

ORIGINAL RESEARCH

Association between preoperative hemoglobin, albumin, lymphocyte, and platelet (HALP) score and stricture recurrence after urethroplasty

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Abstract

Background: Recurrence after urethroplasty remains a challenging treatment issue, and there is a lack of validated preoperative biomarkers for risk classification. Although the hemoglobin, albumin, lymphocyte, and platelet (HALP) score serves as a composite marker of systemic inflammation and nutritional status, its association with urethroplasty results has not been explored. This study aimed to evaluate the association between the preoperative HALP score and stricture recurrence after urethroplasty. **Methods:** This retrospective cohort study included 91 male patients who underwent urethroplasty for urethral stricture disease at a tertiary referral center between January 2018 and December 2024. Preoperative HALP scores were calculated using routine laboratory parameters. Patients were classified into recurrence and recurrence-free groups based on postoperative follow-up. Univariable and multivariable logistic regression analyses were performed. The discriminatory performance of the HALP score was assessed using receiver operating characteristic (ROC) curve analysis. **Results:** During a median follow-up of 18 months, 17 patients (18.7%) experienced stricture recurrence. Patients with recurrence had significantly lower preoperative HALP scores compared with those without recurrence (34.8 vs. 48.9, $p = 0.003$). In multivariable logistic regression analysis adjusted for stricture length and history of prior urethral intervention, the HALP score remained independently associated with stricture recurrence (adjusted odds ratio (OR) 0.95, 95% confidence interval (CI): 0.91–0.99; $p = 0.012$). ROC analysis demonstrated moderate discriminatory ability of the HALP score for predicting recurrence (area under the curve (AUC) = 0.73). **Conclusions:** The preoperative HALP score was independently associated with stricture recurrence and may serve as a useful adjunct to conventional clinical risk factors; however, larger multicenter prospective studies are required before routine clinical implementation.

Keywords

HALP score; Nutritional status; Stricture recurrence; Systemic inflammation; Urethral stricture; Urethroplasty

1. Introduction

Urethral stricture disease is a prevalent urologic condition characterized by fibrotic narrowing of the urethral lumen. This narrowing can cause obstructive urinary symptoms, urinary tract infections, and impaired quality of life [1]. Despite advancements in reconstructive urology, urethral strictures recur in a considerable proportion of patients after surgery even after technically successful procedures. Reported recurrence rates range from 5% to over 20%, depending on factors such as stricture characteristics, surgical methods, and patient-related factors [2, 3]. Traditionally, studies of risk factors for recurrence after urethroplasty have focused on anatomic and procedural characteristics, such as stricture length, anatomic

location, etiology, and surgical method [4]. Recent studies have highlighted the importance of biological factors in wound healing and tissue remodeling. In addition to systemic inflammatory and immune responses, nutritional status is increasingly recognized as an important factor influencing surgical outcomes across various medical disciplines [5, 6].

Chronic inflammation promotes fibroblast proliferation, extracellular matrix deposition, and microvascular dysfunction, all of which may contribute to pathologic scar formation and stricture recurrence [7]. Conversely, adequate nutritional status and immune competence are important in wound healing and resistance to infection [8]. Various hematologic indices derived from routine blood tests, such as the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio, and sys-

temic immune-inflammation index (SII), have been assessed as potential prognostic markers in urological disorders [9–11]. However, these indices generally capture only individual aspects of inflammation and, therefore, do not fully represent the broader biological state. The hemoglobin, albumin, lymphocyte, and platelet (HALP) score is a composite index that integrates oxygen-carrying capacity, nutritional status, immune function, and inflammatory activity. Recent studies suggest that lower HALP scores may reflect greater systemic inflammatory burden and poorer nutritional status, factors that may adversely affect tissue healing [12–14].

To the best of our knowledge, the prognostic value of the HALP score for stricture recurrence after urethroplasty has not been well established. Given the biological links among inflammation, nutritional status, and urethral healing, we hypothesized that the preoperative HALP score may be associated with recurrence.

