HACETTEPE JOURNAL OF BIOLOGY AND CHEMISTRY
Volume 35, Issue 2, June 2007
Research Article
Hacettepe J. Biol. & Chem., 2007, 35 (2), 101-104

Serum Selenium Levels in Ischaemic Heart Disease

Afife Izbirak
Hacettepe University; Department of Biology, Ankara, Turkey

Abstract

Selenium is an essential element and a cofactor required to maintain glutathione peroxidase activity. Its deficiency may induce modification in the cellular antioxdative status and the appearence of different diseases such as cardiovascular diseases and cancer. This study was conducted to determine whether an association exists between serum selenium levels and ischaemic heart disease. Serum selenium concentrations of the test and control groups were measured with hydride generation atomic absorbtion spectrometry. Statistical analysis indicated that there is a significant difference between the serum selenium levels of two groups.

Key Words: Serum selenium, ischaemic heart disease, cellular antioxidants.

Introduction

The relation between trace elements and human health has been scarcely studied. With respect to cardiovascular diseases and hypertention, attention has mostly focused on arsenic, cobalt, copper, chromium, fluorine, manganese, vanadium, zinc, selenium, silicon, cadmium and lead. Environmental contamination can influence organ concentrations through long-term, low-level effects. Attention is paid to interpretation problems due to the complexity of biochemical interactions with proteins of various sorts which determine metabolic processes and to the occurance of detoxification mechanisms in which trace elements interact. This can also lead to strong variations in individual vulnerability. In general the elements selenium, copper, zinc, chromium and manganese seem to counteract the development of cardiovascular diseases.

Depending on its concentration, selenium can either be beneficial or toxic to humans and certain plants and animals.

The key role of selenium in mammalian metabolism is attributed to the pesence of four selenocystein residues in the active site of the enzyme glutathione peroxidase. This enzyme catalyzes the reduction of organic hydroperoxides- in particular, hydrogen peroxide and thus as an endogeneous antioxidant is important for intracellular defense. Selenium, functioning as a part of glutathione peroxidase, has been recognized as a cellular antioxidant (1). In addition, the element is also known as a protective agent against heavy metal toxicity (2-4), cancer (5-7), and cardiovascular diseases (8-11). Lack of selenium or disturbance in its metabolism by metals may promote free radical production (12). Interest in the biochemical role of selenium has noticeably increased in the last decades and many epidemiolgical studies have been performed to investigate its potential protective role in preventing carsinogenesis and other choronic diseases (13-24). Low blood levels of the element have been reported in individuals from several countries, and its deficiency has been associated with several pathological conditions (25-32). Dietary selenium deficiency in people in certain areas of China is associated with an endemic cardiomyopathy called "Keshan disease", which affects primarily children and women of childbearing age (33,34). In the industrialized West, dietary selenium deficiency is thougth to be associated with cardiovascular diseases. A prospective epidemiological study done in Finland revealed the selenium concentration in serum to be inversly related to the risk of cardiovascular disease (35,36). However, other prospective epidemiological studies found no such association (37-40).

* Correspondence to: Afife Izbırak

Hacettepe University; Department of Biology, Ankara, Turkey

Tel: + 90312 297 8022 Fax: +90312 299 2028
E-mail: izbirak@hacettepe.edu.tr

Materials and Methods

Sample Preparation

Following an overnight starvation, 10 ml of venous blood was collected from the patients and the control group and centrifuged at 3500 rpm for 15 min. Serum samples stored in polystyrene tubes were prevented from metal contamination and kept in deep-freezer at -20˚C. Biochemical blood parameters of two groups were recorded using an autoanalyzer (Roche, Cobos Mira Plus).

Selenium Analysis

1 ml of serum sample was added into a test tube and was digested by wet acid ashing using 2 ml of concentrated (65%) nitric acid. Tubes were placed in the acid digestion owen and the temperature was raised gradually up to 140˚C within 15 minutes. After keeping 25 min in the owen and cooling down to room temperature, a mixture of concentrated sulphuric acid and 60% perchloric acid (1 : 0.4 ml) was added to each tube and the temperature was raised step by step up to 310˚C within 2 h. The clear, colourless samples were removed from the owen and redissolved in 5 ml of 37% hydrochloric acid and kept 20 min in digestion owen at 90 ˚C. Upon cooling, the total volume of each tube was completed to 40 ml with bidistilled water.

