Effectiveness of endoscopic hemostasis in preventing diverticular bleeding with extravasation detected by contrast-enhanced computed tomography
A single-center retrospective cohort study

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Abstract

In diverticular bleeding, extravasation detected by computed tomography indicates active bleeding. It is unclear whether an endoscopic procedure is the best method of hemostasis for diverticular bleeding. This retrospective study was conducted to examine the effectiveness of endoscopic hemostasis in preventing diverticular rebleeding with extravasation visualized by contrast-enhanced computed tomography.

This single-center, retrospective, the observational study utilized data from an endoscopic database. Adult patients admitted to our hospital due to diverticular bleeding diagnosed by colonoscopy were included. We compared the data between the extravasation-positive and extravasation-negative groups. The primary outcome was the proportion of successful hemostasis without rebleeding within 1 month after the first endoscopic procedure. Altogether, 69 patients were included in the study (n = 17, extravasation-positive group; n = 52, extravasation-negative group). The overall rebleeding rate was 30.4% (21/69). The rebleeding rate was higher in the extravasation-positive group than in the extravasation-negative group, although without a statistically significant difference. However, among the patients who underwent endoscopic hemostasis, the rebleeding rate was significantly higher in the extravasation-positive group than in the extravasation-negative group (50% [8/16] vs 10.5% [2/19], p = .022). In the extravasation-positive group, all 8 patients with rebleeding underwent repeat colonoscopy. Of these, 5 patients required additional clips; bleeding was controlled in 3 patients, while arterial embolization or surgery was required for hemostasis in 2 patients. None of the remaining 3 patients with rebleeding in the extravasation-positive group required clipping; thus, their conditions were only observed.

Many patients with diverticular bleeding who exhibited extravasation on computed tomography experienced rebleeding after endoscopic hemostasis. However, bleeding in more than half of these patients could be stopped by 2 endoscopic procedures, without performing transcatheter arterial embolization or surgery even if rebleeding occurred. Some serious major complications due to such invasive interventions are reported in the literature, but colonoscopic complications did not occur in our patients. Endoscopic hemostasis may be the preferred and effective first-line therapy for patients with diverticular bleeding who have extravasation, as visualized by contrast-enhanced computed tomography.

Abbreviations: CECT = contrast-enhanced computed tomography, CKD = chronic kidney disease, DOAC = direct oral anticoagulant, EBL = endoscopic band ligation, FFPs = fresh frozen plasmas, HR = heart rate, IQR = interquartile range, IR = interventional radiology, NSAID = non-steroidal anti-inflammatory drug, PCs = platelet concentrates, RBCs = red blood cells, SBP = systolic blood pressure, SRH = stigmata of recent hemorrhage, TAE = transcatheter arterial embolization.

Keywords: computed tomography, diverticular bleeding, endoscopic hemostasis, extravasation of contrast media, therapeutic embolization

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1. Introduction

Diverticular bleeding is the most common cause of lower gastrointestinal bleeding in adults.[1,2] In 1 study, active life-threatening diverticular bleeding only occurred in 3.1% of patients,[3] and most diverticular bleeding is self-limiting.[4] However, patients who have experienced diverticular bleeding with stigmata of recent hemorrhage (SRH) (eg, active bleeding, non-bleeding visible vessel, adherent clot) without receiving any intervention have an appreciable risk for rebleeding (52.9%–65.8%).[5,6] Therefore, treating the bleeding site is crucial in cases with SRH. However, the endoscopic detection of the bleeding point from the diverticula is difficult, with a detection rate of 18.4% to 31.4%; the detection rate increases from 60% to 78% in patients with extravasation visualized by contrast-enhanced computed tomography (CECT).[7–9]

Extravasation detected by CECT is thought to be active, as the bleeding rate exceeds 0.3 to 0.5 mL/min.[10] However, it is unclear whether endoscopic hemostasis is the best method for the control of this active bleeding. Thus, the purpose of the present study was to examine the effectiveness of endoscopic hemostasis in preventing diverticular rebleeding with extravasation visualized by CECT.

2. Materials and methods

2.1. Study design and setting

This retrospective, observational study was conducted at our institution, which is a secondary care hospital covering a local population of approximately 1,200,000. When primary care or emergency physicians deal with patients with hematochezia at the outpatient or emergency department, they refer the patients to endoscopists for urgent endoscopy. Even during midnight, on-call endoscopists are called if necessary.

The institutional review board of our hospital approved this study (approval number: 2019–29). The requirement for obtaining informed consent from the patients before study participation was waived, because the patients did not undergo additional interventions, the study was retrospective and observational in nature, and the data were collected anonymously.

