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ORIGINAL RESEARCH

Prognosis of Ischemic Stroke Patients Undergoing Endovascular Thrombectomy is Influenced by Systemic Inflammatory Index Through Malignant Brain Edema

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Purpose: The systemic immune inflammatory index (SII), as a new marker, is widely used to predict the disease prognosis. We investigated the predictive value of SII for malignant cerebral edema (MCE) and whether postoperative MCE mediates the relationship between SII and functional prognosis in patients undergoing endovascular thrombectomy (EVT).

Patients and Methods: A total of 829 patients with anterior circulation large-vessel occlusive stroke (LVOS) were registered, and 675 (81.4%) met the inclusion criteria. We collected baseline data upon admission, including SII. Postoperative computed tomography was performed to assess the presence and grading of cerebral edema (CED), and MCE was defined as a CED score of 3. A good prognosis was defined as a modified Rankin Scale (mRS) score of 0–2 at the 90-day follow-up.

Results: A total of 132 patients developed MCE after EVT. The patients were divided into MCE and non-MCE groups, and univariate and multifactorial analyses were performed. Among these risk factors, an elevated SII was independently correlated with the occurrence of MCE. In addition, the receiver operating characteristic (ROC) curve was used to assess the predictive capability of SII levels for prognosis. The area under the ROC was 0.69, and the optimal critical value was 2.14. In addition, postoperative MCE may partially account for the poorer functional prognosis of patients with elevated SII (regression coefficient changed by 40.3%).

Conclusion: The SII is an independent predictor of malignant brain edema after EVT. Postoperative MCE is partly the reason for the poorer prognosis in patients with elevated SII.

Keywords: acute ischemic stroke, endovascular treatment, systemic immune inflammatory index, malignant cerebral edema

Introduction

In recent years, endovascular thrombectomy (EVT) has become the mainstay treatment for large-vessel occlusion stroke (LVOS).[1] However, the overall outcome is limited, with only 30–50% of patients having a good prognosis.[2] Postoperative malignant cerebral edema (MCE) is a catastrophic complication that can lead to rapid neurological deterioration, midline shift, brain herniation, and death.[3] Although there are limited therapeutic approaches to treating MCE, early decompressive hemicraniectomy may potentially reduce mortality and improve the opportunity for good functional outcomes.[4] Therefore, early prediction of MCE may be beneficial for patients after EVT.

Inflammation is intimately linked to the pathogenesis of stroke.[5] Ischemia induces a local immune response and inflammatory factor production, thereby disrupting the tight junctions of the blood-brain barrier (BBB).[6] Previous studies have shown that leukocytosis, thrombocytosis and platelet activation are associated with aggravated injury and disruption

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of the BBB following ischemic stroke.[6,7] Based on these studies, the neutrophil-lymphocyte ratio (NLR), platelet-lymphocyte ratio (PLR), prognostic nutritional index (PNI), and lymphocyte-to-monocyte ratio (LMR) have become widely used in the prediction of poor prognosis and complications in ischemic stroke.[8–12] And Chen et al reported that the combination of both NLR and PLR had a better predictive value than either alone for predicting poor prognosis following ischemic stroke.[13] However, few studies have examined the association between malignant brain edema and inflammation.

The systemic immune inflammatory index (SII) is calculated as platelets ×neutrophils/lymphocytes based on cell counts in the peripheral blood.[14] Previous studies have reported that the SII is associated with the severity of ischemic stroke;[15] in addition, the SII can predict hemorrhagic transformation after ischemic stroke.[16] Considering that MCE is thought to share inflammatory and BBB catabolic pathways with cerebral hemorrhage, a similar association may exist between SII and MCE, which deserves further elucidation.

Thus, we hypothesized that elevated SII index at admission predicted the development of MCE caused by anterior circulation LVOS in EVT-treated patient. We further explored the relationship between elevated SII and poor prognosis at 90 follow-up, and to investigate the role of postoperative MCE as a mediator between elevated SII and poor prognosis by mediating effect analysis.

Patients and Methods

Patients Selection

In this retrospective study, we included 675 patients with anterior circulation LVOS treated with EVT at two comprehensive stroke centers (January 2014 to December 2018 at Jinling Hospital and September 2015 to July 2021 at Yijishan Hospital). The study was approved by the Ethics Committee of the First Affiliated Hospital of Wannan Medical College (201,900,039). All private data of the participants were anonymized and maintained with confidentiality.

