Medical Science and Discovery
ISSN: 2148-6832

Prognostic values of LDH and Hematological factors in Patients with Sudden Hearing Loss

Serkan Dedeoğlu[1]*, Muhammed Ayral[2], Serdar Ferit Toprak[2]

1 University of Health Sciences Gazi Yasargil Training and Research Hospital, Department of Otorhinolaryngology, Diyarbakır, TR
2 Dicle University, Department of Otorhinolaryngology, Diyarbakır, TR

*** Corresponding Author:** Serkan Dedeoğlu **E-mail:** drserkandedeoglu@gmail.com

ABSTRACT

Objective: In our study, we aimed to evaluate the relationship between Lactate Dehydrogenase and hematological parameters, neutrophil, Neutrophil lymphocyte ratio, platelet lymphocyte ratio, and mean platelet volume serum levels in patients with Sudden sensorineural hearing loss prognosis.

Methods: 60 patients were hospitalized and treated for Sudden Hearing Loss at Dicle University Hospital Ear Nose Throat Clinic between May 2013 and April 2020, and 60 healthy individuals without any health problems were included in the study. Pretreatment peripheral blood was drawn from all subjects, followed by routine blood cell analysis. The absolute numbers of neutrophils, lymphocytes, and platelets in peripheral blood were obtained, and the Neutrophil lymphocyte ratio, platelet lymphocyte ratio, and mean platelet volume of each case were calculated.

Results: A total of 120 participants, including 60 Sudden sensorineural hearing loss patients case group and 60 healthy individuals in the control group, were included in the study. The median age of the case group was 46.0 (29.0-55.0), and the control group was 48.0 (33.5-58.5), and no statistically significant difference was found between the groups in terms of age ($p = 0.191$). The median Lactate Dehydrogenase, Neutrophil, and Neutrophil lymphocyte ratio of the case group was significantly higher than the control group ($p < 0.05$). There was no significant difference between the groups in terms of thrombocyte, mean platelet volume, lymphocyte, platelet lymphocyte ratio, body mass index, and gender ($p > 0.05$).

Conclusion: We think that the increase in Lactate Dehydrogenase level may be a poor prognostic factor in patients with sudden hearing loss that does not improve. In addition, we believe that the increase in neutrophil count and Neutrophil lymphocyte ratio is quite significant but cannot be considered a poor prognostic factor.

Keywords: Sudden hearing loss, Lactate Dehydrogenase, hematological factors, mean platelet volume, Neutrophil lymphocyte ratio

INTRODUCTION

Sudden sensorineural hearing loss (SSNHL) is characterized by an acute sensorineural hearing loss, almost always unilateral, with a hearing loss of at least 30 decibels (dB) at three consecutive frequencies over 72 hours (1). Although the exact incidence of idiopathic SSNHL is unknown since recovery may be spontaneous, it is thought to range from 11 to 77 per 100,000 people (2). The ratio of men and women is equal. It most commonly affects individuals between 43 and 53 (3).

Although it is caused by various reasons such as neoplastic, infectious, autoimmune, neurological, otological, metabolic diseases, ototoxic drugs, and trauma, most of the SHL cases are idiopathic (4). Various theories have been proposed for idiopathic SSNHL. Viral infections, vascular occlusion, autoimmune, and inflammatory conditions have been associated with sudden hearing loss (5). The total number of white blood cells and their subtypes are inflammatory markers in sudden hearing loss. Increased neutrophil count and decreased lymphocyte count were observed during the inflammatory response (6).

Evaluating these markers as a ratio rather than separately may reveal the inflammatory status more clearly (7). Among these rates, increased neutrophil-lymphocyte ratio and platelet-lymphocyte ratio have been shown in studies conducted with patients with sudden hearing loss (8). Studies say there is a correlation between sudden hearing loss and NLR (9).

Research Article

Received 26-05-2022

Accepted 08-06-2022

Available Online: 10-06-2022

Published 30-06-2022

http://dx.doi.org/10.36472/msd.v9i6.747

LDH (lactate dehydrogenase) is a tetrameric protein that catalyzes the reversible conversion of pyruvate to lactate. Extracellular LDH itself has no known biological activity and is therefore only considered a biomarker of cellular damage (10).

