SERUM ELECTROLYTES AND CALCIUM STATUS IN NIGERIAN PATIENTS WITH ESSENTIAL HYPERTENSION

A. S. M. GIASUDDIN
C. O. ADESANYA
H. S. ISAH

SUMMARY : Serum electrolytes and calcium levels (mmol/L) were investigated in Nigerian patients with essential hypertension. The N_2^+ and Cl^- levels were within the normal ranges and no significant differences were observed between the control subjects and hypertensive patients. No significant difference was observed for serum Ca^{++} level also between the two groups of subjects. Mean serum K^+ level was significantly higher in patients compared to controls (5.4±0.8, 4.5±0.5, $p<0.01$), but it was not much different from the upper limit of the normal value for this population (5.0 mmol/L). The mean value of serum Mg^{++} level for the hypertensives was higher than that of the control subjects (0.84±0.04, 0.76±0.09, $p<0.01$). However, the mean levels of Mg^{++} in both the groups of subjects were within the normal range. These observations suggest that subclinical renal defects in handling K^+ and Mg^{++} may exist in these patients with essential hypertension..

Key Words: Hypertension, electrolytes, calcium, magnesium.

INTRODUCTION

Hypertension is regarded as a multi-factorial disorder in which a myriad of physiological mechanisms participate to elevate blood pressure (10,22). Many hypotheses were proposed in the past about the possible mechanisms of essential hypertension which are incompletely understood (4,18). Of the many factors, the question remains whether the kidney provides the causative mechanisms or bears the brunt of the vascular disease. The majority of patients with essential hypertension exhibit plasma renin activity within normal range (7). Most of them also have normal aldosterone secretion and normal renin-aldosterone relationships over a wide range of altered sodium balance (2). Although the supporting evidence about the association of essential hypertension with obvious renal disease is not very persuasive there remains the possibility that subtle renal defects, primary or secondary, may be involved. This subtle renal defect, may have considerable influence on electrolytes and water balance leading to hypertension. Also, considerable discrepancies exist in the reported studies related to blood electrolytes concentrations in hypertensive populations (9,10,23). Furthermore, in recent hypotheses regarding the pathogenesis of hypertension, calcium has been implicated as an important factor (1,12,16). We have, therefore, studied serum electrolytes and calcium in Nigerian patients with essential hypertension.

*From Departments of Immunology, Medicine and Chemical Pathology, Ahmadu Bello University, Zaria, Nigeria.

MATERIALS AND METHODS

Patients

There were 34 subjects who were divided into two groups. Group I (controls) consisted of 17 healthy normotensive subjects (8 males and 9 females), aged 20-59. Their mean age 43±12 years. In Group II there were 17 (7 males, 10 females) hypertensive patients, whose age ranged between 20 and 59 years (Mean age was 44±11 years). The hypertension appeared to be essential in all the patients, who were not previously treated. The duration of hypertension in these patients ranged from 1 month to 1 year. Physical examination revealed

Table 1: Blood pressure (BP) measurements of normotensive control subjects (Group I) and hypertensive patients (Group II).

	Group I (n=17)	Group II (n=17)	P value (Group I vs Group II)
Erect BP (Systolic)			
Range	104-140	150-220	<0.01
Mean±SD	123±9	181±21	
Erect BP (Diastolic)			
Range	70-90	110-150	<0.01
Mean±SD	81±7	125±12	
Supine BP (Systolic)			
Range	118-140	170-260	<0.01
Mean±SD	127±7	200±25	
Supine BP (Diastolic)			
Range	80-90	110-160	<0.01
Mean±SD	85±5	131±16	

BP: Blood pressure (mmHg), SD: Standard deviation, n: number of subjects

no underlying disease in any of the subjects. Blood pressure was recorded in the supine and erect positions using the mercury sphygmomanometer and phase 4 Korotkoff sound. The average of 3 separate readings in each subject was recorded.

Peripheral blood specimens

An aliquot of 10 ml venous blood was drawn by venipuncture from each individual and allowed to clott at room temperature for 1 hour. It was kept at 4ºC for another hour and then serum was separated by spinning the tubes at 1800 xg at 4ºC using a bench centrifuge (MES, Chilspin, England). Each serum specimen was immediately divided into various aliquots and were stored at -70ºC until used for assays.

Determination of serum electrolytes

Routine flame photometric technique (24) were followed to quantitate serum levels of sodium (Na^+) and potassium (K^+). Chloride (Cl^-) was estimated by the titrimetric method of Schales and Schales as described by Varley *et al.* (24).

Quantitation of Serum magnesium

Magnesium (mg^{++}) level in serum was determined by the titan yellow method of Farner as modified by Neil and Neely and described by Henry *et al.* (14).

Estimation of serum calcium

Serum total calcium level was measured spectrophotometrically by the method of Ferro and Ham (8). Each serum total calcium value was adjusted for its total protein concentration. Adjusted total calcium (ATC) was obtained from the following equation of Parfitt as modified by Husdan *et al.* (15).

$$ATC = \frac{\text{Measured total serum calcium}}{0.6 + \frac{\text{Total protein}}{19.4}}$$

The concentration of calculated ionized calcium (CIC) was derived according to the procedure of McLean and Hastings (19).

Statistical Analysis

The statistical evaluation of the results was done by the Student's test.

