EFFECTS OF AGE, HEIGHT AND WEIGHT VARIATIONS ON ASCORBIC ACID, BLOOD PRESSURE AND HDL-CHOLESTEROL LEVELS IN NORMAL AND HYPERTENSIVE MALES

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Summary

The plasma ascorbic acid (PAA), HDL-C, weight, height and levels of blood pressure were evaluated in different age groups in normal, mild and moderate hypertensive subjects. The results also showed that 24 hrs urinary excretion of ascorbic acid is indirectly related with its plasma level, age and blood pressure while no relationship was found with weight and height of subjects. However, HDL-cholesterol and 24 hrs urinary ascorbic acid were positively correlated with each other but negatively correlated with age in normotensive individuals. The weight in hypertensive and control groups has no direct relation with the age. Regarding age of subjects, results are interesting as it was highest in 41-45 years age-group in control and in 51-55 years age-group in both mild and moderate hypertensives. The systolic and diastolic BP correlated directly with age in control as well as in hypertensive groups and was increased to the highest level in moderate hypertensives. The PAA levels in hypertensive group were significantly higher but in comparison to mild and moderate hypertensives, levels were lower significantly in both hypertensives than normal **toll** (?) group. It may be concluded that PAA status in those having risk of cardiovascular mortality secondary to hypertension should definitely be evaluated as its lower values can give rise to rise in blood pressure, as PAA deficiency is completely treatable and curable while hypertension is only treatable but not curable.

Key Words: Adult males, Hypertension, HDL-Cholesterol, Plasma ascorbic acid

Introduction

Determination of vitamin C is of great clinical importance for evaluating its deficiency in various diseases (1) while blood and urine examinations are usually taken as an index for checking adequacy of this vitamin in the body (2). Various acids are used for extraction of ascorbic acid, including acetic, trichloracetic, meta-phosphoric and oxalic acids. The later two acids not only stabilize vitamin C by reducing the pH of medium but also form complexes with metal ions e.g. copper; preventing the catalytic oxidation of this vitamin.

Ascorbic acid is an example of the ene-diol functional compounds. Such compounds oxidize smoothly to dehydro compounds by variety of oxidizing agents. This gives the basis of their determination by oxidation method (5, 6). Numerous methods have been reported (7,8) for determination of vitamin C but most of the methods are tedious, lengthy, time consuming and not free from interferences (9). Correlation between vitamin C and heart disease risk factors including plasma cholesterol and blood pressure levels, are the primary evidences relating vitamin C to heart disease (8). Positive correlation was reported between plasma ascorbic acid and HDL-cholesterol in young and elderly Welish residents by Bur *et al* (2) and proved by Jacques (10). Some studies showed decrease in BP with an increase in PAA levels. This was 6-7% in young Japanese males (11), 4 -5% in middle aged Finnish males (12) and 6-11% in men and women from United States (13). The present study was conducted with the aim to find any correlation between plasma and/or urinary ascorbic acid with HDL-C, age, weight, levels of blood pressure in human subjects.

Materials And Methods

Experimental Procedure

The normotensive and hypertensive subjects were selected randomly from local population following the criterion of Andreoli *et al* (14). The 24 hours urinary samples were collected from 100 subjects; 20 healthy controls and 80 hypertensive adults which were subdivided into mild and moderate hypertensive subjects (40 in each group). Samples were stored immediately at -4° C for determination of ascorbic acid. Fresh blood samples were also collected from the same subjects and were immediately stored at -4° C in bottles, containing 3% sodium citrate. The remaining blood and urine samples were stored at -20° C temperature in a

refrigerator for future record. Vitamin C contents of blood and urine samples from 10 normal subjects were estimated first as a pilot study to evaluate the best possible method. Three different methods applied were Iqbal and Yaqub (9), Barakat *et al* (15) and modified Roe and Keuther method cited by Nino and Shah (16). HDL-Cholesterol was isolated by Lopes-Virella *et al* (17) and its cholesterol contents were estimated by Richmond (18) while systolic and diastolic BP (SBP and DBP) were determined by a standard sphygmomanometer. Similarly, height and weight were measured by measuring scales. The results were evaluated by applying appropriate statistical tests (19).

Results and Discussion

The results obtained have been summarized in Tables 1-VII and were compared in both normal and hypertensive subjects. The 24 hour urinary excretion in controls were 450.26, 420.16 and 350.16 mg/day in 41-45, 46-50 and 51-55 years age groups, respectively and in hypertensive the values were 323.5, 285.2 and 220.1 mg/day, respectively. In mild hypertensive subgroup, these were 330.0, 300.0 and 240.0 mg/day and in moderate hypertensive the values were 315.4, 270.2 and 200.2 mg/day, respectively. These data indicated that in normal subjects values were within range as also reported by Haris and Ray (20) while these values were below normal in hypertensive subjects. The PAA levels found in normotensive controls of 41-45, 46-50 and 51-55 years old male adults were 0.659, 0.470 and 0.368 mg/dl, respectively. These values are similar and consistent with the values of Evans *et al* (21) i.e., 0.37 ± 0.19mg/dl, Greco and La Rocca (22) i.e., 0.588 ± 0.034 mg/dl and Chio *et al* (23) i.e., 42.3 ± 21.2 mg/dl and Yoshioka e*t al* (11) i.e., 0.48 mg/dl) in normotensive subjects. It was further observed that the values were 0.420, 0.376 and 0.174 mg/dl in hypertensives which decreased with the severity of hypertension. Similarly, HDL-Cholesterol in control was 50.34, 43.23 and 39.95 mg/dl while in hypertensives these values were 43.49, 41.44 and 37.24 mg/dl, respectively. It is clear that the values were decreased with the age in both the groups. On the other hand, SBP increased with the age in both the groups and similar was the case with DBP.

