

Factors influencing the yield of mesenteric angiography in lower gastrointestinal bleed

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Abstract

AIM: To assess if certain triaging rules could be established to optimize the yield of mesenteric angiography.

METHODS: Medical records of 101 patients were retrospectively reviewed and parameters relating to age, gender, pulse rate, blood pressure, serum hemoglobin, intensive care unit (ICU) admission, and the number of packed red blood cells (PRBC) transfused in the 12 and 24 h prior to the angiography were tabulated in two groups with positive and negative angiography results.

RESULTS: We found no correlation between gender, pulse rate, blood pressure or serum hemoglobin and positivity of the mesenteric angiogram. But patients with positive angiogram were found to be on average 7 years older (73.2 years vs 65.9 years old) ($P = 0.02$). Angiogram was positive in 39.3 % (11/28) of patients

admitted in ICU vs 23.2% (17/73) who were admitted elsewhere in the hospital ($P = 0.03$). In the 12 and 24 h prior to angiography, patients with a positive angiogram received a mean of 2.7 ± 2.3 and 3.3 ± 2.6 units of PRBC s respectively, while patients with a negative angiogram had a mean of 1.6 ± 1.9 ($P = 0.02$) and 2.1 ± 2.6 units ($P = 0.04$) received respectively in the same period.

CONCLUSION: Older age, ICU admission, having received at least 4 units PRBC over 12 h or 5 units over 24 h prior to angiogram are leading indicators for a positive study.

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Key words: Angiography; Diagnostic use; Colon; Blood supply; Radiograph; Gastrointestinal hemorrhage; Emergencies; Mesenteric arteries

Core tip: Mesenteric angiography is associated with a low yield of about 30%. We evaluated several factors in 101 patients undergoing mesenteric angiography in a tertiary care institution to see if any could be used for predicting a positive angiogram. We found that vital signs are poor discriminators but older age, intensive care unit admission, having received at least 4 units PRBC over 12 h or 5 units over 24 h prior to angiogram are leading indicators for a positive study. We postulate that the reason is that patients are given enough blood units to compensate for blood loss and stabilize vital signs and therefore the number of blood units given indirectly correlate with severity of active bleeding.

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INTRODUCTION

Lower gastrointestinal bleeding (LGIB) is defined as any blood loss originating in the bowel from a site distal to the ligament of Treitz^[1]. Acute LGIB is a life threatening event that can lead to an overall mortality rate of 3.9%^[2] and account for 1%-2% of hospital admissions^[3]. Because identifying the source of bleeding is essential for the endoscopic, interventional and surgical treatments, the intermittent nature of the bleed can be a difficult and frustrating problem to both the clinician and the patient. Once the source is identified, management strategies and available treatment options specific for each individual case can be applied.

In young adults and adolescents, the most common causes of bleeding are Meckel's diverticulum, inflammatory bowel disease, and polyps. In adults aged 60 years and younger, the most frequent sources include diverticula, inflammatory bowel disease, and neoplasms, whereas angiodysplasia, diverticula, and neoplasms account for the most common etiologies in adults older than aged 60 years^[4]. Ischemia, ulceration, anticoagulation and trauma including iatrogenic trauma are other possible causes of LGIB. Although most bleeds stop spontaneously, patients with recurrent or continued blood loss may require colonoscopy, angiographic embolotherapy and failing them surgery in 10%-15% of instances^[5]. Without having a positive angiogram and active extravasation no embolotherapy would normally be carried out and the morbidity and mortality associated with colectomy is higher in patients who have no preoperative localization of a bleeding source^[6,7]. Therefore, identifying the bleeding site prior to surgery is of utmost importance. Recent application of computed tomography (CT) diagnosis to the detection of source of LGIB^[8] has improved the odds but still a bleeding source localized by CT to the small intestine can not be directly referred to surgery.

Historically, endoscopy has been the initial investigation of choice^[9] but presence of blood and fecal material in the setting of emergent colonoscopy is associated with a low yield in diagnosis of bleeding site. Also introduction of air insufflation in the course of colonoscopy interferes with subsequent subtraction angiography.

