American Journal of Pharmacology and Toxicology 5 (1): 48-51, 2010
ISSN 1557-4962

Interaction between Cadmium and Calcium in Human Blood at the Smokers

[1]Lulzim Zeneli, [2]Nexhat Daci, [1]Hidajet Paçarizi and [2]Majlinda Daci-Ajvazi
[1]Institute of Biochemistry, Faculty of Medicine, University of Prishtina, Republic of Kosova
[2]Department of Chemistry, University of Prishtina, Republic of Kosova

Abstract: Problem statement: Defining of correlation between toxic and essential elements in human beings is an important clinical screening procedure. **Approach:** The aim of this study was to determine the correlation between cadmium as toxic element and calcium as an essential element in the blood at the smokers. We have investigated 50 human blood samples of different ages and genders (age: 35-45 years old), of the citizens from the Municipality of Dragash (an environment without pollution). **Results:** The results that were achieved in this study showed the significant difference in the average of cadmium concentration in human blood of the smokers group from nonsmokers group ($p = <0.0001$, $t = 8.33$). Between cadmium and calcium in the blood of the smokers group exists the positive correlation with high statistical reliability ($r = 0.544$, $p = 0.003$) while at no-smokers group does not exist ($r = -0.097$, $p = 0.317$). **Conclusion/Recommendations:** Correlation between Cd^{2+} and Ca^{2+} in the human blood with a high statistical significance in the group of smokers comes as a result of powerful competitive reaction between Cd^{2+} and Ca^{2+} in biochemical processes. Competitive reaction between Cd^{2+} and Ca^{2+} in biochemical processes.

Key words: Cadmium, calcium, smoking, blood

INTRODUCTION

Cadmium is one of the most commonly found toxic metals present in our environment. The major route of exposure to cadmium for the general non-smoking population is via food, while the contribution from other pathways to total uptake is small. Cadmium also is one of the many toxic components of inhaled tobacco smoke. Total cadmium content is associated with smoking. One cigarette contains from 0.82-3.67 µg L^{-1} of Cadmium, about 10% of which is absorbed by the smokers. Cadmium has a long elimination time (estimated at 10-30 years). Exposure to cadmium has been shown to have detrimental effects on human health. Cadmium has been implicated in accelerated aging, mutations associated with cancer and neurogenerative disease (McMurray and Tainer, 2003). In Japan, the Itai-Itai disease is causes by ingestion of cadmium contaminated rice and water (Ikeda *et al*., 2004).

Non workplace exposure of cadmium has been linked to the progression of diabetic renal complications, hypertension, osteoporosis, leukemia and cancer of the lung, kidney, urinary, bladder, pancreas, breast and prostate (Waisberg *et al*., 2003). Cadmium is capable of causing iron deficiency by binding to cysteine, glutamate, aspartate and histidine ligands (Castagnetto *et al*., 2002). The influence of cadmium is inhibitory in enzymes that participate in bilirubine conjunction (Zeneli *et al*., 2009). Cadmium increases urine Ca^{2+} excretion which can affect bone metabolism and cause severe bone pathology (Takebayashi *et al*., 2000) Cadmium has been classified by the International Agency for Research in Cancer as a class 1 of human carcinogen (IARC, 1993). The epidemiological data linking cadmium and lung cancer are much stronger than for prostate cancer, whereas links between cadmium and cancer in liver, kidney and stomach is considered equivocal (Waalkes, 2000). Other effects of cadmium exposure are disturbances in calcium metabolism, hypercalciuria and formation of stones in the kidney. On the other hand, it has been recently understood that calcium is an important factor to regulate very complexes physiological conditions on the function of cells in organisms. The objective of this study was to determine interaction between the cadmium and calcium concentration in the blood of the smokers.

Corresponding Author: Lulzim Zeneli, Institute of Biochemistry, Faculty of Medicine, University of Prishtina, 10000 Prishtina, Republic of Kosova

MATERIALS AND METHODS

We have investigated 50 human blood samples, from different ages and genders, of the citizens from the Municipality of Dragash (an environment without pollution). The preparation of samples for cadmium determination in blood was realized by putting 4.9 mL dilution solution (Triton X-100, 0.01% and nitric acid 0.1%) and 100 µL blood in monovets. Each sample was then centrifuged in 2500 rpm for 15 min, after which they were put in auto-sampler cells and the measurement with graphite furnace Atomic Absorption Spectrometry (AAS) was performed (Knowles, 2004). For the elimination of different obstacles during the phase of the absorbing signal measurement, there were used different modificatory matrixes in the graphite tube, like $NH_4H_2PO_4$ or $(NH_4)_2HPO_4$. Monovets with blood samples were centrifuged for 10 min/4500 rpm, serum was divided and proceeded for analysis. Biochemical parameters were determined with BECKMAN COULTER Syncron CX7 (Burtis *et al*., 2008).

