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Impact of catheter location during mesenteric angiography in identifying sources of acute lower gastrointestinal bleeding

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ABSTRACT

Objectives: The objective of this study was to compare the sensitivity of selective to superselective mesenteric angiography in identifying acute lower gastrointestinal bleeding (LGIB) after computed tomography angiography (CTA) demonstrating active arterial bleeding.

Material and Methods: This is a single-center retrospective study of all patients who underwent mesenteric angiography to evaluate LGIB between January 2012 and September 2021. The inclusion criterion was a CTA demonstrating active arterial LGIB immediately before intervention. Patient demographics, etiology of bleeding, and procedural details were recorded. Selective angiography was defined as an ostial visceral branch injection; superselective was defined as any selection into or beyond a 2nd order branch. Technical success was defined as the successful embolization of the target vessel. Clinical success was defined as the clinical resolution of gastrointestinal bleeding without additional procedural or surgical interventions within 30 days.

Results: After inclusion criteria, 78 angiograms from 72 patients were evaluated. Active arterial bleeding was identified in 50% (39/78) of angiograms, and embolization was performed in 49% (38/78) of cases. The diagnostic sensitivity of superselective angiography was significantly greater than selective angiography (56.3% vs. 32.1%, $P = 0.018$). In 12.8% (10/78) of all angiograms, active bleeding was identified only with superselective angiography (25.6%, 10/39, of cases where any bleeding was identified). Embolization was performed in 38 of the angiograms; technical success was 97.4% (37/38), clinical success was 71.1% (27/38), and 26% (10/38) required further intervention. Embolization was not performed in 40 angiograms, with 68% (27/40) requiring an additional intervention.

Conclusion: Superselective angiography is significantly more sensitive than selective angiography for patients with known acute LGIB identified on CTA.

Keywords: Computed tomography angiography, Embolization, Lower gastrointestinal bleeding, Mesenteric angiography

INTRODUCTION

Acute lower gastrointestinal bleeding (LGIB) is a common cause of presentation to the emergency department and hospital admission. Commonly reported etiologies of bleeding include diverticulosis, hemorrhoids, ischemic colitis, inflammatory bowel disease, bleeding after polypectomy, and malignancy.[1-3] The incidence of LGIB ranges from 20 to 36 cases/100,000

population.[1,4,5] While the outcome of LGIB tends to be favorable, with the majority of cases ceasing spontaneously, mortality rates can reach up to 23% in patients with ongoing or recurrent bleeding, with in-hospital mortality rates ranging from 2.4 to 3.9%.[2,3,6,7] Urgent diagnosis and intervention are essential to achieve hemostasis, especially in high-risk populations such as the elderly and those with significant comorbidities.[8]

Several modalities are currently used to diagnose and treat acute LGIB. Colonoscopy is generally agreed to be the initial procedure of choice for patients presenting with non-emergent LGIB because it has diagnostic and therapeutic utility and a low complication rate.[1,9] However, computed tomography angiography (CTA) has also gained popularity as a widely available, highly accurate, and non-invasive method of diagnosing acute LGIB. Studies have shown CTA sensitivities ranging from 84.8% to 89% and specificities ranging from 85 to 100%.[6,8,10] Several groups have even proposed CTA as the first-line diagnostic examination in evaluating acute LGIB due to its ability to quickly provide accurate localization of the bleeding source.[11-13]

Mesenteric angiography remains one of the primary interventions for treating LGIB due to its diagnostic and therapeutic capabilities. Unfortunately, studies have reported a wide range of bleeding site localization, ranging from 23.7% to 57%.[14-16] The primary outcome of the present study is to compare the sensitivity of selective mesenteric angiography to superselective mesenteric angiography in identifying sources of acute LGIB following an initial CTA demonstrating active extravasation. The secondary outcome includes an evaluation of the technical and clinical success in the same cohort.

MATERIAL AND METHODS

Study design

The Local Institutional Review Board approved this single-center retrospective study, and the requirement for written informed consent for publication was waived. Acute LGIB was defined as arterial gastrointestinal (GI) bleeding originating beyond the ligament of Treitz.

