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Original Research Article

CORRELATION OF SERUM ELECETROLYTE LEVELS WITH THE TYPE OF STROKE IN THE EMERGENCY DEPARTMENT

B. Satyavathi Sadhana[1], B S S S Sagarika[2], A Venkata Suresh[3], Archana. A. Dharwadkar[4], Praveena S[5]

[1]Post Graduate, Department of Biochemistry, Kamineni Academy of Medical Sciences and Research Centre, L.B.Nagar, Hyderabad, India.
[2]Post graduate, Department of General Medicine, Maharajah's Institute of Medical Sciences, Vizianagaram, Andhra Pradesh, India.
[3]Associate Professor, Department of Community Medicine, GVP Institute of Health Care & Medical Technology, Vishakhapatnam, India.
[4]Professor and HOD, Department of Biochemistry, Kamineni Academy of Medical Sciences and Research Centre, L.B.Nagar, Hyderabad, India.
[5]Professor, Department of Biochemistry, Kamineni Academy of Medical Sciences and Research Centre, L.B.Nagar, Hyderabad, India.

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Corresponding Author:
Dr. B.S.S.S.Sagarika.,
Post graduate, Department of General Medicine, Maharajah's Institute of Medical Sciences, Vizianagaram, Andhra Pradesh, India.
Email: drsadhana1990@gmail.com

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ABSTRACT

Background: Stroke is a leading cause of disability and death, with a high burden in South Asia. Electrolyte imbalances, such as hyponatremia and hypokalemia, are common in stroke patients and can worsen outcomes. This study evaluated serum sodium and potassium levels in stroke patients compared to controls.

Materials and Methods: A cross-sectional study was conducted on 200 participants, including 100 stroke patients (50 ischemic, 50 hemorrhagic) and 100 controls. Stroke types were diagnosed via CT or MRI scans. Serum electrolytes were analyzed statistically, with a significance level of $p < 0.05$.

Results: Sodium levels were higher in stroke patients (146.03 mEq/L) than controls (138.88 mEq/L, $p = 0.001$). Potassium levels were lower in stroke patients (3.79 mmol/L) than controls (4.28 mmol/L, $p = 0.001$). Hemorrhagic stroke patients had higher sodium levels (149.26 mEq/L) than ischemic patients (142.80 mEq/L, $p = 0.001$). Potassium and chloride showed no significant differences between stroke types.

Conclusion: Elevated sodium and reduced potassium levels were significant in stroke patients and varied by stroke type. Early detection and correction of these imbalances are critical for improving outcomes.

Keywords: Stroke, Electrolyte Imbalance, Sodium, Potassium, Ischemic Stroke, Hemorrhagic Stroke.

INTRODUCTION

The WHO reports 85% stroke mortality in underdeveloped nations.[1] Over the past 30 years, western stroke rates have fallen. South Asian countries including India, Pakistan, Bangladesh, and Sri Lanka are anticipated to have a higher illness burden.[2] Stroke or cerebrovascular accident is a sudden, non-convulsive localised neurological impairment caused by brain ischemia or haemorrhage. CVA is the most disabling neurological illness and the third greatest cause of mortality.[3] Acute ischemic stroke patients can have metabolic issues, including electrolyte abnormalities. If not addressed promptly, it has the potential to result in patient mortality. The most prevalent electrolyte abnormalities in acute stroke patients are sodium and potassium balance problems.[4]

The INTERSALT study has shown that in CVA patients there is increased renal excretion of various cations and this also contributes to the serum electrolyte disturbances.[5] Mild hypo or hypernatremia may be auto reversible but may cause death in severe conditions. Common complications after acute stroke include neurological complications like recurrent stroke and seizures and medical complications like chest infection, UTI, bowel or bladder dysfunction, deep vein thrombosis, pulmonary embolism, upper gastrointestinal bleeding, aspiration, bedsores, falls, malnutrition6

Objectives: To assess serum sodium and serum potassium levels in patients with different types of CVA in comparison to a control group.

MATERIALS AND METHODS

A cross sectional study was conducted on 200 patients at Kamineni institute of medical sciences during July 2023 to January 2024. 100 patients are with common cold, urinary tract infection, low back pain, cluster and tension headache or migraine. 100 patients are with first ever cerebrovascular accidents including hemorrhagic CVA, ischemic CVA and transient ischemic attack. as diagnosed on contrast tomography (CT) scan of the head or magnetic resonance imaging (MRI) of the brain, were enrolled in the study. The biochemical analysis of the stroke patients was done. Data entry was done using M.S. Excel and statistically analysed using Statistical package for social sciences (SPSS Version 16) for M.S Windows. The difference in the two groups was tested for Statistical Significance using Parametric tests such as t-test and categorical variables tested by chi square test. P-value less than 0.05 considered to be statistically significant.

