RESEARCH ARTICLE

Capsule endoscopy in hemodialysis versus non-hemodialysis patients with suspected small bowel bleeding: a prospective cross-sectional study

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Abstract

Background: Gastrointestinal (GI) bleeding is common among hemodialysis (HD) patients. Endoscopic examination of the upper and lower GI tract often fails to identify hemorrhagic lesions in anemic HD patients. The study aims to evaluate lesions of the small bowel mucosa in HD vs non-HD patients with suspected small-bowel bleeding (SSBB) using capsule endoscopy (CE) after negative upper and lower GI endoscopies.

Methods: This prospective cross-sectional study included all consecutive patients presenting with occult GI bleeding at the Dialysis Unit (HD patients) and the Gastroenterology Outpatient Clinic (non-HD patients) of the University Hospital of Alexandroupolis. Within a pre-specified period of 13 months (01/07/2022 to 31/07/2023), we collected all relevant demographic data, laboratory parameters, comorbidity records, treatment profiles, and endoscopic findings. We used univariate and optimal scaling multivariate analyses to evaluate all parameters correlating with CE findings and Rhemitt score.

Results: The study included 100 patients (25 HD and 75 non-HD). Considering any lesion (oozing blood, red spots, angiodysplasias, and erosive/ulcerative lesions) at any site (duodenum, jejunum, and ileum) as separate binary variables, the prevalence per patient was superior in HD patients (3.8 ± 1.6 vs 1.3 ± 1.4; p <0.001). More specifically, endoscopic capsule findings in HD vs non-HD patients identified oozing blood (28 % vs 15 %; p =0.133), red spots (96 % vs 44 %; p <0.001), angiodysplasias (32 % vs 9 %; p =0.006), and erosive/ulcerative lesions (64 % vs 24 %; p <0.001). In 25 non-HD patients, no findings were observed (p =0.001). The number of total endoscopic findings was independently correlated with dialysis (p <0.001), male sex (p =0.048), dyslipidemia (p =0.004), liver disease (p =0.001), and mean corpuscular volume (MCV) (p =0.015). Lastly, we found that HD patients rebleed more often (Rhemitt score 6.5 ± 1.4 vs 2.9 ± 2.1; p <0.001). The Rhemitt score was independently correlated with dialysis (p <0.001), body mass index (p =0.024), MCV (p <0.001), smoking (p <0.001), dyslipidemia (p =0.007), GI bleeding (p <0.001), Calcium channel blockers (p =0.023), and preparation (p =0.001).

Conclusion: Compared with non-HD patients, HD patients who were investigated for potential GI bleeding demonstrated more severe and frequent small intestinal lesions with a higher probability of rebleeding. HIPPOKRATIA 2024, 28 (1):22-28.

Keywords: Hemodialysis, capsule endoscopy, small intestine, anemia, occult gastrointestinal bleeding, Rhemitt score, Greece

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Introduction

Hemodialysis (HD) patients often present complications related to end-stage renal disease (ESRD). Although the primary cause of anemia in HD patients is the diminished ability of the kidneys to produce erythropoietin, anemia can also be caused by occult gastrointestinal (GI) bleeding[1]. Moreover, uremia itself increases the risk of bleeding[2]. Consequently, it is challenging to distinguish renal anemia from anemia due to occult GI blood loss. Even when clinical or laboratory examinations indicate GI blood loss, the absence of hemorrhagic lesions in the stomach, duodenum, or large intestine is frequent. As recent European Society of Gastrointestinal Endoscopy (ESGE) and American College of Gastroenterology (ACG) guidelines suggest, suspected small-bowel bleeding (SSBB) was defined as recurrent or persistent gastrointestinal bleeding after negative upper and lower GI endoscopy[3,4]. Numerous studies have demonstrated that

obscure GI bleeding occurs more frequently in HD patients[5,6], contributing to a significant proportion of annual deaths among these patients[7]. Thus, examining the small intestine should be an integral part of GI investigation for SSBB.

