Assessment of Serum Magnesium, Calcium and Phosphate in Sudanese Cigarette Smokers

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Abstract

**Background:** Smoking is one of the major community environmental pollution in the world, Cigarette smoking is a worldwide major cause of preventable morbidity and mortality. The minerals are very essential for human skeleton and many physiological mechanisms and cofactors of metabolic pathway in the human body.

**Aim:** The purpose of this study was to assess the level of serum magnesium (Mg), calcium (Ca) and phosphate (P) in Sudanese cigarette smokers.

**Methodology:** This case-control study included 50 adult male of a current smoking status; the ages were matched, and the age ranged between 15 and 80 years and their mean 35 years. Fifty non-smokers were considered as control group. We evaluated the effect of cigarette smoking on serum Mg, Ca and P. Three ml of fasting venous blood were collected from each volunteer; serum obtained and analyzed using spectrophotometers (URIT-810), and measured using end point method (enzymatic method).

**Results:** Our study revealed a significant ($p$ value=0.001) increase in the levels of serum phosphate, while the serum calcium significantly ($p$ value=0.040) decreased, among smokers compared to controls, whereas the mean level of serum magnesium and calcium/ phosphate ratio did not differ. Their ages positively correlated to serum phosphate ($r=0.345$, $p=0.023$). Moreover, the duration of smoking/ years negatively correlated to serum Ca ($r=-0.367$, $p=0.034$) and positively correlated to serum phosphate ($r=0.305$, $p=0.044$), and did not effect serum magnesium. There was no correlation between the numbers of cigarette/day and serum parameters in our study.

**Conclusion:** It was found that there was an increase in serum phosphate and a decrease in serum calcium, while the serum phosphate correlated with the age. The duration of smoking correlated with serum calcium and phosphate respectively.

**Key words:** serum calcium, serum magnesium, serum phosphate, Sudanese.

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Introduction

Worldwide more than 3 million people currently die each year from smoking, half of them before the age of 70, an enormous human cost, and more than one third have cardiovascular events that often determine permanent disability of the affected Subjects (Aurelio, 2005). Smoking is a practice in which a substance, most commonly tobacco or cannabis is burned and the smoke tasted or inhaled. The most common method of smoking today is through cigarettes (Shiffman and Robert, 2007). Minerals are very essential substances involved as catalysts in most cellular enzymatic reactions and assume a major role in metabolism (John, 2007). The cigarette smoke contains many harmful carcinogenic constituents, including metals, PAHs, dioxins, and some non-volatile nitrosamines. Smokers are at greater risk for bone and skeleton and nerve system, bone matrix loss, and hepatotoxicity (Aurelio, 2005). Smoking has effect on skeleton and concentration of mineral, calcium is important mainly for bone structure and teeth; the normal level of serum calcium is 8.9-10.1 mg/dl. Like calcium, phosphate is also an important mineral. Phosphate is a constituent of bone and teeth. The normal value of serum phosphate is 2.4-4.1 mg/dl (Hopper et al., 1994). Serum calcium and phosphate regulation are achieved by hormonal action on the bone, kidney and intestine. The parathyroid hormone causes mobilization of calcium and phosphate from bone to plasma, while its action on the renal tubules is to enhance reabsorption of calcium and loss of phosphate, the overall action of PTH is to increase serum calcium and to reduce serum phosphate (Dawson et al., 1984). Magnesium is a critical cation and cofactor in numerous intracellular processes. It is
involved in more than 300 essential metabolic reactions, some of which are: energy production, synthesis of essential molecules, structural roles, ion transport across cell membranes, cell signaling, and cell migration (Rude and Shills, 2006). The role of magnesium is an essential cofactor of metabolic pathway enzymes including those important in glycolysis, transcellular ion transport, neuromuscular transmission, synthesis of carbohydrates, proteins, lipid and nucleic acids in the liver, adipose tissue, renal, intestinal and other tissues in the human body (Seed and Samia, 2013). It is also beside the calcium and phosphate involved in several processes including: hormone receptor binding, gating of calcium channels, trans-membrane ion flux and regulation of adenylate cyclase, muscle contraction, neuronal activity, and control of vasomotor tone, cardiac excitability and neurotransmitter release in the most vital tissues in human body (Seed and Samia, 2013). The objective of present study was to assess the level of serum magnesium (Mg), calcium (Ca) and phosphate (P) ions in Sudanese tobacco smokers.

