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ARTICLE

The Systemic Inflammatory Response Index as a Novel Diagnostic Indicator for Bell's Palsy

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Abstract

Aims/Background The systemic inflammatory response index (SIRI), an emerging hematological marker of inflammation, has shown promise as a promising biomarker for a variety of inflammatory conditions. This study aims to explore the diagnostic role of SIRI in Bell's palsy (BP).

Methods For this retrospective study, 73 people diagnosed with BP between January 2021 and December 2023 were recruited, along with 73 healthy controls who were age- and sex-matched. The SIRI and other blood inflammatory markers, including the systemic immune-inflammation index (SII), neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR), were determined for all participants, by enumerating their peripheral blood cell counts. Facial nerve function was assessed upon admission and after one month of treatment using the House-Brackmann Facial Nerve Grading System (H-B). According to this system, patients with an H-B grade of 1–2 are considered recovered, while those with an H-B grade of 3–6 are regarded as not recovered.

Results The SIRI (0.94 vs 0.48, $p < 0.001$), SII (480.3 vs 329.12, $p < 0.001$), NLR (2.42 vs 1.41, $p < 0.001$), and PLR (141.05 vs 117.28, $p = 0.001$) showed a significant increase in the BP group compared to the control group. The receiver operating characteristic (ROC) curve analysis revealed that the area under the curve (AUC) for SIRI was higher than those for SII, NLR, and PLR, respectively. Upon one-month follow-up, significant differences in the values of SIRI, SII, and NLR were observed between the favorable prognosis group and the poor prognosis group (SIRI: 1.07 vs 0.87, $p = 0.011$; SII: 647.85 vs 422.11, $p = 0.005$; NLR: 3.31 vs 2.11, $p = 0.013$). The AUC of ROC curve for SIRI was found to be lower than that of SII but higher than that of NLR.

Conclusion The SIRI has the potential to be an important BP diagnostic and prognostic marker.

Key words: Bell's palsy; inflammatory markers; SIRI; SII; NLR

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Introduction

Bell's palsy (BP), also known as acute idiopathic facial nerve paralysis, is the most common cause of peripheral facial palsy, accounting for 60–75% of facial nerve paralysis cases (Heckmann et al, 2019). The annual incidence of BP ranges from 11.5 to 53.3 cases per 100,000 individuals (Zhang et al, 2020). The facial muscles are typically paralyzed, either partially or completely, in people with BP. Despite the spontaneous resolution in most cases, some individuals may experience

persistent facial paralysis, which can have a significant impact on their quality of life.

Although the precise origins and underlying mechanisms of BP remain elusive, its pathophysiology is believed to involve a complex interplay of factors, including structural abnormalities, viral infection, ischemic events, inflammatory processes, and sensitivity to cold stimuli (Zhang et al, 2020). Prevailing hypotheses suggest that BP is primarily associated with the reactivation of herpes simplex virus type 1 (HSV-1) or varicella-zoster virus (VZV) within the geniculate ganglion (Abdel-Aziz et al, 2015; Furuta et al, 1998), along with a cell-mediated autoimmune inflammatory response (Greco et al, 2012). This form of response damages nerve fibers, leading to demyelination and nerve damage that can compress the facial nerve within the stylomastoid foramen (Liston and Kleid, 1989). Combining corticosteroids and antiviral agents has proven to be more effective for treating BP than using corticosteroids or antiviral agents alone, attesting to both the viral and inflammatory origins of this disease (Kim et al, 2021a). Separately, inflammatory markers, such as neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and systemic immune-inflammation index (SII), have been found to be significant in predicting BP prognosis (Kınar et al, 2021; Oya et al, 2019). Recently, systemic inflammatory response index (SIRI) has increased attention as a novel inflammatory marker. High SIRI has been observed in various pathological conditions, including malignancies (Wei et al, 2020), hypertension (Zhao et al, 2023), type 2 diabetic retinopathy (Wang et al, 2023a), cardiovascular diseases (Dziedzic et al, 2022; Jin et al, 2021), ischemic stroke (Zhang et al, 2021, 2023), sepsis (Ru and Luo, 2023), rheumatoid arthritis (Xu et al, 2022), gouty arthritis (Jiang et al, 2023), and periodontitis (Luo et al, 2024). Elevated SIRI is also consistently associated with worse clinical presentations or prognosis (Dziedzic et al, 2022; Jiang et al, 2023; Jin et al, 2021; Luo et al, 2024; Ru and Luo, 2023; Wang et al, 2023a; Wei et al, 2020; Xu et al, 2022; Zhang et al, 2021; Zhang et al, 2023; Zhao et al, 2023). Conversely, a reduction in SIRI is correlated with improved outcomes (Chen et al, 2021; Liu et al, 2021; Wang et al, 2024). However, the precise relationship between SIRI and BP remains still unclear.

