International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Validity of Siriraj Stroke Score in Early Differential Diagnosis of Acute Stroke

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Received: 25-04-2026
Accepted: 02-06-2026
Available online: 06-06-2026

ABSTRACT

Background: Early differentiation between cerebral infarction and intracerebral haemorrhage is crucial for appropriate management of acute stroke. The Siriraj Stroke Score (SSS) is a clinical tool developed to distinguish stroke subtypes when neuroimaging is not immediately available. This study evaluated the validity of the SSS in the early differential diagnosis of acute stroke using computed tomography (CT) as the reference standard.

Material and Methods: This prospective observational study was conducted in the Department of Medicine, SVP Hospital, Smt. NHL Municipal Medical College, Ahmedabad, from March 2021 to September 2022. A total of 100 adult patients with acute stroke confirmed by CT brain imaging were enrolled. Clinical data required for SSS calculation were recorded at admission. SSS findings were compared with CT scan diagnoses. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated.

Results: Among the 100 patients studied, 73% had cerebral infarction and 27% had intracerebral haemorrhage on CT scan. The mean age was 58.62±8.62 years, and 68% were males. According to the SSS, 53% were classified as infarction, 32% as haemorrhage, and 15% had equivocal scores. For the diagnosis of ischaemic infarction, the SSS showed a sensitivity of 63.01%, specificity of 74.07%, PPV of 86.79%, NPV of 42.55%, and accuracy of 66.00%. For haemorrhagic stroke, sensitivity, specificity, PPV, NPV, and accuracy were 55.56%, 76.71%, 46.88%, 82.35%, and 71.00%, respectively.

Conclusion: The Siriraj Stroke Score demonstrated moderate diagnostic performance in differentiating acute stroke subtypes. Although useful as an initial bedside screening tool, it cannot replace CT brain imaging for definitive diagnosis.

Keywords: *Acute stroke, Siriraj Stroke Score, cerebral infarction, intracerebral haemorrhage, computed tomography, diagnostic validity.*

INTRODUCTION

Stroke remains a major public health challenge worldwide and is a leading cause of mortality and long-term disability. Despite advances in prevention and management, the global burden of stroke continues to rise, particularly in low- and middle-income countries, where a substantial proportion of stroke-related deaths and disability-adjusted life years occur [1,2]. Ischaemic stroke accounts for the majority of incident stroke cases globally, whereas haemorrhagic stroke contributes disproportionately to mortality and severe neurological disability [3].

Early differentiation between cerebral infarction and intracerebral haemorrhage is crucial because the therapeutic approach, prognosis, and clinical outcomes differ considerably between the two stroke subtypes [4]. Timely administration of antithrombotic therapy in ischaemic stroke and appropriate management of intracerebral haemorrhage depend on accurate diagnosis at the earliest possible stage. Computed tomography (CT) of the brain is considered the standard initial imaging modality for distinguishing between these entities and guiding acute management [4].

In many resource-constrained healthcare settings, however, immediate access to neuroimaging may not always be available. This limitation has prompted the development of clinical scoring systems designed to differentiate stroke subtypes using bedside clinical parameters. One such tool is the Siriraj Stroke Score (SSS), which incorporates level of consciousness, vomiting, headache, diastolic blood pressure, and atheroma markers to predict the likely stroke subtype [5]. Although the SSS was originally developed as a practical alternative when CT imaging was unavailable, its diagnostic performance has shown considerable variation across different populations and healthcare settings. Recent studies have reported moderate sensitivity and specificity, suggesting that the score may be useful as an adjunctive tool but may not reliably replace neuroimaging for definitive diagnosis [6].

Given the continued need for simple and cost-effective diagnostic aids in resource-limited environments, evaluation of the validity of the Siriraj Stroke Score in local populations remains important. The present study was undertaken to assess the diagnostic accuracy of the Siriraj Stroke Score in the early differential diagnosis of acute stroke using CT brain findings as the reference standard.

MATERIALS AND METHODS

Study Design and Setting: This prospective observational study was conducted in the Department of Medicine, SVP Hospital, Smt. NHL Municipal Medical College, Ahmedabad, Gujarat, India. The study was carried out over a period of 19 months from March 2021 to September 2022.

Study Population: The study included 100 consecutive patients admitted with acute-onset focal neurological deficits suggestive of stroke. Patients fulfilling the predefined eligibility criteria were enrolled after obtaining informed consent from the patient or an authorized relative when the patient was unable to provide consent.

