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ENDOSCOPY

Effectiveness of risk scoring systems in predicting endoscopic treatment in colonic diverticular bleeding

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Key words
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Abstract

Background and Aims: The identification of stigmata of recent hemorrhage (SRH) in colonic diverticular bleeding (CDB) enables an endoscopic treatment and can improve the clinical outcome. However, SRH identification rate remains low. This study aims to investigate whether NOBLADS and Strate scoring systems are useful for predicting SRH identification rate of CDB pre-procedurally via colonoscopy.

Methods: In this single-center retrospective observational study, 302 patients who experienced their first episode of CDB from April 2008 to March 2018 were included. Patients were classified into SRH-positive and SRH-negative groups. The primary outcome was SRH identification rate. The secondary outcomes were active bleeding in SRH and early rebleeding rates. The usefulness of the NOBLADS and Strate scores as predicted values of SRH identification was evaluated using the area under the receiver operating characteristic curve.

Results: There were 126 and 176 patients in the SRH-positive and SRH-negative groups, respectively. The area under the receiver operating characteristic curve for SRH identification using the NOBLADS score was 0.74 (95% confidence interval, 0.69–0.80) and that using the Strate score was 0.74 (95% confidence interval, 0.68–0.79). Active bleeding and early rebleeding rates increased according to each score. By setting the cut-off of the NOBLADS score to four points, treatment was possible in 70.2% (66/94) patients. Addition of extravasation at computed tomography to a NOBLADS score of ≧ 4 points allowed treatment of all patients (24/24).

Conclusions: Severity scoring in acute lower gastrointestinal bleeding was effective for predicting SRH identification in CDB. We suggest that combination of these scorings and CT findings could offer a new therapeutic strategy.

Introduction

Colonic diverticular bleeding (CDB) is the most common cause of acute lower gastrointestinal bleeding (ALGIB) in adults and accounts for about 50% of all cases of ALGIB.[1–4] Although 75% of CDB cases stop spontaneously, CDB sometimes causes severe bleeding and requires intervention to control the bleeding.[5,6] Even if hemostasis is achieved, rebleeding occurs in 14–38% of cases.[2,5]

Either endoscopic treatment or interventional radiology is performed for CDB. Stigmata of recent hemorrhage (SRH), such as active bleeding (AB), non-bleeding visible vessels, and adherent clot, was proposed as an indication for endoscopic treatment.[7] CDB with SRH, especially AB, has been associated with a high rate of rebleeding following conservative management.[7,8] The identification of SRH in CDB enables endoscopic treatment and can improve the clinical outcome.[7]

Current consensus guidelines from the American Society for Gastrointestinal Endoscopy recommend early endoscopic evaluation for severe ALGIB within the first 24 h of admission.[9] It was reported that early colonoscopy in cases of ALGIB significantly reduced hospital stay, total hospitalization cost, rebleeding rate, blood transfusion requirement, and length of ICU stay.[10–12]

Reliable endoscopic procedures are required to achieve hemostasis and prevent recurrent bleeding. However, because of the large and complex surface area of the colon and the multitude of diverticula present, the identification rate of SRH by colonoscopy is still low.[7,13,14] At present, it is unclear whether SRH can be identified pre-procedurally via colonoscopy.

For upper gastrointestinal bleeding (UGIB), severity scores, such as the Glasgow Blatchford score and the Rockall score, are useful for predicting whether endoscopic treatment is appropriate.[15,16] Comparisons of each score have been performed and their usefulness has also been reported.[17] As a scoring system for prediction of severe ALGIB, Aoki *et al*. in 2016 reported the NOBLADS score, with Strate *et al*. reporting their scoring system

in 2005 (Table 1).[18,19] The NOBLADS and the Strate scores are scoring systems evaluating the risk of severe ALGIB. However, these scores include all causes of ALGIB (such as malignant tumor, ischemic colitis, and hemorrhoids), which do not require endoscopic treatment. In this study, we investigated whether the SRH identification rate in CDB could be predicted pre-procedurally via colonoscopy using the NOBLADS and Strate scores.

Methods

This retrospective study was undertaken at St. Luke's International Hospital. The predetermined primary outcome was the SRH identification rate by endoscopy for CDB using the NOBLADS and Strate scores. Secondary outcomes were AB rate in SRH and early rebleeding (within 30 days after initial treatment)[5] rate.

