Original Research Article

Serum calcium in newly diagnosed essential hypertensives

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Abstract

Background: The role of calcium in clinical hypertension can be best understood by a hierarchal model in which the blood pressure effects of a dietary signal depend on alterations of hormonal systems specific for that signal. These alterations mediate both the cellular recognition of these signals as well as the resultant clinical responses to them. In the case of both dietary calcium and dietary salt, these systems appear to include calcium regulating hormones having direct, calcium-dependent vasoactive properties, and which are linked to the activity of the renin-angiotensin system. Altered salt and calcium intake exert reciprocal linked effects on these hormone systems and blood pressure.
Aim of the study: To study the levels of serum calcium in patients with primary hypertension.
Materials and methods: This analytical study was conducted in the year 2018, at Madha Medical College and Research Institute, Chennai. Totally 100 cases (70 cases and 30 controls) were included in the study. All the patients were subjected to detailed history taking, careful physical examination, and biochemical analysis to exclude secondary hypertension.
Results: Body mass index was independent of gender and electrolyte status, but it was significantly more in those with grade II hypertension. History of headache and chest pain was noticed among men and these patients were suffering from very high blood pressure. In contrast history of palpitation was elicited more among women. The mean value of serum calcium was 8.90 in Grade I systolic BP and8.85 in Grade II systolic BP among cases. The mean value of serum calcium was 9.66 among controls. This is shown in table XV given below. This table clearly shows that the serum Ca++ level was significantly lower among Grade II systolic BP cases studied.
Conclusion: Essential hypertension is a major risk factor for coronary cerebral and renal vascular disease. The etiology for essential Hypertension is not known many theories were postulated. Given the significant changes in Serum Calcium among the Hypertensive population, the community must be motivated to consume a Calcium-rich diet as a form of primary prevention for essential Hypertension.

Key words

Obesity, Smoking, Alcohol, Hypertension, Serum calcium.

Introduction

Hypertension is one of the leading causes of death and disability among adults all over the world [1]. It remains the major risk factor for coronary, cerebral, and peripheral vascular disease. Essential hypertension comprises more than 90% of hypertension. Hypertension is an emerging health problem in India [2]. When the majority of people come to know that they have hypertension they have already advanced into a stage with target organ damage – a fatal stroke or myocardial infarction or irreversible renal failure. Unfortunately, even in developed countries like the United States, fifty million people are found to have hypertension [3]. Of these, 70% are aware of their diagnosis, but only 50% are receiving treatment and only 25% are under control [4]. According to JNC (Joint National Committee) 7 report, in adults aged18 years and above, systolic blood pressure of <120 mm of Hg and diastolic blood pressure of <80 mm of Hg is normal. Systolic blood pressure of 120 – 139 mm of Hg and diastolic blood pressure of 80 – 89 mm of Hg is prehypertension. In stage I hypertension, the systolic blood pressure is 140 – 159 mm of Hg and the diastolic is 90 – 99 mm of Hg. In stage II hypertension, systolic blood pressure is ≥ 160 mm of Hg and diastolic blood pressure is ≥ 100 mm of Hg [5]. In addition to a primary increase in cardiac function propelled by the overactive sympathetic nervous system, primary retention of salt and water by the kidney, other factors contributing to hypertension are hereditary predisposition and high sodium and low potassium intake and excretion [6].

Materials and methods

This analytical study was conducted in the year 2018, at Madha Medical College and Research Institute, Chennai. Totally 100 cases (70 cases and 30 controls) were included in the study. All the patients were subjected to detailed history taking, careful physical examination, and biochemical analysis to exclude secondary hypertension.

Inclusion criteria:

- Patients with primary hypertension.
- Patients whose age was above 18 years were included.
- Both sexes were included.

Exclusion criteria:

- Patients below 18 years.
- Patients with renal failure, Pregnancy.
- Patients with secondary hypertension.
- Patients on non-steroidal anti-inflammatory agents, anti-hypertensives, diuretics, beta-blockers, or stimulants.
- Patients with malignant hypertension.
- Females on oral contraceptive medication.
- Patients with peripheral vascular disease.
- Patients with diabetes mellitus.
- Patients with acute diarrhoeal diseases.