Capsule endoscopy (CE) is a reliable technique for non-invasively evaluating small bowel diseases. In patients with SSBB, careful patient selection and the short time between CE and the most recent bleeding event may increase the diagnostic yield of CE. Several studies have identified non-steroidal anti-inflammatory medications and novel oral anticoagulants (NOACs) as contributing factors[8-10]. A history of overt bleeding, the use of antithrombotic medications, inpatient status, male sex, advanced age, and hepatic and renal comorbidities are additional factors linked to a higher yield[3]. According to recent ESGE guidelines, physicians should consider CE as a first-line procedure for small bowel evaluation after excluding upper and lower GI bleeding sources[3].

Moreover, small intestinal bleeding has an additional negative impact on the low quality of HD patient's life, along with a significant economic burden on healthcare resources as these patients frequently require several hospitalizations, diagnostic tests, and blood transfusions. Thus, the rebleeding rate should also be a concern apart from the primary diagnosis. De Sousa Magalhães et al reported the use of the Rhemitt score to predict the risk of small bowel rebleeding after CE, taking into account parameters like renal or heart failure, major bleeding, endoscopic findings, smoking, and endoscopic intervention, thereby helping physicians assess these patients by focusing on those at higher risk of rebleeding and requiring more regular monitoring[11,12]. In this study, we evaluated small intestinal mucosal lesions in HD *vs* non-HD patients with SSBB using CE and assessed the risk of rebleeding using the Rhemitt score.

Materials and Methods

Study population and data collection

This prospective cross-sectional study included all HD patients from the Dialysis Unit and non-HD patients with normal renal function from the Gastroenterology Outpatient Clinic of the University General Hospital of Alexandroupolis (Alexandroupolis, Greece) with SSBB. The study protocol was reviewed and approved by the Institutional Review Board and the Science and Research Office of the University Hospital of Alexandroupolis (Scientific Council decision No 21, protocol/date 06-03/11/2022). Patients with potential GI bleeding had been initially investigated with upper and lower GI endoscopy and subsequently underwent CE within a period of three months during their regular visits to the unit. Before study enrollment, all participants or their legal guardians provided informed written consent. Within a pre-specified period of 13 months (01/07/2022 to 31/07/2023), we recorded all relevant demographic data, blood laboratory tests, comorbidities, history of GI bleeding, and medication. One hundred patients fulfilled the inclusion criteria, were divided into two groups, and underwent CE. Group I consisted of 25 patients on HD for more than six months. They were undergoing regular blood transfusions and iron administration in terms of everyday clinical practice. Group II comprised 75 non-HD patients with normal renal function, defined as creatinine clearance (glomerular filtration rate) of >60 mL/min/1.73m^2. Blood transfusion and/or iron administration were needed in some patients. None of them had critical anemia or underwent any small bowel intervention.

CE procedure

All CE procedures were performed using the MiroCam® Capsule Endoscope System (Intromedic, Seoul, Republic of Korea) between July 2022 and July 2023 at the University Hospital of Alexandroupolis. Patients' preparation and CE procedure followed the generally recommended guidelines[13] and were according to the capsule constructor guidelines. Adequate bowel preparation before CE improves the diagnostic yield by enhancing the visibility of the small intestine surface[13]. Routine medications were administered as usual, and all patients were instructed to fast at least 12 hours before the examination. Non-HD patients were further instructed to take two L of polyethylene glycol preparation (PEG) eight hours before the procedure.

By contrast, due to fluid intake restriction, HD patients were given either limited preparation with 0.5-1 L of one pouch of PEG (14/25) or nothing (11/25) in a ratio of 1:1. Simethicone (2 mL/80mg) was administered orally at 30 min before the examination, as an anti-foaming agent. The video capsule was swallowed with tap water. The examination's duration was about 12 hours. Drinking water was permitted two hours after the examination onset; four hours later, patients could consume a light meal.

Assessment of CE results

Two gastroenterologists experienced in performing CE reviewed all videos and separately selected images of potential abnormalities. All images were discussed extensively; both reviewers identified findings and only those considered definitive were included in the report. The prevalence of red spots, erosions/ulcers, and vascular lesions was investigated in the HD and control groups and correlated with demographic factors, underlying disease, drug history, and the probability of rebleeding.