2.2. Treatment protocol

CT is not performed routinely, but it is conducted at the discretion of the primary care physicians, emergency physicians, or endoscopists. When CECT shows extravasation, which indicates active bleeding, emergency colonoscopy is usually performed. In general, at least 2 endoscopists perform colonoscopy all day. Polyethylene glycol that contains ascorbic acid (MoviPrep; EA Pharma Co., Ltd, Tokyo, Japan) was used for oral preparations. If the colonoscopy was urgent, the endoscopist sometimes skipped the oral preparation owing to its limited effectiveness. The endoscopist then sees the patients as an attending doctor in the general ward after colonoscopy. If the bleeding could not be stopped completely with only colonoscopy and hematochezia still continued, the endoscopist then refers the patient to surgeons for surgical hemostasis or radiologists for interventional radiology (IR) with transcatheter arterial embolization (TAE).

2.3. Participants

The participants included patients aged ≥18 years who were diagnosed with diverticular bleeding by colonoscopy and admitted to our hospital from March 1, 2016 and April 30, 2019. This study used data extracted from an endoscopic database. A definitive diagnosis of diverticular bleeding required the findings of SRH, which was identified by reviewing the endoscopic pictures and descriptions obtained from the database. The diagnosis of the presumed diverticular bleeding was made if a diverticulum is present even without any evidence of bleeding and no other major colonic lesions or bleeding sites were identified by colonoscopy.[5,6] Patients were excluded if they: were <18 years old, required additional treatment for the issue other than diverticular bleeding (for eg, aspiration pneumonia, heart failure, and so on), underwent a colonoscopy more than twice due to rebleeding or underwent a re-examination of the bleeding origins during their hospital stay, were not admitted to our hospital, and did not undergo CECT.

2.4. Exposure and comparison group definition

As mentioned previously, CT was performed according to the physician's or endoscopist's discretion. Some patients with extravasation of the contrast media detected by CECT were classified as the exposure group (extravasation-positive group), whereas those without extravasation were categorized as the comparison group (extravasation-negative group).

2.5. Data collection

The baseline clinical characteristics of all enrolled patients were collected from the electronic medical records. We collected data on age, sex, comorbidities (congestive heart failure, myocardial infarction, liver cirrhosis, chronic kidney disease [CKD], diabetes mellitus, hypertension, dyslipidemia, and diverticular bleeding), prescribed medications (antiplatelet, anticoagulant [vitamin K antagonist], direct oral anticoagulant [DOAC]), or non-steroidal anti-inflammatory drug [NSAID]), vital signs on admission (systolic blood pressure [SBP], heart rate [HR], and shock index [HR/SBP]), laboratory data on admission (hemoglobin, platelet count, blood urea nitrogen, creatinine, international normalized ratio of prothrombin time).[11–14] Moreover, data on the presence of extravasation by CECT,[7–9] time interval from the last hematochezia episode to clinical examination, colonoscopy, and CT,[9,15] whether a preparation before colonoscopy was performed or not,[16] colonoscopic diagnosis (confirmed diagnosis or presumptive diagnosis), treatment methods (endoscopic clipping, endoscopic band ligation [EBL], TAE, surgery, or observation), acute rebleeding event (within 1 month after the last colonoscopy), additional treatment (endoscopic clipping, EBL, TAE, surgery, or observation), the total amount of administered red blood cells (RBCs), fresh frozen plasmas (FFPs), and platelet concentrates (PCs) within the first 24 hours, length of hospital stay, death, and transfer to another hospital were also collected. A radiologist interpreted the presence of radiologic extravasation of the contrast media on the CECT images. Additional treatment was defined as the last method applied for bleeding control in patients without rebleeding within 1 month.

