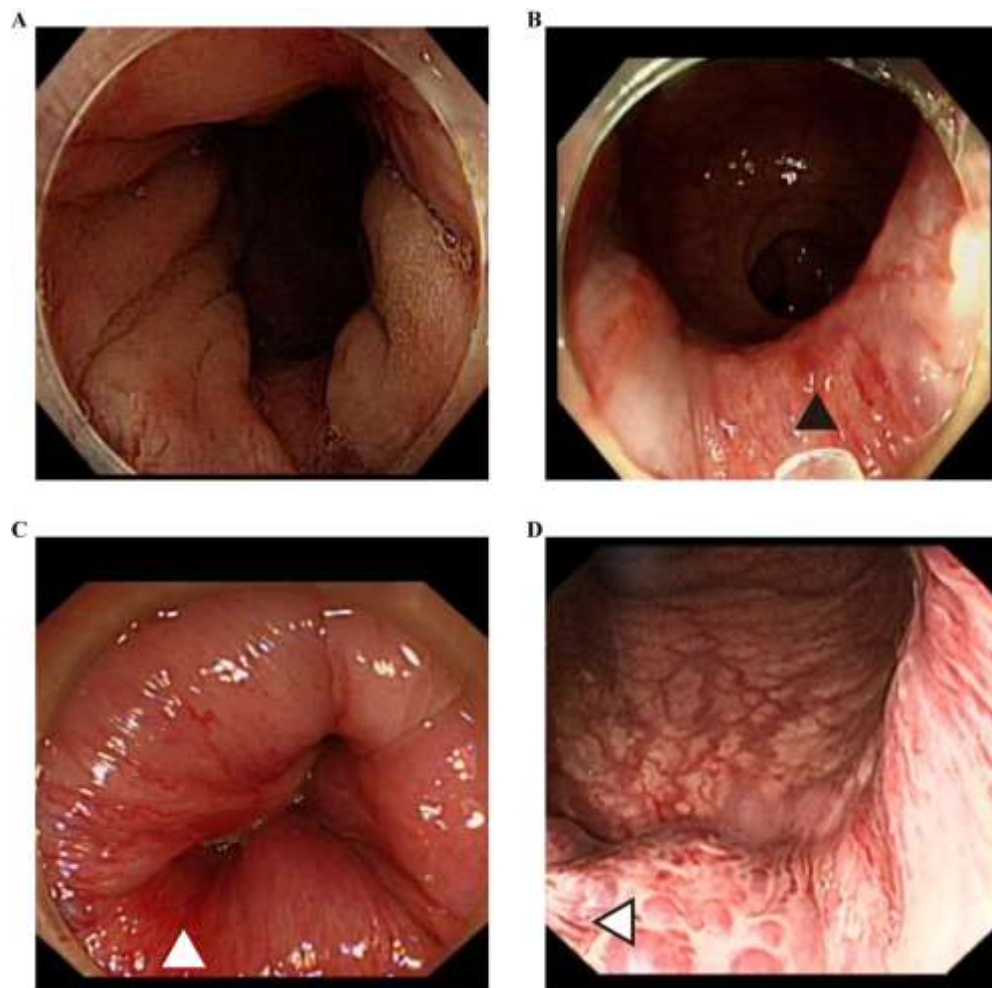
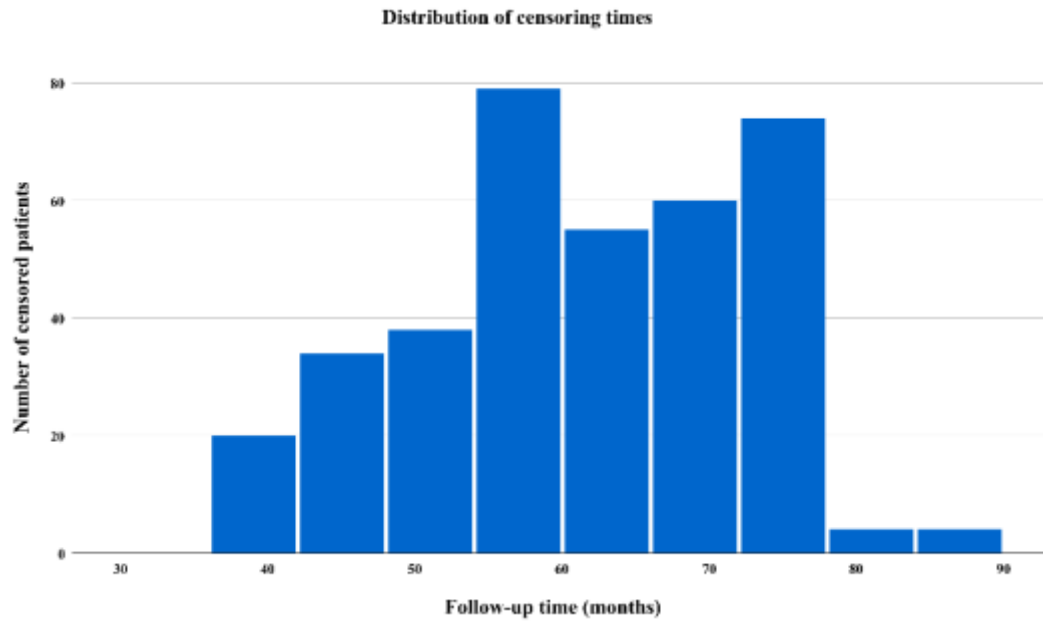
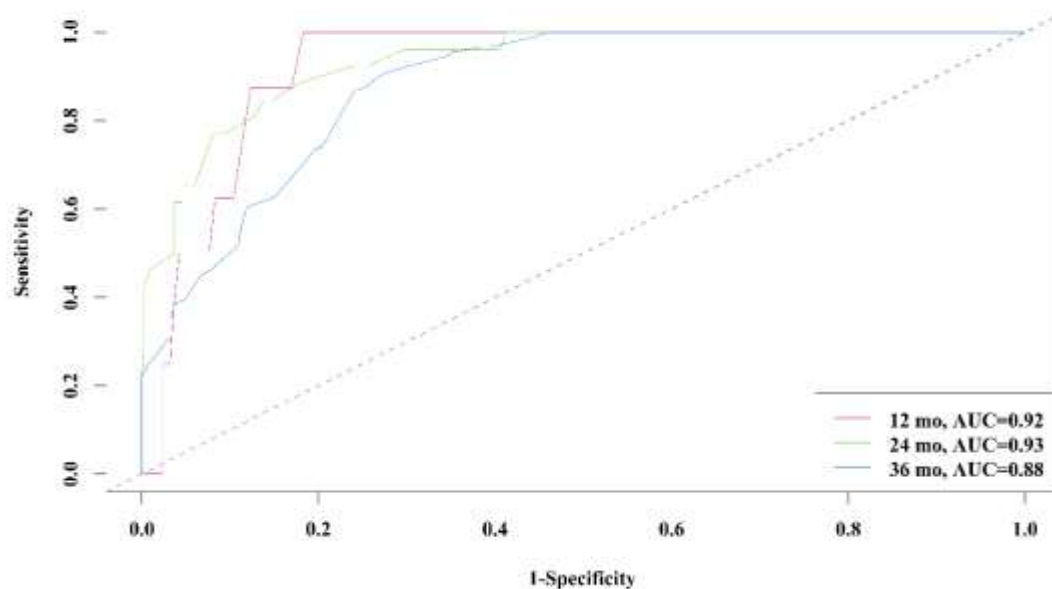




