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Original Article

Comparative Analysis of the Risk of Rebleeding between Catheter Angiography and Colonoscopy Following a Positive Computed Tomography Angiography Results in Patients with Severe Lower Gastrointestinal Bleeding

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Background/Aims: Few studies have compared the outcomes of catheter angiography and colonoscopy after positive computed tomography angiography (CTA) results in patients with severe lower gastrointestinal bleeding. This study aimed to evaluate differences in clinical outcomes between these approaches.

Methods: We analyzed data from 254 patients with positive CTA results of the lower gastrointestinal tract at Severance Hospital, South Korea (2014–2024). Clinical outcomes were compared between the catheter angiography group (n=108) and the colonoscopy group (n=146), and the predictive risk factors for rebleeding were examined.

Results: There were no significant differences in the confirmation yield (59.3% vs 47.9%), therapeutic yield (64.8% vs 56.2%), and mean hospitalization duration (20.1 days vs 21.3 days) between groups. However, the mean time to procedure (12.3 hours vs 19.2 hours) and rebleeding rate (36.1% vs 48.6%) were lower in the catheter angiography group. Logistic regression revealed that time to procedure predicted higher confirmation and therapeutic yields. Multivariate Cox regression showed that risk factors for rebleeding included receiving >5 units of packed red blood cells (hazard ratio [HR], 1.711; 95% confidence interval [CI], 1.025 to 2.857, p=0.040) and undergoing colonoscopy instead of catheter angiography (HR, 1.922; 95% CI, 1.242 to 2.974, p=0.003).

Conclusions: Following a positive CTA result, colonoscopy (compared to catheter angiography) and the need for more than 5 units of packed red blood cell transfusion were significant risk factors for rebleeding. **(Gut Liver, 2025;19:860-867)**

Key Words: Gastrointestinal hemorrhage; Computed tomography; Colonoscopy; Angiography; Treatment outcome

INTRODUCTION

According to data from the Centers for Disease Control and Prevention, gastrointestinal bleeding is the most common symptom requiring hospitalization in the United States.[1] Acute lower gastrointestinal bleeding is defined as hematochezia originating in the colon or rectum.[2] While the incidence of upper gastrointestinal bleeding has recently declined, the incidence of lower gastrointestinal bleeding has increased due to the rising global burden of age-related diseases and the use of antithrombotic agents.[3] Lower gastrointestinal bleeding is now more common than upper gastrointestinal bleeding but has lower mortality and fatality rates.[4]

Lower gastrointestinal bleeding is generally less severe because bleeding resolves spontaneously in 80% of cases.[5] In a recent study of 46,179 patients with lower gastrointestinal bleeding, 17,896 (38.8%) underwent inpatient

colonoscopy, 79 (0.2%) received endoscopic hemostasis during colonoscopy, and 15 (0.03%) underwent mesenteric embolization at 140 hospitals across the United States.[6] Although the mortality rate of lower gastrointestinal bleeding is relatively low, patients with severe, hemodynamically significant hematochezia require intravenous fluid resuscitation, blood pressure optimization, blood transfusions, or prompt diagnostic intervention.[7]

According to the 2021 European Society of Gastrointestinal Endoscopy guidelines, patients with hemodynamic instability and suspected ongoing bleeding should undergo computed tomography angiography (CTA) before colonoscopy or catheter angiography to locate the source of bleeding.[8] CTA has become an alternative to colonoscopy as the initial diagnostic test for patients with hemodynamically significant lower gastrointestinal bleeding.[9] Patients with positive CTA results are recommended to undergo catheter angiography with possible embolization; however, colonoscopy can be performed at specialized centers with experience in therapeutic hemostasis, as outlined in the updated 2023 American College of Gastroenterology guidelines.[10]

Despite this, there have been few studies comparing the clinical outcomes of catheter angiography and colonoscopy following positive CTA in patients with severe lower gastrointestinal bleeding. Therefore, we aimed to compare the confirmation, therapeutic, and rebleeding rates between the catheter angiography and colonoscopy groups after positive CTA results. We also aimed to investigate factors predictive of confirmation yield, therapeutic yield, and rebleeding after these procedures.