RESULTS

In this study, out of 200 study population; 50 patients are with ischaemic stroke, 50 patients are with hemorrhagic stroke and 100 are normal patients. Among males; ischemic stroke was present in 27.7% patients and Haemorrhagic stroke was present in 28.6% patients. Among females; ischemic stroke was present in 21% and haemorrhagic stroke was present in 19.8% patients. The association between them was found to be statistically not significant.

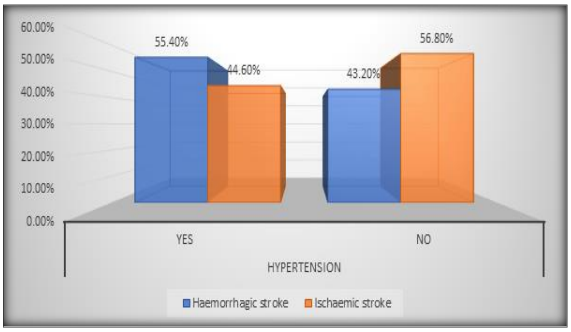

Figure 1: Distribution of stroke patients based on the presence of hypertension

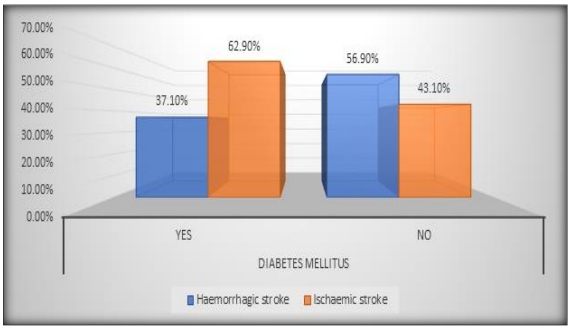

Figure 2: Distribution of stroke patients based on the presence of diabetes mellitus

Table 1: Distribution of patients based on the age group and diagnosis

			Diagnosis			Total
			Ischaemic stroke	Haemorrhagic stroke	Normal Patients	
Age Group	40-50 years	n	13	8	10	31
		%	41.9%	25.8%	32.3%	100.0%
	51-60 years	n	15	15	37	67
		%	22.4%	22.4%	55.2%	100.0%
	61-70 years	n	13	14	28	55
		%	23.6%	25.5%	50.9%	100.0%
	71-80 years	n	8	10	16	34
		%	23.5%	29.4%	47.1%	100.0%
	>81 years	n	1	3	9	13
		%	7.7%	23.1%	69.2%	100.0%
Total		n	50	50	100	200
		%	25.0%	25.0%	50.0%	100.0%

Table 2: Distribution of stroke patients based on the sodium, potassium and chloride levels

	Ischaemic stroke		Haemorrhagic stroke		T Test	P Value
	Mean	SD	Mean	SD		
Sodium (mEq/L)	142.80	5.73	149.26	5.54	-5.73	0.001
Potassium (mmol/L)	3.78	0.30	3.79	0.51	-0.11	0.90
Chloride (mEq/L)	99.66	1.73	99.62	1.49	0.12	0.90

Table 3: Distribution of stroke and normal patients based on the sodium, potassium and chloride levels

	Stroke Patients		Normal Patients		T Test	P Value
	Mean	SD	Mean	SD		
Sodium (mEq/L)	146.03	6.48	138.88	2.15	10.46	0.001
Potassium (mmol/L)	3.79	0.41	4.28	0.43	-8.15	0.001
Chloride (mEq/L)	99.64	1.61	99.81	1.45	-0.78	0.43

Table 4: Distribution of stroke and normal patients based on the Sodium to Potassium Ratio

	Stroke Patients		Normal Patients		T Test	P Value
	Mean	SD	Mean	SD		
Sodium to Potassium Ratio	38.93	4.20	32.74	3.42	11.43	0.001

DISCUSSION

Hyponatremia is the most common electrolyte imbalance in stroke and negatively impacts the mortality and functional outcome of stroke. Electrolyte imbalance adversely affects the stroke outcome with negative impacts on mortality and morbidity. To enhance the outcome of a stroke, electrolyte abnormalities must be identified early. Therefore, early electrolyte imbalance identification is crucial for preventing morbidity and mortality in acute stroke patients.

