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RESEARCH ARTICLE

Role of Allen Stroke Score in Differentiating Acute Ischemic Stroke from Hemorrhagic Stroke in A Tertiary Institution

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Abstract: ***Introduction:*** Stroke is a leading cause of mortality and disability worldwide, with ischemic stroke (IS) and hemorrhagic stroke (HS) being the major subtypes. In resource-limited settings where neuroimaging may not be immediately available, clinical tools like the Allen Stroke Score (ASS) provide a valuable means of differentiating IS from HS. This study aimed to evaluate the diagnostic accuracy of ASS in comparison with CT brain findings in a tertiary care hospital. ***Materials and Methods*** This study was conducted in the Department of General Medicine, Sree Balaji Medical College and Hospital, Chennai, from July 2023 to January 2025. Ninety-four adult patients presenting with acute stroke within seven days of onset were enrolled. Detailed demographic, clinical, and neurological examinations were performed, and ASS was calculated for each patient. CT brain served as the gold standard for stroke subtype classification. Data were analysed using SPSS, and diagnostic accuracy parameters were calculated. ***Results*** Of 94 patients, the majority were males (59.6%), with the largest age group being 70–79 years (28.7%). Hypertension (74.5%) and diabetes mellitus (50%) were the most common comorbidities. Weakness was the predominant presenting symptom (61.7%). According to ASS, 54.2% were infarcts, 30.8% haemorrhages, and 15% indeterminate. CT confirmed 74.5% infarcts and 25.5% haemorrhages. ASS showed a sensitivity of 87.5%, specificity of 88.5%, positive predictive value of 72.4%, and negative predictive value of 95.4%. ***Conclusion*** The Allen Stroke Score demonstrated good diagnostic accuracy in differentiating IS from HS, particularly useful in ruling out haemorrhage. While neuroimaging remains essential, ASS can serve as a valuable triage tool in resource-limited settings.

Keywords: Stroke, Allen Stroke Score, Ischemic stroke, Hemorrhagic stroke, CT brain, Diagnostic accuracy.

INTRODUCTION

Stroke remains a significant global health burden, ranking among the leading causes of death and disability. The World Health Organisation (WHO) defines stroke as the sudden onset of clinical symptoms suggestive of focal or global cerebral dysfunction lasting more than 24 hours, or leading to death, with no apparent cause other than vascular origin [1]. Two major subtypes dominate stroke presentations—acute ischemic stroke (AIS), which occurs due to vascular occlusion and subsequent cerebral ischemia, and hemorrhagic stroke (HS), which results from vascular rupture and intracerebral bleeding [2]. Given their divergent pathophysiology and management strategies, rapid differentiation between AIS and HS is imperative for timely intervention and a favourable prognosis. While neuroimaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI) are considered the gold standards for stroke diagnosis, they may not be universally available, particularly in resource-limited or peripheral healthcare settings. In such contexts, clinical scoring systems like the Allen Stroke Score (ASS) can play a pivotal role [3]. The ASS incorporates clinical variables, including onset characteristics, neurological deficits, and vascular risk factors, to predict the probability of AIS versus HS. Its simplicity, low cost, and bedside applicability make it an attractive adjunct where advanced imaging is either delayed or inaccessible. The global burden of stroke underscores the urgency of such tools. In 2019, stroke accounted for approximately 6.55 million deaths and 143 million disability-adjusted life years (DALYs) worldwide [4]. Notably, nearly 70% of this burden arises from low- and middle-income countries, where healthcare infrastructure, preventive programs, and early diagnostic capabilities remain limited [5]. Alongside mortality, the economic consequences are substantial, driven by acute care costs, rehabilitation needs, and long-term disability [6].

