Should Emergency Endoscopy be Performed in All Patients With Suspected Colonic Diverticular Hemorrhage?

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ABSTRACT

OBJECTIVE: We attempted to develop a scoring system for facilitating decision making regarding the performance of emergency endoscopy in patients with colonic diverticular hemorrhage.

METHODS: This study involved analysis of the data of 178 patients who presented with hematochezia and were diagnosed as having colonic diverticular hemorrhage by colonoscopy. The patients were divided into 2 groups depending on whether the bleeding source was identified or not at the initial endoscopy (source-identified and source-not-identified groups), and on the basis of the results obtained, we established a scoring system for predicting successful identification of the bleeding source.

RESULTS: The percentages of patients on oral anticoagulant therapy or with a Charlson comorbidity index of ≥6, serum C-reactive protein level of ≥1 mg/dL, or extravasation of contrast medium visualized on contrast-enhanced computed tomographic (CT) images were all significantly higher in the identified than in the nonidentified group. Multivariate analysis identified extravasation of contrast medium on contrast-enhanced CT images (odds ratio [OR]: 10.6; 95% confidence interval [CI]: 2.7-42.2) and use of anticoagulants (OR: 4.5; 95% CI: 1.5-13.5) as independent predictors of successful identification of the bleeding source at the initial endoscopy in patients with colonic diverticular hemorrhage. On the basis of these results, we established a scoring system, which showed a sensitivity of 80% and specificity of 81% for successful identification of the bleeding source at the initial endoscopy.

CONCLUSIONS: Herein, we propose a scoring system as a useful tool for determining whether emergency endoscopy is indicated in individual patients with suspected colonic diverticular hemorrhage.

KEYWORDS: Colonic diverticular hemorrhage, colonoscopy, bleeding source, scoring system

Introduction

Colonic diverticulosis has been historically considered as a common disease in Europe and the United States, and its prevalence has recently been increasing in other regions of the world as well, reportedly as a result of changes in the dietary habits, including reduced consumption of dietary fiber.[1] In Japan, consumption of dietary fiber is decreasing[2]; therefore, the incidence of colonic diverticulosis is expected to continue to increase. Colonic diverticular hemorrhage is considered as the cause of bleeding in approximately 40% of patients presenting with hematochezia and is the most common underlying disorder among patients presenting with lower gastrointestinal bleeding.[3,4] With the aging of society and increase in the number of patients receiving oral antithrombotic drug treatment, the incidence of colonic diverticular hemorrhage is only expected to increase in the future.[5]

Emergency endoscopy is considered to be useful in patients presenting with lower gastrointestinal bleeding, to avoid surgery and prevent rebleeding.[6,7] However, this procedure often fails to identify the source of bleeding. In daily clinical practice, with various constraints, such as the small number of medical staff available during nights and holidays, it is important to determine whether emergency endoscopy will be definitively beneficial in a patient presenting with lower gastrointestinal hemorrhage.

Our hospital, which provides a 24-hour on-call emergency endoscopy service, receives not only patients transported by ambulance from home but also many patients transferred from other hospitals. Although our principle is to perform emergency endoscopy as soon as possible, the timing of the procedure is left to the discretion of the physician on duty. At present, the timing is empirically determined on the basis of the vital signs, comorbidities, and medication history of the patients. Moreover, because emergency endoscopy is frequently performed at night, it poses a burden on the medical professionals.

In this study, we analyzed the data of patients with colonic diverticular hemorrhage divided into 2 groups: those in whom

the bleeding source was identified at the initial endoscopy and those in whom the bleeding source was not identified at the initial endoscopy. On the basis of the results of this analysis, we developed a scoring system aimed at allowing selection of patients with a high probability of the bleeding source being identified at the initial endoscopy, in other words, identifying those who would benefit from emergency endoscopy. Thus, this study was conducted to develop a more efficient endoscopy protocol.

