



BIOCHEMICAL ROLE OF MAJOR MINERALS IN PREECLAMPSIA

Biochemistry

Dr. Kanchan V. Virkhede

Resident Doctor, Department Of Biochemistry, IGGMC Nagpur.

Dr. Monali M. Rewatkar

Assistant professor, Department Of Biochemistry, IGGMC Nagpur.

Neha Ghate

MBBS, DMMC DMIHER Nagpur.

Dr Narendra S. Domke*

Medical Officer TCU katol, Nagpur. *Corresponding Author

ABSTRACT

Background - Preeclampsia is pregnancy-specific, multi-systemic syndrome of widespread endothelial malfunction and vasospasm developing after 20 weeks of gestation, defined by hypertension (BP > 140/90 mm Hg), fluid retention and proteinuria. Imbalances in serum sodium and potassium causes vasoconstriction and hypertension in PE. Hypocalcemia stimulates parathyroid hormone, causing vasoconstriction. Magnesium regulates blood pressure by monitoring vascular tone and structure. **Material And Methods**- Analytical cross-sectional study conducted at biochemistry department IGGMC Nagpur, includes 150 pregnancies. Serum Electrolytes, Magnesium, Calcium level were estimated on auto analyzer and compared between two groups. students t -test was used to see the level of significance ($P < 0.01$). **Result**- Serum sodium (142.17 ± 5.66 mmol/L and 136.13 ± 4.17 mmol/L), potassium (3.45 ± 0.54 mmol/L and 3.98 ± 0.36 mmol/L), Magnesium (1.530 ± 0.299 and 1.742 ± 0.226) and calcium (7.9 ± 0.4 and 9.7 ± 0.7) observed in preeclamptic and normotensive respectively. ($p < 0.05$). **Conclusions** - Estimation of serum electrolytes, calcium and during pregnancy could help in early detection and prompt treatment of preeclampsia.

KEYWORDS

Preeclampsia, electrolytes, minerals

INTRODUCTION

Preeclampsia is a hypertensive condition involving multiple systems of the body. It is unique to human pregnancy. The hypertensive condition developing during pregnancy after 20 weeks of gestation is known as Preeclampsia.⁽¹⁾ Preeclampsia is characterized by onset of hypertension (BP \geq 140/90 mmHg) and proteinuria (>300 mg/24hr urine) along with oedema.

Incidence of Pre eclampsia in India is 8-10%, contributing the main cause of maternal and perinatal morbidity and mortality.⁽²⁾

Minerals like sodium, potassium, magnesium and calcium may play a role in preeclampsia since it is a vascular endothelial disorder. Serum sodium and potassium that is important for functioning of vascular smooth muscles, imbalance in electrolytes leads to vasoconstriction and hypertension in PE. Decrease in Calcium levels activates parathyroid hormone, leading to vasoconstriction. Magnesium regulates vascular tone and structure so as to blood pressure.

Biochemical Role Of Major Minerals In Preeclampsia

Preeclampsia affects kidney function, leading to impaired regulation of electrolytes. Proteinuria and reduced glomerular filtration rate (GFR) in pre-eclampsia influences serum electrolyte levels. Changes in sodium and potassium may reflect the renal system's inability to maintain proper electrolyte balance, further complicating blood pressure regulation.

Sodium (Na+):

Hypernatremia is sometimes observed in preeclampsia. Elevated sodium levels may contribute to increased blood pressure by promoting water retention and increasing blood volume, which exacerbates hypertension—a hallmark of pre-eclampsia.

Potassium (K+):

Hypokalemia may also be present in preeclampsia. Potassium is essential for vascular tone regulation and maintaining normal blood pressure. Reduced potassium can worsen hypertension by impairing vasodilation, thereby increasing vascular resistance.

Calcium (Ca2+):

Calcium plays a vital role in vascular smooth muscle contraction and relaxation. Low calcium levels may impair the balance between vasodilation and vasoconstriction, leading to persistent vasoconstriction, increased peripheral resistance, and hypertension.

