ORIGINAL ARTICLE

ANALYSIS OF NEW POTENTIAL HEMOGRAM BIOMARKERS IN PATIENTS PRESENTING TO THE EMERGENCY DEPARTMENT WITH EPILEPTIC SEIZURES

Acil Servise Epileptik Nöbet ile Başvuran Hastalarda Yeni Potansiyel Hemogram Biyobelirteçlerinin Analizi

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Geliş tarihi/Received: 24.05.2024
Kabul tarihi/Accepted: 03.09.2024
DOI: 10.16919/bozoktip.1489352

Bozok Tıp Derg 2024;14(3):144-151
Bozok Med J 2024;14(3):144-151

ABSTRACT

Objective: We aimed to analyze the diagnostic value of new potential hemogram biomarkers in patients presenting to the emergency department with epileptic seizures.

Material and Methods: Patients presenting with epileptic seizures to a tertiary hospital's emergency department between January 1, 2023, and January 1, 2024, were retrospectively reviewed. The patients were categorized into Group A (seizure patients) and Group B (healthy volunteers). Hemogram and biochemistry data from routine blood tests were examined. To predict seizure status, ROC analysis was performed to evaluate NLR, PLR and PNR. The area under the curve and cutoff values were calculated for each marker.

Results: Our study examined two groups: seizure patients and the control group. The mean age of the seizure group was 50.31±1.83 years, and the mean age of the control group was 49.58±1.96 years (p>0.05). In the seizure group (n=116), 55.8% were male and 44.2% were female, whereas in the control group (n=104), 57.8% were male and 42.2% were female (p>0.05). WBC, neutrophil count, NLR, and PLR values were significantly higher in seizure patients compared to the control group (p<0.001, p<0.001, p<0.001, and p=0.035, respectively). PNR and lymphocyte values were significantly lower in seizure patients compared to the control group (p<0.001 and p=0.01, respectively).

Conclusion: We found significant changes in NLR, PLR, and PNR values in patients with epileptic seizures. We believe that these biomarkers can assist clinicians in diagnosing seizures and distinguishing between seizures and pseudoseizures, especially in emergency departments.

Keywords: *Epileptic Seizure; Neutrophil/Lymphocyte Ratio; Platelet/Lymphocyte Ratio; Platelet/Neutrophil Ratio*

ÖZET

Amaç: Acil servise epileptik nöbet ile başvuran hastalarda yeni potansiyel hemogram biyobelirteçlerinin tanısal değerini analiz etmeyi amaçladık.

Gereç ve Yöntemler: 01 Ocak 2023 ile 01 Ocak 2024 tarihleri arasında, epileptik nöbet ile 3. basmak bir hastanenin acil servisine başvuran hastalar retrospektif olarak incelenmiştir. Hastalar A grubu ve sağlıklı gönüllüler B grubu olarak tanımlanmıştır. Hastalardan rutin alınan kan tetkiklerinden hemogram ve biyokimya verileri incelendi. Nöbet durumunu öngörmek amacıyla NLR, PLR ve PNR'yi değerlendirmek için ROC analizi yapıldı. Her değer için eğri altında kalan alan ve kesim değeri hesaplandı.

Bulgular: Çalışmamız iki grubu inceledi: Nöbet hastaları ve kontrol grubu. Nöbet geçiren grubun yaş ortalaması 50,31±1,83, kontrol grubunun yaş ortalaması 49,58±1,96 idi (p>0,05). Nöbet geçiren grubun (n=116) %55,8'i erkek, %44,2'si kadın iken, kontrol grubunun (n=104) %57,8'i erkek, %42,2'si kadındı (p>0,05). WBC, nötrofil, NLR, PLR değerleri nöbet hastalarında kontrol grubuna göre anlamlı derecede yüksekti (sırasıyla; p<0,001, p<0,001, p<0,001 p=0,035). Nöbet geçiren hastalarda PNR ve lenfosit değerleri kontrol grubuna göre anlamlı derecede düşüktü (sırasıyla; p<0,001 ve p=0,01).

Sonuç: Epileptik nöbet geçiren hastalarda; NLR, PLR ve PNR değerlerinde anlamlı değişiklikler olduğunu ortaya koyduk. Bu biyobelirteçlerin nöbet-psödonöbet ayrımında kullanılmasının özellikle acil servislerde klinisyene tanı koymada yardımcı olabileceği kanaatindeyiz.