Patents and Methods

Study population

This study included patients who underwent colonoscopy for hematochezia at our hospital during the 5-year period from January 2010 to December 2014. The inclusion criteria were as follows: (1) patients aged 20 years or older, (2) patients presenting to the hospital within 1 week of the occurrence of hematochezia, (3) patients without a history of treatment of hematochezia within 1 month prior to their presentation to our hospital, (4) patients diagnosed as having colonic diverticular hemorrhage by detailed examinations, and (5) patients admitted to our hospital. The exclusion criterion was patients with bleeding not caused by colonic diverticulosis. Finally, the data of 178 patients meeting these criteria (143 men and 35 women with a mean age of 63±13 years) were analyzed in this study.

From the medical records of the patients, the following data were collected: age, sex, anamnesis, daily oral medications, physical findings at presentation, the Charlson comorbidity index,[8,9] and laboratory test findings (eg, blood tests, endoscopy, and computed tomography [CT]). The patients were divided into 2 groups according to whether or not bleeding source was identified at the time of the initial endoscopy (identified group and nonidentified group), and the clinical and laboratory findings of the 2 groups were retrospectively compared and analyzed. Then, on the basis of the results obtained from this analysis, we identified factors that would be useful for predicting the probability of identification of bleeding source at the initial endoscopy and established a scoring system by assigning the factors numeric scores.

Diagnosis of hemorrhagic colonic diverticulosis

The bleeding source in patients presenting with colonic diverticular hemorrhage is considered to be identified when colonoscopy reveals active bleeding from the diverticula or confirms the presence of clots or exposed blood vessels in the diverticula.[6,10] In addition, the diagnosis of colonic diverticular hemorrhage is considered to be confirmed when colonoscopy reveals no bleeding source other than diverticular bleeding and there are no findings suggestive of hemorrhagic lesions in the upper gastrointestinal tract or small intestine.[6,10] Colonoscopy was performed by a 2-physician team composed of a certified endoscopist and a gastroenterology resident. We usually used a single-channel endoscope with a water-jet system, CF-Q260J or PCF-260J (Olympus, Tokyo, Japan) and an attachment hood (Olympus).

Ethical considerations

This study was conducted with the approval of the Etiological Study Ethical Review Board of Saitama Medical Center, Jichi Medical University. Informed consent from the study subjects was not needed because we obtained and used anonymized data.

Statistical analysis

Data are expressed as mean ± SD or percentages. Statistical analyses were performed using the Student t test and Fisher exact test. The location of the bleeding source was compared by the χ^2 test. Factors identified as significant, with P values of less than .15, by univariate analysis were entered into a multivariate logistic regression analysis model using backward stepwise selection. We conducted receiver operating characteristic curve analysis to determine the appropriate cutoff values of the factors for predicting successful identification of the bleeding source at the initial endoscopy in patients with colonic diverticular hemorrhage. All the statistical analyses were performed using EZR (Saitama Medical Center, Jichi Medical University), which is a graphic user interface for R (The R Foundation for Statistical Computing, version 2.13.0).[11] Differences at P values of less than .05 were regarded as being significant.

Results

Comparisons between the identified group and nonidentified group

The bleeding source was identified by endoscopy in 47 of the 178 patients (26.4%). The bleeding source in the identified group was located in the cecum in 4 patients (9%), ascending colon in 30 patients (64%), transverse colon in 3 patients (6%), descending colon in 1 patient (2%), and sigmoid colon in 9 patients (19%). Endoscopic treatment was performed in 42 of the 47 cases of the identified group. Endoscopic clip placement was performed in 41 cases and endoscopic band ligation in 1 case; in the remaining 5 cases, the endoscopists lost sight of the bleeding source during the procedure or judged that endoscopic treatment would be difficult or unnecessary due to the location of the lesion and the natural healing process.

Although no significant differences between the 2 groups were observed in the male-to-female ratio, age at onset, body mass index, smoking and drinking history, etc, the comorbidity index in the identified group (5.4 ± 2.5) was significantly higher than that in the nonidentified group (4.5 ± 2.2) (*P* = .0220). However, there were no significant differences in the prevalences of ischemic heart disease, cerebrovascular disease, hypertension, diabetes mellitus, and renal failure, which comprise the conditions included in the calculation of the comorbidity index.