Statistical analysis

We utilized the χ^2 test was used for comparisons between expected and observed frequencies, while we alternatively used Fisher's exact test for residuals smaller than five. We used the Student's t-test to compare continuous variables between two groups and Levene's test to compare the variances between groups. We used separate linear logistic regression models for univariate analyses to predict the association between potential independent predictors and scale-dependent variables. All variables that reached statistical significance in the univariate anal-

yses performed using linear regression were incorporated in multivariate models which were subsequently processed using optimal scaling with discretization (seven categories for scale and two for nominal variables), no imputation, random initial configuration, ridge regression, and 10-fold cross-validation. The lowest accepted tolerance after transformation was set to 0.333. We present the values as mean with at least two significant digits ± their standard deviation. We set the level of statistical significance to p =0.05 and performed all statistical analyses using the IBM SPSS Statistics for Windows, Version 26.0 software package (IBM Corp., Armonk, NY, USA).

Results

Overall characteristics of patients

The HD group (Group I) included 25 patients (20 males and five females with a mean age of 64.4 ± 12.5 years), whereas the non-HD group (Group II) included 75 patients (28 males and 47 females, with a mean age of 66.5 ± 10.8 years). The body mass index (BMI) was comparable between the two groups (27.9 ± 4.2 kg/m^2 in Group I and 27.0 ± 4.3 kg/m^2 in Group II). Among the primary diseases of HD patients, hypertension was the most common cause of ESRD (44 %), followed by diabetic nephropathy (20 %). The duration of dialysis ranged from one to 23 (mean 5.52 ± 4.74) years, and the treatment schedule consisted of a four-hour HD session three times a week.

Laboratory tests showed normocytic anemia in HD patients [hematocrit (Ht) 35.2 ± 4.3 % and mean corpuscular volume (MCV) 91.6 ± 5.9 fl) compared with microcytic anemia in non-HD patients (Ht 31.9 ± 3.6 % and MCV 82.2 ± 12 fl); both Ht and MCV demonstrated a statistically significant difference between HD and non-HD patients (p =0.014 and p <0.001, respectively).

History of smoking, diabetes, hypertension, dyslipidemia, stroke, heart failure, coronary artery disease, liver disease, and GI bleeding were evaluated for all patients (Table 1). Heart failure and liver disease were more frequently encountered in Group II (p =0.013 and p =0.023, respectively). Furthermore, patients in Group II received treatment more often with antiplatelets (aspirin or clopidogrel), NOACs (p =0.003), calcium channel blockers (CCBs) (p <0.001), and angiotensin receptor blockers (p =0.012) (Table 1).

CE findings

Considering any lesions (oozing blood, red spots, angiodysplasias, and erosive/ulcerative lesions) at any site (duodenum, jejunum, and ileum) as separate binary variables, the prevalence per patient was superior in HD vs non-HD patients (3.8 ± 1.6 vs 1.3 ± 1.4; p <0.001). Images of endoscopic findings via CE are presented as paradigms in Figure 1. More specifically, endoscopic capsule findings in HD vs non-HD patients identified oozing blood (28 % vs 15 %; p =0.133), red spots (96 % vs 44 %; p <0.001), angiodysplasias (32 % vs 9 %; p =0.006), and erosive/ulcerative lesions (64 % vs 24 %; p

Table 1: Descriptive statistics and comparability of patients and controls groups.

