

Relationship between Serum Calcium Levels, NIHSS Score, and Infarct Size in Acute Ischemic Stroke: A Hospital-Based Cross-Sectional Study**Lalu Banothu¹, Naruttam Sonowal², Jilimili Devi³, Rupak Bhuyan⁴**¹MD General Medicine, Fellowship in Diabetes Mellitus (FDM), Post graduate Diploma in Family Medicine (PGDFM).²MD General Medicine, Professor, Department of General Medicine, Bongaigaon Medical College and Hospital, Bongaigaon, Assam.³MD Biochemistry, Associate Professor, Gauhati Medical College and Hospital, Guwahati, Assam.⁴MD, Professor & Head, Department Of Radiology, Jorhat Medical College and Hospital, Jorhat, Assam.

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Abstract

Background: Acute ischemic stroke (AIS) is a leading cause of death and long-term disability worldwide. One key to enhancing stroke patient outcomes is early evaluation of stroke severity and finding reliable prognostic indicators. Some recent research has pointed to a link between serum calcium levels and both neurological severity and cerebral infarct size in AIS patients. Therefore, the present study aims to evaluate the clinical profile of patients with acute ischemic stroke and assess its association with serum calcium levels and stroke severity with the help of the National Institute of Health Stroke scale (NIHSS).

Methods: This cross-sectional study was carried out at the Department of General Medicine, Jorhat Medical College and Hospital, between March 2023 and February 2024 after obtaining approval from the institutional ethics committee. A total of 182 patients diagnosed with acute ischemic stroke and having low serum calcium levels were enrolled in the study. Information on demographics, comorbidities, risk factors, clinical manifestations, radiological data, NIHSS scores, infarct size, and corrected serum calcium levels was documented and analyzed using SPSS version 26.

Results: The mean age of the patients was 57.9 ± 7.2 years, with a male predominance (68.2%). Among the comorbidities, hypertension was the most prevalent one while among the risk factors, alcohol consumption was the most frequent. In the majority of cases, stroke severity was moderate as per NIHSS scoring. Corrected serum calcium levels were inversely and significantly correlated with infarct size ($r = -0.75$, $p = 0.001$) as well as NIHSS score ($r = -0.82$, $p = 0.003$).

Conclusion: Lower corrected serum calcium levels were significantly associated with larger infarct volumes and greater stroke severity. Serum calcium may serve as a simple and cost-effective biomarker for assessing severity and prognosis in acute ischemic stroke patients.

Keywords: Acute ischemic stroke, serum calcium levels, National Institute of Health Stroke scale (NIHSS).

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Introduction

Stroke remains a major global public health challenge and is currently the second leading cause of death and one of the leading causes of long-term disability worldwide. Acute ischemic stroke (AIS), caused by the obstruction of cerebral blood flow due to thrombotic or embolic occlusion, accounts for the majority of the cases and is associated with significant morbidity, mortality and socioeconomic burden.

In developing countries, the incidence of ischemic stroke is increasing because of the population, age, lifestyle transitions, and the rising prevalence of

vascular factors such as hypertension and diabetes mellitus. Furthermore, stroke related mortality rates remained disproportionately high in South Asian countries, including India, Pakistan, Nepal, Sri Lanka, and China, emphasising the need for improved stroke prevention and management strategies [1-3].

Early assessment of stroke severity is essential for therapeutic decision-making, prognostication, and evaluation of treatment outcomes. Although intravenous thrombolysis administered within 4.5 hours of symptom onset has been shown to

improve outcome in eligible patients with delayed presentation, and limited access to specialized stroke care continues to hinder widespread utilisation in many low and middle-income countries [1,2]. Consequently, reliable clinical tools for rapid assessment of neurological deficit remain fundamental to acute stroke management.