Anahtar Kelimeler: *Epileptik Nöbet; Nötrofil/Lenfosit Oranı; Platelet/Lenfosit Oranı; Platelet/Nötrofil Oranı*

INTRODUCTION

Epileptic seizures are defined as short bursts of symptoms and/or signs brought on by extremely high levels of synchronous or excessive cortical neuronal activity. Epilepsy, on the other hand, is a clinical condition characterized by recurrent epileptic seizures (1). Prevalence studies conducted worldwide report an average active prevalence of epilepsy at 6.38 per 1000 individuals. Although no significant differences were observed in gender subgroups, epilepsy was found to be more common in males (Male/Female ratio: 1.5-1.2). Prevalence studies conducted in Turkey showed that the frequency of active epilepsy varied between 5.6/1000 and 10.2/1000 (2). The primary components of epilepsy etiology include structural factors, genetic predisposition, infections, metabolic causes, and immunity (3). Additionally, community-based studies report the proportions of identified presumed causes of epilepsy as follows: cerebrovascular disease 11−21%, trauma 2−6%, neoplasia 4−7%, infection 0-3%, and idiopathic 54−65% (2,3).

Although epileptic seizures in patients with epilepsy are often diagnostic, recognizing these seizures can be quite challenging (4). Subjective findings called aura (such as sensation of bad odor and taste, various visual hallucinations, nausea, etc.) may be observed before an epileptic seizure. However, the most important feature of epileptic seizures is that they are short-lived and transient. Because it is temporary, it has a beginning and an end. Despite their acute and dramatic onset, the end of a seizure may not be as distinct, due to the clinical symptoms being blurred in the postictal phase. While clinical signs are muted in the postictal phase, epileptic seizures present a noisy clinical picture, making seizure recognition relatively easy for clinicians during convulsive episodes. However, certain diseases and conditions can mimic epileptic seizures. These include cardiac and neurological syncope, psychogenic non-epileptic events (such as conversion disorders), transient ischemic attacks, sleep disorders, panic attacks, migraines, acute confusional states, and metabolic disorders, all of which should be considered in the differential diagnosis (4,5). Due to the difficulties in diagnosing epilepsy, the rate of misdiagnosis leading to unnecessary antiepileptic drug use is estimated to be 25% (5).

In patients with epilepsy, epileptic seizures are persistent, and various triggering factors (such as infections, metabolic disorders, inappropriate drug use, etc.) can lead to recurrent seizures. For patients presenting to the hospital, distinguishing between a true epileptic seizure and a pseudoseizure can be significantly challenging for clinicians, even if the patient has experienced one or more seizures. Often, the clinician's only source of information is the history taken from the patient and witnesses. When the reliability of this history is low, it can lead the clinician to a misdiagnosis. Therefore, there is a need for more objective data to definitively diagnose an epileptic seizure (6,7). Electroencephalogram (EEG), computed tomography (CT), and magnetic resonance imaging (MRI) are imaging methods used in the diagnosis of epilepsy (8). Although these imaging methods provide objective results, they are associated with high costs. Additionally, access to these methods can be difficult due to long appointment wait times and equipment shortages. The gold standard for diagnosing patients presenting with seizures, where differentiation between epileptic and non-epileptic seizures cannot be made through history and physical examination, is video electroencephalogram monitoring (VEM) (9). However, VEM is not available in all healthcare facilities and can prolong the definitive diagnosis process.

Clinicians also use blood biomarkers to diagnose epileptic seizures. Elevated levels of blood prolactin and lactate bring the diagnosis of an epileptic seizure a step closer (6,9). Additionally, partial carbon dioxide pressure, white blood cell count, and mean erythrocyte and platelet volumes can be found above normal limits in patients experiencing epileptic seizures (6). Evaluating blood parameters does not take as long as EEG and VEM, making it more useful for clinicians in the acute period for diagnosis. It also surpasses imaging methods such as MRI and CT in terms of cost and potential radiation exposure.