Neutrophil lymphocyte ratio (NLR), platelet lymphocyte ratio (PLR), and mean platelet volume (MPV) can be determined in the hemogram analysis made from peripheral blood. In recent years, it has been shown that the ratio of neutrophil and platelet count to lymphocyte count (N/L and T/L ratio) can be an indicator of systemic inflammation and is associated with prognosis in many cardiovascular diseases, malignancies, and chronic inflammatory diseases (11-14). Publications are stating that NLR and PLR may be essential parameters for the diagnosis of irritable bowel syndrome (15). A study conducted on type 2 diabetic men suggested that the NLR value and HbA1c value were correlated and that high NLR values could be a marker of poor diabetic control in type 2 diabetic men (16). Another study showed that increased NLR value in patients with Hashimoto's thyroiditis could be a cheap and valuable marker in complicated patients (17). Studies state that high NLR in patients with thyroid nodules may be an indicator of underlying malignant nodular disease in the preoperative period (18).

In one of the studies on PLR, Atak et al. suggested that PLR, an inexpensive and easy-to-use marker, may help predict the development and control levels of type 2 diabetes (19). It was thought that PLR could be beneficial in distinguishing the group with high thyroid uptake from the standard group in thyroid uptake scintigraphy (20). A high PLR value, together with ultrasonography, scintigraphy, and cytology, may be a marker to differentiate malignant thyroid nodules from benign thyroid nodules (21).

A study of MPV and PLR on chronic hepatitis-associated liver fibrosis suggests that high MPV and low PLR values are a feature of chronic hepatitis disease (22). MPV can be a marker for type 2 diabetes mellitus and obese patients to determine the degree of inflammation (23). We can think that platelet ratio with high MPV may be a marker for type 2 diabetes mellitus (24). Publications are stating that low MPV may be associated with rheumatoid arthritis (25). Low MPV may be a marker for nasal polyp formation (26).

As seen in the publications mentioned above, NLR, PLR, and MPV values suggest that they are related to inflammatory diseases. Therefore, we wanted to compare these values in patients with sudden hearing loss. Our study aimed to evaluate the relationship between LDH and hematological parameters, neutrophil, NRL, PLR, and MPV serum levels with prognosis in patients with SSNHL.

MATERIAL and METHODS

Sixty patients were hospitalized and treated for sudden hearing loss at Dicle University Hospital Ear Nose Throat Clinic between May 2013 and April 2020, and 60 healthy individuals without any health problems were included in the study. Before starting steroid medication, blood samples were taken from the patients. All patients were treated with 60 mg prednisone once daily for ten days. Afterward, the treatment was gradually reduced and ended.

Inclusion criteria for the study were as follows:

- SSNHL more than 30 dB appearing at least three consecutive frequencies within three days,
- being over 18 years of age and being hospitalized within three days from the beginning,
- 8th cranial nerve pathology findings,
- neurological disorder,
- head trauma,
- otologic hearing loss due to surgery history,
- drug-induced ototoxicity,
- noise-induced hearing loss, or absence of Meniere's disease were not included in the study.

Exclusion criteria:

- Patients with acute systemic infection,
- malignancy,
- chronic obstructive respiratory disorders,
- asthma were excluded from the study.

Hematological analysis and LDH measurement

LDH measurements were carried out by enzymatic spectrophotometric (UV) method using commercial Olympus kits on Olympus 2700 autoanalyzer. The complete blood counts of the participants were obtained using the Sysmex XE-2100 device (Sysmex Corp, Kobe, Japan), and neutrophil, lymphocyte, and platelet counts were used to determine NLR and PLR. Pretreatment peripheral blood was drawn from all subjects, followed by routine blood cell analysis. The absolute numbers of neutrophils, lymphocytes, and platelets in peripheral blood were obtained, and the NLR, PLR, and MPV of each case were calculated.

Audiological evaluation

A standard pure tone speech audiometry assessment was performed for all SSNHL patients. Pure tone thresholds were obtained for air conduction at 250, 500, 1000, 2000, 4000, and bone at 250, 500, 1000, 2000, and 4000 kHz, respectively. Audiological data were reported using the methods recommended by the American Academy of Otorhinolaryngology and the Head and Neck Surgery Hearing Committee (27). Levels of improvement based on Siegel criteria, a classification was made according to treatment success and average pure tone averages at follow-up after two months (28). Later, the patients were divided into 2 groups as "recovery (Siegel 1 (complete) + Sigel 2 (partial) + Siegel 3 (mild)" and "non-recovery (Siegel 4 (no recovery)).