The National Institute of Health Stroke scale (NIHSS) has emerged as the most widely accepted and standardised instrument for qualifying neurological impairment in the patient with acute ischemic stroke. The scale assesses various domains, including level of consciousness, language, motor function, sensory deficits, visual fields, coordination, and neglect, thereby providing an objective measure of severity. Previous studies have demonstrated that admissions, NIHSS scores are significantly associated with mortality, functional recovery, and long-term clinical outcomes among patients with acute ischemic stroke. In Nepal, NIHSS was identified as a predictor of short-term mortality among STROKE patients, while subsequent studies demonstrated its association with three-month functional outcomes. Similarly, studies from Pakistan and China have highlighted the prognostic significance of NIHSS in predicting patient outcomes and guiding clinical decision-making [1-3].

Evaluation of the clinical profile of acute ischemic stroke patients along with NIHSS-based assessment can facilitate early risk stratification, identify factors associated with disease severity, and aid in optimising management strategies. Therefore, the present study aims to evaluate the relationship between serum calcium levels, NIHSS score, and infarct size in acute ischemic stroke.

Materials and Methods

The present hospital-based cross-sectional observational study was conducted in the

Department of General Medicine, Jorhat Medical College and Hospital, Assam, from March 2023 to February 2024 after obtaining approval from the institutional ethics committee. A total of 182 consecutive patients aged 40 years with a confirmed diagnosis of acute ischemic stroke presenting within 2 to 3 days of symptom onset and having low serum calcium levels were enrolled. Patients with haemorrhagic stroke, malignancy, pancreatitis, hepatic or renal disease, and those receiving calcium supplementation for osteoporosis or vitamin D deficiency were excluded from the study. After obtaining informed consent, detailed demographic, and laboratory data were collected using a predesigned study proforma. Stroke severity was assessed using the National Institutes of Health Stroke Scale (NIHSS). Laboratory investigations included complete blood count, renal function tests, liver function tests, fasting lipid profile, random blood sugar, thyroid-stimulating hormone, serum electrolytes, and serum calcium levels, with corrected serum calcium calculated when necessary. Data were entered into Microsoft Excel and analyzed using SPSS version 26. Qualitative variables were expressed as frequencies and percentages, whereas quantitative variables were summarized as mean $\pm$ standard deviation. Pearson's correlation analysis was used to evaluate the relationship between serum calcium levels and stroke severity. A p-value of less than 0.05 was considered statistically significant.

Results

The present study was conducted among 182 patients with acute ischemic stroke admitted to the Department of General Medicine. The study primarily focused on the demographic profile, comorbidities, risk factors, stroke severity assessed by the National Institutes of Health Stroke Scale (NIHSS), and the correlation of corrected serum calcium levels with infarct size and stroke severity.

Table 1: Baseline demographic and clinical characteristics of acute ischemic stroke Patients (N = 182).

Parameter	Variable	Number of Patients (N)	Percentage (%)
Age (years)	41 to 50	20	11.0
	51 to 60	102	56.0
	61 to 70	56	30.8
	>70	4	2.2
Age (years), Mean $\pm$ SD		57.9 $\pm$ 7.2	
Sex	Male	124	68.2
	Female	58	31.8
Comorbidities	Hypertension	80	44.0
	Hypertension + Diabetes Mellitus + Dyslipidaemia	40	22.0
	Diabetes Mellitus	22	12.0
	Hypertension + Diabetes Mellitus + Hypothyroidism	20	11.0
	CAD + Hypertension	8	4.6

Risk Factors	Bronchial Asthma	2	1.0
	None	10	5.4
	Alcohol consumption	80	44.0
	Alcohol + Smoking	62	34.0
	Tobacco chewing	18	9.8
	Obesity	16	8.7
	None	6	3.5

The mean age of the patients was 57.9 ± 7.2 years. The majority of patients belonged to the 51 to 60 years age group (56.0%), followed by 61 to 70 years (30.8%). Males constituted 68.2% of the

study population, resulting in a male-to-female ratio of 2.1:1. Hypertension was the most common comorbidity (44.0%), while alcohol consumption was the most common risk factor (44.0%).

Table 2: Distribution of patients according to NIHSS severity (N = 182).