The data showed that 24 hour urinary excretion is indirectly related with PAA, age and blood pressure levels, while no relationship could be found with weight and height of the subjects. The correlation co-efficients of PAA with height, age and weight showed that PAA levels had strong negative correlations (r=-0.355) with the age of the subjects and similar was the case

with the weight of the subjects (r = -0.213). From the r values it was clear that age has stronger correlation with PAA level than the weight of the subjects.

PAA and HDL cholesterol were positively correlated with each other and have negative correlation with age in normotensive individuals. It may be suggested that similar patterns were seen in both the groups of hypertensive subjects too. The r-value for HDL-C with age was 0.482, with weight, it was -0.103 and with DBP, it was -0.658. Similarly, PAA with SBP has negative correlation with r = -0.891 and with DBP r = -0.826 while with HDL cholesterol, the r value was positive i.e. 0.869.

No direct relation was also seen with the age in both groups. However, compared to other groups the weight was highest in second (46-50 year) age group. The finding seems difficult to explain; probably that it was due to relative inactivity in all the groups with passage of age. In male hypertensives the weight was highest in 46-50 years and in moderate hypertensives of 51-55 years age groups which cannot be explained theoretically. Similarly, the weight patterns in control and hypertensive groups were almost similar (Tables I – VI). Regarding height, our results were interesting as it is highest in 41-45 years age in control group, while the highest height was found in 51-55 years age group in both the mild and moderate hypertensive subjects. Again probably the 41-45 years control group appears to be more active and utilizing better nutrients due to active life style. The relative comparison showed no significant difference between control and mild hypertensive subjects, while in moderate hypertensive subjects the height had definite correlation with the levels of blood pressure. The height may be co-related with built of body and the taller people had higher blood pressure as shown in Table V. Comparison of plasma ascorbic acid in control and hypertensive subjects showed that levels were higher in control than hypertensive patients. Variation in different age groups decreased in control and hypertensive subjects. It showed higher decrease with age in hypertensive subjects and especially the highest decrease was noted in moderate hypertensive subjects (Table I). Regarding HDL cholesterol, it was found that results are almost similar to ascorbic acid as HDL-C also decreased with age in both groups. It appears that the rise of blood pressure with age was inversely related with HDL-C in blood. However, in our data the HDL-C in moderate hypertensive did not decrease directly with the age as it was highest in second (46-50 year) age group (Table III). Comparison of blood pressure levels, SBP correlated directly with age in control as well as in hypertensive groups. It increased to the highest in moderate hypertensive

subjects. These results are similar to others studies (22, 23, 24). The DBP also increased directly with age and were highest in 3rd (51-55 years) age group in both the control and hypertensive subjects. In addition, they were highest in mild hypertensive and not in moderate hypertensive subjects as shown in Table VI.

The levels of PAA were with in normal range in normotensive male adults. The levels in the hypertensive group were significantly lower than the normal control group. When the mild and moderate hypertensive groups were compared with normotensive controls it was found that the levels were lower significantly in both the hypertensive groups. There was a strong negative correlation between PAA and blood pressure. Plasma ascorbic acid deficiency and subsequently its reduced utilization by the tissue due to one reason or the other may be responsible for the development of hypertension or vice versa. The ascorbic acid may regulate blood pressure through its check over the normal lipid metabolism.

The PAA values in hypertensive group were 0.295± 0.10 mg/dl while in mild and moderate hypertensives the values were 0.374 ± 0.068 mg/dl and 0.218 ± 0.0077 mg/dl, respectively as already reported (2, 22, and 24). There was a continuous rising trend of BP and fall in PAA with age. Similar results were also observed by Jacques *et al* (10). The values decreased with age, probably the reason is that the elderly appears to be some what less likely than young adults to consume fresh fruits and vegetables and adequate amount of vitamin C. The levels are even less in aged hypertensive subjects. This factual evidence suggests a need of extra ascorbic acid, especially in four population groups, hypertensive, elderly, smokers and diabetics (25). Yoshioka *et al* (11) showed significant association of PAA with SBP and DBP. The study has reported an inverse association between PAA and blood pressure (r = -0.264). Similarly, negative association between blood pressure and PAA had been demonstrated by Choi *et al* (23) in elderly Chinese Americans. They showed that PAA is correlated positively with HDL-C (r = 0.09). In the present study, HDL-C has been observed to significantly decrease with the rise in blood pressure. These findings are similar to Bates *et al* (24) and PAA values of Greco and La Roca (22) were are quite close to our values.

