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Original Research Article

Clinical Profile of Acute Ischemic Stroke with Reference to Patients with Abnormal Serum Calcium Levels

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Abstract:

Background: Acute ischemic stroke (AIS) is a major cause of mortality and long-term disability worldwide. Identification of simple and reliable biomarkers for assessing stroke severity is essential for early risk stratification. This study evaluated the clinical profile of AIS patients and investigated the association between corrected serum calcium levels and stroke severity.

Methods: A hospital-based cross-sectional observational study was conducted among 182 patients with first-ever acute ischemic stroke admitted to the Department of General Medicine, Jorhat Medical College and Hospital, Assam, between March 2023 and February 2024. Clinical characteristics, comorbidities, risk factors, radiological findings, and corrected serum calcium levels were recorded after obtaining informed consent and approval from ethics committee. Stroke severity was assessed using the National Institutes of Health Stroke Scale (NIHSS), and Pearson's correlation analysis was performed.

Results: The mean age was 57.9 ± 7.2 years, with male predominance (68.2%). Hypertension was the commonest comorbidity, while alcohol consumption and smoking were the predominant behavioral risk factors. Most patients had moderate stroke severity (45.0%). Corrected serum calcium showed a significant inverse correlation with NIHSS score ($r = -0.82$, $p = 0.003$), indicating that lower calcium levels were associated with greater neurological impairment.

Conclusion: Corrected serum calcium is a simple, inexpensive, and readily available biomarker that may aid in the early assessment of stroke severity in patients with acute ischemic stroke.

Keywords: Acute ischemic stroke, Corrected serum calcium, NIHSS, Stroke severity, Neurological deficit.
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Introduction

Stroke remains among the top reasons for death and disability worldwide and its management is still costing healthcare systems, patients and society, time and effort. About 85% of strokes are acute ischemic strokes (AIS) resulting from interruption of blood supply to a part of the brain.

Despite considerable advances in acute stroke management, ischemic stroke remains associated with significant neurological morbidity, functional impairment, and mortality. Early identification of reliable prognostic biomarkers that reflect stroke severity and predict clinical outcomes is therefore essential for improving patient management and prognosis [1]. Calcium is associated in pathophysiology of cerebral ischemia. When oxygen and nutrients are deprived during ischemia, the supply of ATP is exhausted and the ion pumps on the cell membrane start to fail causing neuron depolarization and a massive calcium ion influx. The calcium overload leads to the activation of cytotoxic pathways involving proteases, phospholipases, endonucleases, the generation of reactive oxygen species, mitochondrial dysfunction, and programmed cell death, that in the end causes permanent damage of the neuron. [2,3]

The role of calcium in brain damage caused by ischemia has led investigators to a growing recognition of the importance of serum calcium in

the assessment of the prognosis of patients with acute ischemic stroke. Several clinical studies have investigated the relationship between serum calcium levels and stroke severity, but the findings remain inconsistent. Several clinical studies have investigated the relationship between serum calcium and stroke severity, but the findings remain inconsistent. Buck et al. found that higher serum calcium levels upon admission to the hospital predicted less infarct size in diffusion-weighted MRI scans, which indicated that calcium is neuroprotective [4]. Similarly, Ovbiagele et al. noted that higher serum calcium levels at later stages independently predicted better functional recovery and greater independence after a stroke [2]. On the other hand, Zhang et al. reported that higher serum calcium concentrations were positively related to more severe strokes, greater cerebral infarct size, and worse functional recovery, indicating that the relationship between calcium metabolism and ischemic brain injury is still complex and incompletely understood. [1]

Recent studies conducted in India have confirmed the relationship between serum calcium and acute ischemic stroke. Prabhu et al., found that people who had low ionized calcium in their bloodstream got significantly worse scores when measured with NIH Stroke Scale and this meant that their neurological problemswere worse at presentation [3]. Similarly, Nayak and Narayanaswamy showed a marked negative association between both infarct volume and NIHSS scores on the one hand and serum ionized calcium levels on the other hand. This suggests that serum calcium would be a simple, cheap and readily available biomarker for predicting stroke severity/ prognosis [5].

Therefore, the present study was undertaken to evaluate the clinical profile of patients with acute ischemic stroke with particular reference to abnormal serum calcium levels. The study aimed to determine the association between serum calcium levels and demographic characteristics, clinical presentation, stroke severity, and radiological findings, thereby assessing its potential utility as an early prognostic biomarker in acute ischemic stroke.

