Mesenteric angiography for the localization and treatment of acute lower gastrointestinal bleeding

Paul J. Karanicolas, MD;[*†] Patrick H. Colquhoun, MD, MSc;[*] Erin Dahlke, BSc;[*] Gordon H. Guyatt, MD, MSc[†‡]

Background: There is limited evidence regarding the effectiveness and complications of mesenteric angiography in the diagnosis and management of acute lower gastrointestinal bleeding (ALGIB). Our objective was to determine the complications and outcomes of mesenteric angiography in patients with ALGIB and to identify predictors of a positive result at angiography. **Methods:** We identified and reviewed the records of all patients who underwent mesenteric angiography for ALGIB at our institution during a 10-year period. We compared potential predictors of positive versus negative angiograms. **Results:** Of 47 mesenteric angiograms in 35 patients, 22 (47%, 95% confidence interval [CI] 33%–61%) revealed a source of bleeding, most commonly the colon. Hematomas developed in the groins of 3 patients (6.4%, 95% CI 0%–18%), and 1 of these patients also experienced a myocardial infarction during the procedure. None of the potential predictors were significantly associated with a positive result at angiography, although the confidence intervals were wide. Twenty patients (57%, 95% CI 41%–74%) continued to bleed after the angiogram, and 18 of the patients (51%, 95% CI 35%–68%) were discharged without a definitive diagnosis. **Conclusion:** With a diagnostic success of about 50%, mesenteric angiography may play an important part in the diagnosis and management of patients with ALGIB; however, one or more large, prospective multicentre studies are needed to more clearly define its role. Canadian surgeons have the opportunity to initiate collaborative multicentre studies to address such diagnostic and therapeutic clinical questions.

Contexte : Les données probantes sur l'efficacité et les complications de l'angiographie du mésentère dans le diagnostic et la prise en charge du saignement gastro-intestinal inférieur aigu (SGIIA) sont limitées. Nous voulions cerner les complications et les résultats de l'angiographie du mésentère chez les patients atteints de SGIIA ainsi que les prédicteurs de résultats positifs de l'angiographie. **Méthodes** : Nous avons repéré et étudié les dossiers de tous les patients ayant subi une angiographie du mésentère pour un SGIIA à notre établissement au cours d'une période de 10 ans. Nous avons comparé les prédicteurs possibles d'une issue positive et négative de l'angiographie. **Résultats** : Sur 47 angiogrammes du mésentère subis par 35 patients, 22 (47 %, intervalle de confiance [IC] à 95 %, 33 %–61 %) ont révélé une source de saignement, le plus souvent le côlon. Trois patients (6,4 %, IC à 95 %, 0 %–18 %) ont eu un hématome à l'aine et un de ces patients a aussi subi un infarctus du myocarde au cours de l'intervention. Aucun des prédicteurs possibles n'était associé significativement à un résultat positif de l'angiographie, même si les intervalles de confiance étaient importants. Vingt patients (57 %, IC à 95 %, 41 %–74 %) ont continué de saigner après l'angiographie et 18 des patients (51 %, IC à 95 %, 35 %–68 %) ont obtenu leur congé sans que l'on pose de diagnostic définitif. **Conclusion** : Avec un taux de réussite diagnostique d'environ 50 %, l'angiographie du mésentère peut jouer un rôle important dans le diagnostic et la prise en charge du SGIIA, mais il faudra toutefois procéder à une ou plusieurs études multicentriques prospectives d'envergure pour en définir le rôle plus clairement. Les chirurgiens canadiens ont l'occasion de lancer des études multicentriques en collaboration afin de répondre à ces questions cliniques sur le diagnostic et le traitement.

