Neutrophil-to-Lymphocyte Ratio and Platelet-to-Lymphocyte Ratio in Patients with Sudden Sensorineural Hearing Loss

Xiao-Feng Qiao^a Xin Li^b Guo-Ping Wang^a Yin-Huan Bai^a Wei Zheng^a
Tong-Li Li^a

^aDepartment of Otorhinolaryngology, Shanxi Provincial People's Hospital Affiliated to Shanxi Medical University, Taiyuan, China; ^bDepartment of Surgery, Children's Hospital of Shanxi Province, Taiyuan, China

Significance of the Study

- This study shows that the peripheral blood neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) are associated with the outcome and prognosis of sudden sensorineural hearing loss (SSNHL). A higher NLR in patients with SSNHL suggests local inflammation, while a higher PLR suggests pathological damage of endothelial cells. The detection of NLR and PLR can be used as the basis for individualized treatment of SSNHL as it is convenient, reliable, and economical.

Keywords

Sudden sensorineural hearing loss · Neutrophils · Lymphocytes · Platelets · Ratios

Abstract

Objective: Sudden sensorineural hearing loss (SSNHL) is a common acute disease with an incidence of 0.5–2/10,000. This study aimed to determine whether the neutrophil-to-lymphocyte ratio (NLR) and the platelet-to-lymphocyte ratio (PLR) could be indicators for SSNHL. **Methods:** A total of 60 confirmed cases of SSNHL and 60 healthy volunteers were included in this study. Peripheral blood NLRs and PLRs were compared between these groups. The SSNHL patients were divided into two groups, according to therapeutic effect: an effective group and an ineffective group. Peripheral blood NLRs and PLRs before and after treatment were compared between these two groups. **Results:** The average NLRs and

PLRs of these patients were both significantly higher than in controls. The average NLRs and PLRs of the ineffective group were both significantly higher than those of the effective group. **Conclusion:** Peripheral blood NLR and PLR could be used as a convenient, reliable, and cost-effective indicator to predict the prognosis of SSNHL.

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Introduction

Sudden sensorineural hearing loss (SSNHL) is a common acute disease with an incidence of 0.5–2/10,000 [1, 2]. Many causes have been proposed; these include viral infection, vascular disturbance, microcirculatory failure, and immune mediation, but none of these are supported by definitive evidence [3–5]. Recent etiological research on SSNHL has focused on chronic inflammation [6]. Bac-

teria- or virus-induced chronic inflammation may cause microvascular injuries and atherosclerosis, raising the risks of cochlear ischemia [7]. However, cochlear ischemic alteration is just one potential pathological change of SSNHL with a vascular cause. Chronic inflammation can also induce corresponding endocochlear immune responses, further leading to cochlear injuries [3]. Researchers in cardiovascular diseases have used the neutrophil-to-lymphocyte ratio (NLR) in peripheral blood as a marker for cardiovascular diseases, and it may serve as a useful predictor of development of cardiovascular disease. Furthermore, the platelet-to-lymphocyte ratio (PLR) has been closely correlated with peripheral arterial occlusion diseases such as arteriosclerosis and arterial thrombosis [8]. Hence, elevation of peripheral NLR and PLR indicates the occurrence of vascular endothelial injury, atherosclerosis, and local microartery inflammation. On this basis, we hypothesized that peripheral NLR and PLR can also be used to predict the metastasis/development of SSNHL and applied as markers to easily measure prognosis. In the present study, we aimed to investigate the relationship of SSNHL with NLR and PLR, in an attempt to validate our hypothesis.

Materials and Methods

Clinical Data

A total of 60 SSNHL patients treated at Shanxi Provincial People's Hospital between December 2015 and December 2016 (average age: 45.62 ± 13.16 years; male: 28; female: 32), according to the Sudden Hearing Loss Diagnosis and Treatment Guidelines of the Chinese Medical Association [9], were included in the study. In addition, 60 healthy subjects were assigned as the control group (average age: 49.62 ± 10.66 years; male: 31; female: 29). The inclusion criteria were as follows: no history of steroid treatment, blood abstraction and pure-tone hearing inspection before treatment, and magnetic resonance imaging excluding hearing loss due to organic lesions. Subjects with the following diseases were excluded: any acute inflammatory infection, diabetes, hypertension, hyperlipidemia, coronary diseases, acute or chronic kidney failure, chronic liver disease, lung disease, infectious diseases (e.g., syphilis), immunological diseases, and any otological diseases (e.g., chronic otitis, otosclerosis, history of ear trauma, and Meniere's disease).