This study aimed to evaluate the association between the preoperative HALP score and stricture recurrence.

2. Materials and methods

This retrospective cohort study included male patients who underwent urethroplasty for urethral stricture disease at a tertiary referral center between January 2018 and December 2024. A total of 91 consecutive patients met the inclusion criteria and were included in the final analysis. The study was conducted in accordance with the Declaration of Helsinki. Institutional ethics approval was obtained. Informed consent for surgical intervention was documented according to institutional standards, whereas consent for retrospective use of anonymized data was waived by the ethics committee (AESH-BADEK2-2025-495).

2.1 Inclusion criteria

Inclusion criteria were age ≥ 18 years, presence of primary or recurrent urethral stricture treated with urethroplasty, and availability of complete preoperative laboratory data, including hemoglobin, albumin, lymphocyte count, and platelet count. Patients were excluded if they had active malignancy, systemic inflammatory or autoimmune disease, active urinary tract infection at the time of surgery, or incomplete clinical data.

2.2 Preoperative evaluation

All patients underwent standardized preoperative evaluation, including medical history, physical examination, uroflowmetry, and imaging studies. Retrograde urethrography and/or urethroscopy were used to assess stricture location (bulbar, penile, or posterior), length, and severity. Baseline demographic and clinical characteristics, including age, comorbidities, stricture etiology, and prior interventions, were recorded.

2.3 HALP score calculation

Preoperative blood samples were obtained as part of routine surgical assessment. The HALP score was calculated according to a previously published method [12].

$$\text{HALP} = [\text{hemoglobin (g/L)} \times \text{albumin (g/L)} \times \text{lymphocyte count } (\times 10^9/\text{L})] / \text{platelet count } (\times 10^9/\text{L}).$$

All laboratory values were measured within 1 week before surgery. Data were extracted from a prospectively maintained institutional database.

2.4 Surgical technique and follow-up

All urethroplasties were performed by experienced reconstructive urologists using standardized techniques selected according to stricture characteristics, including excision and primary anastomosis or substitution urethroplasty when indicated. All patients received a single preoperative dose of ceftriaxone as standard perioperative antibiotic prophylaxis.

Patients were followed postoperatively with clinical assessment and uroflowmetry, including an assessment 1 month after surgery. Recurrence was suspected when maximum urinary flow rate (Qmax) was < 15 mL/s in patients with obstructive symptoms and was confirmed by imaging or urethroscopy. Surgical success was defined as the absence of recurrence without the need for secondary intervention, in line with previously published definitions [15], and was evaluated throughout follow-up.

2.5 Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Normality was assessed using the Shapiro–Wilk test. Continuous variables were summarized as mean $\pm$ standard deviation (SD) or median (interquartile range; IQR), as appropriate. Categorical variables were summarized as n (%). A complete-case approach was used for the primary analysis, and data imputation was not performed because missing values in the laboratory parameters required for HALP calculation would have resulted in an estimated rather than directly calculated HALP score. No a priori sample size calculation was performed given the retrospective design; all consecutive patients meeting the predefined eligibility criteria during the study period were included. Group comparisons were performed using the independent-samples Student's t -test or Mann–Whitney U test for continuous variables and the chi-square test for categorical variables. Categorical variables with sparse subgroup counts were presented descriptively without formal between-group hypothesis testing. Univariable and multivariable logistic regression analyses were conducted to identify predictors of stricture recurrence. Variables were selected for the multivariable model based on clinical relevance and univariable findings. Given the limited number of recurrence events, the multivariable model was kept parsimonious to limit the risk of overfitting. The discrimination of the HALP score was assessed using receiver operating characteristic (ROC) curve analysis. The optimal HALP cut-off was determined using the Youden index. The area under the curve (AUC) with a 95% confidence interval (CI) was calculated. A two-sided p -value < 0.05 was considered statistically significant.