Inclusion Criteria:

- Age greater than 18 years.
- Neurological deficit persisting for more than 24 hours.
- Computed tomography (CT) scan of the brain confirming either cerebral infarction or intracerebral haemorrhage.

Exclusion Criteria:

- Age less than 18 years.
- Focal neurological deficits due to causes other than stroke, such as intracranial tumors, tuberculosis, or trauma.
- Current anticoagulant therapy.
- Inability to undergo CT brain imaging.
- Presentation more than 72 hours after the onset of neurological symptoms.
- Subarachnoid haemorrhage.
- Recurrent or repeat stroke.
- Transient ischemic attack (TIA).

Data Collection: A structured proforma was used for systematic data collection. Epidemiological, clinical, laboratory, and radiological information was recorded for each patient. The collected data included demographic characteristics such as age and sex; presenting symptoms; comorbid conditions including hypertension, diabetes mellitus, dyslipidaemia, cardiovascular disease, and peripheral vascular disease; and relevant laboratory investigations including complete blood count, serum creatinine, C-reactive protein, erythrocyte sedimentation rate, lipid profile, liver function tests, coagulation profile, and electrocardiography findings.

Radiological evaluation included chest radiography and non-contrast CT scanning of the brain. Hospital outcome in terms of discharge or death was also documented. Whenever a patient was unconscious or unable to provide an adequate clinical history, information was obtained from accompanying relatives or caregivers. If information regarding a particular clinical variable was unavailable, the corresponding variable score was assigned a value of zero for score calculation.

Siriraj Stroke Score Assessment: The Siriraj Stroke Score (SSS) was calculated for all enrolled patients at the time of admission using the following formula:

SSS = (2.5 × Level of Consciousness) + (2 × Vomiting) + (2 × Headache) + (0.1 × Diastolic Blood Pressure) − (3 × Atheroma Markers) − 12

Based on the calculated score, patients were categorized as follows:

- SSS < −1: Cerebral infarction
- SSS > +1: Intracerebral haemorrhage
- SSS between −1 and +1: Equivocal result

The diagnostic classification obtained using the Siriraj Stroke Score was compared with the final CT scan diagnosis, which was considered the reference standard.

Statistical Analysis: Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) software version 22.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. A p-value of less than 0.05 was considered statistically significant. The diagnostic performance of the Siriraj Stroke Score was evaluated by comparing its classification with CT brain findings. The following validity indicators were calculated:

- Sensitivity
- Specificity
- Positive predictive value (PPV)
- Negative predictive value (NPV)
- Diagnostic accuracy

Computed tomography findings were considered the gold standard for determining stroke subtype.

RESULTS

The mean age of the study population was 58.62 ± 8.62 years. The largest proportion of patients belonged to the 61–70 years age group (48%), followed by the 51–60 years age group (33%). Among patients with infarction, 46.58% were aged 61–70 years, whereas 51.85% of haemorrhagic stroke patients were in the same age category. Males constituted 68% of the study population, while females accounted for 32%. Right-sided hemiparesis was observed in 67% of patients and left-sided hemiparesis in 33% (Table 1).

Regarding clinical presentation at admission, 41% of patients were drowsy, 18% were alert, 16% were stuporous, 12% were in semicoma, and 13% were comatose. Vomiting was present in 26% of patients, whereas headache was reported by 33% of patients at presentation (Table 2).

Hypertension was the most common risk factor and was present in 74% of the study population. It was observed in 72.60% of infarction cases and 77.78% of haemorrhagic stroke cases, without a statistically significant association between stroke type and hypertension (p=0.60). Atheroma markers were present in 77% of patients, occurring in 72.60% of infarction cases and 88.89% of haemorrhagic cases (p=0.09). Heart disease was identified in 23% of patients and was noted more frequently in infarction (26.03%) than haemorrhagic stroke (14.81%), although this difference was not statistically significant (p=0.24) (Table 3).

CT scan findings revealed that 73% of patients had cerebral infarction and 27% had intracerebral haemorrhage. The mean age of patients with infarction was 57.95 ± 9.12 years, compared with 60.26 ± 6.80 years among those with haemorrhage; this difference was not statistically significant (p=0.23) (Table 4A).

