

# Acute Nonvariceal Gastrointestinal Hemorrhage

CT angiography and cone-beam CT in the diagnosis and treatment of GIH.

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**A**cute nonvariceal gastrointestinal hemorrhage (GIH) is a medical emergency with an overall mortality rate of approximately 7%.<sup>1</sup> During the last decade, best medical care improved resulting in a trend to a lower mortality rate. However, in specific high-risk situations, such as severe hemodynamic instability, older patients with cardiovascular comorbidity, perforation, nonsteroidal anti-inflammatory drug intake, and recurrent bleeding, mortality rates may still run up to 40%.<sup>2</sup> GIH is classically divided into upper GIH and lower GIH based on whether the bleeding source is proximal or distal to the ligament of Treitz. The annual incidence is 40 to 150 episodes per 100,000 persons for upper GIH and 20 to 27 episodes per 100,000 persons for lower GIH.<sup>3</sup>

Depending on the location of the blood loss, the first clinical signs of GIH may consist of hematemesis (bloody or “coffee ground” vomit), melena, or hematochezia (anal loss of red blood), followed by signs of hypovolemia (tachycardia > 100/min and systolic blood pressure < 100 mm Hg). Causes of upper GIH include peptic ulcer, esophagitis, gastritis, bulbitis (erosions, mucosal inflammation), neoplasms, and vascular malformations (angiodysplasia, Dieulafoy lesion, and aortoenteric fistula). Diverticular disease, inflammatory bowel disease, angiodysplasia, arteriovenous malformation, malignancy, and bowel ischemia can cause lower GIH.

To detect the source of the bleeding, several diagnostic strategies have been investigated, such as barium examinations, upper and lower GI endoscopy, capsule endoscopy, technetium-labeled red blood cell scintigraphy, and digital subtraction angiography (DSA).

In upper GIH, gastroduodenoscopy is the procedure of choice with a high sensitivity of 90% to 95%<sup>4</sup> and the capacity to stop the bleeding at the same time. However, in massive bleeding (> 1 mL/min), endoscopy fails to depict the exact focus of the bleeding in 10% to 20% of cases.<sup>5,6</sup>

In lower GIH, colonoscopy is performed as the initial investigation with a diagnostic accuracy of 72% to 86%.<sup>7</sup> However, visibility during colonoscopy may be obstructed if bleeding is severe and the bowel cannot be prepared. Moreover, in an acute setting, the small bowel remains largely inaccessible. Computed tomographic angiography (CTA) has been investigated to explore GIH. Recently, a variant CT, called *cone-beam CT* (CBCT), became integrated in flat-panel angiographic suites, enabling dynamic CT scanning during angiography. In this article, we discuss the role of both CT technologies, particularly in lower GIH. Illustrated by two typical cases, the potential value of CBCT as an additional tool for angiography and guidance of endovascular treatment will be highlighted.

## CTA

On CTA, acute GIH is confirmed when, in the arterial and/or venous phase, extravasation of intravenously administered contrast into the bowel lumen can be demonstrated. According to studies in a swine model, CTA should be able to detect bleeding even below 0.4 mL/min, which is somewhat less sensitive than red blood cell scintigraphy but higher than angiography.<sup>8</sup> Sensitivity has been reported to be approximately 86%<sup>9</sup> in several studies, with a high specificity up to 95%. Aside from



**Figure 1.** CTA shows contrast extravasation into the lumen of the sigmoid (large arrow) and ventral of the endoscopically placed metal clip (small arrow) (A). CBCT after mesenteric angiography: extensive endoluminal contrast (arrow) is seen around the clip (arrowhead)(B). Superselective mesenteric angiogram, late phase. Contrast extravasation (large arrow) is seen near the metallic clip (small arrow) (C).

location, information concerning the underlying cause may be obtained.<sup>10</sup>

CTA has the advantages of a noninvasive technique in that it is fast, widely available, and fairly independent of the investigator.

