



Correlation of mineral status with levels of blood pressure in essential hypertension among patients attending a tertiary care hospital in South-India

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ABSTRACT

Essential or primary hypertension is considered to be the major reason of the complex interplay associated with several regulatory systems. It leads to main risk factors of cerebrovascular diseases, heart diseases, kidney malfunctioning. Essential hypertension is a chronic increase in blood pressure in the artery walls above 140 mm SBP and 90 mm DBP. It has a direct effect on the kidney, heart vessel by controlling the functions of endothelial layers and the RAAS mechanism by the kidney. The study designed to assess mineral status among patients with essential hypertension. 37 essential hypertension patient (25-50 years) & 37 normal control subject of same age and sex participated in the study. Serum level of different electrolytes & minerals were compared in both the groups. Serum sodium & calcium were significantly higher in patients with essential hypertension when compared to control group. A significant positive correlation of systolic blood pressure with serum potassium were observed. The correlation between sodium, iron, phosphorus and calcium was negative, while the correlation between magnesium and chloride was not significant. It was also evident that male gender is more likely to develop hypertension than females. It is seen that calcium and sodium levels are increased among essential hypertension patients and therefore exist a significant positive correlation between blood pressure with phosphorus levels. Therefore, patients diagnosed with essential hypertension must be regularly monitored for electrolytes and minerals levels to prevent further complications as a result of hypertension.

Keywords: *essential hypertension, Mg⁺² (magnesium), Cl⁻(chloride), Ca⁺ (calcium), Na⁺(sodium) Fe⁺² (iron), Po⁴⁻ (phosphorus), K⁺(potassium)*

INTRODUCTION

Essential or primary hypertension leads to the main risk factors of cerebrovascular diseases, heart diseases, and kidney malfunctioning. Essential hypertension is medically defined and

diagnosed as an increased blood pressure (BP) in the artery walls above 140 mm (systolic blood pressure (SBP) and 90 mm above diastolic blood pressure (DBP) (as defined by the clinical

excellence guidelines of the National Institute of Health) [1].

Essential, primary or idiopathic hypertension is stated to change the quality of lifespan (rise in morbidity & death rate). It has a direct effect on the kidney, heart vessel by controlling the functions of endothelial layers (endothelial & vascular restoration) and the RAAS mechanism by the kidney. EHT has a significant socioeconomic impact worldwide, primarily on developing countries. It is the predominant risk factor for noncontagious diseases worldwide and it is responsible for 15% of deaths and global disease in the year 2013 [2]. According to WHO (2008) statistics, the prevalence of hypertension among males is 23.1% and 22.6% among females. At present nearly one billion suffer from hypertension and is estimated to surge to 1.56 billion in 2025 [3].

Essential hypertension is a multifaceted progression with multifactorial examination. It is caused by hereditary genetic factors, oxidative stress, inflammation, micronutrients, and immunomodulation. Hereditary genetic factors, lifestyle and environmental design, oxidative stress, inflammation, micronutrients, and immunomodulation are the major pathological aspects linked to EHT [4]. Nutritional and dietary modifications are the main roles of essential blood pressure control or prevention projects. In the late ages, scientists focused on small organic molecules and hypertensive medications to investigate the role of electrolytes and minerals in essential hypertension [5,6,7].

Minerals work together with complex nutrients to balance pH, fluid pressure, muscular retrenchment and relaxation. An abundance of studies has shown that various minerals and electrolytes can directly or indirectly affect blood pressure [8]. There is an association between the minerals and hypertension [9]. Minerals They also act as co-factors of enzymes and are required for DNA synthesis in cells. Ionized minerals act alone or along with complex nutrients to perform their biological functions [10]. An extensive investigation stated that different minerals like calcium, sodium, magnesium, potassium, phosphorus, iron, and chloride could directly or indirectly affect blood pressure [11,12]. The most important details are that sodium (Na⁺) is an essential electrolyte for blood pressure regulation, and that excessive consumption of