Patient selection

The electronic medical records of all patients who underwent mesenteric angiography to evaluate gastrointestinal (GI) bleeding between January 2012 and September 2021 were identified. Inclusion criteria mandated a CTA demonstrating active arterial LGIB immediately before intervention. The following patients were excluded: (1) those who did not undergo CTA as an initial diagnostic test, (2) those in whom CTA did not demonstrate active arterial extravasation specific to the lower GI tract, (3) those who presented with upper gastrointestinal bleeding (UGIB), and (4) those whose GI bleeding source could not be localized on initial assessment (i.e., neither lower nor upper GI bleeding could be confidently identified).

Data collection

Patient demographics, etiology of bleeding, location of bleeding, angiographic findings, and details of embolization were recorded in compliance with the Health Insurance Portability and Accountability Act. Selective angiography was defined as an ostial visceral branch injection, whereas superselective was defined as any selection into a 2nd order or further branch vessel. Identifying active bleeding was defined as evidence of active contrast extravasation into the bowel lumen, whereas a suggestion of bleeding was defined as an abnormal vessel, hyperemia, or neovascularity suspicious of hemorrhage without evidence of active contrast extravasation. Two interventional radiologists with 11 and 14 years of experience arbitrated any uncertain diagnosis to reach a consensus. Of note, the CTA and angiographic protocols at the study center were unchanged over the 8-year study period.

Statistical analysis

Detection of LGIB

Superselective angiography and selective angiography LGIB diagnostic sensitivities were computed as the percentage of angiograms in which LGIB was detected. The 95% confidence intervals (CIs) for diagnostic sensitivity (%) were calculated using the exact binomial test and compared using the McNemar test.[17]

Technical and clinical success rates

Technical success was summarized as the percentage of targeted vessels in which angiographic resolution of arterial bleeding or successful embolization was achieved. Clinical success was summarized as the percentage of cases in which there was no: (1) need for additional mesenteric angiography, endoscopic procedure, or surgery, (2) suspicion or confirmation of bowel ischemia, and (3) in-hospital mortality from any cause attributed to the mesenteric angiography procedure. The 95% CIs for the technical and clinical success rates (%) were computed using the exact binomial test.

Adverse events (AEs)

AEs) were summarized per event type by frequencies and percentages using the Society of Interventional Radiology AE classification.[18]

Selective to superselective angiography time differential

For the 64 cases in which both selective and superselective angiography were performed, the time differential between selective and superselective angiography completion time is summarized by the empirical time differential cumulative probability functions. Mean and median time differentials were estimated and the 95% CIs were constructed. The 95% CI was constructed through the *t*-distribution 97.5% quantile multiplier for the meantime differential. The 95% CI was constructed through BCa bootstrap CI for the median time differential.[19]

Bleed versus non-bleed selective and superselective angiography time differentials

For 64 of the 78 total cases, both selective and superselective angiography were conducted, and the time differentials between diagnostic computed tomography time and angiography completion times of active bleed and non-bleed cases were summarized by the empirical time differential cumulative probability functions and compared by way of a log-rank Chi-square test.

Software package

All data analyses were conducted using the TIBCO Spotfire + version 8.2 statistical software package (TIBCO Inc., Palo Alto, CA).

RESULTS

A total of 413 mesenteric angiograms were performed during the study period (January 2012 through September 2021) to evaluate acute GI bleeding. The final analysis included 78 cases comprising 72 patients who presented with LGIB, had a CTA demonstrating active hemorrhage, subsequently underwent mesenteric angiography, and met the remaining inclusion and exclusion criteria [Figure 1]. This cohort had the demographics described in Table 1.