A major drawback of CTA is the potential time lost due to the lack of therapeutic options. A high radiation dose and the nephrotoxicity of the contrast agents, particularly in hemodynamic, unstable, cardiovascular-compromised patients, should be taken into account. Therefore, a reasonable, low amount of contrast medium should be used for CTA: less than 100 mL at a rate of 4 mL/s followed by 60 mL saline flush at 4 mL/s seems suitable.

Pitfalls in reviewing the CT images result from high-density fluids filling the bowel and metallic materials. Suture material, clips, foreign bodies, retained contrast material, and cone-beam artifacts next to intraluminal air can give false-positive results.<sup>11</sup> To minimize this chance of error, an oral (positive or negative) contrast agent should be omitted, and the CT protocol should always start with a noncontrast-enhanced scan.

Chua et al<sup>9</sup> reviewed eight published studies of CTA in acute GIH and suggested that CT has a potential role in the diagnostic workup and direction of further management. However, the number of patients in these retrospective studies was relatively small, and in most investigations, older scanners were used. With the modern multidetector scanners with faster scanning times, higher spatial resolution, and better multiplanar reformatting, accuracy could be improved. In our and others' experience, CTA has already found its role in endoscopically unclear GIH, mostly of lower origin. CTA

seems an efficient modality for triage of good candidates for angiography and subsequently embolization. If, after a positive CTA, transfer to the angiosuite is optimally timed, the number of positive angiographies will increase, thereby offering therapeutic embolization to a higher number of patients. Of course, to prove the usefulness of this algorithm, a large prospective study should establish the definitive role of CTA in GIH.

### CBCT

Recently, high-end C-arm angiographic suites have been equipped with a dynamic flat-panel detector instead of a classical television image intensifier. Based on the conversion of absorbed x-ray photons by cesium iodide rods into light photons, which induce electronic signals directly read by amorphous silicon photodiodes, flat-panel technology offers a number of advantages and creative imaging possibilities. The detector's field of view is homogenous, large (up to 40 X 40 cm), and contains a 2048 matrix of diodes. This matrix actually represents a 2048 detector panel, catching the x-ray photons cone-beamed from the focus of the Röntgen tube fixed on the C-arm at 180°. During rotation of the C-arm, sequential images (300–600) can be made at a rate up to 60/s, similar to three-dimensional angiography. Because of the excellent low-contrast resolution of flat panels, images can be reconstructed in a CT mode, obtaining an isometric three-dimensional volume for multiplanar reconstructions.

Interventional radiologists have desired to combine CT-scan technology with angiography for quite some time. In the past, transfer of the patient from the angiosuite with indwelling arterial catheters to the CT scan



**Figure 2.** On CTA, extravasation (arrow) is clearly seen near the ileostomy (A). On mesenteric angiography, no extravasation is detected (B). On CBCT during intra-arterial contrast injection, extravasation (cross reference) near the ileostomy is seen on the reformatted images in the axial (C) and coronal (D) plane. Contrast injection in the microcatheter after superselective catheterization of one of the ileal arteries shows the extravasation (arrow) (E).

room was too impracticable for routine use. Now, with the CBCT integrated in the flat-panel C-arm, the interventional radiology community has what they have been asking for. Interventional neuroradiologists can now quickly perform CBCT of the brain when bleeding is suspected. In transarterial embolization of the liver, CBCT during intra-arterial contrast injection will inform the operator exactly about the liver region to be treated and if all tumors are within the injection range. Other CBCT-supported interventions are vertebroplasty, biliary stenting, and portal vein embolization.

Nonenhanced CBCT does not have the spatial and contrast resolution of multislice CT; it is not appropriate for diagnostic purposes. However, organ differentiation is sufficient, particularly in combination with intra-arterial contrast administration. Therefore, it is not surprising that extravasation of contrast medium after intra-arterial injection can be visualized on CBCT. In the subsequent case studies, we demonstrate the potential of arterial contrast-enhanced CBCT in localizing GIH.