sodium can lead to complications such as hypertension and kidney malfunction. Table salt and vegetables are the dietary sources of sodium [13]. The new research study found that dietary or table salt is responsible for 50% of all forms of hypertension. The mechanism of sodium-induced hypertension is yet to be understood [14]. Potassium plays a major role in BP regulation, and recent studies have explored the potential for an increased K⁺/Na⁺ ratio to favor low blood pressure and increase heart disease and vascular disease. Studies have also revealed that K⁺ feeding is opposite to the values of systolic and diastolic blood pressures, and that increased intake of K⁺ results in a slight increase in blood pressure, but the cause is not clear. The relationship between calcium ingestion and BP management is not fully understood. Many studies, however, have found an inverse relationship between calcium diet and eat, similar to potassium [15]. Magnesium's role in hypertension is not clearly known. However, some scientists have pointed out that low levels of Mg²⁺ may lead to elevated BP, thus indicating that Mg²⁺ has the opposite action to BP [16]. Iron and transferrin were significantly altered in hypertension [17]. Experimental investigations have identified that people who intake high amounts of dietary phosphate or calcium phosphate are at a higher risk of having adverse heart and vascular system consequences, such as great ventricular muscle mass and vascular calcification [18]. Chloride is the most essential and abundant electrolyte in serum, with a total body weight of 0.15% and approximately 60% of the entire anion concentration. The direct role of chloride action on EHT is not clear, but suggestions from a monogenic set of symptoms, animal studies, and dietary intake suggest that chloride stability in the kidney, blood pressure regulation, and Cl⁻ concentrations are important points for chloride channels in vascular organs or tissues.[19] This project review was conducted to identify major minerals involved in essential hypertension and predict their mechanism of action in patients with essential hypertension.

MATERIALS & METHODS

The present study was a cross-sectional study conducted at a tertiary care center. This study was approved by Institute Ethics committee (ethical approval number IEC: 2879/IEC/2021). Written informed consent was obtained from the

participants of the study. The study included 37 hypertension patients attending the General Medicine department. A detailed history of general medicine ward admitted patient, blood pressure (BP) examination, gender, height, weight, occupation, genetic history, life style management, basal metabolic rate, type and duration of hypertension, drugs usage, were noted hypertension with/without under drug usage were monitored and samples were collected. Recently diagnosed patients with essential hypertension, under the age group of 25-50 years were included in the study. Participants with conditions that will affect serum mineral status levels like diabetes, renal failure including hemodialysis & kidney transplant, pregnant women, alcoholism or drug dependence. All subjects are subjected to detailed history and relevant investigations, after obtaining informed and written consent Cases and controls will be investigated for conventional risk factors (BP, BMI) Then study subjects will be evaluated for minerals on essential hypertension. All patients were interviewed as per the prepared preform and then complete clinical examination and laboratory investigations would be done.

Venous blood sample of 2-3 ml will be collected in plain tube after overnight fasting (12 hours) and the parameters will be assessed in fully

automated analyzer (Beckman Coulter AU 480) namely Sodium, potassium, calcium, chloride, iron, magnesium, phosphorus. Venous blood samples collected from hypertensive patients after overnight fasting was collected and was centrifuged for 5 minutes at 3000 rpm. A clear supernatant was transferred to a sterile tube and used for the biochemical estimations using (Beckman Coulter) Auto Analyzer (Figure) on the day of sample collection in the central laboratory of clinical biochemistry department.

RESULTS

The study participants consisted of 74 adults, among them 37 hypertensive subjects with high blood pressure formed the case group and 37 apparently healthy non hypertensive subject with normal blood pressure formed the control group. (Table 1) Among the 37 cases 16 were females and 22 were males. Among the 37 controls 23 were females and 14 were males. (Table 2) The body weight of subjects was categorized as low weight (55Kg), normal weight (60-70Kg) and overweight or obese. Among 37 of cases subjects, 3 were low weight, 8 were normal weight and 26 were overweight (obese). Among 37 of controls, 4 were low weight, 17 were normal weight, 16 were overweight (obese). (Table 3)

TABLE 1: Total number of subjects

Subjects	
Case	37
Control	37
Total	74

TABLE 2: Gender of subjects in cases and controls

Gender	Male	Female	Total
Cases	22	15	37
Controls	14	23	37

TABLE 3: Weight of subjects in cases and controls

Weight	Low (< 60 kg)	Normal (60-70kg)	Over weight (above 70kg)
Cases (37)	3	8	26
Controls (37)	4	17	16

Cases and controls were analyzed for the electrolytes and minerals namely sodium, potassium, chloride, calcium, iron, magnesium and phosphorus. Using independent sample t test both the group were compared for the analyzed biochemical parameters and found that electrolyte sodium was increased in

concentration significantly in cases than the controls and mineral calcium was also significantly higher in cases compared to controls. The minerals namely iron, magnesium and phosphorus were lower in cases compare to controls but was not significant. (Table 4)

TABLE 4: Comparison of minerals between cases and controls

Parameters	Cases (N=37)	Controls (N=37)	P Value
Sodium	140.81 ± 9.75	136.50 ± 3.05	0.0001***
Potassium	4.08 ± 0.50	3.97 ± 0.64	0.469
Chloride	100.37 ± 15.60	103.46 ± 5.43	0.2580
Calcium	11.85 ± 22.34	9.34 ± 0.49	0.005***
Iron	73.65 ± 33.78	77.92 ± 38.03	0.879
Magnesium	2.19 ± 0.39	2.41 ± 0.40	0.149
Phosphorus	3.49 ± 0.59	3.57 ± 0.60	0.831

Comparison is made between the two groups by using student 't' test. *p- value 0.05, **p-value

0.01, ***p-value 0.001 are considered significant. Not Significant: p - value >0.05.

