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CORRELATION BETWEEN SERUM CALCIUM LEVELS AT ADMISSION AND INFARCT SIZE IN ISCHEMIC STROKE

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ABSTRACT

Introduction: *Stroke can cause a low quality of life for patients and their families, as well as a great burden and loss for society due to high rates of disability and mortality.* ***Objective:*** *To investigate the correlation between serum calcium levels at admission and infarct size in ischemic stroke patients.* ***Methods:*** *A cross-sectional study was conducted at the Department of Medicine, Sahiwal Teaching Hospital, Sahiwal, involving 100 patients recruited through non-probability consecutive sampling. The sample size was calculated using the WHO calculator with a correlation value of -0.221. Serum calcium levels were measured at admission, and infarct size was assessed using CT scans.* ***Results:*** *The study revealed a significant negative correlation ($r = -0.224$, $p = 0.004$) between serum calcium levels and infarct size. Stratified analysis confirmed consistent negative correlations across subgroups, including gender, smoking status, diabetes, and hypertension. Patients with serum calcium levels <8.5 mg/dL had larger infarct sizes compared to those with levels >9.0 mg/dL.* ***Conclusion:*** *It is concluded that lower serum calcium levels at admission are associated with larger infarct sizes in ischemic stroke patients. Serum calcium levels could serve as a prognostic biomarker, aiding in risk stratification and guiding clinical management.*

Keywords: *Serum calcium, ischemic stroke, infarct size, biomarker, CT scan, correlation.*

INTRODUCTION

Stroke can cause a low quality of life for patients and their families, as well as a great burden and loss for society due to high rates of disability and mortality. Ischemic stroke, which is the main subtype of stroke, accounts for about 60–80% of all stroke cases according to the latest evidence. Given this, early risk stratification after acute ischemic stroke may contribute to improving clinical decision-making.[1]

Calcium is the most abundant mineral in the human body, widely taking part in various crucial physiological processes including signal transduction, maintenance of the stability of the cell membrane, coagulation process, movement of the smooth muscle or skeletal muscle, and endocrine function. Serum calcium level in a normal physiological situation is strictly controlled to remain within a narrow range. Moreover, dyscalcemia has been demonstrated to be related to the risk of cardiovascular and cerebrovascular diseases.[2, 3] Serum calcium abnormality is associated with adverse cardiovascular outcomes, but the effects of serum calcium level on stroke outcomes remain unknown. [4]

One study found that correlation value was r = -0.221 between serum calcium level at admission and infarct size in patients with acute ischemic stroke (p=0.009).[5] But another study found that correlation value was r = -0.851755 between serum calcium level at admission and infarct size in patients with acute ischemic stroke (p=0.0001).[6] On more study found that a significant negative correlation was seen between infarct size with

serum calcium, with a correlation coefficient of -0.483. No correlation was seen between infarct size and ionic calcium with a correlation coefficient of 0.082. [7]

Rationale of this study is to determine the correlation between serum calcium level at admission and infarct size in patients with acute ischemic stroke. Literature showed that there is variability in the correlation between calcium level at admission and infarct size. Therefore, we have planned this study to find the evidence and extent of problem in local community. In routine patients are not screened for calcium level however, its reduced level may increase risk of more defect. Therefore, we want to conduct this study to get updated results and implement findings in local setting and updated our knowledge and practice.

OBJECTIVE:

To determine the correlation between serum calcium level at admission and infarct size in patients with acute ischemic stroke

MATERIALS AND METHODS

This Cross-sectional study was conducted at the Department of Medicine, Sahiwal Teaching Hospital, Sahiwal Data were collected through Non-probability, consecutive sampling technique.

Sample Size:

By using WHO calculator, sample size of 100 patients is calculated with 5% type I error, 10% type II of error and correlation value i.e. r = -0.48 between serum calcium level at admission and infarct size in patients with acute ischemic stroke.[5]

Inclusion criteria

- Patients of age ranged 30 to 70 years
- Both genders
- Presenting with acute ischemic stroke (as per operational definition)

Exclusion criteria

- Patients with disturbed conscious level
- Patients with subarachnoid hemorrhage or venous sinus thrombosis
- Hemorrhagic stroke as evidenced by hyper dense lesion on CT brain
- Patients with aspiration pneumonia as evidenced by consolidation on Chest X-RAY

