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Original Research Article

Serum Levels of Magnesium, Copper, Zinc and Iron in Patients with Essential Hypertension

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Abstract

Hypertension (HTN) is an asymptomatic easily detectable chronic cardiovascular disorder which can cause coronary heart diseases, stroke and other complications. The relationship between trace elements and cardiovascular diseases is under investigation and showed conflicting results.In this study levels of magnesium, copper, zinc, iron in hypertensives were estimated and compared with normal healthy controls. A case control study was undertaken over a period of 6 months included 100 individuals aged between 25-65 years. 50 cases were hypertensive patients free from diabetes mellitus, thyroid disorders, any other chronic diseases, while 50 normal healthy subjects were controls. In both the groups, systolic and diastolic blood pressures, serum magnesium, copper, zinc and iron levels were obtained. The systolic and diastolic blood pressure, serum copper, zinc was significantly high (p value <0.05) and magnesium, iron levels were significantly low in hypertensives. Excess free radicals, increased stress has been implicated in the etio-pathogenesis of hypertension. Copper and iron increase the levels of free radicals acting as a pro-oxidant leading to increased peripheral vascular resistance and hypertension. Increased zinc can be due to intracellular increase in renal zinc favoring the activity of carbonic anhydrase and causing an effect opposite to that of some diuretics. Elevated zinc leads to high sympathetic nervous activity. Decreased magnesium potentiates vasoconstriction and increase vascular tone leading to hypertension. We conclude that there exists a relationship between serum magnesium, copper, zinc, iron and hypertension but, further large-scale population studies should be undertaken to establish the role of various trace elements in hypertension.

Keywords: Hypertension, Copper, Zinc, Magnesium, Iron, Systolic Blood Pressure, Diastolic Blood Pressure.

INTRODUCTION

Hypertension (HTN) is observed throughout the world and is an asymptomatic easily detectable chronic cardiovascular disorder which causes coronary heart diseases, stroke and other vascular complications [1]. Primary hypertension is the commonest type of blood pressure elevation of unknown cause [2]. It is important in promoting atherosclerosis and accompanies adult ischemic heart diseases. Essential hypertension accounts for 90-95% of cases whose etiology is unknown [1].

About 5 to 10% of cases are of secondary hypertension. Primary HTN is a condition characterized by increase in blood pressure above 140/90 mm Hg in adults with at least three consecutive measurements. Primary HTN occurs without definitive signs and symptoms and is caused by multiple factors and there is an interaction between genetic and environmental factors. Besides these factors, there are many behavior risk factors that can cause HTN that include high salt and fat and low fiber consumption, alcohol consumption, smoking, physical inactivity and lack of exercise and poor stress management [3].

Numerous studies have shown the involvement of trace elements involvement in the development of hypertensive process. [4]However, the relationship between trace elements and cardiovascular diseases is still under investigation [1]. The levels of trace elements in Essential HTN showed conflicting results [4, 5].

AIMS AND OBJECTIVES

To study the levels of trace elements magnesium (Mg), copper (Cu), zinc (Zn) and iron (Fe) in hypertensive patients and their comparison with the normal subjects. To find the relation of these trace

elements with systolic and diastolic blood pressure in patients with essential hypertension.

MATERIALS AND METHODS

A hospital based cross sectional case control study was conducted on total of 50 patients of age group 25-65 years over a period of 6 months with convenient sampling of hypertensive patients attending the medical out-patient department of Owaisi Hospital and Research Center and Princess Esra Hospital, Deccan College of Medical Sciences, Hyderabad, Telangana, India. The patients were compared with 50 normal age & sex matched controls.

Patients with diabetes mellitus, thyroid disorders and any other chronic diseases and those who are on vitamin or mineral supplements, steroids were excluded from the study besides the patients who did not give voluntary consent & patients less than 25 and more than 65 years.

Informed consent was taken and approval from ethics committee was also obtained. Detailed medical history and relevant clinical examinations were carried out in these patients.

Sample collection – Venous blood (5ml) was collected from antecubital vein using aseptic precautions into red capped plain vaccutainers for estimation of serum levels of magnesium, copper, zinc and iron.

Various study parameters were estimated by the following methods –

- Magnesium: Xylidyl blue method on Cobas C311 autoanalyzer.
- Copper: Colorimetric method (Di-Br PAESA Method) on Chem-7 semi autoanalyzer.
- Zinc: Colorimetric method (Nitro-PAPS method) on Chem-7 semi autoanalyzer.
- Iron: Ferrozine method on Cobas C311 autoanalyzer.
- Measurement of Systolic Blood Pressure (SBP) and Diastolic BloodPressure (DBP) using sphygmomanometer in cases and controls.

All the analytes estimated are subjected to standard quality control (QC) guidelines. External Assurance Quality Scheme (EQAS) is under CMC Vellore. Internal Quality control is run twice daily with both first party controls (Cobas-PCC1, PCC2 and third-party controls (Randox)).

