Diagnostic Modalities in Gastrointestinal Bleeding

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Abstract

Keywords

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A variety of diagnostic modalities is available to assist in the evaluation of patients presenting with acute gastrointestinal (GI) bleeding. This article reviews some older technologies like colonoscopy, nuclear scintigraphy, and conventional angiography and will also review the newest additions to the lower GI bleeding diagnostic toolbox, which are video capsule endoscopy and computed tomography (CT) angiography. The management algorithm used at a given institution depends on the available expertise and resources.

Lower GI bleeding, often defined as originating distal to the ligament of Treitz, accounts for about 100,000 hospital admissions annually and is the source of bleeding in approximately 30% of all patients with GI bleeding. About 80% of lower GI bleeding patients will be found to have a colon source and about 20% will have small bowel pathology (▶ **Table 1**). With recent advances in diagnostic capabilities targeting specifically the small bowel, like video capsule endoscopy and balloon enteroscopy, a new concept has been coined “median GI bleeding” or “midgut bleeding” which pertains to bleeding originating between the duodenum and the ileocecal valve. One of the challenges for the clinician that may be addressed to some degree by the different diagnostic modalities is not just to localize the site of bleeding but also to determine the actual cause of bleeding, as this can impact the recommendation for therapeutic intervention.

Localization studies to accurately identify the bleeding site are typically performed simultaneously with resuscitation efforts that also include appropriate monitoring and addressing any underlying coagulopathy. As severe upper GI bleeding can present with frank rectal bleeding, patients are evaluated for a possible upper GI source by aspirating a nasogastric tube or by performing an upper endoscopy.

One of the factors that impede attempts at localization is the intermittent nature of lower GI bleeding; approximately 80% of patients reported stop-bleeding spontaneously after presentation to the hospital. This is a major issue because, with the possible exception of colonoscopy, the available diagnostic modalities require active bleeding in order to

localize a bleeding source. Other factors to keep in mind regarding localization in the setting of lower GI bleeding deal with cost of care, resource availability (or unavailability), and how to adjust the diagnostic algorithm used at a particular institution to include new or improved diagnostic modalities. Several of the more common diagnostic modalities are reviewed in the following. Provocative angiography with fibrinolytic agents, push enteroscopy, and spiral overtube and balloon endoscopy will not be reviewed.

Historically, colonoscopy has been the preferred initial test for most patients with lower GI bleeding because of its safety, wide availability, and ability to diagnose, localize, and treat bleeding.¹ The diagnostic yield of colonoscopy in the setting of acute bleeding is highly variable ranging from 20% to as high as even 100% depending on the definitions used.² The potential utility of colonoscopy is enhanced because patients without active bleeding may be diagnosed with some degree of confidence using criteria related to stigmata of recent bleeding like visualizing nonbleeding vessels and adherent clot. Practical issues related to the use of colonoscopy in the setting of a GI bleed include the need for bowel preparation, and the time delay this causes, and the inherent risks of performing urgent colonoscopy. Recent large studies document the risk of major complications like perforation or aspiration at less than 1%.

Although colonoscopy has been the initial test of choice for lower GI bleeding, there is still controversy as to whether or not urgent colonoscopy actually improves clinical outcomes in this setting. Small-scale trials published over the past 15 years were underpowered to adequately address this question.

Table 1 Some of the potential sources of lower GI bleeding

Diverticular disease
Angiodysplasia
Neoplasia
Colitis (ischemic, IBD, and infectious)
Benign anorectal sources
Iatrogenic (postpolypectomy and postresection)
Varices
Meckel's diverticulum
Radiation induced
NSAID colopathy

Abbreviations: IBD, inflammatory bowel disease; GI, gastrointestinal; NSAID, non-steroidal anti-inflammatory drugs.

Navaneethan and colleagues studied a large dataset of patients with acute lower GI bleeding from the Nationwide Inpatient Sample and compared 9,156 patients who were colonoscoped within 24 hours of presentation to 13,564 patients who were colonoscoped more than 24 hours after presentation.³ The group of patients who took longer to have a colonoscopy was sicker at baseline (61% had a Charlson's comorbidity index ≥ 3 compared with 39% in the group of patients colonoscoped more quickly, $p < 0.001$). Mean length of stay (2.9 vs. 4.6 days), need for transfusion (44 vs. 54%), and mean hospital charges (\$22,142 vs. 28,749) were significantly lower in the urgent colonoscopy group, while the mortality rates in the two groups were comparable (0.3 vs. 0.4%). A possible explanation as to why urgent colonoscopy was not associated with decreased mortality is that most patients with lower GI bleeding stop bleeding spontaneously within about 24 to 48 hours.

