Original Article

Serum Sodium and Potassium Levels in Cerebro-vascular Accident Patients

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Abstract

***Background*: We aim to assess serum sodium and potassium levels in patients with different types of cerebro-vascular accidents (CVA) in comparison to control group.**

***Methods*: A comparative cross-sectional study conducted on patients admitted to the emergency department from January to August 2012. Control group consisted of patients admitted to emergency department due to common cold, urinary tract infection, low back pain, cluster, and tension headache or migraine. Serum sodium and potassium levels were measured via standard laboratory methods.**

***Results:* There were 77 patients in control group and 78 in CVA group. Forty nine patients from the CVA group had ischemic CVA, 11 had hemorrhagic CVA and 18 suffered a transient ischemic attack (TIA). Serum sodium level in control group was significantly lower than in patients with TIA, ischemic CVA, and hemorrhagic CVA ($P < 0.001$). Serum potassium level in control group was higher than patients with TIA, ischemic CVA, and hemorrhagic CVA ($P < 0.001$). Patients with hemorrhagic CVA showed significantly lower serum potassium level than patients with TIA and ischemic CVA ($P < 0.001$). Correspondingly, it was observed that serum sodium to potassium ratio was higher in patients with TIA, ischemic CVA, and hemorrhagic CVA ($P < 0.001$). In patients with hemorrhagic CVA serum sodium to potassium ratio was higher when compared to patients with TIA and ischemic CVA ($P < 0.001$).**

***Conclusion:* This study shows that higher serum sodium and lower serum potassium level may be associated with higher incidence of CVA. Further studies are paramount to elucidate the role of serum electrolyte levels in vascular events.**

Keywords: *cerebro-vascular accident, cross-sectional studies, emergencies, sodium, potassium*

Introduction

Cerebro-vascular accidents (CVA) cause significant impairments particularly in older age and are amongst the major health issues in several countries.

Previous studies have highlighted the role of serum electrolytes in vascular events. It has been shown that high dietary sodium intake is associated with increased risk of different types of cerebral vascular events (1,2). High sodium intake may increase the mortality of stroke as well as cardiovascular diseases (3). It has been previously shown that higher sodium intake is associated with incidence of congestive heart failure in overweight patients (4). Higher potassium excretion has been associated with a lower risk of CVA (3–5) and increased potassium intake is inversely related to mortality due to coronary artery disease (2).

Despite various studies on significance of dietary sodium and potassium intake in cerebral vascular events, the role of serum sodium and serum potassium level in these conditions is not well studied. In this case-controlled study, we aim to assess serum sodium and serum potassium levels in patients with different types of CVA in

comparison to a control group.

Materials & Methods

This is a comparative cross-sectional study including patients who had been admitted to emergency departments of two referral hospitals from January to August 2012.

We selected a representative case group from patients with the first-ever cerebro-vascular accidents including hemorrhagic CVA, ischemic CVA, and transient ischemic attack (TIA) who were aged more than 45 years old. CVA in participants was diagnosed according to clinical presentations suggestive of such events and was confirmed by brain computed tomography. Magnetic resonance imaging (MRI) was performed on patients with uncertain clinical diagnosis. TIA was defined according to American Heart Association/American Stroke Association criteria (6). Patients with hypertension, diabetes, or with serious comorbidities such as congestive heart disease, kidney or liver failure, hypernatremia or hyponatremia, hyperkalemia or hypokalemia were excluded from the study. Furthermore, patients who were using medications with an effect on Na^+ or K^+ metabolism including diuretics were also excluded.

The control group consisted of the same number of patients above an age of 45 years, who were admitted to the emergency departments of the same hospitals due to common cold, urinary tract infection, low back pain, cluster, and tension headache or migraine .

Five milliliters blood was collected from each patient on admission into the hospital. Sodium and potassium ion concentrations were measured by flame photometry and recorded via standard laboratory methods.

Data was presented as mean (standard deviation), unless otherwise specified. Comparisons of serum sodium and potassium concentrations among three patient groups and the control group were analyzed by one-way analysis of variance (ANOVA). The differences between continuous variables among case and control groups were analyzed by independent *t* test. Further analysis was performed with Bonferroni post-hoc test. *P* value of less than 0.05 was considered significant. All statistical calculations were performed with Statistical Package for the Social Sciences (SPSS) version 16.

Results

Of the total 155 participants, 77 (49.7%) comprised the control group and 78 of (50.3%) patients were recruited in case group. Mean age of the participants was 56.53, ranging from 45 to 84 with standard deviation of 11.06 years.

As seen in Table 1, no significant differences were observed between patients in CVA group and the control group, in terms of age ($P = 0.059$), weight ($P = 0.071$) and the frequency of gender of the participants ($P = 0.694$). Further post-hoc analysis revealed that patients with hemorrhagic CVA were significantly older than patients with TIA, ischemic CVA and control group ($P < 0.001$). Age of the participants among other groups did not differ significantly ($P > 0.05$).

Table 2 summarizes serum sodium and potassium levels as well as sodium to potassium ratios in control group and patients with TIA, ischemic CVA, and hemorrhagic CVA. Post-hoc analysis showed that serum sodium level in control group was significantly lower than patients with TIA ($P < 001$), ischemic CVA ($P < 001$), and hemorrhagic CVA ($P < 001$).