*From the *Department of Surgery, University of Western Ontario, London, and the Departments of †Clinical Epidemiology and Biostatistics and ‡Medicine, McMaster University, Hamilton, Ont.*

Correspondence to: *Dr. P.J. Karanicolas, University Hospital, Rm. C8-114, Windermere Rd., London ON N6A 5A5; fax 519 663-3068; pjkarani@uwo.ca*

Acute lower gastrointestinal bleeding (ALGIB) is a common, potentially life-threatening clinical problem that leads to an estimated 20–27 hospital admissions per 100 000 people each year in the United States.[1] Although most bleeding stops spontaneously, 10%–15% of patients require urgent surgery, with a mortality rate varying from 4% to 21%.[2,3]

Clinicians use several diagnostic methods to investigate the source of the bleeding, including colonoscopy, nuclear scintigraphy, mesenteric angiography, helical computed tomography (CT) and wireless capsule endoscopy. Despite the use of a combination of these tests, the diagnosis of the source and localization of ALGIB remains a challenge; 35%–42% of patients are discharged without a definitive diagnosis.[4,5] The difficulty may be related to the broad differential diagnosis of ALGIB, the frequently intermittent nature of the bleeding and the lack of a standardized diagnostic approach to investigation.[3]

Although experts have suggested several different algorithms for investigating ALGIB, little data exist to support their validity.[4,6–9] As a result, the decision to use colonoscopy, nuclear scintigraphy or mesenteric angiography as the initial diagnostic method remains controversial and varies depending on the physician and medical centre. In particular, there is limited evidence regarding the effectiveness of mesenteric angiography in the localization and treatment of ALGIB or the frequency of complications following this procedure. Our objective was to identify the outcomes of patients with ALGIB who underwent mesenteric angiography and the predictors of a positive result at angiography.

Methods

Patient population

We identified all patients who underwent mesenteric angiography at the London Health Sciences Centre (LHSC) or St. Joseph's Healthcare Centre in London, Ontario, from Nov. 1, 1993, to Oct. 31, 2003. One of us (P.J.K.) reviewed the medical records of each patient. We included only patients who underwent angiography within 3 days of the documented onset of ALGIB. For the purposes of this study we defined ALGIB as red blood in the rectum or melena stool with a negative gastroduodenoscopy or nasogastgric lavage among patients who presented less than 1 week after the bleeding began.

Data extraction

One of us (P.J.K.) reviewed the chart of each patient and extracted data regarding potential predictors of a positive angiography, selected based on a literature review and consultation with experts in the field. Potentially important features in the patients' histories included comorbid conditions (measured with the Charlson Comorbidity Index, a weighted index of 19 comorbid conditions[10]), prior gastrointestinal bleeding, diverticulosis, inflammatory bowel disease, daily use of acetylsalicylic acid (ASA, any dosage), use during the previous week of at least 2 doses of a non-steroidal anti-inflammatory agent, daily use of an anticoagulant medication, bright red bleeding in the rectum, diarrhea, time since onset of bleeding, syncope, abdominal pain and the number of blood transfusions. We extracted data on the following physical findings: abdominal tenderness, heart rate, blood pressure, orthostatic changes in vital signs and presence of gross blood on rectal examination. Prior diagnostic investigations included hemoglobin concentration, hematocrit levels, platelet count, International Normalized Ratio (INR), nasogastric lavage, gastroduodenoscopy, colonoscopy and nuclear scintigraphy.

For each angiogram, we recorded the time from admission, the location of the bleeding (if identified), any therapeutic interventions performed and complications following the procedure. Finally, we documented whether patients experienced further bleeding during that hospital admission, what additional interventions were conducted, the final diagnosis and the total length of stay in hospital.