In India, the epidemiological transition has shown a rising incidence of stroke, with prevalence ranging from 84 to 262 per 100,000 population. Rural areas are disproportionately affected due to inadequate healthcare facilities [7]. Stroke accounts for more than 4% of total deaths in the country and is one of the top four contributors to DALYs lost [8]. Moreover, Indian patients often present with stroke at a younger age, with the mean age of onset 5–10 years earlier than that observed in developed nations [9]. Hypertension, diabetes, obesity, sedentary lifestyles, and tobacco use are the most common risk factors, with hypertension alone implicated in over half of stroke cases [10].

In this context, cost-effective diagnostic aids such as ASS gain clinical relevance. Studies have reported variable diagnostic performance of ASS, with sensitivity for differentiating ischemic and hemorrhagic stroke reaching up to 80% in certain studies [11]. However, its reliance on subjective clinical interpretation, susceptibility to stroke mimics, and variability across populations limit its stand-alone utility [12]. To overcome these challenges, contemporary research suggests integrating ASS with other scales such as the National Institutes of Health Stroke Scale (NIHSS) and Glasgow Coma Scale (GCS), or supplementing it with biomarkers (e.g., S100B) and point-of-care ultrasonography to improve diagnostic accuracy [12]. The role of ASS is particularly relevant in tertiary institutions where patient load is high, immediate neuroimaging may be constrained, and early therapeutic decision-making is crucial. In AIS, rapid initiation of thrombolysis within the therapeutic window markedly improves outcomes, while inappropriate thrombolysis in HS can be catastrophic [13]. Thus, bedside clinical tools like ASS serve as pragmatic triage strategies to prioritise patients for urgent imaging and intervention.

Therefore, the present study aims to evaluate the role of the Allen Stroke Score in differentiating AIS from HS in a tertiary care institution.

MATERIALS AND METHODS

This hospital-based cross-sectional study was conducted in the Department of General Medicine, Sree Balaji Medical College and Hospital, Chennai, over an 18-month period from July 2023 to January 2025, after obtaining approval from the Institutional Human Ethics Committee. The minimum sample size was calculated using a prevalence of 42.4%, a 95% confidence interval (Z = 1.96), and a 10% allowable error, yielding 94 as the required sample size.

Inclusion Criteria

- Patients admitted to the Department of General Medicine with a diagnosis of acute stroke.
- Patients presenting within 7 days of symptom onset.

Exclusion Criteria

- Patients admitted more than 72 hours after onset of symptoms.
- Patients with recurrent infarcts.
- Patients with cortical vein thrombosis.
- Patients with chronic infarcts.

Data Collection

Data collection was performed using a pretested semi-structured questionnaire and detailed clinical examination.

Part 1: Questionnaire

- Section 1: Demographic details such as name, age, sex, and residence.
- Section 2: Presenting complaints, detailed history of current illness, past history of stroke, ischemic heart disease, tuberculosis, comorbidities (e.g., hypertension, diabetes), family history, and lifestyle factors.

Part 2: Clinical Examination

All patients underwent a detailed systemic and neurological examination at admission and 24 hours later. The assessment included:

- Higher mental functions and cranial nerve examination.
- Motor and sensory system evaluation.
- Reflex assessment (superficial and deep tendons).
- Cerebellar function tests.
- Examination for meningeal signs.
- Systemic examination of cardiovascular, respiratory, and abdominal systems.

Part 3: Allen Stroke Score (ASS)

The Allen Stroke Score was calculated based on eight parameters: apoplectic onset, state of consciousness, plantar response, diastolic blood pressure, atheroma markers, history of hypertension, prior stroke, and cardiac disease.

- Score > +24: Intracerebral Haemorrhage (ICH).
- Score < +4: Ischemic Stroke (IS).
- Score +4 to +24: Indeterminate.