Statistical analysis: SPSS (Statistical Package for Social Sciences) for Windows 22.0 program was used for statistical analysis. He used Chi-square analysis to compare categorical data. While evaluating the study data, the suitability of the parameters to the normal distribution was assessed with the Kolmogorov-Smirnov test. Descriptive data in the study were shown with n,% values in categorical data, and median, interquartile range (25-75 percentile values) in continuous data. The Kruskal-Wallis test and Mann-Whitney U test were used to compare parameters that did not show the normal distribution in quantitative data. The post Hoc test was used to determine where the significance came from. Value was evaluated at the $p < 0.05$ level.

http://dx.doi.org/10.36472/msd.v9i6.747

RESULTS

A total of 120 participants, including 60 SSNHL patients case group and 60 healthy individuals in the control group, were included in the study. The median age of the case group was 46.0 (29.0-55.0), and the control group was 48.0 (33.5-58.5), and no statistically significant difference was found between the groups in terms of age (p = 0.191). The median value of LDH, Neutrophil, and NLR of the case group was significantly higher than the control group (**Figures 1-3**). No significant difference was found between the groups in terms of platelet, MPV, lymphocyte, PLR, BMI, and gender (p> 0.05) (**Table 1**). When the hearing loss level of the case group included in the study was evaluated, 22 (36.7%) were between 30-70 dB, 25 (41.7%) were between 71-90 DB, and 13 (21.6%) were 91db. And above.

Again, when the healing levels of the patients were evaluated according to Siegel criteria, 37 (61.7%) Siegel 1, 10 (16.7%) Siegel 2, 7 (11.7%) Siegel 3, and 6 (10%) were found as Siegel 4. No significant difference was found between LDH, MPV, NLR, and PLR levels according to the level of hearing loss (p> 0.05) (**Table 2**).

According to recovery levels, a statistically significant difference was found between the groups in terms of LDH (p = 0.028). It has been seen that this difference is due to the difference between Siegel 2 and Siegel 4. In addition, no significant difference was found between MPV, NLR, and PLR levels according to recovery levels (p> 0.05) (**Table 3**).

Table 1: The groups in terms of platelet, MPV, lymphocyte, PLR, BMI, LDH, NLR Neutrophil, and age

Specifications	Control	SSNHL	P-value
Age	48 (33.5-58)	46 (29-55)	0.191
LDH(U\L)	145.5 (129-176.5)	165 (148-215.5)	0.001
Platelet (10^3/U)	252 (198-286)	254 (213-298)	0.457
MPV (fl)	8.36 (7.49-9.42)	8.34 (7.12-9.24)	0.364
Neutrophil (10^3/U)	3.89 (3.25-4.65)	4.4 (4.1-5.78)	0.001
Lymphocyte (10^3/U)	2.20 (1.8-2.32)	2.21 (2.1-2.52)	0.260
NLR	1.99 (1.27-2.33)	2.24 (1.8-3.17)	0.001
PLR	152.7(116.2-237.7)	146.6(109.1-175.1)	0.090
BMI (kg/m^2)	24 (22.3-25.3)	23.4(22.2-24.8)	0.426

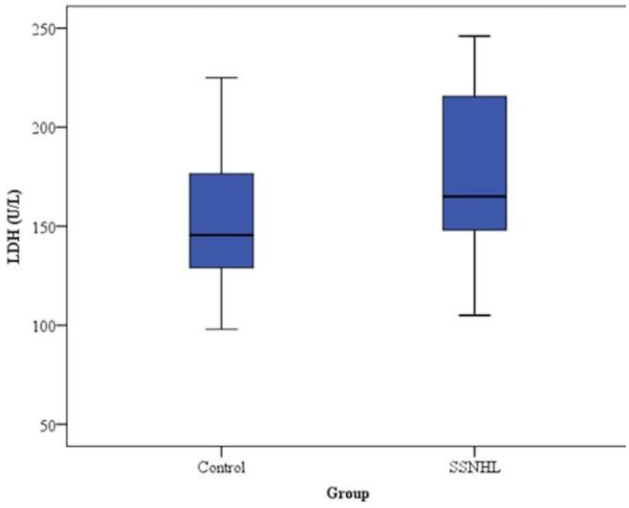
LDH: Lactate dehydrogenases MPV: Mean platelet volüme NLR: Neutrophil lymphocyte ratio PLR: Platelet lymphocyte ratio BMI: Body mass index