Analytical Instrumentation

Ultrapure grade chemicals (Merck and Sigma) were used throughout. Water was purified by ion-exchange and double-distillation.

High purity Se was stock material and used for preperation of standart. Working standarts and a standart blank were prepared with the same procedures.

Measurements were caaried out on a Varian Spectra AA-30/40 absorbtion spectrophotometer equipped with Varian VGA-76 hydride generation system. The instrument was calibrated for the Se analysis using standarts containing 20, 40, 60, 80 and 100 μg Se per litre (41).

Hydride generation of selenium was based on the reaction of acidic digest with a sodium tetraborohydride/ perchloric acid reaction system. The hydride was transferred into a reaction cell which was heated by an ethylene- air flame for the decomposition of the hydride. Absorbance values were measured at 196 nm.

The mean absorbances produced by the standarts (corrected for the standart blank) were plotted vs the concentrations of the Se in the standarts. The concentrations of the analyte in the original samples were obtained using the standart curve in units of μg Se /L.

Student -t test was employed for the statistical evaluation of the results while r-correlation test was used for the correlation analysis (42).

Results and Discussion

In this study of 20 petients with ischaemic ECG findings at exercise having mean age of 49 years were under investigation and their serum Se concentrations had no association with plasma HDL cholesterol (r= 0.2260; p= 0.338). On the other hand, they had a lower mean serum selenium than others (35.05 μg/L vs 61.39 μg/L, p=0.046 for difference). Because of $p<0.05$, it was concluded that there is a difference between the variances of two groups.

Our data is in aggrement with those of Oster et al. (43) and Salonen et al. (8, 35, 36). In another study effect of selenium supplementation was evaluated in 81 patients with acute myocardial infarction in a double-blind, plecebo-controlled study. The results encourage further studies to evaluate the efficiacy of antioxidants in the prevention and therapy of myocardial infarction (9).

Selenium is a naturally occuring trace element that is essential for animal and human nutrition. But range between dietary requirements and toxic levels is relatively narrow. Therefore, further epidemiological studies related to selenium levels in different tissues throughout the Turkish population should be carried out. In addition to these, quantitative status of trace elements together with selenium should be investigated in soil, major foods and crops like ones done in some other countries such as Saudi Arabia (44, 45) because of the very limited data according to the intensity of the counter effects of selenium deficiency on public health.

References

1. Xia, J., Hill, K.E., and Burke, R.F., Biochemical studies of a selenium-deficient population in China: measurement of selenium, glutathione peroxidase and other oxidant defence indices in blood. J Nutr ,119, 1318-1326, 1989.
2. Magos, L., and Webb, M., The interaction of selenium with cadmium and mercury. CRC Crit Rev Toxicol ,8, 1-42, 1980.
3. Andersen, O., and Nielsen, J.B., Effects of simultaneous low-level dietary supplementation with inorganic and organic Se on blood and organ toxic levels of metals in mice. J Trace Elem Elect Health Dis, 7, 122, 1993.
4. Hui-Min, J., Guo'an, H., Xi, C., and Hongjun, Z., Effect of selenium on the change in cadmium-induced distribution of trace elements in pregnant rats. Trace Elem Elect, 14, 9-12, 1997.
5. Willett, W.C., Polk, B.F., Morris, J.S., Stampfer, M.J., Pressil, S., Rosner, B., Taylor, J.O., Schneider, K., and Hames, C.G., Prediagnostic serum selenium and risk of the cancer. Lancet, 2,130-134, 1983.

6. Helzlsouer, K.J., Comstock, G.W., and Morris, J.S., Selenium, lycopene, alpha-tocopherol, beta-carotene, retinol and subsequent bladder cancer. Cancer Res, 49, 6144- 6148, 1989.

7. Overvad, K., Selenium and cancer in role of trace elements for health promotion and disease prevention, Sandstrom, B., and Walter , P. (eds) Kargel, Basel, 141-149, 1998.