MATERIALS AND METHODS

1. Patients

Data were retrospectively collected from patients with severe lower gastrointestinal bleeding at Severance Hospital, South Korea, between 2014 and 2024. Severe lower gastrointestinal bleeding was defined as both hemodynamically stable or unstable hematochezia, and positive CTA which defined as evidence of contrast extravasation. Exclusion criteria included patients younger than 18 years, those with negative CTA results, and those whose bleeding source was confirmed to be upper gastrointestinal tract or small bowel. Patients who underwent both CTA and catheter angiography within 7 days were categorized into the catheter angiography group, while patients who underwent both CTA and colonoscopy within 7 days were categorized into the colonoscopy group. The study protocol was approved by the institutional review board and hospital research ethics committee of each facility (IRB number: 4-2024-1186). Written informed consent was waived by the institutional review board.

2. Clinical outcomes

Confirmation yield was defined as the presence of active bleeding on colonoscopy or active extravasation on catheter angiography.[11] Therapeutic yield was defined as the performance of therapeutic procedures, such as hemostatic clipping, epinephrine injection, argon plasma coagulation, or Beriplast injection during colonoscopy, or vessel embolization during catheter angiography.[11] Time to procedure was defined as the interval from CTA to colonoscopy or CTA to catheter angiography. Rebleeding was defined as gastrointestinal bleeding signs and/or the need for a repeat procedure due to a decrease in hemoglobin level or transfusion requirements. Hemodynamic instability was defined as systolic blood pressure of less than 90 mm Hg.

3. Statistical analysis

Means and standard deviations were calculated for continuous variables, and frequencies and percentages were reported for categorical variables. An independent t-test (or Mann-Whitney U test) was used to compare continuous variables. The distribution of categorical variables was compared between the catheter angiography and colonoscopy groups using the chi-square test. Predictive factors for confirmation and therapeutic yields in patients with a positive CTA result and severe lower gastrointestinal bleeding were analyzed using logistic regression analysis. Multivariate Cox regression analysis was performed to identify the predictive factors of rebleeding in these patients. A p-value <0.05 was considered statistically significant. All statistical analyses were performed using the IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA).

RESULTS

1. Patient characteristics

Between August 2014 and August 2024, 1,416 patients underwent both CTA and catheter angiography, and 5,109 patients underwent both CTA and colonoscopy for hematochezia at Severance Hospital, South Korea (Fig. 1). Of the 1,416 patients, 1,237 were excluded due to the absence of evidence of contrast extravasation on CTA, and 71 were excluded because they were confirmed to have upper gastrointestinal and/or small bowel bleeding. Thus, the final analysis included 108 patients with lower gastrointestinal tract bleeding in the catheter angiography group. Of the 5,109 patients, 4,923 were excluded due to the lack of