This study aimed to explore the relationship between changes in SIRI and BP and assess its potential impact on patient outcomes, with the aim to investigate the diagnostic utility in BP by comparing patients with the disease and healthy individuals. In a subsequent analysis, we divided BP patients into recovered and unrecovered groups to determine the prognostic significance of SIRI. Furthermore, we conducted comparative analyses of other hematologic parameters, such as NLR, PLR, and SII, in the context of BP.

Methods

Study Participants

The current study was approved by the Ethics Committee of the Second Affiliated Hospital of Guizhou University of Traditional Chinese Medicine, China (LW2024128). The study was conducted in adherence to the Declaration of Helsinki

2000. Furthermore, due to the retrospective nature of the study, The Second Affiliated Hospital of Guizhou University of Traditional Chinese Medicine has granted a waiver of informed consent for this study. In this study, we reviewed the clinical records of patients diagnosed with BP, who were hospitalized in the Department of Neurology, The Second Affiliated Hospital of Guizhou University of Traditional Chinese Medicine between January 2021 and December 2023, and gathered data such as gender, age, duration of illness, severity, treatment outcomes, comorbidities, medications, and hematological parameters. The BP patients fulfilling the following set of characteristics were included in this study: (1) diagnosed with BP, (2) aged over 18 years, and (3) hospitalized during the specified timeframe at our institution. The exclusion criteria for BP patients are as follows: (1) patients with symptom onset beyond three days; (2) patients with facial paralysis due to other causes such as otolaryngological diseases, trauma, tumours, stroke, or Guillain-Barré syndrome; (3) patients with comorbidities affecting inflammatory marker levels, such as malignancies, infections, autoimmune diseases, hypertension, diabetes (Mohammed et al, 2024), hyperlipidemia (Scicali et al, 2021), cardiovascular diseases, ischemic stroke, severe kidney disease (Yuan et al, 2019), or carotid artery plaques (Corriere et al, 2018); (4) postpartum patients; (5) patients not receiving glucocorticoids; (6) patients who did not undergo hematological examination; and (7) patients who were lost to follow-up.

The individuals in the control group were selected from the patients hospitalized at our institution during the same period, who were age- and gender-matched with the subjects in the BP patient group. To ensure proper age matching, we divided the subjects into the following age groups: $<$20 years, 20–29 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years, 70–79 years, and $\geq$80 years. Within each age group, we ensured that the number of subjects and the gender ratio were the same in both the BP patient group and the control group. We allowed an age tolerance of $\pm$3 years for the age matching in each group.The exclusion criteria for the control group are as follows: (1) individuals with no history of major chronic diseases such as cardiovascular disease, cancer, or diabetes; (2) individuals with no symptoms suggestive of infection, such as fever, cough, or sore throat; (3) individuals not currently receiving immunomodulatory medications, such as immunosuppressants or steroids; (4) not pregnant or lactating; and (5) individuals with no severe psychiatric disorders and who were able to comply with the blood testing procedure. After the proper selection of research subjects, this study recruited 73 individuals diagnosed with BP (Fig. 1), alongside an equivalent number of healthy participants (Fig. 2).

The House-Brackmann Facial Nerve Grading System (H-B) was utilized to assess facial paralysis in patients after one month of treatment (Engström et al, 1998). The study participants with an H-B grade of 1–2 were categorized as recovered (n = 48), while those with an H-B grade of 3 and above were regarded as not recovered (n = 25) (Fig. 1).

