

Inverse relation between Serum Silicon levels and Microalbuminuria in non-diabetic hypertensive patients of Mica Mine workers.

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Abstract

Hypertension is an important risk factor in cardiovascular diseases. Microalbuminuria in non diabetic hypertension is an important early marker for cardiovascular risk. Silicon is an important trace element and possesses beneficial effects on cardiovascular events. Mica mines consists of large amount of silicon, hence workers were exposed to huge amounts of silicon dust. Aim of this study is to find out the relation between silicon levels and microalbuminuria in non diabetic hypertensive patients of mica mine workers. We have recruited 61 non diabetic hypertensive subjects from mica mine (group-I), 60 non diabetic hypertensive subjects who were not exposed to mica mines (group-II) and 60 healthy non exposure to mica mines were included as control subjects (group-III). We did biochemical analysis, urine albumin/creatinine ratio and serum silicon for all the study subjects. Among hypertensive groups (group-I&II) we observed serum total cholesterol, and urine albumin/creatinine ratio were decreased in group-I, whereas serum silicon levels were elevated significantly in group-I than group-II. Percentage of microalbuminuria is less in group-I patients (15%) than group-II patients (28%). Among group – I patients, serum silicon shows negative correlation with total cholesterol ($r=-0.04$, $p<0.05$) and urine albumin/creatinine ratio ($r=-0.03$, $p<0.05$) There is a significant inverse relationship observed in group-I towards serum silicon, whereas there was no such relationship found in group-II. Our study concludes Silicon can decrease microalbuminuria which is an endothelial damage marker and hence it has beneficial effect on endothelial functions but exact mechanism of action is not yet clear.

Key words: Hypertension, Mica Mine, Microalbuminuria, Silicon

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Introduction

Hypertension is reported to be the fourth contributor to premature death in developed countries and the seventh in developing countries [1]. Recent reports indicate that nearly 1 billion adults (more than a quarter of the world's population) had hypertension in 2000, and this is predicted to increase to 1.56

billion by 2025 [2]. High blood pressure (BP) increases the risk of cardio vascular disorders (CVD) for millions of people worldwide, and there is evidence that the problem is only getting worse. In the past decade, age-adjusted rates of stroke incidence have risen, and the slope of the age-adjusted rate of decline in coronary disease has levelled off. The incidence of end-stage renal disease and the prevalence of heart failure have also increased.

An association between microalbuminuria and several cardiovascular risk factors, such as BP, dyslipidemia, endothelial dysfunction, insulin resistance, salt sensitivity, and increased renin-angiotensin system activity, has been widely demonstrated in hypertensive patients [3] Furthermore, increased urinary albumin excretion is associated with signs of subclinical organ damage, such as left ventricular hypertrophy (especially concentric geometry), and increased carotid wall thickness [4]. Very less is known about the

pathogenic mechanism(s) underlying the development of microalbuminuria. The severity of BP and the increased systemic permeability to albumin, possibly due to early endothelial dysfunction, seem to play a major role.

Silicon is contained in plants and also present in animals including humans. The quantity in humans is 7 grams being more than all other trace elements together. Nevertheless Silicon is not (or hardly) considered as beneficial: there is a lot of scepticism in regular Medicine because silicon has been considered to be inert in humans. Silicon accumulating plants like *Equisetum arvense* (horsetail) have been used therapeutically for aging disorders, Alzheimer's disease, atherosclerosis, brittle hair, fractures, fragile nails, back pain, osteoporosis, skin disorders, tendinitis, improved wound healing and wrinkles [5]. On the other hand there is a lack of sufficient data on the metabolism of silicon in animals and humans. The absorption and bioavailability of silicon of the different silicon sources (silicates, metasilicates etc.) is hardly known. There are neither standardized methods nor assays for assessing the silicon status in humans and animals.