Table 2: LDH, MPV, NLR, and PLR levels according to the level of hearing loss

	30-70dB Median (IQR)	71-90 dB Median (IQR)	91- dB Median (IQR)	P-value
LDH(U/L)	181.5 (154-215)	165 (147-184)	216(154-220)	0.089
MPV (fl)	8.28 (7.1-8.6)	8.35 (7.1-8.6)	8.6 (7.5-9.4)	0.590
NLR	2.2 (1.5-3)	2.2 (1.8-2.6)	2.6 (2.2-3.6)	0.114
PLR	150.7 (114-190.3)	133.2(101-158.1)	151(110-175.2)	0.608

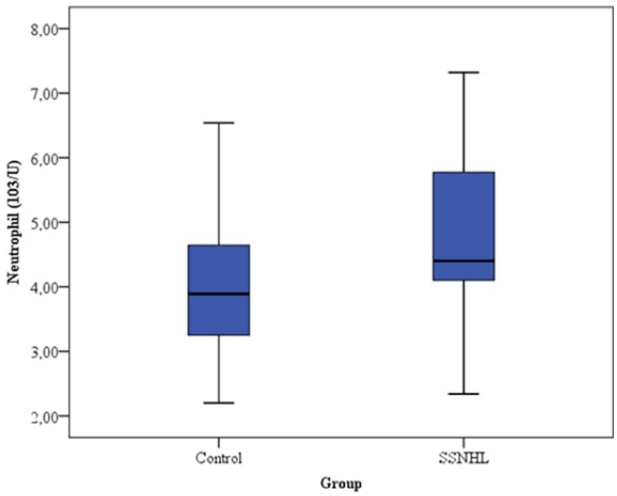
Table 3: LDH, MPV, NLR, and PLR levels according to recovery levels

	Siegel 1 Median (IQR)	Siegel 2 Median (IQR)	Siegel 3 Median (IQR)	Siegel 4 Median (IQR)	P value
LDH(U/L)	180(154-209)	155.5(145-165)	154(125-209)	220(216-225)	0.028
MPV (fl)	8.3 (7.1-9.3)	8.5 (8.2-8.7)	8.3 (6.3-8.5)	8.6 (7.5-9.2)	0.782
NLR	2.2 (1.5-3)	2.2 (2.1-2.8)	3.1 (2.6-3.6)	2.3 (2.2-4.3)	0.119
PLR	133.2(110-158.1)	129.9(110-200.1)	160(151-220.2)	131.1(88.5-175.2)	0.334

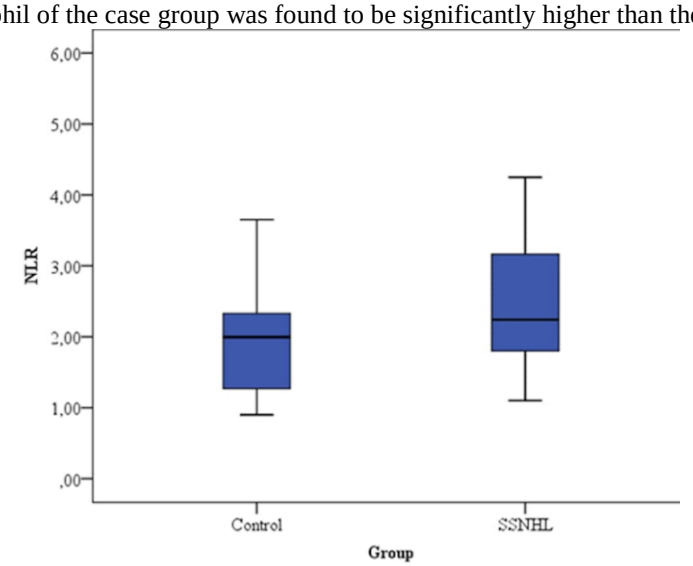


Figures 1: Median LDH of the case group was found to be significantly higher than the control group.

http://dx.doi.org/10.36472/msd.v9i6.747



Figures 2: Median of Neutrophil of the case group was found to be significantly higher than the control group



Figures 3: Median NLR of the case group was found to be significantly higher than the control group

DISCUSSION

This study aimed to evaluate whether lactate dehydrogenase and hematological parameters NLR, PLR, and MPV could be prognostic factors in patients with sudden hearing loss. In this study, we observed that although LDH values were average at diagnosis in 60 SSNHL patients, they were higher than the control group. We found a statistically significant difference ($p < 0.01$). We found that the LDH level of patients who did not respond to treatment (nonrecovery) was higher than patients who responded to treatment at various levels (recovery group 1, group 2, group 3). However, we could not detect a difference between the LDH levels of the patients who responded to the treatment. On the other hand, when the patient and control groups were compared, a significant difference was found in terms of neutrophil count and NLR. Although the NLR value in the non-recovery group was higher, there was no statistically significant difference between the recovery group and the non-recovery group. In addition, no significant difference was found between the patient and control groups in terms of PLR and MPV.

