RESEARCH ARTICLE

SERUM TOTAL CALCIUM, MAGNESIUM, SODIUM AND POTASSIUM IN SUDANESE WOMEN WITH PREECLAMPSIA.

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Abstract

Preeclampsia is characterized by new-onset hypertension, proteinuria and is responsible for substantial maternal and fetal morbidity. The electrolytes like sodium, potassium and chloride contribute significantly in the functioning of the vascular smooth muscles and may play an important role in hypertension. This study was carried out to measure serum levels of sodium, potassium, magnesium and calcium in preclamptic women. Sixty blood samples were collected from patients in period between June to October 2016, chosen from Omdurman Maternal hospital (thirty of them used magnesium sulfate as supplement and thirty not used supplement) and sixty normal pregnant women as control. Serum sodium and potassium were measured by using ion selective electrode (Easlyte), while serum magnesium and serum calcium were measured by using Mindray 380.

The study showed that, women with preeclampsia had significantly lower levels in means serum total calcium, magnesium, and potassium (7.34±0.51mg/dL) vs. (8.58±0.71mg/dL) P<0.05, (1.29±0.23mmol/L) vs (1.83±0.32 mmol/L), and (3.08±0.24 mmol/L) vs 3.55±0.34 mmol/L) p value <0.05 respectively. There was significant increase in mean of serum sodium in women with preeclampsia compared to control group (144.57±3.93 mmol/L) vs (138.27±3.8 mmol/L) p value <0.05.

There was significantly positive correlation between serum magnesium in preeclamptic women used magnesium sulfate and preeclamptic women not used magnesium sulfate ( r= 0.3 / p= 0.049), while there were weak negative correlations between serum calcium and potassium in these two groups.

Introduction:

Hypertensive disease of pregnancy (HDP) is one of the most common complications of pregnancy, occurring in 5-8% of the pregnancies3. Hypertensive disorders are the second most common cause of maternal deaths worldwide (3). There are several major categories of hypertensive disorders in pregnancy ranging from mild to moderate rise in blood pressure without proteinuria (usually called pregnancy induced hypertension (PIH)), preeclampsia (hypertension with proteinuria), severe preeclampsia and eclampsia3. Maternal hypertension, even of the mild to

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moderate category, can lead to adverse perinatal outcomes like low birth weight, pre-maturity, stillbirth and intrauterine growth retardation \(^{(4)}\).

Hypertension results primarily from the interplay of internal derangements (primarily in the kidney) and the external environment. Sodium, the main extracellular cation, has long been considered the pivotal environmental factor in the disorder. Numerous studies show an adverse effect of a surplus of sodium on arterial pressure \(^{(5, 6)}\). By contrast, potassium, the main intracellular cation, has usually been viewed as a minor factor in the pathogenesis of hypertension. However, abundant evidences indicates that potassium deficit has a critical role in hypertension and its cardiovascular development \(^{(7,8)}\).

Calcium plays a critical role in the function of the cardiac and vascular smooth muscles. It is known that the deficiency of calcium may lead to irritable nervous muscular symptoms, even tetanic convulsions, bleeding diathesis, capillary haemorrhages, tissue exudation and osteomalacia. These features have got some resemblance to the clinical manifestations and pathological findings in pregnancy induced hypertension (PIH), particularly eclampsia. Increase in the intracellular calcium causes vasoconstriction, increase in the peripheral resistance and therefore, an increase in the blood pressure \(^{(9)}\). Magnesium modulates the cardiovascular effect of sodium and potassium and it is the cofactor for the sodium potassium ATPase activity \(^{(10)}\). Since the electrolytes: calcium, magnesium, sodium and potassium contribute significantly in the functioning of the vascular smooth muscles, the present study was designed to evaluate the role of these electrolytes in the genesis of PIH.

**Materials and Methods:**

**Study Population:** The study was carried out at College of Medical laboratory Sciences, and the subjects were recruited from Omdurman Maternal hospital, in Khartoum(Sudan) from June to October 2016. A total of 120 pregnant women were enrolled in this study ; divided into three groups, 60 healthy normotensive pregnant women (Control group), 30 pregnant women with preeclampsia , and 30 women with preeclampsia under magnesium sulfate as treatment. The study was approved by hospital’s ethics committee. Informed consent was obtained from patients before blood sampling.