Seventy newly diagnosed essential hypertensive patients attending the medicine OPD or admitted to the medical wards. Thirty healthy people were kept as controls. This control group comprised of normotensive individuals who were attendants of patients with primary hypertension living in the same environment other than their siblings. All the patients were subjected to detailed history taking, careful physical examination, and biochemical analysis to exclude secondary hypertension. Patient's height and weight were measured. The body mass index was calculated using the formula weight/height^2. The patient's hip and waist circumferences were measured. All the peripheral pulses were checked with special attention to carotid and the femoral to detect evidence for early atherosclerosis. An ocular fundus examination was done to detect hypertensive retinopathy. Patients were informed to refrain from smoking or drinking tea or coffee for at least thirty minutes before measuring blood

pressure. Then blood pressure was measured using the following guidelines.

Statistical analysis

The collected data were entered in a Microsoft Excel spreadsheet and analyzed statistically using the epidemiological Information package – 2002 developed by the centers for disease control and prevention, Atlanta in collaboration with World Health Organization. Student 't' values were applied for significance. Significance was considered if the 'p' value was below 0.05. 't' test is used to find out whether or not there exists a mean difference between the two groups. If there is then it attempts to see whether or not there exist statistically significant differences between the means of the two groups.

Results

The mean age distribution for the males in the case and control groups was 52.92 ± 5.52 years and 50.28 ± 5.66 years respectively. The mean age distribution for the females in the case and control groups was 53.31 ± 5.27 years and 51.8 ± 2.17 years respectively. Among the 70 cases studied, there were 38 males and 32 females. Among the 30 controls, there were 20 males and 10 females (**Table – 1**).

The mean body mass index in the case group was 23.73 ± 3.28 and in the control group was 21.36 ± 2.12. 'p' value = 0.00004. This showed that the difference in Body Mass Index between cases and controls was statistically significant. The mean body mass index in male (case group) was 23.78 and controls 20.9, in female case 23.68, and controls 23.62 (**Table – 2**).

Body mass index was independent of gender and electrolyte status, but it was significantly more in those with grade II hypertension (**Table – 3**).

Table – 1: Distribution of cases and controls about age.

Age group (Years)	Cases		Controls	
	No	%	No	%
41 – 50	24	34.3	18	60
51 – 60	46	65.7	12	40
Total	70	100	30	100
Mean	53.1		51.5	
S.D	5.37		5.38	

Table – 2: Distribution of cases and controls concerning body mass index (BMI).

BMI	Cases		Controls	
	No	%	No	%
Underweight <18.5	7	10	3	10
Normal weight 18.5 – 22.9	24	34.3	20	66.7
Overweight 23 – 24.9	15	21.4	6	20
Obese > 25	24	34.3	1	3.3
Total	70	100	30	100

History of headache and chest pain was noticed among men and these patients were suffering from very high blood pressure. In contrast history of palpitation was elicited more among women. Since alcoholism and smoking were noticed among men only in this part of the country, statistical analysis was not attempted for these risk factors (**Table – 4**).

The mean systolic blood pressure for the cases was 172.14 ± 15.12 mm Hg. Similarly, the mean diastolic blood pressure for the cases was 103.29 ±6.07 mm Hg. Since the systolic and diastolic

blood pressure was elevated in cases and it was due to the nature of the disease taken into the study, the statistical analysis was not done. The mean systolic and diastolic blood pressure distribution for the males was 172.63 ± 16.71 mm Hg and 103.42 ± 7.08 mm Hg respectively. Similarly for the females, the mean systolic and diastolic blood pressure distribution was 171.56 ± 13.22 mm Hg and 103.13 ± 4.71 mm Hg respectively. There was no statistical significance in the systolic and diastolic blood pressure among the cases (**Table – 5**).

Table – 3: BMI concerning hypertension.