In the present study, we sought retrospectively to identify factors that may lead to a higher rate of positive mesenteric angiography in patients with LGIB.

MATERIALS AND METHODS

After obtaining approval from our institutional Review Board, we conducted a retrospective chart review of 101 consecutive patients who had undergone urgent angiography for acute lower gastrointestinal (GI) bleeding at the two campuses of our tertiary care institution over the preceding three years. Patients were separated into two groups according to the results of their angiogram (positive *vs* negative). The data we studied included gender, age, pulse, blood pressure (systolic, diastolic, and mean arterial pressure), number of packed red blood cells

(PRBC) transfused, serum hemoglobin, and whether or not the patient required admission to the intensive care unit (ICU). The decision for admission to ICU was left to the discretion of the intensivist on duty who assessed the patient's various risk factors based on vitals, oxygenation status, renal function and blood chemistry. The vital signs immediately prior to the angiography were recorded for the purpose of the study. The number of transfusions at 12 h and 24 h prior to the procedure was also recorded. We compared the above mentioned clinical variables of patients with positive mesenteric angiography with those of patients without active extravasation to identify predictor of positive result at angiography.

Statistical analysis

Analysis was performed using the SAS 9.1 statistical software package (SAS Institute Incorporated, Cary, NC, United States). For univariate analysis, significance was taken as $P < 0.05$ by χ^2 or Fisher exact tests for categorical variables and *t*-test for continuous ones. Multivariate analysis was done by logistic regression modeling. Independent variables that reached significance by univariate analysis were compared to the dependent variables of angiogram outcome. To assess the impact of PRBC transfusion in the logistic regression model on the outcome of angiogram, patients receiving no transfusion or 1 to 3 units of PRBC in the prior 12 h (or 1-4 units in 24 h) were grouped together, while patients requiring more than 4 units of PRBC (or 5 units in 24 h) were grouped separately and the prevalence of positive angiograms in the two groups were compared. Results of the multiple logistic regression analysis have been presented as *P*-values and as odds ratios with 95% CIs.

RESULTS

A total of 101 mesenteric angiograms were reviewed in patients with LGIB over the study period. There were 55 males (54.5 %) and 46 females (45.5%) with a mean age of 68. Overall, contrast medium extravasation was present in 28 of 101 (27.7%) angiograms. Mean ages for the positive and negative angiogram were 73.2 and 65.9 years respectively; therefore, older patients were more likely to have a positive angiogram ($P = 0.023$) (Table 1). Of the 28 patients who had a positive angiogram, 16 (57.1%) were male and 12 (42.9%) were female, therefore gender did not affect the likelihood of angiogram outcome. Almost a quarter of our patients were admitted to ICU. Eleven of the 28 patients (39.3%) with positive angiograms were patients admitted to the intensive care unit, while there were 17 positive angiograms among the 76 patients (22.4%) admitted to the general wards ($P = 0.0361$). Of the 101 patients included in the study, 25 were admitted to the intensive care unit.

The number of PRBC transfused in 12 and 24 h prior to angiography was strongly associated with a positive angiogram. In the 12 and 24 h prior to angiography, patients with a positive angiogram received a mean of 2.7 ± 2.3 and 3.3 ± 2.6 units of PRBCs respectively, while

Table 1 Factors that were found to be significant determinants of a positive angiogram¹

	Positive angiogram (28 patients)	Negative angiogram (73 patients)	t-test P value
Average age (yr)	73.2 ± 10.9	65.9 ± 15.3	0.023
ICU admission (n)	11	14	0.036
Number of PRBCs transfused 12 h prior angiography (units)	2.7 ± 2.3	1.6 ± 1.9	0.022
Number of PRBCs transfused 24 h prior angiography (units)	3.3 ± 2.6	2.1 ± 2.6	0.043