In this study, the highest prevalence of stroke (both ischemic and hemorrhagic) is observed in the 51-60 and 61-70 age groups, with each contributing to about 22-25% of the stroke cases. Normal patients are predominant in the 51-60 age group (55.2%). The proportion of normal patients increases significantly with age, accounting for 69.2% in individuals above 81 years. Overall, ischemic and hemorrhagic strokes contribute equally (25% each) across the study population. Sodium levels show a significant difference, with ischemic stroke patients having a mean of 142.80 mEq/L and hemorrhagic stroke patients having a higher mean of 149.26 mEq/L (P = 0.001). Potassium levels are almost identical (3.78 mmol/L for ischemic and 3.79 mmol/L for hemorrhagic stroke), showing no statistical significance (P = 0.90). Similarly, chloride levels are comparable between the two groups (99.66 mEq/L for ischemic and 99.62 mEq/L for hemorrhagic stroke), with no significant difference (P = 0.90). Differences in serum electrolyte levels between stroke patients (both ischemic and hemorrhagic combined) and normal individuals: Stroke patients showed significantly higher sodium levels (mean 146.03 mEq/L) compared to normal individuals (mean 138.88 mEq/L, P = 0.001). Conversely, potassium levels are significantly lower in stroke patients (mean 3.79 mmol/L) than in normal individuals (mean 4.28 mmol/L, P = 0.001). Chloride levels show no significant variation between the two groups (mean 99.64 mEq/L for stroke patients and 99.81 mEq/L for normal individuals, P = 0.43). Stroke patients had significantly higher sodium-to-potassium ratio (mean 38.93) compared to normal patients (mean 32.74, P = 0.001).

Javeed A et al,[7] conducted as a prospective observational study with 186 stroke patients, it assessed the prevalence and significance of electrolyte imbalances, including sodium, potassium, calcium, and magnesium, in ischemic stroke (ISCHS) and intracerebral hemorrhage (ICH). Hyponatremia was significantly more common in ICH (38.6%) compared to ISCHS (9.5%). The mean sodium levels in ISCHS patients were 137.4 ± 12.29 mEq/L, while in ICH patients, it was notably lower at 128.7 ± 14.71 mEq/L. The association between sodium levels and stroke type was statistically significant (P < 0.001). This highlights the role of sodium disturbances in differentiating between stroke types and their potential influence on outcomes. Potassium levels also showed significant variations. Hypokalemia was observed in 16.4% of ISCHS and 22.9% of ICH patients, with mean potassium levels being 3.79 ± 0.47 mmol/L in ISCHS and 3.53 ± 0.53 mmol/L in ICH patients (P < 0.024). This finding suggests a higher predisposition of ICH patients to potassium depletion, which could exacerbate stroke severity.

Kalyan M et al,[8] Conducted on 50 acute stroke patients at Dr. D.Y. Patil Medical College highlights critical differences in serum sodium, potassium, and chloride levels among ischemic and hemorrhagic stroke patients. They found that dyselectrolytemia was present in 50% of the stroke patients, with a statistically significant association between dyselectrolytemia and the type of stroke (P = 0.047). Among ischemic stroke patients, 62.9% had electrolyte disturbances compared to 34.7% in hemorrhagic stroke patients. This emphasizes the higher prevalence of electrolyte imbalances in ischemic stroke. Hyponatremia was more common in ischemic strokes (37%) compared to hemorrhagic strokes (26.1%), with a statistically significant difference (P = 0.048). Hypernatremia was less frequent, affecting 10% of the total stroke population. In ischemic stroke, 59.2% of patients had normal sodium levels, while 56.5% of hemorrhagic stroke patients maintained normal sodium levels. Potassium levels revealed hypokalemia in 22.2% of ischemic stroke patients and 43.5% of hemorrhagic stroke patients. Normal potassium levels were observed in 66.7% of ischemic and 52.2% of hemorrhagic stroke patients. Although differences were noted, the association between stroke type and potassium disturbances was not statistically significant (P > 0.05). Chloride levels showed no significant association with stroke types. Hypochloremia was observed in 21.7% of hemorrhagic and 11.1% of ischemic stroke patients, with normal chloride levels in 78.3% and 85.2% of hemorrhagic and ischemic strokes, respectively (P > 0.05).

Ahmed M et al,[9] investigated the prevalence of serum electrolyte imbalances in patients with acute ischemic and hemorrhagic strokes, highlighting their impact on morbidity and mortality. They conducted on 106 patients at Khairpur Medical College, emphasizes the significance of serum sodium and potassium levels as indicators of clinical outcomes. Hyponatremia was more prevalent in ischemic stroke patients compared to hemorrhagic stroke.