The inclusion criteria were as follows: (1) age ≥ 18 years old; (2) onset-to-puncture time (OTP) ≤24h; (3) preoperative modified Rankin Scale (mRS) score < 2; and (4) the occlusion site included the internal carotid artery (ICA) or M1 segment of the middle cerebral artery. The exclusion criteria were as follows: (1) multiple vessel occlusion (MVO) or anterior cerebral artery (ACA) occlusion or M2 segment of the middle cerebral artery occlusion; (2) missing neutrophil, lymphocyte or platelet counts; (3) absence of postoperative imaging data; (4) unavailability of outcome data; and (5) failed edema assessment because of massive cerebral hemorrhage after EVT. A flowchart for inclusion in the study cohort is shown in Figure 1.

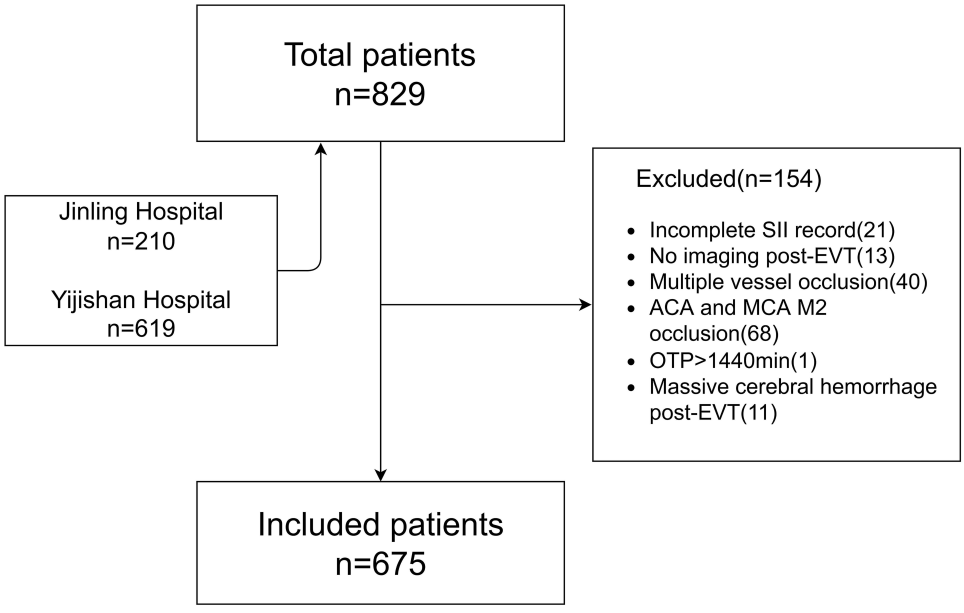

Figure 1 Flow chart of the inclusion of the study population.

Variable Definition

Prospective registry demographics included age, sex, medical history, and vascular risk factors. We also collected the clinical characteristics of patients, including stroke severity as assessed using the National Institutes of Health Stroke Scale (NIHSS) score and stroke subtype as classified by the Org10172 trial of acute stroke treatment(TOAST).[17]

The surgical staff recorded procedural variables, including onset-to-puncture time (OTP), site of the occluded vessel, status of cerebral collateral circulation, onset-to-reperfusion time (OTR), and degree of revascularization. Successful recanalization was defined as a Thrombolysis in Cerebral Infarction (mTICI) score of 2b or 3.[18] Collateral circulation was evaluated using retrograde angiography of the vessels in the occluded area on digital subtraction angiography (DSA) images prior to reperfusion therapy. Grade 0 collateral circulation was defined as no obvious reconstruction area of collateral blood flow or occluded vessels less than one-third of collateral vessels; grade 1 collateral circulation was defined as collateral blood flow less than two-thirds and more than one-third of the occluded vessel area, and grade 2 collateral circulation was defined as collateral blood flow more than two-thirds of the occluded vessel area or proximal to the main trunk.[19,20]

Blood samples were collected in tubes containing ethylenediaminetetraacetic acid after reperfusion therapy and within the first 24h after admission. We further collected laboratory data, including the total white blood cell count, neutrophil count (NC), lymphocyte count (LC), and platelet count (PLT). The SII index was calculated using the following formula: SII = [(PLT × NC/LC)/1000].