The study included 814 patients who experienced their first episode of ALGIB and underwent colonoscopy between April 2008 and March 2018. We excluded 512 patients who were hospitalized, were inadequately scored, or had an obvious cause of hematochezia other than CDB (malignant tumor, ischemic colitis, infectious colitis, inflammatory bowel disease, rectal ulcer, bleeding after polypectomy, or angioectasia) on clinical assessment, imaging, and endoscopy. NOBLADS and Strate scores were determined retrospectively for patients who met the earlier conditions during the study period.

Data were also collected regarding patients' characteristics, comorbidity, extravasation (the presence of extravasated contrast material with an attenuation level $>$ 90 Hounsfield units on computed tomography [CT] and types of SRH). After screenings, 302 patients met all criteria for CDB.

Definite CDB cases (SRH identified by colonoscopy) were classified as the SRH-positive group, and endoscopic clipping (EC) or endoscopic band ligation (EBL) was applied to the diverticulum as treatment. Presumptive CDB cases (ALGIB in the presence of a diverticulum but without any other major colonic lesions or evidence of SRH) were classified as the SRH-negative group.

The study protocol was approved by the institutional review board (18-R063) at St. Luke's International Hospital, and patient consent was waived owing to the study's retrospective design.

Table 1 NOBLADS score and Strate score

NOBLADS score (all factors are 1 point)	
No abdominal pain	No diarrhea (< 3 times)
NSAIDs	Systolic blood pressure ≦ 100 mmHg
Albumin < 3 g/dL	Antiplatelet agents (nonaspirin)
Charlson comorbidity index ≧ 2	Syncope
Strate score (all factors are 1 point)	
Heart rate ≧ 100/min	Systolic blood pressure ≦ 115 mmHg
Syncope	No abdominal pain
Aspirin	Charlson comorbidity index ≧ 3
Hemorrhage more than 4 h	

NSAIDs, non-steroidal anti-inflammatory drugs.

Management of acute lower gastrointestinal bleeding. Patients with ALGIB underwent contrast-enhanced CT whenever possible after medical examination and preliminary investigations.

Patients considered as having CDB underwent colonoscopy for diagnosis and treatment within 24 h of admission, with bowel preparation using polyethylene glycol. Hemodynamically unstable patients underwent colonoscopy without bowel preparation. Colonoscopy was performed with a water-jet scope (PCF-Q260AZI, PCF-Q260JI, or PCF-H290I; Olympus Medical Systems, Tokyo, Japan). A soft hood (D201-12704; Olympus Medical Systems) was attached to the endoscope. Colonoscopy was performed by expert endoscopists (board-certified members of the Japanese Society of Gastroenterology, having experience with $>$ 1000 routine colonoscopies) or by nonexpert endoscopists under expert supervision.

The most commonly performed endoscopic treatment for CDB was EC, between April 2008 and May 2009, and EBL, performed between April 2009 and March 2018. Hemoclips (HX-600-090L, HX-600-135, HX-610-090L, or HX-610-135; Olympus Optical CO. Ltd, Tokyo, Japan) were used for EC. EBL was performed using a band-ligator device (MD-48710 EVL Device, Sumitomo Bakelite Co. Ltd, Tokyo, Japan).

Statistical analysis

Risk factor evaluation. We compared patients' characteristics between the SRH-positive and SRH-negative groups using bivariate analyses, a χ^2 test for categorical variables, and a *t*-test for continuous variables. We performed multivariable logistic regression, controlling for potential covariates, defined as clinically important variables or those with a *P*-value $<$ 0.05 on bivariate analyses. All analyses were performed in 2019, using SPSS (ver. 24.0, IBM, Japan).

Adaptation of NOBLADS and Strate scoring. We calculated the NOBLADS and Strate scores for each patient to assess whether these could predict SRH identification in patients with CDB. Sensitivity and specificity were calculated based on the scores, and receiver operating characteristic curves were drawn. The area under the curves (AUCs) with 95% confidence interval (CI) were also calculated to examine validity of cut-off scores.

Results

The data from 302 patients were included in our analysis, 126 cases (41.7%) in the SRH-positive group and 176 (58.3%) in the SRH-negative group. Patients' characteristics, endoscopic findings, and mean scores are reported in Table 2. The median age of patients was 67.4 (95% CI, 40.2–94.6) years, and 231 (76.4%) were men. The distribution of SRH types was as follows: AB 44/126 (34.9%); non-bleeding visible vessels 41/126 (32.5%); and adherent clot 41/126 (32.5%). Ninety-six (76.2%) of the detected sites of bleeding in the SRH-positive group were on the right side of the colon. Severe LGIB (transfusion of ≧ 2 units of packed red blood cells, a decrease in hematocrit of ≧ 20%, and/or recurrent bleeding after initial colonoscopy) occurred in 113 patients (37.4%).