Methods

Blood specimens were examined before the treatment. Based on medical history and test results, unqualified cases were excluded, while the included cases were assigned to the same therapeutic scheme.

Peripheral Blood Laboratory Examination

Peripheral blood was collected from all included subjects before treatment and 15 days after treatment, followed by routine blood cell analysis. The sample collection was done between 7 and

Table 1. Peripheral blood data in patients and controls

Parameter	Patients (n = 60)	Controls (n = 60)	p value
WBC count, $\times 10^9/L$	8.38 ± 1.33	5.24 ± 1.39	0.001
Neutrophil count, $\times 10^9/L$	7.23 ± 1.41	3.57 ± 1.02	0.000
Platelet count, $\times 10^9/L$	263.90 ± 47.90	201.45 ± 41.11	0.356
Lymphocyte count, $\times 10^9/L$	2.20 ± 1.00	1.88 ± 0.57	0.022
NLR	3.96 ± 1.92	2.33 ± 0.97	0.000
PLR	145.69 ± 74.66	117.30 ± 44.06	0.003
Age	45.62 ± 13.16	49.62 ± 10.66	0.081

NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; WBC, white blood cell.

8 a.m. and the subjects were in a fasting state. The absolute counts of neutrophils, lymphocytes, and platelets in peripheral blood were obtained and the NLR and PLR of each case computed.

Detection of Pure-Tone Hearing

For the 60 patients, pure-tone hearing was measured before treatment and 15 days after treatment. Specifically, the bone conduction threshold and air conduction threshold at 250, 500, 1,000, 2,000, 4,000, and 8,000 Hz were recorded. According to the therapeutic effect evaluation standards of the Sudden Hearing Loss Diagnosis and Treatment Guidelines of the Chinese Medical Association, patients who achieved "cured," "markedly effective," and "effective" outcomes were classified as the "effective group," and patients who achieved "ineffective" outcome were classified as the "ineffective group."

Treatment Regimen

All 60 patients were treated with the following regimen: intravenous injection of 10 mg of dexamethasone for 3 consecutive days and intravenous drip injection of 70 mg of ginkgo biloba extract (Ginaton) for 15 consecutive days.

Statistical Methods

The average peripheral NLR and PLR were tested via *t* test for the test group versus control group and the effective group drip injection ineffective group on SPSS 20. The NLR and pure-tone hearing thresholds were examined on the straight line correlation analysis.

Results

The white blood cell (WBC) count, neutrophil count, lymphocyte count, NLR, and PLR of SSNHL patients before the treatment were all significantly higher than those of the controls (Table 1).

The lymphocyte count and NLR were both significantly different before treatment in the effective group compared to the ineffective group ($p < 0.05$). After treatment,

Table 2. Peripheral blood data in the effective and ineffective subgroups

Parameter	Before treatment			After treatment		
	effective (<i>n</i> = 48)	ineffective (<i>n</i> = 12)	<i>p</i> value	effective (<i>n</i> = 48)	ineffective (<i>n</i> = 12)	<i>p</i> value
WBC count, ×10 ⁹ /L	8.31±1.32	8.65±1.42	0.124	6.24±1.06	8.74±1.20	0.018
Neutrophil count, ×10 ⁹ /L	7.26±1.41	7.10±1.48	0.245	6.68±1.27	7.16±0.99	0.157
Platelet count, ×10 ⁹ /L	256.15±50.16	226.08±54.08	0.350	199±50.02	212±34.87	0.351
Lymphocyte count, ×10 ⁹ /L	2.62±1.22	1.54±0.56	0.002	2.91±1.59	1.45±1.44	0.285
NLR	3.39±1.71	5.21±2.27	0.031	2.45±1.45	5.03±1.68	0.000
PLR	132.81±60.89	154.23±63.85	0.258	121.02±46.98	158.31±52.38	0.025

NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; WBC, white blood cell.

Table 3. Correlation analysis between NLR and hearing thresholds before and after treatment in the SSNHL patients

Subgroup	Before treatment			After treatment		
	NLR	hearing threshold	<i>r</i>	NLR	hearing threshold	<i>r</i>
Effective	3.39±1.71	48.62±16.62	0.45	2.45±1.45	22.81±11.80	0.57
Ineffective	5.21±2.27	60.42±11.77	0.64	5.03±1.68	57.50±13.06	0.54

NLR, neutrophil-to-lymphocyte ratio; SSNHL, sudden sensorineural hearing loss.