Viral infection is considered one of the leading causes of SSNHL. Although acute viral infections can cause this damage, latent infections and reactivation may also explain the lesion. The main latent viruses are part of the herpes virus group. They are found everywhere. They characteristically carry strong neurotropism; they do not always cause symptoms (subclinical infection) and have a complex relationship with SSNHL. A large number of viral agents have been implicated (29). Mechanisms by which viral infection causes SSNHL; first mechanism; although inflammation of neural fibers and ganglia due to viral infection is the most commonly accepted theory, it has not been proven (30). The second mechanism is the reactivation of the latent virus, and the third is the pathological activation of cellular stress pathways within the cochlea (31).

The most important prognostic factor is the degree of hearing loss. The lower the hearing loss at the first presentation, the more likely it is to improve(32). LDH is an intracellular enzyme; therefore, it is not organ-specific. Oxygen-glucose deprivation in auditory cells has been shown to reduce cell viability and increase lactate dehydrogenase (LDH) time-dependent (33).

More increases were detected in these LDH fractions, especially after viral infection. It appears to have been used to indicate various inflammations and diseases. LDH is inflammation biomarker in infectious conditions such as bacterial meningitis, empyema, and arthritis(34). When these data are evaluated together, it is thought that the level of LDH changes due to various reasons affecting the inner ear. The effect of this change on the serum level is unknown. More support for pathologies for which viral pathologies are blamed in patients with sudden hearing loss, for which inflammatory etiology is blamed, suggests that changes in LDH levels may occur. We planned to evaluate the LDH level in SSNHL patients and evaluate its relationship with prognosis in this context. Our study found that the LDH level was significantly higher in patients with sudden hearing loss than in healthy individuals, and we found a statistically significant difference ($p < 0.05$). Clinically this rate was higher in the non-recovery group. We observed that the LDH level triggered by the inflammatory event was higher, especially in the non-recovery group. As the level of damage in the inner ear increases, the level of LDH increases more.

The prognostic effect of hematological indices of complete blood count test on outcomes of SSNHL patients is being investigated. NLR is a widely available inflammation biomarker that can easily measure incomplete blood count tests at no additional cost.

A study involving 348 patients claimed that atherosclerosis-associated NLR and PLR values were significantly higher in SSNHL patients and that endothelial dysfunction may be necessary for SSNHL patients. The mean NLR and PLR values of SSNHL patients were substantially higher than the control group (both <0.001). The NLR value was 5.98 ± 4.22 in the non-recovered group and 3.50 ± 3.38 (<0.001) in the recovered group. However, after adjusting by multivariate analysis, only the NLR level was strongly associated with the recovery of SSNHL. It was then considered an independent risk factor for improving pure tone averages. They stated that the NLR level could be viewed as a new potential marker to predict patients' prognosis for improvement (35).

Again, Cao Z et al., In a meta-analysis of 972 patient groups, showed that NLR, PLR, and neutrophil count are negative prognostic indicators, and lymphocyte level is a favorable prognostic indicator for recovery in SSNHL patients. However, other hematological indices of the hemogram test indicated that it was not associated with the prognosis of SSNHL (36).

IN THEIR EXTENSIVE META-ANALYSIS, Chen L et al. included 1029 SSNHL patients and 1020 healthy individuals to evaluate the relationship between NLR levels and SSNHL. They showed that SSNHL patients had a much higher NLR than healthy populations. They showed that neutrophils and lymphocytes can play essential roles in the pathogenesis of SSNHL and that the level of NLR can be a potential determinant for SSNHL formation. This meta-analysis also compared the NLR levels among SSNHL patients with different degrees of improvement. They found that the NLR of the 'unhealed' patients was significantly higher than that of the 'recovered' patients. This result could be attributed to a higher inflammatory state in 'undiscovered' patients. They stated that the clinician should be afraid of SSNHL patients with higher NLR levels regarding treatment and prognosis (6). We also think that NLR is an essential inflammatory parameter in our study, but it is a weak marker that will affect sudden hearing loss and a poor prognosis.