NIHSS score	Severity category	Number of patients (N)	Percentage (%)
1 to 4	Mild	39	21.4
5 to 15	Moderate	82	45.0
16 to 20	Moderate-Severe	55	30.3
21 to 42	Severe	6	3.3
Mean NIHSS $\pm$ SD		11.7 ± 7.2	

The National Institutes of Health Stroke Scale (NIHSS) was used to assess stroke severity among all study participants.

Most patients had moderate stroke severity (45.0%), followed by moderate-severe stroke

(30.3%) and mild stroke (21.4%). Severe stroke was observed in only 3.3% of patients.

The mean NIHSS score was 11.7 ± 7.2 , indicating an overall moderate severity of stroke among the study population.

Table 3: Correlation of corrected serum calcium with infarct size and NIHSS score.

Variable	Pearson correlation (r)	p-value
Infarct size vs corrected serum calcium	-0.75	0.001*
NIHSS score vs corrected serum calcium	-0.82	0.003*

*Statistically significant at $p < 0.05$

A significant negative correlation was observed between infarct size and corrected serum calcium levels ($r = -0.75$, $p = 0.001$), indicating that lower calcium levels were associated with larger infarct volumes. Similarly, NIHSS score showed a strong negative correlation with corrected serum calcium levels ($r = -0.82$, $p = 0.003$), suggesting that patients with lower serum calcium levels had more severe neurological deficits at presentation.

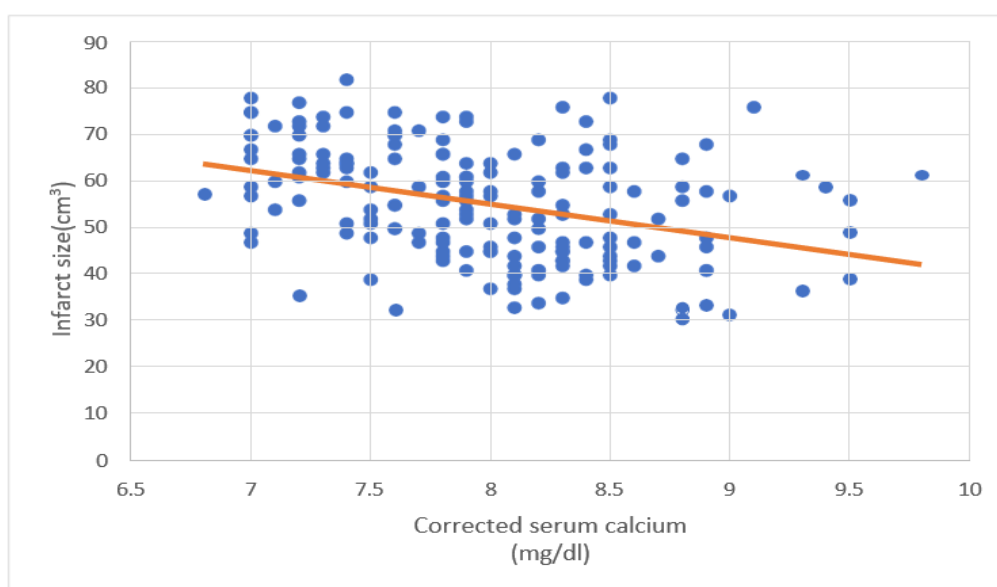


Figure 1: Scatter diagram showing correlation between infarct size and calcium.