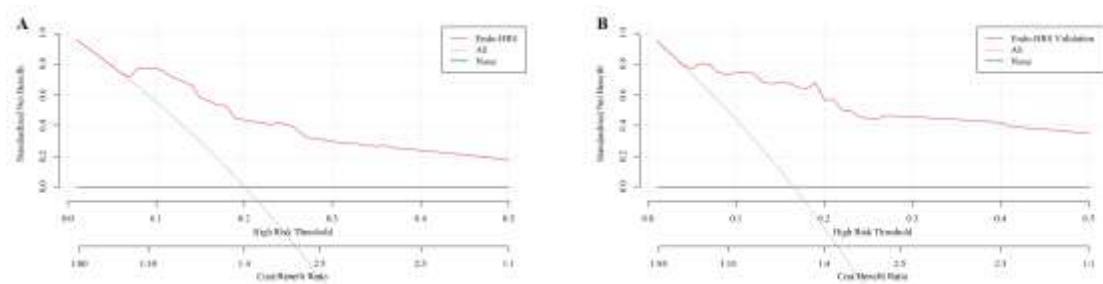
Supplementary Figure 1 Definition and representative endoscopic images of the “red color sign”. The “red color sign” refers to endoscopic vascular abnormalities characterized by dilated, tortuous, and irregularly distributed capillaries on the surface of internal hemorrhoids. It was graded on a scale of 0 to 3 based on severity: grade 0 (absent), grade 1 (scattered red dots), grade 2 (linear red streaks), and grade 3 (confluent areas of red congestion). A: Grade 0 (absent); B: Grade 1 (black arrows indicate red dots); C: Grade 2 (white arrows indicate linear streaks); D: Grade 3 (arrow in a black-bordered box indicates an area of confluent congestion).



