International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 12, December 2024 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.12.2024.60

ORIGINAL RESEARCH

A study of correlation of serum magnesium levels with blood pressure in normotensive and hypertensives

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Received Date: 23 October, 2024 Accepted Date: 27 November, 2024

ABSTRACT

Background: hypertension is one of the leading cause of morbidity and mortality and must me studied rigorously. One of the factors influencing blood pressure is magnesium level and hence research on the same is very important. A case control study, aiming to understand the correlation of serum magnesium with Blood pressure among normotensives and hypertensive patients. **Materials and Methods:** The study in Vijayapura in Karnataka had a total of 156 participants divided in two groups of 78 each. Group A with 78 cases with normal blood pressure as control and group B with 78 cases of primary hypertension. Individuals with who were known cases of secondary hypertension like chronic kidney disease were not included. The patients who were included gave their consent. In order to evaluate further proper procedure was followed to take patients blood pressure and blood sample. For normally distributed continuous variables between three groups will be compared using t- test For not normally distributed variables Kruscal walli's test will be used. Categorical variables between two groups will be compared using Chi square test. **Results:** Out of a total 78 cases in the normotensive group 11 have a sr magnesium level of 1.8 while the remaining 67 patients have a level of 1.8 or higher. Normotensive group has only 14% of patients with hypomagnesemia. Out of a total 78 cases in the normotensive group, 54 have a sr magnesium level of less than 1.8 while the remaining 24 patients have a level of 1.8 or higher. Hypertensive group has 69% of patients with hypomagnesemia. Which is 55% higher than the normotensive group.When the 2 groups are compared using t-test for equality of means it is found that the p-value for sodium is slightly below < 0.05 which is significant. It also showed Mg with a p-value of 0.004 which is well below 0.05 which is statistically significant.With a p value of 0.09 for systolic blood pressure and a value of 0.20 for diastolic blood pressure. There is no corelation between sr mg and SBP/DBP within the hypertensive group itself. **Conclusion:** From the study conducted, the following observations were madePatients in the hypertensive group have 5 times more cases of low serum magnesium. Primary hypertension has significant negative corelation to serum magnesium levels.

Key words- Primary hypertension, serum magnesium, serum electrolytes,

INTRODUCTION

According to the World Health Organization's Global Status Report (2010), non-communicable diseases are the leading cause of death globally, accounting for 60% of all deaths. In India, the situation is particularly severe. In 2005, non-communicable diseases were responsible for 53% of total mortality and 44% of disability-adjusted life years lost. By 2030, it is projected that non-communicable diseases will account for 67% of total mortality in India.[(1)]The alarming rise in the magnitude of non-communicable diseases requires urgent attention. The world health organization recognizes six risk factors within the non-communicable diseases for deaths. The six risk factors are hypertension, impaired glucose tolerance, tobacco usage, dyslipidaemia, lack of physical activity and obesity.[(2)] Among the above-said risk factors, hypertension is responsible for the 13% of total deaths in the world followed by tobacco usage (9%), impaired glucose tolerance (6%), physical inactivity (6%), and obesity (5%).[(2)]

Hypertension holds several top spots among non-communicable diseases due to its prevalence as the most common chronic condition, a leading risk factor for both heart disease and stroke, and the condition that results in the highest number of drug

DOI: 10.69605/ijlbpr_13.12.2024.60

prescriptions. Globally, it is the primary attributable risk factor for mortality. Additionally, hypertension is a key element of metabolic syndrome, a condition that significantly raises the likelihood of cardiovascular diseases when present in an individual.[3]

Besides carbohydrates, proteins, and fats, minerals are crucial in a diet. Among these, magnesium often gets the least attention. Yet, magnesium has significant medicinal benefits. It is an essential mineral found in ample amounts in foods like legumes, nuts, whole grains, and leafy green vegetables.[4] Magnesium plays a role in creating many proteins and serves as a cofactor for specific enzymes in the body. It is vital for hundreds of physiological processes that maintain balance in the body. One of magnesium's main functions is regulating blood pressure. [4]

Given that hypertension is a major risk factor for cardiovascular diseases and stroke, a well-structured approach is essential to understand its pathogenesis and to prevent it. Therefore, it is important to study magnesium levels in individuals with hypertension to determine the relationship between serum magnesium and blood pressure. This knowledge could inform future dietary interventions and supplementation strategies to control blood pressure increases, even alongside pharmacological treatments.

OBJECTIVES

The objective of the study is to estimate the serum magnesium level in controls (normotensive) and hypertensives andto study the correlation of serum magnesium levels among them.The above will we achieved by doing a case control study on two groups,Group A being normotensives (SBP< 140, DBP< 90) and group B being hypertensive (SBP ≥ 140 or DBP ≥ 90) and studying the levels of serum magnesium in these two groups through blood sampling.

MATERIAL AND METHODS

Source of data- Patients who were diagnosed as newly detected cases of Primary hypertension and were treated at Shri B.M. Patil medical college, hospital and research centre, Vijayapura, Karnataka provided the data. This data was collected from September 2022 to Jully 2024.