3. Results

3.1 Patient characteristics

During the study period, 128 patients who underwent urethroplasty were initially screened. Twelve patients were excluded because of active urinary tract infection at the time of surgery, and 25 were excluded because the required clinical or laboratory data were incomplete. Thus, 91 male patients were included in the final analysis. During a median follow-up of 18 months (IQR: 12–28), 17 patients (18.7%) experienced stricture recurrence, while 74 patients (81.3%) remained recurrence-free.

The median age of the cohort was 46 years (IQR: 34–58). Patients with recurrence more often had a history of prior urethral intervention (52.9% vs. 27.0%, $p = 0.041$) and longer strictures (3.1 ± 1.2 cm vs. 2.3 ± 1.0 cm, $p = 0.018$). Stricture location, etiology, surgical technique, and diabetes mellitus were also described according to recurrence status. Median preoperative Qmax did not differ significantly between the recurrence and recurrence-free groups (6.1 (0.0–9.1) vs. 4.9 (0.0–6.95) mL/s, $p = 0.357$). In contrast, median first-month postoperative Qmax was significantly lower in patients with recurrence (12.25 (10.48–27.03) vs. 25.00 (16.10–40.35) mL/s, $p = 0.017$). These findings are summarized in Table 1.

3.2 Preoperative HALP score and logistic regression analysis

The preoperative HALP score was significantly lower in patients with stricture recurrence than in those without recurrence

(median (IQR): 34.8 (28.1–41.6) vs. 48.9 (39.4–57.3), $p = 0.003$).

When individual laboratory parameters were evaluated separately, hemoglobin, albumin, lymphocyte count, and platelet count did not differ significantly between groups (all $p > 0.05$). In contrast, the composite HALP score was significantly associated with recurrence.

In univariable logistic regression analysis, lower HALP scores were associated with greater odds of recurrence (OR 0.94 per unit increase, 95% CI: 0.90–0.98, $p = 0.004$). Other variables associated with recurrence included prior urethral intervention and stricture length.

In multivariable logistic regression analysis adjusting for stricture length and history of prior intervention, the HALP score remained independently associated with recurrence (adjusted OR 0.95, 95% CI: 0.91–0.99, $p = 0.012$). These results are summarized in Table 2.

3.3 Discriminatory performance of the HALP score

ROC analysis showed moderate discrimination of the HALP score for stricture recurrence, with an AUC of 0.73 (95% CI: 0.61–0.85) (Fig. 1). The HALP cut-off of 42.0 yielded a sensitivity of 70.6% and specificity of 67.6% for predicting recurrence.

TABLE 1. Clinical characteristics according to stricture recurrence status.

Characteristics	Recurrence (n = 17)	No Recurrence (n = 74)	p-value
Age, yr, median (IQR)	48 (36–60)	45 (33–57)	0.580
Prior urethral intervention, n (%)	9 (52.9%)	20 (27.0%)	0.041
Stricture length, cm, mean $\pm$ SD	3.1 ± 1.2	2.3 ± 1.0	0.018
Stricture location, n (%)			
Bulbar	14 (82.4%)	64 (86.5%)	
Penile	2 (11.8%)	8 (10.8%)	–
Posterior	1 (5.9%)	2 (2.7%)	
Etiology, n (%)			
Iatrogenic	10 (58.8%)	44 (59.5%)	
Traumatic	5 (29.4%)	22 (29.7%)	
Idiopathic	1 (5.9%)	7 (9.5%)	–
Lichen sclerosus-related	1 (5.9%)	1 (1.4%)	
Preoperative Qmax, mL/s, median (IQR)	6.1 (0.0–9.1)	4.9 (0.0–6.95)	0.357
First month postoperative Qmax, mL/s, median (IQR)	12.25 (10.48–27.03)	25.00 (16.10–40.35)	0.017
Surgical technique, n (%)			
Excision and primary anastomosis	4 (23.5%)	10 (13.5%)	–
Substitution urethroplasty	13 (76.5%)	64 (86.5%)	
Comorbidities, n (%)	6 (35.3%)	21 (28.4%)	0.570
Diabetes mellitus, n (%)	4 (23.5%)	15 (20.3%)	–
Follow-up duration, mon, median (IQR)	17 (12–26)	18 (13–29)	0.720

Categorical variables with sparse subgroup counts were presented descriptively without formal between-group hypothesis testing. IQR, interquartile range; SD, standard deviation; Qmax, maximum urinary flow rate.