Durmus et al. stated that PLR, PDW, NLR, PLT, MPV, lymphocyte%, and lymphocyte level could be considered potential markers in predicting the prognosis in recovery (37). In this study, we found that the NLR values (2.24 (1.8-3.17)) in the patient group were significantly higher than the control group (1.99 (1.27-2.33)) ($p < 0.05$). We could not detect a significant difference between the recovery (median 2,2) and non-recovery (median 2,6) groups ($p = 0.114$). Therefore, we think that the NLR value is important because it is an inflammatory marker, but it is not associated with prognosis. We could not find a significant difference between SSNHL patients and the control group.

Ha, et al. showed that NLR could be used in terms of prognosis to study patients with sudden hearing loss in the pediatric age group. Still, there was no significant difference in the comparison of PLR between the control group and the patient group. In our study, we found that there was no difference between PLR and sudden hearing loss, and NLR was a poor prognostic factor (38). Another study reported that NLR and PLR values are high in patients with sudden hearing loss. In our research, it was found that NLR was high and PLR was normal (39).

While vascular occlusion, acute or chronic syndromes, and vasculitis increase MPV levels, infections, autoimmune diseases, and inflammatory conditions reduce it (40). Ulu et al. found that MPV and thrombocyte distribution width was significantly higher in SSNHL in their study with 40 SSNHL patients. SSNHL appeared to be characterized by ischemic or thrombotic events and could contribute to the pathogenesis of SSNHL given increased MPV levels (41). In another study, Sagit M et al. stated that MPV, the determinant of platelet activation in patients with SSNHL, is high. Their findings indirectly support the vascular disorder hypothesis as a pathogenetic factor in sudden sensorineural hearing loss (42).

On the contrary, Karli et al. 46 patients. They observed no significant difference in MPV values between the control and the patient groups receiving SSNHL treatment (43). They stated that this supports the theory that there is no microvascular response in the etiology of SSNHL. In this study, we found no statistically significant difference between the platelet count ($p = 0.457$) and MPV ($p = 0.364$) values in terms of the patient and control group.

CONCLUSION

According to the literature information, this study is the first study evaluating the LDH level of patients with sudden hearing loss. We think that the increase in LDH level may be a poor prognostic factor in patients with sudden hearing loss. In addition, we believe that the increase in neutrophil count and NLR is significant but cannot be considered a poor prognostic factor. We predict that lymphocyte count, platelet count, MPV, and PLR cannot be evaluated as prognostic factors.

Author Contributions: SD, MA, SFT: Concept, Data collection and/or processing, Analysis and/or interpretation, Literature review**, SD:** Writing, Revision**.**

Acknowledgments: None

Conflict of interest: The authors declare no competing interests.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the institutional and/or national research committee's ethical standards and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