Parameter	Dialysis n =25	Non-dialysis n =75	p-value
Patient characteristics			
Sex as males/females	20 / 5	28 / 47	<0.001
Age	64.4 ± 12.5	66.5 ± 10.8	0.439
Weight	80.7 ± 12.1	80.3 ± 13.6	0.915
Height	170 ± 1	172 ± 1	0.166
BMI	27.9 ± 4.2	27.0 ± 4.3	0.370
Ht	35.2 ± 4.3	31.9 ± 3.6	0.014
MCV	91.6 ± 5.9	82.2 ± 12.0	<0.001
eGFR	4.9 ± 2.4	81.1 ± 16.1	<0.001
Patients history			
Smoking (Yes/Ex-/No)	5 / 14 / 6	25 / 24 / 26	0.099
Hypertension (Yes/No)	22 / 3	56 / 19	0.163
Diabetes (Yes/No)	6 / 19	31 / 44	0.120
Dyslipidemia (Yes/No)	11 / 14	26 / 49	0.403
CAD (Yes/No)	6 / 19	24/ 51	0.450
Stroke (Yes/No)	1 / 24	5 / 70	1.000†
Heart failure (Yes/No)	3 / 22	29 / 46	0.013
Liver disease (Yes/No)	2 / 23	23 / 52	0.023
GI bleeding (Yes/No)	8 / 17	18 / 57	0.430
Treatment			
Clopidogrel as Yes/No	2 / 23	13 / 62	0.258
Acenocoumarol/ NOACs (Yes/No)	1 / 24	26 / 49	0.003
Acenocoumarol (Yes/ No)	1 / 24	5 / 75	1.000†
NOACs (Yes/No)	0 / 25	21 / 54	0.003
Aspirin (Yes/No)	9 / 16	14 / 61	0.075
ACEi (Yes/No)	3 / 22	11 / 64	0.739
ARBs (Yes/No)	4 / 21	33 / 42	0.012
CCBs (Yes/No)	16 / 9	12 / 63	<0.001
β-blockers (Yes/No)	11 / 14	29 / 46	0.637
Preparation			
Preparation (Yes/No)	14 / 11	69 / 6	<0.001
Preparation effectiveness Fair/Good/Excellent	3 / 4 / 18	6 / 25 / 44	0.245
Endoscopic findings at any type/site			
Yes/No	25 / 0	55 / 20	0.004
Total number	3.80 ± 1.63	1.29 ± 1.38	<0.001
Endoscopic findings at number of different sites			
Duodenum	1.04 ± 0.84	0.31 ± 0.61	<0.001
Jejunum	1.44 ± 0.77	0.72 ± 0.86	<0.001
Ileum	1.32 ± 0.69	0.27 ± 0.50	<0.001
Endoscopic findings at number of different types			
Oozing	0.32 ± 0.56	0.15 ± 0.36	0.154
Angiodysplasias	0.36 ± 0.57	0.11 ± 0.35	0.044
Erosions	1.00 ± 0.96	0.24 ± 0.43	0.001
Rebleeding tendency			
Rhemitt score	6.5 ± 1.4	2.9 ± 2.1	<0.001

Fisher's exact test. ACEi: angiotensin-converting-enzyme inhibitor, ARBs: angiotensin receptor blockers, BMI: body mass index, CAD: coronary artery disease, CCBs: Calcium channel blockers, eGFR: estimated glomerular filtration rate, GI: gastrointestinal, Ht: hematocrit, MCV: mean corpuscular volume, NOACs: novel oral anticoagulants.

<0.001). Regarding GI sites, it was found that the duodenum (88 % vs 25 %; p <0.001), jejunum (96 % vs 56 %; p <0.001), and ileum (92 % vs 24 %; p <0.001) had statistically more findings in HD than non-HD patients. At the same time, 25 patients, all of whom belonged to the non-HD group (p =0.001), had no findings.

In total, 14 of the 25 HD patients and 69 of the 75 non-HD patients were administered PEG. After analyzing preparation effectiveness (fair/good/excellent), we found no significant difference between the two groups (3/4/18 vs 6/25/44; p =0.245). We performed univariate analyses to determine the potential correlation between the total number of endoscopic findings and the Rhemitt score with every other parameter assessed (Table 2). Subsequently, we incorporated all parameters that revealed statistically significant results in the univariate process into the multivariate models.

The number of total endoscopic findings was independently correlated with dialysis (p <0.001), male sex (p =0.048), dyslipidemia (p =0.005), liver disease (p =0.001), MCV (p =0.015), In contrast with preparation (p =0.105) (Table 3, Figure 2).

Moreover, the study data showed that HD patients had a higher risk of rebleeding than non-HD patients (Rhemitt score 6.5 ± 1.4 vs 2.9 ± 2.1, respectively; p <0.001). The Rhemitt score was independently correlated with dialysis (p <0.001), BMI (p =0.024), MCV (p <0.001), smoking (p <0.001), dyslipidemia (p =0.007), GI bleeding (p <0.001), CCBs (p =0.023), and preparation (p =0.001) (Table 4, Figure 3).