India produces about 62% of the world's mica. Mica commonly occurs as flakes, scales or shreds. Sheet muscovite (white) mica is used in electronic insulators; ground mica in paints, as joint cement, as a dusting agent, in well-drilling muds; and in plastics, roofing, rubber and welding rods. It is siliceous in nature. It contains large amount of Silicon. In India the mica mines are mainly found in Andhra Pradesh at Atmakur, Ravuru, Gudur of Nellore district. Silicon is the major composition of mica. Workers working in the mines are exposed to this element. Inverse relation between silicone and cardiovascular events and the anti-atheromatous action of silicon was found in 1979 [6]. Hypertension is one of the important cardiovascular risk factor. Present study aimed to demonstrate the relation between the serum silicon and urine albumin excretion in hypertensive patients working in the mica mines.

Materials and Methods

Study subjects: Total 504 mica mine workers were screened who are working in various mica mines of Nellore district. Data collected which included, demographics (age, gender), anthropometric measurements (relative body weight, height), lifestyle related factors (smoking status, alcohol consumption,

diet and physical activity) and clinical findings, medication profile and family history. Sixty one (61) subjects were diagnosed as non diabetic essential hypertensive patients and they are categorized as group-I. Sixty (60) essential hypertensive patients not exposed to mica mine works were included as group-II. Sixty (60) healthy age, sex matched subjects were selected as controls (Group-III). Based on the Joint National Committee (JNC) 7 report, hypertensives were subjects with SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg and normotensives with SBP < 120 mmHg and DBP < 80 mm Hg. Only patients having mild to moderate hypertension were included in this study. Study subjects suffering with secondary hypertension liver, renal, cardiac and other systemic diseases and pregnant women were excluded from the study.

Biochemical Analysis: Fasting blood samples were collected and plasma Glucose, serum Total cholesterol, HDL-Cholesterol, LDL-Cholesterol, Triglycerides were carried out by Chemistry analyzer (HUMAN GmbH, Germany). Urine samples (spot) collected in a sterile container and subjected to centrifuge. From the supernatant urine spot Albumin estimated by immune turbidometry method and urine spot creatinine estimated by modified Jiff's method by diluting urine with 1:5 ratio using distilled water. Albumin/creatinine ratio was obtained and expressed in microgram of albumin/mg of creatinine ratio between 31 to 300 consider as microalbuminuria.

Serum Silicon Analysis: Serum silicon was estimated by Graphite furnace - Atomic Absorption Spectrophotometer from Shimadzu-Japan by using method of K. Van Dyck [7] & W. Verwaal, M [8].

Statistical Analysis: SPSS 12 statistical software package was used (SPSS Inc., Chicago, IL). Continuous variables were described as mean/standard deviation; Comparison of means was done by independent sample t-test & Chi-square test. The relation between study parameters and Silicon concentration was analyzed using Spearman's rank correlation coefficient test. Statistical significance was set at $p < 0.05$.

Results

Sixty one Mica mine workers with hypertension (group-I) and sixty non mica workers with hypertension (group-II) and sixty healthy subjects (group-III) included in this study. The mean and standard deviation of variables shown in Table 1. Systolic and Diastolic blood pressures were different

from controls to hypertensive groups. Among the biochemical parameters serum total cholesterol, LDL-Cholesterol and triglycerides are statistically significant ($p=0.05$, table-1). Serum Silicon levels and Urine albumin/creatinine also shows difference among three groups and statistically significant ($p=0.05$, Table-1). Among hypertensive groups (group-I&II) Serum Total Cholesterol, and Urine Albumin/creatinine ratio were decreased in group-I when compared with Group-II, whereas serum silicon levels were elevated significantly in group-I than group-II (Figure-1). Percentage of microalbuminuria

is less in group-I patients (15%) than group-II patients (28%). Among group –I patients, serum silicon shows negative correlation towards total cholesterol ($r=-0.04$, $p<0.05$) and Urine Albumin creatinine ratio ($r=-0.03$, $p<0.05$) as shown in Table-2. There is a significant inverse relationship observed in microalbuminuric hypertensive patients in group-I towards serum silicon, whereas there was no such relationship found in group-II microalbuminuric hypertensive patients as shown in Figure-3&4.