In light of all this information, it is clear that distinguishing between epileptic seizures and pseudoseizures can be challenging for clinicians. At the same time, it is evident that evaluating blood parameters is easier and more accessible for diagnosis than methods such as CT, MRI, EEG, and VEM. Therefore, in this study, we aimed to evaluate changes in blood parameters in patients

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experiencing epileptic seizures to identify parameters that could aid in diagnosis.

MATERIAL AND METHODS

Retrospective cross-sectional study was the methodology used for our research. Patients presenting with complaints of epileptic seizures to the emergency department of a tertiary care hospital between January 1, 2023, and January 1, 2024, were defined as Group A. Group B, the control group, comprised healthy volunteers. Consents were obtained from the subjects or their relatives regarding the procedures to be performed. After receiving approval from Ordu University's Ethics Committee for Clinical Research, the study was started (Ethics Committee Session No: 2024/06, Meeting Date: 29.03.2024). The Helsinki Declaration's principles guided to conduct of our study. Hemogram and biochemical parameters from routine blood tests were evaluated. Hemogram analysis included white blood cell count (WBC), hemoglobin level (Hgb), platelet count (PLT), neutrophil count, lymphocyte count, mean platelet volume (MPV), red cell distribution width (RDW), and mean corpuscular volume (MCV). The neutrophil/lymphocyte ratio (NLR), platelet/lymphocyte ratio (PLR), and platelet/neutrophil ratio (PNR) were manually calculated and recorded. Biochemical analysis included glucose, BUN, and creatinine levels. Furthermore, sociodemographic information was recorded, including gender and age.

Group A included patients over 18 years of age with a diagnosis of epilepsy, who experienced witnessed epileptic seizures, and who were on active antiepileptic medication at the time of the seizure. Patients with known infections, those with chronic diseases known to cause abnormalities in blood hemogram parameters (such as leukemia, lymphoma, multiple myeloma, and iron deficiency anemia), pregnant women, patients undergoing treatment for known intracranial masses, patients with intracranial pathology detected on neuroimaging (intracranial mass, intracranial hemorrhage, ischemic/hemorrhagic stroke), patients without witnessed seizures, those with incomplete data, patients under 18 years of age, and trauma patients were excluded from the study. The control group consisted of healthy volunteers over 18 years of age with no comorbidities who volunteered for the study.

Statistical Analysis

The Statistical Package for Social Sciences (IBM, Armonk, NY, USA) version 22.0 was used to conduct the statistical analyses. Continuous data were tested for normality using the Kolmogorov-Smirnov test, and the findings were reported as mean±standard deviation (std.). For comparing baseline characteristics between the Group A and Group B, chi-square and student t-tests were used. The non-normal distribution of the test results across the two groups was compared using a non-parametric Mann-Whitney U test. The accuracy of NLR, PLR, and PNR analysis for seizure indicate prediction was assessed using ROC (receiver operating characteristic) analysis. For every value, the cut-off value and the area under the curve were determined. Each score's diagnostic test performance was assessed using derived measures of sensitivity, selectivity, and cutoff value. P-values under 0.05 were considered as significant.

RESULTS

At the beginning of the study, 164 patients were admitted to Group A (Seizure group) and 136 patients to Group B (Control group). However, 48 patients in group A were excluded from the study because they met the exclusion criteria (22 with intracranial pathology, 13 with trauma, 6 with iron deficiency anemia, 7 with known infection). When Group B was evaluated, 32 people were excluded from the study due to lack of data (Figure 1).

Seizures and the control group were the two groups we investigated in our study. The seizure group (n = 116) had an average age of 50.31±1.83 years, while the control group (n = 104) had an average age of 49.58±1.96 years. While 55.8% of the seizure group were male and 44.2% were female, 57.8% of the control group were male and 42.2% were female.

Comparison of The Groups

The comparison of the seizure group's and control group's laboratory data and demographics are shown in Table 1. WBC value of 9.8±0.39, neutrophile value of 6.27±0.32, NLR value of 3.95±0.21 and PLR value of 163.42±14.97 were significantly higher in seizure patients compared to the control group ($p<0.001$, $p<0.001$, $p<0.001$ $p=0.035$; respectively). The PNR

value of 48.64±2.42, lymphocyte value of 1.67±0.52 were significantly lower in seizure patients compared to the control group (p<0.001 and p=0.01; respectively). There was no statistically significant difference between the two groups when Hb, PLT, MCV, and RDW levels were evaluated (p>0.05).

