

ORIGINAL ARTICLE

HALP Score as a Mortality Predictor in Elderly Home-Care Patients

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ABSTRACT

Background: The hemoglobin, albumin, lymphocyte, and platelet (HALP) scoring system reflects nutritional status and systemic inflammation and aims to provide information about patients' prognosis. This study aims to evaluate the association between the HALP score and mortality risk in elderly home-care patients.

Methods: This retrospective study included 481 elderly patients who died between January 2021 and December 2023 while being followed by the Home Health Care Service. The dates of death were recorded, and survival durations were categorized into groups. Laboratory parameters obtained from hospital electronic records were used to calculate HALP scores (hemoglobin x albumin x lymphocyte)/platelet. Additionally, neutrophil-to-lymphocyte ratio (NLR) and C-reactive protein-to-albumin ratio (CAR) were calculated for comparison. Statistical analyses included ROC curve analysis, correlation tests, and group comparisons based on survival duration.

Results: A HALP score cutoff of ≤ 25.22 predicted mortality with a sensitivity of 68.27% and specificity of 53.68%. Both NLR and CAR were inversely correlated to survival times ($p < 0.05$). Patients with longer survival durations had significantly higher HALP scores and lower NLR and CAR values compared to those with shorter survival durations.

Conclusions: The HALP and modified HALP may serve as useful prognostic markers for mortality prediction in elderly home-care patients. Since HALP is calculated from simple, routinely available laboratory parameters, its use in home health care settings-where geriatric and multimorbid patients predominate-could contribute to early risk stratification and cost-effective care planning.

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KEYWORDS

hemoglobin albumin lymphocyte and platelet (HALP),
mortality, inflammation, elderly, home care

LIST OF ABBREVIATIONS

HALP - Hemoglobin, albumin, lymphocytes, and platelets
M-HALP - Modified hemoglobin, albumin, lymphocytes, and platelets
NLR - neutrophil-to-lymphocyte ratio
PLR - Platelet-to-lymphocyte ratio
CAR - C-reactive protein -albumin ratio

INTRODUCTION

Aging is a process associated with increased disease risk and progressive impairment in personal functions, and it carries biological, chronological, and social dimensions. This process restricts an individual's daily activities and increases the need for healthcare [1]. With the extension of the human lifespan and consequent increase in the elderly population, the number of elderly patients in clinical practice has increased, necessitating adequate assessment of death risk to tailor and optimize treatment. Moreover, understanding the factors determining prognosis in old age can direct clinicians toward potential new interventions [2].

In clinical settings, various markers and scoring systems are employed to assess the risk of death among elderly patient groups [3-5]. Parameters such as platelets, neutrophils, lymphocytes, and C-reactive protein (CRP) have been examined in various mortality studies. The CRP/albumin ratio (CAR), neutrophil-lymphocyte ratio (NLR), and platelet-lymphocyte ratio (PLR) are recognized as strong indicators of inflammation. Previous studies indicate that elevated CAR, NLR, and PLR values correlate with increased inflammation severity and serve as independent predictors of mortality risk in diseases with comorbid conditions [6,7].

One such mortality-related scoring system is the hemoglobin, albumin, lymphocyte, and platelet (HALP) score, which is calculated based on the levels of these four parameters. Introduced by Chen et al. in 2015 for predicting survival times in gastric cancer patients, this system involves parameters linked to inflammation, nutrition, and immune status [8]. The HALP score has been utilized as a prognostic marker in various clinical contexts, including malignancies, pancreatitis, ileus, and myocardial infarction [9-14].

Although numerous studies have employed the HALP score as a mortality indicator in specialized patient groups, research focusing on its relationship with mortality in elderly groups is limited. Our study aims to assess the relationship between HALP and modified HALP (m-HALP) scores with both short- and long-term mortality risks in an elderly patient group, utilizing accessible, cost-effective, and quickly obtainable laboratory parameters.

MATERIALS AND METHODS

Study Population

This retrospective study included patients aged ≥ 65 years who received home healthcare services from Niğde Ömer Halisdemir University Hospital between January 2021 and December 2023. A total of 481 patients who died during follow-up were included in the analysis. The date of death and the interval between the last hospital visit and death were recorded. Laboratory data for hemoglobin, lymphocytes, neutrophils, platelets, CRP, and albumin were retrieved from the hospital

information system.