TABLE 2. Univariable and multivariable logistic regression analyses for stricture recurrence after urethroplasty.

Variables	Univariable OR (95% CI)	<i>p</i> -value	Multivariable OR (95% CI)	<i>p</i> -value
HALP score	0.94 (0.90–0.98)	0.004	0.95 (0.91–0.99)	0.012
Age, yr	1.01 (0.97–1.05)	0.610	–	–
Prior urethral intervention	2.89 (1.03–8.10)	0.043	2.41 (0.91–6.39)	0.078
Stricture length, cm	1.58 (1.07–2.34)	0.021	1.42 (1.01–2.01)	0.046

The multivariable logistic regression model included HALP score, prior urethral intervention, and stricture length. For continuous variables, ORs represent the effect of a one-unit increase in the corresponding variable. CI, confidence interval; HALP, hemoglobin-albumin-lymphocyte-platelet score; OR, odds ratio.

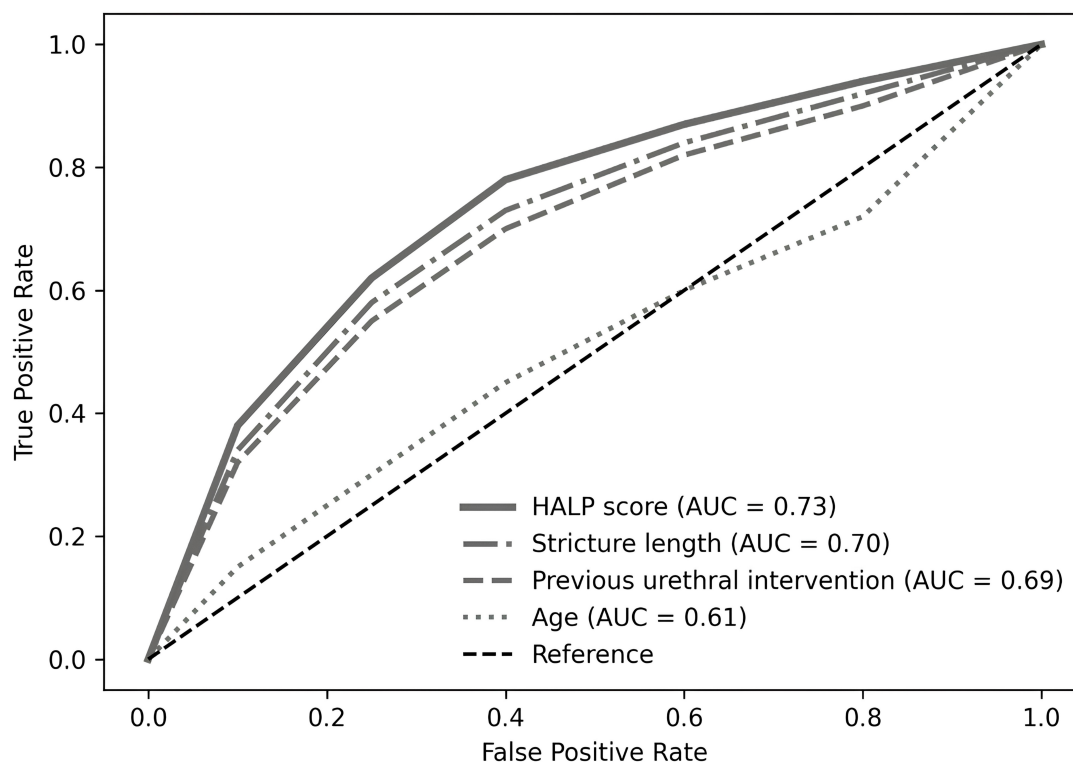


FIGURE 1. Receiver operating characteristic (ROC) curves illustrating the predictive performance of the HALP score, stricture length, prior urethral intervention, and age for urethral stricture recurrence after urethroplasty. The diagonal dashed line indicates the reference line representing no discriminatory ability. AUC, area under the curve; HALP, hemoglobin, albumin, lymphocyte, and platelet score.

