

Research Article

Effect of Stress in Unilateral Sudden Sensorineural Hearing Loss Patients

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Abstract

The aim of this study is to investigate the relationship between stress markers and Sudden Sensorineural Hearing Loss patients. This retrospective study was approved by the Renmin Hospital of Wuhan University. We collected Magnetic resonance imaging (MRI) images and data of 41 patients in our hospital. All patients underwent conventional MRI. An independent sample t-test was utilized for continuous data, and a chi-square test was employed for categorical data. We utilized logistic and linear regression analyses to evaluate the relationship between Sudden Sensorineural Hearing Loss (SSNHL) and clinical variables for constant variables ($p < 0.05$ was considered statistically significant). The logistic regression shows all these factors (stress level, neutrophil-to-lymphocyte ratio (NLR), Platelet-to-lymphocyte ratio (PLR), and White blood cell count (WBC)) play a significant role in SSNHL. Odds ratio (OR) value was 10.06 for stress (95% CI: 2.81-36.08; $p < 0.001$), 1.47 for PSS (95% CI: 1.31-1.80; $p < 0.001$), 50.73 for NLR (95% CI: 2.76-931.15; $p < 0.001$), 1.03 for PLR (95% CI: 1.01-1.05; $p < 0.05$), 1.87 for WBC (95% CI: 1.34-2.63; $p < 0.001$). In SSNHL patients, a significant relationship was observed with NLR (F-statistic=9.05, p-value=0.003), WBC (F-statistic=14.51, p-value=0.0003), PLR (F-statistic=5.6, p-value=0.02). Our study has provided substantial evidence supporting the involvement of stress and systemic inflammation in the development of sudden sensorineural hearing loss (SSNHL). We found that elevated stress levels and inflammatory markers such as NLR, PLR, and WBC were statistically significant factors related to the disease. This suggests that these markers could be utilized for both diagnosis and prognosis. Additionally, our research explored the relationship between inflammatory markers and the severity of SSNHL. Consequently, targeting inflammation may offer therapeutic benefits for patients with SSNHL, potentially aiding in the prevention of its onset and the reduction of severity.

Keywords

Arterial Spin Labeling, Cerebral Blood Flow, Sudden Sensorineural Hearing Loss, Stress

1. Introduction

Sudden sensorineural hearing loss (SSNHL) is a distressing experience for patients, often perceived as an otologic emergency due to its rapid onset [1]. It is defined as a hearing loss of 30 dB for three consecutive frequencies or more that ap-

pears within three days and is accompanied by tinnitus, vertigo, and other discomforts. Most SSNHL cases are unilateral [1, 2] and are often idiopathic due to unclear etiology and pathophysiology [3]. Over the years, several potential hy-

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potheses have been put forth, including vascular disorders, viral infections, immunological disease, hyperviscosity, and membrane rupture [4]. It is widely believed that stress is linked to the onset of SSNHL [3]. It harms the quality of life and raises the likelihood of depression and cognitive deterioration [5]. The clinical symptoms, etiology, severity of hearing loss, configuration of the audiogram, duration between the commencement of therapy and the onset of hearing loss, and the prognosis for recovery exhibit considerable variability in idiopathic SSNHL [6]. Despite extensive investigations, no single cause has been conclusively identified, underscoring the complexity of SSNHL's pathophysiology. Hence, the need for research to uncover contributing factors continued.

According to the National Epidemiological Survey conducted in Japan between 1971 and 1974, 25% of the 2,418 participants diagnosed with idiopathic SSNHL reported experiencing physical or mental fatigue, the common cold, or other identifiable triggers before the onset of hearing loss [3]. A clinical study showed elevated peripheral blood inflammatory markers as diagnostic and prognostic factors induced by ischemic changes or infections in SSNHL patients [7, 8]. Another clinical research found that SSNHL is developed during or shortly after a period of extreme stress [3]. A study shows that stress may play a role in triggering SSNHL, as elevated stress levels and biochemical changes were observed before

onset [3]. From the functional perspective, a resting-state functional magnetic resonance imaging (fMRI) study showed a functional alteration in auditory and non-auditory brain regions within acute periods of hearing loss [9].

Despite the significant volume of research on idiopathic SSNHL that has been published, the small sample sizes and methodological heterogeneity hinder a proper analysis and comparison of the findings and the identification of its etiology. Therefore, this study analyzes the relationship between various factors and stress biomarkers. Additionally, we seek to utilize conventional MRI for diagnostic purposes.