Although there was no significant difference in the rate of use of antiplatelet drugs between the 2 groups, the proportion of patients receiving warfarin and other anticoagulants was 17% in the identified group and only 5% in the nonidentified group (*P* = .0271). Regarding the physical findings at presentation, no significant difference in the systolic/diastolic blood pressure or pulse rate was observed between the 2 groups. No significant differences in any of the blood test results at presentation were observed between the 2 groups. Contrast-enhanced CT was performed in 47 patients (26%) overall, including 21% of patients of the identified group and 29% of patients of the nonidentified group; the difference in the rate of performance of contrast-enhanced CT between the 2 groups was not statistically significant. However, the percentage of patients in whom extravasation of contrast medium was identified on the contrast-enhanced CT images was 80% in the identified group, significantly higher than the percentage of 8% in the nonidentified group (*P* = .0012). There was no significant difference in the rate of use of oral laxatives before the endoscopy, the interval from onset to endoscopy or the interval from presentation to endoscopy between the 2 groups. The percentages of patients who underwent surgery and those who required blood transfusion were significantly higher in the identified group (*P* = .0083 and *P* = .0150, respectively) as compared with the corresponding percentages in the nonidentified group (Table 1).

Setting cutoff values

Receiver operating characteristic curve analysis was performed to determine the optimal cutoff values of all the parameters for predicting successful identification of the bleeding source (Figure 1). Significant cutoff values were obtained for the comorbidity index, serum C-reactive protein (CRP) level, and interval from presentation to the performance of emergency endoscopy. The cutoff value for the comorbidity index was set at 6, with the percentage of patients with a comorbidity index of ≥6 being 51% in the identified group, significantly higher than the percentage of 33% in the nonidentified group (*P* = .0350). The cutoff value for the serum CRP level was set at 1.0 mg/dL, with the percentage of patients with a serum CRP level of ≥1.0 mg/dL being 34% in the identified group, significantly higher than the percentage of 19% in the nonidentified group (*P* = .0444). The cutoff value for the interval from presentation to the performance of emergency endoscopy was set at 5 hours, with the percentage of patients with an interval of 5 hours or less being 64% in the identified group, significantly higher than the percentage of 41% in the nonidentified group (*P* = .0104).

Establishment of a scoring system for predicting successful identification of the bleeding source at the initial endoscopy in patients with colonic diverticular hemorrhage

Univariate analysis identified the following 4 parameters as significant predictors of successful identification of the bleeding source at the initial endoscopy: visualization of extravasation of contrast medium on contrast-enhanced CT images, use of anticoagulants, comorbidity index of ≥6, and a serum CRP level of ≥1 mg/dL. The odds ratio (OR) was 9.8 (95% confidence interval [CI]: 2.2-34.6) for visualization of extravasation of the contrast medium on contrast-enhanced CT images, 3.6 (95% CI: 1.2-10.7) for use of anticoagulants, 2.1 (95% CI: 1.1-4.2) for a comorbidity index of ≥6, and 2.2 (95% CI: 1.0-4.6) for a serum CRP level of ≥1 mg/dL. Multivariate analysis identified only 2 parameters, namely, extravasation of contrast medium visualized on contrast-enhanced CT images and use of oral anticoagulants, as significant predictors; the ORs for these 2 factors were 10.4 (95% CI: 2.6-41.6) and 4.5 (95% CI: 1.5-13.2), respectively (Table 2).

On the basis of these ORs, we attempted to develop a scoring system using approximations with simple numerical values. We assigned numerical scores as follows: visualization of extravasation of contrast medium on contrast-enhanced CT images was assigned a score of 3, use of oral anticoagulants was assigned a score of 2, and a comorbidity index of ≥6 and serum CRP level of ≥1 mg/dL were each assigned a score of 1. We applied this scoring system to the 47 patients who underwent contrast-enhanced CT in this study (Table 3); use of a cutoff score of 3 allowed successful identification of the bleeding source at the initial endoscopy to be predicted at a sensitivity of 80% and specificity of 81% (Figure 1).

