients, when rapid diagnosis is required, both procedures carry limitations since they last several hours and excessive intraluminal blood and clots can impair the endoscopic visibility [13]. The advent of multidetector-row helical computed tomography (CT) provides high temporal and spatial resolution and these attributes promise superior depiction of the site and cause of bleeding [2,3,14,15].

In patients with signs of active bleeding both digital subtraction angiography (DSA) and CT angiography (CTA) are diagnostic options. Hence, the purpose of this single-center study was to prospectively compare the diagnostic yield of multidetector-row CTA and DSA in patients with OGIB and signs of active bleeding.

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2. Material and methods

2.1. Patients and study design

24 consecutive patients who fulfilled the inclusion criteria were included in this prospective single center study over a four-year period. The institutional review board (#2006/044) as well as the German Federal Office for Radiation Protection (#Z5-22462/2-2006-013) approved the protocol. The study was curried out following the guidelines of the Declaration of Helsinki. All patients gave informed consent before enrollment in the study or, in case of initial inability to give informed consent, the latter was obtained after recovery of the patients' status. The results of six patients have previously been included in a feasibility study [15] and a study on intrarterial CT mesentericography [16].

The inclusion criteria of the present study were as followed: 1) patients presenting with OGIB, defined as gastrointestinal bleeding with negative gastroduodenoscopy and negative colonoscopy. 2) Major bleeding was present, defined as bleeding with a drop of hemoglobin level of at least 2 g/dL or requirement of at least 2 packed red blood cell units within the last 24 h. 3) Age was at least 18 years, pregnancy was ruled out and serum creatinine level was below 1.7 mg/dL. 4) Written informed consent was obtained.

During the study period 31 patients fulfilled the inclusion criteria #1–3. Seven patients did not give informed consent because of increased contrast material and radiation exposition required for performing both CTA and DSA; leaving 24 patients who gave inform consent and were finally included in the study.

2.2. Multi-Detector computed tomography

The study protocol has been published before [15]. In brief, immediately before CTA scanning 200–500 mL of water was administered orally as negative contrast agent for gastroenteric distension. If there were no contraindications for application of N-butylscopolamine, 40 mg were given intravenously to minimize artifacts by bowel motion. Scanning was performed on a 16-row multi-detector CT scanner (Somatom Sensation 16, Siemens Medical Solutions, Erlangen, Germany). An antecubital vein was used as access route and 130 mL nonionic contrast material (iohexol (Accupaque^{TM}), 300 mg iodine/mL, GE Healthcare) was injected at a rate of 5 mL/sec, followed by a 60 mL saline flush at 4 mL/s. Arterial and venous phase scans of the abdomen and pelvis extending from the diaphragm to the symphysis were acquired. Automatic bolus-triggering software (Care Bolus Software; Siemens Medical Solutions, Erlangen, Germany) was applied with a circular region of interest placed in the abdominal aorta at the level of the diaphragm and a trigger threshold of 100 Hounsfield Units. Data acquisition of the arterial phase started twelve seconds after bolus-trigger threshold was reached. The venous phase scan was started 150 s after onset of contrast material injection. Images were reconstructed in the axial and coronal planes (3-mm slice width/3-mm intervals; soft reconstruction kernel (B30f)).

The depiction of hyperdense material consistent with extravasated contrast agent within the gastrointestinal tract in the arterial phase and progressive accumulation and redistribution of contrast material in the venous phase was considered diagnostic for an active bleeding [15,17–19]. Multiple criteria including tumors infiltrating the bowel wall, abnormal enhancement and thickening of the bowel wall, fistulas, ulcers, strictures, diverticula and vascular disorders were regarded as potential bleeding lesions [9]. Angioectasia, arteriovenous malformation, Dieulafoy's lesion, varices, phlebectasia, aneurysms and arterial fistula were counted as vascular disorders [4]. Criteria to diagnose angioectasia were the presence of ectatic, dilated vessels within the bowel wall, early filling veins and enlarged arteries of the target area [20]. Two radiologists (O.W.H.; P.H.; with 16 and 12 years of experience in body imaging, respectively) reviewed each CTA independently and unaware of the findings of DSA. After completion of independent review, the two radiologists reached a consensus regarding patients for whom their results were discrepant.

2.3. Mesenteric DSA

After CTA the patients were transferred to the angiography suite (Polystar, Siemens Medical Solutions, Erlangen, Germany) and standard mesenteric DSA was performed by an interventional radiologist with at least 4 years of experience in body angiography. If there were no contraindications for application of N-butylscopolamine, 40 mg were administered intravenously and continuously during angiography to minimize artifacts by bowel motion. A 5 French pigtail catheter was placed into the abdominal aorta at the level of the twelfth thoracic vertebra and abdominal aortography was performed. Subsequently, selective DSA (two images per second) of the celiac trunk as well as the superior and inferior mesenteric artery was carried out. The volume and rate of the administered contrast material (iohexol (Accupaque^{TM}), 300 mg iodine/mL, GE Healthcare) were 20 mL/4–5 mL/sec, 20–30 mL/4–6 mL/sec and 10–15 mL/2–3 mL/sec for imaging of the vascular territory of the celiac trunk, superior and inferior mesenteric artery, respectively.

After completion of standard mesenteric DSA the findings of CTA and DSA were compared. If CTA displayed an active bleeding, which was not depicted on DSA, superselective angiography of the vascular territory where CTA depicted an active bleeding was carried out.

Extravasation of contrast material into the gastrointestinal tract was considered diagnostic for an active bleeding. Multiple criteria including hypervascular tumors of the bowel wall, abnormal enhancement and thickening of the bowel wall and vascular disorders were regarded as potential bleeding lesions [9]. Angioectasia, arteriovenous malformation, Dieulafoy's lesion, varices, phlebectasia, aneurysms and arterial fistula were counted as vascular disorders [4]. Angiographic criteria of angioectasia were a densely opacified, slowly emptying, dilated tortuous vein, a vascular tuft and/or an early filling vein [21]. Two radiologists (M.W.; R.M-W.; with 5 and 7 years of experience in interventional radiology) reviewed each DSA independently and unaware of the findings of CTA. After completion of independent review, the two radiologists reached a consensus regarding patients for whom their results were discrepant.

2.4. Data analysis

Medical history, characteristics of OGIB as well as time interval between CTA and DSA were recorded. Primary endpoint of the study was the diagnostic yield for each technique, defined as the frequency a technique identified an active bleeding or a potential bleeding lesion. In addition, the frequency a technique depicted an active bleeding, a vascular and a non-vascular cause of bleeding was analyzed.

CTA and DSA findings were classified into clinically relevant and non-relevant. CTA and DSA findings were considered clinically relevant if the findings of each one resulted in specific treatment defined as angiographic, endoscopic or surgical intervention or specific medication, which would have not been performed without knowledge of the imaging results. Complications were defined as need for dialysis, vascular injury or any complication related to CTA or diagnostic DSA that prolonged hospital stay.

Demographic data are presented as median and range. Two-sided 95% confidence intervals (CI) for single proportions were

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