Cerebral edema (CED) was classified as focal brain swelling up to 1/3 (CED-1) or greater than 1/3 (CED-2) of the hemisphere, or midline shift (CED-3).[21] Malignant cerebral edema was defined as CED-3 according to the follow-up images obtained 3–5 days after EVT. A score of 0–2 was defined as a good prognosis based on the 90-d mRS score at outpatient or telephone follow-up.

Statistical Analysis

We grouped patients based on the presence or absence of MCE or favorable and adverse outcomes. Categorical variables are expressed as percentages. Normally distributed continuous variables are summarized as mean ± SD, and non-normally distributed continuous variables are expressed as median and interquartile range (IQR). Nominal variables were compared using the Fisher's exact test or Pearson's chi-squared test, and comparisons of continuous variables were made using the Mann–Whitney *U*-test or Kruskal–Wallis test based on the data distribution. Logistic regression analysis was used to determine predictors of MCE. Variables with $P<0.05$ in the univariate analysis were included in the multivariate logistic regression model.

Receiver operating characteristic (ROC) curves were used to evaluate the ability of the 24-hour postoperative SII index to predict the occurrence of MEC. The optimal test cut-off point was established by calculating Youden's index.

The Sobel test was used for mediation analysis to explore whether postoperative cerebral edema mediated the association between elevated SII (continuous variable) and poor prognosis (90-day mRS score).

Statistical significance was set at $P<0.05$. Statistical analysis was performed using SPSS 26.0 (IBM, Armonk, NY, USA) and data analysis was performed using GraphPadPrism (version 9, La Jolla, CA).

Results

Patient Baseline Characteristics

A series of 829 patients with LVOS were enrolled in these two centers. In total, 154 patients were excluded based on the exclusion criteria and 675 patients were eligible for inclusion in the study.

The baseline patient characteristics are shown in Table 1. The mean age of all patients was 67.1 ± 11.4 years; 273 (40.4%) were female. A total of 445 (65.9%) patients had a history of hypertension, 112 (16.6%) had a history of type 2 diabetes, and 327 (48.4%) had a history of atrial fibrillation. The white blood cells count was $10.6 \pm 4.1 \times 10^3/\mu L$, neutrophil count was $8.9 \pm 3.8 \times 10^3/\mu L$, lymphocyte count was $1.1 \pm 0.6 \times 10^3/\mu L$, platelets count was $171.6 \pm 60.4 \times 10^3/\mu L$, and SII was $1.75 \pm 1.47 \times 10^3/\mu L$. The median NIHSS and Alberta Stroke Program Early CT(ASPECT) scores at admission were 15 (12–19) and 9 (7–10), respectively. Of the included patients, 540 (80%) had an mTICI grade of 2b/3.

Table 1 Baseline Clinical Characteristics of the MCE and No MCE Patients

Variables	ALL (n=675)	No MCE (n=543)	MCE (n=132)	P
Demographic characteristics				
Age, y, mean (SD)	67.1(11.4)	66.9(11.5)	68.3(11.0)	0.171
Female sex, n (%)	273(40.4)	216(39.8)	57(43.2)	0.475
Past Medical History, n (%)				
Hypertension	445(65.9)	343(63.2)	102(77.3)	0.002
Diabetes mellitus	112(16.6)	86(15.8)	26(19.7)	0.285
Atrial fibrillation	327(48.4)	256(47.1)	71(53.8)	0.171
Clinical data				
Admission SBP, median (IQR)	149(130–161)	149(130–161)	149(130–163)	0.732
Admission DBP, median (IQR)	80(73–90)	80(74–90)	82(70–91)	0.880
Admission NIHSS, median, (IQR)	15(12–19)	14(12–18)	18(16–21)	<0.001
Admission ASPECT, median, (IQR)	9(7–10)	9(8–10)	7(5–9)	<0.001
IV-rtPA, n (%)	129(19.1)	98(18.0)	31(23.5)	0.154
Occlusion site, n (%)				<0.001
ICA	312(46.2)	218(40.1)	94(71.2)	
MCA-M1	363(53.8)	325(59.9)	38(28.8)	
TOAST type, n (%)				0.061
LAA	230(34.1)	195(35.9)	35(26.5)	
CE	368(54.5)	284(52.3)	84(63.6)	
Others	77(11.4)	64(11.8)	13(9.8)	
Procedure process				
OTP, median (IQR)	280(220–345)	280(220–346)	280(223–343)	0.999
OTR,median (IQR)	350(286–429)	347(283–420)	370(313–441)	0.036
Collateral, n (%)				<0.001
Grade 0	115(17.0)	56(10.3)	59(44.7)	
Grade 1	232(34.4)	179(33.0)	53(40.2)	
Grade 2	328(48.6)	308(56.7)	20(15.2)	
mTICI (2b/3), n (%)	540(80.0)	458(84.3)	82(62.1)	<0.001
Laboratory data on admission				
FBG, mmol/L,mean (SD)	7.2(5.1)	6.9(5.3)	8.5(3.5)	0.001
Leukocytes, 103/μL, mean (SD)	10.6(4.1)	10.1(3.4)	12.7(5.7)	<0.001