All 78 cases included in the analysis underwent selective mesenteric angiography. In addition, 82% (64/78) also included superselective angiography. Active arterial bleeding was identified in 50% (39/78) of cases overall. Selective angiography detected the active bleeding site in 25 of 78 cases (diagnostic sensitivity 32.1%; 95% CI: [21.9, 43.6%]), with 8.9% (7/78) of cases also demonstrating an abnormal vessel or hyperemia suspicious for recent hemorrhage. Superselective angiography detected an active bleeding site in 36 of 64 cases (diagnostic sensitivity 56.3%; 95% CI: [43.3, 68.6%]), with 4.7% (3/64) of cases also suspicious for bleeding. In 17.9% (14/78) of cases, the active bleeding site was not identified on the initial selective angiogram but subsequently identified on superselective angiography as guided by the prior CTA [Figure 2]. A comparison of the diagnostic sensitivities between selective angiography and superselective angiography shows the diagnostic sensitivity of superselective angiography to be significantly greater than the diagnostic sensitivity of selective angiography ($P = 0.018$). A complete breakdown of the outcomes of mesenteric angiography seen in this cohort is shown in Table 2.

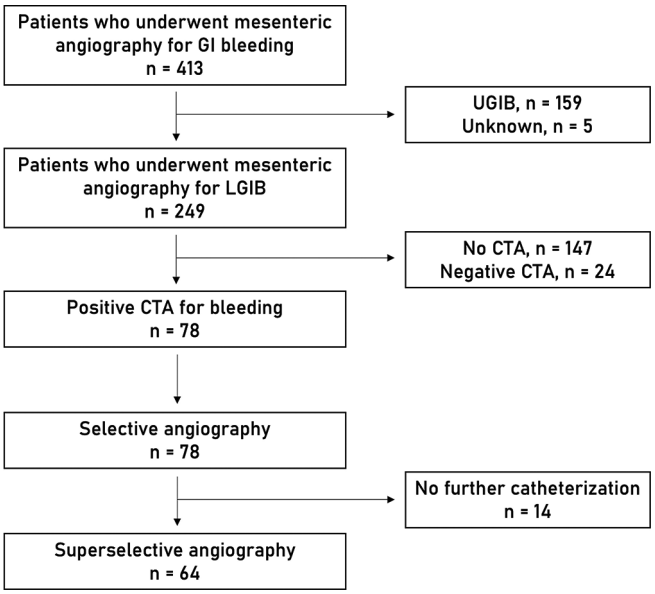

Figure 1: Flow diagram of inclusion and exclusion criteria. After applying the criteria, 78 selective and 64 superselective angiograms were included in the study. (GI: Gastrointestinal; UGIB: upper gastrointestinal bleeding; LGIB: lower gastrointestinal bleeding; CTA: computed tomography angiography).

Table 1: Patient demographics.

Variable	Patients (%)
Age, years (mean±SD)	71±13
Sex	
Male	37 (51)
Female	35 (49)
Location of bleed	
Small bowel	15 (21)
Cecum	4 (6)
Colon	49 (68)
Rectum	3 (4)
Unknown	1 (1)
Etiology of bleed	
Diverticular disease	34 (47)
Ulcer	5 (7)
Colitis	5 (7)
Malignancy	3 (4)
Procedural	4 (6)
Complication	1 (1)
Hemorrhoid	2 (3)
Angiodysplasia	18 (25)
Unknown	

SD: Standard deviation

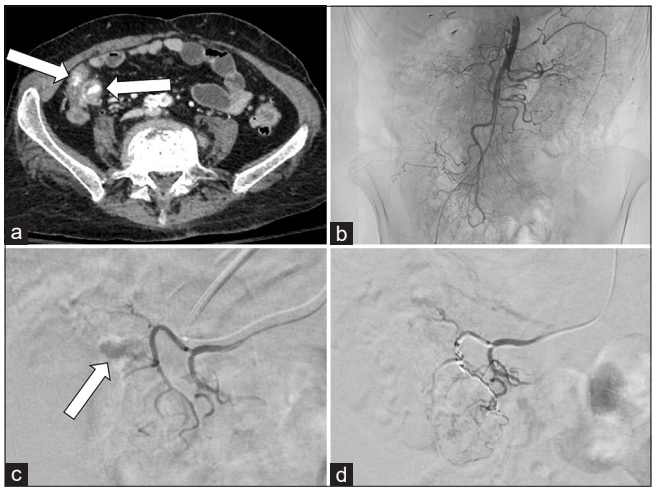

Figure 2: Case example of active lower gastrointestinal bleed. (a) A single slice axial image from a multiphase computed tomography angiography (CTA) demonstrating active bleeding in the proximal ascending colon (white arrows). (b) Selective superior mesenteric artery arteriogram demonstrates patent vasculature without arterial bleeding. (c) Superselective angiogram demonstrates the focus of active bleeding (white arrow) corresponding to the location on prior CTA. (d) Repeat superselective angiogram demonstrating successful coil embolization of the target vessel with cessation of bleeding.