Materials and Methods

The present study is a cross sectional and observational study has been carried out at the Department of General Medicine, Jorhat Medical College and Hospital (JMCH), Jorhat, Assam from March 2023 to February 2024.

Altogether, 182 consecutive patients aged 40 with a definite diagnosis of first episode stroke who presented within a period of 2 to 3 days after the onset of the symptoms and with low calcium levels in their blood were participants. The patients with haemorrhagic stroke, malignancy, pancreatitis, hepatic or renal disease, and calcium supplementation being used for osteoporosis or vitamin D deficiency were excluded. After obtaining informed consent and approval from ethics committee, patient details and laboratory data were collected with a pre designed study proforma. Stroke severity was estimated using National Institute of Strokes Stroke Scale (NIHSS). Laboratory tests were carried out which included complete blood picture, renal function tests, liver function test, fasting lipid profile, random blood sugar, thyroid stimulating hormone, serum electrolytes and serum calcium, with corrected serum calcium calculated when necessary. The data collection and entry were done using a Microsoft excel spreadsheet, and then the SPSS version 26 was used for analysis. The data on categorical variables were expressed in frequencies and percentages. The data on numerical variables were expressed as mean with standard deviation. Pearson correlation coefficient was used to determine the association (correlation) between serum calcium levels and other study variables the correlation coefficient was reported as well, and a P-value of <0.05 was considered statistically significant.

Results

A total of 182 patients with acute ischemic stroke were included in the present study. The demographic characteristics, clinical profile, risk factors, radiological findings, stroke severity, and correlation between corrected serum calcium levels and NIHSS score were analyzed.

Demographic details of the participants at baseline are shown in Table 1. The study population had an average age of 57.9 years with a standard deviation of 7.2 years. The majority of patients, 102 (56.0%), were between 51 to 60 years of age group followed by 61 to 70 years 56 (30.8%), 41 to 50 years 20 (11.0%), and > 70 years 4 (2.2%). 124 (68.2%) of the patients were male while 58 (31.8%) were female.

The comorbiditiesof the patients involved in the study, as well as their risk factors, have been presented in Table 2.

Out of comorbid conditions, majority of patients had hypertension 8(44.0%), followed by combination of hypertension, diabetes mellitus, and dyslipidaemia in 40 (22.0%) patients. Diabetes mellitus and the combination of hypertension, diabetes mellitus, hypothyroidism, were noted respectively in 22(12.0%) and 20 (11.0%) patients. Patients presented with history of heart disease in the presence of hypertension were 8 (4.6%), bronchial asthma 2 (1.0%), and 10 (5.4%) patients had no documented comorbid disease.

The clinical profile of the patients involved in the study presented in Table 3.

Concerning lifestyle risk factors, 80 (44.0%) of the respondents were drinking alcohol, followed by both alcohol drinking and smoking which was recorded in 62 (34.0%) patients. Only 18 (9.8 %) and 16 (8.7 %) patients respectively, showed tobacco chewing and obesity habits. Whereas, 6 (3.5%)had no risk factors that could be identified. The clinical profile of patients with acute ischemic stroke is shown in Table 3. The most common presenting complaint was left hemiparesis with deviation of the mouth to the right, observed in 65(35.7%) patients, followed by right hemiparesis with deviation of the mouth to the left 43(23.7%). Other common presentations included right hemiparesis with loss or disturbance of speech 23 (12.7%) and left hemiparesis with slurring of speech 22 (12.1%).

With regard to cranial nerve involvement, right upper motor neuron facial palsy was the most frequent finding 88 (48.4%), followed by left upper motor neuron facial palsy 61 (33.5%). No facial nerve palsy was observed in 24 (13.2%) patients, while lower motor neuron facial palsy and other cranial nerve involvement were relatively uncommon.

Radiological evaluation demonstrated that right corona radiata infarction was the most common imaging finding 43 (23.6%), followed closely by right frontotemporal infarction 40 (21.9%). Other commonly observed lesions included left corona radiata infarction and left fronto-temporo-parietal infarction 22 (12.1%) each, whereas pontine, cerebellar, bilateral thalamic, and chronic lacunar infarcts were less frequently encountered.

