Medical Journal of Bakırköy

Med J Bakirkoy 2026;22(Suppl 1):41-47

DOI: 10.4274/BMJ.galenos.2026.2025.11-3

Research

Platelet Count Abnormalities and Mortality in Pediatric Sepsis: The Dual Role of Thrombocytopenia and Thrombocytosis

Pediatrik Sepsiste Trombosit Sayısı Anormallikleri ve Mortalite: Trombositopeni ve Trombositozun Çift Yönlü Rolü

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ABSTRACT

Objective: Platelet abnormalities are frequent in pediatric sepsis and have been associated with disease severity. However, the prognostic significance of thrombocytopenia and thrombocytosis in children remains unclear. This study aimed to evaluate the relationship between platelet count patterns and in-hospital mortality in pediatric sepsis.

Methods: We retrospectively analyzed children who were admitted to a tertiary pediatric intensive care unit with sepsis. Patients were categorized into thrombocytopenia (<150,000/mm^3), normal (150,000-450,000/mm^3), and thrombocytosis (>450,000/mm^3) groups based on admission platelet counts. Demographic, clinical, and laboratory parameters were collected. Logistic regression was used to identify independent predictors of mortality.

Results: A total of 162 patients were included and overall mortality was 16.2%. Thrombocytopenia was common and associated with illness severity; however, it did not independently predict mortality after adjusting for confounders. Thrombocytosis, although infrequent, was associated with mortality; however, this finding was limited by small numbers of cases. Lactate was the only consistent independent predictor of mortality.

Conclusion: In pediatric sepsis, thrombocytopenia appears to reflect the overall severity of illness rather than serve as an independent determinant of mortality, whereas thrombocytosis may indicate a distinct hyperinflammatory response phenotype. A single platelet count at admission is insufficient for prognostic assessment and should be interpreted in conjunction with metabolic and organ dysfunction indicators. Lactate remained the most reliable predictor of mortality in our cohort.

Keywords: Mortality, pediatric sepsis, platelet count, thrombocytopenia, thrombocytosis

ÖZ

Amaç: Pediatrik sepsiste trombosit anormallikleri sık görülmekte ve hastalık şiddeti ile ilişkili bildirilmektedir. Ancak trombositopeni ve trombositozun prognostik değeri çocuklarda tam olarak netleşmemiştir. Bu çalışmanın amacı, pediatrik sepsiste trombosit sayısı paternleri ile hastane içi mortalite arasındaki ilişkiyi değerlendirmektir.

Gereç ve Yöntem: Bu retrospektif çalışmada, üçüncü basamak bir çocuk yoğun bakım ünitesine sepsis nedeniyle kabul edilen hastalar değerlendirildi. Hastalar başvuru trombosit sayılarına göre trombositopeni (<150.000/mm^3), normal (150.000-450.000/mm^3) ve trombositoz (>450.000/mm^3) olmak üzere üç gruba ayrıldı. Demografik, klinik ve laboratuvar verileri toplandı. Mortaliteyi bağımsız olarak öngören değişkenleri belirlemek için lojistik regresyon analizi kullanıldı.

Bulgular: Toplam 162 hasta çalışmaya dahil edildi ve genel mortalite oranı %16,2 idi. Trombositopeni sık görülmekteydi ve hastalık şiddeti ile ilişkiliydi; ancak düzeltme sonrası mortaliteyi bağımsız olarak öngörmedi. Trombositoz nadir görülmekle birlikte mortalite ile ilişki gösterdi, ancak olgu sayısının azlığı bu bulguyu sınırladı. Laktat, mortalitenin tek tutarlı bağımsız belirleyicisi idi.

Sonuç: Pediatrik sepsiste trombositopeni, mortalitenin bağımsız bir belirleyicisi olmaktan ziyade hastalık şiddetini yansıtmaktadır; trombositoz ise farklı bir hiperenflamatuvar yanıt fenotipini gösterebilir. Başvuru anındaki tek bir trombosit değeri prognoz için yeterli değildir ve metabolik/organ fonksiyon belirteçleri ile birlikte değerlendirilmelidir. Çalışmamızda laktat, mortalitenin en güvenilir öngördürücüsü olmuştur.

