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Comparison of Siriraj Stroke Score with Computed Tomography to Differentiate Acute Embolic and Hemorrhagic Stroke in a Tertiary Care-Teaching Center

Karthik Narayan Padmanabhan, Melvin Dominic, Hari HaraSudhan Chidambaram, Chandrasekaran Vp, Ram Kirubakarthangaraj Rajkumar, Syed Abthhir Sirajudeen

Department of Emergency Medicine, Vinayaka Mission's Kirupananda Variyar Medical College, Salem, India

Abstract

Aim: The study aimed to compare Siriraj Stroke Score (SSS) with computed tomography (CT) in differentiating stroke subtypes.

Materials and Methods: This cross-sectional study consists of eighty consecutive patients admitted to the emergency department of the tertiary care-teaching center within four hours of the onset of stroke. A single experienced emergency medicine physician observed the patients for Siriraj score. An independent radiologist analyzed the CT of the patients who were not aware of the clinical condition. CT findings were considered the gold standard. Siriraj score findings were considered as a screening test. The sensitivity, specificity, predictive values, and diagnostic accuracy of the screening test, along with their 95% confidence interval (CI), were presented.

Results: A total of 80 subjects were included in the study. The mean age of the participants was 56.4 years, with the majority being males (58.8%). The sensitivity and specificity for SSS were 96.92% and 90.91%, respectively. The SSS had excellent predictive validity in predicting CT findings, as indicated by the area under the curve of 0.994 (95% CI 0.983 to 1.000, p value <0.001).

Conclusion: The clinical score, SSS, showed high sensitivity and specificity, and the results were satisfactory compared with CT imaging. Thus, it was concluded that SSS could be used for the bedside diagnosis to differentiate stroke subtypes in settings where CT scan facilities are lacking.

Keywords: Hemorrhagic stroke, ischemic stroke, cerebral hemorrhage, Siriraj stroke score

Introduction

Stroke is a significant health issue and the third major cause of mortality across the globe. A review by Kamalakannan et al. (1) showed that crude stroke prevalence ranged from 44.29 to 559/100,000 people in different regions of India during the past two decades. Stroke is characterized by sudden cessation of blood flow to an area of the brain and results in corresponding neurological function loss and disabilities like physical dependence, dementia, and depression (2). There are two types of strokes; hemorrhagic or ischemic. In ischemic stroke, thrombosis or embolism causes blockage of cerebral blood flow. Around 10%-15% of all strokes are hemorrhagic strokes and are associated with high mortality rates (3). An accurate diagnosis of the stroke subtype is required to make appropriate decisions regarding its therapeutic management (4).

Computed tomography (CT) imaging is an accurate, safe, non-invasive procedure routinely used and considered as the gold standard technique to distinguish between hemorrhagic and ischemic stroke (5). CT's cost and availability constraints prohibit its widespread usage in developing countries like India, mainly in rural and semi-urban regions. Different clinical stroke scores were developed on the basis of clinical parameters to overcome certain shortages of CT machines. Different clinical stroke scores are Siriraj Stroke Score (SSS), the Guys' Hospital Score or Allen Score, the Besson Score, and the Greek Stroke Score (6-9).

Corresponding Author: Prof. Karthik Narayan Padmanabhan, M.D., Department of Emergency Medicine, Vinayaka Mission's Kirupananda Variyar Medical College, Salem, India
E-mail: karthiknarayan17@gmail.com ORCID ID: orcid.org/0000-0001-5585-0748
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Although several studies validating different stroke scores concluded that these scores were not sensitive enough compared to CT imaging in detecting hemorrhage and differentiating the stroke subtypes (10-13), a consistent higher predictive ability was observed with SSS in detecting ischemic stroke by ruling out hemorrhagic stroke (11). The SSS was developed by Poungvarin et al. (6) in 1991 in Thailand (Siriraj Hospital). SSS can be used as a diagnostic tool in clinical settings where a CT is not available, particulary in the rural health facilities. It seems more accurate than those made by physicians in clinical diagnosis b there was no literature available in this particular geographic area (Salem district) and the results provide an additional data to support the use of siriraj stroke score.

Hence, this study aimed to evaluate and compare the Siriraj stroke scoring system with CT findings to differentiate acute embolic and hemorrhagic stroke. The objectives were:

1. To differentiate cerebral hemorrhage from infarction using the Siriraj scoring system
2. To assess the accuracy of the Siriraj scoring system in differentiating stroke subtypes by comparing with CT brain.

Materials and Methods

Study population and Study site: The study was conducted in the Department of Emergency Medicine, Vinayaka Missions Medical College Hospital (VMKV MCH), Salem.