2. Material and Method

2.1. Subjects

A retrospective study of 49 SSNHL patients (19 males and 22 females aged 19 to 68) admitted to our hospital's otorhinolaryngology department between August 2023 and June 2024 were recruited. We excluded eight patients in total after pure tone audiometry (PTA) and MRI scan. A group of 27 healthy controls without deafness or other medical conditions with matching age and education levels were included. (Figure 1)

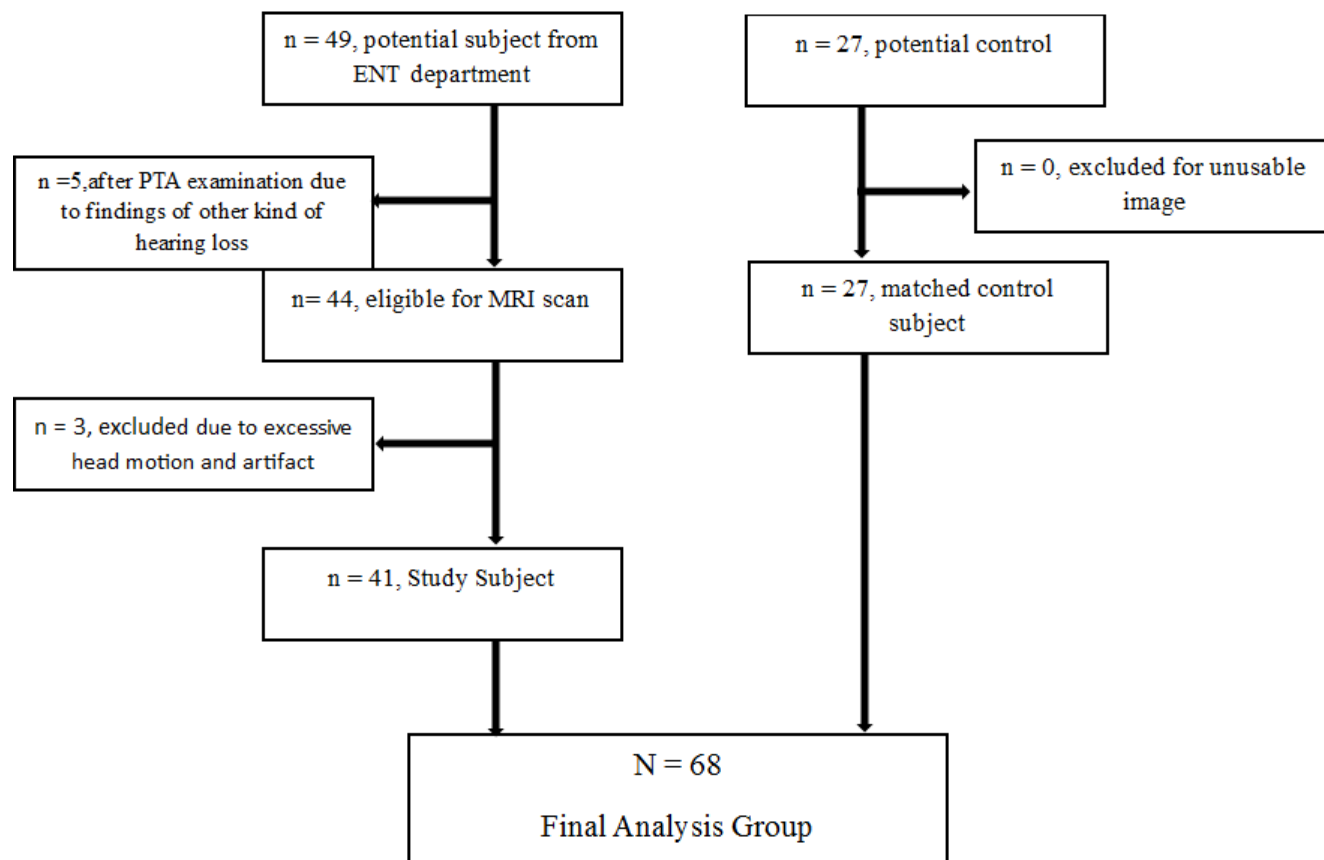


Figure 1. Flowchat defining the process of selecting the subject and control for the study.

Before the MRI scan, the clinical assessment was done. Exclusion criteria of Individuals with 1) Mixed hearing loss, 2) other Ear disorders, 3) any contraindication to MRI, and 5) Pregnancy.

The following were the inclusion criteria. 1) Acute hearing loss that had no apparent cause, 2) hearing loss above 30 dB in three sequential frequencies.

2.2. Clinical Data

Age, gender, education level, related symptoms, drinking, smoking, and other baseline data were collected from these patient's investigations. A physical examination and audiometry were also included. The routine hematological data encompassed the following parameters: white blood cell count (WBC), neutrophil count (NEU), monocyte count (MONO), platelet count (PLT), neutrophil-to-lymphocyte count ratio (NLR), platelet-to-lymphocyte count ratio (PLR), and fibrinogen level (FIB). All blood tests were conducted on the same day between 20:00 and 21:00 hours following an 8-hour fasting period. The questionnaire for stress was also included as a binary response (Yes or No). Furthermore, stress levels were measured using the Perceived Stress Scale (PSS-10), which comprises ten items. This scale assesses individuals' perceptions of their lives as stressful over time. Scores ranged from 0 (never) to 4 (very often), with 0 representing the lowest possible score and 40 the highest.