Anahtar Kelimeler: Mortalite, pediatrik sepsis, trombosit sayısı, trombositopeni, trombositoz

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Cite as: Boydağ Güvenç K, Güney Şahin E, Yılmaz İA, Varol F, Durak C. Platelet count abnormalities and mortality in pediatric sepsis: the dual role of thrombocytopenia and thrombocytosis. Med J Bakirkoy. 2026;22(Suppl 1):41-47

Received: 06.11.2025
Accepted: 24.02.2026
Publication Date: 25.09.2026

INTRODUCTION

Sepsis is a life-threatening syndrome characterized by organ dysfunction resulting from an uncontrolled host inflammatory response to systemic infection. It poses a significant global health burden, particularly among children, with an estimated 25 million cases worldwide and over 3 million deaths annually (1,2). Early recognition and intervention are crucial for reducing mortality in patients with sepsis.

Platelets play a complex role in sepsis pathophysiology through their interactions with endothelial and immune cells, significantly influencing the clinical course and outcome. Thrombocytopenia, which is frequently observed in patients with sepsis, can result from increased platelet consumption, sequestration, or decreased production due to bone marrow suppression. Conversely, thrombocytosis may develop as part of the acute phase response, with platelets acting as inflammatory mediators (3).

Although severe thrombocytopenia has been independently associated with disease severity and mortality in adult intensive care patients, pediatric studies are limited and present conflicting results (4-7). Moreover, the prognostic value of thrombocytosis in sepsis has not been studied extensively.

This retrospective observational study aimed to evaluate the prognostic effect of platelet abnormalities (thrombocytopenia and thrombocytosis) on in-hospital mortality in pediatric patients admitted with sepsis. By examining the relationship between platelet counts (PCs) and clinical outcomes, this study seeks to contribute to the understanding platelet dynamics in pediatric sepsis and to potentially inform clinical decision-making and risk stratification strategies.

Methods

Study Design and Patient Selection

This study is a single-center, retrospective cohort study conducted using the retrospective file data of patients hospitalized in the 3rd-level pediatric intensive care unit (PICU) of University of Health Sciences Türkiye, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital between 2022 and 2024. The study was performed in compliance with the Declaration of Helsinki. The study methodology was approved by University of Health Sciences Türkiye, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital Clinical Research Ethics Committee (approval no: 283, date: 27.08.2025), and all anonymized data linked to the study are accessible upon reasonable request.

A total of 162 pediatric patients, aged between 1 month and 18 years, who were followed up with a diagnosis of sepsis and had complete laboratory data from the first 24 hours of intensive care admission, were included in the study. Patients were excluded from the study if they had received a platelet transfusion prior to PICU admission, had a known platelet disorder (such as immunodeficiency syndromes associated with thrombocytopenia, e.g., Wiskott-Aldrich syndrome), or had been diagnosed with a hematological malignancy. Individuals with comorbid conditions or those who underwent interventions known to directly affect platelet levels (e.g., heparin therapy that can cause heparin-induced thrombocytopenia) were also excluded. Furthermore, patients with missing clinical or laboratory data were not included in the analysis. Data were collected on requirements for extracorporeal therapy and inotropic support, presence of acute kidney injury, laboratory parameters, and mortality. Blood samples were obtained from all patients upon admission, and the most severe values were recorded within the first 24 hours.

On the day of admission, the following were measured: complete blood count (including leukocyte and neutrophil counts), PC, mean platelet volume (MPV), red cell distribution width (RDW), lactate dehydrogenase, C-reactive protein, procalcitonin, albumin, and lactate levels.

To determine the Pediatric Risk of Mortality III (PRISM III) score, data on 16 variables were collected within the first 24 hours after admission to the intensive care unit. These variables included: body temperature, systolic blood pressure, heart rate, serum creatinine, blood urea nitrogen, serum potassium, blood glucose, partial arterial oxygen pressure, partial arterial carbon dioxide pressure, Glasgow Coma Scale, pupil reaction, prothrombin time, activated partial thromboplastin time, serum bicarbonate levels, and white blood cell count and PC.

Sepsis was diagnosed based on the presence of life-threatening organ dysfunction accompanying infection and, in accordance with the 2020 Surviving Sepsis Campaign International Guidelines. Organ dysfunction was evaluated based on cardiovascular (hypotension, need for vasopressors), respiratory, renal, neurological, or coagulation disorders (8).