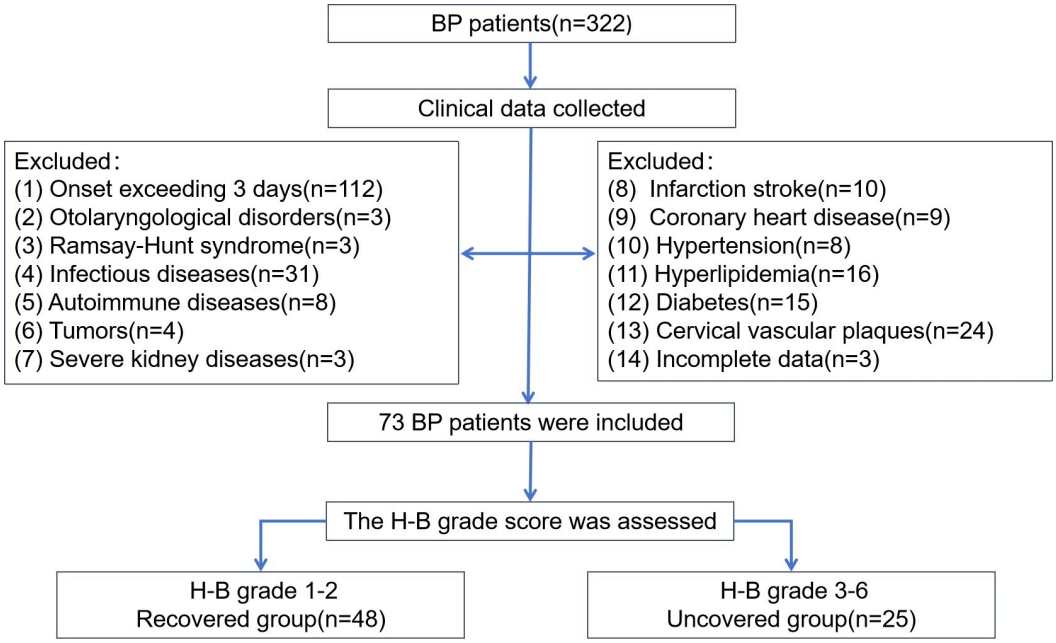

Fig. 1. Flowchart depicting the selection and inclusion of the study participants. H-B, House-Brackmann Facial Nerve Grading System; BP, Bell's palsy.

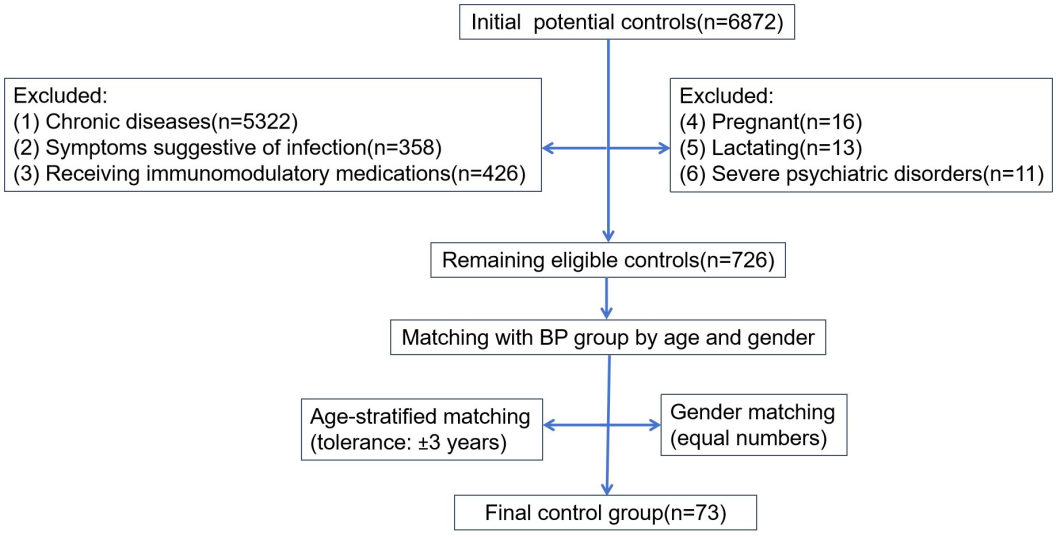

Fig. 2. Flowchart of control group selection.