Inclusion Criteria

- The study group consists of patients admitted in the emergency ward of VMKV MCH, Salem, within four hours of the onset of stroke (stroke as defined by WHO definition), rapidly developing clinical syndrome of focal (or global in the case of subarachnoid hemorrhage), disturbance of cerebral function lasting longer than 24 h (unless interrupted by surgery or death), presumably of vascular origin (14).
- Patients in whom CT scan showed cerebral infarction or intracerebral hemorrhage.

Exclusion Criteria

- Previous history of stroke
- Subarachnoid hemorrhage
- Patients with a clinical picture suggestive of postictal paralysis
- Patients with a history of trauma

Study Design: Cross-sectional study.

Sample Size: Eighty patients who were admitted during the study period were selected by universal sampling.

Study Duration: Fourteen months from March 2019 to May 2020.

Ethical Considerations: Ethics Committee approval was taken before initiating the study from Vinayaka Missions Kirupananda Variyar Medical College, Ethics Committee number: VMKVMC&H/IEC/19/49, on 06.03.2019.

Data Collection Tools and Clinical Examination

On admission, detailed history and thorough clinical examination including age, gender, comorbidities, presenting complaint, general examination findings, and neurological assessment (head injury Glasgow Coma scale) were carried out by an experienced emergency medicine physician.

Siriraj Stroke Score (6)

All the patients were clinically examined for Siriraj score by a single experienced emergency medicine physician on admission. The parameters measured for Siriraj score was the presence of headache and vomiting (yes or no), level of consciousness (alert, stupor, drowsy, semicoma, coma), blood pressure (mmHg), history of hypertension, atheroma markers (transient ischaemic attack, diabetes mellitus, obesity, presence of history suggestive of angina pectoris, intermittent claudication) (none, one or more). The Siriraj score was computed as follows;

Siriraj Stroke Score (SSS) was calculated using the formula;

$$(2.5 \times \text{level of consciousness}) + (2 \times \text{vomiting}) + (2 \times \text{headache}) + (0.1 \times \text{diastolic blood pressure}) - (3 \times \text{atheroma markers}) - 12$$

Scores were calculated by obtaining details of each clinical variable. If any variable was not available, e.g., if the patient was unconscious, information was obtained from the patient's relatives. If the relatives were unaware of a particular variable, then the variable score was adjusted as zero. A score above one indicates intracranial hemorrhage, while a score below minus one indicates infarction. The score between one and minus one represents an equivocal result.

CT (GE revolution act 16 slices) scan was obtained for all patients and was considered as the gold standard. Siriraj stroke score was compared with the CT findings by a radiologist from the institute, blind to the clinical features, classified the CT brain scans as those demonstrating infarction hemorrhage or equivocal.

Statistical Analysis

Siriraj score and CT findings were considered as primary outcome variables. Demographic variables were considered as primary explanatory variables. Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency, and proportion for categorical variables. Non-normally distributed quantitative variables were summarized by

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the median and interquartile range (IQR). Categorical outcomes were compared between study groups using the chi-square test/ Fisher's exact test (If the overall sample size was <20 or if the expected number in any one of the cells is <5, Fisher's exact test was used). CT findings were considered as the diagnostic test (sensitivity and specificity) and Siriraj score as screening test. The sensitivity, specificity, predictive values, diagnostic accuracy of the screening test, and their 95% confidence interval (CI) were presented. P value <0.05 was considered statistically significant. Data was analyzed using coGuide software, V.1.03 (15).

Results

A total of 80 subjects were included in the final analysis.

The mean age of the study population was 56.4±7.61 years, 47 participants (58.8%) were males and 33 participants (41.2%) females. The majority of the participants (60%) had hemiparesis, followed by 16.3% hemiplegia, 13.8% headache and slurred speech each, and 12.5% had vomiting. Among comorbidities, diabetes mellitus was the highest (33.8%), followed by hypertension (28.8%), and coronary heart disease (CAD) (7.5%). Among the study population, four participants (5%) had pallor, two (2.5%) had cyanosis, and 13 (16.3%) had edema, 42 (52.5%) had a mild injury, 32 (40.0%) had moderate, and six (7.5%) had a severe injury (Table 1).

The majority of the participants (76.25%) had infarct, followed by 13.75% with bleeding and 10% was equivocal in Siriraj score findings. In CT findings, 65 participants (81.25%) had infarct, 11 (13.75%) had bleeding, and four (5.00%) were equivocal (Table 2).

Among the people with infarct in CT findings, 60 patients (92.31%) had Siriraj stroke score infarct, one (1.54%) had a bleed, and four (6.15%) were equivocal. Among the people with bleeding in CT findings, ten patients (90.91%) had Siriraj stroke score bleeding, and one (9.09%) was equivocal (Table 3).