Discussion

Although a number of studies have been reported on the clinical course of patients with colonic diverticular hemorrhage,[12,13] most have focused mainly on the risk factors for colonic diverticular hemorrhage requiring blood transfusion, risk factors for rebleeding, and other factors affecting the clinical course. There have been no clinical studies focusing on the identification of the bleeding source in colonic diverticular hemorrhage at the initial endoscopy. The reported success rates in identifying the bleeding source by emergency endoscopy in patients with colonic diverticular hemorrhage from studies including at least 100 patients range widely from 10% to 42%; differences in the capacity of medical facilities to provide care could also be one of the reasons for this wide variation.[14–19] Because emergency care of patients with lower gastrointestinal bleeding is affected by the condition of the medical institutions and expertise level of the endoscopists, it is currently difficult to establish uniform health care standards.

Identification of the bleeding source in patients with colonic diverticular hemorrhage is affected by various factors, which can broadly be divided into treatment-related and patient-related factors. The treatment-related factors that contribute to identification of the bleeding source include the proficiency level of the examiners, timing of performance of the emergency endoscopy, use/nonuse of a lens hood attachment on the scope, and use/nonuse of an endoscope with a water-jet system.[14]

Table 1. Patient characteristics of 178 hemorrhagic diverticulosis cases.

	IDENTIFIED (N=47)	NOT IDENTIFIED (N=131)	P VALUE
Baseline characteristics			
Male/female	39/8	104/27	.6733
Age, y	70±13	69±13	.5529
BMI	24.5±3.4	24.0±3.2	.3705
Smoking	26 (58%)	83 (64%)	.3836
Brinksman index	446±589	513±566	.4996
Drinking	16 (35%)	52 (41%)	.5935
Comorbidity index	5.4±2.5	4.5±2.2	**.0220**
Past history			
Hemorrhagic diverticulosis	19 (40%)	47 (36%)	.6008
Hemodialysis	2 (4%)	12 (9%)	.3604
Lifestyle-related disease: HT, DM, DL	30 (64%)	83 (63%)	1.0000
Cerebrovascular disease	5 (11%)	15 (11%)	1.0000
Coronary heart disease	16 (34%)	30 (23%)	.1734
Regular medication			
Antiplatelet agent	18 (38%)	42 (32%)	.4743
Anticoagulant agent	8 (17%)	7 (5%)	**.0271**
NSAIDs	22 (47%)	51 (39%)	.3892
Physical finding			
Systolic BP, mmHg	131±26	132±25	.3631
Diastolic BP, mmHg	75±18	77±19	.5990
Heart rate, bpm	82±20	84±17	.5960
Laboratory finding			
White cell count, /μL	8022±2496	7883±4098	.8264
Hemoglobin, g/dL	11.3±2.4	11±2.7	.4872
Platelet count, ×10⁴/μL	21.5±6.7	23.3±6.9	.1271
C-reactive protein, mg/dL	1.4±2.9	0.7±2.7	.1799
Albumin, g/dL	3.8±0.5	3.8±0.5	.7856
Creatine, mg/dL	1.2±1.1	1.4±2.0	.4435
Examination			
Contrasting CT	10 (21%)	38 (29%)	.4416
Extravasation image	8 (80%)	3 (8%)	**.0012**
Time from onset to CS, h	28.8±41.3	32.6±18.6	.5797
Time from consultation to CS, h	8.3±13.1	12.5±15.5	.0968
Oral bowel preparation performed	21 (45%)	63 (48%)	.8657
Endoscopic treatment			
Endoscopic clip placement	41 (87%)		
Endoscopic band ligation	1 (2%)		
No treatment	5 (11%)		
Additional treatment			
Operation	7 (15%)	4 (3%)	**.0083**
Angiography	2 (4%)	0	.0686
Blood transfusion	26 (55%)	45 (34%)	**.0150**
Amount of blood transfusion, unit	3.6±4.7	2.3±4.3	.0731

Abbreviations: BMI, body mass index; BP, blood pressure; CT, computer tomography; DL, dyslipidemia; DM, diabetes mellitus; HT, hypertension; NSAIDs, nonsteroidal anti-inflammatory drug.
The significance of bold values indicates $P < 0.05$.