Treatments

All individuals diagnosed with BP received a combined treatment regimen comprising acupuncture and steroid therapy within the first 24 hours of their hospitalization. The treatment commenced with an initial dose of 1 mg/kg of prednisone (H42021526, Huazhong Pharmaceutical Co., Ltd., Xiangyang, China) or an equivalent dose of methylprednisolone (H20020224, Tianyao Pharmaceutical Co., Ltd., Tianjin, China), which was administered once daily for a consecutive 5 days, followed by a gradual tapering. Alternatively, patients received an initial dose of 5–10 mg/day of dexamethasone (H32021560, Chengdu Pharmaceutical Co., Ltd.,

Chengdu, China) via intravenous injection, followed by a tapering regimen and oral prednisone (H42021526, Huazhong Pharmaceutical Co., Ltd., Xiangyang, China).

Laboratory Parameters

Before commencing glucocorticoid therapy, venous blood samples were collected from each fasting patient. These samples were analyzed using the Sysmex XN 1000-B3 automated hematology analyzer (Sysmex Corp, Kobe, Japan) to measure cell counts and differentials for hematological parameters. Subsequently, SIRI, SII, NLR, and PLR were determined.

Assessment of Outcomes

The severity of facial paralysis among BP patients was assessed by utilizing the H-B grading system. Initially, upon admission, all BP patients exhibited H-B grades ranging from 4 to 6. Following one month of treatment, facial paralysis was re-evaluated using the H-B scale: patients with a grade of 1–2 were classified as recovered and those with a grade of 3 and above as unrecovered patients. Subsequently, we compared the SIRI, SII, NLR, and PLR values between the BP group and the healthy control group, and then investigated pivotal parameters associated with poor prognosis for BP.

Statistical Analysis

The statistical analysis was performed using SPSS software (version 26, IBM, Chicago, IL, USA). The choice of statistical methods was based on the nature of the data and the specific objectives of our analysis. Shapiro-Wilk test was used to assess the normality of continuous data. Normally distributed data are expressed as mean ± standard deviation (SD) to provide a measure of central tendency and dispersion, whereas non-normally distributed data are presented as median (P25, P75) to better represent central tendency and variability. *t*-test was used to compare means of normally distributed data between two groups, as it is suitable for detecting differences in means. Mann-Whitney U test was applied for comparing non-normally distributed data because it is more robust for skewed data. Chi-square test was used to compare frequencies and percentages of categorical data to determine associations between groups. To ascertain disease prediction thresholds for SIRI, SII, NLR, and PLR, we employed receiver operating characteristic (ROC) curve analysis. This method is effective for evaluating diagnostic test performance and identifying optimal cut-off points. Additionally, ROC curves were used to compare the predictive values of SIRI, SII, and NLR, which are indicative of different prognoses for BP. This comparison helps determine which marker is most reliable for predicting outcomes. Statistical significance was set at $p < 0.05$. The ROC curves were plotted using GraphPad Prism 10 (GraphPad Software, San Diego, CA, USA).

Results

Both study groups had equivalent gender proportions of subjects: 28 males (38.4%) and 45 females (61.6%). The average ages of the subjects were 45.41

Table 1. Comparison of the baseline characteristics between the BP and control groups.

