Role of Heavy Metals Composition in Cardiac Vascular Diseased Patients

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Summary: This study was focused to quantify and compare the concentration of different heavy metals in normal and cardiac patients of some zones of Sargodha region. Trace elements, which show a significant role in healthy as well as in diseased subjects, diverted the attention of scientists to explore the role of these trace elements in the cardiovascular diseases. In this study we compared the levels of zinc, cadmium, copper, nickel, manganese, chromium, and cobalt in hair, nail and plasma samples of different cardiac patients and control subjects. The study was undertaken on equal number of cardiac patients and healthy subjects. In each category 50% was male with age more than or less than 40 years. Analysis was done by using Atomic Absorption Spectrophotometer. The mean values of some metals like Zn, Cu and Cr are low in patients rather than normal subjects, while amount of Cd, Mn, Co and Ni were seen higher in patients than in control subjects. Male patients have ($p<0.05$) high values of metals than females; the same is with smoker cardiac patients against non-smokers. On the other hand the patients (male and female) whose age is < 45 have greater values of metals as compare to the cardiac patients of age greater than 45 years. From the results of this study it can be concluded that increase or decrease in heavy metal composition play an adverse effect on the normal function of heart.

Introduction

Heart disease as defined as "A structural or functional abnormality of the heart, or of the blood vessels supplying the heart, that impairs its normal functioning" Cardiovascular disease is any of a number of specific diseases that affect the heart itself and/or the blood vessel system, especially the veins and arteries leading to and from the heart. Research on disease dimorphism suggests that women who suffer with cardiovascular disease usually affected through the blood vessels while men usually through heart muscle itself. Cardiovascular disease is the main cause of death in both of the developed and developing countries, resulting for 16.7 million deaths worldwide. Overall, 12 million Pakistanis, 18% of its people aged 15 and above, have high blood pressure, but most of them continue to be unaware of their disease status [1]. The high release of certain chemicals (Carbondisulfide, Halogenated hydrocarbons and Chlorofluorocarbons, Methylene Chloride, etc), metals (Antimony, Arsenic and Arsine, Cadmium, Cobalt, Lead, Thallium, Zinc, Nickel, Copper, Manganese etc), gases (Carbon monoxide, Cyanide, Hydrogen Sulfide, etc) Pesticides (Carbamates and Organophosphates, Organic Nitrates, etc) can be the main cause of Cardiovascular disease. Out of these factors, release of metals into environment has direct impact on the health of human. Because metals are very important part of a large quantity of enzymes, variety of different physiological methods are regulated by them, but some metals have bad effects on human body if they are in excess like lead, cadmium, arsenic and mercury etc, through to become the cause of a number of different diseases. Metal contents through food chain enter in consumer's body and become a part of different body enzymes and hormones. The over concentration cause male functioning of enzymes and hormones resulting in different diseases [2, 3]. The main body parts that might be affected by these changes include; heart, hair, intestine, kidney, liver, lungs, male sexual hormones, nail, skeleton and skin. Copper plays an important role in the regulation of oxidative free radicals and its deficiency increases the susceptibility of lipoprotein peroxidation, which in turn can lead to the risk of cardiovascular events [4, 5]. Manganese is a constituent of the antioxidant enzymes superoxide dismutase and adentylcyclase [7, 8]. Chromium deficiency has also been linked with glucose tolerance, elevated serum cholesterol levels and the presence of aortic plaques in animals [9-11]. Kidneys, the most important organ of the body collect cadmium, lead, and mercury [4, 5]**.** Lungs are mostly affected by cadmium, lead and mercury. Commonly, metals stored in nails include Na, K, Mg, Cu, Zn, Cr, Fe, Ag, Au, Pb, Se, Co, Sb, and V etc [3]. Skeleton disorders have been reported to be interlinked with cadmium. This study mainly focuses to the effects of some heavy metals (Cr, Cd, Mn, Co,

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Ni, Zn, and Cu) in the prevalence of heart disease among people of different zones in Sargodha (Pakistan**).**

Results and Discussion

The main threats to human health from heavy metals are associated with exposure to cadmium, lead, mercury and arsenic [4]. Access or deficiency of essential heavy metals also has deep effect on the health of human beings. An effort was done to find out a correlation between heart disease and metal concentration in different parts of the body such as, hairs, nails and blood plasma. This study was carried out to assess the concentration level of the Cr, Cu, Zn, Ni, Cd and Co was analysed by Atomic Absorption Spectrometer. The concentration of the Cr, Cu and Zn was found higher than that of patients in control subjects. Among the hair, nail and blood the concentration of Cu and Zn was found in significant difference while the concentration of the Cd, Cr, Co and Ni found in non-significant values.