Table 4. Correlation analysis between NLR and age before and after treatment in the SSNHL patients

Subgroup	Before treatment			After treatment		
	NLR	age	<i>r</i>	NLR	age	<i>r</i>
Effective	3.39±1.71	45.86±13.65	0.19	2.45±1.45	45.86±13.65	0.17
Ineffective	5.21±2.27	45.10±11.29	0.14	5.03±1.68	45.10±11.29	0.11

NLR, neutrophil-to-lymphocyte ratio; SSNHL, sudden sensorineural hearing loss.

a significant difference in the effective group versus the ineffective group was found in WBC count, NLR, and PLR, but not in neutrophil count, platelet count, or lymphocyte count ($p > 0.05$) (Table 2).

The NLR was significantly and positively correlated with hearing thresholds both before and after treatment among SSNHL patients ($p < 0.05$) (Table 3).

In the treatment group and the control group there was no correlation between NLR and age ($r = 0.07$ and $r = 0.13$, respectively). In the effective treatment group and the ineffective treatment group, there was no correlation between NLR and age before and after treatment, indicating that for patients, NLR in the peripheral blood was not influenced by age. Details are depicted in Table 4.

Discussion

SSNHL is a common acute disease in otolaryngology that mainly manifests as sudden acute deafness. SSNHL is defined as sudden hearing loss without definite cause within 72 h, with a hearing drop of ≥ 20 dB in at least two adjacent frequencies [9]. However, the precise pathophysiological mechanisms underlying SSNHL remain unknown and may be induced by local and systemic factors. A number of hypotheses have explained the cause of SSNHL, such as immune reactions, microcirculatory disturbance, infection, infectious disease, and tumors. Many researchers have suggested viral etiologies, but antiviral treatment has not achieved a satisfactory effect. To date,

there are no specific reports on serological characteristics. Merchant et al. [4] studied the temporal bone histopathology of 15 deaf ears and found viral particles without microscopy; thus, no direct cochlear evidence has been found for viral infection. No immune- or autoimmune-mediated injuries have been reported [10], indicating a lack of support for possible immune etiologies. The thrombosis hypothesis regarding the pathogenesis of SSNHL should be questioned because there was no difference in incidence rate between males and females [11]. Existing etiological research on SSNHL has focused on chronic inflammation. It has been believed that bacteria- or virus-induced chronic inflammation could cause microvascular injury, vascular endothelial dysfunction, and atherosclerosis, leading to an increased risk of cochlear ischemia [7, 12, 13]. Furthermore, susceptibility to genetic thrombosis or cardiovascular risk factors would further aggravate the risk of cochlear ischemia [14, 15]. The NLR in peripheral blood has not only been proved to be one of the definitive markers of chronic inflammation in the cardiovascular system, it is also a reliable predictor of functional recovery after vascular disease. Furthermore, this index is easy to measure in clinical practice [16–18]. Moreover, the PLR is closely correlated with peripheral arterial occlusion diseases such as arteriosclerosis and arterial thrombosis [8]. Hence, the elevation of peripheral NLR and PLR indicates the occurrence of atherosclerosis and local microartery inflammation [19–23]. In the present study, we aimed to investigate the relationship of SSNHL with NLR and PLR.

The WBC count, neutrophil count, lymphocyte count, NLR, and PLR of SSNHL patients before treatment were all significantly higher than those of the controls. The lymphocyte count and NLR before treatment in the effective group were both significantly lower than those in the ineffective

group. After treatment, WBC count, NLR, and PLR were all significantly different between groups, while NLR was positively correlated with hearing thresholds in SSNHL patients both before and after treatment. This indicates that the NLR can be considered for use as a predictor of SSNHL.

A higher peripheral NLR suggests the occurrence of local microartery vascular inflammation, which involves the labyrinthine artery. However, the NLR before treatment was higher in the ineffective group than in the effective group, indicating that the cochlear microvascular local inflammation was more severe. Thus, as for treatment, systemically or locally used glucocorticoid exerts an anti-inflammatory effect and reduces the microvascular local inflammatory reaction, which involves the labyrinthine artery [24]. This indicates the achievement of a satisfactory therapeutic effect [9]. A larger PLR indicates that a patient with SSNHL may be suffering from pathological injury to peripheral vascular endothelial cells that involves the labyrinthine artery. On this basis, antioxidant drugs and antiplatelet aggregative drugs may be beneficial. As for the ineffective group, the PLR after treatment increased relative to the effective group, suggesting that the more severe injuries to vascular endothelial cells and the formation of atherosclerotic plaques accounted for the bad prognosis in these ineffective patients, which should be taken into consideration for therapy.

Conclusion

The NLR can be considered for use as a marker for prognosis and the development of SSNHL, while the NLR and the PLR can be considered for use as a basis for personalized therapy.

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