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Serum Calcium and Magnesium Level in Pre-Eclamptic and Normotensive Pregnant Women: A Comparative study in a Tertiary care Hospital in West Bengal, India

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ABSTRACT

Background: Hypertensive disorders of pregnancy (HDP), particularly pre-eclampsia, remain a major cause of maternal and perinatal morbidity and mortality worldwide. Alterations in serum calcium and magnesium levels have been implicated in the pathophysiology of pre-eclampsia, yet their role remains incompletely understood.

Objectives: This study aimed to assess and compare the serum calcium and magnesium levels in pre-eclamptic and normotensive pregnant women to elucidate their association with pre-eclampsia.

Methods: A hospital-based observational cross-sectional study was conducted among 100 pregnant women (50 pre-eclamptic and 50 normotensive) attending the Department of Obstetrics and Gynaecology, North Bengal Medical College and Hospital, West Bengal, between January 2023 and May 2024. Serum calcium and magnesium concentrations were estimated using standard colorimetric and photometric methods. Sociodemographic and clinical parameters were analyzed, and statistical comparisons were made using SPSS version 22, with p-values <0.05 considered significant.

Results: The two groups were comparable in age, gravida, socioeconomic class, and booking status. Mean systolic and diastolic blood pressures were significantly higher in the pre-eclamptic group (174.4 ± 22.1 mmHg and 107.2 ± 11.2 mmHg, respectively) compared to the normotensive group (119.9 ± 6.6 mmHg and 71.9 ± 7.4 mmHg) ($p<0.001$). Serum calcium levels were significantly lower in pre-eclamptic women (8.1 ± 0.9 mg/dL) than in normotensive women (10.3 ± 0.8 mg/dL) ($p<0.001$), while serum magnesium levels were significantly higher in pre-eclamptic women (4.1 ± 1.1 mg/dL vs. 2.6 ± 0.9 mg/dL; $p=0.016$).

Conclusion: The findings demonstrate a significant alteration in serum calcium and magnesium levels among pre-eclamptic women, suggesting their involvement in the disease's pathophysiology. Hypocalcemia and elevated magnesium may serve as potential biochemical markers for identifying women at risk of developing pre-eclampsia and for improving maternal care strategies.

Keywords: Pre-eclampsia, Hypertensive disorders of pregnancy, Serum calcium, Serum magnesium, Maternal health.

INTRODUCTION

Hypertensive disorders of pregnancy (HDP) represent a significant health challenge globally, particularly in India, where the burden of these conditions impacts both maternal and neonatal outcomes. These disorders are primarily characterized by elevated blood pressure and are classified into four main categories: chronic hypertension, gestational hypertension, pre-eclampsia, and eclampsia. Among these, pre-eclampsia is especially critical due to its severe complications and potential for progression to eclampsia, a life-threatening condition. Pre-eclampsia involves hypertension developing after

20 weeks of gestation accompanied by proteinuria or other systemic disturbances. Eclampsia is the most severe form, marked by the onset of seizures in a woman with pre-eclampsia, and not attributable to other causes.

In India, the prevalence of hypertensive disorders in pregnancy is estimated to affect about 8-10% of all pregnancies. However, the incidence of pre-eclampsia is particularly concerning, affecting approximately 2-5% of these. Variations exist between different regions, with higher rates often observed in rural areas. These differences are likely influenced by disparities in access to healthcare, nutritional status, and socio-economic factors. The burden of hypertensive disorders in pregnancy is substantial and contributes significantly to maternal and neonatal morbidity and mortality in India. These conditions are among the leading causes of maternal deaths, accounting for about 10-15% of maternal mortality worldwide, with higher rates in low- and middle-income countries.

In pre-eclampsia, the disruption of kidney function and alterations in cardiovascular and cellular metabolism can lead to significant changes in the levels of serum electrolytes such as sodium, potassium, calcium, magnesium, chloride, phosphate, and bicarbonate. The disruption of calcium and magnesium homeostasis can contribute to the pathophysiological processes underlying pre-eclampsia and affect the clinical management of this condition. Calcium plays a vital role in various cellular processes, including muscle contraction, nerve transmission, and blood coagulation. It is also pivotal in regulating vascular smooth muscle tone and endothelial function. In normal pregnancy, calcium homeostasis is altered to meet the increased metabolic demands; however, these changes can be exacerbated in pre-eclampsia. Studies have consistently shown that women with pre-eclampsia tend to have lower serum calcium levels compared to normotensive pregnant women. Increased renal loss, altered vitamin D metabolism, and hypoalbuminemia are all probable casual mechanisms for hypocalcemia in pre-eclamptic women.