Supplementary Figure 2 Follow-up duration among censored patients. Histogram showing the distribution of time to censoring, which includes both administrative censoring at the study end and loss to follow-up.



Supplementary Figure 3 Time-dependent receiver operating characteristic (ROC) curves for recurrence prediction at 12, 24, and 36 months, with corresponding area under the curve (AUC) values of 0.92, 0.93, and 0.88, respectively. Abbreviations: mo: months.



Supplementary Figure 4 Decision curve analysis (DCA) of development cohort and validate cohort. A. DCA of development cohort. B. DCA of validate cohort.

Endo-HRS Recurrence Risk Calculator

Sex:

Number of Hemorrhoids:

Maximum Hemorrhoid Diameter (cm):

Grade of Red Color Sign:

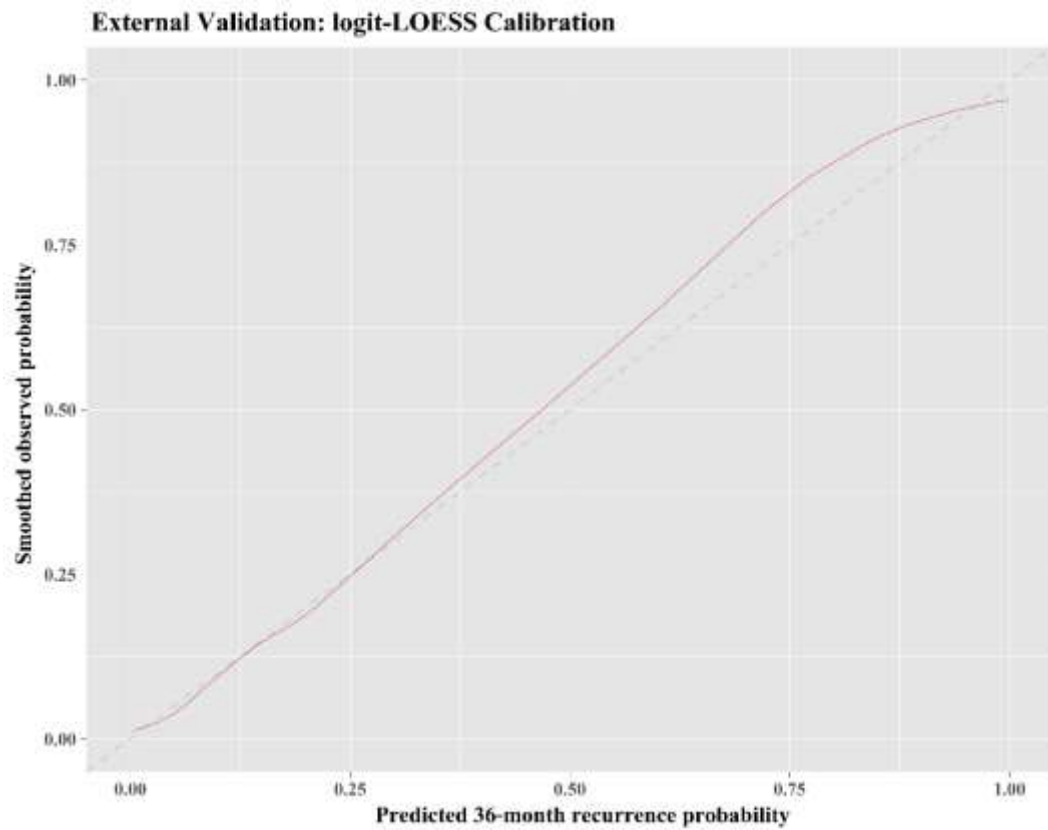
[Calculate Endo-HRS](#)