Cardiac vascular diseased (CVD) men usually have higher concentration of all metals than in CVD women. Anyhow in sense of significant and non-significant values, the concentration of Zn, Cu, Mn and Cd was found in significant form (p<0.05) while Ni, Co and Cr in non-significant figures (p>0.05) as shown in Table-1.

Very careful comparison between CVD men patients and control patients revealed that the concentration of Cd, Mn and Ni was increased in CVD patients than control subjects. On the other hand the concentration of Cr, Zn and Cu was decreased than control subjects. Similar study was carried out to metal ion concentration deviation in CVD women patients and control subject. The results revealed that increase in concentration of Cd, Ni, Mn and Co and decrease in Zn, Cr and Cu was found than control subjects as shown in Table-2.

The age factor was also observed to map out the complete picture of the role of metal concentration in heart diseased. Mn, Cu and Zn was found in higher concentration significantly in patients less than 45 years age than more than 45 years subjects and the same trend was found in case of CVD women. Further the effect of smoking was also estimated on the accumulation of the heavy metals and ultimately the heart disease as shown in the Table-3. Despite evidence of exposure from environmental tobacco smoke, however, this is probably contributing little to total cadmium and other heavy metal body burden. All the metal concentrations were found in higher values in CVD smokers than non CVD smokers.

Table-1: Mean±S.D concentration (µg/g for Hairs and Nails, µg/mL for Plasma Samples) of Cardiac subjects and controls.

	Samples	Cd	Cr	Co	Cu	Mn	Ni	Zn
H.D Patients (N=42)	Hair	0.78±0.72	2.44±0.967	5.88±2.04	12.80±7.12	6.14±3.10	2.05±0.55	87.60±7.25
	Nail	0.52±0.39	1.32±1.22	6.55±1.82	15.78±6.22	5.61±2.75	2.76±0.95	54.74±3.66
	Plasma	0.26±0.11	0.34±0.25	1.75±0.45	4.32±1.41	0.95±0.25	0.78±0.26	36.32±1.72
Control Subjects (N=42)	Hair	0.52±0.04	4.02±0.63	6.75±1.32	19.79±1.45	4.02±1.15	1.26±0.74	102.44±12.72
	Nail	0.41±0.02	2.90±0.67	6.90±1.05	22.72±2.32	4.05±0.85	1.66±0.12	85.93±11.92
	Plasma	0.23±0.07	1.91±0.32	3.32±0.84	9.95±1.11	0.46±0.06	0.34±0.25	54.72±11.24
P_{value}	Hair	p>0.05	P<0.05	p>0.05	P<0.05	P<0.05	p>0.05	P<0.05
	Nail	p>0.05	P<0.05	p>0.05	P<0.05	P<0.05	p>0.05	P<0.05
	Plasma	p>0.05	P<0.05	p>0.05	P<0.05	P<0.05	p>0.05	P<0.05

t-Test Analysis (p<0.05= significant difference, p>0.05= Non-significant difference)

Table-2: Mean±S.D. concentration (µg/g for Hairs and Nails, µg/mL for Plasma Samples) of Cardiac subjects (Men Vs Women).

	Samples	Cd	Cr	Co	Cu	Mn	Ni	Zn
H.D Patients (N=42)	Hair	0.84±0.93	2.54±0.17	8.44±1.37	10.24±3.22	7.88±1.82	1.92±0.34	95.12±10.24
	Nail	0.34±0.22	2.22±1.44	6.92±0.81	13.22±4.33	7.56±1.42	2.92±0.84	69.76±6.66
	Plasma	0.22±0.04	0.26±0.04	1.84±0.34	3.24±0.54	0.92±0.05	0.82±0.05	42.12±1.28
Control Subjects (N=42)	Hair	1.76±0.14	3.42±0.76	6.26±0.52	15.48±2.24	4.33±0.85	2.15±0.32	78.12±11.38
	Nail	0.81±0.14	2.44±1.59	6.28±0.72	18.26±2.80	3.72±0.65	2.63±0.78	39.94±4.06
	Plasma	0.72±0.02	0.32±0.04	1.65±0.12	5.22±0.62	0.92±0.05	0.74±0.05	25.85±1.95
P_{value}	Hair	P<0.05	P>0.05	P<0.05	P<0.05	P<0.05	p>0.05	P<0.05
	Nail	p>0.05	P>0.05	p>0.05	P<0.05	P<0.05	p>0.05	P<0.05
	Plasma	p>0.05	P>0.05	p>0.05	P<0.05	P>0.05	p>0.05	P<0.05

t-Test Analysis (p<0.05= significant difference, p>0.05= Nn-significant difference)

Table-3: Mean±S.D. concentration (µg/g for Hairs and Nails, µg/mL for Plasma Samples) of Cardiac subjects Smoker (Men) Vs Non-Smoker (Men).