The possible explanation to above findings is that protective factors such as superoxide dismutase, glutathione peroxidase and catalase are normally present in cells to prevent damage by free radicals which exert dilatatory effect on blood vessels and imbalance of nitric oxide free radical interactions might facilitate the development of hypertension in humans (26). This may

be protected by antioxidants like vitamin C which maintains adequate level of sulphated glycosa-aminoglycans and thus help to regulate the process of atherosclerosis. Similarly, vitamin C concentration associated with reduced 6-ketoprostaglandin F1 alpha, a possible protective agent for blood pressure rise. Ascorbic acid can also exert a chelating effect on intra and extra cellular calcium (27). Our data have showed that plasma ascorbic acid had a direct positive correlation with HDL cholesterol, as ascorbic acid supplementation increases the HDL-C in blood. In a study, 500 mg/day ascorbic acid to volunteer had led to increase in HDL-C. The mechanism is still not clear. Triau (28) has reported that oxidation modifies Apolipoprotein A1 structure which alters the ability of apoprotein to associate the lipids and thus HDL particle oxidative modification may be prevented by antioxidants like vitamin C. Therefore, it may be suggested that ascorbic acid deficiency might be responsible for development of hypertension. It would be important to access the plasma ascorbic acid status along with other factors. It will not only be beneficial for prevention and treatment of the disease but also to propose ascorbic acid reduction in plasma as independent causative agent in development of primary hypertension. Thus PAA status in those having risk of cardiovascular mortality secondary to hypertension should definitely be benefited, as PAA deficiency is completely treatable and curable while hypertension is only treatable but not curable.

Table I: Comparison of Plasma Ascorbic acid (mg/dl) between different age groups

Age Group	**Control**	**Mild Hypertension**	**Moderate Hypertension**
40-45	0.659 ± 0.014^{a}	0.418 ± 0.019^{a}	0.421 ± 0.007^{a}
45-50	0.47 ± 0.027^{b}	0.38 ± 0.029^{b}	0.372 ± 0.038^{a}
50-55	0.368 ± 0.025^{c}	0.205 ± 0.020^{c}	0.142 ± 0.020^{b}
LSD	**0.786**	**0.086**	**0.088**

Table II: Comparison of 24 hours Urinary Ascorbic acid (mg) between different age groups

Age Group	Control	Mild Hypertension	Moderate Hypertension
40-45	450.26±0.545[a]	330.00±0.489[a]	315.40±0.920[a]
45-50	420.16±0. 715[b]	300.02±0.748[b]	270.2±0.593[b]
50-55	350.4±0.606[c]	240.00±0.748[c]	200.2±0.769[c]
LSD	**2.15**	**3.71**	**2.66**

Table III: Comparison of HDL-C (mg/dl) between different age groups

Age Group	Control	Mild Hypertension	Moderate Hypertension
40-45	50.34±0.921[a]	46.19±0.444[a]	40.75±1.26[ab]
45-50	43.23±0.822[b]	41.77±0.814[b]	41.98±1.36[a]
50-55	39.95±1.42[b]	37.43±0.935[c]	37.09±1.38[b]
LSD	**3.748**	**3.849**	**4.603**

Table IV: Comparison of SBP (mm of Hg) between different age groups

Age Group	Control	Mild Hypertension	Moderate Hypertension
40-45	112.6±2.49[c]	122.4±2.49[c]	130±0.979[c]
45-50	123±1.131[b]	171.2±3.46[b]	170.6±3.14[b]
50-55	137.2±5.47[a]	190.2±2.90[a]	195±2[a]
LSD	**12.157**	**10.256**	**7.664**

Table V Comparison of DBP (mm of Hg) between different age groups

Age Group	Control	Mild Hypertension	Moderate Hypertension
40-45	75±2.29[c]	102.8±2.007[c]	110.4±1.99[c]
45-50	91.6±0.358[a]	103.2±0.438[b]	112.8±0.715[b]
50-55	90.8±0.438[b]	105.6±0.669[a]	115.8±0.438[a]
LSD	**4.706**	**4.299**	**4.299**

Table VI Comparison of Height (meters) between different age groups

Age Group	Control	Mild Hypertension	Moderate Hypertension
40-45	168±1.876[a]	164.6±1.31[b]	164.2±0.912[c]
45-50	165.6±4.12[a]	165.2±1.145[ab]	165.2±2.124[b]
50-55	163±1.74[a]	169.6±1.458[a]	167.4±0.963[a]
LSD	**9.655**	**4.521**	**4.981**

Table VII Comparison of Weight (Kg) between different age groups

Age Group	Control	Mild Hypertension	Moderate Hypertension
40-45	67±3.2[a]	66.2±2.456[b]	63.2±1.906[a]
45-50	69.4±2.128[a]	76±1.743[a]	74.8±2.644[a]
50-55	64.4±1.219[a]	69.8±2.198[ab]	77.4±3.377[a]
LSD	**8.019**	**7.416**	**9.335**

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