Asian Journal of Chemistry Vol. 13, No. 4 (2001), 1312–1316

Hair Calcium and Cardiovascular Disease

S. MOHAN*, K.S.P. DURAIRAJ, V. ARJUNAN†, B. KARTHIKEYAN
and E. JAMES JABASEELAN SAMUEL‡
Raman School of Physics, Pondicherry University, Pondicherry-605 014, India
E-mail: s_mohan@lycos.com

The determination of major, minor and trace elements in human hair shows high promise in clinical medicine and toxicology for the easy detection of diseases. In particular, the elemental analysis of human hair is becoming popular for the identification of the major element calcium in human hair samples in connection with ischaemic heart disease. Hence, an attempt has been made in the present work to investigate calcium concentration in human hair, particularly in patients suffering from coronary heart diseases through atomic absorption spectrophotometry and X-ray studies. It is concluded from the results that the south Indian partients suffering from myocardial infarction belong to the low calcium concentration peak while in healthy population the calcium level in hair is high.

INTRODUCTION

Heart and cardiovascular diseases are common in developing countries and the mortality rate is also high. The high CVD (cardiovascular disease) death rate is due to the risk factor such as serum cholesterol, serum triglyceride, hypertension, smoking and life style. The role of micro elements such as V, Mn, Cu, Se, Zn and Cu in developing atherosclerosis proceeding to myocardial infarction was studied in detail[1–7]. It is also suggested that CVD is strongly influenced by fat and cholesterol in everyday diet. Many researchers have already studied the role of physical activity of occupation in developing atherosclerosis. One such study indicates that CVD incidence is common in sedentary as well as more active men[8]. It is also observed that hardness of drinking water has nothing to do with CVD. But blood pressure, serum cholesterol and cigarette smoking are the major risk factors for CVD. In developing countries like India, heart and cardiovascular diseases have been found to be increasing in recent decades. Factors behind cardiovascular diseases can be classified into two categories: (i) hereditary, age and sex which are unavoidable and, (ii) smoking, stress, style of life, cholesterol and triglyceride in blood, blood pressure, obesity etc[8], which are avoidable. The life style and the diet one adopts result in the variation of some inorganic materials present in certain parts of the body. Studies indicate that this variation

†Department of Chemistry, Tagore Arts College, Pondicherry-605 008, India.
‡Department of Physics, Vellore Engineering College, Vellore-632 014, India.

seems to be a signature of cardiovascular disease (CVD). Taylor investigated the role of physical activity of occupation in building atherosclerosis[9]. Taylor's follow-up activity showed no correlation between the sedentary and more active men in the buildingup of atherosclerosis and subsequent CVD[10].

The role of diet in CVD was also studied by many workers. One study reveals that hardness of drinking water can not be correlated with occurrence of CVD[8]. But excess alcohol and coffee are reported to be increasing CVD[11]. Highly saturated fatty diet and cigarette smoking are firmly established as increasing the CVD risk factor[12]. The major, minor and trace elemental analysis of human hair is becoming popular to know the intoxication for the diagnosis of diseases. Since hair contains wide range of elements and high concentration of several elements, it is preferred for analytical studies. Besides, the sample collection of hair is easy and it is stable after collection which is the most important factor for stable analysis. Basco[13] and Bozsai *et al.*[14] have already reported the role of calcium in human hair in coronary heart diseases.

The aim of the present work is to study the calcium concentration in human hair among south Indians and to correlate it to the CVD risk factor. The study confirms that level of hair-Ca can be linked with occurrence of CVD. The relationship between level of hair-Ca and CVD has been established using the data collected.

EXPERIMENTAL

X-ray Studies: Hair samples of length 4 cm, cut very close to the skin from the crown of head were collected from 25 patients suffering from myocardial infarction at Pondicherry and nearby districts of Tamilnadu. The samples were used in their natural form for investigation. The sample was first washed with 2% acetic acid for a minute to remove all exogenous materials without altering the endogenous element content and later rinsed in deionised water for 2 min. After drying and cutting in sections of 10 to 11 mm, square shaped 10×10 mm samples of about 100 to 150 mg were formed for X-ray analysis. The measurements were carried out by an energy disperse X-ray spectrometer. The resolution of the instrument was 165 eV for MnK line with a multi-channel analyzer. X-ray spectra and the elemental concentrations in the samples were carried out using an HCL-PC with a Pentium III processor of clock speed 730 MHz.