	BP group (n = 73)	Control group (n = 73)	$\chi^2/t/z$	*p*-value
Sex (M/F) (n)	28/45	28/45	0.000	1.000
Age (years)	45.41 ± 15.24	44.78 ± 15.17	–0.250	0.803
WBC ($\times 10^9$/L)	6.15 (5.33, 7.09)	5.21 (4.49, 6.17)	–3.918	<0.001
Neutrophil ($\times 10^9$/L)	3.79 (3.15, 4.83)	2.75 (2.33, 3.26)	–6.650	<0.001
Lymphocyte ($\times 10^9$/L)	1.64 (1.22, 2.00)	1.95 (1.60, 2.38)	–3.928	<0.001
Monocytes ($\times 10^9$/L)	0.40 (0.33, 0.51)	0.34 (0.27, 0.42)	–2.965	0.003
Platelet ($\times 10^9$/L)	222.00 (181.50, 258.00)	222.00 (188.00, 260.00)	–2.292	0.771
SIRI	0.94 (0.71, 1.38)	0.48 (0.39, 0.57)	–8.236	<0.001
SII	480.30 (347.37, 847.07)	329.12 (245.73, 405.66)	–6.319	<0.001
NLR	2.42 (1.71, 3.55)	1.41 (1.17, 1.71)	–7.582	<0.001
PLR	141.05 (106.21, 179.32)	117.28 (89.65, 114.85)	–3.378	0.001

Abbreviations: M, male; F, female; WBC, white blood count; SIRI, systemic inflammatory response index; SII, systemic immune-inflammation index; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; BP, Bell's palsy.

Table 2. The ROC curve analysis for SIRI, SII, NLR, and PLR values.

	AUC	Cut-off	*p*-value	Sensitivity (%)	Specificity (%)	Youden	95% CI
SIRI	0.895	0.72	<0.001	75.3	91.8	0.671	0.843–0.947
SII	0.803	457.08	<0.001	57.5	89.0	0.465	0.734–0.872
NLR	0.864	1.87	<0.001	71.2	87.7	0.589	0.805–0.922
PLR	0.662	157.53	0.001	38.4	87.7	0.261	0.575–0.749

Abbreviations: AUC, area under the curve; CI, confidence interval; SIRI, systemic inflammatory response index; SII, systemic immune-inflammation index; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio.

± 15.24 years in the BP group and 44.78 ± 15.17 years in the healthy control group, exhibiting comparable age distributions. There was no significant difference between the two groups in terms of gender proportions and age distribution ($p > 0.05$). However, significant differences were observed in the SIRI, SII, NLR, and PLR values between the BP and control groups. Specifically, the SIRI (0.94 vs 0.48, $p < 0.001$), SII (480.3 vs 329.12, $p < 0.001$), NLR (2.42 vs 1.41, $p < 0.001$), and PLR (141.05 vs 117.28, $p = 0.001$) were significantly elevated in the BP group compared to the control group (Table 1).

After performing the ROC curve analysis, we found that the area under the curve (AUC) for SIRI surpassed those for SII, NLR, and PLR (Fig. 3), indicating that SIRI is a more promising diagnostic indicator for BP than SII, NLR, and PLR. Additionally, SIRI showed higher sensitivity and specificity (75.3% and 91.8%, respectively), making it a more potent diagnostic marker for BP than the other three inflammatory markers (Table 2).

Based on the H-B grades, the BP patients were stratified into recovered and unrecovered groups. The recovered group comprised 48 cases, with 20 males (41.7%)

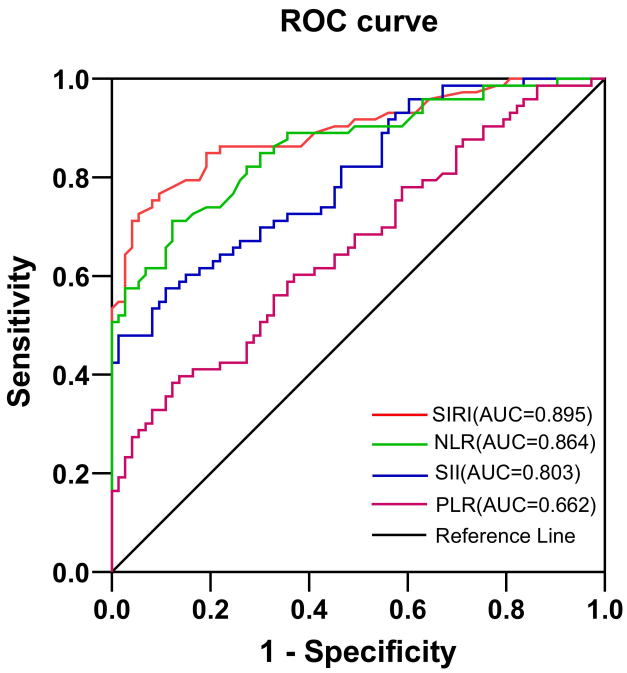

Fig. 3. Receiver operating characteristic (ROC) curves of systemic inflammatory response index (SIRI), systemic immune-inflammation index (SII), neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR) values. Abbreviation: AUC, area under the curve.

