Radiological Evaluation of Bowel Ischemia

Harpreet S. Dhatt, MD, Spencer C. Behr, MD, Aaron Miracle, MD, Zhen Jane Wang, MD, Benjamin M. Yeh, MD*

KEYWORDS

• Computed tomography • Bowel ischemia • Intestinal ischemia • Oral contrast • Bowel infarction • Mesenteric ischemia • Pneumatosis intestinalis • Mesenteric artery occlusion

KEY POINTS

- Choice of computed tomography (CT) technique affects the visibility of CT findings. Positive oral contrast may improve the detection of fluid collections, hematomas, and bowel leakage. Neutral oral contrast improves visualization of bowel wall hypoenhancement or hyperenhancement.
- Findings of bowel ischemia include mural hypoenhancement associated with adjacent mesenteric edema, pneumatosis, and free fluid.
- Hyperemia (shock bowel) may be seen adjacent to segments of acute pale ischemia.
- Evaluation of the arteries and veins leading to and from diseased bowel can reveal the cause of bowel ischemia as embolic, dissection, thrombosis, inflammation, or malignant.

PATHOPHYSIOLOGY AND PRESENTATION

Intestinal ischemia has diverse causes and presentations.[1,2] Mesenteric ischemia is classified into 2 forms, acute and chronic, which are differentiated on the timing of symptom onset and extent of decreased blood flow. Mesenteric ischemia is further subdivided by cause: arterial, venous, and nonocclusive. In a general sense, intestinal ischemia frequently presents with nonspecific clinical symptoms. The classic triad of abdominal pain, hematochezia, and fever is seen in only 1 out of 3 patients.[3] More commonly, nonspecific symptoms are seen and include diarrhea, vomiting, and bloating.

ACUTE MESENTERIC ISCHEMIA

Acute mesenteric ischemia (AMI) occurs from arterial embolic or thrombotic obstruction, mesenteric venous thrombosis, or a nonocclusive cause.[4] The mean age of patients with acute mesenteric arterial occlusive ischemia (embolic and thrombosis) is 70 years. However, patients younger than 50 years may also form occlusive emboli in the setting of atrial fibrillation.[5] Arterial emboli from a cardiac[6] or septic source are the most common causes of AMI and compose 40% to 50% of the cases. Patients often present with abrupt onset of abdominal pain, diarrhea, and vomiting.[7]

Thrombotic arterial ischemia may be acute or chronic and occurs in patients with a preexisting atherosclerotic lesion in a mesenteric artery with superimposed thrombosis formation. The major risk factors in these patients include atherosclerotic disease, aortic dissection and aneurysm, arteritis, and dehydration. These patients undergo gradual progression of arterial occlusion. Therefore, many present with abdominal angina, a syndrome of postprandial pain lasting up to 3 hours. This syndrome results in food fear, early satiety, and weight loss. In the acute setting, however, the clinical symptoms are similar to those found in patients with the arterial embolic disease.[5]

Chronic arterial bowel ischemia presents with subacute and even less specific symptoms.

Department of Radiology and Biomedical Imaging, University of California San Francisco, 505 Parnassus Avenue, San Francisco, CA 94143-0628, USA
* Corresponding author.
E-mail address: Ben.Yeh@ucsf.edu

Radiol Clin N Am 53 (2015) 1241–1254
http://dx.doi.org/10.1016/j.rcl.2015.06.009
0033-8389/15/$ – see front matter

Although chronic bowel ischemia may present with abdominal pain, it may also present with weight loss or food fear.[3] Although chronic mesenteric ischemia remains rare, occurring in 1 out of 1000 hospital admissions, it has a high mortality, with death rates ranging from 30% to 90%.[7] Chronic bowel ischemia generally presents in patients older than 60 years and is 3 times more common in women.[8]

This syndrome occurs in the setting of long-standing mesenteric arterial atherosclerotic disease resulting in constant decreased blood flow, especially in the postprandial state. Patients may present with significant weight loss secondary to postprandial pain lasting up to 90 minutes. These patients often report prior such episodes of intestinal angina clueing the clinician to the diagnosis. However, 15% to 20% of these patients demonstrate no symptoms. Over time, as the vascular obstructive process progresses, chronic, dull abdominal pain ensues.[9]

In contrast, mesenteric venous ischemic, although a less common cause of AMI, has a more variable patient population presentation and occurs in younger patients, often less than 50 years old.[3] It can commonly occur because of segmental bowel strangulation or thrombosis. Pertinent medical history is also critical for diagnosis as other risk factors for venous thrombosis include hypercoagulable predispositions, such as pregnancy, protein C and S or antithrombin deficiencies, polycythemia vera, malignancy, infection, portal hypertension, or venous trauma.[10] Patients may present with acute or subacute abdominal pain. They may have symptoms of AMI over a prolonged period with gradual progression.[11]

Nonocclusive mesenteric ischemia (NOMI), occurring in 10% to 20% of AMI cases, is most common in elderly patients with severe systemic illnesses that reduce cardiac output. It most commonly occurs in the postoperative intensive care unit setting. The clinical diagnosis can be challenging because of the diminished mental state of these patients. These patients may have nonspecific symptoms that can range from abdominal pain and nausea to ileus. Other predisposing factors include trauma, cocaine use, ergot ingestion, digoxin, alpha-adrenergic medications, cardiac failure, myocardial infarction, abdominal surgery, and aortic insufficiency.[12–14]

Ischemic bowel may result as a complication of other underlying intra-abdominal comorbidities. For example, the identification of bowel obstruction on computed tomography (CT) should always prompt the search for the complication of bowel ischemia because rapid triage to surgery may be necessary to prevent an abdominal catastrophe from bowel perforation.[15] Other underlying processes, such as embolic disease or vascular dissection, are important to identify so that long-term treatment can be directed toward future prevention of complications.[16] **Tables 1** and **2** summarize the major CT findings and reformations useful for diagnosis of bowel ischemia.

LABORATORY TESTS AND ADDITIONAL CONSIDERATIONS

In patients with abdominal pain, physicians are faced with a broad differential diagnosis that includes pancreatitis, cholelithiasis, diverticulitis, and appendicitis. Physical examination findings and laboratory values can be suggestive of a bowel cause but are generally nonspecific.[15] Elevated lactic acid levels, leukocytosis, and the presence of an anion gap may or may not be present. Elevated serum lactate levels indicate anaerobic metabolism in the setting of ischemic bowel but are also associated with other pathologic conditions.

Given the frequent ambiguous clinical presentation of intestinal ischemia, only one-third of patients are diagnosed accurately preoperatively.[17] CT imaging has been shown to outperform all other laboratory and physical examination findings for the detection of bowel ischemia.[15] Catheter-angiography, providing both diagnosis and treatment, has improved mortality over the last 40 years but is an invasive test.[7]

Multidetector CT (MDCT) provides reliable imaging of bowel in the acute setting. Particular benefits of MDCT over magnetic resonance and ultrasound include the rapid speed of image acquisition, which minimizes bowel motion artifact, large field of view

Table 1
CT findings or reformations that may be highlighted or be obscured by the use of positive bowel contrast agent

Possibly highlighted	Possibly obscured
Intra-abdominal abscess*	Bowel wall nonenhancement*
Enteric fistula or leak*	Bowel wall hyperenhancement*
Extraluminal tumor	CT angiogram reformation
Hematomas	Active gastrointestinal bleed

The presence of these frequently coexisting conditions (* often occur together) is usually not known until after the CT scan is done. The choice to administer positive bowel contrast is based on clinical best guess and institution-based expertise.