TABLE 5: Pearson's Correlation Analysis among essential hypertension subjects

Parameters	Blood pressure (R-value)	(P-value)
Sodium Na ⁺	-.166	0.325
Potassium K ⁺	0.323	0.051
Magnesium Mg ⁺²	0.028	0.868
Chloride Cl ⁻	0.064	0.705
Iron Fe ²⁺	-.145	0.391
Phosphorus Po ₄ ⁻	-.259	0.122
Calcium Ca ⁺²	-.079	0.642

A significant positive correlation of systolic blood pressure with serum potassium was observed. A negative correlation was observed for sodium, iron, phosphorus and calcium. A positive correlation was observed for magnesium and chloride but these correlation results were not significant. (Table 6)

DISCUSSION

Essential hypertension is most common and highly prevalent now a days. In the year 2015 the mortality rate of 20-30% is noted and according to statistical analysis the mortality and prevalence rate may surge up to 30-50% by the year 2025 [20]. Essential hypertension is a multifactorial disorder caused by organ

malfunction, genetic defects, diabetes, lifestyle, environmental factors, and deficiency or imbalance in micro nutrient status [21]. Research suggests that it may be due to a defect in the central nervous system, conducting system, genetic defects, diabetes, lifestyle, environmental factors, and mainly due to deficiency or imbalance in micronutrient (vitamins, minerals, electrolytes) status [22]. Various studies have concluded that some Essential minerals and electrolytes regulate blood pressure through signal transduction [23].

However, recent research studies on hypertension are highly focusing on mineral deficiencies and imbalances. In this study we selected a total of 74 adult subjects in which 37

were hypertension subjects (case group) and 37 were apparently healthy no hypertensive subjects between the age group of 25-50 years. We examined their blood pressure, weight, height, previous history of illness and subjects were tested for the blood electrolyte and mineral levels by using semi-automated analyzer in clinical biochemistry laboratory.

Among 37 subjects 22 (59.45%) were males and 16 (43.24%) were females in case group and among 37 subjects 14 (40.24%) were males and 26 (60.45%) were females in control group. It indicates that males are more prone to essential hypertension and it is believed to be androgenicity in males [24]. Wiener et al reported that blood pressure rose with age in both men and women, but that men had a 6 to 10 mm Hg higher 24-hour mean blood pressure than women until they were 70 to 79 years old [25]. When comes to the weight of the subjects we considered (<60) is normal weight (<60-70) moderate and above (>70) is overweight or obese. In case 3 were normal weight, 8 were moderate, 26 were obese. Likewise, in control 4 were normal, 17 were moderate, 16 were obese. This study shows that obese person was more likely to develop hypertension. Another study reported that obesity is the major risk factor for developing essential hypertension, diabetes and kidney disease [26].

In the current study, sodium (140.81 ± 9.7496) and calcium (14.85405 ± 22.33547) were significantly higher among case group when compared control groups. Despite the fact that there is a well-known common myth about sodium (table salt) that excessive sodium intake can cause high blood pressure, and some research studies have shown that excessive sodium intake can cause high blood pressure.

Phosphorus has hypotensive activity, several research studies suggested that low dietary intake of phosphorus elevates blood pressure mainly DBP. And increased phosphorus decreases blood pressure, in this current study phosphorus showed no significant changes in hypertension patients. There was no link between total phosphorus intake and significant BP changes. There was found to be a relationship between phosphorus intake and blood pressure [27].

Magnesium in our current study showed no correlation in case and control subjects by student's 't' test. As well as, in Pearson's

correlation between elevated BP and magnesium. A high number of studies revealed that magnesium has reducing capability on blood pressure. Though, the exact mechanism is not clearly known. Chloride also showed no significant alteration by Pearson's correlation and Student's 't' test. However, large epidemiological studies curiously showed that lower circulating levels of chloride are associated with blood pressure and heart diseases and cause mortality. Calcium and sodium levels are altered in hypertension patients in the current study.

CONCLUSION

Essential hypertension increases the risk of various noncontagious diseases worldwide. In the present study it was found that males are more prone to hypertension when compared to females. This study shows that essential hypertension results in imbalance in various minerals and electrolytes levels. It was seen that calcium and sodium levels were increased significantly among essential hypertension patients. Therefore, patients diagnosed with essential hypertension must be regularly monitored for electrolytes and minerals to prevent further complications as a result of hypertension.

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