BMI	Grade I Hypertension		Grade II Hypertension	
	No.	%	No.	%
Underweight <18.5	-	-	6	8.6
Normal 18.6 – 22.9	5	7.1	20	28.6
Overweight 23 – 24.9	4	5.7	11	15.7
Obese >25	2	2.9	22	31.4

Table – 4: Analysis of cases concerning presenting symptoms.

Symptoms	Male		Female	
	No.	%	No.	%
Nil	1	1.4	1	1.4
Headache	7	10	1	1.4
Giddiness	18	25.7	19	27.1
Chest pain	6	8.6	3	4.3
Palpitation	4	5.7	8	11.4
Dyspnoea	2	2.9	-	-

Table – 5: Distribution of systolic and diastolic blood pressure.

Blood Pressure	Cases	Control
	Mean + SD	Mean + SD
Systolic	172.14 ± 15.12	106.53 ± 6.37
Diastolic	103.29 ± 6.07	71.4 ± 4.24

Table – 6: Distribution of cases and controls about serum calcium.

	Case (70)		Control (30)		t value	'p' value
	Mean	SD	Mean	SD		
Serum calcium	8.87	1.071	9.66	0.617	4.62	p<0.05

Serum calcium in the study population varied from 6.9 mg/dl to 10.9 mg/dl. The man and standard deviation and serum calcium among cases was 8.87±1.07 mg/dl while in the control group it was 9.66±0.61 mg/dl respectively. This table clearly shows that the serum calcium level was significantly lower among the hypertension population studied. The mean value of serum calcium was 8.90 in Grade I systolic BP and8.85 in Grade II systolic BP among cases. The mean value of serum calcium was 9.66 among controls. The value shows that the serum Ca++ level was significantly lower among Grade II systolic BP cases studied. The mean value serum calcium was 9.20 in mg/dl Grade I systolic BP of 8.86 in Grade II diastolic BP among cases. The mean value of serum calcium was 9.66 among controls (**Table – 6**).

Discussion

Hypertension is one of the leading causes of death and disability among all over the world. Hypertension the most common form and cardiovascular disease is present nearly 25% of adults and increases in prevalence with age [7]. It remains the major risk factor for coronary, central, and peripheral vascular disease. Essential hypertension comprises more than 90% of hypertension [8]. Patients were studied based on clinical parameters and simple biochemical investigations serum calcium and albumin was done for all the patients. Serum calcium was lower in the hypertensive group than the control group even though both were within the normal range [9]. The mean and standard deviation of serum calcium among cases was 8.87±1.07 mg/dl while in the control group if was 9.66±0.61mg/dl respectively [10]. Our study was supported by Esler M, et al.; in his study serum, calcium levels were measured in 117 subjects with E.T. and 77 first-degree relatives. The results showed that serum calcium levels significantly ($p<0.01$) decreased in both males: females with essential hypertension and their first-degree relatives [11] when compared with the normotensive controls. This is the first study in the Indian population. With the use of sex-specific multiple linear regression model with age calcium and body mass index cholesterol, HDL, triglycerides, systolic and diastolic blood pressure, and pulse as possible covariates, serum calcium was significantly ($p<0.001$) and positive association with systolic and diastolic blood pressure, serum cholesterol and HDL cholesterol in both sexes [12]. Fisher NDL study shows that disturbance of calcium metabolism has been described in hypertension, measurement of plasma and serum concentration of ionized calcium, total calcium, magnesium, and serum were made in 38 patients with E.T. and age and sex-matched control subjects. Urinary excretion of calcium, magnesium, and sodium was also determined. The mean serum concentration and ionized calcium were 1.23±0.04 (SD) mmol/l in the HT group and 1.21±0.03mmol/l in control and results were similar after correction for pH. There was a weak positive correlation between serum ionized calcium pH 7.4 and systolic pressure ($r=0.26$, p less than 0.02) but no correlation with plasma renin concentration. Although the difference between serum total calcium concentration in the hypertensive (2.29±0.09 mmol/l) and control (2.26±0.01 mmol/l) subject was not significant, there was a significant correlation between total calcium and systolic pressure ($r=0.23$, $p<0.05$) which was maintained after correction for other variables [13]. Gupta R, et al. study conducted in Johannesburg, South Africa, states that the heterogeneous status of magnesium and calcium metabolism in the hypertensive population may be related to the plasma renin activity (PRA). 39 normotensive (20 black, 19 white) and 47 hypertensives (2 black, 22 white) subjects were studied. PRA and ionized calcium were significantly lower in black hypertensive as compared with the white hypertensive group (1.99±0.3 vs 5.6±1.02ng) ml/h for RA; 1.28±0.07 vs 1.42±0.01mmol/l for ionized calcium: black hypertensives as compared with white hypertensives group ($p<0.05$). Ionized calcium was significantly increased ($p<0.05$) in the white hypertensive patient as compared with the normotensive control (1.42±0.01 vs 1.29±0.04 mmol/l) [14]. Harrap SP study states that serum ionized calcium and pH: effects of blood storage, some physiological, influences of comparison between normotensive and hypertension subjects. We proceeded to examine a group of age, sex, and race matched hypertension and normotensive subjective under standardized conditions designed to minimize such technical and physiological artifacts. Ionized calcium was not significantly different in the two groups. However, serum pH was significantly elevated in the hypertensive group. In the combined group of normotensive and hypertension subjects, serum pH was significantly correlated with blood pressure [15]. In Illiadou, et al. study states that a pattern of negative calcium balanced with lowered levels of serum ionized calcium (ca2+) increased urinary excretion of calcium has been reported in hypertensive men. In a present study, 10 untreated hypertensive subjects were salt loaded (20-gram Nacl) for one week after a weak