Based on these parameters, HALP, m-HALP, NLR, PLR, and CAR values were calculated for each patient. Demographic data (age, gender) and laboratory findings were collected and entered into a standardized data form.

Calculation of the Parameters

Complete blood counts and biochemical parameters were tested using an automated Sysmex XN-1000 hematology analyzer and a Roche cobas C701 chemistry analyzer.

HALP score = hemoglobin (g/L) x albumin (g/L) x lymphocyte count ($10^3/\mu\text{L}$) $\div$ platelet count ($10^3/\mu\text{L}$) [15]

m-HALP score = hemoglobin (g/L) x albumin (g/L) x lymphocyte count ($10^9/\text{L}$) x platelet count ($10^9/\text{L}$) [14]

PLR = platelet count $\div$ lymphocyte count

NLR = neutrophil count $\div$ lymphocyte count

CAR = CRP $\div$ albumin

All derived indices were calculated using the latest available laboratory values prior to death.

Statistical analysis

All statistical analyses were carried out using IBM SPSS Statistics for Windows 23.0 (IBM Corp., Armonk, NY). The normality assumption was assessed using the Shapiro-Wilk test. Continuous variables were summarized as mean $\pm$ standard deviation (SD) for normally distributed data and median (interquartile range [IQR]: 25 - 75 percentile) for non-normally distributed data. Categorical variables were presented as frequencies (n) and percentages (%) and analyzed using the chi-squared test. The Mann-Whitney U test and the Kruskal-Wallis test were performed for non-parametric comparisons of continuous data, while the independent *t*-test and the one-way ANOVA were used for parametric comparisons. Posthoc analysis was performed using Bonferroni correction and the Tukey HSD test. The Spearman's correlation test was applied to investigate the association between laboratory indicators. The optimal cutoff values of the laboratory indicators differentiating mortality were evaluated with receiver operating characteristic (ROC) curve analysis. The area under the curve (AUC), sensitivity, and specificity were calculated and reported with 95% confidence intervals. The threshold for statistical significance was set at a difference of 0.05.

RESULTS

The study involved 481 individuals, with 41.6% (n = 200) male and 58.4% (n = 281) female participants. Participants were categorized based on their death dates and the dates of their last laboratory tests. There were 101 deaths within the last month, 108 deaths within the last three months, 75 deaths within the last six months, 98 deaths within the last year, and 99 deaths within the

Table 1. Patient characteristics.

Variables	All Patients (n = 481)
Age (years), median(IQR)	82 (75 - 88)
Gender, n (%)	
Male	200 (41.6)
Female	281 (58.4)
Day mortality, n (%)	
1-month mortality	101 (21)
3-month mortality	108 (22.5)
6-month mortality	75 (15.6)
1-year mortality	98 (20.4)
3-year mortality	99 (20.6)
Hospitalization duration (day), median (IQR)	129 (37 - 294)
Hemoglobin, mean $\pm$ SD	11.67 $\pm$ 2.25
Platelet, median (IQR)	242 (188 - 314)
Neutrophil, median (IQR)	5.1 (3.72 - 6.99)
Lymphocyte, median (IQR)	1.49 (1.03 - 1.97)
CRP, median (IQR)	20.2 (5.7 - 64.9)
Albumin, median (IQR)	34 (30 - 37)
HALP, median (IQR)	22.49 (14.33 - 36.84)
M-HALP, median (IQR)	1,358,456.4 (762,614.68 - 2,211,855.36)
NLR, median (IQR)	3.49 (2.25 - 5.66)
PLR, median (IQR)	169.59 (120.31 - 234.34)
CAR, median (IQR)	0.61 (0.16 - 2.1)

CRP: C-reactive protein, HALP: hemoglobin, albumin, lymphocytes, and platelets, M-HALP: Modified hemoglobin, albumin, lymphocytes, and platelets, NLR: neutrophil-to-lymphocyte ratio, PLR: Platelet-to-lymphocyte ratio, CAR: C-reactive protein -albumin ratio.

Table 2. Comparison among groups.