and 28 females (58.3%) and an average age of 44.23 ± 15.76 years. The unrecovered group consisted of 25 cases, with 8 males (32%) and 17 females (68%) and an average age of 47.68 ± 14.21 years. There was no significant difference in gender proportion and age between the two groups ($p > 0.05$). However, substantial variations were found in SIRI, SII, and NLR values between the recovered and unrecovered groups. Specifically, the SIRI (1.07 vs 0.87, $p = 0.011$), SII (647.85 vs 422.11, $p = 0.005$), and NLR (3.31 vs 2.11, $p = 0.013$) were significantly higher in the unrecovered group compared to the recovered group (Table 3).

The ROC curve analysis revealed that the AUC for SIRI was slightly lower compared to that for SII but higher than that for NLR (Fig. 4). These findings suggest that SIRI can potentially predict the prognosis of BP to some extent, exhibiting sensitivity and specificity of 64% and 64.6%, respectively (Table 4).

Discussion

The reactivation of viral infection and the inflammatory mechanism are crucial to BP development. NLR, a blood cell-derived inflammatory marker, is a reliable hematological indicator for assessing severity and predicting prognosis of inflammatory disorders (Buonacera et al, 2022). Studies have shown that significantly elevated NLR values in adult and pediatric BP patients compared to healthy controls, suggesting a potential predictive value for disease progression (Cayir and Kilicaslan, 2021; Kim et al, 2021b; Oya et al, 2019). Furthermore, a higher NLR value

Table 3. Characteristics of the recovered and unrecovered groups.

	Recovered group (n = 48)	Uncovered group (n = 25)	$\chi^2/t/z$	*p*-value
Sex (M/F) (n)	20/28	8/17	0.650	0.420
Age (years)	44.23 ± 15.76	47.68 ± 14.21	0.917	0.362
SIRI	0.87 (0.64, 1.26)	1.07 (0.84, 1.94)	2.540	0.011
SII	422.11 (323.50, 683.63)	647.85 (477.98, 1037.38)	2.790	0.005
NLR	2.11 (1.69, 3.00)	3.31 (1.97, 4.05)	2.470	0.013
PLR	130.87 (96.91, 176.07)	156.96 (122.96, 191.97)	1.825	0.068

Abbreviations: M, male; F, female; WBC, white blood count; SIRI, systemic inflammatory response index; SII, systemic immune-inflammation index; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio.