Based on the Siriraj Stroke Score (SSS), 53% of patients were categorized as infarction (SSS < −1), 32% as haemorrhage (SSS > +1), and 15% fell into the equivocal range (−1 to +1) (Table 4B).

Comparison of SSS classification with CT brain findings demonstrated that among 53 patients classified as infarction by SSS, 46 were confirmed as infarction and 7 were haemorrhages on CT. Of the 32 patients classified as haemorrhage by SSS, 15 were confirmed as haemorrhage and 17 were infarctions on CT. Fifteen patients had equivocal SSS values, among whom 10 had infarction and 5 had haemorrhage on CT imaging (Table 5).

For the diagnosis of ischaemic infarction, the Siriraj Stroke Score correctly identified 46 true-positive and 20 true-negative cases, while 7 cases were false positives and 27 were false negatives. The sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were 63.01%, 74.07%, 86.79%, 42.55%, and 66.00%, respectively (Table 6).

For the diagnosis of haemorrhagic stroke, the Siriraj Stroke Score yielded 15 true-positive and 56 true-negative cases, with 17 false-positive and 12 false-negative results. The sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy for haemorrhagic stroke were 55.56%, 76.71%, 46.88%, 82.35%, and 71.00%, respectively (Table 6).

Table 1: Patient demographics (n = 100)

Variable	Category	Infarction (n=73)		Haemorrhage (n=27)		Total (n=100)	
		No.	%	No.	%	No.	%
Age (years) Mean±SD: 58.62 ± 8.62	≤40	3	4.11	0	0.00	3	3
	41–50	10	13.70	3	11.11	13	13
	51–60	24	32.88	9	33.33	33	33
	61–70	34	46.58	14	51.85	48	48
	>70	2	2.74	1	3.70	3	3

Sex	Male	51	69.86	17	62.96	68	68
	Female	22	30.14	10	37.04	32	32
Hemiparesis	Right	—	—	—	—	67	67
	Left	—	—	—	—	33	33
Total		**73**	**100**	**27**	**100**	**100**	**100**

Table 2: Clinical presentation at admission (n = 100)

Variable	**Category**	**No.**	**%**
Level of consciousness	Alert	18	18
	Drowsy	41	41
	Stupor	16	16
	Semicoma	12	12
	Coma	13	13
Vomiting	Present	26	26
	Absent	74	74
Headache	Present	33	33
	Absent	67	67
Total		**100**	**100**

Table 3: Risk factors by stroke type

Risk factor	**Status**	**Infarction (n=73)**		**Haemorrhage (n=27)**		**Total (n=100)**		**p value**
		No.	**%**	**No.**	**%**	**No.**	**%**	
Hypertension	Present	53	72.60	21	77.78	74	74	0.60 (NS)
	Absent	20	27.40	6	22.22	26	26	
Atheroma markers	Present	53	72.60	24	88.89	77	77	0.09 (NS)
	Absent	20	27.40	3	11.11	23	23	
Heart disease	Present	19	26.03	4	14.81	23	23	0.24 (NS)
	Absent	54	73.97	23	85.19	77	77	
Total		**73**	**100**	**27**	**100**	**100**	**100**	**—**

Table 4: CT scan findings and Siriraj Stroke Score distribution

4A — CT scan diagnosis

CT diagnosis	**n**	**%**	**Mean age (years)**	**SD**	**p value**
Infarct	73	73	57.95	9.12	0.23 (NS)
Haemorrhage	27	27	60.26	6.80	
Total	**100**	**100**	**58.62**	**8.62**	**—**

4B — Siriraj Stroke Score distribution

SSS category	**Interpretation**	**No.**	**%**
< −1	Infarct	53	53
−1 to +1	Equivocal	15	15
> +1	Haemorrhage	32	32
Total		**100**	**100**

Table 5: Comparison of Siriraj Stroke Score with CT brain findings

SSS category	**SSS interpretation**	**CT infarction**	**CT haemorrhage**	**Row total**
< −1	Infarct	46	7	53
−1 to +1	Equivocal	10	5	15
> +1	Haemorrhage	17	15	32
Column total		**73**	**27**	**100**

Table 6: Diagnostic performance of Siriraj Stroke Score

For ischaemic infarction			
	CT infarct +ve	**CT infarct −ve**	**Total**
SSS infarct +ve	46 (TP)	7 (FP)	53
SSS infarct −ve	27 (FN)	20 (TN)	47
Total	73	27	100
For haemorrhagic stroke			
	CT haemorrhage +ve	**CT haemorrhage −ve**	**Total**