Variables	1-month mortality (n = 101)	3-month mortality (n = 108)	6-month mortality (n = 75)	1-year mortality (n = 98)
Hemoglobin	11.75 $\pm$ 2.25	11 $\pm$ 2.25	11.69 $\pm$ 2.35	11.9 $\pm$ 2.33
Platelet	239 (184 - 309)	255.5 (179.5 - 305.5)	249 (203 - 319)	232.5 (191 - 308)
Neutrophil	6.18 (4.15 - 8.41)	5.35 (3.76 - 7.29)	5.16 (3.75 - 6.67)	4.44 (3.41 - 6.73)
Lymphocyte	1.28 (0.95 - 1.76)	1.41 (0.9 - 1.95)	1.51 (0.99 - 1.98)	1.62 (1.16 - 2.13)
CRP	47.6 (19.6 - 107.8)	32.25 (8.75 - 70.6)	15 (3.3 - 49.8)	12.6 (4.6 - 44.8)
Albumin	31 (26 - 35)	32 (27 - 36)	34 (31 - 38)	34 (31 - 39)
HALP	20.6 (12.16 - 29.18)	19.84 (13.09 - 30.24)	22.65 (16.61 - 34.96)	26.69 (17.1 - 40.95)
M-HALP	1,029,408.48 (562,049.6 - 1,745,583.84)	1,167,461.91 (586,239.54 - 2,013,490.56)	1,408,397.76 (840,153.6 - 2,013,465.72)	1,452,692.31 (888,271.52 - 2,421,309.6)
NLR	5.06 (3.01 - 8.09)	3.99 (2.4 - 6.5)	3.31 (2.15 - 5.12)	2.92 (1.97 - 4.53)
PLR	188.6 (133.87 - 261.02)	173.63 (118.75 - 248.62)	171.6 (125.93 - 225.56)	151.77 (114.8 - 213.39)
CAR	1.59 (0.58 - 3.65)	1.04 (0.26 - 2.68)	0.4 (0.09 - 1.8)	0.37 (0.13 - 1.49)

Data given as mean $\pm$ SD, median (IQR) and n (%), CRP: C-reactive protein, HALP: Hemoglobin, albumin, lymphocytes, and platelets, M-HALP: Modified hemoglobin, albumin, lymphocytes, and platelets, NLR: Neutrophil-to-lymphocyte ratio, PLR: Platelet-to-lymphocyte ratio, CAR: C-reactive protein -albumin ratio.

Table 3. Correlation analysis among study parameters (n = 481).

Variables	Age		Hospitalization day		HALP		M-HALP		NLR		PLR		CAR	
	r	p	r	p	r	p	r	p	r	p	r	p	r	p
Age	1	-												
Hospitalization day	-0.002	0.970	1	-										
HALP	0.016	0.728	0.189	< 0.001	1	-								
M-HALP	0.046	0.317	0.235	< 0.001	0.400	< 0.001	1	-						
NLR	-0.093	0.041	-0.248	< 0.001	-0.600	< 0.001	-0.421	< 0.001	1	-				
PLR	-0.021	0.644	-0.108	0.018	-0.896	< 0.001	-0.244	< 0.001	0.656	< 0.001	1	-		
CAR	-0.040	0.378	-0.318	< 0.001	-0.475	< 0.001	-0.306	< 0.001	0.501	< 0.001	0.330	< 0.001	1	-

Spearman's correlation test. HALP: Hemoglobin, albumin, lymphocytes, and platelets, M-HALP: Modified hemoglobin, albumin, lymphocytes, and platelets, NLR: Neutrophil-to-lymphocyte ratio, PLR: Platelet-to-lymphocyte ratio, CAR: C-reactive protein -albumin ratio.

Table 4. Comparison of study parameters according to 3-months mortality.