(*Continued*)

Table 1 (Continued).

Variables	ALL (n=675)	No MCE (n=543)	MCE (n=132)	P
Neutrophils, 103/μL, mean (SD)	8.9(3.8)	8.3(3.2)	11.1(5.3)	<0.001
Lymphocytes, 103/μL, mean (SD)	1.1(0.6)	1.2(0.6)	0.9(0.5)	<0.001
Platelets,103/μL,mean (SD)	171.6(60.4)	173.0(61.2)	165.8(56.7)	0.222
SII index, 103/μ, mean (SD)	1.75(1.47)	1.57(1.30)	2.46(1.86)	<0.001
90d mRS ≤ 2, n (%)	325(48.1)	313(57.6)	12(9.1)	<0.001
90d Death, n(%)	141(20.9)	59(10.9)	82(62.1)	<0.001

Abbreviations: MCE, Malignant cerebral edema; SD, standard deviation; IQR, interquartile range; SBP, systolic blood pressure; DBP, diastolic blood pressure; NIHSS, National Institutes of Health Stroke Scale; ASPECT, Alberta Stroke Program Early CT; IV-rtPA, intravenous alteplase; TOAST, the Trial of ORG 10172 in Acute Stroke Treatment; LAA, large-artery atherosclerosis; CE, cardioembolic; ICA, internal carotid artery; MCA-M1, M1 segment of the middle cerebral artery; OTP, onset-to-puncture time; OTR, onset-to-reperfusion time; mTICI, modified Thrombolysis in Cerebral Infarction; FBG, fasting blood glucose; SII, systemic immune inflammatory index; mRS modified Rankin Scale.

Relationship Between SII and MCE in Patients with LVOS

According to the postoperative imaging follow-up, the patients were divided into two groups: the MCE and the non-MCE. Univariate analysis showed that there were significant differences between the two groups in fasting blood glucose (FBG), leukocyte count, neutrophil count, lymphocyte count, SII, history of hypertension, NIHSS score at admission, ASPECT scores at admission, occlusion site, OTR, collateral circulation, rate of recanalization, and 3-month mRS ($P<0.05$); however, there were no differences between the two groups in age, sex, history of diabetes, atrial fibrillation, systolic or diastolic blood pressure at admission at admission, rate of intravenous alteplase, TOAST type, or OTP ($P>0.05$, Table 1).

Binary logistic regression analysis indicated that after adjustment for NIHSS at admission, ASPECT at admission, collateral circulation, site of occlusion, recanalization status, and FBG level, SII (adjusted odds ratios [OR], 1.209; 95% confidence interval [CI], 1.034–1.413; $P=0.017$) was independently associated with MCE in the study (Table 2).

SII for Predicting the Development of MCE

Receiver operating characteristic (ROC) analysis was used to determine the ability of the SII to discriminate between patients with LVOS who developed MCE after EVT. An SII of 2.14 was calculated to be the optimal cut-off value to distinguish MCE from non-MCE in patients with LVOS after EVT. The area under the curve was 0.69 (95% CI, 0.66–0.73). An SII value of 2.14 was used as the threshold value to discriminate MCE with a sensitivity and specificity of 0.55 and 0.80, respectively.

