(RESEARCH ARTICLE)

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Complete blood count changes in sudden sensorineural hearing loss caused by *Streptococcus suis* bacterial meningitis at Prof. Dr. I.G.N.G. Ngoerah Hospital Denpasar from January 2019 – May 2023

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Abstract

Introduction: Sudden sensorineural hearing loss (SSNHL) is an emergency case that requires immediate and comprehensive management. This condition can be caused by *Streptococcus suis* bacterial meningitis. Complete blood counts (CBC) examinations are often carried out in SSNHL patients that caused by infection. Some CBC components can be clinical indicators of the severity and prognosis of SSNHL.

Objective: To find out the differences in CBC among *S. suis* bacterial meningitis patients with SSNHL and *S. suis* bacterial meningitis patients with normal hearing at Prof. Dr. I.G.N.G. Ngoerah Hospital Denpasar from January 2019 – May 2023.

Methods: This study used an analytical research design using a retrospective case control method to compare CBC results (hematocrit, NLR, PLR, MLR, RDW and MPV) in 40 cases patients with SSNHL due to *S. suis* bacterial meningitis and 40 controls patients with *S. suis* bacterial meningitis patients with normal hearing.

Result: In this study, it was found that there is no significant difference between case group compared to control group in terms of CBC results. The mean hematocrit value was 40.67 (± 4.45) in cases and 40.87 (± 4.08) in controls, with *p-value* 0.842. The mean MPV value was 9.82 (± 1.58) in cases and 9.33 (± 1.78) in controls, with *p-value* 0.200. The mean NLR value in the case group was 24.46, while in the control group it was 28.79, with *p-value* 0.124. The mean PLR value in the case group was 200.01, while in the control group it was 247.80, with *p-value* 0.126. The mean MLR value was 1.33 in cases and 1.19 in controls, with *p-value* 0.303. The mean RDW value was 12.98 in cases and 12.81 in controls, with *p-value* 0.950.

Conclusion: From 40 people suffering SSNHL due to *S. suis* bacterial meningitis it was found that most of research subjects are men (75%) and the average age of subjects is 53 years. This study found that there were no significant differences between the results of mean hematocrit, NLR, PLR, MLR, RDW and MPV in patients with SSNHL due to *S. suis* bacterial meningitis compared to controls.

Keywords: Hearing loss; Sudden sensorineural hearing loss; Complete blood count; *Streptoccocus suis*; Bacterial meningitis

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1. Introduction

Sudden sensorineural hearing loss (SSNHL) is a decrease in sensorineural hearing of 30 dB or more, at least three frequencies in a row on audiometric examination and lasts less than 3 days. This event is a neurotological emergency that requires immediate and comprehensive management. The estimated incidence of sudden deafness ranges from 5-20 cases per 100,000 population [1,2].

Sudden deafness can be caused by autoimmune, infection, metabolic, neoplastic, neurological, traumatic and vascular causes [3]. One of the infections that can cause sudden deafness is bacterial meningitis. Bacterial meningitis is inflammation of brain meningens due to bacterial invasion of the central nervous system (CNS). Bacterial meningitis itself can be caused by infection of *Streptococcus suis*. This bacteri is a gram-positive cocci bacteria and normal flora in the upper respiratory tract of pigs which is potentially pathogenic, after contact with pork and processed pork food [2]. Sudden deafness is usually unilateral so it is often ignored by patients. Symptoms that accompany sudden deafness are a feeling of fullness in the ears, vertigo and tinnitus. The diagnosis can be made based on anamnesis, physical examination, tuning fork, pure tone audiometry and supporting examinations [4].

Supporting examinations carried out include laboratory markers of inflammation, serum cholesterol, blood glucose and imaging with Computed Tomography (CT) scan or Magnetic Resonance Imaging (MRI). Complete blood counts (CBC) examinations are simple examinations that are often carried out at various levels of health facilities, apart from being easy to collect, the process is also simpler. From the results of CBC, information is obtained regarding hematocrit, neutrophil-lymphocyte ratio (NLR), platelet-lymphocyte ratio (PLR), monocyte-lymphocyte ratio (MLR), red cell distribution width (RDW) and mean platelet volume (MPV).[2] Some CBC components can be clinical indicators of the severity and prognosis of SSNHL [1].

Based on this background, the researchers were interested in conducting research on the differences in CBC results in patients with SSNHL caused by *S. suis* bacterial meningitis compared to controls at Prof. Dr. I. G. N. G. Ngoerah Hospital Denpasar for the period January 2019 – May 2023. This study objectives are to compare hematocrit, NLR, PLR, MLR, RDW and MPV levels in patients with and without SSNHL for *S. suis* meningitis.