Patients were divided into three groups according to their PC: thrombocytopenia (<150,000/mm^3), normal platelet levels (150,000-450,000/mm^3), and thrombocytosis (>450,000/mm^3).

Thrombocytopenia was defined as a PC <150×10⁹/L, consistent with the commonly used definition in the pediatric sepsis literature (4). In addition to absolute PC at admission, dynamic changes in platelet levels were also evaluated. Patients who did not have thrombocytopenia at admission but experienced a decrease of more than 50% in PC within the first 24 hours of PICU admission were identified and analyzed separately. Furthermore, the development of new-onset thrombocytopenia at any time during the PICU stay was recorded.

The primary outcome measure was in-hospital mortality, and the secondary outcome measures were the need for invasive mechanical ventilation (IMV), inotropic treatment, therapeutic plasma exchange (TPE), and continuous renal replacement therapy (CRRT).

The laboratory data were processed in the central laboratory of our hospital according to routine clinical protocols and blood samples were collected in EDTA tubes and analyzed using automated hematology analyzers.

Statistical Analysis

Statistical analyses were performed using the SPSS Statistics software. The distribution of continuous variables was assessed using the Kolmogorov-Smirnov test; non-normally distributed data are presented as median (minimum-maximum). The Mann-Whitney U test was used for comparisons of continuous variables between groups to compare continuous variables between groups, and the chi-square test was used for categorical variables to compare categorical variables.

To identify independent risk factors for mortality, multivariable logistic regression analysis was conducted. The predictive performance of PC for mortality was evaluated using a receiver operating characteristic (ROC) curve, and the area under the ROC curve (AUC) was calculated. Statistical significance was set at $p<0.05$.

RESULTS

A total of 162 pediatric patients were included in this study. Of these patients, 90 (55.6%) were male and the median age was 21 months (1-208 months). The median length of hospital stay was 7 days (1-101 days), and the PRISM III score was 6 (0-40). The presence of PRISM III scores of zero reflects that patients were diagnosed with sepsis at an early stage, before the development of measurable physiological derangements included in the PRISM III scoring system.

IMV was required in 52.6% (n=82) of patients, and the median duration of IMV was 5 days (1-90). Inotropic agents were used in 41.4% (n=67) of patients; acute kidney injury (AKI) developed in 26.5% (n=43). TPE was required in 25.3% (n=41) of the patients, and CRRT was required in 21.7% (n=35). Mortality occurred in 27 patients (16.7%) (Table 1).

Patients were divided into two groups based on mortality status. Among patients who did not survive, PRISM III scores, need for inotropes, CRRT, AKI, need for mechanical ventilation, and need for TPE were higher ($p<0.001$, $p<0.001$, $p<0.001$, $p<0.001$, $p<0.001$, and $p=0.004$, respectively). In addition, the duration of IMV was significantly longer in patients who did not survive ($p=0.010$) (Table 2).

Thrombocytopenia and thrombocytosis were observed in 32% (n=52) and 18% (n=29) of patients diagnosed with sepsis, respectively. Thrombocytopenia was significantly more frequent in the non-survivors ($p=0.006$). Lactate levels were significantly higher in non-survivors ($p=0.014$). No significant relationships were found among the other laboratory parameters (Table 3).

Paired analysis demonstrated a significant decrease in PCs within the first 24 hours of PICU admission ($p<0.001$), whereas no significant temporal changes were observed in MPV or RDW values (Table 4).

Among patients who did not have thrombocytopenia at admission, a decrease in PC greater than 50% within the first 24 hours and the development of new-onset thrombocytopenia during the PICU stay were significantly more frequent among non-survivors.