Part 4: Laboratory and Imaging Investigations

All patients underwent baseline investigations, including complete blood count, serum lipid profile, coagulation profile (PT, INR), chest X-ray, and electrocardiogram (ECG). Brain imaging with a CT scan was performed to confirm stroke subtype and served as the reference standard

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS.21 Statistics for Windows (IBM Corp., Armonk, NY). Categorical variables were expressed as frequencies and percentages, while continuous variables were summarised using mean and standard deviation. Associations between categorical variables were tested using the Chi-square test. Independent sample t-tests were applied to compare continuous variables. The sensitivity, specificity, and diagnostic accuracy of the Allen Stroke Score were calculated against CT scan findings as the gold standard. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 94 patients with acute stroke were included in the study. The majority were aged 70–79 years (28.7%), followed by 40–49 years (27.7%), 50–59 years (22.3%), and 60–69 years (21.3%). Males constituted 59.6% of the study population, while females constituted 40.4%.The most common presenting complaint was weakness (61.7%), followed by facial droop (18.1%), slurred speech (11.7%), and unconsciousness (8.5%).A history of stroke was reported in 11.7% and transient ischemic attack in 18.1% of participants. Hypertension was present in 74.5% of patients, while diabetes mellitus was observed in 50%. Rheumatic heart disease (2.1%) and peripheral arterial disease (5.3%) were less frequent. A positive family history of stroke or related conditions was reported in 23.4% of participants (Table 1). Alcohol consumption was reported in 29.8% of patients, while 70.2% were non-alcoholic. Smoking history was present in 44.7% of patients. Among smokers, 45.2% reported smoking for 11–20 years, 38.1% for more than 20 years, and 16.7% for less than 10 years. In terms of intensity, 61.9% consumed fewer than 10 cigarettes per day, 33.3% between 11–20 per day, and 4.8% more than 20 per day.

At admission, altered higher mental function was observed in 61.7% of patients, decreasing to 55.3% after 24 hours. Cranial nerve deficits were found in 47.9% of patients. Motor weakness was the most common neurological deficit, present in 70.2%. Sensory loss was reported in 46.8% of cases. Reflex examination showed hyperreflexia in 38.3%, hyporeflexia in 30.9%, and normal reflexes in 30.9%. Cerebellar signs appeared in 50% of patients. Signs of meningeal irritation were observed in 45.7% (Table 2). Application of the Allen Stroke Score identified infarcts in 54.2% of cases, haemorrhages in 30.8%, and uncertain findings in 15%. CT brain imaging, regarded as the diagnostic gold standard, detected infarcts in 74.5% and haemorrhages in 25.5% of patients.

A comparison of the Allen Stroke Score with CT findings revealed a statistically significant correlation (Chi-square = 54.259, $p < 0.001$). Among 51 patients predicted to have infarcts by Allen Score, all were confirmed on CT. For haemorrhages, 21 were correctly classified, while 8 were misclassified as infarcts. Fourteen patients were categorised as “uncertain” by the Allen Score, of whom 11 had infarcts and 3 had haemorrhages(Table 3).

The Allen Stroke Score demonstrated a sensitivity of 87.5%, specificity of 88.5%, positive predictive value of 72.4%, and negative predictive value of 95.4% for differentiating ischemic from hemorrhagic stroke. Receiver Operating Characteristic (ROC) curve analysis confirmed the strong discriminative ability of the Allen Stroke Score. The area under the curve (AUC) indicated good diagnostic performance. The optimal cut-off value provided an effective balance between sensitivity (87.5%) and specificity (88.5%). The high negative predictive value (95.4%) suggested excellent reliability in ruling out hemorrhagic stroke, while the positive predictive value (72.4%) indicated reasonable accuracy in predicting haemorrhage (Figure 1).