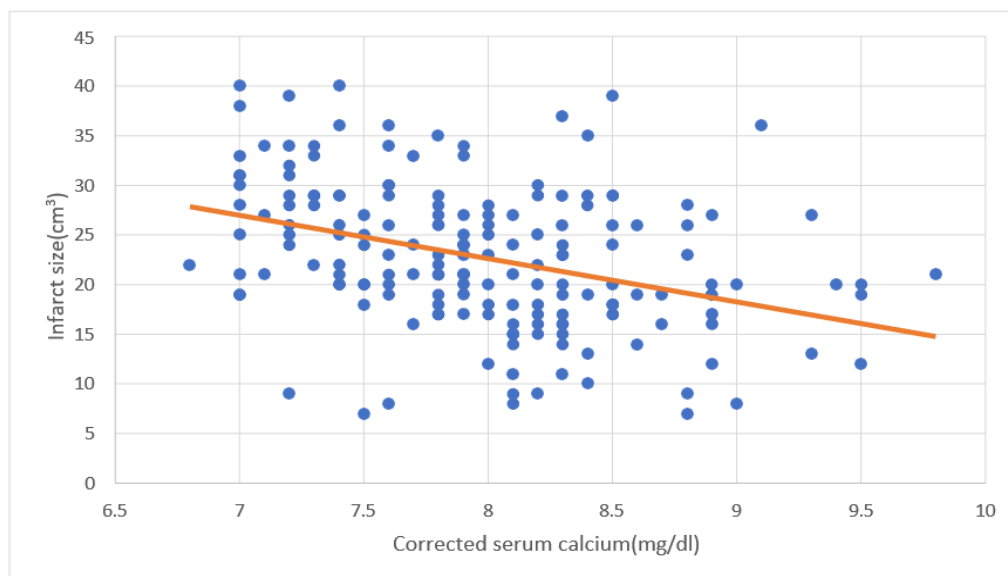


Figure 2: Scatter diagram showing correlation between NIHSS and calcium level

Discussion

This study found that both middle-aged and elderly individuals were mostly affected by acute ischemic stroke. In fact, most patients were in their fifties and sixties, which aligns with other reports by Shrestha et al [1], and Kurmi RN et al [5], who also found that ischemic stroke is more common in the elderly. This variation can be explained by the fact that young adults in developing countries are increasingly getting exposed to risk factors such as hypertension, diabetes mellitus, dyslipidaemia, smoking, alcohol consumption, and a sedentary lifestyle.

In this study, there was a very strong male predominance. This observation was supported by Shrestha et al [1], Khan et al [2], and Suhil Azmi et al [4], who, like us, noted ischemic stroke occurred more in males than females. Men tend to have a higher incidence of stroke because they generally adopt more risk behaviors, such as smoking, drinking alcohol, and stress at work, and also tend to have more cardiovascular diseases. Moreover, it can be speculated that the hormonal protection in premenopausal women is one reason for females having a lower incidence of stroke.

Hypertension was the most frequent comorbidity in the current study. Also, Shrestha et al [1], Khan et al [2], and Suhil Azmi et al [4], in their studies, identified hypertension as the top risk factor for ischemic stroke in most cases. Petty et al [6], have reported similar findings, further highlighting the pivotal role of hypertension in the pathogenesis of both large-vessel and small-vessel cerebrovascular disease. The high rate of hypertension found in this study calls for the implementation of effective blood pressure management interventions to alleviate the incidence of stroke. Along with hypertension, diabetes mellitus and dyslipidaemia

were among the commonest comorbidities in the study group. Khan et al [2], and Suhil Azmi et al [4], have also reported similar results, highlighting these metabolic disorders as significant risk factors for ischemic stroke. The simultaneous presence of hypertension and diabetes mellitus and dyslipidaemia has been identified as one of the main drivers of atherosclerosis resulting in cerebral infarction.

In the current study, alcohol use and smoking were the most common behavioral risk factors. Again, similar findings have been reported by Khan et al [2], and Suhil Azmi et al [4], where tobacco and alcohol use were strongly linked to ischemic stroke. Through various mechanisms like endothelial dysfunction, atherosclerosis acceleration, and increased thrombogenicity, these lifestyle factors can increase stroke risk.

Using the National Institutes of Health Stroke Scale to measure stroke severity, it was found that most people had moderately severe stroke. Shrestha et al [1], and Khan et al [2], also gave similar reports that NIHSS can be used as a dependable tool for determining stroke severity and the ability to function post-stroke. Studies before this have continually indicated that those who score higher on NIHSS tend to have more mortality, disability, and also a lesser degree of functional restoration. So, it is a very valuable tool for assessing the condition when acute ischemic stroke occurs.

A major discovery of the current research was that the serum calcium levels, after correction for relevant factors, and infarct size were significantly negatively correlated. In fact, Ovbiagele et al [7], and Nayak RR et al [8], have reported the same findings. By means of their studies, they highlighted that compromised serum calcium levels correlate with an increased infarct volume and bad

outcomes. Their rationale is that cerebral ischemia induces the deregulation of calcium channels and the excess of calcium ions leads to neuron damage which, in turn, reduces circulating calcium in cases of large infarctions.