Method of collection of data

Study Design- Case control study

Sample size- The anticipated Mean±SD of Serum magnesium in control group 2.068±0.4515, in hypertension group 1.762±0.403 . The required minimum sample size is 78 per group (i.e. a total sample size of 156, assuming equal group sizes) to achieve a power of 90% and a level of significance of 5% (two sided), for detecting a true difference in means between two groups. using G* power software 3.1.9.7

A detailed pro forma will be used to obtain a detailed history and to record the vital parameters. Standardized mercury sphygmomanometer will be used to record the BP. The study will be approved by the Institutional Ethical Committee. The subjects will be explained about the procedure and informed consent obtained. A detailed history will be elicited from them to rule out diabetes mellitus, renal, and kidney diseases and to rule out the causes of secondary hypertension.

First, the subjects will be asked to sit relaxed for 15 min in a quiet room with comfortable room temperature. The subject should be seated in a quiet room in an armed chair with the arm and back supported and the legs uncrossed. The mercury manometer should be at his/her heart level. It is necessary that there should be abstinence from caffeine ingestion before 30 min of measurement of BP. Then BP will be recorded in all subjects using a standard sphygmomanometer having a cuff size of 25 cms × 12.5 cms. The BP will be recorded 2 times by auscultatory method, and the mean value was taken for analysis. Antecubital vein in the front of the forearm will be selected for venous blood collection. The skin over the vein will be sterilized with a cotton swab. A disposable sterile needle fitted with 10 ml syringe will be introduced into the vein and desired amount of blood will be collected for serum magnesium estimation. Serum magnesium levels below 1.8mg/dl indicates hypomagnesemia while levels of 1.8mg/dl or above is considered normal serum magnesium levels.

Inclusion Criteria-Newly diagnosed essential hypertensive (SBP ≥ 140 or DBP ≥ 90) patient.Known cases of essential hypertension.Non hypertensives individuals as control.

Exclusion criteria-Patients with CKD.Patients with diagnosed causes of secondary hypertension.

STATISTICAL ANALYSIS

The data obtained was entered in a Microsoft Excel sheet, and statistical analysis was performed using statistical package for the social sciences (Version 20). Results will be presented as Mean±SD, Median and Inter quartile range, frequency, percentages and diagrams. For normally distributed continuous variables between two groups will be compared using t- test For not normally distributed variables Kruscal walli's test will be used. Categorical variables between two groups will be compared using Chi square test. Pearson's/Spearman's correlation analysis will be done to find correlation between serum magnesium and BP. p values of 0.05 will be considered statistically significant. All statistical tests will perform two tailed.

RESULTS

In this present study, the participants are divided into group control (C) and hypertensive group (H) (SBP ≥ 140 or DBP ≥ 90) with 78 samples in each group. Below are the values of age, sr creatinine and sr magnesium.

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Table 1: Group Statistics				
	Group	**N**	**Mean**	**Std. Deviation**
AGE	C	78	54.81	9.114
	H	78	55.65	8.922
CREATININE	C	78	.790	.2622
	H	78	.803	.2407
Mg	C	78	2.044	.3254
	H	78	1.647	.2700

Table 1: age, creatinine and serum magnesium mean and std deviation in each group.

In the above table (Table 1) we can see the mean age in group control is 54.81 and 55.65 in hypertensive group. The difference in mean is 0.81 which is not significant hence the sample is proven to be age matched.

The mean creatinine values in group control is 0.79 and 0.80 in the hypertensive group. There is no significant variation in mean creatinine values in the two group and rules out any bias associated with kidney disease. (Table 1)

Table 2: Independent Samples Test

	t-test for Equality of Means
	Sig. (2-tailed)
Age	.559
Creatinine	.751
Na	.044
K	.091
Mg	.004

Table 2: t-test for Equality of Means

When the 2 groups are compared using t-test for equality of means it is found that the p-value for sodium is slightly below < 0.05 which is significant. It also showed Mg with a p-value of 0.004 which is well below 0.05 which means its statistically significant. (Table 2)

Table 3: Normotensive group

Sr Mg levels	**Cases**
Low Mg	11
Normal/High Mg	67
Grand Total	**78**

Table 3: number of cases with low serum magnesium in group A (normotensives)

The above table depicts the number of cases with deranged Sr magnesium in normotensive group. Out of a total 78 cases in the normotensive group 11 have a sr magnesium level of 1.8 while the remaining 67 patients have a level of 1.8 or higher. Normotensive group has only 14% of patients with hypomagnesemia. (Table 3)

Table 4: Hypertensive group

Sr Mg levels	**Cases**
Low Mg	54
Normal/High Mg	24
Grand Total	**78**

Table 4: number of cases with low serum magnesium in group B (Hypertensives)

The above table depicts the number of cases with deranged Sr magnesium in hypertensive group. Out of a total 78 cases in the normotensive group, 54 have a sr magnesium level of less than 1.8 while the remaining 24 patients have a level of 1.8 or higher. Hypertensive group has 69% of patients with hypomagnesemia. Which is 55% higher than the normotensive group. (Table 4)

Table 5: Correlations (Group A- normotensive)

	SBP	**DBP**
Mg	r=0.140982	r=-0.029107
	p=0.218256	p=0.800289
	78	78

Table 5: relationship between serum magnesium and blood pressure within Group A.