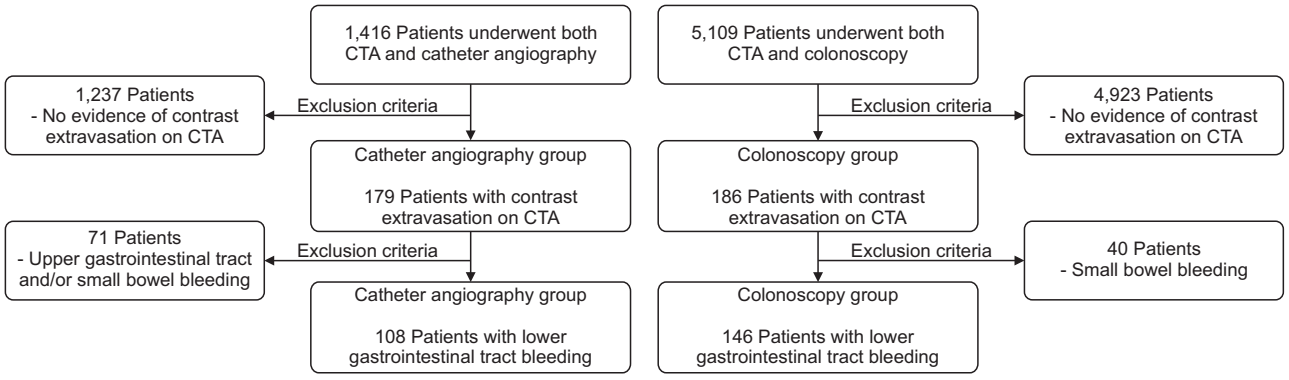

Fig. 1. Flowchart of participants inclusion. CTA, computed tomography angiography.

evidence of contrast extravasation on CTA, and 40 were excluded because they were confirmed to have small bowel bleeding. Therefore, the final analysis included 146 patients with lower gastrointestinal tract bleeding in the colonoscopy group (Fig. 1).

The catheter angiography group had a higher Charlson Comorbidity Index score (3.6±2.4 vs 2.7±2.2, p=0.002), a higher incidence of hemodynamic instability (60.2% vs 39.7%, p=0.001), more frequent use of vasopressors (39.8% vs 24.0%, p=0.009), a higher rate of transfusion of more than 5 units of red blood cells (50.9% vs 32.9%, p=0.004), a higher rate of transfusion of more than 5 units of fresh frozen plasma (29.6% vs 16.4%, p=0.014), a higher rate of transfusion of more than 12 units of platelets (21.3% vs 11.0%, p=0.034), a higher incidence of nadir hemoglobin levels of less than 7 g/dL (25.9% vs 13.0%, p=0.014), and a lower incidence of left-sided colon lesions (42.6% vs 57.5%, p=0.022) compared to the colonoscopy group (Table 1).

2. Confirmation yield and therapeutic yield between groups

Active bleeding was confirmed in 64 patients (59.3%) in the catheter angiography group and in 70 patients (47.9%) in the colonoscopy group (p=0.077) (Table 2). Hemostatic procedures were performed in 70 patients (64.8%) in the catheter angiography group and 82 patients (56.2%) in the colonoscopy group (p=0.196) (Table 2). Among the 82 patients who underwent endoscopic therapeutic procedures, hemostatic clipping, epinephrine injection, argon plasma coagulation, and Beriplast injection were performed in 49 (60.0%), 21 (25.6%), 27 (32.9%), and 14 (17.1%) patients, respectively. In univariate logistic regression analysis, the catheter angiography and colonoscopy groups did not differ in terms of confirmation yield (Supplementary Table 1) or therapeutic yield (Supplementary Table 2). Hospital stay did not differ between the groups.

The mean time to procedure was shorter in the catheter angiography group compared to the colonoscopy group (12.3±25.1 hours vs 19.2±28.1 hours, p=0.044). A longer procedure time was significantly negatively associated with confirmation yield (odds ratio, 0.980; 95% confidence interval [CI], 0.969 to 0.992; p=0.001) (Supplementary Table 1) and therapeutic yield (odds ratio, 0.991; 95% CI, 0.981 to 1.000; p=0.049) (Supplementary Table 2) in the univariate logistic regression analysis. The catheter angiography and colonoscopy groups did not differ in terms of hemodialysis rates due to acute kidney injury (3.70% vs 0.68%, p=0.087) or surgery rates due to treatment failure (5.56% vs 2.05%, p=0.136) (Table 2).