Magnesium, another critical electrolyte, plays essential roles in over 300 enzyme systems, regulating blood pressure, glycemic control, and protein synthesis. It is also involved in neuromuscular conduction and myocardial excitability. Several studies suggest that women with pre-eclampsia might have lower serum magnesium levels compared to their normotensive counterparts. Potential mechanisms for magnesium depletion include poor dietary intake, increased renal excretion, and altered placental transport. Magnesium acts as a natural calcium antagonist at the vascular smooth muscle level, helping to modulate endothelial function and inhibit vasospasm. Lower magnesium levels may therefore exacerbate the vasoconstriction and hypertension seen in pre-eclampsia.

A deeper understanding of these changes is essential for the development of targeted therapies and the effective management of pre-eclampsia, aiming to reduce its impact on maternal and fetal health. In this context, the present study was conducted to assess the serum calcium and magnesium levels patients diagnosed with pre-eclampsia and compare them with that of normotensive patients in a tertiary care hospital of West Bengal, India.

MATERIALS AND METHODS

Study type and design

The current study was an observational analytical study with a cross-sectional design.

Study setting

The study was conducted in the Department of Gynaecology and Obstetrics of North Bengal Medical College and Hospital, a tertiary care teaching hospital of Darjeeling District of West Bengal, India.

Study period

The study was conducted for 18 months, starting at January of 2023 to May of 2024 in the Department of Gynaecology and Obstetrics of North Bengal Medical College and Hospital.

Study population

The study population consisted of pregnant women of age 18 years or above with singleton pregnancies presenting to the study institution during the period of study.

Inclusion criteria

The inclusion criteria for the study population were –

1. Pregnant women aged 18 years or above
2. Women with singleton pregnancies
3. Rollover test positive

Exclusion criteria

The exclusion criteria for the participants that were considered for the current study were as follows

1. Women with previous history of pre-eclampsia

2. Patients with medical diseases complicating pregnancies like hypertension, diabetes, cardiac, renal, liver disorders and congestive heart failure.
3. Known epileptic patients
4. Multiple pregnancies
5. Pregnant women on drugs like calcium channel blockers, diuretics, drug containing calcium and magnesium
6. Seropositive patients for HIV, HBV, and HCV
7. Patients suffering from TORCH infections
8. Women who did not provide written informed consent.

Sample size and sampling technique

The sample size for the present study was calculated based on the sample size formula for difference between two means:

$N = Z1\text{-}\alpha/22 \text{ X } (S12 + S22) / (x1 – x2)2$

Where,

N = number of sample in each group

S1 = standard deviation of outcome in normotensive group

S2 = standard deviation of outcome in pre-eclampsia group

x1 – x2 = difference between two means

Z = critical value at α level of significance

Considering the level of serum magnesium as the outcome variable, based on the study conducted by Kanagal et al., S1 was considered to be 0.5, S¬2 0.7, and x1 – x2 0.2. At an α of 90%, the final calculated sample size for each group was 50, making the total sample size 100.67

A consecutive sampling technique was utilized to obtain sample for each group. For each patient recruited to pre-eclampsia group, a matched normotensive patient (age, BMI, residence, socio-economic status) was recruited.

