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PROGNOSTIC ROLE OF SERUM ALBUMIN AND CORRECTED CALCIUM IN ACUTE ISCHEMIC STROKE: A HOSPITAL-BASED CROSS-SECTIONAL STUDY

Internal Medicine

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ABSTRACT

Background: Stroke remains the second leading cause of mortality worldwide and a major contributor to long-term disability. Identifying reliable biochemical prognostic markers may help in risk stratification and management. Serum albumin and corrected calcium have been proposed as predictors of outcome in acute ischemic stroke. **Aims:** To evaluate the association of serum albumin and corrected calcium levels with stroke severity and functional outcomes at discharge. **Methods:** A hospital-based cross-sectional study was conducted on 100 acute ischemic stroke patients admitted within 48 hours of symptom onset. Stroke severity was assessed with the NIH Stroke Scale (NIHSS) at admission, and functional outcomes were measured with the modified Rankin Scale (mRS) at discharge. Serum calcium, corrected calcium, and serum albumin levels were measured, along with lipid profile and blood glucose. Data were analysed using chi-square test, t-test, and ANOVA. **Results:** The mean age of participants was 65 ± 15.91 years; 60% were male. Hypocalcemia (<8.5 mg/dl) was found in 81% of patients and hypoalbuminemia (<3.5 g/dl) in 75%. Severe stroke (NIHSS >21) was associated with lower serum calcium (6.72 ± 0.63 mg/dl) and albumin (1.92 ± 0.63 g/dl) compared to minor stroke ($p<0.0001$). Poor outcomes (mRS ≥5) showed significantly reduced albumin (2.34 ± 0.35 g/dl) and corrected calcium (7.47 ± 0.48 mg/dl). **Conclusion:** Serum albumin and corrected calcium are simple, cost-effective prognostic biomarkers in acute ischemic stroke. Their routine measurement may aid in predicting severity and outcomes.

KEYWORDS

Acute Ischemic Stroke, Serum Albumin, Corrected Calcium, NIHSS, mRS, Prognosis.

INTRODUCTION

Stroke is one of the leading causes of morbidity and mortality globally. According to the World Health Organization (WHO), approximately 15 million people suffer a stroke each year, of which nearly 5 million die and another 5 million are left permanently disabled. In India, stroke incidence is rising, largely due to the increasing prevalence of risk factors such as hypertension, diabetes mellitus, dyslipidemia, smoking, and sedentary lifestyles.

Acute ischemic stroke, which accounts for about 80% of all strokes, results from obstruction of blood flow to a part of the brain, leading to ischemia and subsequent infarction. The prognosis of stroke depends on multiple factors including the site of lesion, size of infarct, comorbidities, and timely initiation of treatment. Early prognostic indicators are crucial to guide clinical decision-making and resource allocation.

The National Institutes of Health Stroke Scale (NIHSS) is a standardized tool used to assess the severity of neurological impairment in stroke patients. It categorizes strokes into minor (0–4), moderate (5–15), moderate to severe (16–20), and severe (21–42). Functional outcome at discharge is commonly assessed using the modified Rankin Scale (mRS), which ranges from 0 (no symptoms) to 6 (death).

Biochemical parameters have recently gained attention as potential prognostic markers. Among these, serum calcium and albumin stand out. Calcium plays a critical role in neuronal excitotoxicity, and disturbances in calcium homeostasis may worsen ischemic injury. Albumin, a multifunctional plasma protein, exerts neuroprotective effects through antioxidant, anti-inflammatory, and anticoagulant mechanisms. Low serum albumin has been consistently associated with poor outcomes in stroke.

Previous studies, such as those by Chung et al. and Subramanyam et al., have demonstrated a correlation between low serum albumin and adverse stroke outcomes. Similarly, alterations in calcium levels have been linked with stroke severity and mortality. However, data from the Indian population remain limited. This study was conducted to assess the prognostic role of serum albumin and corrected calcium in acute ischemic stroke patients admitted to a tertiary care hospital.

MATERIALS AND METHODS

This was a hospital-based cross-sectional study conducted at the Department of General Medicine, Navodaya Medical College Hospital & Research Centre, Raichur. A total of 100 patients admitted from January 2024 to December 2024 with acute ischemic stroke presenting within 48 hours of onset were included.

Inclusion Criteria

Age >18 years, Clinically and radiologically confirmed ischemic stroke, Presentation within 48 hours of symptom onset.

Exclusion Criteria

Hemorrhagic stroke, Chronic kidney disease, chronic liver disease, or malignancy, Patients on calcium or albumin supplementation.