3. Rebleeding rate after procedure between groups

In the catheter angiography group, 39 patients (36.1%) experienced rebleeding after the procedure, compared to 71 patients (48.6%) in the colonoscopy group (p=0.031) (Table 2). In the multivariate Cox regression analysis, patients who underwent colonoscopy still had a significantly higher rebleeding rate than those who underwent catheter angiography (hazard ratio [HR], 1.922; 95% CI, 1.242 to 2.974; p=0.003) (Table 3, Fig. 2A). Patients who received 5 or more units of red blood cells had a significantly higher rebleeding rate than those who received fewer than 5 units of red blood cells (HR, 1.711; 95% CI, 1.025 to 2.857; p=0.040) (Table 3, Fig. 2B). We additionally analyzed whether the rebleeding rates differ among subgroups that underwent therapeutic procedures, but there was no difference in rebleeding rates between the catheter angiography group and colonoscopy group (38.6% vs 45.1%, p=0.510). Also, the performance of therapeutic procedures (embolization or endoscopic hemostasis) was not associated with rebleeding in the Cox regression analysis (HR, 0.786; 95% CI, 0.538 to 1.147; p=0.212) (Table 3).

Table 1. Baseline Characteristics of Patients with Lower Gastrointestinal Bleeding after Localization on Computed Tomography Angiography

Variable	Catheter angiography (n=108)	Colonoscopy (n=146)	p-value*
Age, yr	66.4±13.6	67.9±14.9	0.404
Male sex	70 (64.8)	90 (61.6)	0.693
Body mass index, kg/m^2	22.4±2.8	22.0±3.2	0.352
Charlson Comorbidity Index score	3.6±2.4	2.7±2.2	0.002
Previous bleeding history	19 (17.6)	15 (10.3)	0.097
Antiplatelet medication history	42 (38.9)	70 (47.9)	0.162
Anticoagulation medication history	12 (11.1)	11 (7.5)	0.379
Hemodynamic instability	65 (60.2)	58 (39.7)	0.001
Vasopressor use	43 (39.8)	35 (24.0)	0.009
Intensive care unit use	19 (17.6)	14 (9.6)	0.088
Transfusion of packed RBC >5 units	55 (50.9)	48 (32.9)	0.004
Transfusion of FFP >5 units	32 (29.6)	24 (16.4)	0.014
Transfusion of platelet concentrates >12 units	23 (21.3)	16 (11.0)	0.034
Nadir hemoglobin level <7 g/dL	28 (25.9)	19 (13.0)	0.014
Platelet level <50,000/mm^3	6 (5.8)	8 (5.5)	1.000
Prothrombin time (INR) >1.5	15 (13.9)	16 (11.0)	0.562
Blood urea nitrogen >50 mg/dL	10 (9.3)	11 (7.5)	0.650
Left-sided colon lesion	46 (42.6)	84 (57.5)	0.022
Diagnosis			0.199
Diverticulosis	30 (27.8)	46 (31.5)	
Angiodysplasia	18 (16.7)	26 (17.8)	
Ulcer	30 (27.8)	58 (40.0)	
Pseudoaneurysm	8 (7.4)	0	
Postpolypectomy bleeding	2 (1.9)	7 (4.8)	
Metastasis/cancer/lymphoma	11 (10.2)	2 (1.4)	
Ischemic colitis	2 (1.9)	4 (2.7)	
Crohn's disease/ulcerative colitis	3 (2.8)	0	
Radiation colitis	1 (0.9)	1 (0.7)	
Rectovaginal fistula	1 (0.9)	0	
Arteriovenous malformation	1 (0.9)	0	
Vasculitis	1 (0.9)	0	
Appendicitis	0	1 (0.7)	
Dieulafoy's lesion	0	1 (0.7)	

Data are presented as the mean±SD or number (%).
RBC, red blood cell; FFP, fresh frozen plasma; INR, international normalized ratio.
*p-value for the comparison between the catheter angiography group and the colonoscopy group.

Table 2. Comparison of Clinical Outcomes between the Catheter Angiography Group and the Colonoscopy Group in Patients with Lower Gastrointestinal Bleeding after Localization on Computed Tomography Angiography

Variable	Catheter angiography (n=108)	Colonoscopy (n=146)	p-value*
Confirmation yield	64 (59.3)	70 (47.9)	0.077
Therapeutic yield	70 (64.8)	82 (56.2)	0.196
Time to procedure, hr	12.3±25.1	19.2±28.1	0.044
Hospital days, day	29.1±35.9	21.3±30.7	0.063
Hemodialysis due to acute kidney injury	4 (3.70)	1 (0.68)	0.087
Surgery due to treatment failure	6 (5.56)	3 (2.05)	0.136
Rebleeding	39 (36.1)	71 (48.6)	0.031

Data are presented as number (%) or mean±SD.
*p-value for comparing catheter angiography group and colonoscopy group.