Among ischemic stroke patients (59 cases), 38 had hyponatremia, while 21 had normal sodium levels (136–148 mmol/L). In hemorrhagic stroke patients (47 cases), 21 had hyponatremia, and 26 had normal sodium levels. Hypokalemia was observed less frequently than hyponatremia but still played a significant role. Among ischemic stroke patients, hypokalemia was seen in 15 individuals, with potassium levels ranging between 2.3 to 3 mmol/L in 3 cases and 3 to 3.5 mmol/L in 12 cases. In hemorrhagic stroke patients, hypokalemia was identified in 9 cases, with potassium levels of 2.3 to 3 mmol/L in 3 cases and 3 to 3.5 mmol/L in 6 cases. Patients with hypokalemia were found to have poorer clinical outcomes due to its role in vascular tone regulation and free radical formation inhibition.

Hossain MF et al,[10] explored the occurrence, causes, and clinical implications of electrolyte imbalances in acute ischemic and hemorrhagic stroke patients in his review. Hyponatremia is the most frequently reported electrolyte abnormality, with studies noting its prevalence ranging from 15% to 39% in acute stroke patients. It is most commonly caused by syndrome of inappropriate antidiuretic hormone secretion (SIADH) and cerebral salt wasting syndrome (CSWS). Hyponatremia is associated with increased hospital stays, higher mortality, and worse functional outcomes. Patients with SIADH benefit from fluid restriction, while those with CSWS require salt and water supplementation. Hypokalemia is another common imbalance observed in acute stroke. Studies reported its prevalence in 18.7% of ischemic stroke patients and noted its association with increased infarct sizes, higher stroke severity, and poor functional outcomes. Conversely, hemorrhagic stroke patients demonstrated significantly higher potassium levels than ischemic stroke patients (6.27 ± 1.12 mmol/L vs. 4.31 ± 0.71 mmol/L, $P < 0.01$), highlighting the electrolyte differences between the stroke subtypes. Hypocalcemia was observed in 11.8% of ischemic stroke patients, and its presence was linked to a higher likelihood of hemorrhagic transformation.

Mansoor F et al,[11] investigated the prevalence and characteristics of electrolyte imbalances in ischemic and hemorrhagic strokes. Conducted at a tertiary care hospital in Pakistan, this descriptive cross-sectional study analyzed 300 stroke patients from December 2019 to March 2021. Hyponatremia was more prevalent in ischemic stroke patients than in those with hemorrhagic stroke. The mean serum sodium level was significantly lower in ischemic stroke patients (129.41 ± 3.12 mEq/L) compared to hemorrhagic stroke patients (134.42 ± 3.46 mEq/L, $P < 0.0001$). Hyperkalemia was more common in hemorrhagic stroke patients. The mean potassium level was significantly higher in hemorrhagic stroke (6.27 ± 1.12 mmol/L) compared to ischemic stroke (4.31 ± 0.71 mmol/L, $P < 0.0001$).

Wang A et al,[12] investigated the association between serum electrolyte levels and outcomes in stroke patients. Using data from 10,299 patients in the China National Stroke Registry III, the study evaluates the prognostic significance of potassium, sodium, chloride, and calcium levels in acute ischemic stroke (AIS) and transient ischemic attack (TIA). hypokalemia) were associated with poor functional outcomes (modified Rankin Scale [mRS] scores 3–6) and increased all-cause mortality at both 3 months and 1 year. Adjusted odds ratios for poor outcomes in patients with potassium levels in the lowest tertile were 1.33 at 1 year. Hyponatremia was strongly associated with poor functional outcomes and increased mortality. The adjusted odds ratio for poor functional outcomes at 1 year was 1.41 for patients in the lowest sodium tertile (<139.7 mmol/L). Low chloride levels were also linked to poor outcomes and higher mortality, with an adjusted odds ratio of 1.27 for poor functional outcomes at 1 year.

Siddiqui et al,[13] demonstrate that hyponatremia (32%) is the most common electrolyte abnormality with a statistical significance difference among types of stroke, but hypokalemia (19%) is statistically significant ($p<0.05$) and more common in hemorrhagic stroke. Headache (74%) is the most common symptom in patients with dyselectrolytemia followed by vomiting (73.4%), vertigo (42.8%), and seizure (2.85%). Studies conducted by Rodrigues et al. and Soiza et al. reported that patients with reduced Na levels or hyponatremia were more inclined toward stroke severity and risk for mortality.[14,15] On the other hand, other researches conducted by Christensen et al. and Farahmand et al. demonstrated that increased venous serum Na concentrations were associated with a higher incidence of stroke and worsening of the neurological conditions.[16,17]

CONCLUSION

Sodium levels were found to be higher among patients with stroke patients than normal patients and the association between them was found to be statistically significant. Potassium levels were found to be lower among patients with stroke patients than normal patients and the association between them was found to be statistically significant. Chloride levels did not show any significant difference when comparing between stroke patients and normal patients. Sodium to Potassium Ratio was found to be higher among patients with stroke patients than normal patients and the association between them was found to be statistically significant.

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