Relationship Between SII, Functional Outcome, and MCE

Based on the outcome after 3 months of follow-up, the patients were grouped into two cohorts: 325 (48.1%) were included in the good outcome group (mRS ≤2) and 350 (51.9%) in the adverse outcome group (mRS >2). In the univariate analysis, the percentage of the population with an SII <2.14 was significantly different between those with good and poor prognosis (84.3% vs 61.7% respectively, $P<0.001$)(Table 3, Figure 2). After adjustment for confounding factors, SII ≥2.14 was associated with a reduced likelihood of functional independence at 90 days (adjusted OR, 3.639; 95% CI, 2.197–6.027; $P<0.001$, Table 4).

We used mediation analysis to explore whether the effect of an elevated SII on worse prognosis was partially mediated by MCE. Using postoperative MCE as a mediator, we observed a mediating effect of postoperative on MCE in the effect of the SII on prognosis. The regression coefficient was changed by 40.3% (Figure 3).

Table 2 Multivariate Analysis of Different Variables in MCE Patients

Independent Variable	Adjusted OR	95% CI	P-value
Hypertension	1.743	0.999–3.041	0.050
Admission NIHSS	1.059	1.012–1.108	0.012
Admission ASPECT	0.750	0.670–0.840	<0.001
Collateral			
Grade 0		Reference	
Grade1	0.524	0.296–0.928	0.027
Grade2	0.175	0.089–0.345	<0.001
Occlusion site			
ICA		Reference	
MCA-M1	0.356	0.217–0.585	<0.001
OTR	1.000	0.999–1.002	0.900
mTICI (2b/3)	0.388	0.229–0.658	<0.001
FBG	1.037	1.002–1.074	0.041
SII	1.209	1.034–1.413	0.017

Abbreviations: OR, odds ratio; CI, confidence interval; NIHSS, National Institutes of Health Stroke Scale; ASPECT, Alberta Stroke Program Early CT; ICA, internal carotid artery; MCA-M1, M1 segment of the middle cerebral artery; OTR, onset-to-reperfusion time; mTICI, modified Thrombolysis in Cerebral Infarction; FBG, fasting blood glucose; SII, systemic immune inflammatory index.

Table 3 Baseline Clinical Characteristics for Different Prognosis

Variables	mRS≤2(n=325)	mRS>2 (n=350)	P
Demographic characteristics			
Age, y, mean (SD)	63.8(11.3)	70.2(10.7)	<0.001
Female sex, n (%)	105(32.3)	168(48.0)	<0.001
Past Medical History, n (%)			
Hypertension	192(59.1)	253(72.3)	<0.001
Diabetes mellitus	36(11.1)	76(21.7)	<0.001
Atrial fibrillation	120(36.9)	207(59.1)	<0.001
Clinical data			
Admission SBP, median (IQR)	146(129–160)	150(134–165)	0.016
Admission DBP, median (IQR)	80(73–90)	80(74–91)	0.635
Admission NIHSS, median, (IQR)	14(11–17)	17(14–20)	<0.001
Admission ASPECT,median, (IQR)	9(8–10)	8(7–9)	<0.001
IV-rtPA, n (%)	65(20.0)	64(18.3)	0.571

(*Continued*)

Table 3 (Continued).

Variables	mRS≤2(n=325)	mRS>2 (n=350)	P
Occlusion site, n (%)			<0.001
ICA	118(36.3)	194(55.4)	
MCA-M1	207(63.7)	156(44.6)	
TOAST type, n (%)			<0.001
LAA	134(41.2)	96(27.4)	
CE	143(44.0)	225(64.3)	
Others	48(14.8)	29(8.3)	
Procedure process			
OTP, median (IQR)	284(220–347)	270(220–344)	0.644
OTR,median (IQR)	347(280–415)	355(294–435)	0.106
Collateral, n (%)			<0.001
Grade 0	13(4.0)	102(29.1)	
Grade 1	93(28.6)	139(39.7)	
Grade 2	219(67.4)	109(31.2)	
mTICI (2b/3), n (%)	294(90.5)	246(70.3)	<0.001
Laboratory data on admission			
FBG, mmol/L,mean (SD)	6.4(6.1)	8.0(3.6)	<0.001
SII <2.14, n (%)	274(84.3)	216(61.7)	<0.001

