Research Article

Effect of cigarettes smoking on the serum levels of calcium and phosphate in Sudanese patients with bone fracture

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Abstract: Smoking is a major health hazard, with detrimental effects on many organs, including skeleton. There are limited international and local data about the effect of cigarette smoking on the serum levels of calcium and phosphate and hence its effect on the skeleton. Therefore, the aim of this study was to evaluate the effect of cigarette smoking on the serum levels of calcium and phosphate, compared to apparently healthy individuals (non cigarette smokers) as a control group. In methodology 105 cigarette smokers and 105 apparently healthy controls were enrolled into the study (all were males).The mean age of the cigarette smokers was 38.6 years (range 20-60), while it was 39.1 years (range19-58) in the control group. The difference was not statistically significant (P=0.097), Serum levels of calcium, phosphate, were measured using Roche Diagnostic/Hitachi 902 analyzer. In results Showed significant differences between the means of serum calcium, phosphate in the case group and the control group (mean ± SD): (8.71 ± 0.32) versus (9.66 ± 0.51) mg/dl, P=0.012, (3.74 ± 0.52) versus (2.82 ± 0.38) mg/dl, P=0.032. In Conclusion cigarette smoking is lead to increase of calcium while reduced of phosphate levels in cigarettes smokers.

Keywords: effect of cigarette smoking on calcium, Khartoum

INTRODUCTION

There are limited international and local data about the effect of cigarette smoking on the serum levels of calcium and phosphate, hence, its effect on the skeleton. WHO estimates that there are about 1100 million smokers in the world, representing about one third of the global population aged 15 years and over[1]. The vast majority of the smokers are in developing countries (800 million) and most of these are men (700 million).In China alone, there are about 300 million smokers (90% men, 10% women), about the same number as in all developed countries combined. About one third of regular smokers in developed countries are women, compared with only about 1 in 8 in developing countries[2,3].

Cigarette smokers have a greater incidence of gastric and duodenal ulcers and delayed healing of these ulcers. Smoking also relaxes the esophageal sphincter and may contribute to esophageal reflux. Several of the constituents of tobacco smoke are capable of inducing hepatic microsomal systems, which then alter the metabolism of other drugs. Theophylline; phenacetin, antipyrine, caffeine, and imipramine are metabolized more rapidly by smokers. Smokers have lower blood levels of vitamins C and B[4,5]. Haematocrit and hemoglobin levels as well as carboxy hemoglobin levels are elevated in smokers, and it is a cause of elevated red cell volume. Smokers also have small alteration in the other diagnostic tests, including higher leukocyte count, but these differences are not usually clinically significant. Tobacco smoke contains most of the toxic and carcinogenic compounds identified in mainstream smoke, absorption of smoke constituents from the environment has been documented in both infants and adults, and a number of epidemiologic studies have demonstrated health effects in humans[6-8]. The risks associated with tobacco smoking appear to be closely related to the amount of smoke inhaled[9].

The mean plasma calcium concentration in healthy subject is about 2.40mmol/l (9.5mg/dl). Calcium is present in plasma in two main Forms as Calcium bound to proteins mainly albumin and Free ionized calcium[10,11]. Serum Calcium regulated by three hormones is known to regulate serum calcium by altering their secretion rate in response to changes in ionized calcium. These hormones are PTH, vitamin D, and calcitonin[12,13]. Calcium was essential for myocardial contraction, while attempting to study how bound and free forms of calcium affected frog heart contraction, ionized calcium concentration was proportional to the amplitude of frog heart contraction, whereas protein-bound and citrate-bound calcium had

no effect. Decreased ionized calcium impairs myocardial function, it is important to maintain ionized calcium at a near normal concentration during surgery and in critically ill patients[14,15].

The body contains about 17mol of phosphorus of which 87% is present in bones, and the remainder being found in cells and soft tissues. Phosphorus is a constituent of many important biological compounds such as some proteins, some lipids, nucleic acids and some coenzymes; it also plays a part in acid base regulation, particularly by kidney[16,17]. Red cells are richer in phosphorus compared to plasma mainly because they contain more ester phosphates. When blood is allowed to stand, the inorganic phosphate rises because these organic forms are hydrolyzed by enzyme action. The plasma should therefore be promptly separated from the red cells and the proteins precipitated by trichloroacetic acid as quickly as possible[18,19].