ROC Analysis

Table 2 gives the ROC analysis findings for the patients and the control group in terms of sensitivity, specificity, cut off values, and area under the curve. High NLR and high PLR were found to be significant in favor of the disease in the ROC curve analysis (p<0.001, p=0.035; respectively). The ROC curve analysis for NLR revealed optimal cut off value of 2.77, corresponding to a sensitivity and specificity of 60.3% and 62.5, respectively. The ROC curve analysis for PLR revealed optimal cut off value of 128.39, corresponding to a sensitivity and specificity of 63.8% and 62.1, respectively. Low PNR was found to be significant in favor of the disease in the ROC curve analysis (p<0.001). Furthermore, PNR revealed an optimal cut-off value of 55.15 in the ROC Curve analysis, corresponding to a sensitivity and specificity of 64.7% and 55.8%, respectively. Figure 2 shows the ROC analysis plots of NLR and PLR values and Figure 3 shows the ROC analysis plots of PNR values.

DISCUSSION

Data that can be accessed quickly and easily is highly valuable in high-volume settings such as emergency departments. Providing the clinician with rapid information about the patient's prognosis makes these parameters highly useful. Thus, they can be employed as supportive biomarkers alongside physical examination and symptoms. In this context, our study aimed to evaluate whether hemogram parameters could assist clinicians in differentiating between true epileptic seizures and pseudoseizures in patients presenting with complaints of epileptic seizures.

Many parameters associated with inflammation and mortality have been the subject of studies. Huang et al. investigated the relationship between neutrophil/lymphocyte and monocyte/lymphocyte ratios and inflammation in patients with Guillain-Barré syndrome and concluded that these ratios could be used as markers of inflammation in such patients (10). Another study examined the relationship between neutrophil/lymphocyte ratio (NLR) and mortality in spontaneous intracerebral hemorrhages and found that NLR could be used to determine mortality (11). In a study by Yu et al. on the use of NLR as an inflammation parameter in acute ischemic stroke patients and its relationship with clinical outcomes, NLR was reported to be a significant marker for predicting the clinical course of the patient (12). Additionally, studies have shown that the lymphocyte/monocyte ratio is a marker in the clinical follow-up of ischemic stroke patients (13). Research on biochemical parameters in patients with epileptic seizures has identified statistically significant differences in WBC, neutrophil, lymphocyte, NLR, CRP, and PLR laboratory values (14). In the study by Yoldaş et al., routine laboratory parameters in patients with epileptic seizures were examined, and CRP, ALT, and