RESULTS AND DISCUSSION

The results obtained for mean and standard deviation of various parameters in hypertensives and normotensive individuals were tabulated as follows –

Table-1: Mean and Standard deviation of various parameters in hypertensives and normotensives

S.NO	PARAMETER	MEAN ± SD IN HYPERTENSIVES	MEAN ± SD IN NORMOTENSIVES	P-VALUE
1.	MAGNESIUM (mg/dL)	1.46 ± 0.19	1.98 ± 0.15	<0.001**
2.	COPPER (ug/dL)	153.78 ± 33.26	105.24 ± 21.62	<0.001**
3.	ZINC (ug/dL)	26.80 ± 8.7	23.36 ± 5.09	<0.01*
4.	IRON (ug/dL)	37.72 ± 1.7	68.21 ± 4.3	<0.001**
5.	SBP (mm Hg)	163.76 ± 12.04	120.20 ± 8.30	<0.001**
6.	DBP (mm Hg)	93.72 ± 3.55	74.48 ± 5.02	<0.001**

As per our study, the serum levels of copper and zinc in the hypertensives show that they were statistically significantly elevated, serum magnesium and iron levels were statistically significantly decreased in hypertensives when compared to the normotensives. There was astatistically significant increase in mean value of SBP and DBP in hypertensives than in normotensives.

*P<0.05 is considered statistically significant. **indicates P<0.001 is highly statistically significant. Parameter values expressed as mean ± SD.

The mean and standard deviation values of all the parameters in hypertensive individuals as well as normotensive subjects were calculated and were represented in the graphical form as bar diagram using MS Excel Software.

The mean values were compared between the hypertensive cases and normal healthy individuals. The P – Values were also calculated using student's paired T test to find out the statistical significance of various parameters.

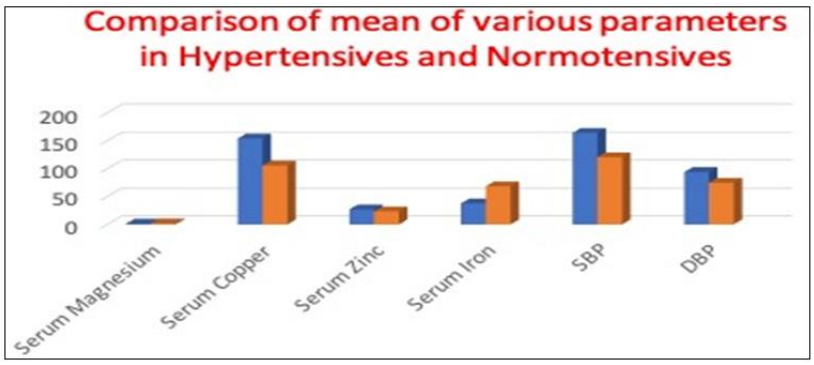

Fig-1: Comparison of mean of various parameters in Hypertensives and Normotensives

Present study demonstrates that there exists a correlation between hypertension and the various trace elements. The systolic and diastolic blood pressure along with serum copper and zinc showed significant increase in hypertensive patients when compared to normal individuals. But, the levels of magnesium and iron in the serum of hypertensive subjects were decreased when compared to their normal aged matched controls. Other authors also found similar results according to their studies [1-6].

Excess production of free radicals and increased oxidative stress has been implicated in the etio-pathogenesis of hypertension [1]. Copper increases the levels of free radicals acting as a pro-oxidant and leading to increased peripheral vascular resistance and hypertension [5]. Copper deficiency reduces the synthesis of hemoglobin and leads to anemia which in turn is a contributor to increase cardiac output and blood pressure. [6] Deficiency of copper results in decreased HDL and increased LDL which causes atherosclerosis leading to hypertension [3].

High sympathetic nervous activity may increase the zinc content in tissue and blood. Further, increased zinc favors the activity of carbonic anhydrase and consequently the development of hypertension [5]. Zinc deficiency plays a role in blood pressure regulation by altering the taste of salt. Increased zinc intake has shown a better taste acuity for salt. Individuals with decreased serum zinc levels tend to increase salt intake leading to blood pressure elevation [6]. Zinc and copper are cofactors of superoxide dismutase. The protein structure of the enzyme copper-zinc-superoxide dismutase is stabilized by zinc while copper catalyzes this enzyme.Superoxide dismutase disables superoxide anion and peroxides that are free radicals and clean up free radicals by copper and zinc mediated induction. Zinc deficiency affects immune system cells, increases oxidative stress and inflammatory cytokines leading to development of hypertension [7].

Magnesium plays a crucial role in blood pressure regulation through direct stimulation of prostacyclin and nitric oxide formation, modulating endothelium dependent and endothelium independent vasodilation, reducing vascular tone and reactivity and prevents vascular injury via its antioxidant and anti-inflammatory functions [2]. Magnesium decreases the vascular resistance by reducing the release of calcium from the sarcoplasmic reticulum into the cytosol. Decreased concentrations of magnesium causes vasoconstriction and increased vascular tone resulting in hypertension [2, 5].

Though iron deficiency has been shown to be associated with idiopathic pulmonary hypertension, both iron deficiency and overload have shown deleterious effects on endothelial function and blood pressure [5, 6]. In our study, iron levels were decreased.

The levels of different trace elements were decreased or increased as a result of development of hypertension or these trace elements in turn led to the development of hypertension is not yet known.

CONCLUSION

Our study concluded that the serum levels of magnesium and iron were significantly decreased in hypertensive individuals when compared to their normal counterparts.

The serum levels of copper and zinc and the systolic as well diastolic blood pressure was found on the higher side in hypertensive subjects than their normal aged matched controls.

Further large scale multi-centric population studies are essential to establish the role of various trace elements in hypertensive and normotensive individuals.

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