In this study, the likelihood of identification of the bleeding source at the initial endoscopy was mainly influenced by patient-related factors, such as the clinical findings at the initial presentation, comorbidities, and concomitant medication use. Then, on the basis of the results of the univariate and multivariate analyses, we assigned a score of 3 for visualization of extravasation of the contrast medium on contrast-enhanced CT images, a score of 2 for anticoagulant use, and a score of 1 each for a comorbidity index of ≥6 and serum CRP level of ≥1 mg/dL. Using a cutoff score of 3, we succeeded in developing a reliable scoring system for predicting successful identification of the bleeding source at the initial endoscopy in patients with colonic diverticular hemorrhage.

In patients with extravasation of the contrast medium visualized on contrast-enhanced CT images, the reported probability of identification of the bleeding source at the initial endoscopy is high,[20,21] and such patients also showed the highest score on our scoring system in this study. Extravasation of the contrast medium visualized on contrast-enhanced CT images suggests active bleeding, which seems to allow
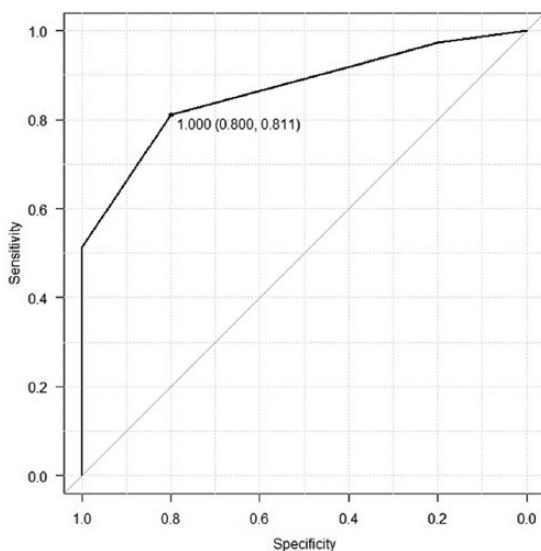

Figure 1. Receiver operating characteristic curve for the scoring system discriminating successful identification of the bleeding source from the unsuccess.

reduction in the observation range at the initial endoscopy and successful identification of the bleeding source. In patients not allergic to contrast media and those without renal dysfunction, contrast-enhanced CT has the merit of allowing safe and rapid clarification of disorders causing hematochezia. In patients with suspected lower gastrointestinal bleeding, an aggressive attempt to perform contrast-enhanced CT seems desirable. Endoscopy has the dual roles of diagnosis and treatment. Therefore, it is recommended as the initial assessment tool in patients with suspected lower gastrointestinal bleeding. Computed tomography does not have a role in treatment but is effective for detecting the cause of lower gastrointestinal bleeding.[20,21] Endoscopists are not available at all hours in the hospital, especially at night or on holidays. Therefore, if performance of emergency endoscopy was restricted to only those patients with lower gastrointestinal bleeding in whom the bleeding source can be expected to be identified, it will reduce the burden on both the patients and the medical staff. Contrast-enhanced CT can also provide information about other abdominal organs and abnormalities. In patients with unstable vital signs, endoscopy should be performed only after stabilization of the hemodynamics. If this is not achieved, interventional radiologic procedures or surgery may need to be considered.[22] Computed tomographic angiography is considered as a reasonable first-line screening test before angiography or emergency surgery.[23] For these reasons, in patients with suspected lower gastrointestinal bleeding, it appears desirable to aggressively pursue contrast-enhanced CT. Performing CT may increase the cost, but it would lessen the chances of unsuccessful emergency endoscopy and also reduce the burden on the patient, besides providing valuable information about the status of the abdomen. Therefore, we strongly believe that the cost-benefit ration for CT is favorable for both the patient and the hospital.