AAS Studies: For atomic absorption studies, the samples were dissolved with PTFE lined bombs. 2 mL concentrated nitric acid was added to 1 g of dried hair samples in PTFE beaker and the contents were digested at 170°C for 1 h with constant stirring. The solution was cooled and transferred to a 50 mL volumetric flask. The samples were analysed by Zeeman corrected atomic absorption spectrophotometry.

Determination of the Concentration of Calcium in Human Hair: Hospitals in and around Pondicherry helped us to collect hair samples of 25 patients suffering from ischaemic heart disease and of 25 healthy individuals. X-ray spectra of samples were recorded with the X-ray spectrometers. X-ray spectra of

hair from healthy individuals and patients suffering from CVD are presented in Fig. 1 and Fig. 2. The spectra indicate that the calcium concentration in hair of

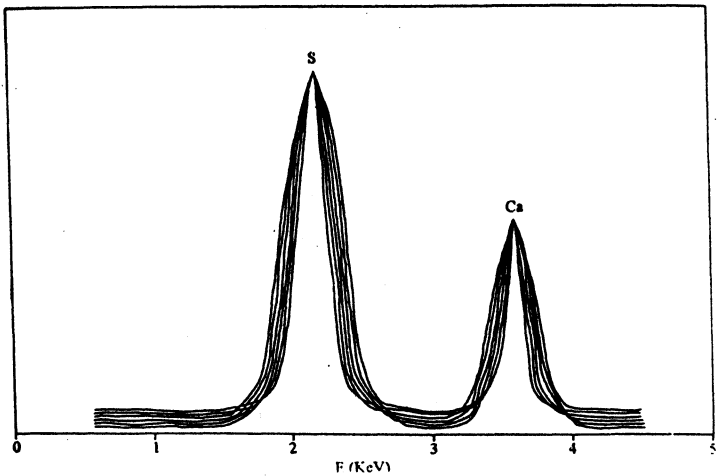

Fig. 1. X-ray spectra of human hair from healthy individual.

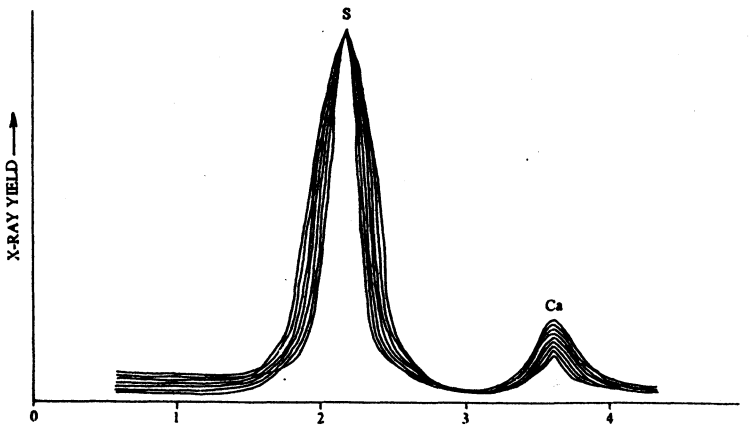

Fig. 2. X-ray spectra of human hair from patients suffering from ischaemic heart disease.

healthy people is higher than that in the case of patients suffering from CVD. The position of peaks in the X-ray spectra of hair samples corresponding to sulphur and calcium was found to be in line with the assignments made by Basco *et al.*[13] This observation implies that the measured hair-calcium is characteristic of body metabolism. The reference group used in the analysis consisted of 25 healthy volunteers. They underwent medical investigations at our request. The

present observation on the low level calcium in myocardial infarction patients agrees well with Basco *et al.*[13] The concentrations of calcium in hair as quantified by AAS for myocardial infarction patients and healthy individuals are presented in Table-1.