Abbreviations: mRS, modified Rankin Scale; SD, standard deviation; IQR, interquartile range; SBP, systolic blood pressure; DBP, diastolic blood pressure; NIHSS, National Institutes of Health Stroke Scale; ASPECT, Alberta Stroke Program Early CT; IV-rtPA, intravenous alteplase; TOAST, the Trial of ORG 10172 in Acute Stroke Treatment; LAA, large-artery atherosclerosis; CE, cardioembolic; ICA, internal carotid artery; MCA-M1, M1 segment of the middle cerebral artery; OTP, onset-to-puncture time; OTR, onset-to-reperfusion time; mTICI, modified Thrombolysis in Cerebral Infarction; FBG, fasting blood glucose; SII, systemic immune inflammatory index.

Discussion

In this retrospective study of acute ischemic stroke caused by LVOS treated with EVT, our findings were as follows: (1) higher SII can independently predict MCE after EVT, and the area under the curve for the SII index predicting the development of MCE was 0.69 with an optimal cutoff value of 2.14 (sensitivity of 0.55 and specificity of 0.80); (2) postoperative MCE acts as a mediator and is partly responsible for the poor prognosis of patients with an elevated SII.

Increasing evidence suggests that inflammation plays a crucial role in the development of malignant brain edema in ischemic stroke. After an ischemic stroke attack, brain-derived antigens, danger-associated molecular patterns (DAMPs), and inflammatory factors enter the body's circulation from the injured brain region, triggering a series of pro-inflammatory responses that eventually disrupt the blood-brain barrier, leading to the development of acute and late MCE.[22,23] In the leukocyte family, neutrophils first infiltrate ischemic brain tissue from approximately 30 min to several hours, and peak 1–3 days after stroke.[24] Neutrophils are an important source of matrix metalloproteinase-9, which can lead to early BBB destruction through the release of pro-inflammatory factors, reactive oxygen species and protein hydrolases acting on tight junction proteins, resulting in vascular-derived water in patients with AIS.[25,26] Lymphocytes have a complex and diverse impact, and specific isoforms have been shown to inhibit inflammatory responses and maintain BBB integrity in the pathophysiology of cerebral ischemia.[27,28] Furthermore, a decrease in lymphocytes was associated with increased pre-stroke cortisol levels and sympathetic tone, suggesting that an overly

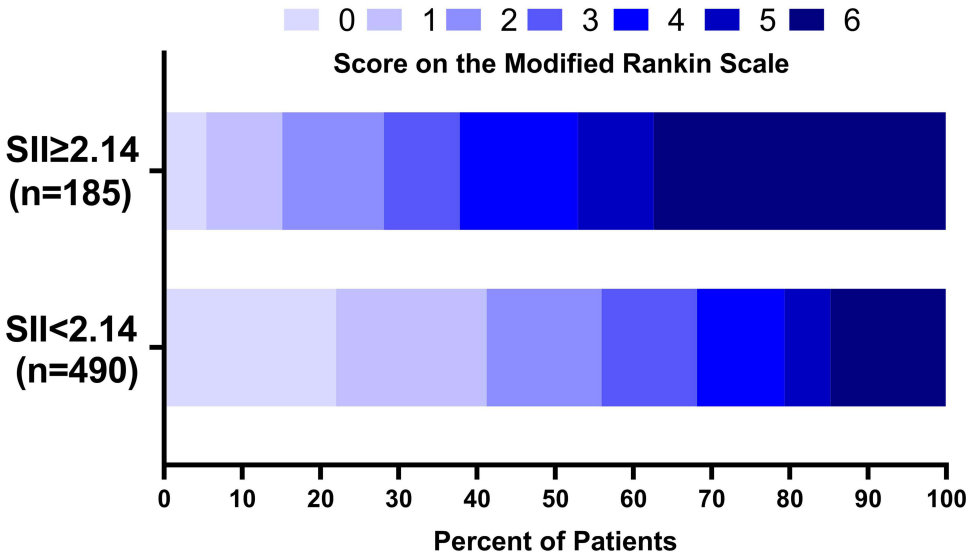

Figure 2 Distribution of modified Rankin Scale (MRS) scores at day 90 according to grouping of SII cutoff values.