In this study, while anticoagulant use was shown to be significantly associated with an increased probability of identification of the bleeding source, no such association was found with the use of antiplatelet drugs. Warfarin may promote gastrointestinal bleeding[24] and increase the need for blood transfusion in patients presenting with colonic diverticular hemorrhage.[25] Antiplatelet drug use is a known risk factor for

Table 2. Predictive factor to identify the bleeding spot.

	UNIVARIATE ANALYSIS		MULTIVARIATE ANALYSIS	
	OR (95% CI)	*P* VALUE	OR (95% CI)	*P* VALUE
Extravasation image in contrasting CT	9.8 (2.2–34.6)	.0012	10.4 (2.6–41.6)	.0009
Using anticoagulant agents	3.6 (1.2–10.7)	.0271	4.5 (1.5–13.2)	.0071
Comorbidity index ≥6	2.1 (1.1–4.2)	.0350		
CRP ≥1 mg/dL	2.2 (1.0–4.6)	.0444		

Abbreviations: CI, confidence interval; CRP, C-reactive protein; CT, computed tomography; OR, odds ratio.

Table 3. Applying the scoring system to 47 cases that performed contrasting computed tomography in this study.

POINT	IDENTIFIED (N=10)	NOT IDENTIFIED (N=37)
0	0	19
1	2	11
2	0	0
3	4	4
4	2	2
5	2	1

Figure 2. Proposed clinical procedure for patients suspected of colonic diverticular hemorrhage. CRP indicates C-reactive protein; CT, computed tomography.

bleeding from colonic diverticula.[24,25] It has been reported that spontaneous hemostasis occurs in 70% to 80% of cases of colonic diverticular hemorrhage, and that rebleeding occurs in 22% to 38% of patients.[10,26,27] Use of antithrombotic drugs is also a risk factor for colonic diverticular hemorrhage. Presumably, spontaneous hemostasis and rebleeding are more unlikely to occur in patients taking anticoagulants as compared with that in patients taking antiplatelet drugs.

The prevalence of colonic diverticulosis is high in the elderly. The reported prevalence is 50% to 66% in subjects aged 80 years or older, as compared with less than 10% in those aged less than 40 years.[28–30] In this study, elderly patients aged 65 years or older accounted for 68.5% of all the patients, and those aged 80 years or older accounted for 23.6%. Because the elderly show a higher prevalence of comorbidities than younger people, the comorbidity index was assessed in this study; this index is widely used to predict the survival rates at 10 years and calculated by assigning numerical values to patient characteristics such as the age and presence/absence of particular comorbidities.[8,9] Although diverticular hemorrhage is likely to become severe in patients with a comorbidity index of ≥2,[31] univariate analysis performed in this study identified a comorbidity index of ≥6 as a significant predictor of successful identification of the bleeding source at the initial endoscopy.

The timing of emergency endoscopy in patients with lower gastrointestinal bleeding is considered to be extremely important because it greatly affects the likelihood of identification of the bleeding source.[20] An improved prognosis is reported in patients in whom emergency colonoscopy is performed within 12 hours of admission.[6,32,33] In this study, the rate of successful identification of the bleeding source was higher in patients undergoing colonoscopy within 5 hours of presentation than in those undergoing the procedure ≥5 hours after presentation. It seems desirable to perform emergency endoscopy as soon as practical after the probability of identifying bleeding source is assessed using the scoring system developed in this study.