Variables	> 3-month mortality (n = 272)	3-month mortality (n = 209)	p-value
Age (years)	82 (74 - 88)	82 (75 - 88)	0.723
Gender			
Male	100 (36.8)	100 (47.8)	0.015
Female	172 (63.2)	109 (52.2)	
Hemoglobin	11.91 ± 2.19	11.36 ± 2.28	0.008
Platelet	238.5 (194.5 - 318.5)	246 (183 - 309)	0.477
Neutrophil	4.68 (3.52 - 6.41)	5.61 (3.94 - 7.72)	< 0.001
Lymphocyte	1.57 (1.13 - 2.03)	1.33 (0.93 - 1.8)	0.001
CRP	11.6 (3.5 - 39.95)	42 (15.7 - 88.1)	< 0.001
Albumin	35 (31 - 39)	32 (26 - 36)	< 0.001
HALP	26.36 (16.69 - 40.16)	20 (12.47 - 30.07)	< 0.001
M-HALP	1,558,697 (960,719.62 - 2,403,518.91)	1,075,814.4 (572,368.68 - 1,804,176)	< 0.001
NLR	2.96 (2.07 - 4.49)	4.44 (2.69 - 7.38)	< 0.001
PLR	161.32 (117.44 - 222.83)	181.76 (129.41 - 256.64)	0.019
CAR	0.32 (0.1 - 1.27)	1.31 (0.44 - 3.11)	< 0.001

Data given as mean ± SD, median (IQR) and n (%). Independent t-test, Mann-Whitney U test, Pearson's chi-squared test. CRP: C-reactive protein, HALP: Hemoglobin, albumin, lymphocytes, and platelets, M-HALP: Modified hemoglobin, albumin, lymphocytes, and platelets, NLR: Neutrophil-to-lymphocyte ratio, PLR: Platelet-to-lymphocyte ratio, CAR: C-reactive protein -albumin ratio.

Table 5. ROC analysis results for study parameters.

Variables	AUC (95% CI)	p	Cutoff value	Sensitivity (95% CI)	Specificity (95% CI)
HALP	0.618 (0.573 - 0.662)	< 0.001	≤ 25.22	68.27 (61.5 - 74.5)	53.68 (47.6 - 59.7)
M-HALP	0.622 (0.577 - 0.665)	< 0.001	≤ 950,686.44	47.37 (40.4 - 54.4)	75.74 (70.2 - 80.7)
NLR	0.639 (0.594 - 0.682)	< 0.001	> 4.976	45.45 (38.6 - 52.5)	79.78 (74.5 - 84.4)
PLR	0.562 (0.517 - 0.607)	0.019	> 169.59	56.94 (49.9 - 63.7)	55.51 (49.4 - 61.5)
CAR	0.687 (0.644 - 0.728)	< 0.001	> 0.677	66.99 (60.2 - 73.3)	65.81 (59.8 - 71.4)

AUC: Area under curve, CI: Confidence interval, HALP: Hemoglobin, albumin, lymphocytes, and platelets, M-HALP: Modified hemoglobin, albumin, lymphocytes, and platelets, NLR: Neutrophil-to-lymphocyte ratio, PLR: Platelet-to-lymphocyte ratio, CAR: C-reactive protein -albumin ratio.