on a low salt diet (3g). The change in mean blood pressure at the end of the high compared with the low salt diet was called salt sensitivity and was related to the index of mineral metabolism. It was found that salt sensitivity and was related to indexes of mineral metabolism. It was found that salt sensitivity was significantly correlated with both plasma ionized ca+ and serum calcium concentration both r=0.64, p<0.05 on a different diet. Salt loading increased the urinary excretion and calcium by 95% and also induced a reduction in Hb, serum albumin, and serum calcium (p<0.0001) [16]. In conclusion, low levels and plasma ionized calcium and serum calcium where mainly support in hypertensive subjects with low sensitivity to salt. The findings support the view that calcium metabolism is related to the regulation of BP. Concerning blood pressure, the clinical trial findings when calcium intake is increased are conflicting, but there is a trend toward a positive effect with calcium supplements of 1.0 to 1.55 per day. The findings have been highly variable across studies and within studies but the largest study (TOHP) - Trials and Hypertension Prevention Study found no significant blood pressure-lowering at 600 mg per day. Investigators have analyzed their data retrospectively and found subgroups and "calcium responders". These responses had persistently lower blood pressure. An analysis of salt sensitivity has been made, but a similar practical problem arises [17]. There are no independent and prospective means of identifying that blood pressure will respond to calcium, just as there is no means of determining salt sensitivity before actually implementing therapy (or) experimental study [18]. Diuretics and other pharmacological agents have a generally beneficial effect on all treatment candidates.In our study, the mean BMI among the study group was 23.73 ± 3.28 and among the control group was 21.36 ± 2.12. The 'p' value was .00004. This shows that overweight and obesity also plays a role in the development of essential hypertension [19]. In further analyses across centers, median body mass index was related significantly to median systolic blood pressure, median diastolic pressure, and the prevalence of hypertension in both men and women. Body mass index was related to the slopes of systolic and diastolic blood pressure with age in women, but not in men [20].

Conclusion

Serum calcium was significantly less among hypertension and correlated negatively with blood pressure. In view of the significant changes in serum calcium among the hypertensive population, the community must be motivated to consume a calcium-rich diet as a form of primary prevention for essential hypertension. Efforts were also made to final out a between body mass index and waist circumference with systolic and diastolic blood pressure. Blood mass index was significantly more in those with stage II hypertension, however, it was independent of gender and Serum Calcium. Mean serum calcium level was significantly lower among hypertensive when compared to healthy controls. The blood pressure also correlated positively with body mass index and waist circumference whereas negatively correlated with serum calcium.

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