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A Comparative Study of Serum Sodium, Potassium, & Calcium Levels in Primary Essential Hypertensive Cases and Healthy Controls In Mahatma Gandhi Hospital, Jaipur

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Abstract
Introduction-Hypertension is one of the most common diseasesworldwide afflicting humans;and is also one of the leadingcauses of death and disability among adults. In addition, it remains the major risk factor for coronary,cerebral and peripheral vascular disease. Primaryhypertension comprises more than 90% of all cases of hypertension.Differences have been noted between normotensive and hypertensive individuals as regards salt intake,serum electrolytes and the renal excretion of sodium and water.Disturbed calcium metabolism has alsobeen postulated to play an important role in the pathophysiology of essential hypertension.
Aim &objectives:-*The aim of this study was to assess the serum levels of sodium,potassiumandcalcium, in patients with essential hypertension, and compare them with their levels in normotensive patients attending the OPD/IPD of Mahatma Gandhi Medical College and Hospital, Jaipur.*
Methods: *This study was a hospital based comparative analysis&included a total of 100 patients of primary essential hypertension as cases,and 100 healthy controlsfrom the Department of Medicine of the hospital.*
Results:100 hypertensive patients and 100 healthy controls of age above 20 years were included in this study. Mean Sodium levelin cases,(145.67 ± 4.60 mmol/L),was significantly higher (p value <0.001) than in controls(135.73 ± 4.11/ mmol). Mean Potassium level in cases was 3.62 ± 0.39 mmol/L which was significantly lower than the mean level incontrols (4.60 ± 0.63 mmol/L)(p value <0.001). Similar results were also found for calcium levels.Mean calcium level for Hypertensive patients was 8.63 ± 0.96 mg/dL; and that in controls was 9.45 ± 0.98 mg/dL- a significant difference (p value <0.001).
Conclusion: *Increased sodium levels and decreased potassium and calcium levels may be associated withthe risk of hypertension. So dietary restriction of sodium and supplementation of potassium and calcium may decreasethe risk of developing essential hypertension. The intervention may also be expected to improve diseaseoutcomes.*

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I. Introduction

Hypertension is recognized as a major risk factor for cardiovascular disease (CVD), and represents a worldwide public health challenge. Known risk factors for hypertension include genetic and environmental factors, such as family history, age, unhealthy diet, overweight, reduced physical activity, and excess alcohol intake.[1],[2]

Hypertension is called the "silent killer" because, very often,it may remain asymptomatic, and only incidentally diagnosed. It is a chronic condition of concern due to its role in causation of coronary heart disease (accounts for 20-50% of all deaths), stroke and other vascular complications. Essential hypertension comprises more than 90% of all cases ofhypertension . Globally, the overall prevalence of hypertension in adults aged 25 years and above was found to be about 40% in 2015[3]. In India, the prevalence of hypertension varied from 17 to 21% with marginal rural-urban differences. It was comparatively more prevalent in executive and service categories[4]. Although our understanding of the pathophysiology of hypertension has been geetin better with the passage of time,itsaetiology still cannot be ascertained in a large number of cases.[5]

Worldwide, hypertension is estimated to cause 7.5 million deaths annually, constituting about 12.8% of the total deaths. This accounts for 57 million DALYs(Disability Adjusted Life Years), or 3.7% of total DALYs. In a country like India, people have a diet rich in sodium and poor in potassium. It is very well known for over 2000 years, that an acute high dietary sodium intake in the form of a salty meal,[6]results in a temporary increase

in blood pressure[7]. In spite of the gravity of the potential damage due to hypertension, its awareness among theIndian population is low.[8]

Differences have been noted between normotensive and hypertensive individuals in salt intake, intracellular electrolytes, total body electrolytes, serum electrolytes and the renal excretion of sodium and water. If changes in serum sodium concentrations could be a reflection of intracellular or metabolic alterations in electrolyte balance, an easily determined factor would be available for the study of electrolyte abnormalities in relation to the development of hypertension.[9]

Calcium plays a key role in vascular smooth muscle function. Calcium influx through receptor and voltage-operated calcium channels is thought to initiate vascular contraction; and the fall in the intracellular free calcium concentration is thought to result in relaxation or vasodilatation. Therefore, the handling of calcium by the vascular smooth muscle cell becomes critical for control of vascular tone and blood pressure. The use of calcium channel blocking agents in the treatment of hypertension shows the critical importance of calcium in the biochemical control of vascular smooth muscle tone ,and thus of blood pressure homeostasis.