RESULTS

The study included a total of 50 seniors aged between 35-45 years. From them, 48% were smokers and 52% nonsmokers. The results achieved with the analyses of blood samples of human population at the smokers group were compared with results of blood samples of non-smokers group. The mean blood cadmium level in the group of smokers is evidently higher than in the group of non-smokers (p = <0.0001). The mean blood cadmium level was 0.94 µg L^{-1} in smokers and 0.40 µg L^{-1} in non smokers (Table 1).

Even though that there is a no-significant distinction (p = 0.317) between the average of calcium concentration in the blood of the smokers and non-smokers group.

Table 1: Comparative of level of Cd, Ca and correlation between Cd/Ca in human blood

N		50	
	Smoking		Non-smoking
Percent	48		52
GM, Cd	0.94		0.40
t		8.33	
p		<0.0001	
GM/Ca	2.52		2.43
t		0.46	
p		0.323	
Correlation	Cd/Ca		Cd/Ca
r	-0.544		-0.097
p	0.003		0.317

N: Number of samples; GM: Geometric Mean; t: T-test; r: Correlation coefficients; p: Probability

Table 1 show that at the group of smokers calcium level is higher with increasing tendency than the non-smokers group. Correlation analysis showed a statistically significant positive correlation between the level of cadmium and calcium concentration in blood at the smokers group (r = 0.544, p = 0.003), while at the nonsmokers group does not exist such correlation (r = -0.097, p = 0.317). The mean blood cadmium level and correlation between cadmium and calcium level in blood according to smoking is shown in Table 1 and Fig. 1.

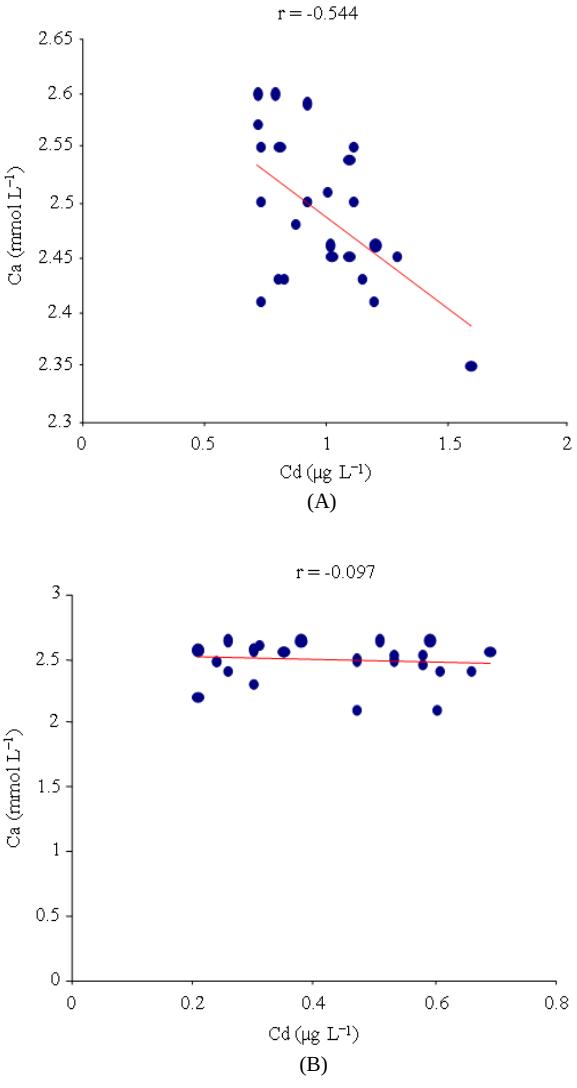

Fig. 1: Correlation between the concentration of Cd and Ca in the smoking group (A) and non-smoking group (B)

DISCUSSION

Cadmium is a heavy metal with a high toxicity. Cadmium is toxic at very low exposure levels and has acute and chronic effects on health and environment.

Cadmium accumulates in the human body and especially in the kidneys. According to the current knowledge kidney damage (renal tubular damage) is probably the critical health effect, both in general population and occupational exposed workers (Jarup *et al*., 1998). Both human and animal studies indicate that skeletal damage (osteoporosis) may be a critical effect of cadmium exposure.

Cadmium is also one of most important heavy metals when the adverse health effects of smoking are considered.

The measurements have shown that cadmium is the main toxic component present in the tobacco cigarettes. In cigarettes, cadmium concentrations range from 0.5-3.5 μg g^{-1}, with a mean level of 1.7 μg g^{-1} (Mussalo-Rauhamaa *et al*., 1986) Study results, Table 1, show that there is a significant distinction between the mean of cadmium concentration in blood in the smoking group and the nonsmoking one. In all studies, blood Cd concentration was found to rise with increasing smoking (Pocock *et al*., 1988).