MATERIALS AND METHODS

105 cigarette smokers and 105 apparently healthy (non smokers) as a control group, were selected randomly from the residents of Khartoum city in Sudan. Both the control group and the test group were matched in age, socioeconomic status and sex (all study subjects were male). Long standing cigarette smokers (10 years and more) were included as a test group in this study. Those with parathyroid gland disease, renal disease, acute pancreatitis, mal absorption, bone disease and liver disease had been excluded from this study.

Materials required:

Plain containers, cotton, marker pens, centrifuge, saline (non-buffered), reagents, cleaning solution system, sample cups, printer paper, samples and reagent probes.

Instruments:

Roche Diagnostic/Hitachi 902 analyzer was used to measure and report the Serum levels of calcium and phosphate. This analyzer is fully automated, computerized and included Photometric measuring system, analytical processing unit, LCD touch screen and a printer. The analyzer uses several operational systems to perform required functions. The system included, control system, sampling, reagent system, photometric measuring system and cell rinse system.

Serum levels of calcium and phosphate were measured using an auto analyzer. The analyzer automatically adds equal quantities from the sample, R1 and R2 to the reaction.

Data analysis:

The data collected in this study were analyzed using (SPSS) version 16.0 computer analysis program. The means and standard deviation of the serum levels of calcium and phosphate were obtained to both the test group and the controls and the t-test was used for comparison (p value of < 0.05 was considered to be significant). Linear regression analysis was used to asses correlation between the duration of cigarette smoking (in years), number of cigarette smoked per day and the serum levels of the above variables.

Ethical consent:

Each participant was asked to sign a written ethical consent form during the interview, before the specimen was taken. The informed ethical consent form was designed and approved by the ethical committee of the Faculty of Medical Laboratory Research Board, University of Science and Technology.

RESULTS

In these descriptive cross-sectional study 105 cigarette smokers and 105 apparently healthy controls were studied. The mean age of the cigarette smokers was 38.6 years (range 20-60), while it was 39.1 years (range19-58) in the control group The difference was not statistically significant (P=0.097).
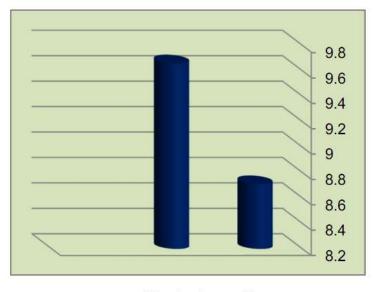
Table1 and figure 1 Showing a significant difference between the means of serum calcium in the test group (n=50) and the control group (n=30) (mean ± SD): (8.71 ± 0.32) versus (9.66 ± 0.51) mg/dl, P=0.012.

Table 1: Comparison of the means of serum calcium between the test group and the control group

Variable	Control (non- smokers) n=105	Cases (smokers) n=105	P .value
Serum calcium Range	(9.66 ± 0.51) (8.9 – 10,9)	(8.71 ± 0.32) (8.1– 9,9)	0.012

The table shows the mean ± SD, rang in brackets ( ) and probability (P).
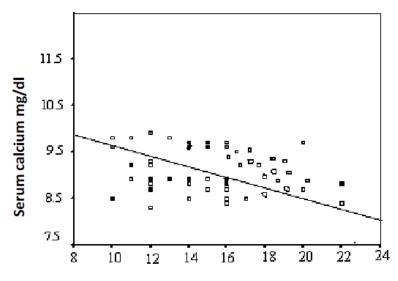T-test was used for comparison.

Fig- 1: The means of serum calcium of the case group and the control group.

Figure 2, 3 showing moderate negative correlations between the levels of serum calcium with both; the number of cigarettes smoking / day. (r = -0.67) and the duration of cigarettes smoking / years, (r = -0.74).

Table 2 and figure 4 Showing significant difference between the means of serum phosphate in the test group and the control group (mean ± SD): (3.74 ± 0.52) versus (2.82 ± 0.38) mg/dl, P=0.032.