A study of the levels of sodium, potassium and calcium is likely to simplify or rationalise the treatment of the global problem of hypertension.It mayalso be helpful in understanding other aspects of the disease. The aim of this study was to assess the levels of serum calcium, serum sodium, serum potassium in patients with essential hypertension and compare them with levels found in normotensive controls.

II. Materials and methods

This study was a Hospital based comparative analysis in the Department of Medicine of Mahatma Gandhi Medical College and Hospital, Jaipur. The Study Design was a Cross sectional study carried out from January2017 to June 2018.It included a total of 100 patients of primary essential hypertension aged over 20 years from both sexes,who were willing to participate; and 100 healthy controls.Patients below 20 years of age, females using contraceptive pills, pregnant females, patients of secondary hypertension, patients on non steroidal anti-inflammatory agents or antihypertensive medications, patients with renal failure, acute diarrheal disease or diabetes mellitus were excluded from the study.

Serum sodium, potassium and calcium levels were measured in both, cases and controls.

The method used for analysis of serum sodium and potassium was direct ISE (IonSelective Electrodes).Serum calcium levels were measured by theArsenazo III method.

III. Result

In this study patients and controls were above 20 years of age.Mean age for cases was 50.73 ± 12.28 years and for controls it was 53.04 ± 10.96 years. There were no statistical difference in mean age of cases and controls which were thus age matched.The sex distribution was 75 males and 25 females in the hypertensive group, and 70 males and 30 females in the control group.(Table 1)

Table 1

Group/Test	Hypertensive patients	Healthy controls	T value	P value
No. of cases	100	100		
Age (years)	50.73 ± 12.28	53.04 ± 10.96	1.592	NS
BMI(kg/m^2)	**26.68 ± 5.14**	**26.49 ± 5.42**	**-0.353**	**NS**
Systolic BP(Mm of Hg)	**167.92± 6.47**	**117.93± 6.50**	**-54.508**	**<0.001**
Diastolic BP(Mm of Hg)	**107.36± 3.01**	**82.41 ± 2.95**	**-59.199**	**<0.001**

In the study, mean BMI for cases was 26.68 ± 5.14 kg/m^2 and for controls it was 26.49 ± 5.4 kg/m^2 .The mean systolic BP in cases and controls was167.92 ± 6.47 mm of Hg and 117.93± 6.50 mm of Hg respectively.Mean diastolic BP for cases and controls was 107.36± 3.01mm of Hg and 82.41 ± 2.95mm of Hg respectively. Difference between these values was statistically significant(p value <0.001).(Table 1)

Table 2

Group/Test	Hypertensive patients	Healthy controls	T value	P value
No. of cases	100	100		
S. Sodium(Mmol/L)	145.67±4.60	135.73±4.11	16.114	<0.001
S. Potassium (mmol/L)	3.62 ± 0.39	4.60 ± 0.63	13.226	**<0.001**
S. Calcium (mg/dl)	8.63 ± 0.96	9.45 ± 0.98	5.977	<0.001

Mean Sodium levelin cases was 145.67 ± 4.60 mmol/L and in controls it was 135.73 ± 4.11 mmol/L. The levels seen in cases were significantly higher than controls .(p value <0.001).Fig.1

Mean Potassium for cases was 3.62 ± 0.39 mmol/L; and in controls it was 4.60 ± 0.63 mmol/L. Serum potassium level were significantly lower in cases in comparison to controls (p value <0.001). Fig. 2

A similartrend was observed in mean calcium levels, being8.63 ± 0.96 mg/dL in Hypertensive patients ,and 9.45 ± 0.98 mg/dL. incontrols (p value <0.001). Fig .3