2.6. Outcome measurements

The primary outcome was the rate of successfully controlling bleeding from the diverticula without rebleeding within 1 month after the first endoscopic procedure (eg, endoscopic hemostasis [clipping or EBL] or colonoscopy with only observation). The incidence rate of bleeding among the patients who underwent the
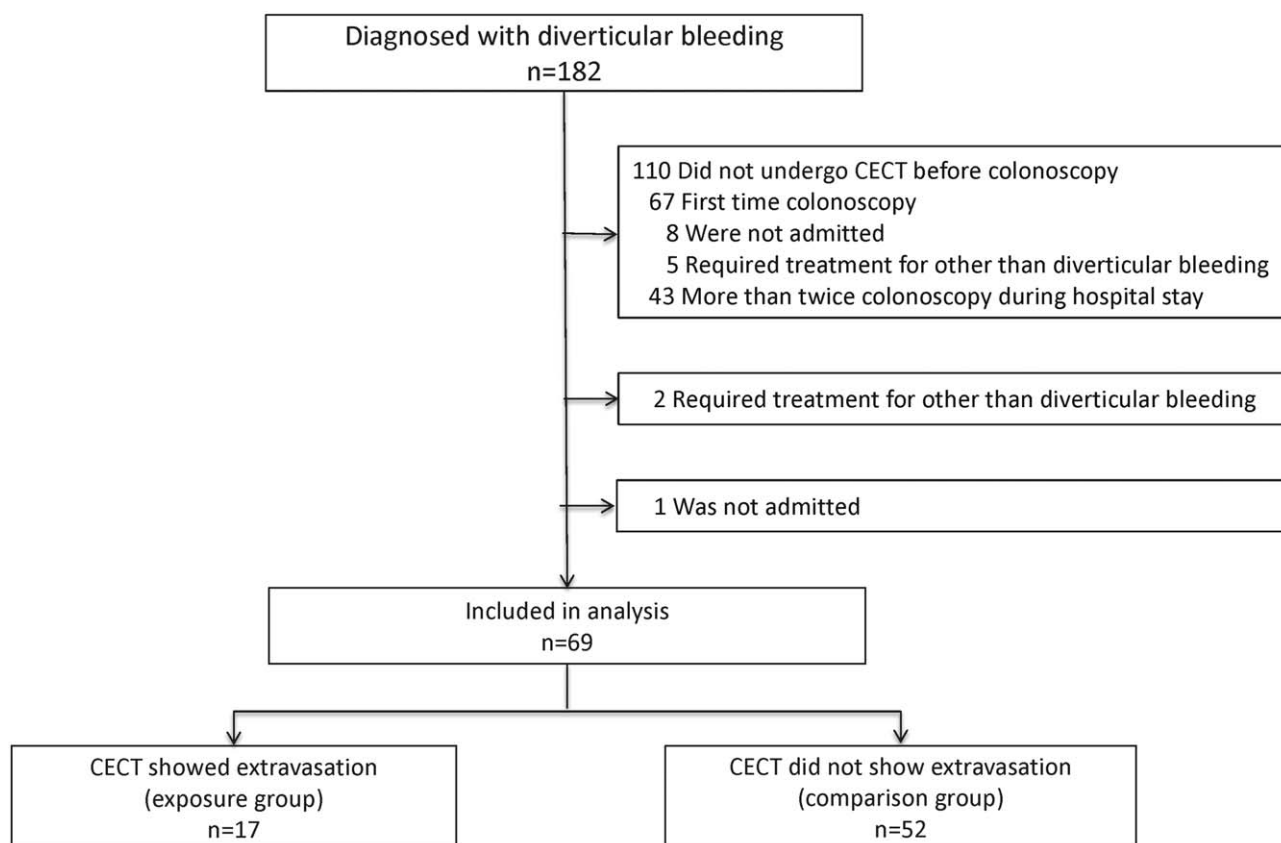
Figure 1. Flowchart of patient enrolment. CECT = contrast-enhanced computed tomography.

first endoscopic hemostasis was also conducted as a sub-analysis. The secondary outcome was the rate of successfully controlling bleeding without rebleeding within 1 month after the additional treatment. These data were compared between the exposure and comparison groups.

We also compared the patients who underwent CECT (the CECT group) and did not undergo CECT (the non-CECT group) to investigate the differences in their characteristics. Patients who needed for causes other than diverticular bleeding and who had already undergone colonoscopy during the hospital stay, ie, were undergoing colonoscopy for the second or more times, were excluded.

2.7. Statistical analysis

Continuous variables are presented as the median and interquartile range (IQR). Categorical data are summarized using numbers and percentages. Univariate analysis was performed using the Mann–Whitney U test for comparing continuous variables, and Fisher exact test was used for categorical variables. All reported p values were 2-tailed, and values $<.05$ were considered statistically significant. Statistical analyses were conducted using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan).[17]

3. Results

3.1. Participant enrollment

During the study period, 182 patients were diagnosed with diverticular bleeding by colonoscopy. Of these, 110 patients did

not undergo CECT, 2 patients were required for causes other than diverticular bleeding, and 1 patient was not admitted to our hospital; these patients were excluded. Therefore, 69 patients were included in the study; of these, 17 and 52 patients were categorized into the extravasation-positive group (exposure group) and the extravasation-negative group (comparison group), respectively (Figure 1).

3.2. Baseline characteristics

The baseline characteristics of the 2 groups are shown in Table 1. There was no significant difference in the baseline characteristics between the 2 groups, except for SBP. The extravasation-positive and extravasation-negative groups did not differ significantly in terms of the proportion of patients with a shock index >1 (0% [0/17] vs 7.7% [4/52], $p=.565$) and the time interval from the last episode of hematochezia to CT (179 minutes [IQR: 125–402 minutes] vs 233 minutes [IQR: 135–417 minutes], $p=.797$). However, the proportion of patients who underwent emergent colonoscopy within 12 hours from the last episode of hematochezia was significantly higher in the extravasation-positive group than in the extravasation-negative group (82.4% [14/17] vs 38.5% [20/52], $p=.002$) (Table 1). Moreover, the proportions of patients with a confirmed diagnosis and endoscopic hemostasis were significantly higher in the extravasation-positive group than in the extravasation-negative group (94.1% [16/17] vs 36.5% [19/52], $p<.001$). Regarding SRH, the prevalence of active bleeding, non-bleeding visible vessel, and adherent clot was higher in the extravasation-positive group than in the

Clinical characteristics of the extravasation-positive and extravasation-negative groups.