**Inclusion criteria:**

Patients with an onset of hypertension more than 140/90 mmHg during the second or third trimester of pregnancy, Excretion of more than 300 mg of urinary Protein per 24 hrs, edema, Patients with or without convulsions.

Control- pregnant women with normal Blood Pressure, absence of proteinuria and without any other systemic or endocrine disorder and age-matched with the cases. All subjects included were in their third trimester (gestational age of ≥24 weeks).

Exclusion criteria Patients with congestive heart failure, Diabetes mellitus, kidney disease, thyroid and parathyroid disorders, cirrhosis of the liver, alcoholics and any other systemic disease were excluded from the study.

**Blood sample and Analysis:**

About 2ml of venous blood was collected from the antecubital vein by taking aseptic precautions. Care was taken to prevent venous stasis during the sample collection. The blood was allowed to clot and the serum was separated by centrifugation. The estimation of the parameters was carried out within 4-6 hrs. The samples were analyzed for serum total calcium by the O-Cresolphthaleincomplexone method \(^{(11)}\), serum magnesium by the calmagite dye method \(^{(12)}\) and for serum sodium and potassium by Electrolyte analyzer (easylyte). The internal control sera of two different levels were used to calibrate the instruments.

Data was analyzed using SPSS computer program, the mean and standard deviation were obtained and the independent 't.test' used for comparison (p value of ≤ 0.05) was considered significant.

**Results:**

The mean age of the preeclamptic patients was 29.4 ± 5.2 years (range 19-40), while in preeclamptic group under magnesium sulfate treatment with magnesium sulfate was 29.2±4.9 year, and in control group was 29.6±4.6 years with p value (0.89, 0.78 respectively).
In comparison with the controls, women with preeclampsia had significantly lower means of serum total calcium, magnesium, and potassium (7.34±0.51 mg/dL) vs. (8.58±0.71 mg/dL) P<0.05, (1.29±0.23 mmol/L) vs (1.83±0.32 mmol/L), and (3.08±0.24 mmol/L) vs (3.55±0.34 mmol/L) P value <0.05 respectively. There was significant increase in mean of serum sodium in women with preeclampsia compared to control group (144.57±3.93 mmol/L) vs (138.27±3.8 mmol/L) p value <0.05 as in table 1.

Table 1: means comparisons of serum calcium, magnesium, sodium and potassium in preeclamptic women compared to control group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Patients (mean ± SD)</th>
<th>Control (mean± SD)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (mg/dL)</td>
<td>7.34±0.51</td>
<td>8.5±0.71</td>
<td>0.000</td>
</tr>
<tr>
<td>Magnesium(mg/dL)</td>
<td>1.29±0.23</td>
<td>1.83±0.32</td>
<td>0.032</td>
</tr>
<tr>
<td>Sodium(mmol/L)</td>
<td>144.57±3.93</td>
<td>138.27±3.80</td>
<td>0.000</td>
</tr>
<tr>
<td>Potassium(mmol/L)</td>
<td>3.08±0.24</td>
<td>3.55±0.34</td>
<td>0.041</td>
</tr>
</tbody>
</table>

Results expressed as Mean ±SD and significant differences considered as p-value ≤0.05.

Table 2: means comparisons of serum total calcium, magnesium, sodium and potassium in preeclamptic women used magnesium sulfate compared to preeclamptic women not used magnesium sulfate.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Preeclamptic women used magnesium sulfate N=30</th>
<th>Preeclamptic women not used magnesium sulfate N=30</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (mg/dL)</td>
<td>7.3± 0.5</td>
<td>8.01± 1</td>
<td>0.000</td>
</tr>
<tr>
<td>Magnesium(mg/dL)</td>
<td>3.0 ± 0.8</td>
<td>1.3± 0.2</td>
<td>0.000</td>
</tr>
<tr>
<td>Sodium(mmol/L)</td>
<td>136.4± 4.7</td>
<td>144.7 ±3.9</td>
<td>0.02</td>
</tr>
<tr>
<td>Potassium(mmol/L)</td>
<td>3.3 ± 0.3</td>
<td>3.08 ± 0.2</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Results expressed as Mean ±SD and significant differences considered as p-value ≤0.05.