intense immune response may exacerbate nerve damage.[29] The time course of lymphocyte recruitment to the ischemic brain region remains unclear. Animal model research has shown that there is an initial accumulation of T cells in the area of injury during the first 24 h after stroke onset.[30] Although platelets mediate thrombosis and coagulation

Table 4 Multivariate Analysis of Factors Influencing 90-Day Prognosis

Independent Variable	Adjusted OR	95% CI	P-value
Age	0.992	0.967–1.018	0.544
Female:Male	1.068	0.624–1.826	0.811
Hypertension	1.922	1.063–3.477	0.031
Diabetes mellitus	0.947	0.497–1.806	0.869
Atrial fibrillation	0.745	0.430–1.293	0.295
Admission SBP	0.998	0.988–1.009	0.755
Admission NIHSS	1.058	1.011–1.107	0.015
Admission ASPECT	0.750	0.669–0.840	<0.001
Collateral			
Grade 0		Reference	
Grade1	0.483	0.265–0.883	0.018
Grade2	0.159	0.079–0.322	<0.001
Occlusion site			
ICA		Reference	
MCA-M1	0.362	0.217–0.604	<0.001
mTICI (2b/3)	0.349	0.201–0.605	<0.001
FBG	1.040	1.002–1.079	0.037
SII (≥2.14)	3.639	2.197–6.027	<0.001

Abbreviations: OR, odds ratio; CI, confidence interval; SBP, systolic blood pressure; NIHSS, National Institutes of Health Stroke Scale; ASPECT, Alberta Stroke Program Early CT; ICA, internal carotid artery; MCA-M1, M1 segment of the middle cerebral artery; mTICI, modified Thrombolysis in Cerebral Infarction; FBG, fasting blood glucose; SII, systemic immune inflammatory index.

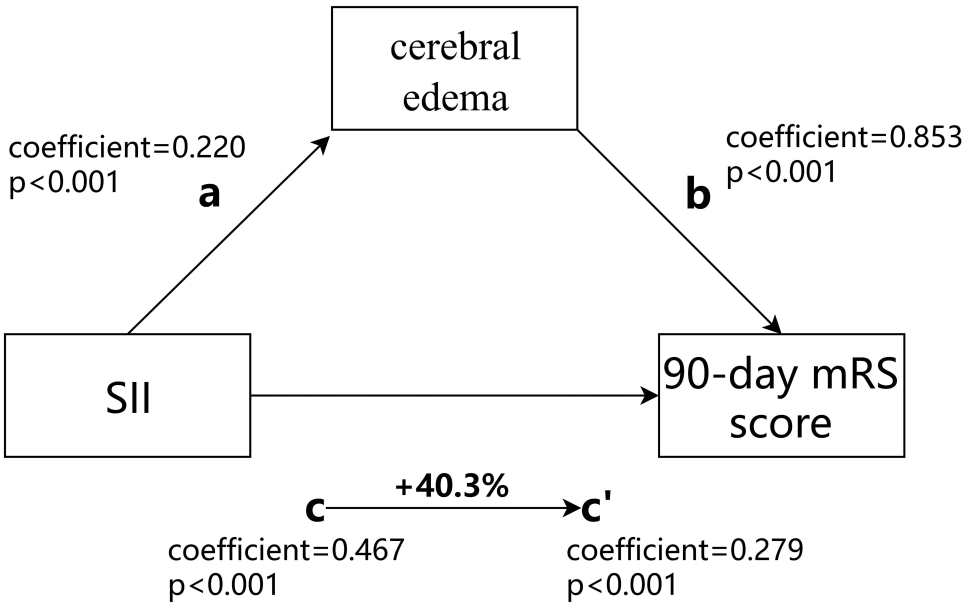

Figure 3 Analysis of the mediating effect of postoperative cerebral edema on the relationship between SII and functional outcome.

complications associated with vascular disease, platelet activation can directly drive local and systemic inflammatory responses.[31] After ischemia/ reperfusion, platelets promote injury by secreting granules and interacting with leukocytes through mechanisms that include enhanced leukocyte extravasation, oxidative rupture, and microvascular occlusion leading to the "no-reflow" phenomenon.[7] In our study, the neutrophil count was higher and the lymphocyte count was lower in the MCE group than in the non-MCE group. Nevertheless, there was no statistically significant difference in platelet count between the two groups.