Discussion

We designed the present study to correlate the morphology of the GI tract in HD patients with SSBB using CE and compare it to patients without renal impairment. The prevalence of lesions per patient in the GI tract was superior in patients undergoing extra-renal dialysis 3.8 ± 1.6 vs 1.3 ± 1.4; p <0.001), with erosions and red spots being the most predominant. This finding may be due to the damage that the uremic environment causes to blood vessels and platelets and the anticoagulant/antiplatelet treatment of these patients. These factors may also contribute to the greater bleeding tendency of hemopurified patients (Rhemitt score 6.5 ± 1.4 vs 2.9 ± 2.1; p <0.001).

Until the last decade, small intestinal pathology in patients with ESRD had been studied in only a limited number of case series[14-18]. Only a few studies are reported in the literature investigating small intestinal mucosal lesions via CE in HD patients. In 2006, Karagiannis et al[14] studied 17 regular patients with CKD, of whom four were on dialysis (six with occult-latent and 11 with overt bleeding), and 51 patients with normal renal function (18 with occult and 33 with overt bleeding). Small intestine lesions were detected in 70.6 % of patients with CKD and 41.2 % of patients without renal disease (p <0.05). Small bowel angiodysplasia was detected in 47 % of patients

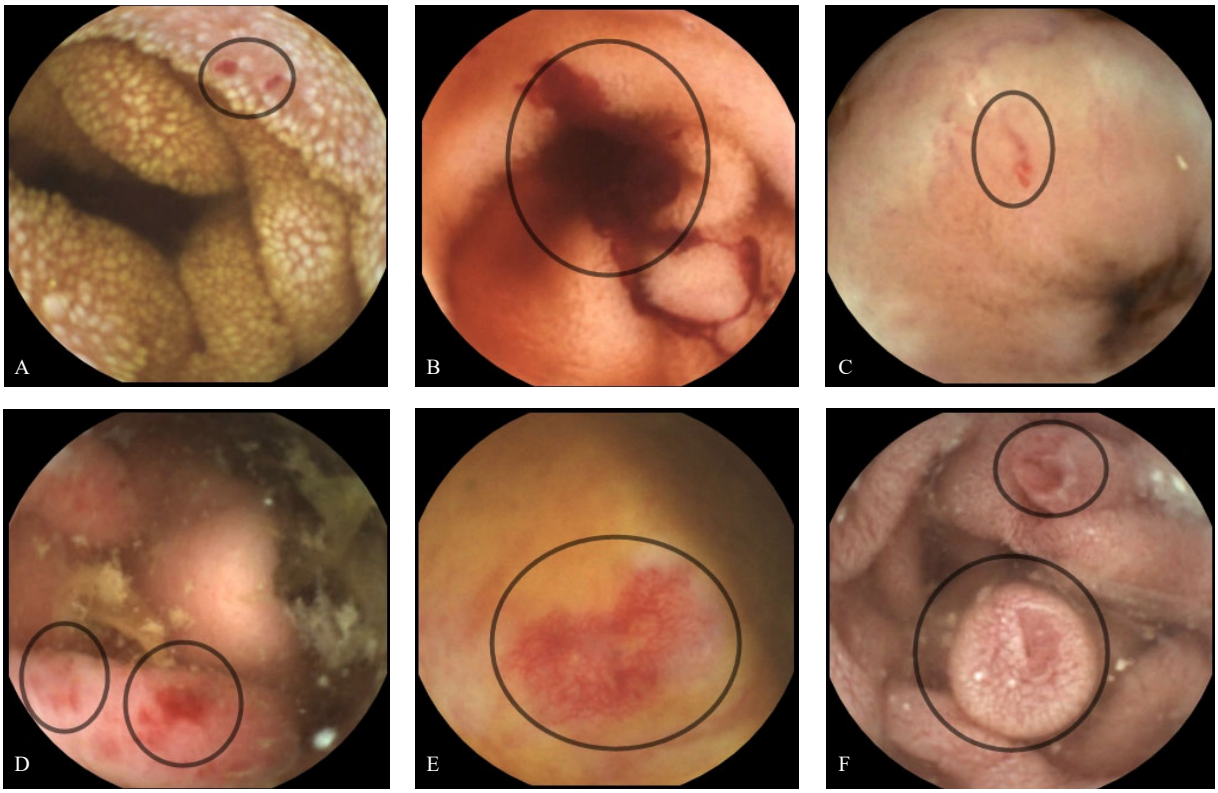

Figure 1: Images of endoscopic findings via capsule endoscopy (the black circle demarcates the area of interest): A) red spots and lymphangiectasia, B) oozing in the jejunum, C) red spot with oozing, D) angiodysplasias in duodenum, E) angiodysplasia, and F) erosions in the duodenum.

Table 2: Univariate analysis incorporating the total number of endoscopic findings and the Rhemitt score as dependent variables.

Parameter	Total number of endoscopic findings p-value	Rhemitt score p-value
Patients		
Dialysis	$<10^{-6}$	3×10^{-12}
Patient characteristics		
Male sex	0.004	0.005
Age	0.172	0.449
BMI	0.727	5×10^{-4}
Ht	0.309	0.195
MCV	0.041	0.007
Patients history		
Smoking	0.449	4×10^{-4}
Hypertension	0.041	0.001
Diabetes	0.652	0.129
Dyslipidemia	0.008	4×10^{-4}
CAD	0.211	0.218
Stroke	0.200	0.403
Heart failure	0.675	0.094
Absence of liver disease	0.007	0.662
GI bleeding	0.892	2×10^{-5}
Treatment		