The difference in Siriraj stroke score between CT findings is significant with a p value of <0.001 (Table 4).

The Siriraj stroke score had excellent predictive validity in predicting CT findings, as indicated by the area under the curve of 0.994 (95% CI: 0.983 to 1.000, p<0.001) (Figure 1).

The Siriraj stroke score had sensitivity of 96.92% (95% CI: 89.32% to 99.63%) in predicting CT findings. Specificity was 90.91% (95% CI: 58.72% to 99.77%), false positive rate was 9.09% (95% CI: 0.23% to 41.28%), false negative rate was 3.08% (95% CI: 0.37% to 10.68%), positive predictive value (PPV) was 98.44% (95% CI: 91.60% to 99.96%), negative predictive value (NPV) was 83.33% (95% CI: 51.59% to 97.18%), and the total diagnostic accuracy was 96.05% (95% CI: 88.89% to 99.18%) (Table 5).

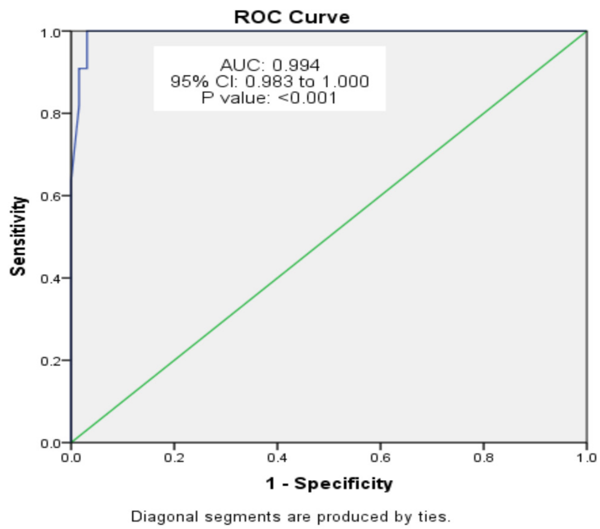

Figure 1. ROC analysis of Siriraj Stroke Score in predicting CT findings (bleed) (n=76)

ROC: Receiver operating characteristics, CT: Computed tomography, AUC: Area under the curve, CI: Confidence interval

Table 1. Summary of demographic variables in the study population (n=80)

Parameter	Summary
Mean age	56.4±7.61 (ranged 29 to 65)
Gender	
Male	47 (58.8%)
Female	33 (41.2%)
Complaints	
Hemiparesis	48 (60.0%)
Hemiplegia	13 (16.3%)
Headache	11 (13.8%)
Slurred speech	11 (13.8%)
Vomiting	10 (12.5%)
Comorbidities	
Diabetes mellitus	27 (33.8%)
Hypertension	23 (28.8%)
CAD	6 (7.5%)
General examination	
Pallor	4 (5.0%)
Icterus	0 (0.0%)
Cyanosis	2 (2.5%)
Edema	13 (16.3%)
Head injury (Glasgow Coma Scale)	
Mild	42 (52.5%)
Moderate	32 (40.0%)
Severe	6 (7.5%)

CAD: Coronary artery disease

Table 2. Summary of outcome parameters (n=80)	
Parameter	**Summary**
Siriraj score findings	
Infarct	61 (76.25%)
Bleed	11 (13.75%)
Equivocal	8 (10.00%)
CT Findings	
Infarct	65 (81.25%)
Bleed	11 (13.75%)
Equivocal	4 (5.00%)
CT: Computed tomography	

Discussion

The mean age of the study population was 56.4±7.61 years, and most participants were males (58.8%) in this study. The majority of the participants presented with hemiparesis (60%) followed by hemiplegia, headache, slurred speech, and vomiting. The majority of the participants had an infarct (76.25%, 81.25%) followed by bleeding (13.75%, 13.75%) in Siriraj Stroke Score and CT findings. The sensitivity, specificity, PPV, and NPV for SSS compared to CT were 96.92%, 90.91%, 98.44%, and 83.33%, respectively, with an overall accuracy of 96.05%. The Siriraj stroke score had excellent predictive validity in predicting CT findings, as indicated by the area under the curve of 0.994 (95% CI: 0.983 to 1.000, $p<0.001$).