Statistical analysis

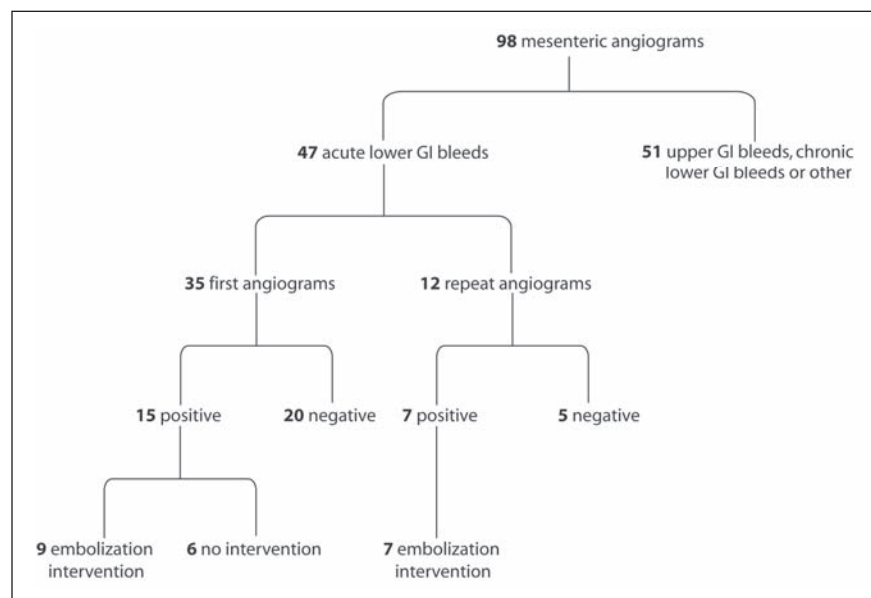We calculated the mean and standard

FIG. 1. Summary of mesenteric angiograms performed during the study period. GI = gastrointestinal.

deviation of normally distributed continuous variables and the median and interquartile range of continuous variables with skewed distributions. We used independent *t* tests to compare means of potential predictors in patients with a positive result on first angiography with those of patients with a negative result. We performed Fisher exact tests to detect between-group differences for categorical vari-ables. We elected not to conduct a logistic regression analysis because of the relatively low ratio of events to variables. We interpreted a result of $p < 0.05$ as suggestive of a difference between groups, but accepted that inferences from this data would be limited by multiplicity in the analysis.

Results

During the 10-year study period, radiologists performed 98 mesenteric angiograms, of which 47 were for patients with ALGIB (Fig. 1). Of the ALGIB angiograms, 35 were from the initial angiography, and the remaining 12 were from follow-up investigations for continued bleeding. Overall, 22 of the 47 angiograms revealed a source of bleeding (47%, 95% confidence interval [CI] 33%–61%). The results of 16 of these 22 angiograms (73%) led us to attempt a therapeutic intervention. The rate of positive angiography was lower in the initial angiograms than in the follow-up angiograms (43% v. 58%). In the positive initial angiograms, the colon was the most common site of bleeding (Table 1).

None of the potential predictors of positive angiography reached statistical significance in the comparative analyses; however, the confidence intervals included important differences for many of the variables (Table 2 and Table 3).

Hematomas in the groin occurred following 3 of the angiograms (6.4%, 95% CI 0%–13%); 1 of these patients also experienced a myocardial infarction during the procedure. No other complications occurred as a result of the angiography. Twenty of the 35 patients (57%, 95% CI 41%–74%) continued to bleed after the angiogram. Of the 16 patients who underwent therapeutic intervention at the time of angiography, 6 (37.5%) continued to bleed after the procedure. Five of the patients (14%) underwent one or more repeat angiograms, and 6 of the patients (17%) ultimately required a surgical procedure. No patient died during their hospital admission. Angiodysplasia was the most common cause of the bleed, although more than half of the patients were discharged without a final diagnosis (Table 4).

Discussion

In this case series exploring the use of mesenteric angiography in the localization of ALGIB, we report the following:

1) Almost half of angiograms revealed a source of bleeding.
2) Complications during angiography were uncommon.
3) More than half of the patients experienced continued bleeding while in hospital.
4) Half of the patients were discharged without a final diagnosis.

Many clinicians hesitate to perform

Table 1

Site of bleeding identified on patients' initial angiograms

Site of bleed	No. (%) of angiograms	95% CI
Not identified	22 (62.9)	46.8–78.9
Colon	8 (22.9)	8.9–36.8
Small bowel	3 (8.6)	0–17.8
Anorectum	2 (5.7)	0–13.4

CI = confidence interval.

