

Comparative Study of Serum Calcium, Magnesium and Zinc Levels in Preeclampsia and Normal Pregnancy

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Research Article

Abstract: The study of serum calcium, magnesium and zinc in preeclampsia proposes the value these biomarkers as indicators in the etiopathogenesis and assessing severity of preeclampsia. Serum levels of calcium, magnesium and zinc were estimated in sixty preeclampsia patients admitted in obstetrics and gynecology department of G.M.C., Nagpur and sixty normal healthy pregnant controls. The result of the study showed that serum calcium, magnesium and zinc levels were decreased significantly in the preeclampsia group compared to the normal pregnant group. Furthermore when levels of serum calcium, magnesium and zinc were correlated with the blood pressure in preeclampsia patients, significant negative correlation was observed. Thus it is concluded that serum calcium, magnesium and zinc can be considered as factors having a role in the etiopathogenesis of the disease and as severity indicators in preeclamptic women.

Keywords: Preeclampsia, Pregnancy, Calcium, Magnesium, Zinc, Cross sectional study.

1. Introduction

Human pregnancy is a physiological stress associated with many complex and interrelated biochemical, physiological and anatomical alterations occurring in the body. More emphasis is laid on the biochemical changes seen in the blood during the normal pregnancy and are exaggerated in various complications of pregnancy like preeclampsia. Hypertensive disorders are the most common medical complications that develop during pregnancy [1] and form a triad along with hemorrhage and infections which together are responsible for large number of maternal deaths [2]. In pregnancy hypertension, preeclampsia is the most frequently encountered hypertensive disorder with medical complications occurring during pregnancy [3]. According to WHO's World Health Report 1998, Preeclampsia is defined as "the development of hypertension ($>140/90$ mm of Hg) after 20 weeks of pregnancy in a woman with proteinuria with or without edema and without previous history of hypertension" [4]. Overall world wide incidence of Preeclampsia is 4-8% [5,6]. But in India, incidence is 5-15% [7]. In spite of various attempts to

understand the primary etiology behind this vascular dysfunction, no particular theory regarding its origin has been established yet and this limits the ability to prevent and treat this medical condition. Nutritional deficiencies are commonly found in pregnant women in developing countries. Deficiency of several essential micronutrients may be a predisposing factor in the development of preeclampsia. The results of many studies have documented that changes in the concentration of minerals like calcium, magnesium and zinc may have a role as etiopathogenesis of preeclampsia [8]-[10]. Comparisons of serum levels of calcium, magnesium and zinc in normal pregnancy and preeclamptic pregnancy may help in identifying whether changes in the levels of these nutrients are contributory to the causation of preeclampsia. This study may help in better understanding of the pathophysiology behind preeclampsia. Further, the work will initiate a general public awareness over improving the overall health of a pregnant woman by taking food rich in these nutrients. Additionally very few studies have been carried out in the central Indian scenario where a majority of the population is from poor socio-economic strata and consumption of these nutrients is low. Hence there is a constant need to conduct studies on this subject in Indian setup. Hence the aim of the study was to measure and compare the levels of serum calcium, magnesium and zinc in preeclamptic pregnancies with normal pregnant women.

2. Material and Methods

The present study was conducted in the department of Biochemistry of Government Medical College, Nagpur for duration of one and half years.

2.1 Study design

Hospital based cross-sectional study with comparison groups.

2.2 Study population

Sixty preeclampsia patients and sixty healthy pregnant women.

2.3 Inclusion criteria

Preeclamptic primigravidae in the third trimester of pregnancy, age between 18-35 years, BP>140/90 mm Hg in third trimester, urinary albumin \geq 1+ dipstick or 300 mg per 24 hour urine, normal pregnant women in the third trimester were taken as controls.

2.4 Exclusion criteria

Multigravidae, previous history of diabetes, hypertension, thyroid or renal disorders, dyslipidemia, family history of preeclampsia, previous history of convulsions.

2.5 Collection of blood sample

5 ml blood was collected from forearm veins in a plain bulb. Blood was allowed to clot. Serum was then separated by centrifugation.

Parameters were estimated with methods as follows

No.	PARAMETER	METHOD
1.	Serum Calcium	O-Cresolphthalein Complexone [OCPC] method [11]
2.	Serum Magnesium	Calmagite colorimetric method [12]
3.	Serum Zinc	Nitro PAPS colorimetric method [13]

2.6 Statistical analysis

- All the values were expressed as mean \pm SD
- p value<0.05 was considered as statistically significant, that<0.001 was considered as highly significant
- Pearson's correlation coefficient (r) was calculated to assess the correlation between biochemical parameters and the blood pressure
- Data was analyzed using STATA version 10.0 software.

3. Result

3.1 Demographic & anthropometric data

Mean age, gestational age and body mass index between the preeclampsia cases and healthy pregnant controls were not significantly different.