¹Plus-minus values are means ± SD. PRBC: Packed red blood cells.**Table 2** Factors that were not found to be significant determinants of a positive angiogram¹

	Positive angiogram (28 patients)	Negative angiogram (73 patients)	t-test P value
Pulse rate	84 ± 17	82 ± 17	0.59
Mean arterial blood pressure	86 ± 14	87 ± 12.1	0.76
Diastolic blood pressure	66 ± 12.4	68 ± 11.6	0.45
Systolic blood pressure	127 ± 23	125.5 ± 19.2	0.59
Hemoglobin	83 ± 19.8	88 ± 18.1	0.59

¹Plus-minus values are means ± SD.**Table 3** Multivariable logistic regression analysis (dependent variable-angiogram outcome)

Independent variables	Coefficient estimate	P-value	OR
Age	0.045	0.017	1.046 (1.008-1.086)
No of PRBC transfused in first 12 h (≥ 4) vs (0-3)	1.423	0.007	4.150 (1.48-11.637)
No of PRBC transfused in first 24 h (≥ 5) vs (0-4)	1.290	0.024	3.640 (1.19-11.125)

PRBC: Packed red blood cells.

patients with a negative angiogram had a mean of 1.6 ± 1.9 ($P = 0.02$) and 2.1 ± 2.6 units ($P = 0.04$) in the same period (Table 1).

Through our analysis, it was found that the following factors were not significant in predicting the outcome of mesenteric angiography: pulse rate, mean arterial pressure, diastolic blood pressure, systolic blood pressure, and hemoglobin level and gender (Table 2). The results of our multivariable logistic regression analysis with the angiogram outcome as the dependent variable are presented in Table 3. It showed an approximately four time increase in the likelihood of having a positive angiogram when the patient had received 4 units or more of PRBC in the 12 h prior to the angiogram and approximately 3.5 times increase when the patient had received 5 or more units in the 24 prior to the study.

DISCUSSION

Mesenteric angiography is one of the most often used procedures for diagnosis and treatment of an acute lower GI bleed, with a yield reported to be between 19%-92%^[9-11]. In a review by Vernava *et al.*^[12], mesenteric angiography localized the bleeding sites in 40% to 86% in 9 different studies. Fiorito *et al.*^[9] showed that the pattern of bleeding (chronic occult *vs* recurrent, acute *vs* acute) affects the frequency of a positive angiogram. In a study by Al Qahtani *et al.*^[11], the diagnostic yield of angiography was only 19% (6/31 patients). However, the low yield

was attributed to the delayed timing of angiography^[11]. These results confirm the importance of setting up triaging rules for angiography to increase the diagnostic yield.

One of the advantages of mesenteric angiography is that once the bleeding site has been localized, therapeutic interventions are possible using the same modality. Mesenteric angiography is used either after a positive technetium 99 m (99 m Tc)-RBC scintigraphy in case of intermittent bleeding^[10], or after a positive CT^[8]. In cases of massive bleeding in order to avoid emergent surgery which could lead to total colectomy and a higher morbidity and mortality straight angiography may be undertaken. It has been shown that angiography's rate of detection of an active bleeding site is dependent on the rate of bleeding, with a required minimal bleeding rate of 0.5 mL/min^[13,14]. However, before undergoing the procedure, the patient's hemodynamics must be stabilized and individuals will receive blood transfusions as needed^[15]. This means that the clinicians will have to transfuse the patients at the rate at which the patients are losing blood, and therefore it is logical to think that the number of the transfusions indirectly equates to the severity of blood loss or extravasation.