Therefore, these pathological findings support our main finding that the SII can be a robust predictor of post-ischemic MCE. Individual blood parameters may be affected by multiple variables such as rehydration, overhydration, and blood specimen disposal. NLR is mainly indicates inflammatory damage, PLR shows hemostatic and thrombotic effects, and SII provides overall information on inflammation, immunity, hemostasis, and thrombosis.[32] Statistical analysis in our study showed that SII remained independently associated with MCE after adjustment for FGB, history of hypertension, NIHSS score at admission, ASPECTS at admission, site of occlusion, OTR, collateral circulation, recanalization, and other factors. We used an SII of 2.14 as the threshold; the rate of a 3-month adverse prognosis was markedly higher in patients with a high SII than in patients with a low SII, which is in accordance with previous studies on aneurysmal subarachnoid hemorrhage.[33]

Our secondary finding was that the effect of an elevated SII on poor prognosis was partially mediated by MCE. Previously, Yi et al investigated the association between SII and clinical prognosis in endovascular therapy.[34] This suggests that an elevated SII is associated with poor prognosis, the process of which has not been explored. Recently, Fonseca et al showed that the systemic inflammatory status at admission influenced the outcome of cerebral hemorrhage by increasing perihematomal edema.[35] Considering the similarity in the mechanism of action, the current study further investigated the association between SII and functional outcomes and assessed the mediating role of postoperative MCE on functional outcomes in patients undergoing EVT. Our data show that the SII is a significant predictor of functional outcome and that its role may be caused by postoperative MCE. These results confirm the recent findings,[15,36] and further illuminate the potential causes of poor prognosis because of elevated SII.

Our study has some limitations. First, as a retrospective study, we did not exclude the effect of tumors and other chronic wasting disease populations on inflammatory indicators in terms of inclusion criteria, nor did we explore the relationship between SII and acute infection. Second, our study only chose SII at 24 hours after admission to predict

MCE, which lacks an evaluation of the change in dynamics of SII with the degree of cerebral edema. Moreover, brain edema is also influenced by various factors such as treatment.

Conclusion

In conclusion, higher SII levels may indicate MCE, poor prognosis, and systemic immune dysfunction. SII has strong utility as an available and easily accessible clinical indicator for the prediction of MCE, and may provide a reference for clinical practice.

Abbreviations

SII, systemic immune inflammatory index; MCE, malignant cerebral edema; endovascular thrombectomy; LVOS, large vessel occlusive stroke; CED, cerebral edema; BBB, blood-brain barrier; NLR, neutrophil-lymphocyte ratio; PLR, platelet-lymphocyte ratio; PNI, prognostic nutritional index; LMR, lymphocyte-to-monocyte ratio; mRS, modified Rankin Scale; SD, standard deviation; IQR, interquartile range; SBP, systolic blood pressure; DBP, diastolic blood pressure; ICA, internal carotid artery; MVO, multiple vessel occlusion; MCA-M1, M1 segment of the middle cerebral; ACA, artery anterior cerebral artery; NIHSS, National Institutes of Health Stroke Scale; IV-rtPA, intravenous alteplase; TOAST, Trial of ORG 10172 in Acute Stroke Treatment; LAA, large-artery atherosclerosis; CE, cardioembolic; OTP, onset-to-puncture time; OTR, onset-to-reperfusion time; mTICI, Thrombolysis in Cerebral Infarction; DSA, digital subtraction angiography; NC, neutrophil count; LC, lymphocyte count; PLT, platelet count; OR, odds ratio; CI, confidence interval; ROC, Receiver operating characteristic; DAMPs, danger-associated molecular patterns; ASPECT, Alberta Stroke Program Early CT; FBG, fasting blood glucose.

Data Sharing Statement

Data are available upon reasonable request.

Ethics Approval

The study was approved by the Ethics Committee of the First Affiliated Hospital of Wannan Medical College (201900039).All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1975 Helsinki declaration and its later amendments or comparable ethical standards.This study got an exemption notice from Independent Ethics Committee approval as it was a retrospective data analysis. We confirmed that all private data of the participants were anonymized and maintained with confidentiality.

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Disclosure

The authors report no conflicts of interest in this work.

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