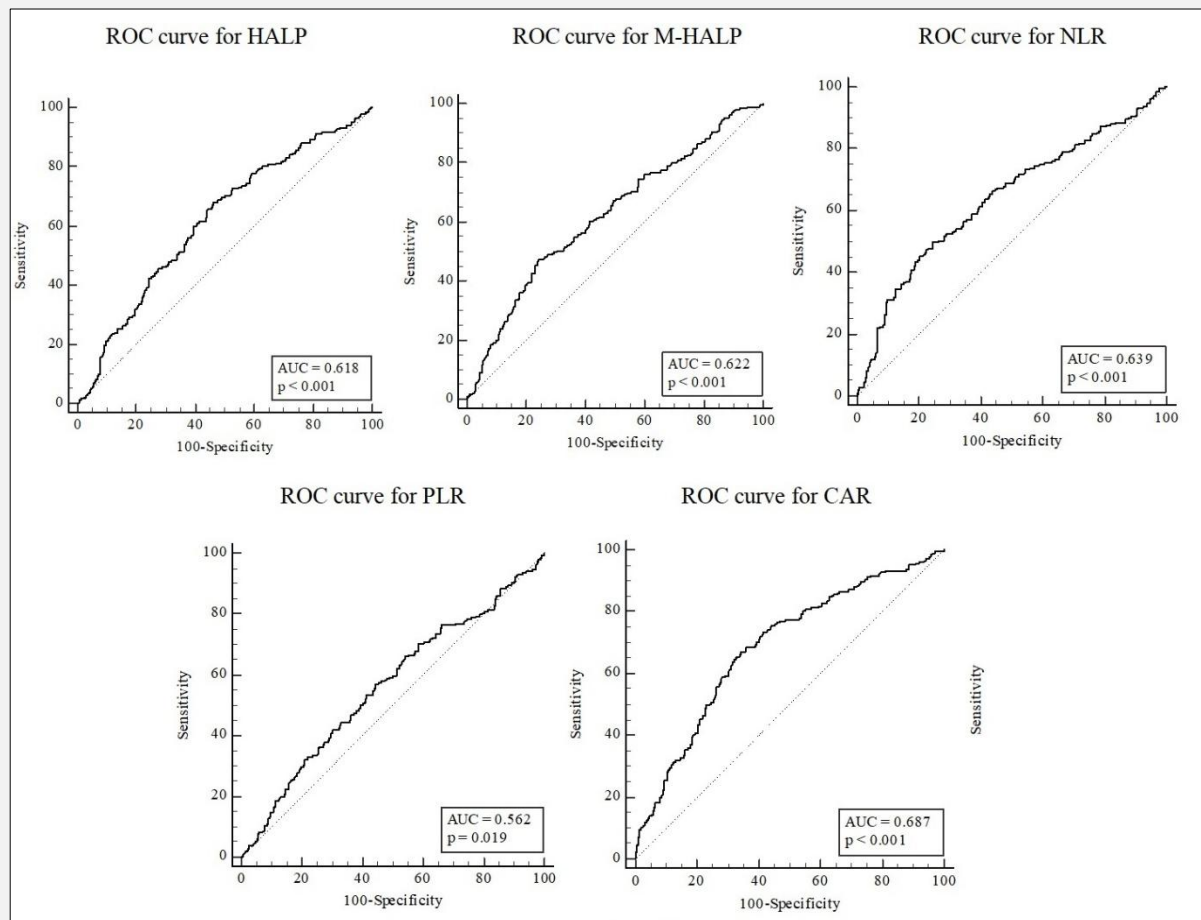


Figure 1. ROC curve analyses of HALP, M-HALP, NLR, PLR and CAR.

last three years. The median survival time was 129 days (IQR: 37 - 294). Table 1 presents the descriptive characteristics of the patients.

A comparison of laboratory values before death showed that the three-month mortality group had the lowest hemoglobin values and the three-year mortality group had the highest ($p = 0.007$). As survival time increased, there was a significant increase in the lymphocyte ($p = 0.012$) and albumin ($p < 0.001$) values and the HALP ($p < 0.001$) and m-HALP ($p < 0.001$) scores. Neutrophil ($p = 0.001$), CRP ($p < 0.001$), NLR ($p < 0.001$), and CAR ($p < 0.001$) values significantly decreased. Significant differences were found between the groups in the HALP, m-HALP, NLR, and CAR levels (Table 2).

Correlation analysis between parameters revealed a negative correlation between the HALP and m-HALP scores with NLR, PLR, and CAR, and a positive correlation with survival time ($p < 0.001$). No significant correlation was found between the HALP and m-HALP scores and age ($p > 0.05$) (Table 3).

When patients were divided into two groups - those who died within three months and those who died after three months - a significant difference was found between the mortality values within three months compared to those after three months, with the HALP and m-HALP scores being significantly lower in patients who died within three months. NLR ($p < 0.001$), PLR ($p = 0.019$), and CAR ($p < 0.001$) values were significantly higher in patients who died within three months (Table 4).

ROC analysis conducted to determine the diagnostic performance of the parameters used in the study found that the HALP score had a sensitivity of 68.27% and specificity of 53.68% at a ≤ 25.22 cutoff value, while the m-HALP score had a sensitivity of 47.37% and specificity of 75.74% at a $\leq 950,686.44$ cutoff value, proving to be discriminative in mortality detection. The optimal cutoff values for NLR, PLR, and CAR were 4.98, 169.59, and 0.68, respectively (Table 5, Figure 1).

DISCUSSION

In this retrospective study of elderly patients receiving home healthcare services, we investigated the relationship between HALP and m-HALP scores and mortality. Our findings demonstrated that the HALP score, at a cutoff value of ≤ 25.22 , had a sensitivity of 68.27% and a specificity of 53.68%, while the m-HALP score, at a cutoff value of $\leq 950,686.44$, had a sensitivity of 47.37% and a specificity of 75.74%. These results indicate that both indices may serve as useful predictors of mortality in this patient population.