Except the direct effect of smoking in cadmium concentration in blood, in this study the main thing of investigation was correlation between cadmium and calcium in human blood.

When the cadmium enters in the human organism, cadmium (Cd^{2+}) is powerful competitor of calcium (Ca^{2+}) in biochemical processes. From the presented results in Table 1 and Fig. 1, we understand that in the smoking group between cadmium and calcium concentration in human blood exists positive correlation with a high statistical significance, whereas in the non smoking group there is no such correlation. Cadmium occurs in a single ionic state Cd^{2+} and is not metabolized into other forms (Patrick, 2003). Cadmium (Cd^{2+}) in its ionic state can displace calcium (Ca^{2+}) and interfere with homeostatic processes requiring calcium (Hardingham *et al*., 1997). The increased intracellular level of Ca^{2+} deregulates expression of genes and also allows Ca^{2+} to interact with specific response elements such as the cAMP-Response Element Binding protein (CREB) and disrupting the normal function of CREB (Hardingham *et al*., 1997).

CONCLUSION

Based on our presented results we have come to these conclusions: smoking is an important contributor of cadmium concentration in blood; between cadmium (Cd^{2+}) and calcium (Ca^{2+}) concentration in human blood at the smokers, exists positive correlation with a high statistical significance.

REFERENCES

Burtis, C., E. Ashwood and D. Bruns, 2008. Tietz Fondamentals of Clinical Chemistry. 6th Edn., St. Louis, Missouri, ISBN: 978-0-7216-3865-2, pp: 711-717.

Castagnetto, J.M., S.W. Hennessy, V.A. Roberts, E.D. Getzoff, J.A. Tainer and M.E. Pique, 2002. MDB: The metalloprotein database and browser at the Scripps Research Institute. Nucleic Acids Res., 30: 379-382. PMID: 11752342

Hardingham, G.E., S. Chawla, C.M. Johnson and H. Bading, 1997. Distinct functions of nuclear and cytoplasmic calcium in the control of gene expression. Nature, 385: 260-265.

IARC., 1993. Beryllium, Cadmium, Mercury and Exposures in Glass Manufacturing Industry. International Agency for Research on Cancer, Lyon, France, ISBN: 10: 9283230019, pp: 119-237.

Ikeda, M., T. Ezaki, T. Tsukahara and J. Moriguchi, 2004. Dietary cadmium intake in polluted and non-polluted areas in Japan in the past and in the present. Int. Arch. Occup. Environ. Health, 77: 227-234. DOI: 10.1007/s00420-003-0499-5

Jarup, L., M. Berglund, C.G. Elinder, G. Nordberg and M. Vahter, 1998. Health effects of cadmium exposure-a review of the literature and a risk estimate. Scand. J. Work Environ. Health, 24: 1-52.

Knowles, M., 2004. The Determination of Lead and Cadmium in Blood and Manganese and Aluminum in Serum, AA-Instruments at Work, Victoria, pp: 1-13.

McMurray, C.T. and J.A. Tainer, 2003. Cancer, cadmium and genome integrity. Nature Genet., 34: 239-241. DOI: 10.1038/ng0703-239

Mussalo-Rauhamaa, H., S.S. Salmela, A. Leppanen and H. Pyysalo, 1986. Cigarettes as a source of some trace and heavy metals and pesticides in man. Arch. Environ., 41: 49-55. PMID: 3963887

Patrick, L., 2003. Toxic Metals and antioxidants: Part II. The role of antioxidants in arsenic and cadmium toxicity. Altern. Med. Rev., 8: 106-128. PMID: 12777158

Pocock, S.J., H.T. Delves, D. Ashby, A.G. Shaper and B.E. Clayton, 1988. Blood cadmium concentrations in general population of British middle aged men. Hum. Toxicol., 7: 85-103. DOI: 10.1177/096032718800700201

Takebayashi, S., S. Jimi, M. Segawa and Y. Kiyoshi, 2000. Cadmium induces osteomalacia mediated by proximal tubular atrophy and disturbances of phosphate reabsorption. A study of 11 autopsies. Pathol. Res. Pract., 196: 853-663. PMID: 10997741

Waalkes, M.P., 2000. Cadmium carcinogenesis in review. J. Inorgan. Biochem., 79: 240-244. DOI: 10.1016/S0162-0134(00)00009-X

Waisberg, M., P. Joseph, B. Hale and D. Beyersmann, 2003. Molecular and cellular mechanisms of cadmium carcinogenesis. Toxicology, 192: 95-117. PMID: 14580780

Zeneli, L., H. Paçarizi, N. Daci, M. Daci-Ajvazi and A. Prenaj, 2009. The effects of air pollution and smoking on cadmium concentration in human blood and correlation with biochemical parameters. Am. J. Biochem. Biotechnol., 5: 30-33. http://www.scipub.org/fulltext/ajbb/ajbb5230-33.pdf