DISCUSSION

In patients with severe lower gastrointestinal bleeding and positive CTA results, the confirmation yield (59.3% vs 47.9%, p=0.077) and therapeutic yield (64.8% vs 56.2%, p=0.196) did not differ significantly between the catheter angiography and colonoscopy groups. However, the time to procedure was approximately 7 hours shorter in

Table 3. Cox Regression Analysis for Rebleeding

Variable	Univariate analysis		Multivariate analysis	
	HR (95% CI)	p-value*	HR (95% CI)	p-value*
Age	1.005 (0.992–1.018)	0.488		
Male sex	1.272 (0.868–1.863)	0.217		
Body mass index	0.997 (0.931–1.063)	0.934		
Charlson Comorbidity Index score	1.122 (1.042–1.209)	0.002	1.066 (0.970–1.171)	0.184
Previous bleeding history	1.062 (0.625–1.805)	0.823		
Antiplatelet medication history	1.484 (1.020–2.158)	0.039	1.250 (0.840–1.860)	0.271
Anticoagulation medication history	0.829 (0.419–1.640)	0.591		
Hemodynamic instability	1.579 (1.082–2.306)	0.018	1.243 (0.726–2.128)	0.428
Vasopressor use	1.568 (1.067–2.305)	0.022	0.940 (0.535–1.649)	0.828
Intensive care unit use	1.268 (0.756–2.127)	0.368		
Transfusion packed RBC >5 units	2.152 (1.475–3.139)	<0.001	1.711 (1.025–2.857)	0.040
Transfusion FFP >5 units	1.755 (1.166–2.641)	0.007	1.110 (0.634–1.944)	0.714
Transfusion platelet conc >12 units	2.015 (1.296–3.133)	0.002	1.247 (0.645–2.411)	0.512
Nadir hemoglobin level <7 g/dL	1.470 (0.941–2.297)	0.091		
Platelet level <50,000/mm^3	2.209 (1.151–4.240)	0.017	1.239 (0.576–2.666)	0.584
Prothrombin time (INR) >1.5	1.039 (0.593–1.821)	0.893		
Blood urea nitrogen >50 mg/dL	1.243 (0.666–2.317)	0.494		
Left colon (vs right colon)	1.630 (1.114–2.385)	0.012	1.286 (0.865–1.912)	0.214
Confirmation yield	0.713 (0.490–1.037)	0.077		
Therapeutic yield	0.786 (0.538–1.147)	0.212		
Colonoscopy (vs catheter angiography)	1.528 (1.034–2.259)	0.033	1.922 (1.242–2.974)	0.003
Time to procedure	1.003 (0.997–1.010)	0.260		

HR, hazards ratio; CI, confidence interval; RBC, red blood cell; FFP, fresh frozen plasma; INR, international normalized ratio.
*p-value for comparing catheter angiography group and colonoscopy group.

