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ORIGINAL ARTICLE

The efficacy of hemoglobin, albumin, lymphocytes, and platelets (HALP) score in signifying acute appendicitis severity and postoperative outcomes

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Abstract
The HALP score, which is a combined index composed of hemoglobin, albumin, lymphocyte, and platelet, is a new indicator showing both inflammation and nutritional status. This study aims to evaluate the relationship of this combined index consisting of simple laboratory values with the degree of appendicitis complication and postoperative results in patients operated on for acute appendicitis. The data of 684 patients operated for acute appendicitis between January 2017 and December 2022 and inclusion criteria were analyzed with a single-center retrospective cross-sectional study design. Using routine laboratory data, patients' HALP scores were divided into two groups as low and high. The cut-off value of the HALP score according to the presence of postoperative complications was determined as < 31.2 by ROC analysis and the ROC curve. Patients were grouped as HALP score cut-off value below (group 1) and above (group 2). Complicated appendicitis and postoperative outcomes were compared to the HALP score groups. According to the cut-off value of the HALP score, 113 (16.5%) of the patients were in Group 1, and 571 (83.5%) were in Group 2. Complications developed in 15 (26%) patients ($p < 0.001$). Low HALP scores were a significant risk factor for peri-appendicular abscess (OR 29.12 95% CI 12.39–68.43), appendicitis perforation (OR = 20.82 95% 12.67–34.19), gangrenous appendicitis (OR = 35, 54, 95% 13.33–94.77), and postoperative complications (OR = 15.29 95% 7.95–29.41) ($p < 0.001$). Besides clinical and radiological findings, the HALP score shows the degree of acute appendicitis complication. It can be used as a simple, inexpensive, and easily applicable diagnostic tool.

Keywords Acute appendicitis · HALP score · Hemoglobin · Albumin · Lymphocytes and platelets score · Inflammation status

Introduction

Acute appendicitis (AA) is among the most common abdominal pathologies in patients presenting to the emergency department (ED) with abdominal pain. It ranks first among the emergency operations surgeons perform in their daily practice [1]. The lifetime incidence is 8.6% in men and 6.7% in women [2]. In addition, the incidence of perforation at the time of diagnosis is between 17 and 20%, as reported in the literature [3]. Although appendectomy has historically been the preferred treatment method in the treatment of AA, studies on conservative methods in treating uncomplicated acute appendicitis have also gained importance in recent years [4, 5].

In addition to the physical examination findings in diagnosing acute appendicitis, complete blood count (CBC) is among the most frequently applied and first looked at by clinicians. In addition, white blood cell (WBC) count, and neutrophil count are among the early markers of inflammatory pathologies [6]. However, the sensitivity and specificity of using these data alone in evaluating inflammatory pathologies vary according to diseases and patient groups. Therefore, researchers used data such as platelets (PLT) count and lymphocyte ratio (NLR) to increase the accuracy in demonstrating inflammatory processes [7–9].

Although serum albumin values were first used to evaluate nutritional status, it was later found to indicate

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inflammation as an acute phase reactant [10–12]. However, decreased albumin level is closely related to postoperative mortality and morbidity in various diseases [13, 14]. Therefore, the combined hemoglobin, albumin, lymphocyte, and platelet (HALP) index is accepted as a new marker reflecting systemic inflammation and nutritional status [15]. In addition, the prognostic and predictive importance of the HALP score in various malignancies has been reported in articles published in recent years [16–18]. However, the relationship between HALP score and non-malignant surgical diseases, especially those requiring emergency surgery, must be clarified sufficiently.

Our study aims to determine whether clinical and radiological data differ between uncomplicated and complicated appendicitis in accordance with the HALP score at the time of admission to the hospital in patients diagnosed with acute appendicitis. It also aims to predict optimal HALP score values according to the complication degree of appendicitis in patients diagnosed with acute appendicitis.

Material – method

Patient selection

The data of patients who had acute appendicitis operation in our clinic between January 2017 and December 2022 were analyzed with a single-center retrospective cross-sectional study design. Patients who underwent appendectomy with the diagnosis of acute appendicitis had preoperative blood tests and had complete data were included in the study. Patients with cancer diagnosis, appendectomy with additional surgery, acute appendicitis in pregnancy, diagnosed as appendiceal carcinoma after pathological thinning and missing data were excluded from the study.

