

# Computed Tomography Angiography of the Small Bowel and Mesentery



Siva P. Raman, MD\*, Elliot K. Fishman, MD

## KEYWORDS

- Computed tomography angiography (CTA) • Small bowel • Mesenteric ischemia
- Acute gastrointestinal bleeding • Median arcuate ligament syndrome • Small bowel vasculitis
- Mesenteric artery dissection

## KEY POINTS

- Positive oral contrast media should be avoided in cases in which small bowel disorder is suspected, because high-density contrast within the bowel may result in beam hardening and streak artifact that can obscure the adjacent bowel wall, thereby preventing the accurate delineation of subtle bowel wall thickening or abnormal bowel wall enhancement.
- Computed tomography (CT) can serve as a valuable diagnostic modality in the evaluation of gastrointestinal (GI) bleeding, allowing delineation of active contrast extravasation, as well as the diagnosis of several other disease entities that might result in GI bleeding.
- Mesenteric ischemia has several different causes, each of which can result in different imaging patterns on CT.

## INTRODUCTION

Multidetector computed tomography (MDCT) has supplanted fluoroscopic studies as the first-line imaging modality in patients with suspected small bowel or mesenteric disorders. Unlike fluoroscopy, which has always been limited by its inherently nonspecific findings and inability to evaluate extraluminal abnormalities, MDCT provides a range of information about both bowel and mesenteric findings that is much more likely to allow a specific diagnosis. The advantages of MDCT as a small bowel-imaging tool have increased over the last 2 decades, both as a result of improvements in imaging protocols (including the continued refinement of enterography protocols) and because of improvements in scanner technology. In particular, the latest generation of MDCT scanners (including 64-slice, 128-slice,

and dual-source scanners) now offer unparalleled improvements in temporal resolution that allow the reliable acquisition of images at peak arterial enhancement, often with associated improvements in spatial resolution as well. Accordingly, it is now possible to acquire exquisite computed tomography angiography (CTA) images of the bowel, mesentery, and mesenteric vasculature (including second-order and third-order branch vessels), as well as create three-dimensional (3D) reconstructions of extraordinary detail.

These technological developments, and the resultant improvements in CTA imaging, have proved particularly valuable in the evaluation of small bowel vascular and inflammatory disorders, diagnoses in which arterial phase images might be able to offer far greater information than standard venous phase imaging. This article details

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Department of Radiology, Johns Hopkins University, JHOC 3251, 601 North Caroline Street, Baltimore, MD 21287, USA

\* Corresponding author.

E-mail address: srsraman3@gmail.com

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the MDCT imaging findings of several small bowel vascular and inflammatory disorders, including mesenteric ischemia, median arcuate ligament syndrome, acute gastrointestinal (GI) bleeding, mesenteric artery dissection, superior mesenteric artery (SMA) syndrome, and Crohn disease, with a special emphasis on the role of CTA findings in the diagnosis of each of these entities.

## COMPUTED TOMOGRAPHY PROTOCOLS

The imaging protocols used to evaluate suspected small bowel inflammatory and vascular disorders should vary depending on the acuity of the patient's presentation. In the setting of an acute presentation, oral contrast of any kind should typically be avoided: positive oral contrast should not be administered, because the accumulation of high-density contrast within the bowel may result in beam hardening and streak artifact that can obscure the adjacent bowel wall, thereby preventing the accurate delineation of subtle bowel wall thickening or abnormal bowel wall enhancement. Alternatively, although neutral contrast agents (eg, VoLumen) can be helpful in terms of allowing bowel distension and better accentuating abnormalities of the bowel wall (both in terms of thickness and enhancement), many acutely ill patients are not able to ingest the requisite contrast, and, moreover, waiting for the ingestion of the contrast agent may delay treatment in the most acutely sick patients. In our own practice, usually in the emergency room setting, we do not routinely administer oral contrast agents for patients with suspected acute small bowel disorders (eg, ischemia), and instead use water as our agent of choice. We also prefer to avoid administering contrast in cases of suspected acute GI bleeding, because the contrast medium can dilute sites of active extravasation, thereby making them more difficult to identify, and may prove a hindrance for the gastroenterologist if endoscopy is required after the computed tomography (CT) scan.<sup>1</sup> When administering water as our only oral contrast agent, we use a short delay of only 20 to 25 minutes before scanning the patient, so as not to delay the patient's treatment.

Alternatively, for patients with a more subacute or chronic presentation, where there is greater importance placed on the need for good bowel distension, we typically perform our standard CT enterography protocol, with the administration of neutral contrast agents to distend the bowel lumen and improve evaluation of the bowel wall. Although several different agents are available and have been described in the literature, the most widely used agent is barium sulfate (eg,

VoLumen, E-Z-EM, New York), which in our experience is probably the most effective contrast medium for this purpose, albeit still providing variable results because of problems with patient compliance. There is a great deal of variability in the literature regarding the manner in which this contrast may be administered, but in our own practice patients are typically instructed to ingest 450 mL of VoLumen slowly over 10 minutes, followed by additional doses of 450 mL of contrast at 10 and 20 minutes after the first dose, for a total of 1350 mL of contrast. In addition, patients are given 500 mL of water immediately before the scan to distend the stomach and duodenum. In our experience, this oral contrast administration schedule maximizes the odds of distending not only the distal small bowel but the stomach and proximal bowel as well.<sup>1,2</sup>

The administration of intravenous (IV) contrast is of critical importance in these cases, with 100 to 120 mL of nonionic contrast typically injected at a rapid rate (4–5 mL/s). Regardless of whether the patient has an acute or chronic presentation, the use of a dual-phase technique is of paramount importance: arterial phase images are acquired using a bolus trigger (usually at roughly 30 seconds), whereas venous phase images are acquired using a fixed scan delay of roughly 60 seconds (Box 1). As is discussed throughout

### Box 1 Imaging protocols

#### *Imaging protocols for small bowel vascular disorders*

- Administer 100 to 120 mL of nonionic IV contrast (4–5 mL/s)
- Arterial phase: bolus trigger during inspiration
- Venous phase: fixed delay at 60 seconds during inspiration
- Avoid oral contrast agents (except water) in patients with suspected GI bleeding or acute presentation
- VoLumen (enterography protocol) in patients with subacute or chronic presentation
  - First dose of VoLumen (slow drink over 10 minutes): 450 mL
  - Second dose of VoLumen (10 minutes after first dose)
  - Third dose of VoLumen (10 minutes after second dose)
  - 500 mL of water immediately before scan

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