Data Collection

Detailed clinical history, including age, sex, risk factors, and comorbidities, was obtained. Stroke severity was assessed using NIHSS at admission, and functional outcome was measured using mRS at discharge.

Investigations

Venous blood samples were analysed for serum calcium, corrected calcium (adjusted for albumin), serum albumin, lipid profile, and random blood glucose. CT brain was used for confirmation of ischemic stroke.

Statistical Analysis

Continuous variables were expressed as mean ± SD and categorical variables as percentages. Associations were tested using chi-square, t-test, and ANOVA. A p-value <0.05 was considered statistically significant.

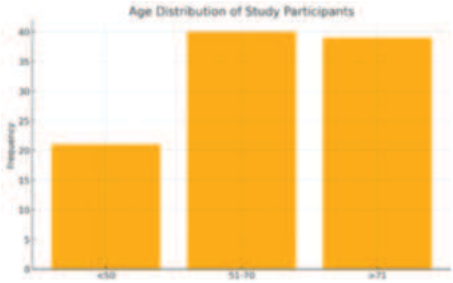
Ethical clearance was obtained from the institutional ethics committee, and informed consent was obtained from all patients or their attendants.

RESULTS

A total of 100 acute ischemic stroke patients were included in the study. The mean age was 65 ± 15.91 years, with 39% aged above 71 years, 21% below 50 years, and the remaining distributed between 51–70 years. Males comprised 60% and females 40% of the cohort.

Table 1: Age and Gender Distribution of Study Participants.

Age Group (years)	Frequency	Percentage
<50	21	21%
51-70	40	40%
>71	39	39%

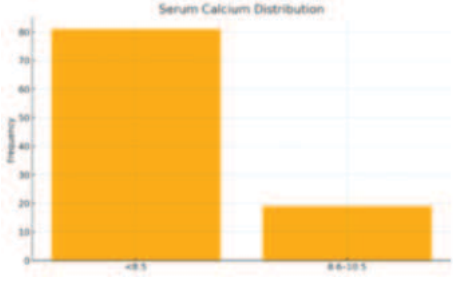


Graph 1: Age Distribution of Study Participants.

Biochemical analysis revealed that 81% had hypocalcaemia (<8.5 mg/dl), with a mean serum calcium of 7.59 ± 1.13 mg/dl and corrected calcium of 7.94 ± 1.06 mg/dl. Hypoalbuminemia (<3.5 g/dl) was observed in 75% of cases, with a mean serum albumin of 2.77 ± 1.10 g/dl. Dyslipidemia was frequent: total cholesterol was elevated (>240 mg/dl) in 52% with a mean of 244.41 ± 45.25 mg/dl, triglycerides were raised (>200 mg/dl) in 37% with a mean of 188.06 ± 48.47 mg/dl, and LDL was high (>160 mg/dl) in 59% with a mean of 172.83 ± 48.25 mg/dl. HDL levels were <40 mg/dl in 67% (mean 33.96 ± 12.48 mg/dl).

Table 2: Distribution of Serum Calcium Levels.

Serum Calcium (mg/dl)	Frequency	Percentage
<8.5	81	81%
8.6–10.5	19	19%



Graph 2: Distribution of Serum Calcium Levels.

Glycaemic status showed that 77% had fasting blood sugar (FBS) >125 mg/dl (mean 165.16 ± 43.85 mg/dl), while 79% had post-prandial blood sugar (PPBS) >200 mg/dl (mean 263.59 ± 62.12 mg/dl). HbA1c was >6.5% in 76% of patients, with a mean of 7.73 ± 1.46%. Renal parameters showed mean serum urea 53.58 ± 17.84 mg/dl and creatinine 1.72 ± 0.91 mg/dl. Urine albumin was present in 70%, with 16% showing 4+ and 17% showing 3+.

Table 3: Distribution of Serum Albumin Levels.

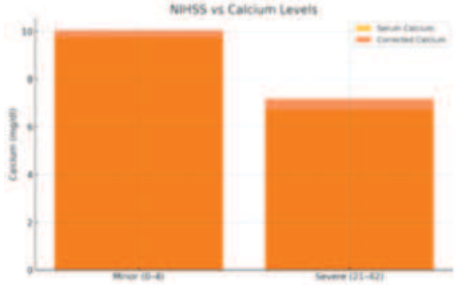
Serum Albumin (g/dl)	Frequency	Percentage
<3.5	75	75%
3.5–5.5	25	25%

Graph 3: Distribution of Serum Albumin Levels.