In clinical practice, inflammatory indexes, such as the NLR, PLR, lymphocyte-monocyte ratio, and prognostic nutrition index, are known to be used for prognosis prediction. The HALP score is reported to be an effective prognostic marker, especially in cases such as gastrointestinal and genitourinary cancers, assessing both the immune system and nutritional status of the patient [16].

A review of the literature suggests that the HALP score is not only useful in malignancy cases but also in predicting mortality in heart failure, distinguishing between benign and malignant conditions, and determining the presence of dyslipidemia [17-19]. A study utilizing data from the National Health and Nutrition Examination Survey (NHANES) in the USA involving 8,245 participants indicated that anemia treatment and being over the age of 65 were independent risk factors associated with lower HALP scores. The same study also noted that males had higher HALP scores than females and that the HALP scores were inversely related to age and negatively associated with the number of comorbidities [20].

In our study, when examining the relationship between hemoglobin levels and mortality duration, we found that hemoglobin levels significantly increased as mortality duration extended from three months to three years. Although our study primarily consisted of older patients, no significant difference was found in the HALP scores when assessed by age, possibly due to the homogeneous age distribution and the majority being over 65 years old. Another study monitoring patients with a lung cancer diagnosis reported that lower HALP scores were associated with poorer survival, with no significant difference found between the HALP scores and factors such as age, smoking history, or body mass index [16]. In our study, a gender-based evaluation showed that men had a higher death rate within the first three months compared to later periods.

Another commonly used parameter in clinics is the NLR. A study in the general US population assessed the relationship between NLR and mortality, stating that increased NLR values were associated with overall mortality and cause-specific mortality due to heart disease, chronic lower respiratory diseases, influenza/pneumonia, and kidney disease [21]. Similarly, in studies evaluating the relationship between laboratory parameters and malignancy conditions, the HALP score was found

to be a significant independent prognostic factor when compared with prognostic indexes NLR and PLR in conditions such as esophageal carcinoma and metastatic prostate cancer [10,22]. In our study, when patients were grouped according to mortality duration from within one month to three years, a significant decrease in NLR values was determined as the time of death increased. Similarly, CAR values were found to be inversely related to mortality duration.

Looking at studies evaluating the relationship of the HALP score with mortality duration, Kocaoğlu et al. noted the effectiveness of the HALP score in predicting one-week and three-month mortality in patients with heart failure [14]. Tian et al., in their study of patients with a history of acute ischemic stroke, reported that the HALP score was associated with 90-day and 1-year mortality [23]. In our study with an older patient group, it was determined that lower HALP scores were associated with an increased risk of mortality within three months. A significant positive correlation was also found between the HALP and m-HALP scores and hospital stay duration, suggesting that a higher HALP score at the time of hospital admission could indicate longer patient survival.

Limitations

This study has several limitations. First, it was conducted at a single center, limiting the generalizability of the results. Second, the retrospective design may introduce selection and information biases. Third, comorbidities and disease severity were not systematically evaluated, which may have influenced the observed relationships. Future multicenter, prospective studies are warranted to validate and expand upon these findings.

CONCLUSION

In this study of elderly home-care patients, lower HALP scores were significantly associated with increased short-term mortality (within three months). Additionally, a positive correlation was found between HALP and m-HALP scores and hospital stay duration. Given that HALP can be derived from simple, routinely performed laboratory tests, it represents a practical and cost-effective tool for mortality risk assessment in geriatric home-care settings. Implementing HALP-based evaluations may support clinicians in developing individualized treatment plans and improving resource allocation.

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Ethics Approval and Consent to Participate:

This study was approved by the Niğde Ömer Halisdemir University Research Ethics Committee (Decision No.: 2024/12). The requirement for informed consent was waived by the same ethics committee due to the retrospective design of the study, in accordance with national regulations. The study was conducted in compliance with the principles of the Declaration of Helsinki.

Availability of Data and Materials:

The datasets analyzed during the current study are available from the corresponding author upon reasonable request.

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Clinical Trial Registration:

Not applicable. This is a retrospective observational study and not a registered clinical trial.

Declaration of Generative AI in Scientific Writing:

No generative AI tools were used in the writing or preparation of this manuscript.

Declaration of Interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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