Clopidogrel	0.622	0.285
Aspirin	0.711	0.130
Acenocoumarol	0.725	0.314
NOACs	0.085	0.156
ACEi	0.332	0.335
ARBs	0.566	0.120
CCBs	0.008	0.026
β-blockers	0.590	0.425
Preparation		
Administered	0.010	5×10^{-4}

ACEi: angiotensin-converting-enzyme inhibitor, ARBs: angiotensin receptor blockers, BMI: body mass index, CAD: coronary artery disease, CCBs: Calcium channel blockers, GI: gastrointestinal, Ht: hematocrit, MCV: Mean corpuscular volume, NOACs: novel oral anticoagulants.

with CKD and 17.6 % of patients without CKD ($p < 0.05$). By contrast, in our study, we included only patients under HD, all of whom presented with SSBB, explaining the lower prevalence of bleeding lesions in our group. In 2012, Ohmori et al[15] published the first cohort study of 90 patients with OGIB, investigating small bowel in HD vs non-HD patients using CE. Specifically, 13 patients had dialysis-related anemia [eight men; mean age 66.5 ± 7.9 years; hemoglobin (Hb) 8.8 ± 1.9 g/dL] and 77 had unrelated anemia with ESRD (47 men; mean age 55.7 ± 19.9 years, Hb 11.9 ± 3.1 g/dL). In HD patients, erosive ulcerative lesions were observed in 30.7 % and vascular lesions in 61.5 %. Per our study, they found that vascular lesions were significantly more common in the dialysis group compared to the control group ($p < 0.001$)[15]. In 2016, Hosoe et al[19] studied the small intestine of 54 HD patients via CE, finding intestinal abnormalities in 64.8 % (vascular lesions in 29 %, mucosal lesions in 60 %, and pathologies in 11 %). Despite the absence of symptoms, the results demonstrated a higher incidence of vascular lesions in this group, with no small bowel-related events recorded during one-year follow-up. These results are in accordance with our findings concerning the lesions, although we also describe a higher rebleeding risk of these lesions. Nakajima et al[20], in a cross-sectional study of HD (n: 16) and non-H (n: 20) patients who underwent CE, showed that erosive and vascular lesions were found more commonly in HD vs non-HD groups (50 % vs 25 %; $p = 0.041$ and 62.5 % vs 25.0 %; $p = 0.188$, respectively). Ozaki et al[21] examined the relationship between small bowel endoscopic findings and anemia. CE was completed in 39 HD patients showing a high risk of small intestinal lesions, although a control group was not described.