	Overall (n=69)	Extravasation (+) (n=17)	Extravasation (−) (n=52)	p-Value
Age (yrs)	71 (62–80)	76 (67–80)	69 (62–76)	.077
Sex (male)	41 (59.4%)	9 (52.9%)	32 (61.5%)	.578
Comorbidity				
Diverticular bleeding	19 (27.5%)	8 (47.1%)	11 (21.2%)	.059
Liver cirrhosis	0 (0%)	0 (0%)	0 (0%)	NA
Congestive heart failure	3 (4.3%)	1 (5.9%)	2 (3.8%)	.999
Ischemic heart disease	4 (5.8%)	0 (0%)	4 (7.7%)	.565
Hypertension	40 (58.0%)	11 (64.7%)	29 (55.8%)	.581
Diabetes mellitus	12 (17.4%)	2 (11.8%)	10 (19.2%)	.716
Dyslipidemia	18 (26.1%)	5 (29.4%)	13 (25.0%)	.756
CKD (eGFR <60 mL/min/1.73 m^2)	4 (5.8%)	1 (5.9%)	3 (5.8%)	.999
Medications				
Antiplatelet drug	12 (17.4%)	4 (23.5%)	8 (15.1%)	.472
Anticoagulant drug	2 (2.9%)	0 (0%)	2 (3.8%)	.999
DOAC	4 (5.8%)	0 (0%)	4 (7.7%)	.565
NSAID	11 (15.9%)	2 (11.8%)	9 (17.3%)	.719
Vital signs on admission				
Systolic blood pressure (mm Hg)	137 (120–152)	148 (140–160)	132 (112–150)	.013
Heart rate (beats/min)	88 (76–100)	90 (80–107)	87 (73–98)	.361
Shock index >1	4 (5.8%)	0 (0%)	4 (7.7%)	.565
Laboratory data on admission				
Hemoglobin (g/dL)	11.9 (10.4–13.1)	12.6 (10.9–14.1)	11.8 (10.3–12.8)	.069
Platelet count (×10^5/μL)	22.2 (18.1–24.6)	23.4 (20.4–24.6)	22.0 (17.7–24.4)	.486
Blood urea nitrogen (mg/dL)	17.9 (14.1–20.2)	17.9 (13.7–18.6)	18.1 (14.2–20.7)	.488
Creatinine (mg/dL)	0.72 (0.60–0.82)	0.62 (0.52–0.75)	0.73 (0.64–0.82)	.051
PT-INR	1.05 (1.00–1.10)	1.04 (0.98–1.07)	1.05 (1.02–1.12)	.088
Interval between colonoscopy and the last hematochezia episode				
Within 24 h	48 (69.6%)	17 (100%)	31 (59.6%)	.001
Within 12 h	34 (49.3%)	14 (82.4%)	20 (38.5%)	.002
Interval between CT and the last hematochezia episode (min)	217 (125–415)	179 (125–402)	233 (135–417)	.797
Preparation	43 (62.3%)	6 (35.3%)	38 (73.1%)	.008

CKD = chronic kidney disease, CT = computed tomography, DOAC = direct oral anticoagulant, eGFR = estimated glomerular filtration rate, NSAID = non-steroidal anti-inflammatory drug, PT-INR = international normalized ratio of prothrombin time.

extravasation-negative group (52.9% [9/17] vs 7.7% [4/52]; 23.5% [4/17] vs 19.2% [10/52]; and 17.6% [3/17] vs 9.6% [5/52]; respectively) (Table 2). The characteristics of the patients in the CECT group (n=70) and the non-CECT group (n=67) are shown in Table 3. The creatinine levels on admission and the proportion of patients who had CKD were significantly lower in the CECT group than in the non-CECT group (0.72 [IQR: 0.60–0.82] vs 0.77 [IQR: 0.60–0.92], p=.050 and 5.7% [4/70] vs 23.9% [16/67], p=.004), respectively. The time interval from the last episode of hematochezia to clinical examination was relatively lower in the CECT group than in the non-CECT group (125 minutes [IQR: 80–349 minutes] vs 213 [IQR: 102–386 minutes], p=.157).