Study tools

The following tools were utilized in the present study:

- Stethoscope
- Sphygmomanometer
- Urine dipstick test
- Vials with clot activator
- Serum calcium estimator kit (Arsezano III)
- Serum magnesium estimation kit (Commercially available)
- Pre-designed pretested researcher administered questionnaire

Data collection technique

All mothers admitted to the department of Obstetrics and Gynaecology and fulfilling the inclusion criteria were assessed during their admission. The predesigned pretested questionnaire was administered in each woman to obtain data regarding their sociodemographic and clinical characteristics related parameters. Women at >20 weeks of gestational age with blood pressure ≥140/90 mm Hg on two consecutive separate measurements 4 hours apart, proteinuria >300 mg in 24 hours or urine dipstick +1 in two midstream urine samples collected 4 hours apart, and with/without pedal edema were diagnosed as pre-eclampsia. A consecutive sampling technique was utilized to obtain 50 sample for each group. For each patient recruited to pre-eclampsia group, a matched normotensive patient (age, BMI, residence, socio-economic status) was recruited. Patients with pre-existing hypertension were excluded from the study. In all of the patients, the rollover test was performed. In it, patients lay on their left side for 15 mins, after which their blood pressure was measured. After which they rolled over to supine position, and their blood pressure was measured again after 5 mins. A rise in diastolic blood pressure in the supine position of >20 mmHg was assessed as positive rollover test. Following it, venous blood samples (5 ml) was drawn from each of the patient and sent to the Department of Biochemistry for the measurement of total serum calcium and magnesium. Serum total calcium concentration was measured by colorimetric test using Arsenazo III, while serum total magnesium concentration was determined by photometric test with xylidyl blue. The data regarding serum mineral concentration was logged in the individual study proforma for each of the patients.

Ethical consideration

The Institutional Ethics Committee of North Bengal Medical College & hospital, Darjeeling, reviewed and approved the project before it was carried out.

All of the participants were informed in their own language about the study and their rights for participation before providing data for the researcher-administered questionnaire. The participants were informed about the participant's role

and rights, to clarify that their participation was voluntary, the information was treated confidentially, and they could withdraw from the study at any time.

After the collection of data, the data was cleaned, anonymised and stored in a password protected spreadsheet for data analysis.

Data analysis

The collected data were checked for consistency, completeness and entered into Microsoft Excel (MS-EXCEL, Microsoft Corp.) data sheet. Analyzed with the statistical program Statistical Package for the Social Sciences (IBM SPSS, version 22). Data were organized and presented using the principles of descriptive and inferential statistics. The data were categorized and expressed in proportions. The continuous data were expressed as mean±SD. The data were graphically presented in the form of tables, vertical bars, horizontal bar, pie diagram. Where analytical statistics were performed, a p-value of <0.05 was considered to be statistically significant for the purpose of the study.

RESULTS

The study enrolled 50 women diagnosed with pre-eclampsia (Group A) and 50 normotensive pregnant women (Group B) to assess and compare their sociodemographic characteristics, blood pressure levels, and serum mineral concentrations. The sociodemographic variables, including age, gravida status, place of residence, socioeconomic class, and booking status, showed no statistically significant differences between the two groups, indicating that the study participants were comparable in baseline characteristics. (Table 1)

A significant difference was observed in the blood pressure parameters between the two groups. The mean systolic blood pressure (SBP) in pre-eclamptic women was markedly elevated at 174.4 ± 22.1 mmHg, compared to 119.9 ± 6.6 mmHg in normotensive women ($p<0.001$). Similarly, the mean diastolic blood pressure (DBP) was significantly higher in the pre-eclampsia group (107.2 ± 11.2 mmHg) than in the normotensive group (71.9 ± 7.4 mmHg) ($p<0.001$). (Table 1)

In terms of serum mineral concentrations, the study revealed a significant disparity in calcium and magnesium levels between the two groups. The mean serum calcium level in pre-eclamptic women was 8.1 ± 0.9 mg/dL, which was considerably lower than that in normotensive women (10.3 ± 0.8 mg/dL), with a highly significant p-value of <0.001. (table 2)

Conversely, the mean serum magnesium level was significantly higher in pre-eclamptic women (4.1 ± 1.1 mg/dL) compared to normotensive women (2.6 ± 0.9 mg/dL), with a statistically significant p-value of 0.016. (table 2)

DISCUSSION

The sociodemographic comparison between the two groups showed no significant differences in age ($p=0.818$), gravidity ($p=0.239$), socioeconomic status, booking status ($p=0.539$), and gestational age at presentation (38.4±1.7 weeks for Group A vs. 38.7±1.8 weeks for Group B). These findings were consistent with previous studies, including those by Gol et al., Tavana et al., and Elmugabil et al., who reported similar distributions of maternal age and gravidity in pre-eclampsia and normotensive pregnancies. The study also observed that the majority of participants were from rural areas and belonged to lower socioeconomic classes. However, there was no statistically significant association between socioeconomic status and pre-eclampsia, aligning with findings from Kanagal et al. and Richards et al.