8. Salonen, J.T., Salonen, R., Seppanen, K., Kantola, M., Paviainen, M., Alfthan, G., Maenpaa, P.H., Taskinen, E., and Rauramaa, R., Relationship of serum selenium and antioxidants to plasma lipoproteins, platelets aggregability and prevalent ischaemic heart disease in eastern Finnish men. Atherosclerosis, 70, 155-160, 1988.

9. Korpela, H., Kumpulainen, J., Jussila, E., Kemila, S., Kaariainen, M., Kaariainen, T., and Sotaniemi, E.A., Effect of selenium supplementation after acute myocardial infarction. Res Commun Chem Pathol Pharmacol, 65, 249-252, 1989.

10. Korpela, H., Selenium in cardiovascular diseases-an update. J Trace Elem Electrolytes Health Dis,7,115, 1993

11. Hattunen, J.K., Selenium and cardiovascular diseases- an update. Biomed and Environ Sci, 10, 220-226, 1997.

12. Johansson,E., Selenium and its protection against the effects of mercury and silver. J Trace Elem Electrolytes Health Dis, 54, 273-274, 1991.

13. Arthur, J.R., and Beckett, G.J., Selenium deficiency and tyroid homone metabolism. *In Selenium In Bioloy And Medicine*, Wendel, A. (Ed.), Berlin, Springer, 1989.

14. Arthur, J.R., Nicol, F., and Beckett, G.J., Hepatic iodothyronine 5' deiodinase:The role of selenium. Biochem J, 227, 537-540, 1990.

15. Clark, L.C., The epidemiology of selenium and cancer. Fed Proc, 44, 2584-2589, 1985.

16. Clark, L.C., and Combs, J.F. Jr., Selenium compounds and the prevention of cancer: Research needs and public health imlications. J Nut, 116, 170-176, 1986.

17. Combs, J.F.Jr., and Mercurio, S.D., Selenium and oxidative injury. In *Nutritional diseases: Research directions in comperative pathology*. Scarpelli, D., and Magaki, G. (Eds.) New York, Liss, 1986.

18. Levander, O.A., Clinical consequences of low selenium intake and its relationship to vitamin E. Ann NY Acad Sci, 393,70-72, 1982.

19. Normura, A., Heilburn, L.K., Morris, J.S., and Stemmermann, G.N., Serum selenium and the risk of cancer by specific sites: Case-control analysis of prospective data. J Natl Cancer Inst, 79, 103-108, 1987.

20. Salonen, J.T., Selenium in ischaemic heart disease. Int J Epidemiol, 16, 323-328,1987.

21. WHO World Health Organization. Selenium and selenium compounds. JARC Monographs 9, 245-260, 1975.

22. Lou, H., Wu, R., and Fu, Y., Relation between selenium and cancer of uterine cervix. Chinese J Oncol 17, 112-114, 1995.

23. Fleet, J.C., Dietary selenium repletion may reduce cancer incidence in people at high risk who live in areas with low soil selenium. Nutr Rev, 55,277-279, 1997.

24. Cowgill, U.M., The distribution of selenium and mortality owing to acquired immune deficiency syndrom in the continental United States. Biol Trace Elem Res, 56, 43-61, 1997.

25. Ward, K.P., Arthur, J.R., Russell, G., and Aggett, P.J., Blood selenium content and glutathione peroxidase activity in children with cystic fisrosis, coliac disease, asthma, and epilepsy. Eur J Pediatr, 142, 21-24, 1984.

26. Hinks, L.J., Inwards, K.D., Lloyd, B., and Clayton, B., Reduced concentrations of selenium in mild Crohn's disease. J Clin Pathol, 41, 198-201, 1988.

27. Robberecht, H., Deelstra, H., and Van Grieken, R., Determination of selenium in blood components by X-ray emission spectrometry: Procedures, concentration levels and health implications. Biol Trace Elem Res, 25, 149-185, 1990.