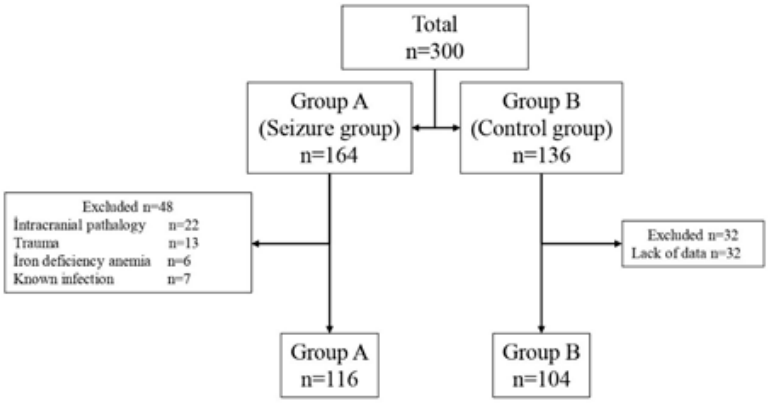

Figure 1. Flow chart of the study

Table 1. Demographic variables and laboratory parameters of groups

	Seizure Group (n=116)	Control Group (n=104)	*p* value
Gender (%)	**n**	**n**	
Male	67 (55.8)	58 (57.8)	0.77
Female	49 (44.2)	46 (42.2)	
	mean±std.	**mean±std.**	***p* value**
Age	50.31±1.83	49.58±1.96	0.78
Glucose (mg/dl)	107.5±3.87	97.58±5.85	**<0.001**
Creatinin (mg/dl)	0.81±0.26	0.77±0.29	0.26
BUN (mg/dl)	13.93±0.58	16.33±1.1	0.81
WBC (10^3uL)	9.8±0.39	7.59±0.23	**<0.001**
Hb (g/dl)	13.35±0.18	13.42±0.17	0.76
Plt (10^3uL)	244.97±8.02	242.69±8.04	0.9
Neutrophile (10^3uL)	6.27±0.32	4.46±0.17	**<0.001**
Lymphocyte (10^3uL)	1.67±0.52	2.09±0.11	**0.01**
MCV (fL)	86.74±0.85	87.86±0.61	0.097
RDW (%)	43.7±0.52	42.09±0.55	0.16
NLR	3.95±0.21	2.99±0.27	**<0.001**
PLR	163.42±14.97	160.07±6.65	**0.035**
PNR	48.64±2.42	62±2.92	**<0.001**

BUN: Blood Urea Nitrogen, Hb: Hemoglobin, Plt: Platelet, MCV: Mean corpuscular volume, WBC: white blood cell, MPV: mean platelet volüme, RDW: Red blood cell distribution width, NLR: neutrophil/lymphocyte ratio, PLR: platelet/lymphocyte ratio, PNR: Platelet/Neutrophil, mg/dl: miligram/desiliter

Table 2. Receiver Operating Characteristic (ROC) Curve analysis of Neutrophil/Lymphocyte Ratio (NLR), Platelet/Lymphocyte Ratio (PLR) and Platelet/Neutrophil Ratio (PNR) in seizure group

Variables	AUC (95%)	cut offf	p	Sensitivity (%)	Spesifity (%)
NLR	0.7 (0.63-0.771)	2.77	<0.001	60.3	62.5
PLR	0.582 (0.505-0.659)	128.39	0.035	63.8	62.1
PNR	0.641 (0.568-0.714)	55.15	<0.001	64.7	55.8

NLR:neutrophil/lymphocyte ratio, PLR: platelet/lymphocyte ratio, PNR: Platelet/Neutrophil

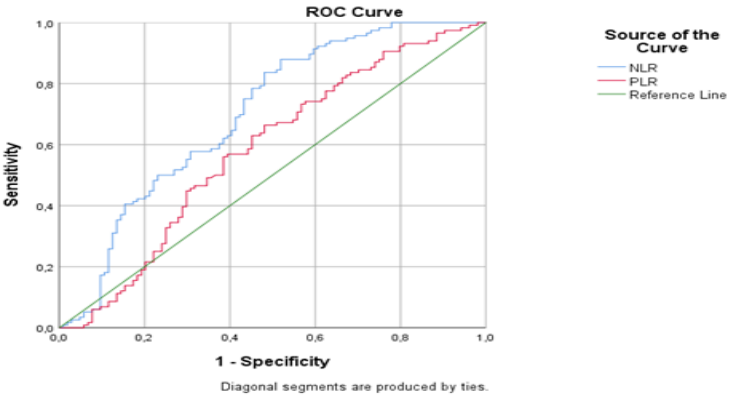

Figure 2. Receiver Operating Characteristic (ROC) Curve analysis of Neutrophil/Lymphocyte Ratio (NLR) and Platelet/Lymphocyte Ratio (PLR) in seizure group

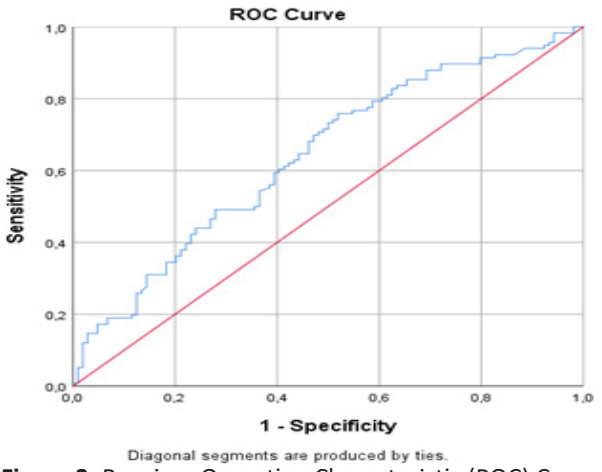

Figure 3. Receiver Operating Characteristic (ROC) Curve analysis of Platelet/Neutrophil Ratio (PNR) in seizure group