REFERENCES

1. Wilson YL, Gandolfi MM, Ahn IE, Yu G, Huang TC, Kim AH. Cost analysis of asymmetric sensorineural hearing loss investigations. Laryngoscope. 2010;120(9):1832-6.
2. Alexander TH, Harris JP. Incidence of sudden sensorineural hearing loss. Otol Neurotol. 2013;34(9):1586-9.
3. Rauch SD. Clinical practice. Idiopathic sudden sensorineural hearing loss. N Engl J Med. 2008;359(8):833-40.
4. Chau JK, Lin JR, Atashband S, Irvine RA, Westerberg BD. Systematic review of the evidence for the etiology of adult sudden sensorineural hearing loss. Laryngoscope. 2010;120(5):1011-21.
5. Hiramatsu M, Teranishi M, Uchida Y, Nishio N, Suzuki H, Kato K, et al. Polymorphisms in genes involved in inflammatory pathways in patients with sudden sensorineural hearing loss. Journal of Neurogenetics. 2012;26(3-4):387-96.
6. Chen L, Zhang G, Zhang Z, Wang Y, Hu L, Wu J. Neutrophil-to-lymphocyte ratio predicts diagnosis and prognosis of idiopathic sudden sensorineural hearing loss: A systematic review and meta-analysis. Medicine (Baltimore). 2018;97(38):e12492.
7. Nash SD, Cruickshanks KJ, Zhan W, Tsai MY, Klein R, Chappell R, et al. Long-term assessment of systemic inflammation and the cumulative incidence of age-related hearing impairment in the epidemiology of hearing loss study. Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences. 2014;69(2):207-14.
8. Qiao X-F, Li X, Wang G-P, Bai Y-H, Zheng W, Li T-L. Neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio in patients with sudden sensorineural hearing loss. Medical principles and practice. 2019;28(1):23-7.
9. Bulğurcu S, Dikilitaş B, Arslan İB, Çukurova İ. Neutrophil-to-lymphocyte and platelet-to-lymphocyte ratios in pediatric patients with idiopathic sudden hearing loss. The journal of international advanced otology. 2017;13(2):217.
10. Ede LC, O'Brien J, Chonmaitree T, Han Y, Patel JA. Lactate dehydrogenase as a marker of nasopharyngeal inflammatory injury during viral upper respiratory infection: implications for acute otitis media. J Pediatric research. 2013;73(3):349-54.
11. Buyukkaya E, Karakas MF, Karakas E, Akcay AB, Tanboga IH, Kurt M, et al. Correlation of neutrophil to lymphocyte ratio with the presence and severity of metabolic syndrome. Clin Appl Thromb Hemost. 2014;20(2):159-63.
12. Imtiaz F, Shafique K, Mirza SS, Ayoob Z, Vart P, Rao S. Neutrophil lymphocyte ratio as a measure of systemic inflammation in prevalent chronic diseases in Asian population. J International archives of medicine. 2012;5(1):1-6.
13. Hamminga EA, van der Lely AJ, Neumann HA, Thio HB. Chronic inflammation in psoriasis and obesity: implications for therapy. Med Hypotheses. 2006;67(4):768-73.
14. Turkmen K, Erdur FM, Ozcicek F, Ozcicek A, Akbas EM, Ozbicer A, et al. Platelet-to-lymphocyte ratio better predicts inflammation than neutrophil-to-lymphocyte ratio in end-stage renal disease patients. J Hemodialysis International. 2013;17(3):391-6.
15. Aktas G, Duman T, Atak B, Kurtkulagi O, Bilgin S, Basaran E, et al. Irritable bowel syndrome is associated with novel inflammatory markers derived from hemogram parameters. Family Medicine & Primary Care Review. 2020;22(2):107-10.
16. Bilgin S, Aktas G, Zahid Kocak M, Atak BM, Kurtkulagi O, Duman TT, et al. Association between novel inflammatory markers derived from hemogram indices and metabolic parameters in type 2 diabetic men. The Aging Male. 2020;23(5):923-7.
17. Aktas G, Sit M, Dikbas O, Erkol H, Altinordu R, Erkus E, et al. Elevated neutrophil-to-lymphocyte ratio in the diagnosis of Hashimoto's thyroiditis. Revista da Associação Médica Brasileira. 2017;63:1065-8.
18. Sit M, Aktas G, Erkol H, Yaman S, Keyif F, Savli H. Neutrophil to lymphocyte ratio is useful in differentiation of malign and benign thyroid nodules. Puerto Rico health sciences journal. 2019;38(1):60-3.
19. Atak B, Aktas G, Duman TT, Erkus E, Kocak MZ, Savli H. Diabetes control could through platelet-to-lymphocyte ratio in hemograms. Revista da Associação Médica Brasileira. 2019;65:38-42.
20. Afsin H, Aktas G. Platelet to Lymphocyte and Neutrophil to Lymphocyte Ratios are useful in differentiation of thyroid conditions with normal and increased uptake. The Ethiopian Journal of Health Development. 2021;35(3).
21. Atak BM, Kahveci GB, Bilgin S, Kurtkulagi O, Kosekli MA. Platelet to lymphocyte ratio in differentiation of benign and malignant thyroid nodules. Experimental Biomedical Research. 2021;4(2):148-53.
22. Kosekli MA. Mean platelet volume and platelet to lymphocyte count ratio are associated with hepatitis B-related liver fibrosis. European Journal of Gastroenterology & Hepatology. 2022;34(3):324-7.
23. Aktas G, Kocak MZ, Duman TT, Erkus E, Atak BM, Sit M, et al. Mean Platelet Volume (MPV) as an inflammatory marker in type 2 diabetes mellitus and obesity. Bali Med J. 2018;7(3):650-3.
24. Duman TT, Aktas G, Atak B, Kocak MZ. Is mean platelet volume to platelet ratio a promising indicator of diabetic regulation in type 2 diabetes mellitus. J Med Res. 2018;4(3):137-9.
25. Cakır L, Aktas G, Mercimek OB, Enginyurt O, Kaya Y, Mercimek K. Are red cell distribution width and mean platelet volume associated with rheumatoid arthritis. Biomed Res. 2016;27(2):292-4.
26. Aktaş G, Sit M, Tekçe H, Alçelik A, Savli H, Simsek T, et al. Mean platelet volume in nasal polyps. West Indian Med J. 2013;62(6):515-5188.
27. Wilson WR, Byl FM, Laird N. The efficacy of steroids in the treatment of idiopathic sudden hearing loss. A double-blind clinical study. Arch Otolaryngol. 1980;106(12):772-6.
28. Siegel LG. The treatment of idiopathic sudden sensorineural hearing loss. Otolaryngol Clin North Am. 1975;8(2):467-73.
29. Lazarini PR, Camargo AC. Idiopathic sudden sensorineural hearing loss: etiopathogenic aspects. Braz J Otorhinolaryngol. 2006;72(4):554-61.
30. Stokroos RJ, Albers FW, Schirm J. The etiology of idiopathic sudden sensorineural hearing loss. Experimental herpes simplex virus infection of the inner ear. Am J Otol. 1998;19(4):447-52.
31. Chen X, Fu YY, Zhang TY. Role of viral infection in sudden hearing loss. J Int Med Res. 2019;47(7):2865-72.
32. Cvorovic L, Deric D, Probst R, Hegemann S. Prognostic model for predicting hearing recovery in idiopathic sudden sensorineural hearing loss. Otol Neurotol. 2008;29(4):464-9.
33. Zhu WY, Jin X, Ma YC, Liu ZB. MIF protects against oxygen-glucose deprivation-induced ototoxicity in HEI-OC1 cochlear cells by enhancement of Akt-Nrf2-HO-1 pathway. Biochem Biophys Res Commun. 2018;503(2):665-70.