28. Mtsuda, A., Kimura, M., and Itokawa, Y., Selenium level and glutathione peroxidase activity in plasma , eryhrocytes and platelets of healthy Japanese volunteers. J Nutr Sci Vitaminol, 43, 497-504, 1997.

29. Van Cauwenbergh, R., Robberdeccht, H., Deelstra, H., picramenos, D., and Kostakpoulos, A., Selenium concentrations in healthy Greek adults. J Trace Elem electrolytes Health Dis, 8, 99-109, 1994.

30. Scieszka, M., Danch, A., Machalski, M., and Drozda, M., Plasma selenium concentration in patients with stomach and colon cancer in the upper Silesia. Neoplasma, 44, 395-397, 1997.

31. Hughes, K., and Ong, C., Vitamins, selenium, iron, and coronary heart disease risk in Indians, Malays, and Chinese in Singhapore. J. Epidemiol and Community Health, 52, 181-185, 1998.

32. Makropoulos, W., Heintz, B., and Stefanidis, I., Selenium deficiency and thyroid function in acute renal failure. Renal Failure, 19, 129-136, 1997.

33. Chen, X.S., Yang, G.Q., Chen, X.C., Wen, Z.M., and Ge, K.Y., Studies on the relations of selenium and Keshan disease. Biol Trace Elem Res, 2, 97-107, 1980.

34. Keshan Disease Research Group Of The Chinese Academy Of Medical Sciences, Beijing, Epidemiological studies on the etiologic relationship of selenium and Keshan disease. Chin Med J, 92, 477-482, 1979.

35. Salonen, J.T., Alfthan, G., Huttunen, J.K., Pikkarainen, J., and Puska, P., Association between cardiovascular death and myocardial infarction and serum selenium in a matched-pair longitutional study. Lancet, 2, 175-191, 1982.

36. Salonen, J.T., Salonen, R., Pentilla, J., Jauhiainen, M., Kantola, M., Lappetelainen, R., Maenpaa, P.H., Alfthan, G., and Puska, P., Serum fatty acids, apolipoproteins, selenium and vitamin antioxidants and the risk of death from coronary artery disease. Am J Cardiol, 56, 226-231, 1985.

37. Miettinen, T.A., Alfthan, G., Huttunen, J.K., Pikkarainen, J., Naukkarinen, V., Mattila, S., and Kumlint, t., Serum selenium concentration related to myocardial infarction and fatty acid content of serum lipids. Br Med J, 287, 517-519, 1983.

38. Virttamo, J., Valkeila, E., Alfthan, G., Punsar, S., Huttunen, J.K., and Karvonen, M., Serum selenium and the risk of coronary heart disease and stroke. Am J Epidemiol 122, 276-282, 1985.

39. Kok, F.J., De Bruijn, A.M., Vermeeren, R., Hofman, A., vanlaar, A., De Bruin, M., Hermus, R.J., and Valkenburg, H.a., Serum selenium, vitamin antioxdants and the cardivascular mortality: A 9 year follow-up study in the Netherlands. Am J Clin Nutr, 45, 462-468, 1987.

40. Ringstad, J., And, D.S., Thelle, D.S., Risk of myocardial infarction in relation to serum concentrations of selenium. Acta Pharmacol Toxicol, 59, 336-339, 1986.

41. Weltz, B., Wolynetz, M., Verlinden, M., Interlaboratory trial on the determination of selenium in lyophilizied human serum, blood, and urine using hydride generation atomic absorbtion spectrometry. Pure and Applied Chem, 59(71), 927-936, 1987.

42. Arıcı, H., İstatistik, Meteksan Yayınları, s 230, 1991.

43. Oster, O., Prellwitz, W., Kaspen, W., Meinertz, T., Congestive cardiomyopathy and the selenium content of serum. Clin Chim Acta, 128, 125-132, 1983.

44. Al-Saleh, I., Selenium status in Saudi Arabia. J Trace Elem in Medicine and Biology, 14(3), 154-160,2000.

45. Al-Saleh, I., Billedo,G., El-Doush,I., El-Din Mohammed, G., and Yosef,G., Selenium and vitamins status in Saudi children. Clinica Chimica Acta, 368(1-2), 99-109, 2006.