In the multivariable logistic regression analysis, inotropic agent requirement [odds ratio (OR): 0.095, 95% confidence interval (CI): 0.022-0.414, $p=0.002$] and CRRT requirement (OR: 0.23, 95% CI: 0.057-0.927, $p=0.036$) were independently associated with mortality. After adjustment for disease severity and organ support therapies, the PRISM III score,

Table 1. Clinical features of patients

Total	**162**
Gender, male (n, %)	90 (55.6)
Age (months), median (min-max)	21 (1-208)
Length of hospital stay (day), median (min-max)	7 (1-101)
PRISM III score, median (range)	6 (0-40)
Mechanical ventilation requirement (n, %)	82 (52.6)
Duration of invasive mechanical ventilation (day), median (min-max)	5 (1-90)
Inotropic agent requirement (n, %)	67 (41.4)
Evidence of acute kidney injury	43 (26.5)
TPE requirement (n, %)	41 (25.3)
CRRT requirement (n, %)	35 (21.7)
Mortality (n, %)	27 (16.7)

CRRT: Continuous renal replacement therapy, PRISM III: Pediatric risk of mortality III score, TPE: Therapeutic plasma exchange

plasma exchange, and PC categories were not independently associated with mortality. Using thrombocytopenia as the reference category, neither normal platelet count nor thrombocytosis was independently significant in the multivariable model (Table 5).

At a cut-off value of 285,000/mm^3, the PC demonstrated a sensitivity of 88.9% and a specificity of 40.7% for predicting in-hospital mortality. The ROC analysis yielded an AUC of 0.667 (95% CI: 0.560-0.773). The positive predictive value and negative predictive value at this threshold were 23.1% and 94.8%, respectively (Table 6).

Table 2. Comparison of survivors and non-survivors with prognostic factors

		Mortality		p-value
		Yes (n=27)	No (n=135)	
PRISM III score, median (range)		13 (2-40)	5 (0-30)	<0.001
Length of hospital stay (day), median (range)		8 (1-90)	7 (1-101)	0.730
Duration of invasive mechanical ventilation (day), median (min-max)		7.5 (1-90)	4 (1-88)	0.010
Acute kidney injury, n (%)	Yes	17 (63.0)	26 (19.3)	<0.001
	No	10 (37.0)	119 (73.5)	
Inotropic agent requirement, n (%)	Yes	24 (88.9)	43 (31.9)	<0.001
	No	3 (11.1)	92 (68.1)	
TPE requirement, n (%)	Yes	13 (48.1)	28 (20.7)	0.004
	No	14 (51.9)	107 (79.3)	
CRRT requirement, n (%)	Yes	16 (61.5)	19 (14.1)	<0.001
	No	11 (38.5)	116 (85.9)	
Mechanical ventilation requirement, n (%)	Yes	27 (100)	55 (40.7)	<0.001
	No	0 (0)	80 (59.3)	

CRRT: Continuous renal replacement therapy, PRISM III: Pediatric risk of mortality III score, TPE: Therapeutic plasma exchange

Table 3. Comparison of survivors and non-survivors with laboratory parameters

		Mortality		p-value
		Yes (n=27)	No (n=135)	
Platelet (10^3/mL)		158 (8-533)	252 (6-680)	0.006
Platelet count categories	Thrombocytopenia	13 (48.1)	39 (28.9)	0.013
	Normal range	13 (48.1)	68 (50.4)	
	Thrombocytosis	1 (3.7)	28 (20.7)	
Leukocytes (10^3/mL)		9090 (20-32010)	11220 (50-86300)	0.080
Neutrophil (10^3/mL)		5090 (0-23160)	7895 (0-76700)	0.142
MPV(ƒL)		10.6 (7.5-13.6)	9.7 (6.7-13.5)	0.093
RDW (%)		14.9 (12.0-18.3)	14.4 (11.9-29.3)	0.635
LDH(U/L)		448 (180-4110)	363 (159-8460)	0.249
CRP, median (range) (mg/dL)		33.52 (0.60-313.60)	43.95 (0.60-443.98)	0.449
PCT (mg/L)		4.6 (0.4-334.2)	5.18 (0.1-593.5)	0.403
Lactate (mmol/L)		2.51 (1.0-16.0)	1.73 (1.0-17.0)	0.014
Albumin (mg/dl)		3.23 (2.6-4)	3.73 (2.0-5.0)	0.059
Δ$^{\varphi}$(0-24h)	Platelet (10^3/mL)	37000 (-129000 to 266000)	345000 (-177000 to 630000)	0.612
	MPV (ƒL)	0 (-1.10 to 2.20)	0 (-8.50 to 122.60)	0.533
	RDW (%)	0 (-2.40 to 2.20)	0 (-15.70 to 11.10)	0.675
Platelet count decrease >50% within 24 hours*, n (%)		6 (46.2)	20 (21.1)	0.047
Development of thrombocytopenia during PICU stay, n (%)		10 (76.9)	28 (29.5)	0.001