The limitations of this study included the retrospective single-center study design and the small number of patients (approximately 30%) in whom contrast-enhanced CT was performed. Moreover, a selection bias occurred in the performance of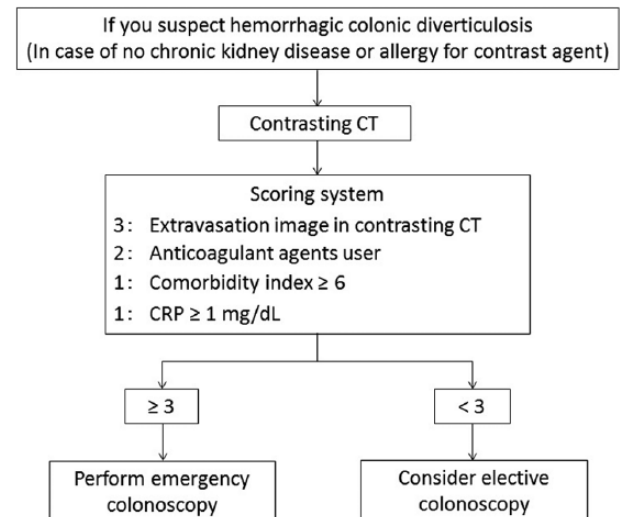 the contrast-enhanced CT because the decision to perform this imaging was left to the discretion of the attending physician at the initial visit, and it was not performed in patients with renal dysfunction.

Conclusions

On the basis of the analyses performed in this study, we developed a scoring system, in which visualization of extravasation of the contrast medium on contrast-enhanced CT images was assigned a score of 3, anticoagulant use was assigned a score of 2, and a comorbidity index of ≥6 and serum CRP level of ≥1 mg/dL assigned were a score of 1 each. In patients presenting with hematochezia, contrast-enhanced CT is performed first, if possible. Then, this scoring system is applied to those with suspected colonic diverticular hemorrhage. Although emergency endoscopy as soon as practical is recommended in patients with a total score of ≥3, we suggest that elective endoscopy be considered, if their condition permits, in patients with a score of <3 (Figure 2). This scoring system is expected to be useful for determining whether emergency endoscopy should be performed or not in individual patients with suspected colonic diverticular hemorrhage. Further accumulation of cases is necessary, and a prospective validation study is needed.

Author Contributions

SM is equally contributed author. Conceived and designed the experiments: SM. Performed the experiments: TU and SM. Analyzed the data: SM. Contributed reagents/materials/analysis tools: SM. Wrote the paper: TU and SM. Approved the final manuscript: TU, SM, HM and HM.

REFERENCES

1. Stollman N, Raskin JB. Diverticular disease of the colon. *Lancet*. 2004;363:631–639.
2. Nakaji S, Sugawara K, Saito D, et al. Trends in dietary fiber intake in Japan over the last century. *Eur Nutr*. 2002;41:222–227.

3. Longstreth GF. Epidemiology and outcome of patients hospitalized with acute lower gastrointestinal hemorrhage: a population-based study. *Am J Gastroenterol*. 1997;92:419–424.

4. Peura DA, Lanza FL, Gostout CJ, et al. The American College of Gastroenterology Bleeding Registry: preliminary findings. *Am J Gastroenterol*. 1997;92:924–928.

5. Bloomfeld RS, Rockey DC, Shetzline MA. Endoscopic therapy of acute diverticular hemorrhage. *Am J Gastroenterol*. 2001;96:2367–2372.

6. Jensen DM, Machicado GA, Jutabha R, et al. Urgent colonoscopy for the diagnosis and treatment of severe diverticular hemorrhage. *N Engl J Med*. 2000;342:78–82.

7. Pilichos C, Bobotis E. Role of endoscopy in the management of acute diverticular bleeding. *World J Gastroenterol*. 2008;14:1981–1983.

8. Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40:373–383.

9. Charlson M, Szatrowski TP, Peterson J, et al. Validation of a combined comorbidity index. *J Clin Epidemiol*. 1994;47:1245–1251.

10. Zuckerman GR, Prakash C. Acute lower intestinal bleeding. Part II: etiology, therapy, and outcomes. *Gastrointest Endosc*. 1999;49:228–238.

11. Kanda Y. Investigation of the freely available easy-to-use software "EZR" for medical statistics. *Bone Marrow Transplant*. 2013;48:452–458.

12. Nagata N, Niikura R, Aoki T, et al. Risk factors for adverse in-hospital outcomes in acute colonic diverticular hemorrhage. *World J Gastroenterol*. 2015;21:10697–10703.

13. Watanabe S, Kodera S, Shimura H. Investigation of risk factors predicting recurrence of colonic diverticular hemorrhage and development of a recurrence risk score. *Acta Gastroenterol Belg*. 2014;77:408–412.