2.3. Hearing Assessment

A clinical PTA test was conducted at 0.125, 0.25, 0.5, 1, 2, 4, and 8 kHz by a qualified otolaryngologist in the Ear, Nose, and Throat Department of our institution, utilizing a GSI-61 audiometer. In the control group, the mean PTA across the seven frequencies was below 25 dB HL, whereas the mean PTA for SSNHL across the seven frequencies exceeded 30 dB HL. According to the Global Burden of Disease (GBD) 2013 report, hearing loss is categorized into five severity levels: moderate (35–49 dB), moderately severe (50–64 dB), severe (65–79 dB), profound (80–94 dB), and complete (greater than 95 dB) [10].

2.4. MRI Acquisition

MRI images were acquired using a 3.0 Tesla MRI scanner with a 48-channel phased array head coil. The participants were given rubber soft foams and ear plugs to reduce equipment noise.

2.5. Statistical Analysis

For statistical analysis, SPSS version 26.0 was utilized. An independent sample t-test was employed for continuous data, and chi-square analysis was conducted for categorical data, with $p < 0.05$ considered statistically significant. Logistic and linear regression analyses were performed to evaluate the

relationship between SSNHL and clinical variables for continuous variables ($p < 0.05$ was deemed statistically significant).

3. Results

3.1. Demographic and Clinical Characteristics of SSNHL Patients and HC

No significant difference between age, gender, education level, handedness, and PTA between the SSNHL group and the HC group ($P > 0.05$). (Table 1)

Table 1. Demographic and clinical characteristics.

Characteristics	SSNHL (n=41)	HC (n=27)	p-value
Age (years)	40.45±12.98	34.52±10.74	0.062
Gender (M/F)	19/22	12/15	1
Education Level (years)	11.70±2.49	13.33±3.04	0.39
Handedness (R/L)	41/0	27/0	-
PTA of affected ear (dB)	58.28±23.6	18±1.8	-

Values are expressed as mean±standard deviation.

SSNHL, Sudden Sensorineural Hearing Loss; HC, Healthy Control; PTA, Pure tone average.

3.2. MRI Imaging Analysis

The scan revealed no visible changes in TIW1 and T2W2, indicating no significant abnormalities for the diagnosis of unilateral SSNHL.

3.3. Logistic Regression Analysis

Clinical variables were enlisted in logistic regression to predict their effects on SSNHL. OR value was 10.06 for stress (95%CI: 2.81-36.08; $p < 0.001$), 1.47 for PSS (95%CI: 1.31-1.80; $p < 0.001$), 50.73 for NLR (95%CI: 2.76-931.15; $p < 0.001$), 1.03 for PLR (95%CI: 1.01-1.05; $p < 0.05$), 1.87 for WBC (95%CI: 1.34-2.63; $p < 0.001$), as shown in Table 2.

Table 2. Logistic regression of multiple factors with their effects on SSNHL. This table shows that all these factors play a significant role in SSNHL, i.e., an increase in stress level, NLR, PLR, and WBC increases the chances of SSNHL.

	OR	LOWER_CI	UPPER_CI	P-VALUE
Stress	10.06	2.81	36.08	0.0003

	OR	LOWER_CI	UPPER_CI	P-VALUE
PSS-10	1.47	1.21	1.80	0.0001
NLR	50.73	2.76	931.15	0.008
PLR	1.03	1.01	1.05	0.01
WBC	1.87	1.34	2.63	0.0002

3.4. Linear Regression Analysis

In SSNHL patients, a significant relationship was observed with NLR (F-statistic=9.05, p-value= 0.003), R WBC (F-statistic= 14.51, p-value= 0.0003), PLR (F-statistic= 5.6, p-value = 0.02) respectively.

4. Discussion

SSNHL is a complex condition with various causes that presents significant diagnostic and treatment challenges due to its rapid onset and largely unknown etiology. This study aimed to investigate factors potentially involved in developing SSNHL, particularly emphasizing the roles of stress and inflammatory markers and the usefulness of conventional MRI for diagnosis. Our findings reveal strong connections between increased stress and inflammatory biomarkers and the occurrence of SSNHL, offering fresh perspectives on its underlying mechanisms and potential diagnostic methods.