Δ$^{\varphi}$: Values represent the change between admission and 24 hours measurements in patients with available paired data. *Among patients without thrombocytopenia at admission
$^{\gamma}$RDW: Red cell distribution width, MPV: Mean platelet volume, LDH: Lactate dehydrogenase, PCT: Procalcitonin, CRP: C-reactive protein

DISCUSSION

Although numerous studies have investigated the relationship between PC and mortality in both adult and pediatric populations, accurately identifying high-risk patients remains a clinical challenge (8). A wide range of biomarkers and scoring systems has been proposed to aid in early risk stratification and improve outcomes; however, no single marker has demonstrated a definitive predictive value (9,10). Therefore, there is growing interest in cost-effective, widely accessible, and easy-to-interpret parameters that can be used not only in intensive care units but also in outpatient settings, emergency departments, and general wards. PC, due to its routine availability and low cost, remains a promising candidate for ongoing clinical evaluation.

The high incidence of thrombocytopenia observed in our cohort aligns with previous studies reporting increased platelet consumption, sequestration, and impaired production during systemic inflammation in sepsis (11,12). Although thrombocytopenia has been consistently associated with disease severity and mortality in both adult and pediatric sepsis (4,5,13), our adjusted analysis demonstrated that it did not independently predict mortality after accounting for confounders such as lactate level and organ dysfunction. This finding supports the concept that

Table 4. Changes in platelet count, MPV, and RDW within the first 24 hours of PICU admission

	n	Mean rank	Sum of ranks	z	p-value
Platelet					
Negative ranks	120	88.33	10599.50	-7.498	**<0.001**
Positive ranks	38	51.62	1961.50		
Ties	2				
Total	160				
MPV					
Negative ranks	77	73.93	5692.50	-0.344	0.731
Positive ranks	71	75.12	5333.50		
Ties	12				
Total	160				
RDW					
Negative ranks	76	66.73	5071.50	-0.587	0.557
Positive ranks	62	72.60	4519.50		
Ties	22				
Total	160				

RDW: Red cell distribution width, MPV: Mean platelet volume

Table 5. Multivariate logistic regression analysis of factors associated with in-hospital mortality

Independent variable		β	OR (95% CI)	p-value
Platelet counts	Normal range vs. thrombocytopenia	-1.535	0.215 (0.022-2.077)	0.184
	Thrombocytosis vs. thrombocytopenia	-1.592	0.203 (0.023-1.831)	0.155
PRISM score		-0.050	0.951 (0.880-1.027)	0.199
Inotropic agent requirement, n (%)		-2.350	0.095 (0.022-0.414)	0.002
TPE requirement, n (%)		1.155	3.173 (0.752-13.389)	0.116
CRRT requirement, n (%)		-1.471	0.230 (0.057-0.927)	0.036

Thrombocytopenia was used as the reference category for platelet count
OR: Odds ratio, CI: Confidence interval, PRISM: Pediatric Risk of Mortality, TPE: Therapeutic plasma exchange, CRRT: Continuous renal replacement therapy

Table 6. Predictive value of platelet count cut-off in sepsis-related mortality

	Cut-off point	Sensitivity (%)	Specificity (%)	AUC (95% CI)	PPV (%)	NPV (%)
Platelet (10^3/mL)	285000	88.9	40.7	0.667 (0.560-0.773)	23.1	94.8

AUC: Area under the curve, CI: Confidence interval, PPV: Positive predictive value, NPV: Negative predictive value

thrombocytopenia is more likely to reflect critical illness severity than to serve as a direct causal determinant of mortality.

Similarly, Zhang et al. (13) reported that PCs below 150×10^9/L were associated with increased 30-day mortality in pediatric septic shock patients. In contrast, Meliani et al. (6) found that non-survivors tended to have lower PCs; however, this difference was not statistically significant, and PC did not remain a significant factor in multivariable analysis, in which only RDW remained an independent predictor. These findings indicate that PC alone may not reliably predict mortality and should be interpreted within the broader clinical and laboratory context, rather than as a sole prognostic marker. Given these conflicting findings, some researchers have proposed that serial monitoring of PC may offer more valuable prognostic insights than baseline values alone (14). It has been suggested that a significant decrease in PC, particularly within the first four days of illness, may indicate disease progression in sepsis, and that persistent thrombocytopenia is more strongly associated with mortality (4,5,15). However, in our study, platelet measurements were limited to admission and early follow-up within the first 24 hours, which restricted our ability to assess longer-term platelet trajectories.