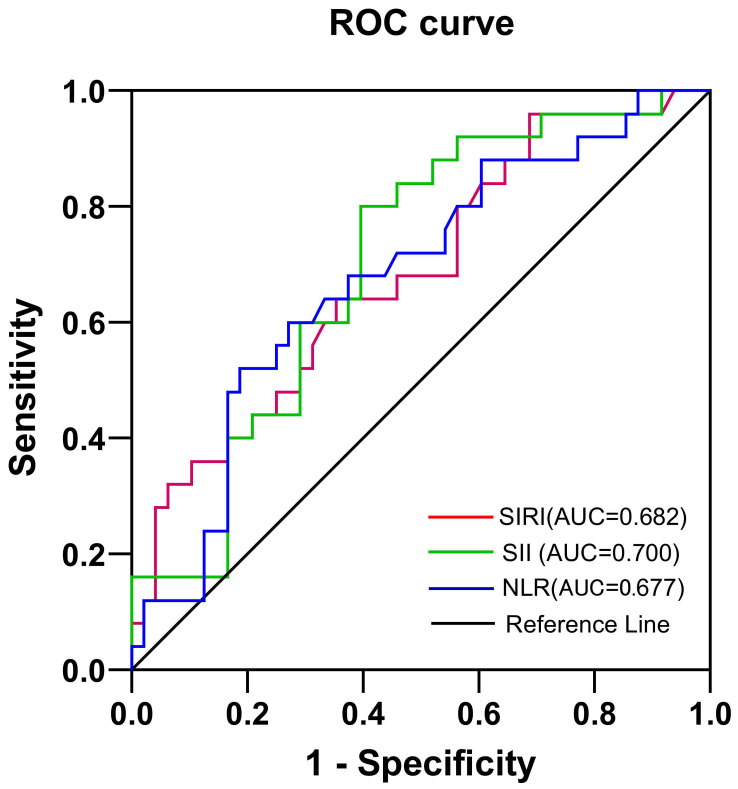

Fig. 4. Receiver operating characteristic (ROC) curves of systemic inflammatory response index (SIRI), systemic immune-inflammation index (SII), and neutrophil-to-lymphocyte ratio (NLR) values. Abbreviation: AUC, area under the curve.

has been linked to more severe palsy and longer extended recovery periods (Kim et al, 2019). The NLR combines the neutrophil and lymphocyte counts in peripheral blood, reflecting the innate immune response driven by neutrophils and the adaptive immunity supported by lymphocytes (Song et al, 2021). Monocytes, a type of white blood cell, play a pivotal role in innate and adaptive immune responses. They are involved in immune defense, inflammation regulation, and tissue restructuring (Kratofil et al, 2017). Recent studies have revealed the monocyte-to-high-density-lipoprotein ratio as a promising biomarker for BP (Jin et al, 2024; Serifler et al,

Table 4. The ROC curve analysis for SIRI, SII, and NLR values.

	AUC	Cut-off	*p*-value	Sensitivity (%)	Specificity (%)	Youden	95% CI
NLR	0.677	3.20	0.014	52.0	81.2	0.332	0.548–0.806
SII	0.700	475.55	0.005	80.0	60.4	0.404	0.578–0.822
SIRI	0.682	1.00	0.011	64.0	64.6	0.286	0.553–0.811

Abbreviations: AUC, area under the curve; CI, confidence interval; SIRI, systemic inflammatory response index; SII, systemic immune-inflammation index; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio.

2024), underscoring the role of inflammation in this medical condition. The SIRI is calculated by multiplying monocyte and neutrophil numbers and dividing it by lymphocyte count—an easily determinable and convenient indicator of the balance between innate and adaptive immune responses. Combining these three critical inflammatory markers, SIRI offers a more comprehensive and sensitive assessment of the body's inflammatory status. Recently, SIRI has emerged as a novel inflammatory index for predicting disease progression and survival outcomes in patients with inflammatory diseases and cancer (Jiang et al, 2023; Luo et al, 2024; Wang et al, 2023b). Furthermore, when combined with SII, SIRI has shown high accuracy in diagnosing diabetic retinopathy (Zhang et al, 2021). In light of our findings, SIRI holds potential in applications such as monitoring and predicting inflammatory status in BP patients.

To the best of our knowledge, this is the first study investigating the diagnostic role of SIRI in BP. Our findings revealed that patients with BP exhibited higher SIRIthan healthy controls, with an AUC of 0.895. These observations indicated that SIRI could serve as a promising diagnostic indicator for BP. Additionally, we analyzed the relationship between BP and other inflammatory markers, demonstrating that the NLR, SII, and PLR were all elevated in the BP group compared to the healthy control group, consistent with previous literature (Kınar et al, 2021; Oya et al, 2019; Sahin and Varım, 2017). However, SIRI outperforms these inflammatory markers and provides a more complete picture of BP's inflammatory status, making it a better diagnostic indicator for BP. Furthermore, all our participants were within three days of symptom onset, lending support to the early inflammation theory of BP and substantiating the potential of SIRI as an early diagnostic marker for BP.