Another aspect of the current study was that corrected serum calcium levels were inversely related to NIHSS score. Research by Ovbiagele et al [7], and Nayak RR et al [8], was in line with the present study as the researchers found that admission serum calcium levels were negatively related to neurological impairment and clinical outcome. The researchers, in fact, pointed out that serum calcium can be used as an indicator of stroke severity and clinical outcome due to its low cost and easy availability.

Conclusion

The present study demonstrated that acute ischemic stroke is a serious medical condition predominantly affecting middle-aged and elderly individuals. Males dominate the disease by a large margin. Hypertension was found to be the most frequent comorbidity, while alcohol consumption and smoking were major risk factors which could be modified.

The majority of patients had moderate stroke severity at presentation as indicated by the National Institutes of Health Stroke Scale (NIHSS). Statistical analysis showed a significant inverse correlation between corrected serum calcium and infarct size as well as NIHSS score, implying that lower serum calcium was linked to larger infarct volume and more severe neurological deficit. This research indicates that serum calcium could be a simple, cheap, and widely accessible biomarker for evaluating stroke severity and infarct burden in acute ischemic stroke. Proper identification and intervention of the risk factors that can be modified, primarily hypertension, diabetes, smoking, and alcohol, are key to lessening the stroke-associated morbidity and mortality.

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References

1. Shrestha S, Poudel RS, Khatriwada D, Thapa L. Stroke subtype, age, and baseline NIHSS score predict ischemic stroke outcomes at 3 months: a preliminary study from Central Nepal. *Journal of multidisciplinary healthcare*. 2015 Oct 1:443-8.
2. Khan MS, Ahmad S, Ghafoor B, Shah MH, Mumtaz H, Ahmad W, Banu R, Ahmad I, Iqbal J, Safi MI, Khan F. Inpatient assessment of the neurological outcome of acute stroke patients based on the National Institute of Health Stroke Scale (NIHSS). *Annals of Medicine and Surgery*. 2022 Oct 1;82.
3. Ding GY, Xu JH, He JH, Nie ZY. Clinical scoring model based on age, NIHSS, and stroke-history predicts outcome 3 months after acute ischemic stroke. *Frontiers in Neurology*. 2022 Aug 5;13:935150.
4. Suhil Azmi¹, J. N. Suresh Kumar², Y. Lakshmi Manasa³, Sk. Rahil ur Rehman¹, K. Gopal Krishna¹, B. Vamsi Nayak¹. (2026). Clinical Profile and Prescription Pattern in Acute Ischemic Stroke At A Tertiary Care Hospital. *World Journal of Pharmaceutical Research*, 15(10), 1115–1128.
5. Kurmi RN, Mandal L, Singh R, Chaudhary PK, Dhungana T, Lamichanne S, Bastola NR, Pokharel P. Stroke among Patients Admitted to a Tertiary Care Centre: A Descriptive Cross-sectional Study. *JNMA J Nepal Med Assoc*. 2023 Apr 1;61(260):305-309. doi: 10.31729/jnma.8075. PMID: 37208887; PMCID: PMC10089024.
6. Petty GW, Brown RD Jr, Whisnant JP, Sicks JD, O'Fallon WM, Wiebers DO. Ischemic stroke subtypes: a population-based study of functional outcome, survival, and recurrence. *Stroke*. 2000;31(5):1062-1068.
7. Ovbiagele B, Liebeskind DS, Starkman S, et al. Are elevated admission calcium levels associated with better outcomes after ischemic stroke? *Neurology*. 2006;67(1):170-173.
8. Nayak RR, Narayanaswamy S. Association of serum calcium levels with infarct volume and stroke scores in acute ischemic stroke patients: An observational study. *Caspian J Intern Med*. 2022 Fall;13(4):780-785. doi: 10.22088/cjim.13.4.779. PMID: 36420322; PMCID: PMC9659820.