In terms of clinical practice management recommendations, the American Society for Gastrointestinal Endoscopy

published updated guidelines in 2014 detailing the role of endoscopy in patients presenting with lower GI bleeding.⁴ This paper recommends that patients with severe hematochezia with hemodynamic instability should undergo emergency upper endoscopy followed by bowel preparation for a colonoscopy if the endoscopy does not localize the bleeding and that patients with lower GI bleeding without hemodynamic compromise should undergo urgent colonoscopy within 24 hours of presentation.

Patients who continue to bleed from an unlocalized source may be studied using a variety of imaging modalities. Up until recently, nuclear medicine imaging with technetium labeled red cells or technetium sulfur colloid has played an important role in the evaluation of patients with lower GI bleeding.⁵ Scintigraphy is noninvasive, demonstrates bleeding with high sensitivity and specificity, and can detect bleeding rates as low as 0.2 mL per minute from anywhere in the GI tract. Strength of this technology is that images are acquired over time which can help to detect the source of intermittent bleeding. From a practical standpoint, the major drawbacks with bleeding scans are the poor image resolution and grainy quality of the images that make accurate anatomic localization difficult. A representative example of a bleeding scan in a patient with lower GI bleeding is shown in ►Fig. 1. Over the 90 minutes that images were acquired, the radiotracer accumulated in what appears to be the terminal ileum making its way across the abdomen to the cecum. While bleeding scans are able to demonstrate bleeding with a high sensitivity, the accuracy of these scans in terms of actually localizing the site of bleeding is limited due to the poor resolution and the lack of anatomic detail. These scans have most commonly been used as screening studies to determine if patients are actively bleeding prior to performing conventional catheter-based angiography.

Other problems related to nuclear imaging include the significant resources that these scans require in terms of

Fig. 1 Sequential images from of a bleeding scan acquired over 90 minutes postinfusion. Arrows demonstrated accumulated radio tracers. (Reproduced with permission from Allen et al. Semin Nucl Med, 2013.)⁵

time, expertise, and equipment. There are also issues related to the on-demand availability of this technology and cost considerations. A recent technical improvement in bleeding scan imaging called “subtraction scintigraphy” subtracts the initial frame from each subsequent image and theoretically improves visualization by removing the background noise. Whether this image manipulation will improve the accuracy of the scans remains to be seen. In the meantime, due to major improvements in the diagnostic performance of computed tomography (CT) angiography, conventional bleeding scans no longer play a major role in the diagnosis of most cases of lower GI bleeding.

Conventional visceral angiography or catheter-directed angiography can detect bleeding as slow as about 0.5 mL per minute and is a key diagnostic modality in the management of bleeding patients.⁶ As with bleeding scans, the success of angiography is limited by the intermittent nature of lower GI bleeding. This technology also requires significant resources similar to nuclear imaging. The major benefit of angiography in the setting of acute GI bleeding is its ability to both localize bleeding and affect therapy. This combined diagnostic/therapeutic platform is unique among the variety of diagnostic modalities available to treat patients with lower GI bleeding. From a practical surgical perspective, in cases where surgery is performed after angiography (for recurrent bleeding or to resect the underlying pathology) combining angiography and methylene blue injection for purposes of localization can facilitate surgery (►Fig. 2).⁷

Fig. 2 An intraoperative photograph of the localized bleeding site in the small bowel. Reproduced with permission. (Reproduced with permission from Frydman et al. *World J Emergency Surg* 2014.)⁷⁷

Video capsule endoscopy, popularized as a diagnostic modality in cases of occult, intermittent GI bleeding has also been used to evaluate the small bowel mucosa in the setting of GI bleeding but its role in the emergency setting is not clear. Lecleire and colleagues published a retrospective review, including 55 patients who had ongoing, unlocalized GI bleeding with negative upper endoscopy and negative colonoscopy.⁸ Patients underwent video capsule endoscopy within an average of 4 days after hospital admission and received an average of 6 units of blood transfusion. A total of 67% of the patients had a lesion found and the majority of these patients were then treated with balloon enteroscopy. As the technology for this noninvasive diagnostic modality improves with wider-angle views, longer battery life, better pattern recognition software, and video capsule endoscopy may assume a more central role in the management of bleeding patients.