Parameter	Cases (n=60)	Controls (n=60)	p-value	Significance
Age (years)	23.13 ± 2.75	22.81 ± 2.48	0.5098	Non Significant
Gestational Age (weeks)	34.2 ± 2.40	34.45 ± 2.38	0.5685	Non Significant
BMI (kg/m^2)	22.75 ± 1.99	23.01 ± 2.02	0.4854	Non Significant

3.2 Vital parameters

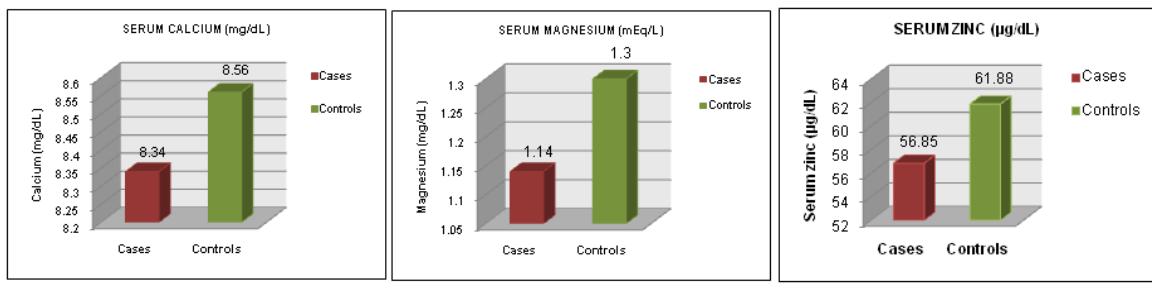
The mean systolic, diastolic and arterial blood pressures were increased significantly in the preeclampsia patients compared to healthy pregnant controls.

Vital parameter	Cases	Controls	p-value	Significance
Systolic blood pressure (mm Hg)	167.23 ± 11.58	119.23 ± 8.79	<0.0001	Highly significant
Diastolic blood pressure (mm Hg)	103.4 ± 8.22	77.56 ± 5.32	<0.0001	Highly significant
Mean arterial pressure (mm Hg)	124.6 ± 8.39	91.4 ± 5.29	<0.0001	Highly significant

3.3 Biochemical parameters

Serum calcium, magnesium and zinc levels were decreased statistically highly significantly in preeclampsia patients as compared to healthy pregnant controls.

Parameter	Cases	Controls	p-value	Significance
Serum calcium (mg/dL)	8.34 ± 0.27	8.56 ± 0.33	<0.0001	Highly significant
Serum magnesium (mEq/L)	1.14 ± 0.12	1.30 ± 0.08	<0.0001	Highly significant
Serum zinc ($\mu\text{g}/\text{dL}$)	56.85 ± 8.31	61.88 ± 6.6	0.0004	Highly significant



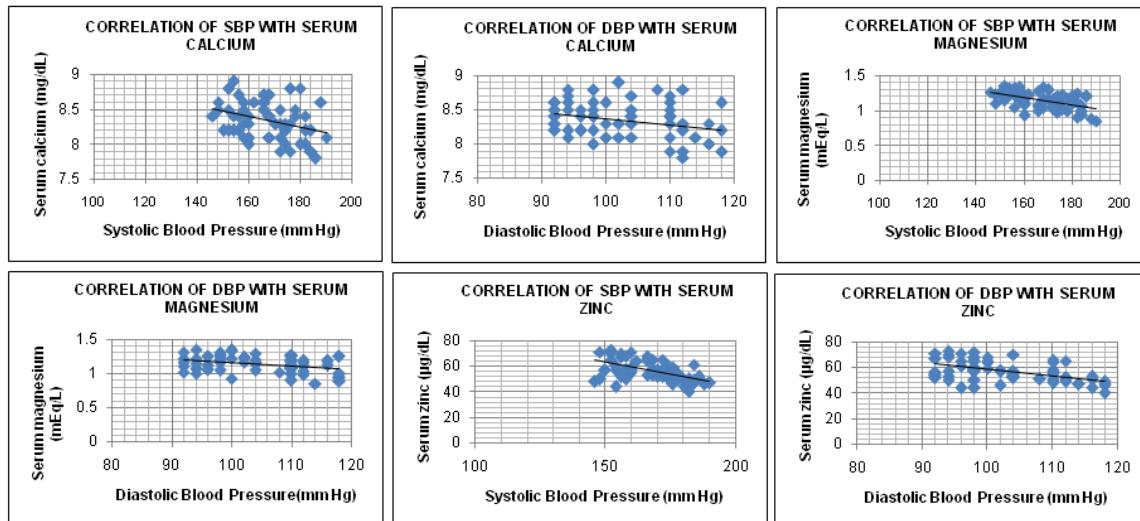
3.4 Correlation of severity

When serum calcium, magnesium and zinc levels were correlated independently with systolic and diastolic blood pressure, a significant negative correlation was obtained.