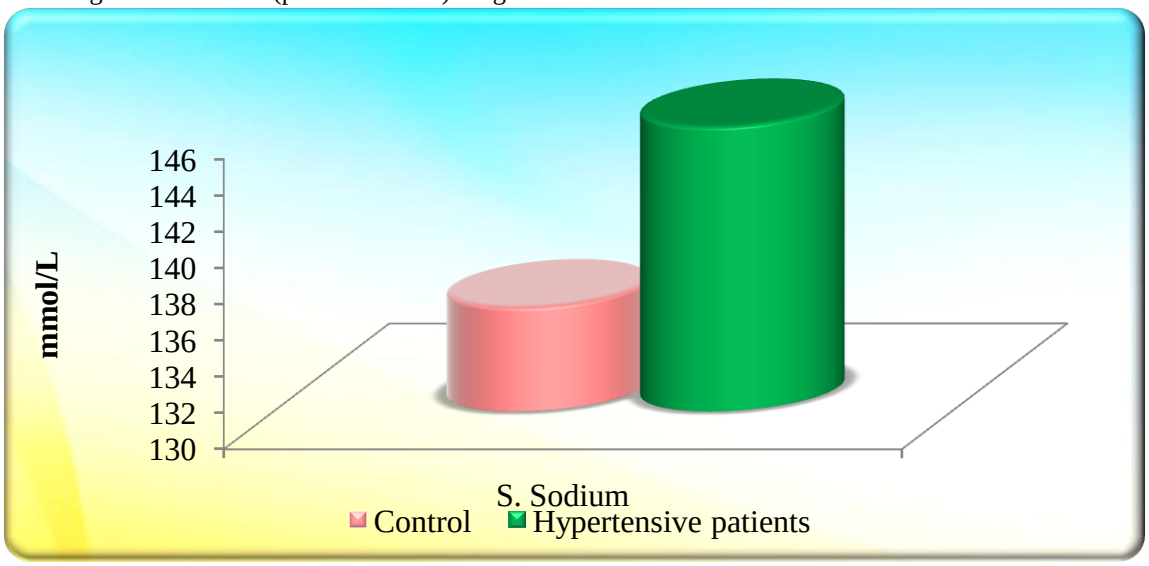

Figure 1: Comparison of Mean Serum Sodium levels between Control group and Hypertensive Patients

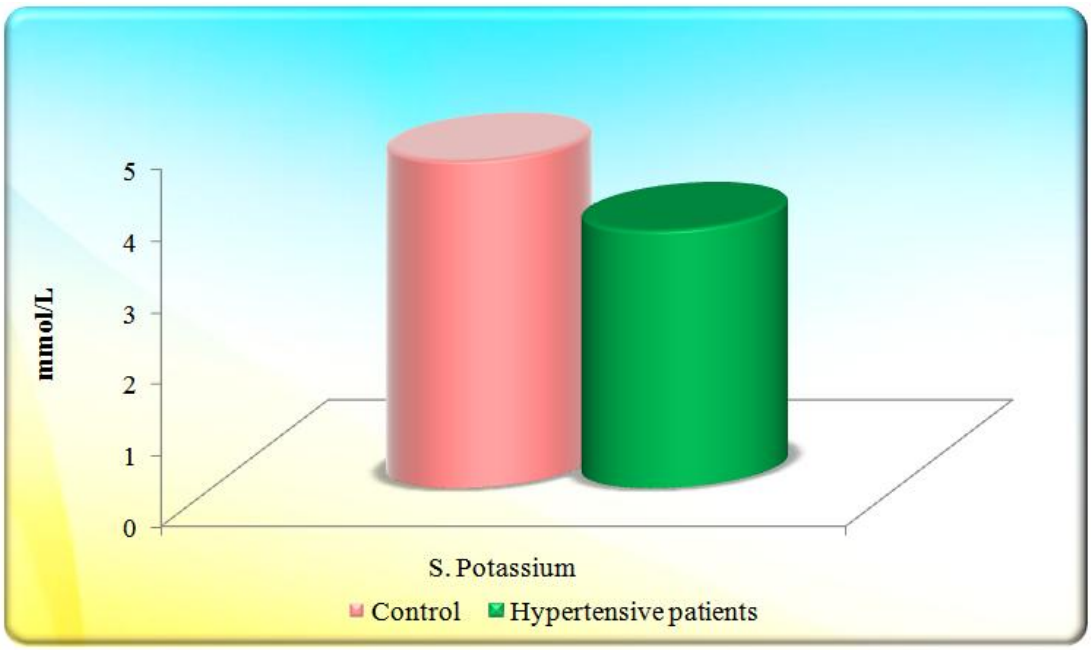

Figure 2: Comparison of Mean Serum Potassium levels between Control group and Hypertensive Patients