Assessment of stroke severity using the National Institutes of Health Stroke Scale (NIHSS) revealed that moderate stroke (NIHSS 5 to 15) was the predominant category, accounting for 82 (45.0%) patients, followed by moderate to severe stroke 55 (30.3%) and mild stroke 39 (21.4%). Only 6 (3.3%) patients presented with severe stroke. The overall mean NIHSS score was 11.7 ± 7.2, indicating moderate neurological impairment in the study population.

The correlation between corrected serum calcium and NIHSS score is presented in Table 4. Pearson's correlation analysis demonstrated a strong negative correlation between corrected serum calcium level and NIHSS score ($r = -0.82$), which was statistically significant ($p = 0.003$). These findings indicate that lower corrected serum calcium levels were associated with greater neurological deficit and increased stroke severity among patients with acute ischemic stroke.

Table 1: Baseline demographic characteristics of the study participants (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
Mean ± SD		57.9 ± 7.2	
Sex	Male	124	68.2
	Female	58	31.8

Table 2: Clinical characteristics and risk factors of the study participants (N = 182).

Parameter	Variable	Number of patients (N)	Percentage (%)
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
	Bronchial Asthma	2	1.0
	None	10	5.4
Risk factors	Alcohol consumption	80	44.0
	Alcohol + Smoking	62	34.0
	Tobacco chewing	18	9.8
	Obesity	16	8.7
	None	6	3.5

Table 3: Clinical profile of acute ischemic stroke (N = 182).

Variable	Number (n)	Percentage (%)
Clinical presentation		
Left hemiparesis with deviation of mouth to the right	65	35.7
Right hemiparesis with deviation of mouth to the left	43	23.7
Left hemiparesis with slurring of speech	22	12.1
Right hemiparesis with loss/disturbance of speech	23	12.7
Weakness of right upper and lower limbs	7	3.9
Weakness of left upper and lower limbs	2	1.1
Facial nerve involvement		
Right upper motor neuron facial palsy	88	48.4
Left upper motor neuron facial palsy	61	33.5
No facial nerve palsy	24	13.2
Left lower motor neuron facial palsy	4	2.2
Right lower motor neuron facial palsy	3	1.6
Other cranial nerve involvement	2	1.1
Radiological finding		
Right corona radiata (CG) infarct	43	23.6
Right frontotemporal infarct	40	21.9
Left corona radiata (CG) infarct	22	12.1
Left fronto-temporo-parietal infarct	22	12.1
Right fronto-temporo-parietal infarct	19	10.4
Left frontotemporal infarct	18	9.9
Left middle cerebral artery (MCA) infarct	6	3.3
Left pontine infarct	4	2.2
Bilateral thalamic infarct with posterior circulation stroke	4	2.2
Acute left corona radiata infarct with chronic multiple lacunar infarcts	2	1.1
Right cerebellar infarct	2	1.1
Stroke severity (NIHSS)		
Mild (0 to 4)	39	21.4
Moderate (5 to 15)	82	45.0
Moderate to Severe (16 to 20)	55	30.3
Severe (21 to 42)	6	3.3
Mean NIHSS ± SD	11.7 ± 7.2	

Table 4: Correlation between NIHSS and corrected calcium level.

	Corrected Serum Calcium(mg/dl)	
	Pearson Correlation (r) value	**P value**
NIHSS score	-0.82	0.003*

Discussion

The present hospital-based cross-sectional study evaluated the clinical profile of patients with acute ischemic stroke and investigated the relationship between corrected serum calcium levels and stroke severity assessed using the National Institutes of Health Stroke Scale (NIHSS).

The study demonstrated that acute ischemic stroke predominantly affected middle-aged and elderly individuals, with a marked male predominance. Hypertension emerged as the most common comorbidity, whereas alcohol consumption and smoking were the principal behavioral risk factors. Furthermore, corrected serum calcium levels showed a significant inverse correlation with NIHSS score, suggesting that lower serum calcium levels were associated with more severe neurological deficits.

Mean age of the patients was 57.9 ± 7.2 years. Half of the patients were from 51 to 60 years age group. Similar findings were reported by Shrestha et al [6], found that more than halfway of ischemic strokes were among people over 50 years of age. In the same context, Kurmi RN et al [7], stated that the elderly formed the largest part of the patient population of ischemic stroke in a referral centre from Nepal. Degeneration of the arteries due to age, high occurrence levels of hypertension, diabetes, dyslipidemia, and atherosclerosis are well-known factors that increase the risk of ischaemic stroke among older adults.