Data collection

Demographic data of the patients included in the study (age, gender), preoperative HALP score, surgical technique (open, laparoscopic), peroperative findings (perforation, abscess, gangrenous), appendicitis classification (normal, simple, and complex), postoperative complications, length of hospital stay, pathology results, radiological and pathological appendix size were recorded. The Clavien Dindo scale was used to evaluate the presence and severity of postoperative complications.

The alvarado score is calculated in all patients with suspected acute appendicitis in our clinic. Patients with an Alvarado score < 7 are followed up clinically for 24 h. Surgery is performed in patients with an Alvarado score ≥ 7. HALP score is not used routinely during acute appendicitis treatment in our clinic. Therefore, there is no comparison between the HALP score and imaging techniques.

Study design

HALP score was calculated in all patients. The cut-off value of the HALP score was determined according to the presence of postoperative complications. The HALP score was grouped according to the cut-off value as Low HALP (group 1) and High HALP (group 2) and compared. Carr et al. developed the classification system for the perioperative evaluation of acute appendicitis. This classification system is clinical severity classification based on preoperative evaluation rather than postoperative histopathology. Acute appendicitis is classified as normal, simple, and complex [19].

HALP score

As a result of preoperative laboratory analysis, hemoglobin, albumin, lymphocyte, and platelet values were recorded. HALP score was calculated as hemoglobin (g/L) × albumin (g/L) levels × lymphocyte count (/L) / platelet count (/L). The cut-off value of the HALP score was determined according to the presence of postoperative complications. ROC analysis and ROC curve were created to establish the HALP score cut-off value. The cut-off value of the HALP score was determined according to the presence of postoperative complications. HALP score cut-off value was determined as < 31.2 (Table 1) (Fig. 1).

Statistical analysis

The mean and standard deviation values were used while performing the statistics of continuous data. Frequency and percentage values were used to define categorical variables. Student's t-test was used to compare the means of two independent groups. The Chi-square test was used to evaluate the relationship between categorical variables. The HALP score was determined by ROC curve analysis to determine the cut-off in its measurements in predicting the presence of postoperative complications. Significance in ROC analysis

Table 1 HALP score cut-off value for detecting the presence of postoperative complications

	Sensitivity	Specificity	AUC	LR +	LR –	*p* value	Cut-off
HALP	68,75	86,16	0,79	4,09	0.38	< 0.001	≤ 31,2

AUC Area under the ROC Curve, *LR* Likelihood Ratio

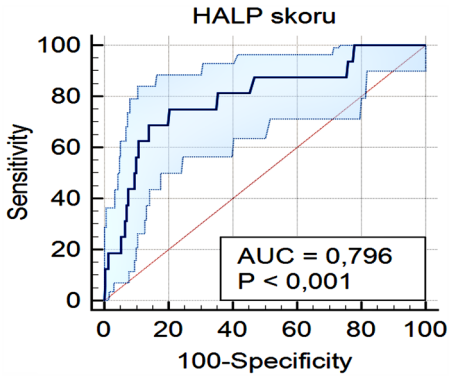

Fig. 1 Receiver operator characteristic curve (ROC) for acute appendicitis complications degree showed the AUC value was 0.796, (95% confidence interval (CI) 4.09–0.38, $p < 0{,}001$) for HALP score and the cutoff value was ≤ 31,2

was determined by sensitivity, specificity, likelihood ratio (+), and likelihood ratio (-) statistics. The statistical significance level of the data was taken as $p < 0.05$. Statistical analyzes were performed using the MedCalc (16.4.3) program and www.e-picos.com.

Results

During the study, appendectomy was performed on 769 patients diagnosed with acute appendicitis in our hospital. Open, and 321 (41.7%) laparoscopic appendectomies were performed in 448 (58.3%) patients. 29 patients with a cancer diagnosis, 17 patients who underwent additional surgery with appendectomy, 11 patients diagnosed with appendiceal carcinoma after pathological thinning, and 28 patients with missing data were excluded from the study. The study included six hundred eighty-four patients who met the inclusion criteria.