3.3. Main analysis

The overall rebleeding rate was 30.4% (21/69). The rebleeding rate was higher in the extravasation-positive group than in the extravasation-negative group, but the difference was not statistically significant (47.1% [8/17] vs 25% [13/52], p=.128) (Table 2).

3.4. Sub-analysis

Among the patients who underwent endoscopic hemostasis, the rebleeding rate was significantly higher in the extravasation-

positive group than in the extravasation-negative group (50% [8/16] vs 10.5% [2/19], p=.022) (Table 4, Figures 2 and 3). In the extravasation-positive group, all 8 patients with rebleeding underwent repeat colonoscopy. Among these patients, 5 required the use of additional clips; of these, bleeding was controlled in 3 patients, whereas TAE or surgery was required in 2 patients. The extravasation in 1 patient who underwent TAE could not be detected by IR; thus, he was transferred to another hospital for further treatment. Among the other 3 patients with rebleeding in the extravasation-positive group, none required clipping; thus, the patients' conditions were only observed (Figure 2). The length of hospital stay was significantly longer in the extravasation-positive group than in the extravasation-negative group (8 days [IQR: 5–11 days] vs 5 days [IQR: 4–7 days], p=.023) (Table 4).

4. Discussion

In the present study, we examined the effectiveness of endoscopic hemostasis in preventing diverticular bleeding with extravasation visualized by CECT. This study highlighted 1 important clinical finding. Despite the higher incidence of diverticular bleeding and endoscopic hemostasis in the extravasation-positive patients who underwent endoscopic therapy, the extravasation-positive patients had a significantly higher proportion of acute rebleeding than the extravasation-negative patients. However, bleeding

Table 2

Clinical outcome of treatment for diverticular hemorrhage.

	Overall (n=69)	Extravasation (+) (n=17)	Extravasation (−) (n=52)	*p*-Value
Colonoscopic findings				
Confirmed diverticular bleeding with SRH	35 (50.7%)	16 (94.1%)	19 (36.5%)	<.001
Active bleeding	13 (18.8%)	9 (52.9%)	4 (7.7%)	
Non-bleeding visible vessel	14 (20.3%)	4 (23.5%)	10 (19.2%)	
Adherent clot	7 (10.1%)	3 (17.6%)	5 (9.6%)	
Presumptive diverticular bleeding	34 (49.3%)	1 (5.9%)	33 (63.5%)	
First treatment				<.001
Clipping	34 (49.3%)	16 (94.1%)	18 (34.6%)	
EBL	1 (1.4%)	0 (0%)	1 (1.9%)	
TAE	0 (0%)	0 (0%)	0 (0%)	
Surgery	0 (0%)	0 (0%)	0 (0%)	
Observation	34 (49.3%)	1 (5.9%)	33 (63.5%)	
Rebleeding (after first treatment)				
Within 1 month	21 (30.4%)	8 (47.1%)	13 (25.0%)	.128
During admission	18 (26.1%)	7 (41.2%)	11 (21.2%)	.121
After discharge	3 (4.3%)	1 (5.9%)	2 (3.8%)	.999
Additional treatment				.098
Clipping	9 (13.0%)	4 (23.5%)	5 (9.6%)	
EBL	0 (0%)	0 (0%)	0 (0%)	
TAE	3 (4.3%)	1 (5.9%)	2 (3.8%)	
Surgery	1 (1.4%)	1 (5.9%)	0 (0%)	
Observation	8 (11.6%)	2 (11.8%)	6 (11.5%)	
Blood transfusion				
RBC (units)	0 (0–0)	0 (0–0)	0 (0–0)	.46
FFP (units)	0 (0–0)	0 (0–0)	0 (0–0)	NA
PC (units)	0 (0–0)	0 (0–0)	0 (0–0)	NA
Length of hospital stay (days)	6 (5–8)	7 (5–10)	6 (5–8)	.15
Death	0 (0%)	0 (0%)	0 (0%)	NA
Transfer	1 (1.4%)	1 (5.9%)	0 (0%)	.246

EBL = endoscopic band ligation, FFP = fresh frozen plasma, PC = platelets concentrate, RBC = red blood cell, SRH = stigmata of recent hemorrhage, TAE = transcatheter arterial embolization.

Table 3

Clinical characteristics of the patients in the CECT and non-CECT groups.