2. Methods

This study used an analytical research design using a retrospective case control method by taking secondary data from patient medical records. Sampling technique used in this research is a total sampling technique where the number of samples is the same as the population. Total number of samples was 80 subject and divided into 40 subjects in case group and 40 subjects in control group. Case group inclusion criteria was patients diagnosed with SSNHL due to *S. suis* bacterial meningitis at RSUP Prof. Dr. I.G.N.G. Ngoerah Denpasar from January 2019 – May 2023 who carried out CBC tests, and the exclusion criteria were patients with incomplete medical records that include information about all variables studied and patients who do not have CBC results. Control group inclusion criteria was *S. suis* bacterial meningitis patients who did not experience SSNHL in the period January 2019 – May 2023 and underwent a CBC test, and the exclusion criteria were patients with incomplete medical records that include information about all variables studied and patients who do not have CBC results. In this study, cases and controls were matched based on gender and age. In each group of cases and controls, components of hematocrit, NLR, PLR, MLR, RDW and MPV were then assessed, followed by analyzing the differences.

Data analysis in this research consisted of descriptive statistical analysis, normality tests and correlation tests. Descriptive statistical analysis aims to describe the characteristics of research subjects and research variables. Variables that scale numerical data are displayed in the form of mean and standard deviation. Categorical scale variables are displayed using numbers and percentages.

Shapiro Wilk technique normality test was used to determine whether the data was normally distributed ($p>0.05$) or not. If the distribution of data in the case and control groups is normally distributed, the mean difference is calculated using the unpaired t-test. However, if the normality test shows that the group has an abnormal distribution of data, then the non-parametric Mann Whitney test is used. The entire data processing process was analyzed using the SPSS (Statistical Package for the Social Science) 26.0 program.

An assessment and statement of the ethical suitability of this study was provided by the Research Ethics Commission of the Faculty of Medicine, Udayana University (0498/UN14.2.2.VII.14/LT/2024).

3. Result

This study is a retrospective case control study where case group are patients diagnosed with SSNHL due to *S. suis* bacterial meningitis who were selected based on inclusion and exclusion criteria. Control group were subjects with *S. suis* bacterial meningitis who did not experience SSNHL and met the inclusion and exclusion criteria. Sample selection used a total sampling technique and the samples obtained in each case and control group were 40 people. The characteristics of research subjects based on age and gender can be seen in **table 1**.

Table 1 Characteristics of research subjects based on age and gender

Characteristics of Research Subjects	Cases (n=40)	Controls (n=40)
Age	53,53 ± 12,26	54,33 ± 12,33
Gender		
Male	30 (75%)	30 (75%)
Female	10 (25%)	10 (25%)
Total	40 (100%)	40 (100%)

In this study, a data normality test was carried out using Shapiro Wilk on hematocrit levels, neutrophil-lymphocyte ratio (NLR), platelet-lymphocyte ratio (PLR), monocyte-lymphocyte ratio (MLR), red cell distribution width (RDW) and mean platelet volume (MPV) in the case and control groups. In the hematocrit and MPV normality test, the p value was > 0.05, which indicates that the data is normally distributed. Next, the analysis of mean differences will be carried out using the unpaired t test. Comparison of mean hematocrit and MPV values can be seen on **table 2**.

In the NLR, PLR, MLR and RDW normality tests, the p value was <0.05, which indicates that the data distribution is not normally distributed. Next, the analysis of mean differences will be carried out using the non-parametric Mann-Whitney U test. Comparison of mean NLR, PLR, MLR and RDW values can be seen on **table 3**.

Table 2 Analysis of mean differences on hematocrit and MPV values.

	Mean Values on Cases	SD	Mean Values on Controls	SD	*p-value*
Hematocrit	40.67	± 4.45	40.87	± 4.08	0.842
MPV	9.82	± 1.58	9.33	± 1.78	0.200

The mean hematocrit value in the case group who experienced SSNHL was 40.67 (± 4.45), while in the control group it was 40.87 (± 4.08). The *p-value* is 0.842, so there is no significant difference. The mean MPV value in the group of cases who experienced SSNHL was 9.82 (± 1.58), while in the control group it was 9.33 (± 1.78). The *p-value* is 0.200, so there is no significant difference.

Table 3 Analysis of mean differences on NLR, PLR, MLR and RDW values

	NLR	PLR	MLR	RDW
Mann-Whitney U	640.000	641.000	693.000	793.500
Wilcoxon W	1460.000	1461.000	1513.000	1613.500
Z	-1.540	-1.530	-1.030	-0.063
Asymp. Sig. (2-tailed)	0.124	0.126	0.303	0.950

The mean NLR value in the case group who experienced sudden deafness was 24.46, while in the control group it was 28.79. The *p-value* in this mean difference test is 0.124 (*p-value* > 0.05), so that there is no significant difference. The mean PLR value in the case group was 200.01, while in the control group it was 247.80. The *p-value* in this mean difference test is 0.126 (*p-value* > 0.05) so there is no significant difference. The mean MLR value in the case group was 1.33, while in the control group it was 1.19. The *p-value* in this mean difference test is 0.303 (*p-value* > 0.05), so there is

no significant difference. The mean RDW value in the case group was 12.98, while in the control group it was 12.81. The *p-value* in this mean difference test is 0.950 (*p-value* > 0.05), so there is no significant difference.