SSS haemorrhage +ve	15 (TP)	17 (FP)	32
SSS haemorrhage −ve	12 (FN)	56 (TN)	68
Total	27	73	100
Validity statistic	**Ischaemic infarction (%)**	**Haemorrhagic stroke (%)**	
Sensitivity	63.01	55.56	
Specificity	74.07	76.71	
Positive predictive value (PPV)	86.79	46.88	
Negative predictive value (NPV)	42.55	82.35	
Accuracy	66.00	71.00	

DISCUSSION

In the present study, CT brain imaging identified cerebral infarction in 73% of patients and intracerebral haemorrhage in 27%. This distribution is comparable to contemporary stroke registries and validation studies from low- and middle-income countries, where ischaemic stroke constitutes the majority of cases while haemorrhagic stroke accounts for a smaller but clinically significant proportion of stroke burden [7,8].

The mean age of the study population was 58.62±8.62 years, and males constituted 68% of the participants. Similar demographic patterns have been reported in recent stroke studies, which consistently demonstrate a higher prevalence of stroke among older adults and a predominance of male patients [8,9]. Hypertension was the most common risk factor in the present study, being present in 74% of patients. This observation is in agreement with current evidence identifying hypertension as the most important modifiable risk factor for both ischaemic and haemorrhagic stroke [10].

The principal objective of the present study was to evaluate the validity of the SSS in differentiating stroke subtypes using CT scan findings as the reference standard. For the diagnosis of cerebral infarction, the SSS demonstrated a sensitivity of 63.01%, specificity of 74.07%, positive predictive value of 86.79%, negative predictive value of 42.55%, and overall accuracy of 66.00%. For haemorrhagic stroke, sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were 55.56%, 76.71%, 46.88%, 82.35%, and 71.00%, respectively.

These findings indicate moderate diagnostic performance of the SSS. A comparable conclusion was reached by Mekonnen and Kebede, who reported that although the Siriraj Stroke Score showed reasonable overall performance, its diagnostic indices varied considerably when compared with CT findings, limiting its utility as a standalone diagnostic tool [8]. Similarly, a recent Nigerian validation study demonstrated that the score could provide useful clinical guidance in resource-limited settings but could not achieve the diagnostic certainty offered by neuroimaging [11].

The sensitivity observed in our study was lower than that reported by Athar et al., who found higher sensitivities for both haemorrhagic and non-haemorrhagic stroke when comparing SSS classifications with CT findings [9]. Variations in diagnostic performance across studies may be attributable to differences in sample size, patient characteristics, prevalence of stroke subtypes, timing of assessment, and the proportion of patients with equivocal scores. Such variability has been consistently highlighted in comparative evaluations of clinical stroke scoring systems [12].

Fifteen percent of patients in the present study had equivocal Siriraj Stroke Scores. This finding is clinically important because equivocal results reduce the practical applicability of the score in emergency settings where rapid therapeutic decisions are required. Recent research aimed at developing prehospital prediction models has suggested that although clinical variables can assist in early stroke subtype differentiation, imaging-based confirmation remains essential because clinical prediction models alone cannot achieve consistently high diagnostic accuracy across diverse populations [13].

The results of the present study therefore support the current view that clinical scoring systems may serve as adjunctive tools when immediate neuroimaging is unavailable, particularly in resource-constrained settings. However, the moderate sensitivity and specificity observed in our study reinforce evidence from contemporary validation studies indicating that CT brain imaging remains the gold standard for accurate differentiation between cerebral infarction and intracerebral haemorrhage and should guide definitive treatment decisions whenever available [8,11,13].

CONCLUSION

The Siriraj Stroke Score demonstrated moderate diagnostic accuracy in differentiating ischaemic infarction from haemorrhagic stroke when compared with CT brain findings. Although the score showed reasonable specificity and positive predictive value for identifying cerebral infarction, its sensitivity for both stroke subtypes was suboptimal, and a proportion of patients were incorrectly classified or had equivocal results. Therefore, while the Siriraj Stroke Score may serve as a useful bedside screening tool in resource-limited settings where immediate neuroimaging is unavailable, it cannot reliably replace CT scanning for definitive stroke subtype diagnosis. Early CT imaging remains essential for accurate diagnosis and appropriate management of patients presenting with acute stroke.

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