4. Discussion

This study shows that the preoperative HALP score is significantly associated with stricture recurrence. Patients with recurrence had significantly lower HALP scores than those without recurrence (median 34.8 vs. 48.9, $p = 0.003$). However, none of the individual hematologic parameters differed significantly between groups (all $p > 0.05$). The HALP score remained independently associated with stricture recurrence even after adjusting for established clinical risk factors, such as stricture length and prior urethral intervention (adjusted OR 0.95, 95% CI: 0.91–0.99; $p = 0.012$). ROC analysis further showed that the HALP score provided moderate discrimination for recurrence (AUC = 0.73) and had a numerically higher AUC than traditional clinical predictors, including age, prior intervention, and stricture length, although the AUCs were not formally compared statistically.

The association between systemic inflammatory–nutritional

status and surgical outcomes has been increasingly recognized in oncologic, cardiovascular, and reconstructive surgery. This relationship has also been increasingly examined in urology [16, 17]. In this context, several studies have examined hematologic inflammatory parameters as potential predictors of recurrence in urethral stricture disease. Urkmez *et al.* [18] reported that an elevated preoperative NLR was significantly associated with recurrence following internal urethrotomy. Özsoy *et al.* [19] also reported that a higher SII was significantly associated with recurrence in patients undergoing internal urethrotomy. Although these studies evaluated internal urethrotomy rather than urethroplasty, they support a potential association between systemic inflammatory markers and stricture recurrence. These indices, however, capture only selected components of the inflammatory process and do not incorporate nutritional status or oxygen-carrying capacity, both relevant to tissue healing. Unlike NLR or SII, the HALP

score integrates nutritional and hematologic parameters, potentially offering a broader measure of systemic physiological reserve.

In contrast, the HALP score combines hemoglobin and albumin levels, lymphocyte and platelet counts to provide a composite measure of systemic physiological status. Although originally developed to predict clinical outcomes in oncology, it has subsequently been associated with outcomes in cardiovascular, metabolic, and inflammatory disorders [13, 20]. Currently, however, evidence regarding the role of the HALP score in reconstructive urology remains limited. Our study contributes to the current literature by demonstrating that the HALP score was independently associated with stricture recurrence, a finding that is biologically plausible given the pathophysiology of urethral stricture disease. Adequate hemoglobin levels are critical for oxygen transport to healing tissues, while albumin reflects nutritional status and systemic inflammatory burden. Lymphocytes play a central role in immune regulation and tissue repair, whereas platelets facilitate angiogenesis and inflammatory signaling. Therefore, a lower HALP score may reflect reduced hematologic and nutritional reserve and altered immune-inflammatory status, conditions that could plausibly impair urethral healing. Consistent with its potential relevance to inflammatory and fibrotic processes, the HALP score has also been evaluated for phase differentiation in Peyronie's disease. A recent study demonstrated a significant increase in HALP scores from the acute (inflammatory) phase to the chronic (fibrotic) phase, showing good discriminative performance in identifying the chronic phase (AUC = 0.83) [21]. These findings suggest that HALP may vary across inflammatory and fibrotic disease phases, although its role in localized fibrotic processes requires further study.