Results

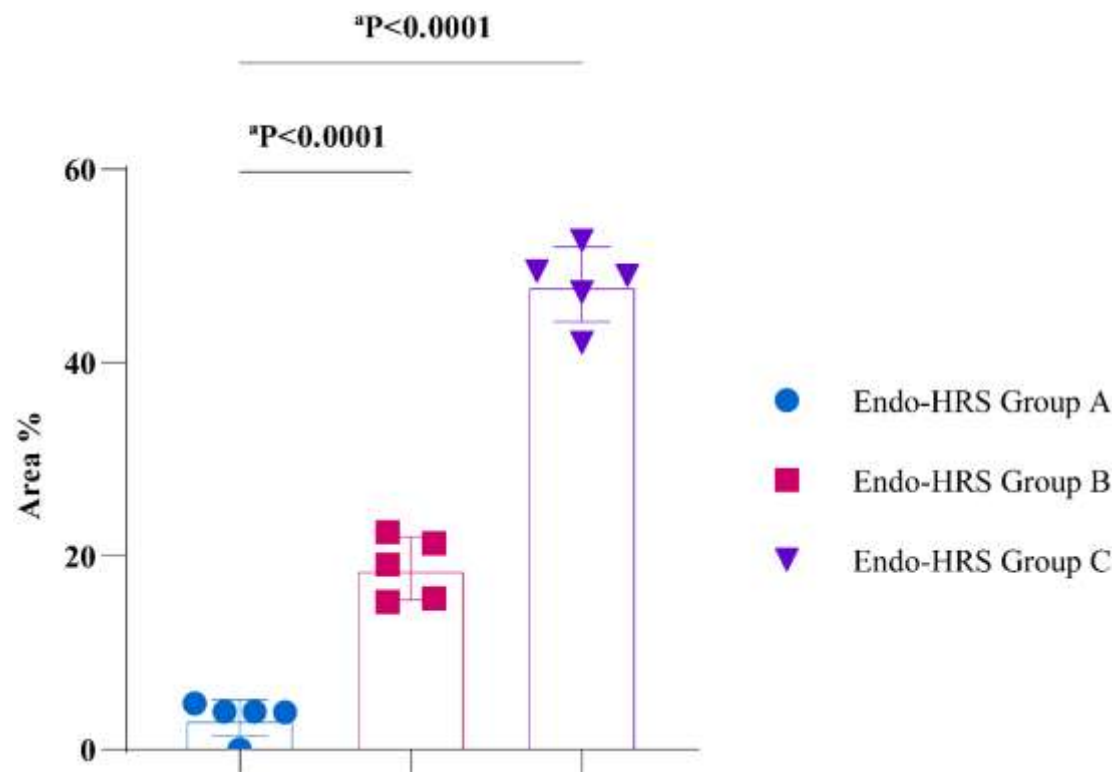
Endo-HRS Score: 19.8

Risk Group: Endo-HRS group B (Moderate Risk)

Supplementary Figure 5 Interface of the Endo-HRS calculator. The web-based calculator allows clinicians to input four parameters, including sex of patients, number of hemorrhoids, maximum hemorrhoid diameter (cm), and grade of red color sign. The Endo-HRS is automatically computed, and patients are stratified into Endo-HRS group A (low risk), B (moderate risk), and C (high risk) according to the prespecified cut-off values.