The mean age of the patients was 37.57 ± 13.04 years. Of the patients, 388 (56.7%) were male, and 296 (43.3%) were female. According to the cut-off value of the HALP score, 113 (16.5%) of the patients were in Group 1, and 571 (83.5%) were in Group 2. There was no statistically significant difference between the groups regarding gender distribution, surgical technique, and an average length of hospital stay ($p > 0.05$). However, the mean age and appendicitis size (radiological and pathological) in group 1 were significantly higher than group 2 ($p < 0.05$). 0.001). In the evaluation of peroperative appendicitis, the incidence of periappendicular abscess, perforation, and gangrenous was significantly higher in group 1 than in group 2 ($p < 0.001$) (Table 2).

Postoperative complications were seen in 33 (29.2%) patients in group 1 and 15 (2.6%) in group 2. The frequency and severity of postoperative complications were significantly higher in group 1 than in group 2 ($p < 0.001$). In addition, when the groups were compared in terms of appendicitis classification, group 1 had a more complex appendicitis distribution than Group 2 ($p < 0.001$) (Table 2).

A ROC curve was generated to determine the cut-off values for the HALP score, and Youden's index was calculated. The area under the curve (AUC) value of the HALP score was 0.796 [95% confidence interval (CI) 4.09–0.38, $p < 0{,}001$], and the cut-off value according to Youden's index was ≤ 31, 2 (sensitivity 68.75%, specificity 86.16%). The ROC curve of the HALP score and HALP score cut-off value for detecting the presence of postoperative complications are shown in Fig. 1 and Table 1.

The effect of a low HALP score on the perioperative appendix clinic and postoperative complications was evaluated. Low HALP score perappendicular abscess (OR 29.12 95% CI 12.39–68.43), appendicitis perforation (OR = 20.82 95% 12.67–34.19), gangrenous appendicitis (OR = 35.54), 95% 13.33–94.77), postoperative complications (OR = 15.29 95% 7.95–29.41) were significant risk factors ($p < 0.001$) (Table 3).

Discussion

This study evaluated the prognostic value of the novel index HALP score in patients with acute appendicitis. In line with the data, we have shown in our study, a low HALP score is associated with the complication of acute appendicitis (perforation, gangrenous, abscess) and postoperative morbidity; A high HALP score is associated with uncomplicated acute appendicitis.

Complicated appendicitis is mentioned in cases of perforation, gangrenous, intra-abdominal abscess, and fecal peritonitis in acute appendicitis, and morbidity and mortality rates are higher in complicated appendicitis [20]. In managing acute appendicitis, early and accurate determination of the extent of the disease as a result of physical examination, laboratory findings, and appropriate radiological examinations is very important in terms of postoperative results. Because the management of uncomplicated acute appendicitis and complicated acute appendicitis are quite different, uncomplicated acute appendicitis cases were discharged from the hospital in a short time with simple appendectomy; In complicated appendectomy cases, it may be exposed to more extensive surgery and interventional radiology drainage procedures, which is an indication that more morbidity will develop [21].

In this study, the degree of complication of acute appendicitis was evaluated with a new scoring system created using preoperative laboratory data. This scoring system examined the complication status of appendicitis (abscess, gangrenous, perforation); and the development of postoperative