We also analyzed the relationship between SIRI and BP short-term prognosis. We observed that the SIRI was significantly higher in the unrecovered BP patients compared to their recovered counterparts after one month, with an AUC of 0.682. This indicates that SIRI is a factor influencing the short-term prognosis of BP. Additionally, evaluating other inflammatory markers showed no significant difference in PLR between the two groups, while NLR and SII were higher in the unrecovered group compared to the recovered group, consistent with the finding of a previous study (Oya et al, 2019). Although the AUC for SIRI was higher than that of NLR, it was lower than that of SII. This does not diminish the significance of SIRI in BP. Derived from monocyte count, SIRI affords a comprehensive picture of inflammation status in BP, while SII, determined from platelet count, also reflects the ischemic

mechanism of BP. Thus, a high SII in BP suggests that ischemia may exist in the early stages of BP and could impact prognosis. SIRI provides a comprehensive assessment of the inflammatory status in BP, guiding early intervention and treatment planning. Additionally, we propose the possibility of combining SIRI and SII, which may provide an overarching understanding of the pathophysiological status and prognosis of BP, facilitating clinical decision-making. The clinical application value of SIRI lies in it being an easily accessible, cost-effective biomarker that may enhance current diagnostic protocols and treatment strategies for BP.

This study has several limitations that should be acknowledged. Firstly, the retrospective design may introduce information bias due to the reliance on previously recorded data. Secondly, the sample used is of relatively small size and was derived from a single center, potentially compromising the study power and posing an obstacle to the wide generalizability of the findings. Increasing the sample size in future studies could enhance the reliability and robustness of the results. Thirdly, the single-timepoint measurement of SIRI limits our understanding of its dynamic changes and response to treatment over time. Future studies should consider longitudinal measurements to better capture these dynamics. Additionally, potential confounding factors such as patients' lifestyles, comorbidities, and disease severity, which could influence the levels of inflammatory markers, were not fully accounted for in the current analysis. Finally, it should be noted that the exclusion criteria applied in this study, while necessary to maintain a homogeneous study population, may limit the applicability of the findings to a broader patient population.

Future research should aim to address these limitations by including larger, multi-center cohorts to improve the generalizability of the findings. Prospective studies with longitudinal follow-up and repeated SIRI measurements over time would provide more insights into the temporal changes and treatment responses. Additionally, a comprehensive analysis of data including potential confounders such as lifestyle factors and comorbidities should be performed to better understand their impact on inflammatory markers. Exploring the underlying mechanisms of elevated SIRI in BP and interpreting it alongside other biomarkers could also provide valuable insights for clinical practice.

Conclusion

The SIRI holds promise as a potential diagnostic indicator and prognostic marker for BP. Future studies should employ larger sample sizes and rigorous study designs to validate our findings and explore the utility of combining SIRI and SII in predicting the prognosis of BP.

Key Points

- The systemic inflammatory response index (SIRI) is a potential hematological marker with high diagnostic significance for Bell's palsy (BP).
- This study demonstrates that SIRI, along with systemic immune-inflammation index (SII), neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR), are markedly higher in BP patients compared to healthy controls, indicating their potential as diagnostic biomarkers.
- The receiver operating characteristic (ROC) curve analysis suggests that the diagnostic accuracy of SIRI for BP is higher than those of NLR and PLR, but slightly lower than that of SII.
- Significant differences in SIRI, SII, and NLR values between recovered BP patients and their unrecovered counterparts during follow-up suggest the utility of these indicators in predicting patient outcomes.
- The findings underscore the potential of SIRI as a crucial parameter not only for diagnosing BP but also for evaluating and predicting disease prognosis.

Availability of Data and Materials

All data included in this study are available upon request by contacting the corresponding author.

Author Contributions

JHL made substantial contributions to the conception and design of the work and was responsible for drafting the manuscript. GYL and RW were responsible for designing the methodology, analyzing and interpreting the data, and reviewing the literature. XQ, SXP and PL were responsible for clinical data collection. JBS was responsible for designing the work, revising it critically, and making the final approval of the version to be published. All authors contributed to the important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Second Affiliated Hospital of Guizhou University of Traditional Chinese Medicine (LW2024128). The Second Affiliated Hospital of Guizhou University of Traditional Chinese Medicine has granted a waiver of informed consent for this study.

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Conflict of Interest

The authors declare no conflict of interest.

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