Supplementary Figure 6 Calibration curves for the 36-month recurrence prediction in the external validation cohort, plotted using the Logit-LOESS method. The gray line represents the ideal reference (perfect prediction), while the orange line shows the observed model performance.



Supplementary Figure 7 The percentage of Masson-stained collagen area across different experimental groups (n=5 per group).

Supplementary Table 1 Inclusion criteria of the study

Inclusion criteria
Age between 18-70 years
Diagnosed with grade I hemorrhagic internal hemorrhoids
Failure of conservative treatment
No previous history of endoscopic treatment for hemorrhoids

Supplementary Table 2 Exclusion criteria of the study

Exclusion criteria
Over the age of 70 or under the age of 18
Diagnosed with grade II, III or IV internal hemorrhoids and external hemorrhoids
Severe cardio- or pulmonary insufficiency
Diagnosis of colon polyps > 1cm in diameter or at > 3 sites; or the presence of malignancy
Diagnosis of inflammatory bowel disease or other perianal diseases
Diagnosis of autoimmune diseases
History of internal hemorrhoids surgery
Allergy to treatment-related drugs
Anticoagulant/ Antiplatelet use within the past 7 days
Chronic constipation or straining, prolonged sitting or standing, alcohol and spicy-food exposure, and pregnancy or childbirth history were not collected prospectively.

Supplementary Table 3 Questionnaire assessment of follow-up

Questions	Answers	
Another bleeding after treatment?	No,	Yes, when? _____
If bleeding, the frequency		
Any other accompanying symptoms?	No.	Yes: _____

Any treatment?	☐ Adequate fluid or fiber intake ☐ Medication ☐ Lifestyle changes ☐ Physiotherapy ☐ Endoscopic therapy ☐ Surgery ☐ Others: _____
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Supplementary Table 4 Metrics of Cox proportional hazards model

Variable	β	SE	HR	95%CI	P
sex	0.28	0.19	1.32	0.90-1.92	0.152
number of hemorrhoids	1.22	0.17	3.39	2.44-4.72	^d <0.0001
maximum diameter of hemorrhoids	3.13	0.61	22.94	6.97-75.72	^d <0.0001
grade of red color sign	0.51	0.15	1.67	1.24-2.25	^d <0.0001

Baseline survival at 36 months: 0.90.

^a $P < 0.05$, ^b $P < 0.01$, ^c $P < 0.001$, ^d $P < 0.0001$.

Supplementary Table 5 Apparent, internal, and external performance metrics of the cohorts

Metric	Development	Internal (Bootstrap corrected)	External
C-index	0.82	0.82	0.90
AUC 12 months	0.92	-	-
AUC 24 months	0.93	-	0.90
AUC 36 months	0.88	-	0.94
AUC 48 months	-	-	0.95
Calibration slope	1.34	0.97	0.97

Brier score	36 0.11	-	0.10
months			
IBS	0.09	-	0.09

Supplementary Table 6 Paper worksheet of the offline calculator

Endo-HRS Recurrence Risk Calculator		
Predictors	Coefficient	Value
Sex (Male = 1, Female = 0)	1	
Number of Hemorrhoids	4	
Maximum Hemorrhoid Diameter (cm)	11	
Grade of Red Color Sign (0, 1, 2, 3)	2	
Results		
Endo-HRS Score		
Risk group classification		
Endo-HRS Group A (Low risk)	< 18.2	
Endo-HRS Group B (Moderate risk)	18.2-27.4	
Endo-HRS Group C (High risk)	≥ 27.4	

Supplementary Table 7 Baseline clinical characteristics of patients in external cohort

Variable	Recurrence (<i>n</i> = 60)	No recurrence (<i>n</i> = 219)	<i>P</i>
Age, years, median (IQR)	54.0 (21.3)	56.0 (19.0)	0.301
Male sex, <i>n</i> (%)	41 (68.3)	117 (53.4)	0.055
Observed follow-up, months (mean ± SD)	29.5 ± 7.3	34.2 ± 6.8	^d <0.0001

Median potential follow-up for the entire cohort (reverse Kaplan-Meier): 33.2 months (32.4-34.1).