The most significant findings of the study were related to blood pressure and serum mineral levels. Pre-eclamptic women exhibited significantly higher systolic and diastolic blood pressure (SBP: 174.4 ± 22.1 mmHg, DBP: 107.2 ± 11.2 mmHg) compared to normotensive women (SBP: 119.9 ± 6.6 mmHg, DBP: 71.9 ± 7.4 mmHg) ($p<0.001$). These results align with previous studies by Ephraim et al., Tavana et al., and Kanagal et al., reinforcing hypertension as a defining feature of pre-eclampsia.

Regarding serum calcium levels, pre-eclamptic women had significantly lower levels (8.1 ± 0.9 mg/dL) than normotensive women (10.3 ± 0.8 mg/dL) ($p<0.001$). This finding supports the hypothesis that calcium deficiency contributes to pre-eclampsia by promoting vasoconstriction and endothelial dysfunction. Studies by Sukonpan et al., Jain et al., and Elmugabil et al. have similarly reported hypocalcemia in pre-eclampsia, reinforcing the potential benefits of calcium supplementation.

Conversely, serum magnesium levels were significantly higher in pre-eclamptic women (4.1 ± 1.1 mg/dL) compared to normotensive women (2.6 ± 0.9 mg/dL) ($p=0.016$). While some studies, such as Tavana et al. and Udenze et al., found hypomagnesemia in early pregnancy as a risk factor for pre-eclampsia, others, including Elmugabil et al. and Sandip et al., suggested that elevated magnesium levels in pre-eclampsia might reflect a compensatory mechanism or renal dysfunction.

CONCLUSION

The study concluded that there is a significant association between pre-eclampsia and altered serum levels of calcium and magnesium in pregnant women. Specifically, women with pre-eclampsia exhibited significantly lower serum calcium levels and higher serum magnesium levels compared to normotensive pregnant women. These findings suggest that disturbances in calcium and magnesium homeostasis play a critical role in the pathophysiology of pre-eclampsia.

Tables and figures

Table 1. Comparison of pre-eclamptic and normotensive women with respect to their sociodemographic characteristics (n=100)

Factors	Group A	Group B	p-value
	Frequency (%) / mean (SD)	Frequency (%) / mean (SD)	
Age			
18-20	19 (38)	18 (36)	0.818
21-22	9 (18)	12 (24)	
23-24	12 (24)	9 (18)	
25 and above	10 (20)	11 (22)	
Gravida			
1	22 (44)	17 (34)	0.239
2	18 (36)	16 (32)	
3	9 (18)	17 (34)	
>3	1 (2)	0 (0)	
Residence			
Rural	25 (50)	28 (56)	0.239
Urban	25 (50)	22 (44)	
SES			
Class I	5 (10)	10 (20)	0.221
Class II	11 (22)	10 (20)	
Class III	9 (18)	15 (30)	
Class IV	12 (24)	7 (14)	
Class V	13 (26)	8 (16)	
Booking status			
Booked	29 (58)	32 (64)	0.539
Unbooked	21 (42)	18 (36)	
Gestational age	28.4 (1.7)	38.7 (1.8)	0.287
SBP	174.4 (22.1)	119.9 (6.6)	<0.001*
DBP	107.2 (11.2)	71.9 (7.4)	<0.001*

Table 2. Comparison of pre-eclamptic and normotensive women with respect to their sociodemographic characteristics (n=100)

Factors	Group A	Group B	p-value
	Frequency (%) / mean (SD)	Frequency (%) / mean (SD)	
Calcium level (mg/dl)	8.1 (0.9)	10.3 (0.8)	<0.001*
Magnesium level (mg/dl)	4.1 (1.1)	2.6 (0.9)	0.016*

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Conflicts of interests: The authors declare no conflicts of interest.
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