Parameter	Systolic Blood Pressure	Diastolic Blood Pressure
Serum calcium	$r = -0.3305; p = 0.0099$	$r = -0.2839; p = 0.0279$
Serum magnesium	$r = -0.5359; p < 0.0001$	$r = -0.3273; p = 0.0107$
Serum zinc	$r = -0.5371; p < 0.0001$	$r = -0.5078; p = <0.0001$

where r - Karl Pearson correlation Co-efficient (-1 to +1).

$p < 0.05$ = statistically significant; $p < 0.001$ = highly significant.



4. Discussion

The present study was undertaken to compare the changes which may occur in the levels of serum calcium, magnesium, copper and zinc in preeclampsia patients and normal pregnant women both in the third trimester of pregnancy and to assess the role of these elements in the etiopathogenesis of preeclampsia. The study group and the control group were comparable with each other in respect to demographic parameters and anthropometric parameters. Pregnant women with higher body mass index are more likely to develop hypertension than those with lower BMI. [14] However in this study; both the groups were comparable on the basis of BMI. Hence BMI was excluded as an etiological factor in preeclampsia.

4.1 Serum Calcium

Serum calcium level in the healthy pregnant women was decreased in our study. Zuzana Adamova et al [15], Chavintya Punthumapol & B

Kittichotpanich [6] have also documented reduced calcium levels in pregnant women in their studies. This might be due to increased fetal demand, inadequate dietary intake or hemodilution. Level of serum calcium in the preeclamptic women was decreased significantly ($p < 0.0001$) when compared to normal pregnant women. Studies conducted by Aruna Patel et al [9], Selina Akhtar et al [10], Abdelmarouf H. Mohieldeen et al [16] and Indumati V et al [17] also showed significant reduction in serum calcium in the preeclampsia patients. Further when serum calcium was correlated with systolic and diastolic blood pressure, a significant negative correlation was obtained. This suggests a strong relationship between deficiency of calcium and risk of developing preeclampsia. Decreased serum calcium leads to increase in parathyroid hormone level and increase in the membrane permeability. This leads to shift of calcium intracellularly and increase in the vascular smooth muscle

contraction [10], [15]. Low calcium in the serum also elicits 1, 25-dihydroxy cholecalciferol response which stimulates calcium influx into vascular endothelial cells thus increasing the blood pressure [16].

4.2 Serum Magnesium

Pregnancy is a state of physiological hypomagnesaemia [18]. The decrease may occur due to poor dietary intake, hemodilution or expansion of extracellular space. Serum magnesium level in preeclampsia patients in our study was decreased significantly ($p<0.0001$) compared to healthy pregnant women. In addition, a significant negative correlation was obtained when serum magnesium was correlated with both systolic and diastolic blood pressure. This demonstrated that as serum magnesium decreased, severity of preeclampsia increased. Results of our study corroborated with the studies conducted by Chanvitya Punthumapol and Boonsri Kittichotpanich [6], Leila Farzin et al [8] and Arpita Singh et al [18]. Reduction in the level of extracellular magnesium causes partial membrane depolarization and decreased repolarization along with opening of membrane calcium channels leading to shift of calcium intracellularly. This phenomenon produces vasoconstriction and rise in the blood pressure [8], [17]. Further it has been said that low serum magnesium increases endothelin-1 mediated smooth muscle contraction and hampers the release of prostacyclins from the endothelial cells of the umbilical arteries again manifesting as increase in the blood pressure [19].

4.3 Serum Zinc

Maternal serum zinc reduces in pregnancy due to increased fetal demand, inadequate dietary intake of zinc etc [20]. In preeclamptic study group, serum zinc was decreased statistically significantly ($p=0.0004$) compared to normal pregnant women. When serum zinc was correlated with systolic and diastolic blood pressures, significant negative correlation was found. This result emphasized that decrease in serum zinc may have a strong relationship with both the risk of development and severity of preeclampsia. Findings obtained in our study were supported by Leila Farzin et al [8], Selina Akhtar et al [10], Jain S. et al [21] and O. Akinloye et al [22]. It has been well implicated that oxidative stress and lipid peroxidation play an important role in the development of preeclampsia. Zinc dependant enzyme Cu-Zn superoxide dismutase is a potent antioxidant. Hence decrease in the concentration of zinc leads to reduced activity of Cu-Zn SOD and increases the oxidative stress [8], [10], [22].

5. Conclusion

Pregnancy is associated with physiological decrease in the concentration of elements like calcium, magnesium and zinc which is further aggravated in

conditions like preeclampsia. As the severity of preeclampsia increases, more and more reduction in the levels of these analytes is seen in the maternal blood. This association may help in understanding the pathophysiological process behind the development of preeclampsia and may help in establishing strategies for prevention and reduction of severity of this disease. Still further studies are required to find out if whether estimation of these minerals at an early gestational age can be used as a predictive marker for early diagnosis preeclampsia taking into consideration the dietary pattern of the study groups.

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