Neurological scoring at admission revealed that 52% had severe stroke (NIHSS 21–42), 14% moderate-severe, 26% moderate, and 8% minor, with a mean NIHSS score of 22.08 ± 12.73. At discharge, functional outcome by mRS showed that 30% died (score 6), 21% were severely disabled (score 5), and only 7% had no symptoms (score 0). The mean mRS score was 3.96 ± 1.96.

Table 4: Association Between NIHSS Score and Calcium Levels.

NIHSS Category	Serum Calcium (Mean±SD)	Corrected Calcium (Mean±SD)
Minor (0–4)	9.75 ± 0.23	10.05 ± 0.23
Severe (21–42)	6.72 ± 0.63	7.16 ± 0.62



Graph 4: Association Between NIHSS and Calcium Levels.

Association analysis demonstrated that increasing NIHSS scores correlated with progressively lower calcium (9.75 mg/dl in minor vs. 6.72 mg/dl in severe, p<0.0001), corrected calcium (10.05 vs. 7.16 mg/dl, p<0.0001), and albumin levels (4.85 g/dl vs. 1.92 g/dl, p<0.0001). Similarly, severe stroke was associated with worse lipid profiles (higher cholesterol, triglycerides, LDL, and lower HDL; p<0.0001) and higher glycaemic indices (FBS, PPBS, HbA1c; p<0.0001).

Table 5: Association Between NIHSS Score and Serum Albumin.

NIHSS Category	Serum Albumin (Mean±SD)
Minor (0–4)	4.85 ± 0.23
Severe (21–42)	1.92 ± 0.63

At discharge, higher mRS scores were linked with significantly lower calcium, corrected calcium, and serum albumin (p<0.0001). A strong positive correlation was also noted between NIHSS and mRS scores, confirming both as reliable predictors of severity and outcome in acute ischemic stroke.

Table 6: Association Between mRS Score and Calcium Levels.

mRS Score	Serum Calcium (Mean±SD)	Corrected Calcium (Mean±SD)
0	9.80 ± 0.20	10.10 ± 0.20
6	6.40 ± 0.59	6.93 ± 0.60

DISCUSSION

This study demonstrates that low serum albumin and corrected calcium levels are significantly associated with higher stroke severity and poorer outcomes. The majority of patients had hypocalcaemia and hypoalbuminemia at admission. Severe strokes (NIHSS >21) and poor functional outcomes (mRS ≥5) were strongly correlated with reduced calcium and albumin.

Our findings are consistent with earlier studies. Chung et al. reported that hypoalbuminemia was associated with increased mortality in ischemic stroke. Similarly, Subramanyam et al. found that low albumin predicted poor short-term outcomes. The Bergen Stroke Study also highlighted albumin as an independent predictor of outcome.

The role of calcium in stroke is linked to neuronal injury mechanisms. Calcium influx triggers excitotoxicity, oxidative stress, and apoptosis. Low systemic calcium may reflect disrupted calcium homeostasis, which worsens neuronal damage. Albumin, on the other hand, exerts antioxidant and anti-inflammatory effects, scavenges free radicals, and prevents endothelial dysfunction. Its deficiency deprives the brain of these protective effects.

This study also showed that dyslipidemia and hyperglycaemia were frequent comorbidities, contributing to stroke risk. However, their associations with severity were weaker compared to calcium and albumin.

Strengths

Focus on simple, cost-effective biomarkers, Prospective evaluation with validated stroke scales

Limitations

Single-centre study with modest sample size, Short follow-up limited to discharge outcomes, Did not evaluate long-term prognosis.

Future multicentre studies with larger cohorts and extended follow-up are needed to validate these findings and explore therapeutic implications.

CONCLUSION

Our study demonstrates that acute ischemic stroke was more prevalent among elderly patients and males, with the majority presenting with reduced serum calcium and albumin levels alongside elevated lipid and blood sugar parameters. Stroke severity at admission, assessed by NIHSS, showed a strong association with biochemical derangements: patients with severe strokes had significantly lower corrected calcium and albumin levels and higher lipid and glucose levels compared to those with milder strokes.

At discharge, poor functional outcomes and mortality, as reflected by higher mRS scores, were consistently associated with decreased serum albumin and corrected calcium. These findings suggest that both parameters serve as simple, cost-effective, and reliable prognostic indicators for predicting stroke severity and short-term outcomes.

Routine measurement of serum albumin and corrected calcium in acute ischemic stroke patients may aid in early risk stratification, timely intervention, and better allocation of healthcare resources. Larger multicentre studies with long-term follow-up are warranted to further validate their prognostic role.

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