Table 2 Patient characteristics, comorbidities, types of SRH, and outcome (n = 302)

Characteristics	Data
Median age (95% CI)	67.4 (40.2–94.6)
Male	231 (76.5%)
Vital sign	
Median heart rate (95% CI)	87.5 (53.1–121.8)
Median systolic blood pressure (95% CI)	127.9 (76.4–179.4)
Median Charlson comorbidity index (95% CI)	1.34 (0–4.27)
Median albumin (95% CI)	3.75 (2.92–4.58)
Comorbidity	
Hypertension	185 (61.3%)
Hyperlipidemia	96 (31.8%)
Diabetes mellitus	64 (21.2%)
Chronic kidney disease	34 (11.3%)
Syncope	52 (19.2%)
Extravasation	58 (22.5%)
Contrast-enhanced CT	256 (84.8%)
Plain CT	25 (8.3%)
No CT	21 (7.0%)
Definitive CDB	126 (41.7%)
Located right side of the colon	96 (76.2%)
Stigmata of recent hemorrhage	
Non-bleeding visible vessels	41 (32.5%)
Active bleeding	41 (32.5%)
Adherent clot	44 (34.9%)
Presumptive CDB	176 (68.3%)
Severe ALGIB	113 (37.4%)
Mean NOBLADS score (95% CI)	3.03 (0.86–5.20)
Mean Strate score (95% CI)	2.94 (0.77–5.12)

ALGIB, acute lower gastrointestinal bleeding; CDB, colonic diverticular bleeding; CI, confidence interval; CT, computed tomography; SRH, stigmata of recent hemorrhage.

In the 281 patients who underwent CT, 256 (84.8%) underwent contrast-enhanced CT and 25 (8.3%) underwent plain CT. The mean NOBLADS and Strate scores were 3.03 (95% CI, 0.86–5.20) and 2.94 (95% CI, 0.77–5.12), respectively. On univariate analysis, significant differences between the two groups were identified for the following variables (Table 3): systolic blood pressure $<$ 100 mmHg; heart rate $>$ 100 beats/min; no diarrhea; no abdominal pain; syncope; use of non-steroidal anti-inflammatory drugs; disease score $\geqq$ 3; on dialysis; and albumin level $<$ 3 g/dL. On multivariate analysis, only non-steroidal anti-inflammatory drugs use was retained a significant factor (Table 4).

The AUC using the NOBLADS score for SRH identification was 0.74 (95% CI, 0.69–0.80) and 0.74 (95% CI, 0.68–0.79) for the Strate score. Both NOBLADS and Strate scores had similar discriminative abilities for predicting SRH identification, and both showed moderate accuracy (Fig. 1). A threshold NOBLADS score of 4 or more was best at predicting endoscopic treatment, with a sensitivity of 53.97% and specificity of 83.52%.

By setting the cut-off of the NOBLADS score to 4 points, treatment was possible in 70.2% (66/94) of patients. AB and early rebleeding rates also increased according to the score (Fig. 2).

We classified the rate of SRH identification with and without extravasation (Figure S1). When the score was limited to 3 or less, there was no significant difference between the presence and absence of extravasation (35.3% *vs* 26.9%). However, addition of the presence of extravasation on CT to a NOBLADS score of 4 or more allowed treatment of all patients (24/24).

Discussion

Our study results showed that severity scoring alone in ALGIB effectively predicted SRH identification. However, prediction could be improved by including extravasation seen on CT.

The previous studies reported an SRH identification rate of 23–43%,[7,11,20–22] which was consistent with our SRH identification rate being 41.7%. SRH identification was improved (i) by colonoscopy performed within 24 h, (ii) by expert endoscopists who have performed $>$ 1000 colonoscopies, (iii) with the use of disposable distal attachments and water-jet systems, and (iv) bowel preparation using oral lavage solution.[7,14] High SRH identification rates of approximately 40% have been reported in studies that have included CT before colonoscopy.[21,22] The earlier conditions were met in our study and, thus, the SRH identification rate was comparatively high.

In recent years, several scoring systems have been proposed as methods of predicting the severity and mortality of ALGIB.[9,10] These methods are scored regardless of the underlying pathology and it is unclear whether they are accurate as CDB is the commonest cause of severe hemorrhage in ALGIB.