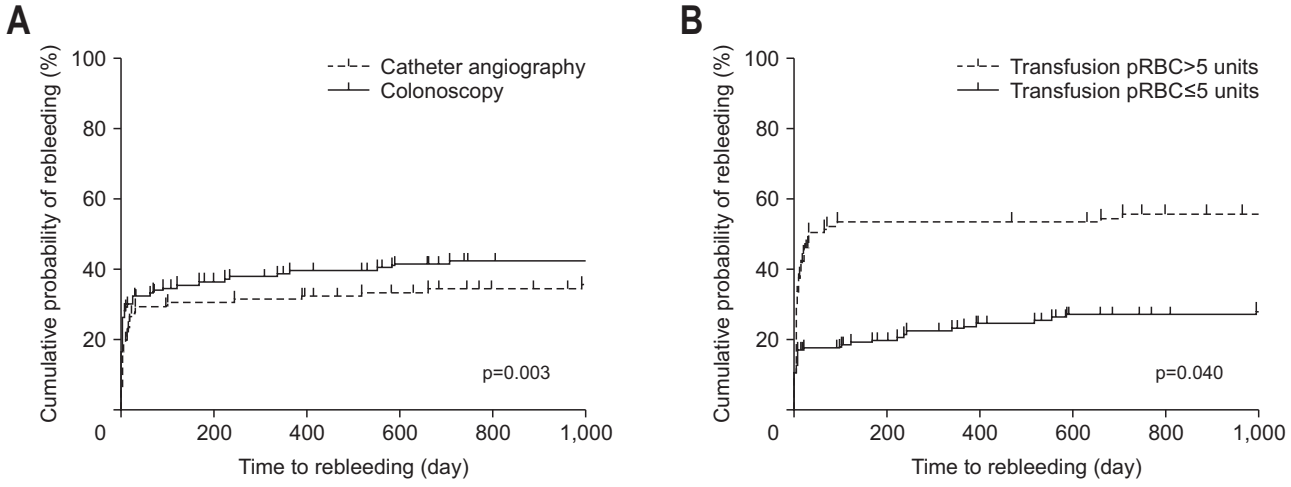

Fig. 2. Cumulative probability of rebleeding. (A) Cumulative probability of rebleeding in the catheter angiography and colonoscopy groups. (B) Cumulative probability of rebleeding in the group receiving more than 5 packed red blood cell (pRBC) transfusions and the group receiving 5 or fewer pRBC transfusions in patients with acute lower gastrointestinal bleeding.

the catheter angiography group than in the colonoscopy group, and the rebleeding rate (36.1% vs 48.6%, p=0.031) was lower in the catheter angiography group. The colonoscopy group had a significantly higher rebleeding risk (HR, 1.922; 95% CI, 1.242 to 2.974; p=0.003) compared to the catheter angiography group after adjusting for confounding variables. Therefore, our findings suggest that catheter angiography might be considered as a first-line treatment option to reduce rebleeding events in patients with severe lower gastrointestinal bleeding who have a positive CTA result, in both hemodynamically stable and hemodynamically unstable conditions. To validate our findings, large-scale prospective comparative clinical trials will be needed in the future.

With recent advancements in CTA and bleeding protocols, CTA has become the mainstay for diagnosing severe lower gastrointestinal bleeding.[12] CTA is widely available at various facilities and can be performed quickly and safely without bowel preparation or invasive procedures in patients with severe lower gastrointestinal bleeding.[13,14] According to recent guidelines, patients with successful CTA localization are recommended to undergo catheter angiography with possible embolization, but colonoscopy can be performed in specialized centers with experience in therapeutic hemostasis.[10] There was only one previous study in the United States that compared the clinical outcomes between the catheter angiography group (n=27) and the colonoscopy group (n=44) in patients with overt lower gastrointestinal bleeding and positive CTA results.[11] The confirmation yield was better in the catheter angiography group than in the colonoscopy group (55% vs 26%), but there were no differences in therapeutic yield (70% vs 56%). In addition, the rebleeding rate was 52% (23/44) in the catheter angiography group and 48% (13/27) in the colonoscopy group, which was not significantly different between the groups (p=0.809) due to the small sample size. Our study is the first to demonstrate that the colonoscopy group has a significantly higher rebleeding rate than the catheter angiography group after a positive CTA result. Recent advancements in CTA have enabled better localization of the bleeding site, leading to successful embolization, and various embolic agents have improved the success of embolization during angiography.[15,16] The higher rebleeding rate in the colonoscopy group compared to the catheter angiography group may be attributed to blood clips falling off after the therapeutic procedure and the inability to completely block the supplying blood vessels with other endoscopic hemostasis techniques.