Calcium also regulates the release of parathyroid hormone and influences the renin-angiotensin system. Hypocalcemia can enhance the sensitivity of vascular smooth muscle to vasoconstrictive agents like angiotensin II, exacerbating hypertension in pre-eclampsia.

Magnesium (Mg2+):

Magnesium is a potent vasodilator and has anti-inflammatory and anti-oxidative properties, which are crucial in the management of hypertension and prevention of endothelial damage in pre-eclampsia. Magnesium acts as a natural calcium antagonist, inhibiting calcium-mediated smooth muscle contraction. Low levels of magnesium contribute to increased vascular tone and resistance, leading to hypertension. Magnesium deficiency is linked to endothelial dysfunction, a key factor in pre-eclampsia. Magnesium can modulate nitric oxide production, which is crucial for maintaining vasodilation and vascular homeostasis. A deficiency in magnesium leads to decreased nitric oxide availability, worsening vasoconstriction. Magnesium has anti-inflammatory properties which helps to decrease the systemic inflammation and oxidative stress which is present in pre-eclampsia.

AIM = to compare the levels of minerals (sodium, potassium, magnesium and calcium) in preeclampsia with normal pregnancy.

MATERIALS AND METHODS

After obtaining institutional ethics committee clearance, this hospital based comparative cross-sectional study was conducted from September 2023 to February 2024 at department of biochemistry, IGGMC Nagpur. 75 preeclamptic and 75 normal pregnancies were selected after fulfilling inclusion and exclusion criteria, by simple random sampling method.

Inclusion Criteria

- Pregnancy with >24 weeks of gestation
- Singleton pregnancy

For Cases

- Blood pressure \geq 140/90 mmhg
- Urine protein – positive

For Controls

- Blood pressure $<$ 140/90 mmhg
- Urine protein - negative

EXCLUSION CRITERIA FOR CASES AND CONTROLS

- Patients, with hypertension <20 weeks.
- Preexisting diabetes mellitus, renal disease, liver disorders, thyroid disorders, epilepsy, heart disease
- Patient with Twin or multiple babies
- Those who do not willing to participate in study.

Under aseptic precautions 5 ml of venous blood sample was collected from antecubital vein in plain vacutainer. This blood sample was allowed to clot and centrifugation done at 3000rpm for 10 minutes. The serum separated and was used to estimate sodium (direct ISE method), potassium (direct ISE method), magnesium (dye binding method) and calcium (arsenazo III method) on XL640 autoAnalyzer (Transasia erba).

Statistical Analysis

Data was compiled in MS Office Excel spreadsheet and analysed using SPSS V: 20(Statistical Package for Social Service). Data variables are expressed in mean and standard deviation. Student's t test applied to see the level of significance. P <0.05 were considered as statistically significant.

RESULTS

The present study included 75 preeclamptic and 75 normal pregnancies.

Table 1 Characteristics Of The Study Participants

Parameters	Normal pregnancy group(n=75)	Pre-eclamptic group(n=75)	p-value
Age in years (mean ± SD)	26.84±4.374	28.19±5.059	0.025
Primigravida(%)	(34%)	(40%)	0.
Secondgravida(%)	(32%)	(30%)	
Multigravida(%)	(33%)	(29%)	

The average age of PE group was 28.19 ± 5.0 and that of comparative group was 26.84 ± 4.4 years. Pre-eclampsia was higher among primigravida (40% in PE) when compared to multigravida women (29% in PE).

Table 2 Association Of Serum Calcium, Magnesium, Sodium And Potassium Levels Among Preeclampsia And Normal Pregnancy Groups

Parameters	Normal pregnancy group (n=75)	Pre-eclamptic group (n=75)	p-value
Serum Sodium (mmol/l) Mean±SD	136.13±4.17	142.17±5.66	P<p00ppppppp K<p < 0.05p5
Serum Potassium (mmol/l) Mean±SD	3.98±0.36	3.45 ± 0.54	
Serum Calcium (mg/dl) Mean±SD	9.7±0.7	7.9±0.4	
Serum Magnesium (mg/dl) Mean±SD	1.742±0.226	1.530±0.299	

The average serum sodium levels in preeclamptics (mean 142.17 ± 5.66 mmol/L), while normal pregnancy comparative group had the serum sodium levels (136.13 ± 4.17 mmol/l). These differences in the serum sodium levels were found to be statistically significant. p <0.05.