The findings of this study showed higher values than those of earlier studies (16-18). A Nigerian study showed that SSS was highly predictive of both acute ischemic stroke and acute hemorrhagic stroke with a PPV of 97% and 86%, respectively, with an overall predictive accuracy of 93% (16). A recent study in India demonstrated that the sensitivity and accuracy of SSS were 59.2% and 82% for hemorrhagic strokes and 95.5% and 87.2% for ischemic strokes, respectively, when compared to the CT scan findings (17). A study conducted in Pakistan reported a sensitivity of 71.4%, specificity of 81.33 %, PPV of 79.7%, NPV of 73.5%, and an overall accuracy of 76.3% (18). In a systematic review, consistently higher specificities with a range from 65%-99% were reported for SSS compared to its corresponding sensitivities in 18 validation studies (11). The difference in settings, the prevalence of different strokes and ethnicity in different countries, and also data collection method used affects the variability of results for SSS (19). The reason for increased sensitivity and specificity in our present study may be due to, a single examiner clinically examined the patients and given the scoring, another blinded radiologist analyzed the CT findings. The cross-sectional nature of the present study might have positively influenced the results which was not in the case of a retrospective design. Over all, Siriraj score has better sensitivity in Asian population and less sensitivity in African and western population (18).

The mean age of the study population was 56.4±7.61 years, with ages ranging from 29 to 65 years and the majority were males (58.8%). In a study by Somasundaran et al. (17), most participants belonged to the age group 61 to 70 years, and the majority were males (55.4%). The mean age of the patients was 63.65±10.2 years in another study (19). The majority of the present study participants had diabetes mellitus (33.8%), followed by hypertension. The findings of an earlier study showed that hypertension was a major risk factor for both stroke subtypes, while diabetes mellitus was considered to be a risk factor for ischemic stroke (16).

Stroke management in patients mainly depends on the differentiation between hemorrhagic and ischemic stroke (18). Some studies recommended that critical decisions regarding the implementation of therapeutic management cannot be made without neuroimaging (18,20). Hence, it is understood that the stroke scoring system cannot completely replace CT but may be utilized in a resource-poor setting in order to initiate antiplatelet therapy.

Our study has a few limitations. First, our sample size was too small and second, the study population represents only a hospitalized subgroup of stroke patients. Another limitation of the study was that none of the patients had diffusion-weighted magnetic resonance imaging (MRI) which is considerably superior to CT in the first hours of an ischemic stroke.

Table 3. Comparison of Siriraj Stroke Score and CT findings (n=80)			
Siriraj Stroke Score	**CT findings**		
	Infarct (n=65)	**Bleed (n=11)**	**Equivocal (n=4)**
Infarct	60 (92.31%)	0 (0%)	1 (25%)
Bleed	1 (1.54%)	10 (90.91%)	0 (0%)
Equivocal	4 (6.15%)	1 (9.09%)	3 (75%)
No statistical test was applied due to 0 subjects in the cells. CT: Computed tomography			

Table 4. Comparison of CT findings with Siriraj Score (n=76)				
Siriraj Score	**CT findings**		**Chi-square**	**p value**
	Infarct (n=65)	**Bleed (n=11)**		
Low (<0.5)	63 (96.92%)	1 (9.09%)	54.584	**<0.001**
High (>=0.5)	2 (3.08%)	10 (90.91%)		

CT: Computed tomography

Table 5. Predictive validity of Siriraj Score in predicting CT findings (n=76)			
Parameter	**Value**	**95% CI**	
		Lower	**Upper**
Sensitivity	96.92%	89.32%	99.63%
Specificity	90.91%	58.72%	99.77%
False positive rate	9.09%	0.23%	41.28%
False negative rate	3.08%	0.37%	10.68%
Positive predictive value	98.44%	91.60%	99.96%
Negative predictive value	83.33%	51.59%	97.91%
Diagnostic accuracy	96.05%	88.89%	99.18%
Positive likelihood ratio	10.66	4.88	42.258
Negative likelihood ratio	0.03	0	0.134

CT: Computed tomography, CI: Confidence interval

Conclusion

Diffusion-weighted MRI and CT imaging is the best option to differentiate stroke subtypes in a clinical setting. In the present study, Siriraj stroke score, a clinical scoring system showed satisfactory results compared with CT imaging. Thus, Siriraj stroke score may be used for the bedside diagnosis of the stroke subtype in scenarios where the availability of a CT scan facility is limited.

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Ethics

Ethics Committee Approval: Ethics Committee approval was taken before initiating the study from Vinayaka Mission's Kirupananda Variyar Medical College, Ethical Committee number: VMKVMC&H/IEC/19/49, on 06.03.2019.

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: K.N.P., Concept: K.N.P., M.D., Design: K.N.P., M.D., H.H.C., Data Collection and/or Processing: K.N.P., H.H.C., S.A.S., Analysis and/or Interpretation: K.N.P., M.D., H.H.C., V.P.C., Literature Search: K.N.P., V.P.C., R.K.R., Writing: K.N.P., S.A.S.

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