A newer diagnostic modality already widely adopted, CT angiography represents a major advance in the diagnosis and management of patients with lower GI bleeding.⁹ Until recently, CT scanning has been of limited use in the evaluation and management of patients with GI bleeding. Advancements in multidetector CT technology have greatly enhanced the ability of CT to localize GI bleeding.^{10–12} Triple-phase CT angiography rapidly acquires images in a precontrast phase, an arterial phase, and a portal phase taken about 90 seconds after the intravenous (IV) contrast injection. High resolution axial images (narrow collimation) are obtained in a standard multiplanar format with axial, coronal, and sagittal views and the software also allows the radiologist to view customized maximum intensity reconstructions (MIP images) that are essentially oblique cuts that allow the optimal plane to be chosen to best display a specific anatomic structure focused on the site of contrast extravasation. This technology is readily available and detects bleeding rates below the reported threshold for conventional catheter-based angiography. This cross-sectional imaging can localize bleeding and help to determine the underlying etiology of bleeding with very little lag time because the scan does not require a bowel preparation or oral contrast. To appreciate the outstanding quality of these images, a few representative examples of CT angiograms are presented (►Figs. 3–5); the literature is replete with examples of this technology, as well.

CT angiography can localize bleeding from anywhere along the abdominopelvic GI tract and has a positive predictive value of about 95%. Certain situations can mimic active hemorrhage and result in false positive scans. Comparing precontrast and arterial phase images is important to differentiate nonspecific mucosal enhancement or retained contrast material from a prior study from a site of hemorrhage. Importantly, in order to achieve a high-positive predictive value, it is essential to avoid using oral contrast for these studies.

In terms of evaluating this technology in a broader sense for purposes of potentially widespread use, García-Blázquez and colleagues evaluated CT angiography in a meta-analysis in 2013 including 672 patients from 22 studies and documented high sensitivity and specificity.¹³ They concluded that CT angiography is being increasingly used to evaluate lower GI bleeding and that CT angiography effectively directs further management by facilitating catheter-directed angiography. CT

Fig. 3 Axial (A) and coronal (B) maximum intensity projection images demonstrate a jet of extravasated contrast material within the lumen of the descending colon (the arrows) consistent with diverticular bleeding. The conventional angiogram (C) confirmed bleeding from the left colic artery with puddling of contrast material in the left colon (arrow). This patient was successfully embolized. Reproduced with permission.¹⁰

Fig. 4 This patient presented with hematochezia and hypotension. The arterial phase of the CT angiogram (A) shows extravasation arising from a diverticulum in the ascending colon. The portal venous phase image (B) shows distal progression of the extravasated contrast. The maximum intensity projection image (C) demonstrates a branch of the right colic artery as the source of the hemorrhage which was confirmed by catheter angiography and was treated successfully with coil embolization. Reproduced with permission.¹¹

angiography is a valuable addition to our diagnostic toolbox. To determine where CT angiography fits in the diagnostic algorithm for acute lower GI bleeding, Ren and colleagues developed a CT angiography-first protocol where 63 consecutive bleeding patients underwent CT angiography as their

initial test.¹⁴ Bleeding was localized in 90% of these patients who were then treated with embolization or surgery. The sensitivity, specificity, and positive and negative predictive values were all excellent. This protocol successfully eliminated bleeding scans from the diagnostic algorithm and used CT

Fig. 5 The CT angiography is not limited to localizing just colorectal sources of bleeding. This man presented with hematochezia. The coronal MIP image (A) shows hyperattenuating contrast within a short segment of jejunum indicating active hemorrhage. The patient then underwent conventional angiography (B) that demonstrated and confirmed hemorrhage from a jejunal branch (arrow). Reproduced with permission.¹⁵ CT, computed tomography; MIP, maximum intensity reconstructions.

angiography to guide management, instead of colonoscopy. Other CT angiography-first protocols have been published with similar results.

There are several important questions about the evolving role of CT angiography that remain incompletely answered. For instance, what are the practical consequences for patients who receive IV contrast for their CT angiography and then go on to receive more IV contrast at the time of their conventional angiogram? Does a normal CT angiography obviate the need for subsequent studies? What are the cost and resource utilization implications of this technology? We also need to evaluate CT angiography in terms of meaningful clinical outcomes, like rebleeding rates, needed for surgery and mortality. And finally, in centers where visceral angiography is not available, does CT angiography provide sufficient localization to proceed directly to surgery? Further research evaluating the application of CT angiography in the setting of GI bleeding will better elucidate the role and utility of this technology.

Conflict of Interest

None declared.

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