TABLE-1
CONCENTRATION OF CALCIUM ($\mu g\ g^{-1}$) IN HUMAN HAIR OF MYOCARDIAL INFARCTION PATIENTS AND HEALTHY INDIVIDUALS

S. No.	Age (years)	MI Patients	Healthy Individuals
1	40	257.0	1175.6
2	40	261.5	1287.4
3	40	389.2	1301.5
4	43	428.7	981.2
5	44	587.7	1801.5
6	45	688.4	1401.2
7	45	461.8	894.6
8	47	304.5	994.2
9	48	710.1	1021.4
10	48	651.3	2080.1
11	48	541.2	2626.3
12	51	623.7	1941.1
13	52	526.6	948.2
14	53	210.2	1186.7
15	54	401.6	1204.7
16	54	102.8	1186.7
17	54	98.6	841.7
18	54	81.2	868.4
19	54	40.4	998.1
20	58	108.6	1014.2
21	60	524.6	1607.2
22	60	212.6	1191.1
23	62	126.7	786.9
24	62	486.7	1408.7
25	38	641.2	2046.8
26	38	459.2	1968.7

RESULTS AND DISCUSSION

Atomic absorption spectrophotometry and X-ray studies offer reliable results and agree well with the NIES reference material 'Human hair'.[14] The low calcium level in hair cautions the development of CVD. It is clear from the above findings

that the falling level of calcium in hair implies that a problem of calcium balance starts earlier before the appearance of clinical signs. Hence, its measurement will be helpful for presignalling many diseases which are controlled with calcium metabolism

Further, one can also arrive at a conclusion that the physiological features determining calcium metabolic disorders manifest themselves as low calcium level in hair. In the modern civilized life style, the reasons for calcium metabolic disorders may be due to dietary habit and style of life. Thus, one can conclude that unbalanced calcium metabolic rate acts as a link between low calcium level in hair and CVD. If the relationship between low hair-calcium level and CVD is caused by calcium metabolic disorders, it can be expected that a correlation exists between hair-calcium level and the degree of atherosclerosis which precedes coronary heart disease. It was established that hair is a metabolic end product which records the metabolic rate of minerals at the time of its formation. So, the mineral concentration in hair reflects the mineral metabolic rate variations in the body.

Conclusion

In the present investigation, the correlation between the calcium content of human hair and cardiovascular disease has been arrived. The results show that the south Indian patients suffering from myocardial infarction belong to the low hair-calcium group.

REFERENCES

1. Th. G. Albers, Cardiovascular Disease and Trace Elements, Thesis submitted to Inter-University Reactor Institute (deft. 1984).
2. A. Key, Coronary Heart Disease: The Global Picture, *Atherosclerosis*, **22,** 149 (1975).
3. H. You and I. Yu, *J. Scanning*, **19,** 431 (1997).
4. C.S. Hamilton *J. Radiotherapy and Oncol.*, **43,** 289 (1997).
5. O.G. Martinsen, S. Grimnes and E.S. Kongshaung, *J. Medl. Biol. Engg. and Comp.*, **35,** 177 (1997).
6. H. Griffiths *J. Physiological Measurement*, **17,** 15 (1999).
7. W.B. Kannel, in: P. Kielholz, W. Siegenthaler, P. Taggart and A. Zanchetti (Eds.), Esteablished Cardiovascular Risk Factors, Framingham Today, Hans Huber Pub., Bern-Stuttgart-Vienna, p. 69 (1985).
8. T.W. Anderson, L.C. Neri, G.B. Schreiber, F.D.F. Talbot and A. Zdrojewski, *J.C.M.A.*, **113,** 119 (1975).
9. H.L. Talor, *Canad. Med. Assoc. J.*, **96,** 825 (1967).
10. A. Keys, Coronary Heart Disease in Seven Countries, Amer, Heart Ass. Monogr. No. 29, p. 20 (1970).
11. A. Davis, Let's Get Well, Unwin Hyman Ltd., UK, p. 46 (1989).
12. A. Menoti, V. Puddu, M. Monoti and F. Fidanzo, *Cardiologio*, **54,** 19 (1969).
13. J. Basco, Proc. 2nd Hungaro-Italia Symp. on Spectrochem., p. 416 (1985).
14. G. Bozsai *et al.*, Proc. 3rd Italo-Hungarian Symp. on Spectrochem., Rome, p. 155 (1989).

(*Received:* 26 February 2001; *Accepted:* 29 May 2001) AJC-2373