### Case 1: Massive Rectal Hemorrhage After Use of Acetylsalicylic Acid

A 78-year-old woman was referred with massive painless rectal hemorrhage. She had taken two aspirin

tablets because of knee pain a few hours earlier. Clinically, the patient was hemodynamically unstable at the time of presentation. A colonoscopy was performed. Extensive diverticulosis was seen with active bleeding from a visible vessel in a sigmoidal diverticulum. The bleeding was coagulated, and a metal clip was placed as a marker for precaution.

During the next 2 days, however, two episodes of rectal GIH reoccurred with a negative colonoscopy. Again, the patient became hemodynamically unstable. CTA was performed and revealed extravasation of contrast in the sigmoid colon. Intraluminal contrast was already visible in the arterial phase and was accumulating in the venous phase.

Subsequently, mesenteric catheter angiography was performed. On the initial images, no extravasation was seen. Selective microcatheterization of the suspected sigmoidal branch was performed, but again, no active bleeding could be detected. CBCT during selective contrast injection via the microcatheter was obtained, but no contrast extravasation was seen. Because there was no contrast medium in the colon, we assumed that no bleeding had occurred since the beginning of the angiographic procedure. On the multiplanar reconstructions, a small, contrast-filled artery was visible

leading to the metal clip, suggesting that the correct sigmoid artery was catheterized. The catheter was progressed into the branch leading to the clip, and DSA images were made during manual contrast injection. Extravasation was immediately observed at the level of the metal clip. A new CBCT was obtained, this time without contrast injection, and pooling of contrast around the clip could easily be seen. After embolization using 0.4 mL polyvinyl alcohol particles of 200  $\mu\text{m}$  (Cook Medical, Bloomington, IN), the artery was occluded, extravasation stopped, and the patient remained stable (Figure 1).

### Case 2: Intestinal Hemorrhage After Ileostomy

An 83-year-old man was referred because of acute blood loss out of his ileostomy. Eight years ago, he had suffered from ischemic colitis, for which he had a subtotal colectomy with double-barrel colostomy. Because of adhesions, the colostomy obstructed 7 days before, and an ileostomy was necessary.

The patient was hemodynamically unstable at the time of admission. Suspecting the bleeding source in the small bowel, we obtained a CTA, which demonstrated intraluminal contrast medium near to the ileostomy. On subsequent mesentericography, no bleeding or vascular anomaly was seen at first sight. One of the ileal arteries leading to the ileostomy was catheterized, and a CBCT during manual arterial injection of contrast medium was made. Using multiplanar reconstruction, the axial images could be compared to the CTA performed earlier, and the extravasation seen on CT could be withheld on the cone-beam images as well. Coronal reconstructions revealed the ruptured artery, which could be traced on the two-dimensional DSA as well. The microcatheter was then progressed distally into the traced ileal artery, and on superselective injection, contrast extravasation could now also be seen on the DSA. Embolization was performed using 0.1 mL of a mixture of glue (Glubran 2, GEM Srl, Viareggio, Italy) and lipiodol/Ethiodol (Guerbet, Villepinte, France) in a 1:3 ratio (Figure 2).

### CONCLUSION

These two cases show that CTA as well as CBCT might become pivotal in the endovascular treatment of acute nonvariceal GIH. CTA can indicate whether the patient is actually bleeding and thus a good candidate for immediate transcatheter embolization. CBCT can indicate whether the bleeding continued during angiography simply by detecting intraluminal contrast medium. Furthermore, the bleeding source can be localized

precisely. Finally, the vessel responsible for the bleeding can be identified by multiplanar reconstructions.

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Guided by CBCT, microcatheterization of the correct arcade and straight artery should become easier. Even if the ruptured artery is no longer bleeding at DSA, prophylactic embolization in the bowel might become realistic and safe. The timing of performing CBCT during the interventional procedure, whether it is necessary and whether it should be contrast-enhanced, depends on the angiographic findings. The role of CTA and, in particular, intra-arterial contrast-enhanced CBCT in GIH should be further explored to define its place in the endovascular workup. ■

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