	Samples	Cd	Cr	Co	Cu	Mn	Ni	Zn
H.D Patients (N=42)	**Hair**	**0.84±0.55**	**2.76±0.60**	**8.44±1.37**	**15.24±2.22**	**7.88±1.44**	**2.15±0.34**	**96.12±10.24**
	Nail	**0.66±0.14**	**2.14±1.54**	**6.44±0.33**	**17.22±4.33**	**6.56±1.04**	**1.62±0.84**	**71.76±6.66**
	Plasma	**0.32±0.04**	**0.44±0.04**	**1.77±0.04**	**5.24±0.54**	**0.92±0.07**	**0.62±0.07**	**43.12±1.76**
Control Subjects (N=42)	**Hair**	**0.76±0.74**	**2.24±0.94**	**5.88±2.02**	**12.48±7.24**	**6.33±3.85**	**1.95±0.94**	**89.12±7.38**
	Nail	**0.44±0.40**	**2.02±1.02**	**5.12±1.62**	**14.26±3.80**	**4.72±2.65**	**1.05±0.18**	**59.94±3.06**
	Plasma	**0.24±0.12**	**0.32±0.22**	**1.05±0.72**	**2.22±1.62**	**0.62±0.22**	**0.15±0.05**	**32.85±1.95**
P_{value}	**Hair**	**P>0.05**	**P<0.05**	**P<0.05**	**P<0.05**	**P<0.05**	**p>0.05**	**P<0.05**
	Nail	**P<0.05**	**P>0.05**	**P<0.05**	**P<0.05**	**P<0.05**	**P<0.05**	**P<0.05**
	Plasma	**p>0.05**	**P>0.05**	**p>0.05**	**P<0.05**	**P>0.05**	**P<0.05**	**P<0.05**

t-Test Analysis (p<0.05= significant difference, p>0.05= Nn-significant difference)

Experimental

Selection of Subjects

Total 34 cardiac and 34 control subjects were selected for present study from urban area of sargodha. Out of these 17 were female and 17 were males patients and similar ratio was selected for control subjects. Among 17 cardiac patients, 11 were smokers and 6 were non-smokers.

Collection of Samples

One gram of nails and hairs samples was taken from both the cardiac and normal subjects. These samples were properly washed with water and acetone for removing dust, oil and gels before storing [14]. Blood sample (5 mL) was collected in Na_2EDTA glass vials from each subject by sterilized syringe and stored in refrigerator at 4^oC till further analysis.

Nail/Hair Sample Preparation

One gram of each washed sample was cut into small pieces and took into labelled digestion flask (100 mL). Using wet acid digestion, each sample was soaked in ultra pure nitric acid (5 mL, 60%) over night followed by addition of H_2O_2 (1 mL) and digested on hot plate at 180 $^{\circ}C$ until the completion of digestion [15, 16]. Volume of each sample was made up to 20 mL with the help of doubly distilled de-ionized water. Each sample was stored in labelled sample vial until analysis.

Blood Sample Preparation

Plasma from each blood sample was taken by centrifugation at 1000 r.p.m. and 4 ^oC. Plasma sample 1 mL of each subject was taken in digestion flask followed by the addition of 60% HNO_3 (1 mL) for digestion process. Digestion was performed on hot plate at 180 $^{\circ}C$ for 2-3 min. After digestion volume of each plasma sample was made up to 15 mL with doubly distilled de-ionized water and stored in sample vials for determining the concentration of the metal ion profile using flame atomic absorption spectrophotometer.

Conclusion

Reports indicate the adverse health effects of Cd, Ni, Cr, Zn, Mn and Co exposure, primarily in the form of renal tubular damage, heart failure but possibly also effects on bone and abnormality may occur at higher exposure levels. Many individuals in Pakistan have exceeded exposure levels of metals and the margin is very narrow for large groups. Therefore, measures should be taken to reduce all these metal exposure in the general population in order to minimize the risk of heart failure and other adverse health effects. Since there is also a risk to the fetus in particular pregnant CVD women.

There should be an extensive debate is required on the safety CVD, but to date no studies have been able to show any associations between variation in metal concentration and CVD. Hopefully this study will furnish some clue to cardiologists that how metal ion concentration are important in this chronic disease and how it can be reduced simple by maintaining the concentration level of metals in the body.

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