14. Niikura R, Nagata N, Aoki T, et al. Predictors for identification of stigmata of recent hemorrhage on colonic diverticula in lower gastrointestinal bleeding. *J Clin Gastroenterol*. 2015;49:e24–e30.

15. Green BT, Rockey DC, Portwood G, et al. Urgent colonoscopy for evaluation and management of acute lower gastrointestinal hemorrhage: a randomized controlled trial. *Am J Gastroenterol*. 2005;100:2395–2402.

16. Tanaka Y, Motomura Y, Akahoshi K, et al. Predictive factors for colonic diverticular rebleeding: a retrospective analysis of the clinical and colonoscopic features of 111 patients. *Gut Liver*. 2012;6:334–338.

17. Suzuki K, Uchiyama S, Imajyo K, et al. Risk factors for colonic diverticular hemorrhage: Japanese multicenter study. *Digestion*. 2012;85:261–265.

18. Yamada A, Sugimoto T, Kondo S, et al. Assessment of the risk factors for colonic diverticular hemorrhage. *Dis Colon Rectum*. 2008;51:116–120.

19. Jansen A, Harenberg S, Grenda U, et al. Risk factors for colonic diverticular bleeding: a Westernized community based hospital study. *World J Gastroenterol*. 2009;15:457–461.

20. Nagata N, Niikura R, Aoki T, et al. Role of urgent contrast-enhanced multidetector computed tomography for acute lower gastrointestinal bleeding in patients undergoing early colonoscopy. *J Gastroenterol*. 2015;50:1162–1172.

21. Nakatsu S, Yasuda H, Maehata T, et al. Urgent computed tomography for determining the optimal timing of colonoscopy in patients with acute lower gastrointestinal bleeding. *Intern Med*. 2015;54:553–558.

22. Strate LL, Syngal S. Predictors of utilization of early colonoscopy vs. radiography for severe lower intestinal bleeding. *Gastrointest Endosc*. 2005;61:46–52.

23. Strate LL, Gralnek IM. ACG clinical guideline: management of patients with acute lower gastrointestinal bleeding. *Am J Gastroenterol*. 2016;111:459–474.

24. Sugihara Y, Kudo SE, Miyachi H, et al. Analysis of risk factors for colonic diverticular bleeding: a matched case-control study. *Gut Liver*. 2015;10:244–249.

25. Nagata N, Sakamoto K, Arai T, et al. Visceral fat accumulation affects risk of colonic diverticular hemorrhage. *Int J Colorectal Dis*. 2015;30:1399–1406.

26. McGuire HH Jr, Haynes BW Jr. Massive hemorrhage for diverticulosis of the colon: guidelines for therapy based on bleeding patterns observed in fifty cases. *Ann Surg*. 1972;175:847–855.

27. McGuire HH Jr. Bleeding colonic diverticula. A reappraisal of natural history and management. *Ann Surg*. 1994;220:653–656.

28. Painter NS, Burkitt DP. Diverticular disease of the colon: a deficiency disease of Western civilization. *Br Med J*. 1971;2:450–454.

29. Painter NS, Burkitt DP. Diverticular disease of the colon, a 20th century problem. *Clin Gastroenterol*. 1975;4:3–21.

30. Parks TG. Natural history of diverticular disease of the colon. *Clin Gastroenterol*. 1975;4:53–69.

31. Strate LL, Orav EJ, Syngal S. Early predictors of severity in acute lower intestinal tract bleeding. *Arch Intern Med*. 2003;163:838–843.

32. Richter JM, Christensen MR, Kaplan LM, et al. Effectiveness of current technology in the diagnosis and management of lower gastrointestinal hemorrhage. *Gastrointest Endosc*. 1995;41:93–98.

33. Jensen DM, Machicado GA. Colonoscopy for diagnosis and treatment of severe lower gastrointestinal bleeding. Routine outcomes and cost analysis. *Gastrointest Endosc Clin N Am*. 1997;7:477–498.