The comparative ROC analysis performed in this study provides additional context for the potential clinical relevance of the HALP score. While conventional predictors such as stricture length and prior urethral intervention exhibited reasonable discriminatory ability, their AUC values were numerically lower than those of the HALP score, whereas age showed relatively poor discriminatory performance. The numerically higher AUC for the HALP score suggests that systemic physiological status may provide useful prognostic information beyond anatomical characteristics; however, the AUCs were not formally compared. From a clinical perspective, the HALP score is attractive because it is derived from routinely obtained preoperative laboratory parameters and can be calculated without additional testing when these laboratory values are already available.

The moderate AUC observed in the present study is consistent with the complex nature of urethral stricture recurrence. Integrating measures of inflammatory burden with indicators of physiological reserve may provide complementary prognostic information. No single factor can be expected to predict surgical outcomes; instead, the HALP score should be considered as an adjunct that could complement current risk-stratification approaches.

The strengths of the present study include a well-defined cohort treated at a tertiary care center using standardized procedures performed by experienced reconstructive urologists. Use of both univariable and multivariable analyses allowed assess-

ment of the independent association of the HALP score beyond established risk factors. Moreover, the ROC analysis allowed descriptive comparison of the HALP score with widely used clinical predictors, providing context for its discriminatory performance.

Our study has several limitations. First, its retrospective design is susceptible to selection bias. Surgical technique was not randomly assigned and may have reflected surgeon preference and patient characteristics. In addition, although several clinically relevant factors, including diabetes mellitus, surgical technique, stricture location, and stricture etiology, were descriptively assessed, the limited number of recurrence events precluded their simultaneous inclusion in the multivariable model, and residual confounding cannot be excluded. Second, this study was conducted at a single center with a relatively small sample size, which may limit the generalizability of the results. Third, the HALP score was assessed at only one preoperative time point, and changes in inflammatory or nutritional status over time were not analyzed. Fourth, the relatively small number of recurrence events may have limited the stability of the multivariable model, despite efforts to minimize overfitting by limiting the number of predictors. Finally, although ROC analysis showed moderate discriminatory performance, external validation in independent cohorts is required before the HALP score can be used routinely in clinical decision-making. Since the cut-off value and the AUC are both derived from the same dataset, the findings may be subject to optimism bias. Thus, further validation in larger, multicenter cohorts is necessary before the HALP score is adopted routinely in clinical decision-making. Despite these limitations, our findings may have important clinical implications. Identifying high-risk patients in the preoperative period may enable personalized counseling and closer monitoring; because some components of the HALP score may be modifiable through nutritional support, correction of anemia, or management of systemic inflammation, future prospective studies should determine whether targeted preoperative optimization can improve outcomes.

5. Conclusions

The preoperative HALP score was independently associated with stricture recurrence and showed moderate discriminatory performance. These findings suggest that inflammatory and nutritional status may be associated with urethroplasty outcomes and that the HALP score could serve as an adjunctive tool for preoperative risk assessment. However, further validation in larger, multicenter prospective cohorts is required before its routine implementation in clinical practice.

ABBREVIATIONS

AUC, area under the curve; CI, confidence interval; HALP, hemoglobin, albumin, lymphocyte, and platelet score; IQR, interquartile range; OR, odds ratio; ROC, receiver operating characteristic; SII, systemic immune-inflammation index; NLR, neutrophil-to-lymphocyte ratio; Qmax, maximum urinary flow rate; SD, standard deviation.

AVAILABILITY OF DATA AND MATERIALS

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

AUTHOR CONTRIBUTIONS

AED and AS—designed the study. AED, AH, AS and MA—developed the methodology. AED, AS and MYA—performed the formal analysis. AED, AS, GO and FS—conducted the investigation. GO, FS, MA and MYA—curated the data. AED—wrote the original draft of the manuscript. AS and TS—reviewed and edited the manuscript. AH and TS—supervised the study. All authors contributed to manuscript revision. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted in accordance with the Declaration of Helsinki and approved by the local ethics committee of Ankara Etlik City Hospital (approval number: AESH-BADEK2-2025-495). The requirement for patient consent was waived due to the retrospective design and the use of anonymized patient data.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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