	CECT group (n=70)	Non-CECT group (n=67)	*p*-Value
Age (years)	71 (63–80)	74 (67–78)	.409
Sex (male)	38 (54.3%)	40 (59.7%)	.607
Comorbidity			
Diverticular bleeding	19 (27.1%)	19 (28.4%)	.999
Liver cirrhosis	0 (0%)	3 (4.5%)	.120
Congestive heart failure	3 (4.3%)	4 (6.0%)	.718
Ischemic heart disease	4 (5.7%)	6 (9.0%)	.532
Hypertension	39 (55.7%)	40 (59.7%)	.863
Diabetes mellitus	13 (18.6%)	16 (23.9%)	.536
Dyslipidemia	19 (27.1%)	15 (22.4%)	.554
CKD (eGFR <60 mL/min/1.73 m^2)	4 (5.7%)	16 (23.9%)	.004
Medications			
Antiplatelet drug	12 (17.1%)	12 (17.9%)	.999
Anticoagulant drug	2 (2.9%)	2 (3.0%)	.999
DOAC	4 (5.7%)	3 (4.5%)	.999
NSAID	11 (15.7%)	5 (7.5%)	.182
Vital signs on admission			
Systolic blood pressure (mmHg)	137 (118–152)	136 (118–154)	.964
Heart rate (beats/min)	86 (76–100)	86 (74–98)	.770
Shock index >1	4 (5.7%)	5 (7.5%)	.745
Laboratory data on admission			
Hemoglobin (g/dL)	12.1 (10.6–13.2)	11.6 (10.1–13.3)	.395
Platelet count (×10^5/μL)	21.7 (18.1–24.6)	22.6 (19.6–26.8)	.324
Blood urea nitrogen (mg/dL)	17.5 (14.0–20.1)	16.8 (12.2–22.5)	.812
Creatinine (mg/dL)	0.72 (0.60–0.82)	0.77 (0.60–0.92)	.050
PT-INR	1.04 (1.00–1.09)	1.05 (1.01–1.11)	.669
Interval between clinical examination and the last hematochezia episode (min)	125 (80–349)	213 (102–386)	.157

CECT = contrast-enhanced computed tomography, CKD = chronic kidney disease, CT = computed tomography, DOAC = direct oral anticoagulant, eGFR = estimated glomerular filtration rate, NSAID = non-steroidal anti-inflammatory drug, PT-INR = international normalized ratio of prothrombin time.

Table 4

Rebleeding rate and length of hospital stay in patients who received colonoscopy as the first treatment.

	Overall (n=35)	Extravasation (+) (n=16)	Extravasation (−) (n=19)	p-Value
Rebleeding (after the first endoscopic treatment)				
Within 1 month	10 (28.6%)	8 (50.0%)	2 (10.5%)	.022
During admission	9 (25.7%)	7 (43.8%)	2 (10.5%)	.05
After discharge	1 (2.9%)	1 (6.2%)	0 (0%)	.457
Rebleeding (after the additional endoscopic treatment)	3 (8.5%)	2 (12.5%)	1 (5.3%)	.582
Length of hospital stay (days)	6 (5–10)	8 (5–11)	5 (4–7)	.023

could be controlled in more than half of these patients, even without performing TAE and surgery.

Several reports on the effectiveness of CECT[7–9] showed that the endoscopic detection rate of the bleeding point from the diverticula increases from 60% to 78% in patients with extravasation (compared to 18.4% to 31% in patients without extravasation) detected by CECT, and the concordance rate of CT and colonoscopic findings was 95.7%.[8] In 1 prospective observational study, colonoscopy had a sensitivity of 57.6% and a specificity of 91.2% in predicting the presence of diverticula with SRH in the extravasation-positive patients.[9] SRH is an important finding for treating diverticular bleeding. Another prospective observational study has shown that the patients with SRH managed medically without endoscopic hemostasis had a clinically significantly high rebleeding rate of 52.4%, a high amount of RBC transfusions, and a high intervention rate (eg, endoscopic hemostasis, TAE, or surgery) for the control of further bleeding.[5] A Doppler endoscopic probe could detect arterial blood flow in 92% of SRH cases, whereas the cases of

diverticular bleeding without SRH did not show any blood flow; patients with SRH who received Doppler-guided endoscopic hemostasis for the obliteration of arterial blood flow did not experience rebleeding.[5]

Compared to the previous studies, our study showed a higher specificity of 97.1% and a higher positive predictive value of 94.1% (sensitivity of 45.7%, the negative predictive value of 63.5%) for identifying the bleeding site of the diverticula with SRH. It is crucial to obliterate the underlying arterial blood flow under the SRH to control the bleeding; thus, even if rebleeding occurred, interfering with the blood supply under the SRH is important. Furthermore, the present study showed that the SRH cases identified owing to the presence of extravasation detected by CECT had a high rebleeding rate after endoscopic hemostasis. In our 3 rebleeding cases with SRH, hemostasis was achieved when using additional clips, apart from the regular number of clips.