The AUC of the Glasgow Blatchford score for prediction of endoscopic treatment for UGIB was 0.75.[17] Our results (AUCs: NOBLADS, 0.74; Strate, 0.74) showed that the usefulness of the NOBLADS and Strate scoring systems for predicting endoscopic treatment for ALGIB was equal to that of the Glasgow Blatchford score for predicting UGIB. Using a cut-off NOBLADS score of 4 points, the SRH identification rate increased to 70.1% (68/97). In their description of the NOBLADS score, Aoki *et al.*[18] suggested that a NOBLADS score of 4 or higher was useful for predicting treatment, with our study results confirm this.

Active bleeding and the rate of early rebleeding also increased according to each score; thus, it is appropriate to perform urgent colonoscopy to implement hemostasis and to prevent rebleeding in cases with a high score. However, because SRH identification, AB, and the rate of early rebleeding are all low, patients with low scores may be assigned to conservative treatment and elective colonoscopy for diagnosis.

The usefulness of contrast-enhanced CT in SRH identification has been shown in the previous reports,[21,22] and in cases of extravasation observed at CT, sensitivity and specificity for SRH identification were 57.6 (95% CI, 44.8–69.7) and 91.2 (95% CI, 85.1–95.4), respectively.[23] However, contrast-enhanced CT in cases of ALGIB is currently not routinely performed, except in some high-volume centers. In our hospital, CT is performed in most cases, and we assessed whether extravasation on CT added value to the scoring systems used (Figure S1). In our study, SRH identification was possible in 62.1% of patients with extravasation and in 36.9% of patients without extravasation, which is similar to the results of the previous reports.[21] When the NOBLADS score and extravasation at CT were combined, scores of 3 points or less did not add value. However, adding extravasation at CT to a score of 4 points or more allowed SRH identification in all appropriate patients. A similar trend was observed for the Strate score. Although patients with a high score should undergo contrast-

Table 3 Univariate analysis comparing risk factors between SRH-positive and SRH-negative groups

	SRH-positive group (n = 126) (%)	SRH-negative group (n = 176) (%)	P-value*
Male	102 (81)	129 (73)	0.122
Systolic blood pressure < 100 mmHg	25 (20)	16 (9)	0.017
Heart rate > 100/min	39 (30)	36 (20)	0.037
No diarrhea	126 (100)	168(95)	0.015
No abdominal pain	126 (100)	165 (94)	0.004
Syncope	35 (28)	17 (10)	0.001
NSAIDs	19 (15)	13 (7)	0.032
Antiplatelet (nonaspirin) agents	19 (15)	14 (8)	0.05
Low-dose aspirin	32 (25)	46 (26)	0.885
Anticoagulants	12 (10)	16 (9)	0.89
Charlson comorbidity index ≧ 3	34 (27)	27 (15)	0.013
Dialysis	5 (4)	1 (1)	0.037
Albumin < 3 g/dL	13 (10)	5 (3)	0.007

*P-value was characterized by χ^2 test and statistical significance was defined as $P < 0.05$.
NSAIDs, non-steroidal anti-inflammatory drugs; SRH, stigmata of recent hemorrhage.

Table 4 Multivariate analysis comparing risk factors between SRH-positive and SRH-negative groups

	Adjusted OR (95% CI)	P-value*
SBP < 100 mmHg	1.23 (0.84–1.80)	0.292
HR > 100/min	1.58 (0.88–2.83)	0.126
No diarrhea	1	No available
No abdominal pain	1	No available
Syncope	1	No available
NSAIDs	2.50 (1.08–5.80)	0.032
Charlson comorbidity index ≧ 3	1.87 (0.96–3.65)	0.065
Dialysis	4.00 (0.40–40.0)	0.238
Albumin < 3 g/dL	2.11 (0.64–7.03)	0.222

*P-value was characterized by likelihood ratio test and statistical significance was defined as $P < 0.05$.
NSAIDs, non-steroidal anti-inflammatory drugs; SRH, stigmata of recent hemorrhage.

enhanced CT in order to identify extravasation, the results of this study suggest that contrast-enhanced CT might not be necessary in patients with a low score.

Colonoscopy is a necessary tool for the diagnosis in CDB, and all patients should be considered for colonoscopy if possible. However, in this study, SRH identification for hemostasis, AB, and rebleeding rates were low in patients with low scores. In hospitals where emergency CT or colonoscopy cannot be performed easily, we recommend that patients with CDB be assigned to management according to their scores. Conservative treatment and elective colonoscopy for diagnosis is an acceptable management strategy for patients with a score of 3 points or less, whereas patients with a score of 4 points or more should undergo CT followed by colonoscopy for the purpose of hemostasis.