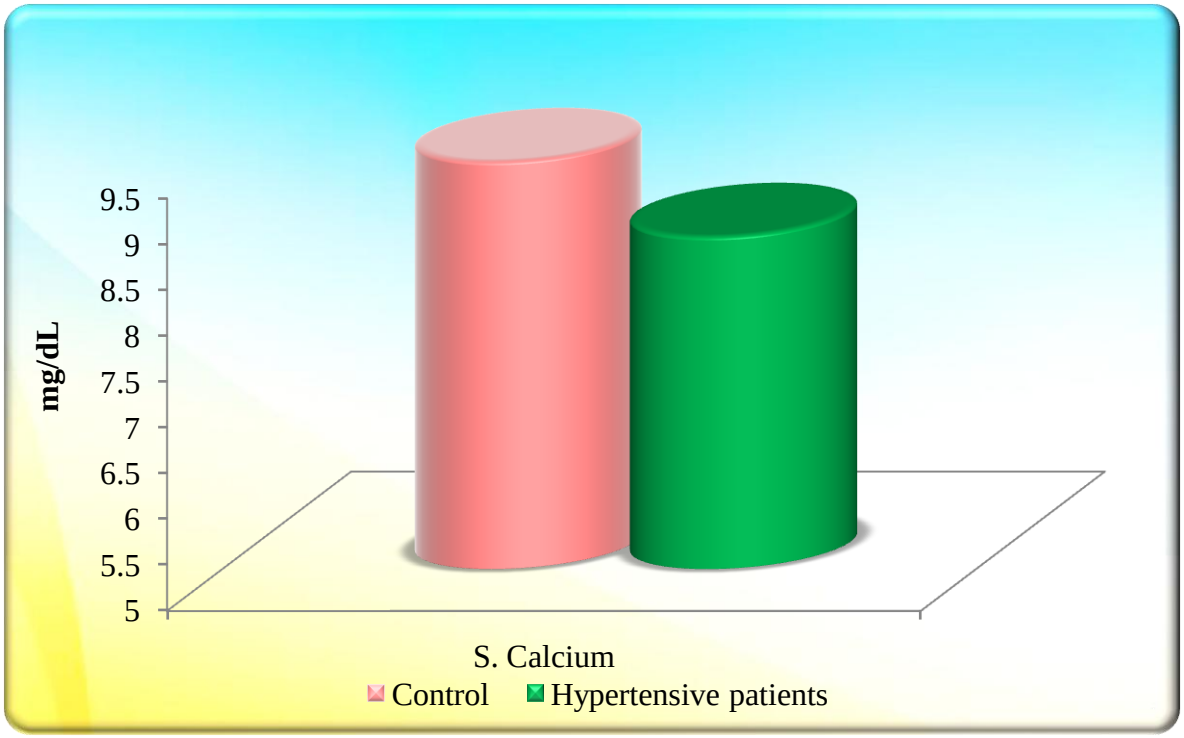

Figure 3: Comparison of Mean Serum Calcium levels betweenControl group and Hypertensive Patients

IV. Discussion

Hypertension is one of the most common diseases afflicting humans, and alsothe leading cause of death and disability among adults, all over the world. It remains the major risk factor for coronary, cerebral and peripheral vascular disease. Primary hypertension comprises more than 90% of hypertension[10]. Even though substantial progress has been made in the awareness, treatment, and prevention of CVD in the last decade, hypertension is often underestimated and underdiagnosed[11]. Hypertension is an emerging health problem in India. When majority of people come to know that they have hypertension they are already in an advanced stage with target organ damage - a stroke, or myocardial infarction or irreversible renal failure[12].

In our study we found mean S. Sodium level In hypertensive patients 145.67 ± 4.60 mmol/L and in the controls the mean serum sodium level was135.73 ± 4.11 mmol/L. The difference between the values was statistically significant. (p value <0.001) . Thus we may logically conclude that increased levels of serum sodium are associated with hypertension. Results of our study are similar to the study conducted by Muruganet al[13] which showed statistically significant difference(p value = 0.000001) in sodium levels of hypertensive patients (145.41 ± 5.55)and controls(139.9± 3.21). Results of Our study also matched with Jan, et al[14] (2006) who in their study on 135 hypertensive patients and 135 age and sex matched healthy controls observed that S. sodium in the hypertensive group was 140 ± 2.90 while in the control group it was 138.5 ± 1.12. Serum sodium was significantly higher(p value <0.001) in the hypertensive group than the control group which was considered as a factor responsible for the causation of hypertension. However a study done by Anandkumar et al[15] in 2017 showed no significant (p value =0.945) difference in serum sodium levels between hypertensive patients(145.44 ± 5.67)and controls(137.80±3.46).