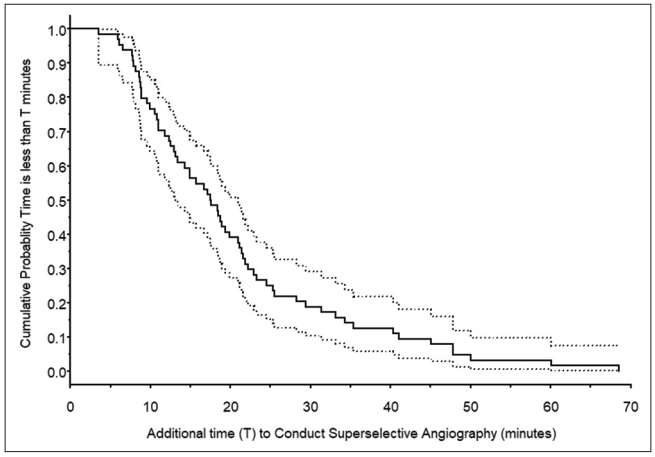

Figure 3: Empirical distribution for selective to superselective angiography time differential. The mean time differential was 17.6 additional min for superselective angiography. The dotted lines are 95% CI

Table 2: Diagnostic outcomes.

Selective	Superselective	Cases (%)
Negative	N/A	14 (18)
Negative	Negative	25 (32)
Positive	Positive	22 (28)
Positive	Negative	3 (4)
Negative	Positive	14 (18)

N/A: not applicable

Comparing the 64 cases that underwent both selective and superselective mesenteric angiography, the median time between CTA and selective angiography completion time was 3.46 h (95% CI: [2.70, 4.56 h]) for the 25 non-bleed cases and 2.65 h (95% CI: [2.22, 3.22 h]) for the 39 active bleed cases (log-rank Chi-square test: P = 0.123), whereas the median time between CTA and superselective angiography completion time was 3.79 h (95% CI: [2.92, 5.24 h]) for the 25 non-bleed cases and 3.01 h (95% CI: [2.44, 3.76 h]) for the 39 active bleed cases (log-rank Chi-square test: P = 0.185). The empirical distribution for selective to superselective angiography time differential is summarized as a cumulative probability distribution function, as shown in Figure 3. Based on the percentiles of the empirical cumulative probability distribution, the mean time differential was 17.6 min (95% CI: [13.1, 21.0 min]). The median selective to superselective angiography time differential was 15.0 min (95% CI: [10.6, 19.0 min]) for the 25 non-bleed cases and 19.4 (95% CI: [13.1, 22.2 min]) for the 39 active bleed cases (log-rank Chi-square test: P = 0.065).

Transcatheter embolization was performed in 49% (38/78) of cases. Technical success was achieved in 37 of 38 cases (97.4%; 95% CI: [86.2, 99.9%]), and clinical success was achieved in 27 of 38 cases (71.1%; CI: [68.2, 84.1%]). About 68% (27/40) of cases where embolization was not performed required an additional procedure (either an additional mesenteric angiogram, endoscopic procedure or surgery). Among cases where embolization was performed, 26% (10/38) required further procedural or surgical intervention. Only 1 patient (2.6%, 1/38) developed bowel ischemia within 30 days of embolization. However, this patient also had an exploratory laparotomy performed 1 month earlier, where the necrotic bowel was resected; 8 days following embolization, further ischemic mucosal changes were seen on colonoscopy. Overall, the in-hospital mortality rate was 6.4% (5/78), higher than literature-reported values of 2.4–3.9%, which was similar between cases where embolization was performed (2/38, 5.3%) and embolization was not performed (3/40, 7.5%).[2,3,7]