In our study, a majority of the participants were male 68.2%. These findings are in line with earlier studies which indicated a greater number of males among ischemic stroke patients. Khan MS et al [8], that found male patients with acute ischemic

strokes constituted almost two-thirds of the study population. Similarly, P. S. K. Suhil Azmi et al [9], in their study at the tertiary care level also reported a high prevalence of male patients. The main reason behind the relatively higher number of males was their greater exposure to modifiable vascular risk factors such as smoking, alcohol, occupational stress and being sick with a cardiac illness. On the other hand, estrogen which acts as a protector is present in the premenopausal period which explains the comparatively smaller proportion of stroke patients are women. Hypertension was identified as the most common co-morbid disease with 44.0% being diagnosed with this disease. Such results were obtained by different researchers including Shrestha et al [6], Khan MS et al [8], and Petty et al [10], who all agreed on hypertension being the main modifiable stroke risk factor. Prolonged exposure to high BP can cause the inner lining of blood vessels to malfunction, lead to development of atheromatous plaques, as well as damage the small blood vessels of the brain that makes someone more susceptible to stroke. Besides having hypertension with a very high percentage of patients also suffering from type 2 diabetes mellitus and dyslipidemia, the presence of such diseases even more confirms the notion of metabolic syndromes contributing to the cerebrovascular risk.

Concerning lifestyle choices of patient's alcohol alone drinking (44.0%) as well as alcohol with smoking (34.0%) ranked as the most common risk factors. Similar to this, Khan MS et al8., along with P. S. K. Suhil Azmi et al [9], in their study showed that tobacco and alcohol combined use greatly raise the risk of stroke due to brain tissue getting insufficient supply of blood. These two factors have a detrimental effect on the health of blood vessels, cause oxidative stress, and activate platelets and speed up the formation of atheroma, all that leads to cerebral ischemia.

In our study, the most noticeable symptoms seen by the doctors were patients who had weakness on their left side and also their face was turned right side, followed by a case when patients had weakness on their right side and also their face was turned left side. Facial expression weakness caused by upper motor neuron was mainly seen on the right side.

These results show that strokes mainly occur in the area supplied by the middle cerebral artery, usually present with motor weakness on the opposite side of the brain and facial nerve involvement. Such clinical patterns have been reported by hospital-based studies evaluating the clinical spectrum of acute ischemic stroke. Radiologically, the most common lesions seen were corona radiata infarction of the right side and frontotemporal infarction of the right.

Stroke severity assessment showed that the majority was with moderate severity (68 patients; 45%) with mean NIHSSI 11.7 ± 7.2. These findings are close to those of Shrestha et al [6], who showed that the most common NIHSS scores upon arrival (the first hour of stroke) were moderate ones and they were also significantly correlated with functional outcomes. Likewise, Ding et al [11], showed that NIHSS scores at admission could predict independently recovery of neurological functions and 3-month functional outcome after acute ischemic stroke. NIHSS is still one of the most used reliable, and validated neurological assessment tools for prognosis and prediction patients' outcomes.

One of the main results derived from the study is that corrected serum calcium levels are strongly negatively correlated with NIHSS score (r =, 0.82, p = 0.003). It was found that patients who had lower corrected serum calcium levels displayed neurological deficits which were more profound when admitted. This is consistent with what was found later by Ovbiagele et al [2], that those patients with higher levels of serum calcium upon admission have better neurological outcomes. In a similar manner, Nayak RR et al [5], found that there was a significant negative correlation between serum calcium concentration, infarct volume, and NIHSS score, and they suggested that hypocalcemia could reflect a more serious cerebral damage.

There may be various reasons that explain this association such as calcium homeostasis changes during cerebral ischemia. Experimental evidence shows that ischemic neuronal injury causes a huge intracellular calcium entry, primarily due to voltage-operated channels and, as secondary contributors, various calcium channels that are glutamate-receptor dependent. As calcium gets confined within the cells, the circulating serum calcium decreases. Hence, the more extended the infarction in the brain (as measured by the volume of dead brain tissue and its related stroke symptoms), the more calcium enters the damaged neuronal cells, serum calcium decreases more and as a result, the patient's condition deteriorates more seriously.

