Assessment of Serum Trace Elements (Zinc, Magnesium, Calcium and Phosphorus) in Pre-Eclampsia

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Abstract

Background: Deficient or excessive levels of blood trace elements can be an adverse factor in pre-eclampsia. During pregnancy, trace elements are important not only for the mother but also for fetal development.

Objectives: To determine and compare the serum levels of zinc (Zn), magnesium (Mg), calcium (Ca) and phosphorus (P) in the pre-eclampsia patients and healthy controls.

Material & Methods: Estimation and comparative study of serum (Zn), (Mg), (Ca) and (P) were determined between 50 Pre-eclampsia patients and 50 healthy controls by using Atomic Absorption Spectrophotometry (AAS) and (Ca) and (P) were determined by using fully automated analyzer. Statistical comparison analyzed, results were expressed as Mean ± SD, $p < 0.05$ was considered statistically significant.

Results: All groups were statistically matched in age distribution ($p > 0.05$). Serum (Zn) concentrations in cases and controls were ($51.14 \pm 4.62 \mu g/dL$) and ($63.00 \pm 6.37 \mu g/dL$) respectively ($p < 0.0001$). Serum (Mg) concentrations in cases and controls were ($1.90 \pm 0.334 mg/dL$) and ($1.5 \pm 0.330 mg/dL$) respectively ($p < 0.0001$). Serum (Ca) concentrations in cases and controls were ($7.65 \pm 0.35 mg/dL$) and ($8.65 \pm 0.34 mg/dL$) respectively ($p < 0.0001$). Serum (P) concentrations in cases and controls were ($4.02 \pm 0.18 mg/dL$) ($3.95 \pm 0.22 mg/dL$) respectively ($p = 0.097$).

Conclusion: Difference in serum (Zn) levels in cases and controls were statistically significant; Serum (Zn) was lower in pre-eclampsia patients as compared to controls. Serum (Mg) was significantly higher in pre-eclampsia patients as compared to controls. Pre-eclampsia patients were found increased serum (Mg) and controls were lower than normal level of serum (Mg). Serum (Ca) was significantly lower in pre-eclampsia patients as compared to controls. Pre-eclampsia patient's shows deficiency of (Ca) and controls were higher than normal value of serum (Ca). Serum (P) was insignificantly higher in pre-eclampsia patients as compared to controls, and both values were within normal range serum (P).

Keywords: Pre-eclampsia (PE), Trace elements, Zinc (Zn), Magnesium (Mg), Calcium (Ca) Phosphorus (P), Atomic Absorption Spectrophotometry (AAS).

Background

Pre-eclampsia (PE) is a multisystemic disorder characterized by triad of high-blood pressure to the extent of 140/90 mmHg or more, edema, and proteinuria, developing after 20 weeks of gestation [1]. The incidence of Pre-eclampsia in pregnancies ranges from 2% to 8% in the world [2-4]. The world health organization reported that preeclampsia is a major reason of mother and fetus morbidity and mortality [5]. There are several literature reported that metabolic- and mineral level changes associated with abnormalities of pregnancy and fetal growth [6-8].

Micronutrients and trace elements play a pivotal role in metabolism and in the preservation of tissue function. Trace elements are important constituents of a number of antioxidants. Therefore they are integral part of a robust antioxidant that protects the cell from damage [9, 10].

Several elemental micronutrients abnormalities (calcium, magnesium, zinc, and phosphorus) play a contributory role in pre-eclampsia [11-16]. However, the results demonstrated in literature describing the associations between serum concentration of zinc, magnesium, calcium, phosphorus in pre-eclampsia subject varied greatly [11, 17-20]. The findings of research on trace elements and pre-eclampsia is an evidence-base and could be implemented for prevention of pre-eclampsia e.g. calcium and zinc supplement [21].

The accurate determination of trace metals was limited by methodology prior to the last three decades. This resulted in a limited knowledge of the concentration of metals in many diseases. Fortunately, this situation is being remedied to a major extent by atomic absorption spectrophotometry and fully automated analyzer.