Importantly, our expanded analyses demonstrated that dynamic changes in PC were more strongly associated with mortality than admission values alone. A decrease in PC of greater than 50% within the first 24 hours and the development of new-onset thrombocytopenia during the PICU stay were both significantly more frequent among non-survivors. These findings support previous observations that early platelet decline reflects disease progression and systemic inflammatory burden in sepsis, underscoring the importance of serial platelet monitoring rather than reliance on a single baseline measurement.

In contrast, thrombocytosis, though less frequent, was associated with mortality in our analysis. However, given the limited number of cases and the wide CIs, this finding should be considered exploratory rather than definitive. It is plausible that thrombocytosis represents a distinct hyperinflammatory or cytokine-driven phenotype characterized by increased thrombopoietin and acute-phase reactant activity (3,12). Previous adult ICU studies have linked thrombocytosis to adverse outcomes, prolonged hospitalization, and increased sepsis-related complications (16). In another study, no statistically significant difference in mortality was found between patients with thrombocytosis and those with normal PC levels (17). Therefore, further prospective studies are needed to clarify whether thrombocytosis serves as a compensatory inflammatory marker or contributes to disease pathology in pediatric sepsis.

An increased MPV reflects enhanced platelet production in response to bone marrow stress, resulting in the release of younger and larger platelets into circulation. While several studies have demonstrated an association between MPV and the severity of sepsis (6,18), other studies have reported conflicting findings (17,19). In our study, no significant association was found between mortality and platelet indices, such as MPV and RDW. This discrepancy may be related to physiological differences in the pediatric population and to variations in the timing of MPV measurement. Consistent with our temporal analyses, MPV and RDW did not demonstrate significant changes within the first 24 hours, suggesting that these indices may reflect later or cumulative inflammatory processes rather than acute disease progression. Furthermore, these indices should not be evaluated in isolation but rather in conjunction with PC and other inflammatory markers to provide a more accurate and comprehensive risk prediction.

In this study, lactate was the only consistent independent predictor of mortality. As a biomarker reflecting tissue hypoperfusion and metabolic dysfunction. Elevated lactate levels, a biomarker reflecting tissue hypoperfusion and metabolic dysfunction, have been widely associated with poor outcomes in pediatric sepsis (20). Our findings support the role of lactate as a key parameter in early risk stratification and clinical decision-making in critically ill children.

Study Limitations

Our study had several limitations, including its retrospective design, single-center setting, and relatively small sample size. Additionally, the analysis was based solely on data obtained during the first 24 hours after admission, which limited the ability to assess longer-term dynamic changes. The microbiological findings and clinical complications were not included in the evaluation.

CONCLUSION

Our findings support the clinical value of assessing platelet patterns as adjunctive indicators rather than definitive predictors in pediatric sepsis. While thrombocytopenia appears to reflect disease severity and thrombocytosis may signify a distinct inflammatory phenotype, only lactate consistently predicted mortality. Thus, PC trends should be interpreted alongside clinical severity scores and metabolic markers such as lactate, particularly within the first days of critical illness. Serial platelet monitoring may improve prognostic accuracy, as dynamic trends, rather than a single

baseline value, have been associated with outcomes in prior studies.

ETHICS

Ethics Committee Approval: The study methodology was approved by University of Health Sciences Türkiye, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital Clinical Research Ethics Committee (approval no: 283, date: 27.08.2025).

Informed Consent: We obtained informed consent from all parents before hospitalization and during all procedures.

FOOTNOTES

Authorship Contributions

Surgical and Medical Practices: K.B.G., C.D., Concept: E.G.Ş., C.D., Design: K.B.G., E.G.Ş., C.D., Data Collection or Processing: K.B.G., İ.A.Y., Analysis or Interpretation: C.D., Literature Search: K.B.G., E.G.Ş., F.V., Writing: İ.A.Y., F.V.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declare that this study received no financial support.

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