Table 1. Baseline Characteristics of the Study Population (n = 94)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	40–49	26	27.7
	50–59	21	22.3
	60–69	20	21.3
	70–79	27	28.7
Gender	Male	56	59.6
	Female	38	40.4
Chief Complaints	Weakness	58	61.7
	Facial droop	17	18.1
	Slurred speech	11	11.7
	Unconsciousness	8	8.5
Past Medical History	Hypertension	70	74.5
	Diabetes mellitus	47	50.0
	Stroke	11	11.7
	TIA	17	18.1
	Peripheral arterial disease	5	5.3
	Rheumatic heart disease	2	2.1
Family History (Stroke/related)	Present	22	23.4
	Absent	72	76.6
Personal History	Alcohol	28	29.8
	Smoking	42	44.7

Table 2. Neurological Examination Findings

Examination Parameter	Category	Frequency (n)	Percentage (%)
Higher mental function at admission	Altered	58	61.7

	Normal	36	38.3
Higher mental function at 24 hrs	Altered	52	55.3
	Normal	42	44.7
Cranial nerve deficits	Present	45	47.9
	Absent	49	52.1
Motor weakness	Present	66	70.2
	Absent	28	29.8
Sensory loss	Present	44	46.8
	Absent	50	53.2
Reflexes	Hyperreflexia	36	38.3
	Hyporeflexia	29	30.9
	Normal	29	30.9
Cerebellar signs	Present	47	50.0
	Absent	47	50.0
Signs of meningeal irritation	Present	43	45.7
	Absent	51	54.3

Table 3. Diagnostic Performance of Allen Stroke Score Compared with CT Brain Findings (n = 94)

Allen Stroke Score Classification	CT-confirmed Infarct (n=70)	CT-confirmed Hemorrhage (n=24)	Total (n=94)
Infarct	51 (72.9%)	0 (0.0%)	51 (54.3%)
Hemorrhage	8 (11.4%)	21 (87.5%)	29 (30.9%)
Uncertain	11 (15.7%)	3 (12.5%)	14 (14.9%)
Total	**70 (100%)**	**24 (100%)**	**94 (100%)**

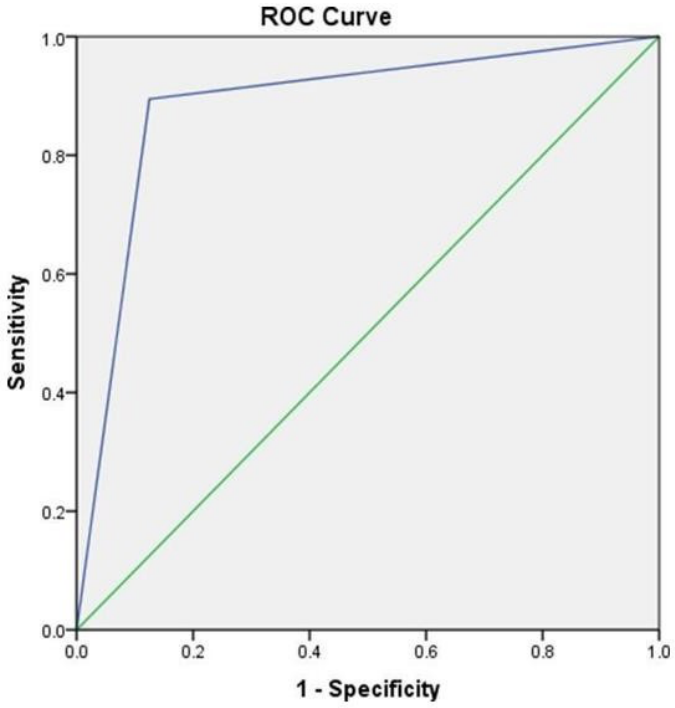

Figure 4. Diagnostic Accuracy of Allen Stroke Score in Differentiating Stroke Subtypes

DISCUSSION

This study evaluated the diagnostic performance of the Allen Stroke Score (ASS) in differentiating acute ischemic stroke (AIS) from hemorrhagic stroke (HS) among patients in a tertiary care hospital. In our study, the majority of patients were aged 70–79 years (28.7%), followed by 40–49 years (27.7%), 50–59 years (22.3%), and 60–69 years (21.3%). This confirms that stroke risk rises with age. Pandian et al. (2007) [14] reported a crude stroke prevalence of 44.29 to 559 per 100,000 population in India, with the highest rates in elderly age groups, confirming that older individuals are disproportionately affected.Male predominance was seen in our study (59.6% vs. 40.4%). Jones et al. (2010) [15] observed a similar trend in India, where men had higher stroke incidence than women. They reported that men accounted for nearly 60% of stroke cases in their sample,

attributing the difference to higher exposure to smoking, alcohol consumption, and occupational stress, which is similar to our finding that almost half of male patients reported smoking.