Table 1: Characteristics of the participants ($n = 155$)

	Patients with CVA								Control ($n = 77$)		*P* value
	Total ($n = 78$)		TIA ($n = 18$)		Ischemic CVA ($n = 49$)		Hemorrhagic CVA ($n = 11$)				
Sex											
Male, *n* (%)	45	(57.69)	11	(61.11)	27	(55.10)	7	(63.63)	42	(54.54)	0.694
Female, *n* (%)	33	(42.30)	7	(38.88)	22	(44.90)	4	(36.36)	35	(45.45)	
Age in years, mean (SD)	59.59	(11.09)	59.30	(11.25)	57.18	(10.65)	70.80	(4.50)	58.43	(10.19)	0.059
Weight in kg, mean (SD)	69.72	(7.19)	71.40	(4.63)	69.91	(7.62)	66.18	(8.00)	69.08	(7.23)	0.071

CVA: Cerebro Vascular Accident. Data derived from independent t test.

Serum potassium levels in the control group were higher than in patients with TIA, ischemic CVA, and hemorrhagic CVA ($P < 0.05$). Patients with hemorrhagic CVA showed significantly lower serum potassium levels when compared to the patients with TIA and ischemic CVA ($P < 0.001$ for both).

Correspondingly, it was observed that serum sodium to potassium ratio was higher in patients with CVA when compared to the control group ($P < 0.001$) and in patients with hemorrhagic CVA the ratio was higher in comparison to patients with TIA and ischemic CVA (both $P < 0.001$).

Discussion

To the best of our knowledge, this is the first study showing that the serum sodium level in patients with CVA is higher than in the control group and patients with CVA tend to have lower serum potassium level in comparison to control participants.

It has been previously shown that exchangeable sodium is increased in hypertensive participants and it is correlated with arterial pressure (7). Furthermore, it has been previously established that for an actual increase in brain volume to occur, additional fluid must be added to the brain's extracellular space. During permanent ischemia, blood sodium rapidly enters the extracellular fluid of the brain, leading to consequences of brain edema (8,9), therefore we postulate that higher serum sodium levels may be associated with higher risk and exacerbation of events following brain ischemia. In line with our findings, in a large cohort study, O'Donnell et al., have reported higher urinary sodium excretion, which is a valid reflection of dietary sodium intake, to be associated with a higher risk of different types of CVA. However, this study has also shown that less than 3 g per day sodium excretion is related with higher mortality following cerebrovascular events and longer hospitalization because of congestive heart failure (2). Previous studies also indicate that systolic but not diastolic blood pressure changes in concordance with the 24 hour urinary sodium excretion. However, only baseline 24-hour urinary sodium excretion is inversely associated with cardiovascular mortality (10). Evidence derived from studies such as Trials of Hypertension Prevention Collaborative Research Group indicate the association of a reduction in sodium intake with long-term reduction in CVA, suggesting a protective role of limiting dietary sodium intake in primary prevention of vascular events (11). However, in contrast to these findings a Cochrane systematic review of controlled trials on the role of reducing sodium intake did not show a significant difference in mortality and morbidity following CVA (12). Our findings further expand our knowledge by demonstrating a relationship between higher serum sodium level and cerebral vascular events, especially in hemorrhagic CVA.

Experimental studies on hypertensive animal models are suggestive of a protective role of potassium intake on vascular events (13,14). Furthermore, Khaw and Barrett-Connor first reported the protective effect of dietary potassium intake on risk of stroke (15). Ascherio et al., in large sample prospective study showed that higher intake of potassium is independently associated with reduced risk of stroke in hypertensive men (16). Fang et al., have previously shown that in black hypertensive patients, increased dietary potassium intake is associated with lower mortality from stroke. However, this association does not exist for white patients or participants who are normotensive (17). Similarly, O'Donnell

Table 2: Serum electrolytes of the participants ($n = 155$)

	TIA ($n = 18$)	Ischemic CVA ($n = 49$)	Hemorrhagic CVA ($n = 11$)	Control ($n = 77$)	*P* value
Na+ (mEq/L), mean (SD)	142.76 (1.90)	143.65 (2.29)	145.00 (1.54)	137.51 (2.65)	< 0.001
K+ (mEq/L), mean(SD)	3.99 (0.15)	3.88 (0.17)	3.46 (0.23)	4.54 (0.27)	< 0.001
Na+/K+ ratio, mean(SD)	35.76 (1.33)	37.03 (1.58)	41.98 (2.86)	30.38 (2.17)	< 0.001

CVA: Cerebro Vascular Accident. Data derived from one-way ANOVA test.

et al., discovered that higher potassium excretion is related with lower risk of CVA (2). It is previously established that high potassium intake causes a mild reduction in blood pressure of hypertensive patients (18,19). However, multiple adjustments for baseline blood pressure level are evidences of independent effect of potassium intake on risk of stroke, suggestive of other currently unknown effects of potassium which might lead to a reduction of risk of vascular events (20). Notably, inhibitions of free radical formation, arterial tone, and vascular smooth muscle proliferation have been proposed as such possible effects (21–24).

There are some limitations that should be considered in generalizing the findings of this study. First, this study has a comparative cross-sectional nature, therefore, no causal relationship can be drawn. Second, in this study we did not assess the role of some variables which may influence serum electrolyte levels such as participants' medical comorbidities, medications, and risk factors. Therefore higher serum sodium or lower serum potassium levels might not independently be associated with CVA.

Conclusion

This study shows that higher serum sodium levels and lower serum potassium levels may be associated with higher incidence of CVA. Further studies are paramount to elucidate the role of serum electrolyte levels in vascular events. This study helps in exploring serum electrolyte thresholds in which interventions for reducing dietary sodium and increasing dietary potassium intake may benefit the population at risk.

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Authors' Contribution

Conception and design: SF, BC
Analysis and interpretation of the data: RH
Drafting of the article: HBG
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