Bowel preparation before CE remains a contradictory issue for patients at risk of fluid overload. Recent studies have indicated no significant difference in bowel preparation with laxative use or simple fasting[22,23], while the latest guidelines for small bowel preparation recommend full preparation[13]. Our study showed that classic preparation, restricted preparation or even simple fasting were equally adequate concerning bowel cleanliness in both groups (HD vs non-HD; $p = 0.245$).

Finally, our study is the first to evaluate the risk of rebleeding in HD patients with SSBB. By calculating the Rhemitt score, we found a significantly higher value in HD patients than in non-HD patients (6.5 ± 1.4 vs 2.9 ± 2.1; $p < 0.001$). Monitoring these patients is the cornerstone of proper future diagnosis, and Rhemitt's score may constitute a quick and easy way to characterize all

Table 3: Multivariate model for the total number of endoscopic findings.

Parameter	Standardized beta	Standardized beta error†	F	Tolerance‡	p
Dialysis	0.226	0.030	57.45	0.39	$<10^{-6}$
Male sex	0.074	0.037	4.03	0.74	0.048
Hypertension	0.051	0.032	2.60	0.77	0.110
Dyslipidemia	0.115	0.039	8.87	0.92	0.004
Liver disease	0.109	0.031	12.37	0.86	0.001
MCV	0.079	0.032	6.12	0.71	0.015
CCBs	0.065	0.035	3.37	0.66	0.070
Preparation	0.058	0.035	2.68	0.70	0.105

†: after 1000× bootstrapping, ‡: after transformation, $R^2 = 0.513$, analysis of variance $p = 4 \times 10^{-9}$. CCBs: Calcium channel blockers, MCV: mean corpuscular volume.

Table 4: Multivariate model for Rhemitt score.

Parameter	Standardized Beta	Standardized Beta error†	F	Tolerance‡	*P*
Dialysis	0.246	0.025	97.64	0.37	$<10^{-12}$
Male sex	0.066	0.034	3.89	0.77	0.052
BMI	0.084	0.037	5.25	0.78	0.024
MCV	0.118	0.027	18.92	0.69	4×10^{-5}
Smoking	0.142	0.032	20.18	0.74	2×10^{-5}
Dyslipidemia	0.108	0.039	7.70	0.90	0.007
GI bleeding	0.153	0.035	19.23	0.80	3×10^{-5}
CCBs	0.072	0.031	5.32	0.70	0.023
Preparation	0.113	0.032	12.61	0.62	0.001

†: after 1000× bootstrapping, ‡: after transformation, R^2 =0.646, analysis of variance p $<10^{-12}$. BMI: body mass index, CCBs: Calcium channel blockers, GI: gastrointestinal, MCV: mean corpuscular volume.

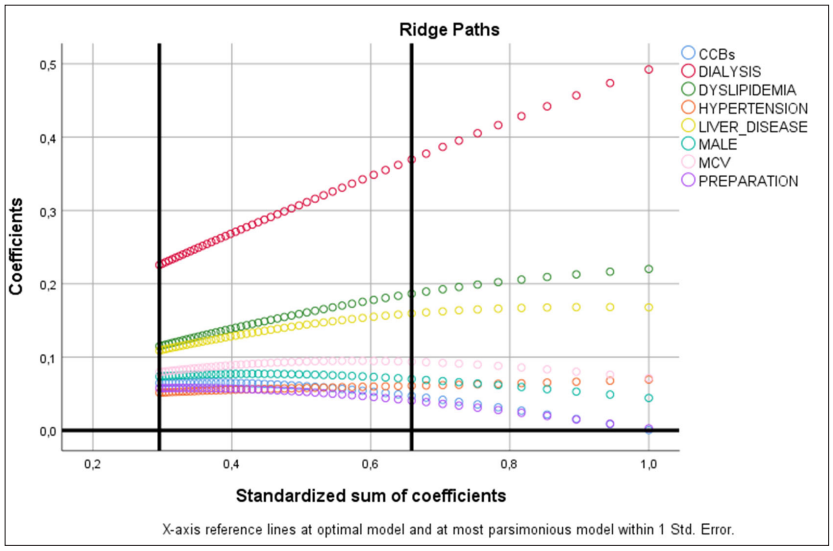

Figure 2: Optimal scaling model for the number of total endoscopic findings (ridge paths).