The above chart shows a p value of 0.21 for systolic blood pressure and a value of 0.80 for diastolic blood pressure. There is no corelation between sr mg and SBP/DBP within the normotensive group. (Table 5)

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Table 6: Correlations (Group B- hypertensive)

		SBP	DBP
Mg		r=-0.189397	r=-0.144240
		p=0.096759	p=0.207696
		78	78

Table 6: relationship between serum magnesium and blood pressure within Group B.

The above chart shows a p value of 0.09 for systolic blood pressure and a value of 0.20 for diastolic blood pressure. There is no corelation between sr mg and SBP/DBP within the hypertensive group. (Table 6)

DISCUSSION

The present age and sex matched study shows that serum magnesium level is lower in hypertensive subjects when compared to the normotensive subjects. The mean serum magnesium level in the control group is 2.044 ± 0.3254 while it is 1.647 ± 0.2700 in hypertensive group. After calculations the P value is < 0.05 hence there is a significant difference in serum magnesium level between the groups. When compared with to the normotensive group, the hypertensive group showed significantly higher number of patients with low serum magnesium levels i.e- serum magnesium levels < 1.8. The results clearly show that as blood pressure (BP) increases, serum magnesium levels decrease. This inverse relationship between serum magnesium and both systolic and diastolic BP is statistically significant ($P < 0.01$) .

The study also showed statistically significant higher serum sodium in the hypertension which could be explained by the effect of the low serum magnesium on aldosterone production. Higher serum magnesium can suppress aldosterone production by mobilizing intracellular calcium. This study also shows that there is no significant correlation between serum magnesium and the blood pressure within the groups. This indicates that the deficiency of serum magnesium is one of the factors that causes hypertension, but the severity of hypertension is not significantly related to the severity of hypomagnesemia.

Rekha S et al. conducted a study similar to the one above where they compared 3 groups (normotensive, stage 1 hypertension and stage 2 hypertension) they reported that the mean serum magnesium level in the control group was 2.068 ± 0.4515, while in Stage 1 hypertensive patients, it was 1.5560 ± 0.40320, and in Stage 2 hypertensives, it was 1.3920 ± 0.4081. With a P-value of less than 0.05, there was a statistically significant difference in serum magnesium levels among the 3 groups.[5]

In a study by Ferdousi et al., it was found that serum magnesium levels (mg/dl) were significantly lower in 30 offspring of parents with essential hypertension compared to 30 age- and sex-matched offspring of normotensive parents (1.90 ± 0.210 vs. 2.13 ± 0.366, $P < 0.01$). Additionally, erythrocyte magnesium levels (mg/dl) were also significantly lower in the hypertensive group compared to the control group (4.46 ± 0.699 vs. 5.43 ± 0.775, $P < 0.001$).[6]

Resnick et al. reported a significant negative correlation between serum magnesium levels and plasma renin activity in individuals with essential hypertension ($r = -0.60$, $P < 0.001$).[7]A Ichihara et al. conducted a study on effects of magnesium on the renin-angiotensin-aldosterone system in human subjects the data indicates that magnesium stimulates renin release through the elevation of prostaglandins and suppresses aldosterone production through the intracellular calcium mobilization. The cause of hypertension in our study could have been caused by similar mechanisms along with peripheral vasoconstriction and calcium deposition in the blood vessels causing atherosclerosis.[8]

Hypertension is primarily driven by elevated peripheral resistance, which stems from changes in vascular tone and endothelial dysfunction. Magnesium plays a key role in regulating blood pressure by influencing both smooth muscle and endothelial functions that control vascular tone. Deficiency in magnesium can lead to hypertension by disrupting nitric oxide (NO) production, altering calcium concentrations, and impacting arterial smooth muscle tone.[9] Low magnesium levels increase the arterial system's sensitivity to vasoconstrictors, reduce the effectiveness of vasodilators, and raise peripheral resistance, all of which contribute to higher blood pressure. In addition to its role in blood pressure regulation, magnesium improves insulin sensitivity, exhibits anti-inflammatory and antioxidant properties, and helps lower cholesterol levels.[10][11]

CONCLUSION

From the study conducted, the following observations were made Patients in the hypertensive group have 5 times more cases of low serum magnesium. Primary hypertension has significant negative corelation to serum magnesium levels. serum sodium had mild yet significant negative corelation to serum magnesium likely due to the increased activity of angiotensin and aldosterone. Given that this study demonstrates a clear link between low serum magnesium levels and elevated blood pressure, it is important to take steps to increase magnesium intake. In addition to enhancing magnesium-rich foods in our diet, magnesium supplementation could be considered as a strategy to help lower blood pressure.

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