In our study we found mean serum Potassium level in hypertensive patients 3.62 ± 0.39 mmol/L; whereas controls had mean potassium level 4.60 ± 0.63 mmol/L. Statistical analysis showed that hypertensive patients had significantly lower levels of potassium (p value <0.001).It may thus be concluded that lower levels of potassium may be a marker for hypertension.Results of our study correlate well with thestudy conducted by Murugan et al[13] which showed statistically significant difference(p value = 0.0026) in potassium levels of hypertensive patients (4.03± 0.49mmol/L)and controls(4.29 ± 0.33mmol/L). Our study results are also similar to the study by Jan, et al[14] (2006), who observedmean Serum Potassium levels of 3.97 ± 0.45mmol/L in hypertensives;and 3.97 ± 0.45mmol/L. in the control group. Serum Potassium was significantly lower (p value =0.05) in the hypertensive group than the control group which was considered as a factor responsible for the causation of hypertension.In contrast, a study conducted by Anandkumar et al[15]showed no significant difference (p value =0.945) in potassium levels between hypertensive patients(3.9 ± 0.39mmol/L) and controls(4.29 ±0.63mmol/L).

In our region, there is excessive intake of dietary salt. But in spite of that not everyone has essentialhypertension[14]. The rarity of hypertension among those consuming large amount of salt may probably be related to chronic adaptation of body system towards renal clearance of sodium. So in addition to the hereditarypredisposition and high sodium intake and lower potassium intake, the renal handling of these cations also playsan important role in pathogenesis of essential hypertension[16].Salt intake was more in the tropical countries by and large in order to overcome sodium loss through sweating. In modern days the consumption of salt is more than earlier days in view of various food preparations or a combination of them, as man is tuned more to taste of the food. Combination of food materials requires additional salt. As a result, people consume 8-10 g / day of salt against the 2 g/ day daily requirement. Such an excess consumption may contribute to the development of hypertension in a genetically susceptible population.

In our study, we also foundthat mean serum calcium levels were8.63 ± 0.96 mg/dLand 9.45 ± 0.98 mg/dL.in hypertensive patientsand controls respectively. These levels were significantly lower in hypertensive patients in comparison to healthy controls.(p value <0.001) It was found that decreased levels of serum calcium were associated with hypertension.Results of our study matched with those of the study conducted by Dr. Uday S. Bande et al[17]whofound mean serum calcium level 8.0020± 0.6520 mg/dl in hypertensives,and 9.02± 0.5077 mg/dlin controls. In this study serum calcium levels were measured in 80 cases of essential hypertension which included 37 cases of grade I and 43 cases of grade II hypertension. The result showed that serum Calcium levels were significantly decreased in grade I (P<.0001) as well as grade II (P<.0001) hypertension cases when compared to age matched normotensive controls.Another study conducted by Sudhakar et al[18] in 2004 which is said to be the first study in Indian population, Serum calcium levels were measured in 117 subjects with essential hypertension and 77 first degree relatives. The results showed that serum calcium levels were significantly (p<0.01) decreased in both males and females with essential hypertension and their first-degree relatives when compared with the normotensive controls. Contrarily, a study conducted by Mohammed Abdul HannanHazari et al[19] showed no statistically significant difference(p value = 0.5) between serum calcium levels of hypertensive patients(8.77±0.83) and controls(8.97±0.73).

Possible explanation of levels of calcium in our study may be abnormal cellular ion transport resulting in altered membrane control over intracellular calcium,which may be related to essential hypertension. Calcium interacts with other ions—sodium, potassium, magnesium in affecting BP[20]. Changes in magnesium levels may contribute to altered cell membrane calcium binding in essentialhypertension[21]. The free intracellular calcium concentration determines the tension in vascular smooth muscle cells, and thus peripheral vascular resistance. Calcium has a direct effect on peripheral vascular tone[22]

To conclude, the present study gives us an idea that the derangement in level of Serum sodium, Serum potassium and Serum calcium may be associated with increased risk of hypertension and more studies may be conducted in this direction to further document the significance of these observations.

V. Conclusion

The conclusion of our study is that increased sodium levels and decreased potassium and calcium levels may be associated with the risk of hypertension. In view of these findings it may be said thatrestriction of dietary sodium ;and potassium rich diet may lower the risk of hypertension, and may improve the outcomes. Calcium supplementation or increased dietary intake of calcium rich foods may also be recommended in future for treatment of hypertension Therefore, a recommendation that calcium intake be maintained at 1.0 to 1.5gm per day through dietary intake or supplements or both can be made for adolescents and adults. This may be sufficient to achieve a blood pressure lowering response in the subjects.

It can also be construed that a large population study on the lines of this study may be planned and carried out. If the observations coincide with the present study, and are statistically significant, it may become a readily accessible tool to predict the future risk of hypertensive disease and its associated co-morbidities of coronary, cerebrovascular and renovascular complications.

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