Therefore, low serum calcium seems like a good indicator of severity of stroke, which is also affordable and easily accessible, as a biological marker at the early stages of an ischemic stroke. The advantages of this study are the use of corrected serum calcium values, standard NIHSS scoring, and clinical assessment of the patients who were admitted consecutively.

Certain drawbacks are worth mentioning nevertheless. As the research was carried out in a single medical centre and the method is that of

cross-sectional study, one cannot deduce causation between variables and the outcomes, and the long-term follow-ups were not investigated. Also, there is lack of serial serum calcium level determinations and infarct volume measurements through sophisticated neuroimaging techniques (such as MRI). Consequently, the findings require further validation through prospective multicenter studies with larger population sizes and longer-term follow-up periods to assess both the stroke severity and, ultimately, the patient's recovery potential. This would also allow us to explore whether serum calcium is a prognostic indicator in cases of acute ischemic strokes.

Conclusion

The present study demonstrated that acute ischemic stroke predominantly affected middle-aged and elderly males, with hypertension, alcohol consumption, and smoking being the major risk factors. Corrected serum calcium levels showed a significant inverse correlation with NIHSS score, indicating that lower calcium levels were associated with greater stroke severity. These findings suggest that corrected serum calcium may serve as a simple and cost-effective biomarker for early assessment of stroke severity. Further large-scale prospective studies are needed to validate its prognostic value.

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References

1. Zhang Y, Zhang G, Chen X. Elevated calcium after acute ischemic stroke predicts severity and prognosis. Molecular Neurobiology. 2024;61:266-275. DOI: https://doi.org/10.1007/s12035-023-03581-8
2. Ovbiagele B, Starkman S, Teal P, Lyden P, Kaste M, Davis SM, et al. Serum calcium as prognosticator in ischemic stroke. Stroke. 2008;39(8):2231-2236. DOI: 10.1161/STROKEAHA.107.513499
3. Vijay Prabhu SN, Tripathi BK, Agarwal Y, Kabi BC, Kumar R. Association of serum calcium levels with clinical severity of ischemic stroke at the time of admission as defined by NIHSS score: A cross-sectional, observational study. Journal of Family Medicine and Primary Care. 2022;11(10):6427-6432. DOI: 10.4103/jfmpc.jfmpc_1033_22
4. Buck BH, Liebeskind DS, Saver JL, Bang OY, Starkman S, Ali LK, et al. Association of higher serum calcium levels with smaller infarct volumes in acute ischemic stroke. Archives of Neurology. 2007;64(9):1287-1291. DOI:10.1001/archneur.64.9.1287
5. Nayak RR, Narayanaswamy S. Association of serum calcium levels with infarct volume and stroke scores in acute ischemic stroke patients: An observational study. Caspian Journal of Internal Medicine. 2022;13(4):780-785. DOI:10.22088/cjim.13.4.779
6. Shrestha S, Poudel RS, Khatiwada 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;8:443-448. DOI: 10.2147/JMDH.S90554.
7. Kurmi RN, Mandal L, Singh R, Chaudhary PK, Dhungana T, Lamichhane S, et al. Stroke among patients admitted to a tertiary care centre: A descriptive cross-sectional study. JNMA Journal of Nepal Medical Association. 2023;61(260):305-309. DOI: 10.31729/jnma.8075.
8. Khan MS, Ahmad S, Ghafoor B, Shah MH, Mumtaz H, Ahmad W, et al. 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;82:104690. DOI: 10.1097/MS9.0000000000001422.
9. Suhil Azmi PSK, Suresh Kumar JN, Lakshmi Manasa Y, Rahil ur Rehman SK, Gopal Krishna K, Vamsi Nayak B. Clinical profile and prescription pattern in acute ischemic stroke at a tertiary care hospital. World Journal of Pharmaceutical Research. 2026;15(10):1115-1128.
10. 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. DOI: 10.1161/01.STR.31.5.1062.
11. Ding GY, Xu JH, He JH, Nie ZY. Clinical scoring model based on age, NIHSS, and stroke history predicts outcome three months after acute ischemic stroke. Frontiers in Neurology. 2022;13:935150. DOI: 10.3389/fneur.2022.935150.