^a*P* < 0.05, ^b*P* < 0.01, ^c*P* < 0.001, ^d*P* < 0.0001.

Supplementary Table 8 Relevant R packages used in the study

R packages	Version	R packages	Version	R packages	Version
survival	3.8.6	timeROC	0.4	rms	8.1.1
riskRegression	2026.03.11	pec	2025.06.24	mice	3.19.0
tableone	0.13.2	dplyr	1.2.1	ggplot2	4.0.3

Supplementary Table 9 Missingness counts of variables

Variables	Missing number
sex	0
age	0
hemorrhoid number	0
maximum hemorrhoid diameter (cm)	0
red color sign grade (0-3)	0
mucosa erosion	0
dentate-line injury	0
recurrence status	0
follow-up period	0

Supplementary Table 10 Number of patients (*n*) and scores distribution of the Endo-HRS model quartile method

Risk	Low	Moderate	High	Very High
<i>a</i> <i>n</i>	136	128	104	115
Score	11.5-20.6	20.6-24.8	24.8-27.2	≥ 27.2
<i>b</i> C-index	0.81			

*a**n*: Number of patients; *b*C-index: Concordance index.

Supplementary Table 11 Number of patients (*n*) and scores distribution of the clinically practical Endo-HRS model

Class	A	B	C
^a <i>n</i>	110	284	89
Score	<18.2	18.2-27.4	≥ 27.4

^a*n*: Number of patients.

Supplementary Table 12 Sensitivity analysis (A) and model performance (B) of the refitting multivariable Cox model after excluding baseline red color sign

Variable	Endo-HRS model HR (95% CI)	P value	Sensitivity model HR (95% CI)	P
Sex	1.32 (0.90-1.92)	0.155	1.38 (0.94-2.01)	0.096
Number of hemorrhoids	3.39 (2.44-4.72)	< 0.0001	3.75 (2.72-5.16)	^d <0.0001
Maximum diameter of hemorrhoids	22.94 (6.97-75.52)	< 0.0001	55.97 (19.11-163.85)	^d <0.0001
Grade of red color sign	1.67 (1.24-2.25)	< 0.0001	-	Excluded
		Endo-HRS model	Sensitivity model	
Harrell's C-index		0.82	0.81	
36-month AUC		0.86	0.87	
Calibration slope (36 months)		1.34	1.34	

^a*P* < 0.05, ^b*P* < 0.01, ^c*P* < 0.001, ^d*P* < 0.0001.

Supplementary Table 13 Risk factors of selected patients for multi-modal verification

Groups		Endo- HRS A (n=9)	Endo- HRS B (n=24)	Endo-HRS C (n=7)	P
Scores		16.1±1.2	23.1±2.4	29.6±1.8	^d P < 0.0001
Status	Recurrence	0	6	2	^b P=0.003
	No recurrence	9	18	5	
Sex	Male	5	10	6	P=0.15
	Female	4	14	1	
Number of hemorrhoids	2	9	3	0	^d P < 0.0001
	3	0	19	5	
	4	0	2	2	
Maximum diameter	<0.8cm	7	8	0	^d P < 0.0001
	0.8cm≤Dia.<1.2cm	2	15	3	
	≥1.2cm	0	1	4	
Grade of red color sign	0	7	1	1	^b P=0.003
	1	2	17	2	
	2	0	4	3	
	3	0	2	2	

^aP < 0.05, ^bP < 0.01, ^cP < 0.001, ^dP < 0.0001.

Supplementary Table 14 The Percentage of Masson-positive staining area in different groups (mean ± SD, n=5)

Endo-HRS Group	A	B	C
Area (%)	3.30±1.88	18.76±3.27	48.10±3.88