The limitations of our study should be acknowledged. First, this was a retrospective observational study from a single center. Due to a lack of clinical information, such as findings on rectal examination, a validated and reliable scoring system such as the Oakland score could not be used.[24] Second, CDB causes hematochezia without abdominal pain or diarrhea and is relatively easy to distinguish clinically and on simple tests. However, bleeding in presumptive CDB cases might not be due to colonic diverticula. Third, our study had many CDB cases of the right side of the colon, where bleeding is apt to be severe. Fourth, routine CT may be an unusual practice in many hospitals. Lastly, it has been reported in the previous studies that colonoscopy preceded by CT offers a high SRH identification rate[21,22]; therefore, because almost all patients underwent CT in our study, information bias cannot be denied.

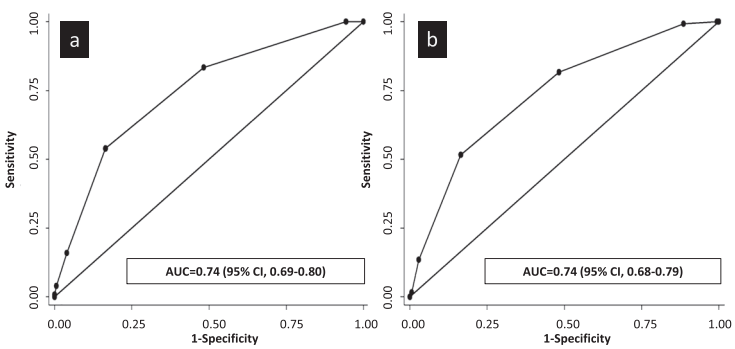

Figure 1 Receiver operating characteristic curves and the AUC using each scores for stigmata of recent hemorrhage identification (n = 302). (a) NOBLADS score and (b) Strate score. AUC, area under the receiver operating characteristic curve.

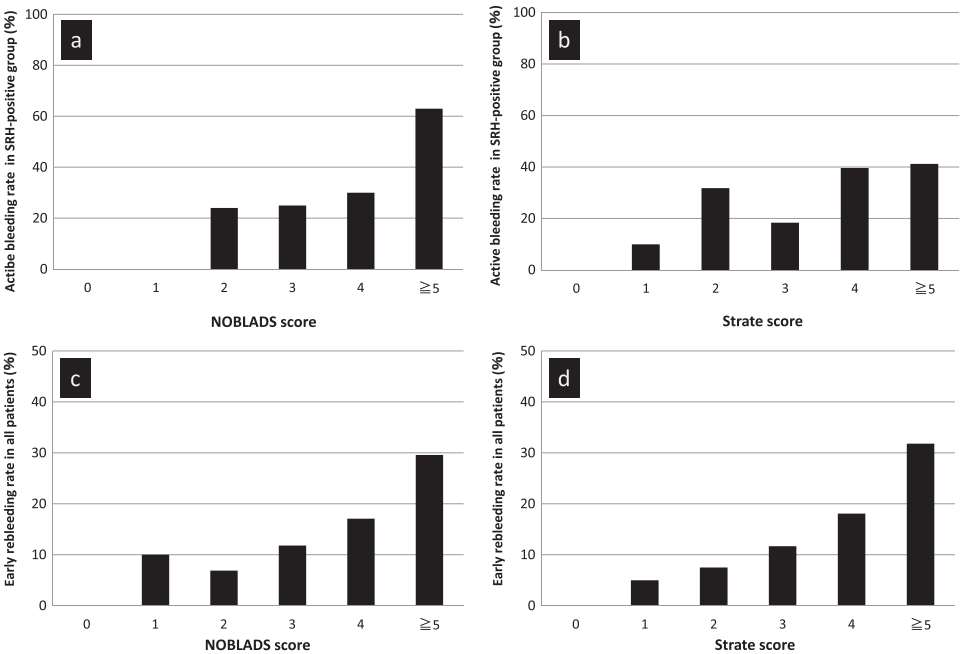

Figure 2 Analysis of secondary outcomes based on scores. (a, b) Proportion of patients defined as having active bleeding in the SRH-positive group. (c, d) Proportion of patients with early rebleeding. SRH, stigmata of recent hemorrhage.

In conclusion, the severity prediction score in ALGIB was useful in predicting SRH identification for CDB. Indications for contrast-enhanced CT together with colonoscopy may be considered according to these scorings and further prospective studies could confirm this therapeutic strategy for CDB.

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Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Figure S1. SRH identification rate using combination of each score and extravasation at CT. P value was calculated by Fisher's exact test.
a) NOBLADS score, b) Strate score.