CCBs: Calcium channel blockers, MCV: mean corpuscular volume.

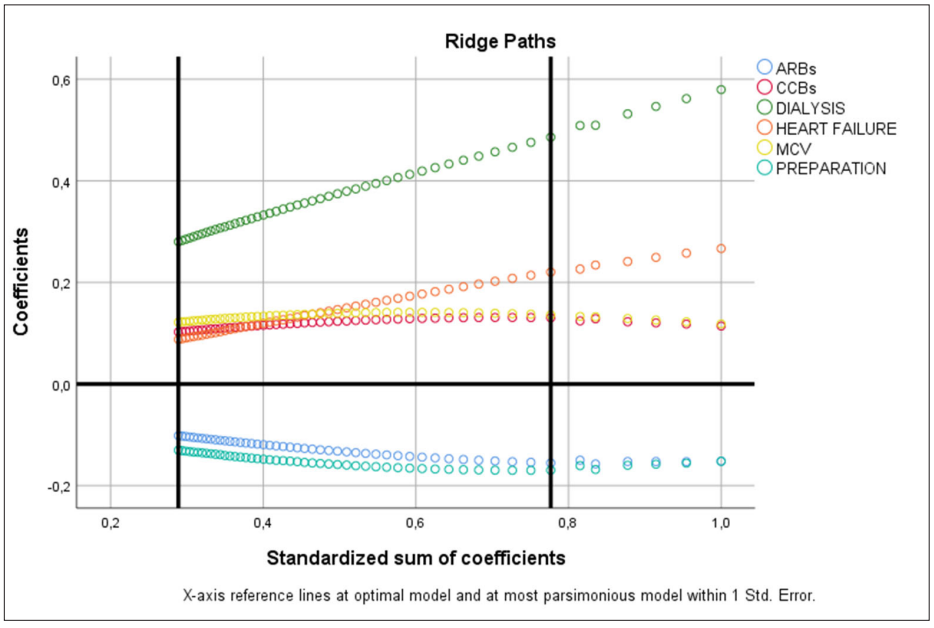

Figure 3: Optimal scaling model for Rhemitt score (ridge paths).

ARBs: angiotensin receptor blockers, CCBs: Calcium channel blockers, MCV: mean corpuscular volume.

patients with a high rebleeding score. More clinical trials, with extensive follow-up over the years, are needed to understand better the clinical evolution of GI lesions, targeting the improved management of HD patients.

The current study had some limitations. Firstly, it was a single-center, cross-sectional study conducted in HD patients and non-HD patients with SSBB over a period of 13 months, which could explain the small sample size and the 1:3 ratio. Nevertheless, more non-HD patients offered a wider spectrum of comorbidities and high-risk medication for GI bleeding, resulting in a more reliable comparison. Also, the massive and random selection of patients was the reason for the predominance of male patients in the study. Furthermore, all patients had been initially investigated with upper and lower GI endoscopy and subsequently underwent CE within three months. Knowing that the sooner the capsule is performed, the higher the diagnostic yield, this time period might affect the endoscopic findings. Finally, we did not investigate the complications of renal anemia and the data supporting iron deficiency anemia. The abolished function of erythropoietin products and the regular administration of iron agents in HD patients made us consider that there was no problem in considering that all HD patients had renal anemia, and it was difficult to evaluate the detailed blood test data.

Conclusion

In this study, HD patients investigated for SSBB by CE demonstrated more severe and frequent small intestinal lesions compared with non-HD patients. Also, monitoring with a mid-gastrointestinal bleeding score, the Rhemitt score indicated a higher probability of rebleeding in HD patients. Early diagnosis of lesions and small bowel enteroscopy accompanied by non-endoscopic monitoring for rebleeding may contribute to the easier and better management of HD patients.

Conflict-of-interest

The authors have no conflicts of interest to declare.

Acknowledgment

Smyrlis Andreas and Kogias Dionysios merit co-first authorship according to their roles in supervising the project and are acknowledge as co-first authors.

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