Variables	Group-I (n= 61)	Group-II (n=60)	Group-III (n=60)	P-value
Age(yrs)	53±16	54±3.2	51±17	0.68
Sex(M/F)	39/23	42/18	36/24	-
S B P (mm/Hg)	151±10.3	148±11.1	118±2.3	<0.05
D B P (mm/Hg)	96±4.2	98±3.2	81±2.2	<0.05
F B S (mg/dl)	96±11.2	98±9.2	94±12.6	0.15
Total Cholesterol(mg/dl)	190.6±40.2	220±31	161.2±14.3	>0.05
HDL (mg/dl)	42.2±4.1	39±6.2	43.4±3.9	0.08
LDL (mg/dl)	122.1±26	128±4.5	94±10.2	<0.05
TG (mg/dl)	147.8±14.4	169±19	146.2±21.3	<0.05
Urine albumin/creatinine ratio($\mu\text{g}/\text{mg}$)	74±11.2	102±23.2	14±3.2	<0.05
Serum Silicon ($\mu\text{g}/\text{L}$)	840±111.2	380±11.2	391±23.2	<0.05

Table 1: Showing mean, standard deviation and P-value of study variables in Group-I, Group-II and Group-III subjects. $P<0.05$ is considered statistically significant. SBP - Systolic Blood Pressure; DBP - Diastolic Blood pressure; FBS - Fasting Blood Glucose; TG – Triglycerides.

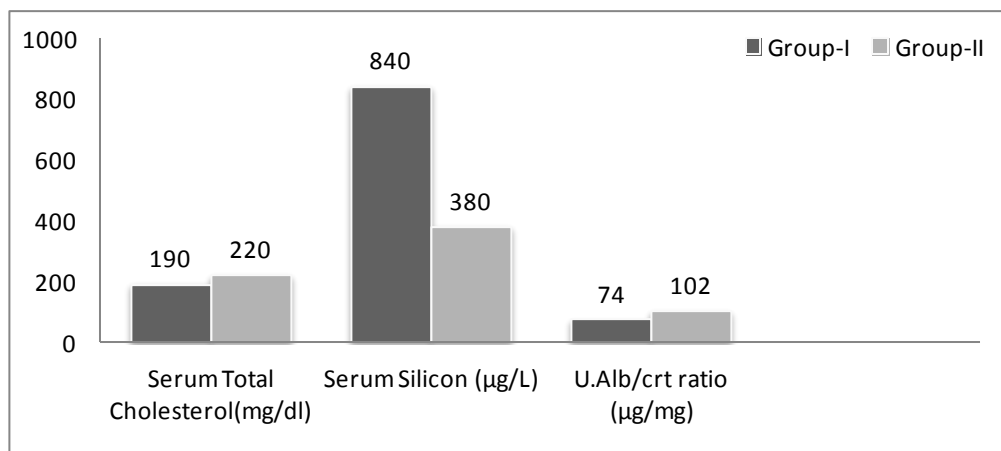


Figure 1: Serum Total Cholesterol, Silicon levels and Urine Albumin/creatinine ratio among hypertensive groups (i.e., group-I & II).