glucose levels were found to be significantly higher, while Na and Ca levels were lower. WBC, neutrophil, RDW, NLR, and PLR values were considerably greater in the seizure group compared to the control group in terms of complete blood count parameters, while lymphocytes, MCV, Hb, Hct, and MPV were significantly lower (15). Similarly, an examination of laboratory parameters in patients with febrile convulsions revealed statistically significant differences between the two groups in hemoglobin, hematocrit, platelet (PLT), eosinophil counts, mean platelet volume (MPV), MPV/PLT, and PLT/MPV ratios (16). Jin et al. examined the relationship between hemogram markers and 90-day survival in ischemic stroke patients and found that NLR and PLRlevels were higher, and PNR levels were lower in patients with poor prognosis compared to those with good prognosis (17). In critical trauma patients, the relationship between NLR and mortality was investigated, and it was concluded that elevated NLR is an indicator of poor prognosis in critical trauma patients (18). Similar parameters were studied in hyperemesis gravidarum patients, and it was concluded that NLR and PLR values could be used as inflammatory biomarkers, with associations also reported between these values and preterm birth and low birth weight (19). Based on these studies, we conclude that NLR and PLR values can be used as inflammatory parameters in various diseases and as predictors of clinical progression and even mortality. In addition to studies on NLR and PLR, PNR has also been shown to be an effective biomarker for indicating inflammation. Studies have demonstrated the role of PNR in mortality and patient prognosis in acute ischemic stroke patients (20).

In our study, we compared the hemogram parameters of patients presenting with complaints of epileptic seizures to those of healthy volunteers. Consistent with the aforementioned studies, we found that WBC, NLR, PLR, and neutrophil values were significantly higher in patients with epileptic seizures. Additionally, we observed that the lymphocyte count in patients with epileptic seizures was significantly lower compared to the control group. There was no significant difference in platelet values between the two groups. The increase in neutrophil count along with the decrease in lymphocyte count makes the NLR and PLR values mathematically more significant. In addition to other studies, our study found significant differences in the platelet/neutrophil ratio (PNR) in patients with seizures. While there was no significant change in platelet values, the increase in neutrophil count resulted in a significantly lower platelet/neutrophil ratio in patients with epileptic seizures. Since the control group consisted of healthy volunteers, comparisons with other patient groups with symptoms similar to epilepsy such as (pseudoseizures) cannot be made. However, this situation enabled us to reveal the difference between blood values in healthy volunteers and patients with epileptic seizures.

In our study, we identified an optimal cutoff value of

2.77 for NLR, corresponding to 60.3% sensitivity and 62.5% specificity. For PLR, the optimal cutoff value was 128.39, with 63.8% sensitivity and 62.1% specificity. For the platelet/neutrophil ratio, the optimal cutoff value was 55.15, with 64.7% sensitivity and 55.8% specificity. Based on these data, the significant cutoff values we identified for differentiating between epileptic seizures and pseudoseizures were >2.77 for NLR, >128.39 for PLR, and <55.15 for PNR. Identifying these cutoff values is another finding that distinguishes our study from others.

The diagnosis of epileptic seizures is generally based on patient history. Often, due inaccuracies and omissions in the history, diagnosis becomes challenging. In some patients, pseudoseizures can closely mimic epileptic seizures, often due to secondary gains. In such cases, more objective tests and examinations come to the aid of clinicians. With this aim in mind, we examined the hemogram markers in patients experiencing epileptic seizures to provide guidance for clinicians in diagnosis.

CONCLUSION

We found significant changes in NLR, PLR and PNR values in patients with epileptic seizures. We believe that using these biomarkers and values in the differentiation of seizures from pseudoseizures can significantly speed up diagnosis, especially in emergency departments. Furthermore, we think that these markers may play a guiding role in determining the need for treatment of seizures in epileptic patients.

Acknowledgements

The authors declare no conflict of interest. The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Fisher RS, Acevedo C, Arzimanoglou A, Bogacz A, Cross JH, Elger CE, Vd. ILAE Official Report: A Practical Clinical Definition of Epilepsy. Epilepsia. 2014;55(4):475-82.

2. Calisir N, Bora I, Irgil E, Boz M. Prevalence of Epilepsy in Bursa City Center, an Urban Area of Turkey. Epilepsia. 2006;47(10):1691-9.