Regarding the time to procedure, our study found that, in patients with positive CTA results, a 1-hour delay in the time to procedure was associated with a 2% decrease in confirmation yield and a 9% decrease in therapeutic yield. However, time to procedure, confirmation yield, and therapeutic yield were not associated with rebleeding risk. The performance of therapeutic procedures (embolization or endoscopic hemostasis) was not associated with rebleeding risk. While rebleeding can occur after these procedures, factors such as the requirements of transfusion or modality of initial hemostasis (catheter angiography or colonoscopy) are more likely to influence rebleeding risk. A recent study regarding colonoscopy reported similar findings, showing that early colonoscopy (≤24 hours) increased the confirmation rate and shortened the length of hospital stay, but was associated with an increased risk of rebleeding and did not improve mortality, catheter angiography, or surgical requirements.[17] In a meta-analysis of randomized trials, early colonoscopy did not improve rebleeding and mortality rates compared to elective colonoscopy.[18] Based on our results, early procedures do not improve important clinical outcomes such as rebleeding, but further randomized studies are warranted to clarify these findings.

Patients who received 5 or more units of red blood cells had a significantly higher rebleeding rate than those who received fewer than 5 units of red blood cells in our study. First, this can be interpreted as the rebleeding rate being higher due to the severity of the bleeding, which necessitated a large blood transfusion. In other words, because the lesions were severe enough to require a high transfusion volume, incomplete hemostasis may have contributed to more rebleeding. Second, our findings suggest that a restrictive transfusion strategy should be used in patients with severe lower gastrointestinal bleeding to reduce the risk of rebleeding. For upper gastrointestinal bleeding, restrictive blood transfusion has been associated with decreased all-cause mortality and rebleeding compared to liberal transfusion in previous randomized controlled trials and meta-analyses.[19] Transfusion increases splanchnic blood pressure, leading to the erosion of newly formed clots, as well as the dilution and reduced activity of clotting factors.[20] However, in patients with lower gastrointestinal bleeding, an analysis of large prospective U.K. National Comparative Audit data showed no significant difference in clinical outcomes between restrictive and liberal transfusion strategies.[21] Since the previous study included all patients with lower gastrointestinal bleeding, the majority of whom were hemodynamically stable, and our study focused on patients with severe lower gastrointestinal bleeding and positive CTA results, the study outcomes may differ. Our study suggests that restrictive blood transfusions should be considered for patients with severe lower gastrointestinal bleeding, similar to recommendations for patients with upper gastrointestinal bleeding.

Our study has some limitations. First, a significant difference was observed between the two groups with respect to baseline characteristics due to the retrospective study design. However, our study included a large number of patients and adjusted for various potential confounders. Further randomized controlled trials are needed to confirm these findings. Second, we enrolled only patients with lower gastrointestinal bleeding who had positive CTA results. Although there were cases where CTA was negative but clinically ongoing active bleeding was present, these patients were excluded from our study. Therefore, caution is warranted when interpreting our results. Third, because we defined rebleeding as signs of gastrointestinal bleeding and/or the need for a repeat procedure due to a decrease in

hemoglobin level or transfusion requirements, we included cases with ischemic colitis, inflammatory bowel disease, radiation colitis, and vasculitis, which are bleeding conditions that can naturally cause rebleeding.

In conclusion, following a positive CTA result, colonoscopy, compared to catheter angiography, and the requirement for more than 5 units of packed red blood cell transfusion were significant risk factors for rebleeding.

CONFLICTS OF INTEREST

J.H.C. is an editorial board member of the journal but was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflicts of interest relevant to this article were reported.

AUTHOR CONTRIBUTIONS

Study concept and design: J.P., J.H.C. Data acquisition: J.P., S.Y.C., S.J.P., J.J.P., T.I.K., J.H.C. Data analysis and interpretation: J.P. Drafting of the manuscript: J.P. Critical revision of the manuscript for important intellectual content: S.Y.C., S.J.P., J.J.P., T.I.K., J.H.C. Approval of final manuscript: all authors.

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SUPPLEMENTARY MATERIALS

Supplementary materials can be accessed at https://doi.org/10.5009/gnl250152.

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