DISCUSSION

While LGIB typically has a favorable clinical course, with the majority of cases resolving without the need for invasive interventions, it is still associated with considerable morbidity and mortality in high-risk populations, such as the elderly and those with significant comorbidities.[8] Numerous diagnostic tools are available for evaluating LGIB, with the first-line procedure typically dependent on the location (i.e., UGIB vs. LGIB) and severity (i.e., hemodynamic stability) of the bleed. CTA is generally considered the first-line imaging modality in urgent cases requiring intervention before bowel preparation for colonoscopy is achieved.

We hypothesized that patients with a positive CTA will have improved detection, localization, and treatment by pursuing superselective angiography compared to selective angiography. To the authors' knowledge, this is the first study evaluating the impact of catheter location during mesenteric angiography for LGIB.

The overall sensitivity of mesenteric angiography, considering both selective and superselective runs, was 50% in the present study, consistent with previous studies reporting a mean positivity rate of 47%.[20] When comparing catheter location, superselective angiography was significantly more sensitive, with a difference of 23%, and identified the site of active bleeding in 18% more cases than selective angiography alone. This finding further supports previous literature, which has shown superselective angiography to be a safe therapeutic method for acute LGIB.[21]

The intermittent nature of LGIB makes time from initial diagnosis to treatment a confounding variable. However, the present study did not find a statistically significant difference in the median time interval from diagnostic CTA to angiography in patients with and without active angiographic bleeding. This suggests factors other than timing, such as patient hemodynamics and stability, operator skill, severity of the bleed, venous versus arterial origin of the bleed, and/or patient comorbidities, play a critical role in successful localization and treatment.

The secondary outcome was also examined, looking at transcatheter embolization's technical and clinical success. The technical success rate, defined as angiographic resolution of arterial bleeding or successful embolization of the target vessel, was 97.4% (37/38) in this study, a rate similar to those previously published.[15,20,21] In one technical failure, the patient became hypotensive during the procedure, despite vasopressor support and transfusion of blood products, ultimately resulting in a ventricular fibrillation cardiac arrest before embolization. Clinical success, defined as cessation of bleeding with no subsequent procedures, bowel ischemia, or death within 30 days, was achieved in 71.1% (27/38) of patients who underwent embolization in this study. Most of those who did not achieve clinical success required additional procedures, including another mesenteric angiogram, colonoscopy, or surgery. Only 1 patient (2.6%) developed bowel ischemia within 30 days of embolization, which is comparable to rates of bowel ischemia previously reported in the literature.[20,21] Nonetheless, this clinical success rate was significantly higher than that of the cohort in whom embolization was not performed (32%).

Limitations of this study include its single-center and retrospective design, as well as the inclusion criteria for patient selection, which limit the power of this study. One option to mitigate this would be not to require an initial CTA demonstrating active extravasation, which would have resulted in a larger cohort. In addition, multivariate risk stratification of patients based on factors such as hemodynamic stability or severity of bleed was not performed. This likely influenced how quickly the patient was prepped for the procedure and how aggressively the operator tried to locate the bleeding site. Finally, it is possible that the failure to detect the site of bleeding on angiography was due to intermittent bleeding. However, there was no significant difference in time from CTA to angiogram in cases where bleeding was detected compared to instances where bleeding was not detected, which was true for both selective and superselective angiograms. Future studies may benefit from potential predictors of positive angiography, specifically following a positive CTA, to elucidate which patients are more likely to be candidates for embolization.

CONCLUSION

In the setting of acute LGIB with a positive CTA for bleeding, superselective angiography is significantly more sensitive for detecting the bleeding site compared to selective angiography alone. Therefore, given the high technical rates, marked improvement in clinical success with embolization, and low complication rates of embolization, superselective diagnostic angiography should be considered in all patients with this clinical presentation to augment therapy.

Ethical approval

The Local Institutional Review Board approved this single-center retrospective study, and the requirement for written informed consent for publication was waived.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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