Owing to the relatively high rebleeding rate after endoscopic hemostasis, we could consider TAE as second-line therapy for
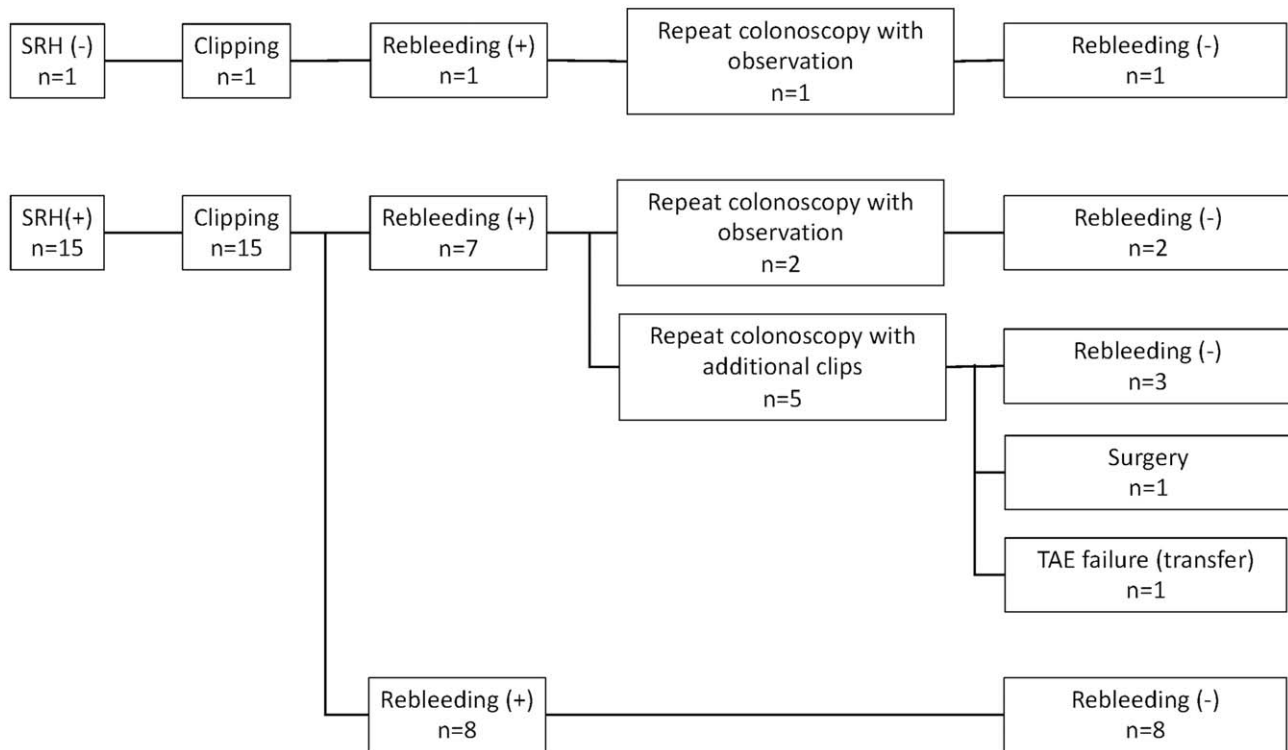

Figure 2. Major clinical outcomes of patients with extravasation who underwent endoscopic hemostasis. SRH = stigmata of recent hemorrhage, TAE = transcatheter arterial embolization.
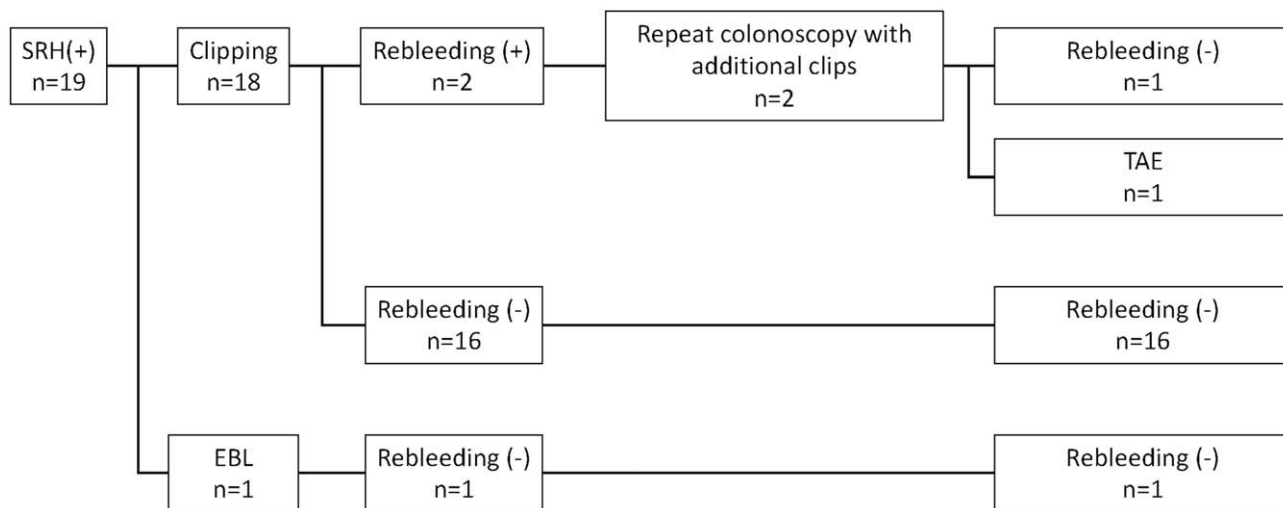
Figure 3. Major clinical outcomes of patients without extravasation who underwent endoscopic hemostasis. EBL = endoscopic band ligation, SRH = stigmata of recent hemorrhage, TAE = transcatheter arterial embolization.