4. Discussion

SSNHL is an emergency condition in ENT departments, and the etiology is still unclear. Some state infarction, vascular ischemia such as thromboembolic stroke and myocardial infarction as causes. Blood flow to the cochlea is via the labyrinthine artery, which is the terminal branch of the cerebral anteroinferior artery that is disrupted causing cochlear injury. Injuries occur when blood flow decreases due to the reduced diameter of blood vessels and the absence of collateral blood flow. Risk factors for vascular disease such as smoking, hypertension and hyperlipidemia are said to be causes of sudden deafness. From a histopathological examination of the temporal bone of a patient with sudden deafness, a viral infection was found. Sudden deafness can also be caused by S. suis bacterial infection which attacks the meningeal layer of the brain, causing the patient to experience meningitis. Research on the epidemiology and clinical characteristics of S. suis meningitis in Bali reported fever as the most common symptom experienced by 40% of patients, followed by stiff neck, impaired consciousness and headache. Deafness is reported to be the most common sequela in patients infected with S. suis, even higher than infections with other bacteria [5].

In this study, it was found that the proportion of men who experienced sudden deafness was greater than women, with the percentage of men being 75% and women being 25%. According to Alexander et al., the prevalence ratio between men and women suffering from sudden deafness is 1.07:1, where men experience sudden deafness more often than women. In addition, according to Lin et al., the estimated incidence of sudden deafness is 8.85 in men and 7.79 in women per 100,000 people [6,7]. The mean age of patients who experienced sudden deafness in this study was 53.53 ± 12.26 years. According to Hidayat et al., the most sufferers were in the 40 – 60 years age group, namely 57.69% [8].

From the results of this study, there was no difference in hematocrit values in the case and control groups. This is not in accordance with Ohinata et al., who stated that blood viscosity values in cases were higher than controls [9]. Research by Levie et al. which states that decreasing hematocrit can reduce blood viscosity and reduce venous return resistance, thereby increasing cardiac output. At the microcirculatory level, decreasing hematocrit improves perfusion and oxygenation [3]. From research by Narozny W et al., hemoconcentration due to high hematocrit is not a prognostic factor for sudden deafness [10]. From the results of this study, there was no difference between NLR in cases and controls. This is not in line with existing previous research. Where according to Bahrami et al., the mean NLR in cases was significantly higher than in controls ($p<0.05$) [11]. According to Doo et al., neutrophils are a thrombogenic marker, and are a risk factor for stroke and myocardial infarction. Neutrophils in sudden deafness patients were positively correlated with hearing loss before therapy, and negatively correlated with hearing improvement after 1 week and final improvement. These findings indicate that a high neutrophil count may be a clinical indicator of the severity and prognosis of sudden deafness. Inflammation can induce sudden deafness. NLR was the most studied factor and it was found that patients with sudden deafness had a higher NLR. In addition, NLR was higher in patients who did not experience improvement in symptoms than in those who did. With these findings, NLR may be a marker for the onset and prognosis of sudden deafness. There is no research that states the exact NLR limit, but there is recent research that suggests an NLR limit of 0.78–3.53 [1]. From the results of this study, there was no difference between PLR in cases and controls. According to research by Doo et al., PLR was found to be higher in the case group than in controls. Platelets are part of the pathophysiology of inflammation, coagulation, thrombosis and atherosclerosis of blood vessels. PLR can be used to evaluate the degree of systemic inflammation and endothelial damage of the peripheral vascular system, with an increase in PLR associated with increased platelet adhesion to damaged blood vessels [1].

From the results of this study, there was no difference between MLR in cases and controls. According to Seo et al., there was no difference in MLR values in controls and cases, apart from that, there was no difference in MLR between groups that improved after treatment and those that did not improve after treatment [12]. According to Fest et al., MLR is influenced by age and gender so it is not reliable as an indicator [13].

From the results of this study, the RDW values between the case and control groups were not significantly different. According to the literature, the pathophysiology of the relationship between RDW and sudden deafness is not clear, where research by Sahin et al., stated that there was no difference in RDW in control patients and sudden deafness [14]. Meanwhile, according to Doo et al., RDW is associated with inflammation and microcirculation disorders, such as in coronary disease and rheumatoid arthritis. It was found that increasing RDW was associated with worse disease outcomes, especially inflammation and thrombosis [1]. From the results of this study, there was no significant difference in MPV values. MPV functions in hemostasis and the processes of coagulation, inflammation, thrombosis and atherosclerosis. MPV is also a parameter of platelet volume, function and activity. MPV levels increase in vascular events

such as atherosclerosis, thrombosis or thromboembolism. Several studies have been conducted regarding the relationship between MPV and sudden deafness, but there have been no consistent and conclusive results [11].

5. Conclusion

From this study, there were 40 people suffering SSNHL due to *S. suis* bacterial meningitis with the characteristics of most research subjects are men (75%) and the average age of subjects is 53 years. Also, there were no significant differences between the results of hematocrit, NLR, PLR, MLR, RDW and MPV in patients with SSNHL due to *S. suis* bacterial meningitis compared to controls in this study.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent is not required because taking secondary data.

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