Table 2

Comparison of potential predictors (continuous variables) of a positive result between patients with a positive initial angiogram and patients with a negative initial angiogram

Continuous variable	Initial angiogram; mean (SD)				95% CI*	p value
	Positive (*n* = 15)		Negative (*n* = 20)			
Age, yr	75.9	(11.7)	68.4	(16.2)	–17.1 to 2.1	0.12
Charlson Comorbidity Index score	2.5	(2.7)	2.9	(1.9)	–1.3 to 2.1	0.65
Hemoglobin level						
At time of angiogram	87.0	(24.2)	96.7	(16.5)	–5.3 to 24.7	0.19
Lowest since admission	84.3	(24.5)	91.9	(15.1)	–7.4 to 22.4	0.31
Hematocrit level						
At time of angiogram	0.25	(0.08)	0.28	(0.05)	–0.02 to 0.07	0.31
Lowest since admission	0.25	(0.07)	0.27	(0.05)	–0.03 to 0.06	0.38
Heart rate						
At time of angiogram	88.5	(13.4)	87.4	(20.0)	–12.6 to 10.4	0.85
Highest since admission	97.7	(14.0)	101.9	(25.2)	–9.5 to 17.8	0.54
Blood pressure						
At time of angiogram						
Systolic	130.3	(32.5)	125.3	(21.0)	–24.9 to 14.9	0.61
Diastolic	70.5	(19.8)	69.1	(11.2)	–13.2 to 10.5	0.81
Lowest since admission						
Systolic	112.6	(28.0)	111.7	(23.6)	–19.3 to 17.4	0.92
Diastolic	64.3	(17.0)	61.4	(18.9)	–15.4 to 9.5	0.63
Units of blood transfused	5.1	(5.0)	3.7	(3.7)	–4.6 to 1.7	0.36
Time to angiogram, h						
From admission	73.1	(79.9)	60.8	(79.3)	–67.9 to 43.2	0.65
From onset of bleed	128.3	(138.4)	134.5	(149.6)	–93.5 to 106.0	0.90

CI = confidence interval; SD = standard deviation.
*The CI is for the difference between groups.

mesenteric angiography as the initial test in patients with ALGIB because of the uncertain rate of positivity (20%–86%) and the potential for complications.[5,11,12] The rate of positive findings in our study fell in the middle of the reported range: 43% in initial angiograms and 47% overall. Given the potentially serious complications of angiography, it would be helpful to clinicians if a strategy existed to select patients most likely to have a positive result at angiography. Several investigators have attempted to identify factors that predict a positive result at angiography, with conflicting results.

Pennoyer and colleagues[13] studied 131 angiograms over a 12-year period and concluded that increasing age and lower hematocrit levels were positively correlated with the results of angiography. Another retrospective review determined that only patients' transfusion requirements were predictive of a positive finding at angiography.[14] More recently, a group of investigators studied a series of 88 patients and found that those who were hemodynamically unstable (defined by blood transfusions of 5 units or more in 24 hours) were more likely to have positive results with selective mesenteric angiography than those who were stable.[15]

Unfortunately, all of these studies had the same important limitation: far too few events (positive angiograms) for the number of predictor variables included in the analysis. Based on rigorous simulation studies, the minimum ratio of events to variables needed to confidently conduct a regression analysis is 10.[16] In these 3 studies, the number of positive angiograms ranged from 30 to 45, yielding a maximum of 4 variables for inclusion in the analyses. In our background review, we identified more than 30 factors that we felt could potentially be associated with a positive finding at angiography (Table 2 and Table 3). Based on the number of positive angiograms in our series, a rigorous regression analysis would have forced us to select only 2 of these variables for analysis. Therefore, we elected not to conduct a regression analysis and instead compared each variable independently. This approach introduced a new limitation into the interpretation of our findings: owing to the multiple testing, we would expect some of the comparisons to be positive based on chance alone. Ultimately, we were not faced with this dilemma, because even with our liberal analysis there were no significant between-group differences.