3. Icagasıoglu Df. Etiology and Risk Factors of Epilepsy. Basic Pediatr Neurology Diagnosis and Treatment. 2022;2091-98.

4. Manford M. Recent Advances in Epilepsy. J Neurol. 2017;264(8):1811-24.

5. Akdag G, Algın D, Erdinç O. Epılepsy. Osmangazi Journal of Medicine 2016;38(1).

6. Banote RK, Akel S, Zelano J. Blood Biomarkers in Epilepsy. Acta Neurol Scand. 2022;146(4):362-8.

7. Sabers A, Kjær TW. Epilepsi. Ugeskr Læg Online. 2014;176(26):1232-5.

8. Hampel KG, Garces-Sanchez M, Gomez-Ibanez A, Palanca-Camara M, Villanueva V. Diagnostic Challenges in Epilepsy. Rev Neurol. 2019;68(6):255-63.

9. Cakıl D, Inanir S, Baykan H, Aygun H, Kozan R. Psychogenic Non-Epileptic Seizures in the Differential Diagnosis of Epilepsy. Goztepe Journal of Medicine. 2013;28(1):41-7.

10. Huang Y, Ying Z, Quan W, Xiang W, Xie D, Weng Y, et al. The Clinical Significance of Neutrophil-To-Lymphocyte Ratio and Monocyte-To-Lymphocyte Ratio in Guillain-Barré Syndrome. Int J Neurosci. 2018;128(8):729-35.

11. Giede-Jeppe A, Bobinger T, Gerner ST, Sembill JA, Sprügel MI, Beuscher VD, et al. Neutrophil-To-Lymphocyte Ratio is an Independent Predictor for in-Hospital Mortality in Spontaneous Intracerebral Hemorrhage. Cerebrovasc Dis Basel Switz. 2017;44(1-2):26-34.

12. Yu S, Arima H, Bertmar C, Clarke S, Herkes G, Krause M. Neutrophil to Lymphocyte Ratio and Early Clinical Outcomes in Patients With Acute İschemic Stroke. J Neurol Sci. 2018;387:115-8.

13. Çaltekin İ, Gökçen E. Evaluation of Changes in Lymphocyte to Monocyte Ratio and İnflammatory Markers in Stroke Subgroups. Bozok Med J. 2020;10(1):190-5.

14. Gunes M, Buyukgol H. Relationship Between Generalized Epileptic Seizure and Neutrophil/Lymphocyte Ratio, Platelet/Lymphocyte Ratio, and Neutrophil Mediated İnflammation. Int J Neurosci. 2020;130(11):1095-100.

15. Yoldas MA, Hanci F, Dincel GK, Bekdas M. The Predictive Role of Neutrophil-To-Lymphocyte Ratio and Platelet-To-Lymphocyte Ratio in Children With Simple Febrile Seizures. Exp Biomed Res. 2021;4(3):198-205.

16. Aydın H, Yazıcı S, Orman A, Ozatay B. Evaluation of hemogram parameters in patients with febrile convulsion: a single center experience. Mersin University Health Sciences Journal. 2023;16(3):375-84.

17. Jin P, Li X, Chen J, Zhang Z, Hu W, Chen L, et al. Platelet-To-Neutrophil Ratio is a Prognostic Marker for 90-Days Outcome in Acute İschemic Stroke. J Clin Neurosci. 2019;63:110-5.

18. Dilektasli E, Inaba K, Haltmeier T, Wong MD, Clark D, Benjamin ER, et al. The Prognostic Value of Neutrophil-To-Lymphocyte Ratio on Mortality in Critically Ill Trauma Patients. J Trauma Acute Care Surg. 2016;81(5):882-8.

19. Caltekin M, Çaltekin İ, Onat T, Kirmizi D, Başer E, Yalcin S, et al. Can Subclinical Inflammatory Markers Predict Birth Time and

Birth Weight in Hyperemesis Gravidarum?: A Comparative Study and Comprehensive Current Literature Review. Med Bull Haseki 2021;59:139-44

20. Geng L, Zuo L, Li H, Wang Y, Zhang Q, Ran J, et al. Association of Platelet-To-Neutrophil Ratios With 1-Year Outcome and Mortality in Patients With Acute İschemic Stroke. Neurosci Lett. 2023;798:137016.