**Materials and Methods**

The present study has been approved by the Faculty of Medical Laboratory Sciences, Sudan International University scientific Committee. Furthermore, all smokers undersigned the formal consent before data and samples were collected. This case-control recruited 50 male cigarettes smokers and 50 age Sex-matched non-smokers. All of them were from the Khartoum State, Khartoum and Bahry towns, Sudan. A questionnaire was designed to collect personal information, clinical data, and smoking history from each participant. The study participants were clinically evaluated for their
health. None of the participant reported to have diseases/disorders or medications that affect magnesium, calcium and phosphate level. Blood samples were collected from participants to measure serum minerals. All the blood samples were centrifuged at 600 x g for 5 min at the room temperature and the serum minerals were measured immediately. The serum minerals were analyzed by enzymatic spectrophotometric method.

Statistical analysis

Statistical analysis was carried out using Statistical Package for Sciences (SPSS, version 20). Data were expressed as (mean ± SD) and compared firstly with controls and secondly with the provided reference values of the reagents and the data published in the literature. Means of continuous variables were compared between the two groups. The p value of was computed for mineral levels in the obtained study results. Besides, Pearson’s correlation test was applied to predict the correlate of serum mineral to age, duration of smoking/years and number of cigarette/day in smokers.

Results

The general characteristics of the study group and the comparison of the measured parameters

Smokers’ ages ranged between 15 and 80 years with the mean age of 35.0±13.59 years. The mean smoking duration was 13.1±9.25 years and the average number of cigarettes per smoker per day was 11.9±7.66, was presented in table (1).

Table (2) shows the measured serum mineral level in the two groups, significantly (p value=0.001) an increase in the levels of serum phosphate, the serum calcium showed a significant (p value=0.040) decrease, among smokers than controls, whereas the mean level of and serum magnesium and calcium/phosphate ratio did not differ.
Table (1): Descriptive Statistics for study variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>15.0</td>
<td>80.0</td>
<td>35.0±13.59</td>
</tr>
<tr>
<td>Duration of smoking</td>
<td>2.0</td>
<td>45.0</td>
<td>13.1±9.25</td>
</tr>
<tr>
<td>Number of cigarette/day</td>
<td>2.0</td>
<td>30.0</td>
<td>11.9±7.66</td>
</tr>
</tbody>
</table>

Table (2): Mean comparison of study parameters in smokers versus non-smokers

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Smoker (Mean ± SD)</th>
<th>Non-Smoker (Mean ± SD)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mg (mg/dl)</td>
<td>2.15±0.21</td>
<td>2.11±0.22</td>
<td>0.314</td>
</tr>
<tr>
<td>Ca (mg/dl)</td>
<td>9.44±0.50</td>
<td>9.61±0.31</td>
<td>0.040*</td>
</tr>
<tr>
<td>Ph (mg/dl)</td>
<td>4.13±0.98</td>
<td>3.58±0.64</td>
<td>0.001**</td>
</tr>
<tr>
<td>Ca/Ph (mg/dl)</td>
<td>2.44±0.70</td>
<td>2.77±0.47</td>
<td>0.008</td>
</tr>
</tbody>
</table>

The correlation of between age and of the measured serum parameters

The ages were positive correlate only to serum phosphate \( r=0.345 \), \( p=0.023 \) and no correlation between the ages and serum calcium and magnesium, were shown in figures (1, 2, and 3) respectively.
Figure (1): The correlation of age and serum magnesium

![Graph showing the correlation of age and serum magnesium]

$R = 0.056$

$P = 0.700$

Figure (2): The correlation of age and serum calcium

![Graph showing the correlation of age and serum calcium]

$R = 0.345^*$

$P = 0.023$

Figure (3): The correlation of age and serum phosphate

![Graph showing the correlation of age and serum phosphate]
The correlation between duration smoking/years and the measured serum parameters
The duration of smoking/years were negatively correlated to serum Ca \( r=-0.367, \ p=0.034 \) and positively correlated to serum phosphate \( r=0.305, \ p=0.044 \) and did not affect serum magnesium, as shown in the figures, below, (4, 5, and 6) respectively.

**Figure (4): The correlation of duration of smoking/years and serum magnesium**
Figure (5): The correlation of duration of smoking/years and serum calcium

![Graph showing correlation between duration of smoking (years) and serum calcium. The correlation line has a slope and an equation: $R = 0.305^*$, $P = 0.044$.]