The simplest solution to avoid overfitting in a regression analysis is to increase the number of events in the study. There are obvious practical difficulties with doing this, particularly when studying uncommon conditions or treatments such as mesenteric angiography in ALGIB. Investigators can overcome this problem by collaborating and pooling the data obtained at individual centres. For example, if we combined the data from the 3 studies cited earlier with the data from our

Table 3

Comparison of potential predictors (dichotomous variables) of positive results between patients with a positive initial angiogram and patients with a negative initial angiogram

| Dichotomous variable | Initial angiogram; no. (%) | | Odds ratio (95% CI) | p value |
	Positive (n = 15)	Negative (n = 20)		
Sex, male	11 (73)	8 (40)	0.24 (0.06–1.03)	0.09
Past GI bleed	6 (40)	4 (20)	2.67 (0.59–12.02)	0.27
Inflammatory bowel disease	0 (0)	0 (0)	1.31 (0.08–22.62)	1.00
Past GI surgery	6 (40)	6 (30)	1.56 (0.38–6.36)	0.72
Diverticulosis	6 (40)	4 (20)	2.67 (0.59–12.02)	0.27
ASA use	4 (27)	7 (35)	0.68 (0.16–2.93)	0.72
Anticoagulant use	2 (13)	4 (20)	0.62 (0.10–3.91)	0.68
Melena	4 (27)	10 (50)	0.36 (0.09–1.54)	0.30
Diarrhea	3 (20)	6 (30)	0.58 (0.12–2.85)	0.70
Constipation	3 (20)	1 (5)	4.75 (0.44–51.11)	0.29
Hematemesis	0 (0)	1 (5)	0.63 (0.05–7.53)	1.00
Syncope/presyncope	5 (33)	9 (45)	0.61 (0.15–2.45)	0.73
Pain/cramping	2 (13)	3 (15)	0.87 (0.13–6.00)	1.00
Mental status change	1 (7)	2 (10)	0.64 (0.05–7.83)	1.00
Orthostatic change in BP	2 (13)	6 (30)	0.36 (0.06–2.11)	0.42
Abdominal tenderness	2 (13)	6 (30)	0.36 (0.06–2.11)	0.42
Blood on rectal examination	15 (100)	15 (75)	6.00 (0.65–55.66)	0.06
Bleeding on gastroduodenoscopy*	2 (25)	3 (27)	1.13 (0.14–9.00)	1.00
Bleeding on colonoscopy†	1 (14)	1 (9)	1.67 (0.09–31.87)	1.00
Nuclear scintigraphy positive‡	10 (100)	10 (83)	0.33 (0.03–3.72)	0.48

ASA = acetylsalicylic acid; BP = blood pressure; CI = confidence interval; GI = gastrointestinal.
*Data available for 8 of 15 patients with positive angiograms and 11 of 20 patients with negative angiograms.
†Data available for 7 of 15 patients with positive angiograms and 11 of 20 patients with negative angiograms.
‡Data available for 10 of 15 patients with positive angiograms and 12 of 20 patients with negative angiograms.

Table 4

Patients' diagnosis at discharge

Final diagnosis	No. (%) of patients	95% CI
Unknown	18 (51.4)	34.9–68.0
Angiodysplasia	8 (22.9)	8.9–36.8
Small intestine	4 (11.4)	0.8–22.0
Diverticulosis	2 (5.7)	0–13.4
Other diagnosis	3 (8.6)	0–17.8

CI = confidence interval.

centre, we would assemble a cohort with more than 130 positive angiograms. This would allow us to confidently perform a regression analysis with 13 predictor variables in the model, which would be far more powerful than any of the analyses we were able to conduct independently. Collaboration among centres provides an additional methodologic benefit: the findings are more generalizable to different practice settings than the results of a single-centre study.

Our study and the others that we identified are also limited by the retrospective nature of the data collection. Although we took precautions to extract data from the charts in a systematic manner, the quality of the data were ultimately dependent upon the accuracy of the chart recordings. A substantial portion of the data that we wished to collect was not recorded in the charts (e.g., orthostatic blood pressure changes). This missing data effectively reduced our sample size further and limited the power of the analyses to detect between-group differences.

In summary, the use of mesenteric angiography for ALGIB at our centre identified the site of bleeding about half of the time, with a relatively low rate of complications. Half of the patients experienced further episodes of bleeding during their stays in hospital, and half were discharged without a firm diagnosis. None of the factors we examined was associated with a positive result at angiography, although our findings were limited by the small sample size. Ultimately, defining the appropriate role for mesenteric angiography in the investigation and management of ALGIB will require one or more large, prospective multicentre studies. Canadian surgeons have the opportunity to initiate collaborative multicentre studies to address such diagnostic and therapeutic clinical questions.

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