Weakness was the most common presenting symptom in our study (61.7%), followed by facial droop (18.1%), slurred speech (11.7%), and unconsciousness (8.5%). Pandian et al. (2007) [14] also observed motor weakness in 72% of patients, facial weakness in 20%, and speech disturbances in 15%, showing similarity to our observation. Recognition of these classical features is crucial for early diagnosis and triage. Hypertension was present in 74.5% and diabetes mellitus in 50% of our participants. Prasad et al. (2012) [16] reported hypertension in 72% and diabetes in 48% of stroke patients, almost identical to our findings. They concluded that effective control of these comorbidities could significantly reduce stroke incidence in the Indian population. Regarding lifestyle habits, 29.8% of our patients consumed alcohol, and 44.7% smoked. Prasad et al. (2012) [16] similarly documented smoking in 41% and alcohol use in 36% of stroke patients, particularly in males. They emphasised that these habits substantially increased the risk of early stroke onset.

At admission, altered higher mental function was present in 61.7% of our patients, which reduced to 55.3% after 24 hours. Cranial nerve deficits were noted in 47.9%, motor weakness in 70.2%, and sensory loss in 46.8%. Pandian et al. (2007) [14] described motor weakness in 68% and cranial nerve deficits in nearly half of their study, while Prasad et al. (2012) [16] reported sensory impairment in 42% of cases. The Allen Stroke Score classified 54.2% of our patients as infarcts, 30.8% as hemorrhages, and 15% as uncertain. Compared with the CT brain, the score achieved a sensitivity of 87.5%, specificity of 88.5%, positive predictive value of 72.4%, and negative predictive value of 95.4%.In contrast, Nouira et al. (2009) [17] studied 126 stroke patients in Tunisia and found that the Allen Stroke Score had a sensitivity of only 65% and specificity of 70%, with poor discrimination between ischemic and hemorrhagic strokes. They concluded that ASS was less reliable in their setting, especially for hemorrhagic stroke, highlighting variability across populations. Our findings suggest that in the Indian context, the score performs better, particularly in excluding haemorrhage, given its high negative predictive value. ROC curve analysis in our study demonstrated an AUC consistent with good discriminative ability, confirming the strong diagnostic performance of the Allen Stroke Score. Ogun et al. (2000) [18], in a Nigerian study of 113 patients, compared the Siriraj and Guy's Hospital Stroke Scores. They reported that the Siriraj Stroke Score achieved 63% sensitivity and 88% specificity for hemorrhagic stroke, while the Guy's Hospital Stroke Score showed 49% sensitivity and 76% specificity. Prasad et al. (2012) [16] also evaluated the Guy's Hospital Stroke Score and found its AUC fell within a fair discrimination range, lower than that of the Allen Stroke Score. These comparative results highlight that the Allen Score may offer superior accuracy in certain studies, as demonstrated in our population.

CONCLUSION

The Allen Stroke Score proved to be a simple and reliable bedside tool for differentiating ischemic from hemorrhagic stroke, with good sensitivity and specificity. Its high negative predictive value makes it particularly useful in ruling out haemorrhage when imaging is delayed. While neuroimaging remains the gold standard, ASS can aid early triage in resource-limited settings. However, confirmation with CT/MRI is essential whenever available.

Limitations of the Study

This study was limited by its single-centre design and modest sample size, which may affect generalizability. The Allen Stroke Score is subject to observer bias, and exclusion of recurrent or late-presenting strokes restricted its wider applicability. MRI, a more sensitive modality, was not uniformly used. Direct comparison with other stroke scores was also not performed.

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