Table 2 Demographic and clinical data of the patients

	All patient ($n=684$)	Group I ($n=113$)	Group II ($n=571$)	p value
	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	
Age (year)	37,57 + 13,04	45,35 + 16,99	36,03 + 11,5	**< 0,001**
Appendicitis size (mm)				
Radiological size (mm)	9,92 + 1,73	10,59 + 1,85	9,78 + 1,67	**< 0,001**
Pathological size (mm)	8,89 + 1,75	9.37 + 1.57	8.73 + 1,92	**< 0,001**
Length of stay in hospital	1,28 + 0,99	1,32 + 1,02	1,26 + 0,89	0,523
HALP score	36,85 + 6,43	26,37 + 2,33	38,93 + 4,74	**< 0,001**
	n (%)	*n* (%)	*n* (%)	
Gender				
Male	388 (56,7)	74 (65,4)	314 (54,9)	0,042
Female	296 (43,3)	39 (34,6)	257 (45,1)	
Surgical Technique				
Open	401 (58,6)	69 (61,1)	332 (58,1)	0,565
Laparoscopy	283 (41,4)	44 (38,9)	239 (41,9)	
Peroperative gangrenous	37 (5,4)	30 (26,5)	7 (1,2)	**< 0,001**
Peroperative perforation	109 (15,9)	69 (61,1)	40 (7)	**< 0,001**
Peroperative abscess	32 (4,7)	27 (23,9)	5 (0,9)	**< 0,001**
Postoperative Complication				
Yes	48 (7,0)	33 (29,2)	15 (2,6)	**< 0,001**
No	636 (93,0)	80 (70,8)	556 (97,4)	
Clavien Dindo Scale				
I	30 (62,5)	18 (54,5)	12 (80)	**< 0,001**
II	6 (12,5)	3 (9,1)	3 (20)	
III	9 (18,7)	9 (27,3)	–	
IV	3 (6,3)	3 (9,1)	–	
V	–	–	–	
Appendicitis classification				
Normal	505 (73,8)	35 (30,9)	470 (82,3)	**< 0,001**
Simple	141 (20,6)	75 (66,4)	66 (11,6)	
Complex	38 (5,6)	3 (2,7)	35 (6,1)	

Bold expressions show statistically significant parameters between HALP score groups

Table 3 Relationship between multivariate analysis and low HALP score and clinical status

	Odds Ratio	95% Confidence interval	p value
Abscess	29,12	12,39–68,43	**< 0,001**
Gangrenous	35,54	13,33–94,77	**< 0,001**
Perforation	20,82	12,67–34,19	**< 0,001**
Complication	15,29	7,95–29,41	**< 0,001**

Bold expressions show statistically significant parameters between HALP score groups

complications. In recent studies, conservative management is essential in treating uncomplicated appendicitis [22, 23]. Therefore, it is crucial to determine the degree of acute appendicitis complication in the preoperative period. Missing complicated appendectomies may delay surgery and increase the risk of postoperative complications. In this context, the HALP score is a simple and applicable tool that can be used to distinguish these two conditions.

Today, USG and CT have a very high accuracy in diagnosing acute appendicitis and have become the standard [24]. Both imaging modalities can distinguish between complicated and uncomplicated cases with varying accuracy [25]. Defects in the wall of appendicitis with deterioration of its wall integrity, extraluminal free air, and fluid collection around the appendix are among the main radiological findings evaluated in favor of complicated appendicitis [26]. However, for treatments other than an appendectomy, it is not appropriate to rely only on imaging methods to exclude the diagnosis of gangrenous or perforated appendicitis [27]. Therefore, in patients with suspected acute appendicitis, the WSES guideline recommends an individualized diagnostic approach to plan an appropriate step-by-step diagnostic pathway for diagnosing the disease and determining its severity based on the patient's age, gender, and clinical signs and

symptoms [28]. Therefore, combining scoring systems created with auxiliary laboratory data is crucial for the correct diagnosis.

In the physiopathology of the diseases, data proving inflammatory response is closely related to the severity of the disease and postoperative results are being replaced by an increasing number of articles in the literature. Consistent with previous research, this study demonstrated that preoperative inflammation scores such as HALP are associated with disease severity and prognosis in patients with acute appendicitis.

There are several limitations to our study. The first small number of patients included in the study and the single-center and retrospective design of the study. To evaluate the accuracy and reliability of the relationship between postoperative outcomes and the HALP score in the management of acute appendicitis, multicenter prospective studies with larger patient populations are recommended. Another limitation is that the radiological tools used to diagnose complicated acute appendicitis should be mentioned. The most important of the study's strengths is that it is the only study in which the HALP score is applied to benign and emergency diseases.

In conclusion, the HALP score is a new marker created using data obtained from simple laboratory values. It shows the degree of complication of acute appendicitis with acceptable sensitivity and specificity. In addition, the HALP score can be used to determine the urgency of cases in radiologically proven acute appendicitis cases. However, it is a new tool that can be used to estimate the degree of complication of appendicitis in cases where cross-sectional imaging methods cannot be used (such as pregnant patients, no tomography in the healthcare facility, and pediatric population).

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Declarations

Conflict of interest The authors declare no conflict of interest.

Compliance with Ethical Standards, Research involving human participants and/or animals, and Informed consent The study was conducted according to the Helsinki declaration about ethical standards.

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