Figure (6): The correlation of duration of smoking/years and serum phosphate

<table>
<thead>
<tr>
<th>Duration of smoking (Years)</th>
<th>Ph (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>30</td>
<td>6</td>
</tr>
<tr>
<td>40</td>
<td>8</td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

There was no correlation between the numbers of cigarette/day and serum parameters in the study, were showed in the figures (7, 8 and 9)

Figure (7): the correlation of number of cigarette/day and serum magnesium

![Graph showing correlation between number of cigarettes per day and serum magnesium. The correlation line has a slope and an equation: $R = 0.052$, $P = 0.604$.]

There was no correlation between the numbers of cigarette/day and serum parameters in the study, were showed in the figures (7, 8 and 9)
Figure (8): the correlation of number of cigarette/day and serum calcium

\[ R = -0.063 \]
\[ P = 0.535 \]

Figure (9): the correlation of number of cigarette/day and serum phosphate

\[ R = -0.006 \]
\[ P = 0.345 \]
**Discussion**

Smoking is a major health hazard, with detrimental effects on many organs, including skeleton (Salah Elden, 2015). There are limited international and local data about the effect of cigarette smoking on the serum levels of calcium, phosphate and magnesium and hence its effect on the skeleton (Salah Elden, 2015). The study was conducted in Khartoum state, yet this study shows the effect of cigarette smoking on serum level of calcium, phosphate and magnesium. There was a decrease in serum calcium and magnesium and an increase in serum phosphate in smokers group compared to control group. The results on calcium and phosphate are similar to Sudanese the study conducted, also, in Khartoum State by (Eiman and Adel, 2017). Moreover our results of serum calcium agree with (Salah Elden, 2015), who reported that serum calcium decreased in smoker than in non-smokers. Another study reported that increase in calcium among smoker groups was observed, compared with non-smoker groups (Hopper *et al.*, 1994). This may be due to interference of smoking with the action of parathyroid hormone in renal tubule, thus lowering the serum calcium level and increasing that of serum phosphate. These results agree with study of (Salah Eldin (2015). Magnesium is a very essential mineral that serves as a cofactor of many enzymes involved in energy metabolism, protein synthesis, RNA and DNA synthesis, and maintenance of the electrical potential of nervous tissues and cell membranes. Of particular importance with
respect to the pathological effects of magnesium depletion is the role of this element in regulating potassium fluxes and its involvement in the metabolism of calcium, (Al-Ghamdi et al., 1994). Our result agree with (Sulafa et al., 2013). The study revealed that serum magnesium decreased in smokers when compared to non-smokers. This result is in agreement with a previous study (Peacock, 2010); as cigarette smoking causes a decreased supply of magnesium leading to a weaker appetite and reduced absorption of the digestive system due to disturbances (Winiarczyk et al., 2008). Depleted magnesium leads to hypertension (Peacock, 1999) and cardiovascular diseases (Liao et al., 1998). Our study the age showed positive correlation with serum phosphate (r=0.345, p=0.023) and no correlation with serum calcium and magnesium respectively. There are no previous studies reported, Except for only one contrary study that reported that serum magnesium level did not change due to age difference (Sulafa et al., 2013). On the other hand our study revealed that the duration of smoking/years with has a positive correlation with serum phosphate (r=0.305, p=0.044), negative correlation with serum calcium (r=-0.367, p=-0.034), yet did not correlation with serum magnesium. The study disagrees with (Sulafa et al., 2013), who reported that a weak negative correlation was found between serum magnesium and the duration of smoking. Our study agrees with (Eiman and Adel, 2017), who reported that serum calcium negatively correlated
with the smoking period. Another study, conducted by (Salah Elden, 2015), yielded similar results to ours, and reported that scatter plot shows negative correlation between the levels of serum calcium and the duration of smoking and also a strange positive correlation between the levels of serum phosphate and the duration of the smoking. Our study found no correlation between the number of cigarette/day and serum parameters. The study differs with (Sulafa et al., 2013), who reported that a weak negative correlation between serum magnesium level and number of cigarette/day. Other studies conducted by (Eiman and Adel, 2017) disagree with our results and also reported that, calcium negatively correlated with number of cigarette/day while the serum phosphate positively correlated with the number of cigarette/day, (Salah Elden, 2015) reported negative correlation between the levels of serum calcium and the number of cigarette smoked/day and positive correlation between the levels of serum phosphate and duration smoked/day, which contradicts with our study results

**Conclusion:** it was found that smoking increased serum phosphate level, yet decreased the serum calcium. As for the serum phosphate level, it correlated positively with the age of the smoker. The duration of smoking correlated together with the serum calcium and phosphate.

**References**


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