Figure 5, 6 showing moderate negative correlations between the levels of serum phosphate with both; the number of cigarettes smoking / day. (r = 0.76) and the duration of cigarettes smoking / years, (r = 0.85).

Fig- 2: A scatter plot shows a moderate negative correlation between the levels of serum calcium and the number of cigarettes smoked /day. (r = -0.67).
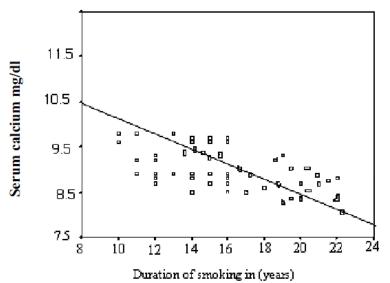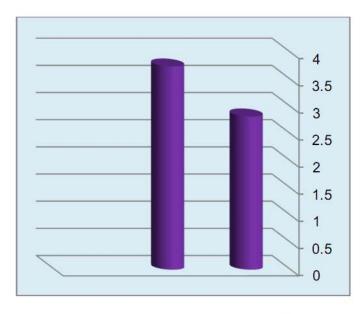
Fig-3: A scatter plot shows a moderate negative correlation between the levels of serum calcium and the duration of smoking (r = -0.74).

Table 2: Comparison of the means of serum phosphate between the test group and the control group

Variable	Control group (non- smokers) n=30	Test group (smokers) n=50	P. value
Serum phosphate Range	(2.82 ± 0.38) (2.4 − 3.8)	(3.74 ± 0.52) (2.5 − 5)	0.032

The table shows the mean ± SD, rang in brackets ( ) and probability (P).
t-test was used for comparison

Case   Control

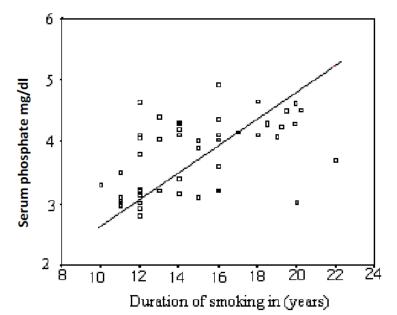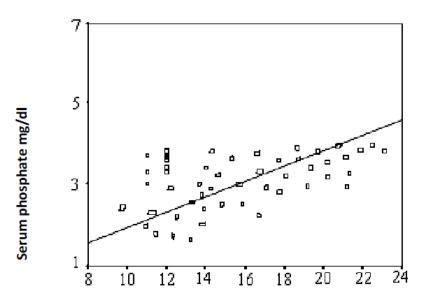**Fig-4: The means of serum phosphate of the test group and the control group.**

Fig-5: A scatter plot shows a strong positive correlation between the levels of serum phosphate and the duration of the smoking(r= 0.85).

Fig-(6): A scatter plot shows a moderate positive correlation between the levels of serum phosphate and the number of cigarettes smoked / day (r= 0.76).

DISCUSSION

Serum calcium and phosphate are regulated mainly by two hormones; the parathyroid hormone and the active form of vitamin D3 [1, 25 (oH) 2 vitD3]. The active form of vitamin D3 increases absorption of both calcium and phosphate in the intestine and also increases their reabsorption, in the renal tubules and hence, increases the level of serum calcium and phosphate in plasma[4]. Therefore, any interference with the action of vitamin D may lead to lowering of both serum calcium and phosphate, which is not the case in the present study[11,12].

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, but in the present study the reverse occurred[12].

A considerable number of chemicals have been found in cigarette smoke. One or more of these chemicals may interfere with action of the PTH. This could be by inhibiting; it's release from the parathyroid gland, its action on bone or its action on the renal tubules[2].

According to the results in this study for both serum calcium and phosphate, the most likely cause is inhibition of the action of parathyroid hormone on the renal tubules and therefore lowering of serum calcium and increasing of serum phosphate. Measuring the level of parathyroid hormone in cigarette smokers, in addition to, urinary excretion of calcium and phosphate may help to clarify the finding in our study. Our results concerning the levels of serum calcium and phosphate in cigarette smokers, agrees with previous studies[8,17].

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