Material and Method: This study designed to analyzed and compare serum zinc, magnesium, calcium and phosphorus levels between pre-eclampsia patients and healthy controls. The study included assessment of serum zinc, magnesium, calcium and phosphorus status in 100 subjects, among them were 50 pre-eclampsia patients admitted in the obstetrics gynecology department of S.R.G. Hospital, Jhalawar (Rajasthan), and 50 healthy controls without any clinical symptoms or disease. Diagnosis of pre-eclampsia, history and physical findings with supportive biochemical evidence were taken as criteria. Comparison of serum zinc, magnesium, calcium and phosphorus in both these groups was done to study the effect of pre-eclampsia on trace element status.

Inclusion Criteria

Patients with history and physical findings of pre-eclampsia. biochemical analysis suggestive of pre-eclampsia. Pregnant female above the age of 18 years.

Exclusion Criteria

Patients with diabetes mellitus, previous history of hypertension before pregnancy, history of anti-thyroid drugs, chronic use of medicine (e.g., steroids, anti-cancer drugs). Any systemic disease (connective tissue disorders, liver disease, chronic kidney disease, other endocrine disorders and psychiatric disorders).

Statistical Analysis

The Statistical software SPSS 15.0 was used for the analysis of the data. Descriptive statistical analysis was carried out in the present study. Results on continuous measurements were presented on Mean ± SD and results on categorical measurements were presented in Number (%). Significance is assessed at 5 % level of significance. Student t test (two tailed,

independent) has been used to find the significance of study parameters on continuous scale between two groups.

Results

This cross-sectional study was done in Department of Biochemistry, Jhalawar

Medical College and Hospital, Jhalawar (Rajasthan) from May 2021 to December 2021. Fifty patients of pre-eclampsia and 50 healthy controls were selected for study. The final observations and results were tabulated .Comparison of age distribution between Group – I and Group – II presented in Table – 1. The present observation shows that the mean age of pre-eclampsia patients was (26.28 ± 4.94 years) and the mean age in healthy controls was (25.46 ± 4.98 years). Statistical analysis showed that p – value between the two groups was 0.411, i.e. (p > 0.05) therefore the age difference in both groups was statistically insignificant.

Comparison of serum zinc concentration in cases and controls was statistically analyzed using unpaired – t test. The mean serum zinc concentration in pre-eclampsia patients was found to be (51.14 ± 4.62μg/dL). The mean serum zinc concentration in healthy controls was found to be (63.00 ± 6.37μg/dL) as shown in table 2. Statistical analysis showed that p – value was <0.0001* therefore the difference in serum zinc concentration in both groups was statistically significant.

Comparison of serum magnesium concentration in cases and controls was statistically analyzed using unpaired – t test. The mean serum magnesium concentration in pre-eclampsia patients was found to be (1.90± 0.334 mg/dL). The mean serum magnesium concentration in healthy controls was found to be (1.50 ± 0.330 mg/dL) as shown in table 3. Statistical analysis showed that p – value was <0.0001* therefore the difference in serum magnesium concentration in both groups was statistically significant.

Comparison of serum calcium concentration in cases and controls was statistically analyzed using unpaired – t test. The mean serum calcium concentration in pre-eclampsia patients was found to be (7.65 ± 0.35 mg/dL). The mean serum calcium concentration in healthy controls was found to be (8.65 ± 0.34mg/dL) as shown in table 4. Statistical analysis showed that p – value was <0.0001* therefore the difference in serum calcium concentration in both groups was statistically significant.

Comparison of serum phosphorus concentration in cases and controls was statistically analyzed using unpaired – t test. The mean serum phosphorus concentration in pre-eclampsia patients was found to be (4.02 ± 0.18mg/dL). The mean serum phosphorus concentration in healthy controls was found to be (3.95 ± 0.22mg/dL) as shown in table 5. Statistical analysis showed that p – value was 0.097, i.e. (p > 0.05) therefore the difference in serum phosphorus concentration in both groups was statistically insignificant.