extravasation-positive patients with diverticular bleeding. Patients who have multiple high-risk clinical features, hemodynamic instability, signs and symptoms of ongoing bleeding, or serious comorbid diseases were recommended to undergo TAE or surgery, according to the guidelines.[2,11,18,19] The effectiveness of TAE could be limited, as it requires active bleeding at the time of angiography for diagnosis and treatment. The bleeding rate of at least 0.5 to 1.0 ml/min is needed for IR to detect extravasation,[20] and, in 1 observation study, angiography showed extravasation in approximately 85% of hemodynamically unstable patients with a systolic blood pressure of <90 mm Hg, who required at least 5 units of RBCs transfused within a 24-hour period.[21] Moreover, patients undergoing TAE are at risk for developing serious major complications (eg, bowel infarction) requiring surgery or resulting in death. In a review of 20 studies involving 338 patients, super-selective embolization for lower intestinal bleeding had a minor complication rate of 26% (eg contrast allergies, nephrotoxicity, hematomas, thromboses, and vascular dissections) and a major complication rate of 17%.[22] On the other hand, the complications related to surgical hemostasis are reported in as many as 60% of patients[23]; thus, surgical hemostasis should only be indicated for hemodynamically unstable patients with active bleeding. In our study, given that only 5.8% of the patients (4/69) were hemodynamically unstable (shock index >1), the proportion of patients managed with colonoscopy alone in the extravasation-positive group was relatively high (88.2% [15/17]), and colonoscopic complications did not occur; therefore, endoscopic hemostasis may be the preferred and effective first-line therapy for patients with diverticular bleeding who have extravasation visualized by CECT.

It is difficult to identify the patients who require CECT. Although the guidelines have recommended CECT in patients with a shock index >1,[19] there are few studies on the shock index as a predictor of content extravasation of contrast on CECT. A prospective multicenter study reported the following: The mean interval from the last hematochezia episode to CT examination was shorter in the extravasation-positive group than in extravasation-negative group (186±138 minutes vs 287±218

minutes, p=.01), The extravasation-positive rate in the 0 to 240 minutes group was higher than that in the >240 minutes group (32.3% [41/127] vs 12% [9/72]; p<.01), and The SBP and shock index were not correlated with extravasation.[9] In our study, 4 patients were in shock (shock index >1); however, they all belonged to the extravasation-negative group. Colonoscopy revealed no active bleeding (a non-bleeding visible vessel and an adherent clot were noted in 1 patient each, while the other 2 patients did not show any SRH). The shock index might not necessarily predict extravasation on CECT and active bleeding during colonoscopy, because diverticular bleeding could only be temporary and self-limiting, irrespective of whether it is active or not.[4]

There are several limitations in the present study. First, the data of patients who underwent endoscopic hemostasis could not be compared to those of patients without endoscopic hemostasis. Almost all cases of diverticular bleeding with extravasation detected by CECT were treated with endoscopic hemostasis within 24 hours, because the extravasation detected by CECT is thought to be active; thus we attempted to immediately control the diverticular bleeding by performing some interventions (colonoscopy, TAE, or surgery), per our institutional protocol. Second, the severity of the diverticular bleeding included in this study might be relatively mild (shock patients [shock index >1] only accounted for 5.8% of all patients). Thus, it is unclear whether endoscopic hemostasis is a proper method for patients with more severe shock who had extravasation detected by CECT. Third, this is a single-center, retrospective, observational study with a small sample size, which might introduce a selection bias. The inclusion of patients in this study was limited by our treatment protocol, for example, CECT was performed at the discretion of the physicians or endoscopists; they tended to conduct CECT in patients who did not suffer from renal failure and had a relatively short time interval between the last hematochezia episode and clinical examination. Further studies are needed to validate the effectiveness of endoscopic hemostasis.

In conclusion, patients with diverticular bleeding who had extravasation detected by CECT showed a high incidence of SRH during colonoscopy, which led to a high incidence of rebleeding.

To obliterate the feeding artery, endoscopic hemostasis was a useful method, even if rebleeding occurs.

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