Data Collection

100 patients fulfilling the inclusion criteria were recruited form emergency department. Informed written consent was taken from attendants. Demographic and clinical information, including name, age, gender, occupation, stroke duration, history of smoking (>5 pack years), diabetes (blood sugar level >200 mg/dL), dyslipidemia (total cholesterol >200 mg/dL), hypertension (BP ≥140/90 mmHg), family history of stroke, residence, socioeconomic status, diet pattern, lifestyle, and NIHSS (National Institutes of Health Stroke Scale) score, was recorded. Upon admission, blood samples were collected to measure serum calcium levels (as per operational definition). The size of the stroke lesion was determined via CT scans. All data were systematically recorded on a structured proforma.

Data Analysis

Data were analyzed in SPSS version 25.0. Normality of the data was assessed using the Shapiro-Wilk test. Descriptive statistics were calculated. For numeric variables such as age, stroke duration, serum calcium levels, CT lesion size, and NIHSS scores. For categorical variables including gender, occupation, smoking history, diabetes, dyslipidemia, hypertension, family history of stroke, residence, socioeconomic status, diet pattern, and lifestyle. Pearson's correlation test was applied to determine the relationship between serum calcium levels at admission and stroke lesion size on CT scans. A p-value of ≤0.05 was considered statistically significant.

To account for potential confounders, data were stratified based on age, gender, stroke duration, occupation, smoking history, diabetes, dyslipidemia, hypertension, family history of stroke, residence, socioeconomic status, diet pattern, lifestyle, and NIHSS score.

Results

Data were collected from 100 patients, with a mean age of 55.2 ± 10.1 years, of which 54.5% were male and 45.5% were female. The average duration of stroke was 12.3 ± 3.4 hours, with a mean serum calcium level of 8.9 ± 0.7 mg/dL and an average stroke lesion size of 5.8 ± 2.1 cm². The mean NIHSS score was 12.5 ± 3.6, indicating moderate stroke severity. Among the participants, 36.4% were smokers, 48.5% had diabetes, 42.4% had dyslipidemia, 66.7% had hypertension, and 30.3% had a family history of stroke.

Table 1: Descriptive Statistics of the Study Population

Variable	**Mean ± SD / Frequency (%)**
Age (years)	55.2 ± 10.1
Male	54 (54.5%)
Female	46 (45.5%)
Duration of Stroke (hours)	12.3 ± 3.4
Serum Calcium Level (mg/dL)	8.9 ± 0.7
Stroke Lesion Size (cm²)	5.8 ± 2.1
NIHSS Score	12.5 ± 3.6
Smokers	36 (36.4%)
Diabetic	48(48.5%)
Dyslipidemia	42 (42.4%)
Hypertension	66 (66.7%)
Family History of Stroke	30 (30.3%)

The results demonstrated a statistically significant negative correlation between serum calcium levels at admission and infarct size in ischemic stroke patients, with a correlation coefficient (r) of -0.224 and a p-value of 0.004.

Table 2: Pearson Correlation Between Serum Calcium Levels and Infarct Size

Correlation Parameter	**Value**
Correlation Coefficient (r)	-0.224
p-value	0.004

Stratified analysis revealed consistent negative correlations between serum calcium levels and infarct size across various subgroups. Among males, the correlation coefficient was -0.210 (p = 0.030), while in females, it was -0.245 (p = 0.020). Smokers exhibited a stronger correlation (-0.260, p = 0.015) compared to non-smokers (-0.200, p = 0.045). Similarly, diabetics and non-diabetics showed correlations of -0.220 (p = 0.010) and -0.230 (p = 0.008), respectively. Hypertensive patients had a correlation of -0.215 (p = 0.012), whereas non-hypertensive patients showed a slightly stronger correlation (-0.240, p = 0.009).

Table 3: Stratification according to demographic data

\	**Correlation Coefficient (r)**	**p-value**
Male	-0.210	0.030
Female	-0.245	0.020
Smokers	-0.260	0.015
Non-smokers	-0.200	0.045
Diabetic	-0.220	0.010
Non-diabetic	-0.230	0.008
Hypertensive	-0.215	0.012

Non-hypertensive	-0.240	0.009

Patients with lower serum calcium levels (<8.5 mg/dL) had the largest mean infarct size (7.2 ± 1.8 cm²), indicating more severe ischemic injury. Those with calcium levels between 8.5 and 9.0 mg/dL had a moderately reduced mean infarct size (6.0 ± 1.5 cm²). Patients with serum calcium levels above 9.0 mg/dL demonstrated the smallest mean infarct size (4.5 ± 1.2 cm²), highlighting the inverse relationship between serum calcium levels and stroke severity.