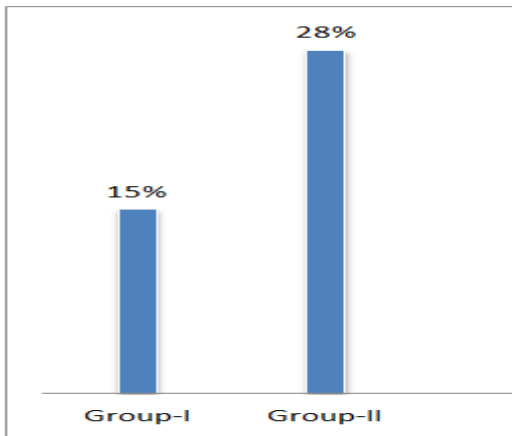


Figure 2: Comparison of microalbuminuria in group-I & group-II

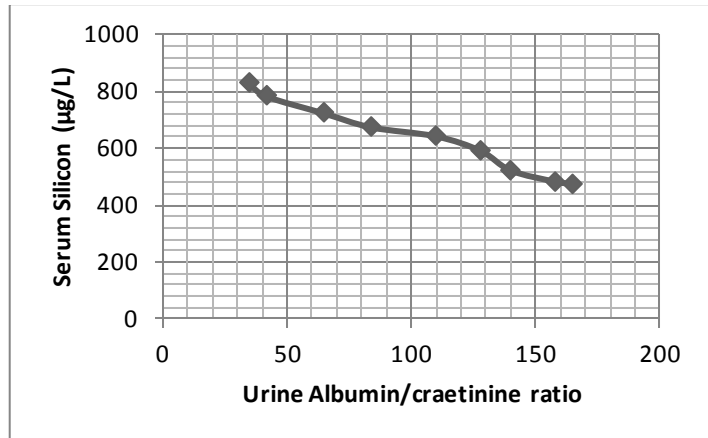


Figure 3: Relationship of serum Silicon levels and microalbuminuria in Group-I

Variable	r-value	p-value
Serum Silicon Vs Total cholesterol	-0.04	<0.05
Urine Alb/creat ratio	-0.03	<0.05

Table 2: Correlation analysis of serum silicon with serum Total cholesterol and Urine albumin/creatinine ratio in group-I. P=<0.05 is statistically significant.

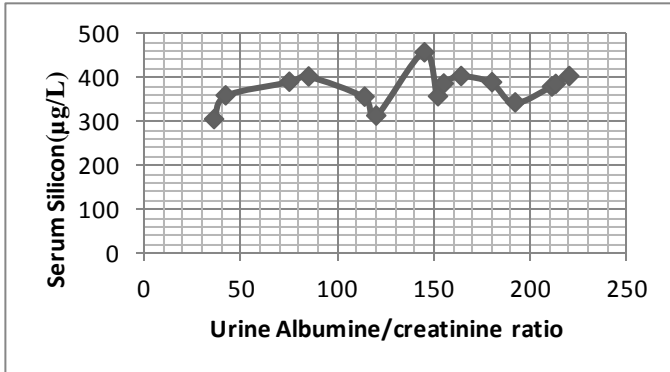


Figure 4: Relationship of serum Silicon levels and microalbuminuria in Group-II

Discussion

Hypertension is not only a well-established cardiovascular risk factor but also increases the risk of atherosclerosis [9]. Microalbuminuria is increasingly recognized as an important predictor of ischemic heart disease in subjects with non-diabetic hypertensive patients [10]. Silicon, an abundant trace mineral in nature is proving to be an essential ingredient for stronger bones, better skin and more flexible joints. Silicon makes the inner lining of arterial tissue and is less permeable. In the case of a high cholesterol diet, silicon supplementation reduces the occurrence of atherosclerotic lesions in blood

vessels. Animal studies in rabbits indicate that silicon can reduce the formation of atheromatous plaques [11]. Silicon is present in important quantity in most of organic tissues, bony tissues, and connective tissues. In the human body, it is in higher concentration (7g) than Iron (Fe), Copper (Cu). It potentialize the action of Zinc (Zn) and Copper (Cu) and allows the fixing of Calcium (Ca) [12]. In the present study silicon levels are elevated in exposure. Our previous study (Subrahmanyam etal) [13] shows decrease in prevalence of hypertension in mica exposure than non exposure. In the present study we compared hypertensive patients of Mica mine workers and non mica exposures. The endothelial

damage marker microalbuminuria was tested in both groups. We got significant decrease in the percentage of microalbuminuria in hypertensive patients of mica workers than non exposed hypertensive patients. The urine albumin/creatinine ratio is negatively associated with silicon levels in group-I than group-II. This is a novel finding in our study. Silicon which makes the inner lining of blood vessels may play a crucial role in decreasing the endothelial damage marker (Microalbuminuria) in the mica exposure (group-I). In addition serum total cholesterol levels also negatively associated with serum silicon in group-I than group-II in our study and supports the anti-atherogenic role of silicon [14]. Further studies are required in this area to understand molecular mechanism by which silicon is reducing the microalbuminuria. Limitation of the present study is sample size. Large sample size study may be required to get the clear data.

Conclusion

To our knowledge this is the first and novel study conducted in India, in mica mine workers with hypertension. The study concludes that silicon was found to decrease microalbuminuria which is an endothelial damage marker in hypertensive patients. Hence we propose silicon is having beneficial effects on endothelial functions. Exact mechanism of action is not yet clear, further studies are required to establish the relationship between silicon and microalbuminuria and its protective effects.

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