Table 1: Distribution of Age According to Groups

Group	N	Mean (μg/dL)	Std. Deviation	t-value	p-value
Group – I Case	50	26.2800	4.94888	0.826	0.411
Group – II Control	50	25.4600	4.98246		

Table 2: Comparison of Serum Zinc in Case and Control

Group	N	Mean (μg/dL)	Std. Deviation	t-value	p-value
Group- I Case	50	51.1400	4.62032	10.651	
Group –II Control	50	63.0000	6.37598		<0.0001*

Table 3: Comparison of Serum Magnesium in Case and Control

Group	N	Mean (mg/dL)	Std. Deviation	t-value	p-value
Group- I Case	50	1.9040	0.33440	5.981	<0.0001*
Group- II Control	50	1.5060	0.33099		

Table 4: Comparison of Serum Calcium in Case and Control

Group	N	Mean (mg/dL)	Std. Deviation	t-value	p-value
Group- I Case	50	7.6580	0.35634	14.163	<0.0001*
Group- II Control	50	8.6560	0.34827		

Table 5: Comparison of Serum Phosphorus in Case and Control

Group	N	Mean (mg/dL)	Std. Deviation	t-value	p-value
Group- I Cas	50	4.0200	0.18736	1.0674	0.097
Group- II Control	50	3.9500	0.22879		

Discussion

In the pre-eclamptic women, the decrease serum concentrations of Zn partly the result of reduced estrogen and Zn-binding protein levels [22]. Study shows that Zn deficiency causes an increased in lipid peroxidation [23] and zinc may play a role in pre-eclampsia through an increase of lipid peroxidation.

High serum magnesium concentration in pre-eclampsia patients observed in our study could be attributed to multiple causes. Many hospitalized patients regularly prescribed antacids, enemas and parenteral fluids which contain exceptionally high concentration of magnesium [24], the resulting increased concentration of serum magnesium was observed in our study, could in part be attributed to excessive intake in form of therapeutic measures in ill patients. Study demonstrated that magnesium counteracts calcium-dependent release of acetylcholine at motor endplates [25]. Thus, magnesium may be regarded as a natural 'calcium antagonist'. In our study we observed that serum calcium was significantly lower in pre-eclampsia patients than healthy controls.

During pregnancy, there is a progressive decline in concentration of calcium in maternal serum possibly due to hemodilution, increased urinary excretion, and increased transfer of these minerals from the mother to the growing fetus [26-28]. In addition, low dietary intake and accelerated metabolism might be other contributing factors [29,30]. Several study reported a link between low dietary calcium intake with increased incidence of pre-eclampsia, and supplementation of calcium were found to prevent pre-eclampsia and its related complications [31–34,35]. Previous studies reported in literature a link between low dietary calcium intakes with increased incidence of pre-eclampsia. Supplementation of calcium reported to prevent pre-eclampsia [36,37]. The existing increased in the foetal Ca^{2+} demand may also block bone resorption of Ca^{2+} with a concurrent intracellular pull [38,39]. This phenomenon produces vasoconstriction together with an increased in the blood pressure, as seen in PIH and PE.

In early pre-eclampsia (PE), placental expression of the sodium-dependent phosphate transporters Slc20a1 and Slc20a2 is highly reduced; however in late PE, Slc20a2 is significantly increased [40]. Maternal phosphate excretion increases

during pregnancy with maximum phosphate urine levels observed during the third trimester [41]. Some study described that renal excretion of phosphorus decreased in pre-eclampsia with women compared to normotensive women [42,43-45], as aresult of a compensatory mechanism of decreased renal filtration rate and increased tubular reabsorption of phosphorus in toxemia [42,45]. Phosphate metabolism is regulated by bone-derived FGF-23 and PTH, which influence the renal production and circulating concentrations of the active metabolite of VD, 1,25-hydroxyvitamin D [1,25(OH)D], which affects bone metabolism, intestinal absorption of calcium and phosphorus, and hypertension and vascular calcification [46].

Conclusion

This study was a study designed to measure and compare serum zinc, magnesium, calcium and phosphorus levels in pre-eclampsia patients and healthy controls. Serum trace element levels in pre-eclampsia patients had a great impact on patient's general condition and might damage to kidneys, liver, lung, heart, or eyes, and may cause a stroke, chronic hypertension, metabolic disorders or other brain injury or even death that may arise decades after pre-eclampsia. In present study patients of pre-eclampsia women found abnormal level of trace elements and determination of trace element in pregnant women important in diagnosis, prognosis and medical management of preeclampsia disease.

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