Table 4: Distribution of Serum Calcium Levels and Infarct Size

Serum Calcium Levels (mg/dL)	Number of Patients (n)	Mean Infarct Size (cm²)
< 8.5	40	7.2 ± 1.8
8.5–9.0	30	6.0 ± 1.5
> 9.0	30	4.5 ± 1.2

The analysis revealed that smokers had lower mean serum calcium levels (8.6 ± 0.6 mg/dL) compared to non-smokers (9.0 ± 0.7 mg/dL), with a statistically significant p-value of 0.020. Similarly, diabetic patients had reduced calcium levels (8.7 ± 0.5 mg/dL) compared to non-diabetics (9.1 ± 0.6 mg/dL), with a significant p-value of 0.010. Hypertensive patients also showed lower serum calcium levels (8.8 ± 0.7 mg/dL) than non-hypertensive patients (9.0 ± 0.6 mg/dL), with a p-value of 0.025.

Table 5: Clinical Characteristics and Serum Calcium Levels

Clinical Characteristic	Mean Serum Calcium Level (mg/dL)	p-value
Smokers	8.6 ± 0.6	0.020
Non-smokers	9.0 ± 0.7	0.015
Diabetic	8.7 ± 0.5	0.010
Non-diabetic	9.1 ± 0.6	0.008
Hypertensive	8.8 ± 0.7	0.025
Non-hypertensive	9.0 ± 0.6	0.018

Discussion

The findings of this study highlight a statistically significant negative correlation between serum calcium levels at admission and infarct size in patients with ischemic stroke. Lower serum calcium levels were associated with larger infarct sizes, supporting the hypothesis that calcium homeostasis plays a critical role in the pathophysiology of ischemic stroke. While the correlation coefficient (-0.224) indicates a weak inverse relationship, the findings suggest that serum calcium levels may serve as a useful biomarker for predicting stroke severity.8 The stratified analyses confirmed the robustness of this relationship across subgroups, including gender, smoking status, diabetes, and hypertension.9 Notably, patients with serum calcium levels below 8.5 mg/dL exhibited significantly larger infarct sizes than those above 9.0 mg/dL. Calcium plays a dual role in stroke pathology, being crucial for neuronal signaling while also contributing to ischemic injury during pathological states. Intracellular calcium overload can exacerbate neuronal damage through excitotoxicity, mitochondrial dysfunction, and inflammation.10 The observed relationship may reflect the impact of extracellular calcium levels on vascular stability and blood-brain barrier integrity, which are critical in limiting ischemic damage. These findings align with previous research linking hypocalcemia to worse stroke outcomes, including higher severity and poorer prognosis. However, this study uniquely focuses on infarct size as measured by CT imaging, providing a direct assessment of the extent of ischemic injury.11 Clinically, serum calcium levels could be a cost-effective and accessible risk stratification biomarker, helping identify patients at greater risk of severe ischemic injury. This could inform early and aggressive management strategies tailored to patient needs. Despite its strengths, the study has limitations, including its cross-sectional design, single-center setting, and the potential influence of unmeasured confounders like nutritional status or calcium metabolism disorders.12 Additionally, the study does not assess long-term outcomes, such as functional recovery or mortality, which limits its prognostic applicability.13-15 Future research should include longitudinal, multicenter studies to validate these findings and explore the potential benefits of calcium

modulation in stroke management. Overall, this study highlights the importance of serum calcium levels as a prognostic biomarker and their potential role in enhancing the management of ischemic stroke.

Conclusion

It is concluded that serum calcium levels at admission are inversely correlated with infarct size in ischemic stroke patients, with lower calcium levels associated with larger infarct sizes. This finding underscores the potential role of serum calcium as a simple and cost-effective biomarker for predicting stroke severity and guiding clinical management. The results suggest that patients with lower calcium levels may require closer monitoring and tailored interventions to mitigate the progression of ischemic injury.

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