In one investigation by Browder *et al.*^[16], a massive lower GI bleed was defined by a systolic blood pressure of less than 100 mmHg while bleeding, and a minimum requirement of 4 units of blood transfused in 2 h. The study resulted in a 72% yield (positive angiogram in 36/50 patients) and showed that in patients who were

bleeding at a fast enough rate to result in a positive angiogram, considerable transfusions were required, with an average of 7.6 units transfused. On the other hand, those with a negative angiogram required fewer transfusions. These patients are more likely to benefit from a colonoscopy, which has a yield of 74%-90%, because it is most diagnostic when bleeding is slow or has stopped^[14,15]. If unsuccessful in determining the location of the bleed, a radionuclide scanning with (99 m Tc)-labeled red blood cell can be used^[17]. Despite the higher sensitivity of nuclear scintigraphy (86%) as compared to angiography and its ability to detect bleeding at rates as low as 0.1 mL/min, its lack of temporal resolution, as well as presence of false positives and error in localization due to presence of reverse peristalsis in the bowel have limited its use in the diagnosis and localization of the LGIB^[17]. In the present study, active contrast medium extravasation was present in 28 of 101 (27.7%) angiograms. We identified age, ICU admission and blood product transfusion as significant predictors for positive angiogram.

Several other studies have attempted to identify predictors for a positive angiogram. Abbas *et al*^[18] reported hemodynamic instability, a drop in hemoglobin and PRBC transfusion as predictors. In a study similar to ours, Pennoyer *et al*^[19] also looked to identify factors that may be used in the evaluation of a patient in order to increase the yield of positive angiography. Like our study, they found age as a discriminating factor but they did not find the number of transfusions as a statistically significant factor in the two groups. Their study, however, differed from ours in that they compared the average number of transfusions in an unspecified time in the two groups rather than comparing the number of transfusions in 12 or 24 h prior to the procedure as we did, and we believe this could have accounted for the difference in the outcome. Our study concur with a recent study by Lee *et al*^[20], in which the number of PRBC units transfused in 24 h pre-angiography correlates with the greater likelihood of a positive study. According to that study each unit of PRBC transfused increased the risk of a positive study roughly by 30%.

In summary, our review found that older patients or patients who were admitted to ICU due to blood loss, as well as patients who had received several packed red blood cell units (4 or more units in 12 h or 5 or more units in 24 h) preceding the angiography had a statistically higher odds of having positive study and would likely benefit from an urgent angiography.

COMMENTS

Background

Lower gastrointestinal bleeding (LGIB) is one of the most common gastrointestinal indications for hospital admission. Mesenteric angiography is one of the tests often used for detecting the location of the bleeding.

Research frontiers

Due to the intermittent nature of LGIB often the test is done after the bleeding has stopped and is not helpful. It is important to do the angiogram which is an minimally invasive test when the patient is actively bleeding. In practice this has proven to be very difficult and approximately 70 percent of mesenteric angio-

grams turn out to be negative due to lack of active bleeding and wrong timing.

Related publications

Many authors have evaluated various vital parameters such as pulse and blood pressure to improve the timing and positive yield of the tests and have found little or no correlation. One investigator however found a very high correlation when more than 4 units were given to the patient in the preceding 2 h before the angiogram. Although the yield was higher but we considered the bar to be set so high that may not encompass many other patients who could be bleeding at a slower pace. The authors examined all patients in their institution who underwent mesenteric angiogram in the preceding 5 years to assess if we could find other factors for this purpose.

Applications

The authors found that likelihood of having a positive angiogram was higher in older patients and patients who had been admitted to intensive care unit due to LGIB. More importantly we found that the chance of having a positive angiogram was higher when the patient had received 4 or more blood units in the preceding 12 h or 5 and more units in the preceding 24 h when the angiogram was performed. By using this set of rules one can predict who is actively bleeding and more likely to benefit from an urgent mesenteric angiogram.

Terminology

Mesenteric angiogram is X-ray images of the vessels that supply blood to the bowel. During an angiogram, a catheter (special tube) inserted in the arterial system, usually from the groin by a radiologist and is advanced under X-ray guidance to the vessels supplying the bowel. A special dye is then injected to make these vessels visible under X-ray. When there is active bleeding, mesenteric angiography allows doctors to clearly see the source of bleeding from the arterial system into the bowel.

Peer review

The article is clear and well written. The statistical analysis appears to be valid and supports the conclusions.

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