In comparison with preeclamptic women used magnesium sulfate with preeclamptic not used magnesium sulfate there was significantly increased in serum magnesium (3.0 ± 0.8 mg/dL) vs (1.3± 0.2 mg/dL) with p value (0.00), while there were significantly decrease in serum sodium, and calcium as in table 2

There was significantly positive correlation between serum magnesium in preeclamptic women used magnesium sulfate and preeclamptic not used magnesium sulfate ( r= 0.3 / p= 0.049) as in fig 1, while there were weak negative correlations between serum calcium and potassium as in fig (2, 3)

Figure 1:- Correlation between Mg level in Preeclamptic women used and not used magnesium sulfate. P-value <0.05 consider as significant.
**Figure 2:** Correlation between serum calcium level in Preeclamptic women used and not used magnesium sulfate. 
*P*-value < 0.05 consider as significant.

**Figure 3:** Correlation between Na+ level in Preeclamptic women used and not used supplement. 
*P*-value < 0.05 consider as significant.

**Figure 4:** Correlation between K level in Preeclamptic women used and not used supplement. 
*P*-value < 0.05 consider as significant.

**Discussion:**
Preeclampsia is a multi-factorial process and multi organ dysfunction with no individual factor strictly essential or sufficient for causing it. The numerous complications associated with it have triggered a phobia in pregnant women (13).
From the finding of this study it appears that serum levels of calcium, magnesium and potassium were significantly decreased and the serum level of sodium was significantly increased in preeclamptic women group compared to control group (p, value=0.000). This result agreed with study carried by many authors \((14,15,16,17)\), which showed that; Low serum calcium may cause high blood pressure by stimulating parathyroid hormone and rennin release which in turn increases intracellular calcium in vascular smooth muscle. This causes vasoconstriction, increase of vascular resistance and rise in blood pressure in preeclamptic women. Magnesium is known to increase the prostacyclin release from the endothelial cells of blood vessels, which acts as potent vasodilator. Like Calcium ion, lowered Mg2+ levels are thought to potentiate contractile response of vascular smooth muscle tovasopressor. An increase in renal clearance during pregnancy may contribute to thereduction in serum Mg2+. In addition Mg2+ depletion increases the vasoconstrictor effect of angiotensin II and noradrenaline. Mg2+ also has a substantial beneficial effect in preeclampsia for theprevention and treatment of convulsions. Potassium deficit in body is as a result of inadequate conservation of potassium by kidney and alimentary canal, fecal potassium losses can exceed even urinary losses. \((18)\) Hypokalemia in preeclampsia may be due to abnormality in the transport of sodium and potassium across the vascular smooth muscle cell membrane, which is normally responsible for the maintenance of blood pressure. \((19)\)

The precise mechanism of sodium retention in preeclampsia is not clear, though the retention is likely due to vasoconstriction leading to reduction of glomerular filtration rate and stimulation of rennin angiotensin aldosterone mechanism. The net effect is decreased intracellular fluid and increased extracellular fluid volume. \((20)\)

Also the findings of this study showed that, there was significant increase in blood pressure in preeclamptic women not used magnesium sulfate compared to preeclamptic women used magnesium. (p value=0.000), This result was in agreement with another study \((22)\) which finding confirmed that, Systolic and diastolic blood pressures were significantly decreased during MgSO4 treatment in preeclamptic patients (p < 0.0001).

Serum magnesium was significantly increased in preeclamptic women used magnesium sulfate as supplement compared to the levels in preeclamptic women not used supplement (p, value =0.000). The results was in agreement with another studies carried by Handwerker \((23)\) showed there is over a 100% increase in venous serum levels of ionized Mg during intravenous MgSO4 therapy of preeclamptic patients.

Conclusion: According to the results of this study it is concluded that the serum levels of calcium, magnesium and potassium are significantly decreased, while the level of sodium is significantly increased in preeclamptic women compared to control group. Magnesium sulfate supplement increase the level of serum magnesium in preeclamptic women.

References:-