34. Baklacı D, Guler İ, Kuzucu İ, Kum RO, Özcan M. Status of Lactate Dehydrogenase, Neutrophil-lymphocyte Ratio, Mean Platelet Volume, and Platelet-lymphocyte Ratio in Bell's Palsy. J Cureus. 2020;12(3).

35. Seo YJ, Jeong JH, Choi JY, Moon IS. Neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio: novel markers for diagnosis and prognosis in patients with idiopathic sudden sensorineural hearing loss. Dis Markers. 2014;2014:702807.

36. Cao Z, Li Z, Xiang H, Huang S, Gao J, Zhan X, et al. Prognostic role of haematological indices in sudden sensorineural hearing loss: Review and meta-analysis. Clin Chim Acta. 2018;483:104-11.

37. Durmus K, Terzi H, Karatas TD, Dogan M, Uysal IO, Sencan M, et al. Assessment of Hematological Factors Involved in Development and Prognosis of Idiopathic Sudden Sensorineural Hearing Loss. J Craniofac Surg. 2016;27(1):e85-91.

38. Ha R, Lim BW, Kim DH, Park JW, Cho CH, Lee JH. Predictive values of neutrophil to lymphocyte ratio (NLR), platelet to lymphocyte ratio (PLR), and other prognostic factors in pediatric idiopathic sudden sensorineural hearing loss. International Journal of Pediatric Otorhinolaryngology. 2019;120:134-9.

39. İkincioğulları A, Köseoğlu S, Kılıç M, Atan D, Özcan KM, Çetin MA, et al. New inflammation parameters in sudden sensorineural hearing loss: neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio. Int Adv Otol. 2014;10(3):197-200.

40. Gawaz M, Langer H, May AE. Platelets in inflammation and atherogenesis. J Clin Invest. 2005;115(12):3378-84.

41. Ulu S, Ulu MS, Ahsen A, Yucedag F, Aycicek A, Celik S. Increased levels of mean platelet volume: a possible relationship with idiopathic sudden hearing loss. Eur Arch Otorhinolaryngol. 2013;270(11):2875-8.

42. Sagit M, Kavugudurmaz M, Guler S, Somdas MA. Impact of mean platelet volume on the occurrence and severity of sudden sensorineural hearing loss. J Laryngol Otol. 2013;127(10):972-6.

43. Karli R, Alacam H, Unal R, Kucuk H, Aksoy A, Ayhan E. Mean platelet volume: is it a predictive parameter in the diagnosis of sudden sensorineural hearing loss? J Indian Journal of Otolaryngology Head Neck Surgery. 2013;65(4):350-3.