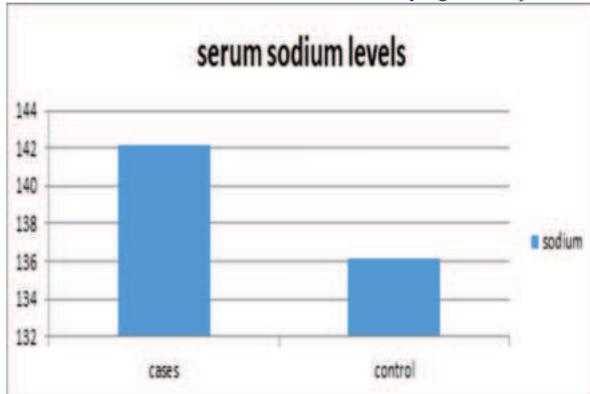


Figure 1 Serum Sodium Levels In Cases And Controls

Serum potassium, calcium and magnesium levels within Pre eclamptic

group (serum potassium: 3.45±0.54 mmol/L, calcium: 7.9±0.4mg/dl, magnesium: 1.530±0.299mg/dl) are decreases as compare to normal groups (serum potassium: 3.98±0.36 mmol/L, calcium: 9.7±0.7mg/dl, magnesium: 1.742 ± 0.226mg/dl). These associations were found to be statistically significant. p <0.05

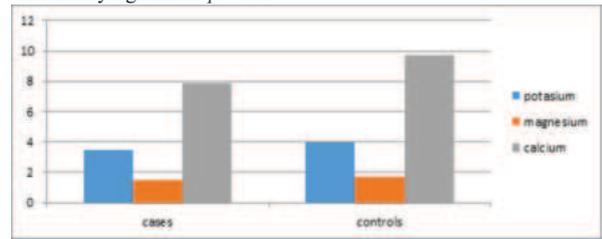


Figure 2 : Potassium Magnesium And Calcium Levels In Cases And Controls

DISCUSSION

The present study was conducted to compare serum sodium, potassium, calcium and magnesium levels between preeclamptic and normal pregnancy group. In this study, preeclampsia was more common among the primigravida (40% of preeclampsia were primigravida). Similar results are found in the study conducted by Guhan VN et al.and Indumati V. et al.

In pre-eclampsia there is decreased production of cyclic GMP, endothelin and PGE2 as well as an increased sensitivity of vasopressor substances like aldosterone. This results in sodium retention and increased peripheral vascular resistance which is responsible for development of hypertension. This increased sensitivity of aldosterone causes hypokalemia. Normally transport of sodium and potassium across the vascular smooth muscle cell membrane, maintains the blood pressure. In my study, hypernatremia and hypokalemia were found in preeclampsia.

In the present study, hypomagnesemia was found in preeclamptic patients (1.530±0.299mg/dl). Similar results are found in the studies conducted by Indumati V. et aland Sayyed AAK et al.

In our study levels of mean serum calcium were significantly lower in severe preeclamptic group (7.9 ±0.4mg/dl) compared to normal pregnancy group (9.7 ± 0.71 mg/dl). Disrupted calcium homeostasis can lead to altered vasoconstrictions. Hypocalcaemia stimulates parathyroid hormone and renin release, which in-turn increase the intracellular calcium in smooth muscle cells, resulting in high sensitivity of these cells to angiotensin II, further causing vasoconstriction and hypertension.

CONCLUSION

Serum sodium, potassium, calcium and magnesium play important roles in the pathophysiology of pre eclampsia. In preeclampsia water and electrolyte imbalances occur, leading to sodium retention and potassium depletion, that lead to peripheral vascular resistance and hypertension. Also, hypomagnesemia, hypocalcaemia are found to be significantly associated with preeclampsia. Serum electrolyte monitoring in pre-eclampsia may improve the early detection and prompt management of pre eclampsia. It also helps to prevent the severity of disease as well as maternal and fetal complications.

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