One of the significant findings in this study is the strong correlation between a high level of stress and the chances of developing SSNHL. The logistic regression analysis showed that stress, evaluated by the Perceived Stress Scale-10, significantly contributed to SSNHL. In particular, increased perceived stress was associated with a substantially higher risk of SSNHL, as indicated by the odds ratio of 10.06 (95% CI: 2.81-36.08; $p < 0.001$). The finding supports previous observations suggesting that stress might play a crucial role in developing SSNHL, probably through mechanisms such as disturbance of vascular tone, immune system dysregulation, or direct interference with cochlear function [3]. Our findings contribute to the growing evidence for stress as a modifiable risk factor for SSNHL, indicating the need for early stress management in high-risk populations. Inflammatory markers also played an essential role in predicting SSNHL. In particular, NLR, PLR, and WBC count were significantly associated with SSNHL. Logarithmic regression analysis showed that NLR with higher values, OR = 50.73 (95% CI, 2.76-931.15, $p = 0.008$); PLR, OR = 1.03 (95% CI 1.01-1.05, $p = 0.01$); and WBC, OR = 1.87 (95% CI 1.34-2.63, $p = 0.0002$) were all associated with SSNHL. NLR, PLR, and WBC are inflammatory markers [11] and stress indicators. These findings suggest that systemic inflammation may be an essential contributor to the pathogenesis of SSNHL, possibly due to stress [3].

The NLR and PLR, in particular, have emerged as de-

pendable biomarkers of systemic inflammation, which can help further early diagnostic capabilities in SSNHL and predict prognosis [12]. Interestingly, MRI studies using conventional protocols in our cohort of SSNHL patients did not yield significant abnormalities, consistent with the current views that the diagnosis of SSNHL is often clinical without prominent imaging findings to support it [9]. The absence of apparent changes in T1-weighted and T2-weighted images underlines the necessity of complementary diagnostic methods, such as inflammatory marker measurement and stress evaluation, which may give further insight into the pathogenesis.

Advanced imaging techniques like functional MRI or magnetic resonance angiography may be of benefit in elucidating underlying pathophysiology mechanisms in SSNHL [9]. Moreover, linear regression analysis showed that inflammatory biomarkers, such as NLR, PLR, and WBC, were significantly related to the severity of hearing loss, supporting the hypothesis that inflammation is related to SSNHL and its severity.

This finding would, therefore, suggest that inflammatory pathways may contribute to cochlear dysfunction [13] and that modulation of the immune response could potentially offer therapeutic benefits for SSNHL patients. These biomarkers may thus serve as both diagnostic and prognostic tools, helping clinicians predict the likelihood of recovery and guide treatment decisions [14].

Limitation

Despite these promising findings, this study is not without limitations. First, the retrospective design does not allow for the establishment of causality between stress, inflammatory markers, and SSNHL. Secondly, while we included a relatively large cohort of 40 SSNHL patients, a greater sample size would give better statistical power to detect subtle differences and improve the generalizability of the results. The investigation depended on conventional MRI, which may not show light neural or vascular changes that could be associated with SSNHL. Future studies should use advanced imaging techniques like functional MRI or contrast enhancement that can give more details on the underlying pathophysiology of the condition. Further studies with a higher sample size and advanced imaging techniques are necessary for elucidating the minute details of pathophysiological changes in this disease. Furthermore, future research is needed to determine if targeted interventions aimed at controlling stress or modulating inflammation might improve outcomes in SSNHL patients.

5. Conclusion

Our study has provided sufficient evidence to support the involvement of stress and systemic inflammation in developing SSNHL. Elevated stress levels and inflammatory markers like NLR, PLR, and WBC were statistically significantly related to the disease, indicating that all these factors

can be used for diagnosis and prognosis.

Our study also investigated the association of inflammatory markers with the severity of SSNHL. Targeting inflammation, then, may be of some therapeutic benefit in patients with SSNHL for the potential of preventing its onset and mitigating severity.

Abbreviations

fMRI	Functional Magnetic Resonance Imaging
MONO	Monocyte Count
MRI	Magnetic Resonance Imaging
NEU	Neutrophil Count
NLR	Neutrophil/Lymphocyte Count Ratio
OR	Odds Ratio
PLR	Platelet/Lymphocyte Count Ratio
PLT	Platelet Count
PTA	Pure Tone Audiometry
SSNHL	Sudden Sensorineural Hearing Loss
WBC	White Blood Cell Count

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Ethics Statement

Renmin Hospital of Wuhan University Medical Ethics Committee approved this study under the principles of the Declaration of Helsinki. All the participants provided written consent to participate in this research study.

Author Contributions

Palpasa Shrestha: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Resources, Validation, Visualization, Writing – original draft

Bibek Shrestha: Data curation, Formal Analysis, Investigation, Software, Validation, Writing – review & editing

Jun Chen: Conceptualization, Funding acquisition, Project administration, Supervision

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Data Availability Statement

The data analyzed for the study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no competing interest.

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