RESULTS

Patients

The results of blood pressure (BP) measurements of Group I subjects (controls) and Group II patients (hypertensives) are shown in Table 1. The blood pressure for Group II (hypertensives) were significantly higher than that of Group I (controls).

Serum Electrolytes

The summarized results are stated in Table 2. Mean serum K^+ level (mmol/L) was found to be significantly higher ($p<0.01$) in hypertensive patients compared to normotensive control subjects, but it was not much different from the upper limit of the normal values for this population (5.0 mmol/L). The serum Na^+ and Cl^- levels (mmol/L) were within the normal ranges and no significant differences were observed for these two electrolytes between the two groups of subjects.

Serum Magnesium

The mean levels of serum magnesium (mmol/L) in both the groups of subjects were within the normal range. However, the mean value for the hypertensives was significantly higher (Table 2) compared to that of the control subjects.

Serum Calcium

Although mean serum concentration of ATC (mmol/L) and CIC (mmol/L) in patients were higher as compared to controls no significant differences were noted when analyzed statistically (Table 2).

DISCUSSION

There are many conflicting reports about the differences in blood electrolyte levels between normotensive and hypertensive population. Some investigators have reported normal level for Na^+, K^+ and Ca^{++}, others have reported increases in Na^+ and Mg^{++} (9,10, 23).

Table 2: Serum electrolytes and calcium status in normotensive control subjects (Group I) and in hypertensive patients (Group II).

Parameters*	Group I (n=17)	Group II (n=17)	P value (Group I vs Group II)
Na+ (mmol/L)			
Range	134-144	128-144	NS
Mean±SD	139±3	138±4	
K+ (mmol/L)			
Range	3.7-5.7	3.8-6.5	<0.01
Mean±SD	4.5±0.5	5.4±0.8	
Cl- (mmol/L):			
Range	94-106	88-104	NS
Mean±SD	90±6	98±5	
Mg++ (mmol/L):			
Range	0.65-0.86	0.78-0.91	<0.01
Mean±SD	0.76±0.09	0.84±0.04	
ATC (mmol/L):			
Range	2.32-2.65	2.40-3.23	NS
Mean±SD	2.45±0.14	2.55±0.19	
CIC (mmol/L):			
Range	1.79-2.32	1.91-2.63	NS
Mean±SD	1.97±0.17	2.10±0.17	

*mmol/L: millimoles per litre, SD: Standard deviation, NS: Not significant ($p > 0.05$), ATC: Adjusted total calcium, CIC: Calculated ionised calcium

Our findings that serum levels of Na^+ and Cl^- were normal whereas K^+ and Mg^{++} concentrations were elevated in hypertensive patients (Table 2) were in partial agreement with these reports. This observation may be taken as an indication that overall renal handling of Na^+ and Cl^- were normal in this set of hypertensive patients. However, handling of electrolytes are modulated by a variety of substances such as aldosterone, angiotensin II, catecholamines and prostaglandins. Of these, aldosterone is the major determinant of potassium balance. The fact that serum K^+ levels was found to be significantly higher in patients (Table 2) may suggest that the patients were deficient in aldosterone. But this was considered to be unlikely since Cl^- level was observed to be normal in hypertensive patients. Both K^+ and Cl^- ions are modulated through aldosterone and renin angiotensin system (6,17).

Raised plasma Mg^{++} level had been shown to occur in chronic and acute renal failure (21, 25). The fact that mean serum Mg^{++} level was slightly elevated in patients indicated that subclinical renal defect in magnesium excretion might exist in these hypertensive subjects. It is important to note that the significantly raised mean level of Mg^{++} in patient was within the normal reference range (26). This may explain why there was no clinically overt renal dysfunction.

Some investigators (3,16) reported a highly significant positive correlation between serum calcium and hypertension. But from our studies we could not establish any significant differences in the serum mean levels of ATC and CIC between the two groups of subjects. It is possible that intracellular calcium level may be more important in systemic hypertension which was not measured in our study.

Besides the calcium mechanism in the pathogenesis of hypertension, suggestions had been mode that ion transport inhibitors (ITI) may also lead to vasoconstriction and the development of hypertension (20). De Wardeners and McGregor (5) and Hamlyn *et al.* (13) hypothesized that a sodium transport inhibitor was produced in the serum of hypertensive patients and the degree of transport inhibition in the kidney was correlated well with the high blood pressure of the patients. Perhaps the production of ITI is linked with T-lymphocytes which are known to produce many regulatory factors (27). Insufficient number of these T-cells may lead to accumulation of ITI in the blood. In our previous study, these patients were reported to have deficient number of T-lymphocytes in their peripheral blood (11). We speculated that the deficient T-lymphocytes were suppressor in nature. In hypertensive patients where T-suppressor cells are deficient, the regulatory mechanism becomes inefficient. In course of time, specific ITI may be produced leading to accumulation of specific ions in the blood or cells. Perhaps this mechanism may explain our findings of K^+ and Mg^{++} levels being on the higher end of the normal range in these patients with essential hypertension.

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Correspondence:
A. S. M. GIASUDDIN
Assistant Professor of Immunology
Dept. of Laboratory Medicine
Al-Arab Medical University
P. O. Box-17383
Benghazi, LIBYA.