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Effect of Vitamin C on Blood Glucose and Glycosylated Hemoglobin in Type II Diabetes Mellitus

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Abstract Ascorbic acid (vitamin C) is an antioxidant which is hypothesized to have an effect on the blood glucose in patients with type II diabetes. The aim of the study is to examine the effect of oral vitamin C on fasting blood glucose (FBG), two hours postprandial blood glucose (PPBG) as well as glycosylated hemoglobin (HbA1c) in the treatment of type 2 diabetes mellitus (DM). One hundred patients participated in this study were divided into two groups. The first group was the control group contained fifty normal patients. The second group contained fifty patients having type II DM and given the drug Glucophage at a dose of 2000 mg/day beside healthy diet to control diabetes. They were left for three months then the blood samples were collected from both groups to detect the FBG, two hours PPBG and HbA1c. After that, the diabetic group was given beside the drug and diet treatment vitamin C drug (Vitacid calcium) 1000 mg orally three times /day for another three months. At the end of the three months, blood samples were collected from both groups to examine the FBG, two hours PPBG and the HbA1c. The diabetic group recorded a significantly higher level of FBG, two hours PPBG and HbA1c compared to the control group after the first three months. The diabetic group after being given vitamin C beside the drug and diet for three months recorded a significant decreased level of FBG, two hours PPBG, and HbA1c compared to the levels it recorded before without being given the vitamin C. In conclusion, oral supplementation of vitamin C reduces FBG, two hours PPBG, and improves HbA1c. Hence, its combination with diabetic drugs may be beneficial in the treatment of type II DM to maintain good glycemic control.

Keywords: *vitamin C, blood glucose, Vitacid calcium, diabetes mellitus, glycemic control*

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1. Introduction

Diabetes mellitus (DM) is a metabolic disorder associated with hyperglycemia, oxidative stress, and inflammation beside great morbidity and economic cost [1]. Despite of the currently available treatments yet, the illness remains having a poor outcome for the conditions which urges scientists to develop new strategies beside the drugs given to improve the outcome. The widely new strategies investigated are the use of the antioxidant vitamin C in combating the hazardous effect of the free radicals in the diabetic patients [2]. Moreover, it is strongly documented that ascorbic acid (vitamin C), the antioxidant vitamin, plays an important role in the protection from the free radical induced damage [3].

Many studies have shown a decreased vitamin C level in type II diabetic patients [3]. Vitamin C is structurally similar to glucose and can replace it in many chemical reactions and thus it is effective for prevention of non enzymatic glycosylation of protein [4]. There are many contradicting results related to the supplementation of vitamin C and the improvement in fasting blood glucose (FBG), two hours postprandial blood glucose (PPBG) , and glycosylated hemoglobin (HbA1C) levels [5,6].

Additionally, several studies recorded an inverse relationship between plasma vitamin C and HbA1C levels, and that the mean plasma vitamin C is significantly higher in individuals when HbA1c less than 7%. On the other hand, it is significantly less in those patients reporting uncontrolled diabetes and hyperglycaemia (HbA1c greater than 7%) [7].

The aim of the current study is to examine the effect of oral vitamin C on FBG, two hours PPBG as well as HbA1c in the treatment of type 2 diabetes mellitus (DM).

2. Material and Methods

One hundred patients half of them with type II DM participated in this study. Patients were derived from the outpatient clinic in October 6 university while the normal

individuals were from those working in the university. All participants were between the ages 30 to 60 years old.

All patients gave their informed consent before being enrolled in the study. Additionally, they were diagnosed as patients of type II DM of the age group between 30 - 60 years old who were on the drug Glucophage and having FBG ranging between 125 - 250% (mg/dl). Exclusion criteria for patients were FBG level more than 250% (mg/dl), other medical illnesses such as endocrine, metabolic, type 1 DM, or pregnancy. Patients of age more than 60 or less than 30 years old were also excluded. None of the patients was heavy smoker or received vitamin C or any other antioxidant treatment over the last three months. Routine investigations like electrocardiogram, serum electrolytes, blood urea, and creatinine, and liver function tests were performed to exclude active medical problems in all patients.

The diabetic patients were given strict orders to have the drug Glucophage at a dose of 2000 mg/day and to have a daily diet containing about 130 g carbohydrates, 175 - 250 g proteins and about 75 g fats and rich fibers to be having healthy diet for diabetics. Their blood glucose levels were measured and recorded three times per day.

After the first three months, blood samples were taken from the healthy and diabetic patients to measure the FBG, two hours PPBG, and HbA1c. Then the diabetic patients were given vitamin C ascorbic acid (Vitacid calcium) drug at a dose of 1000 mg/day divided on three doses for three months beside the normal drug Glucophage and diet for another three months. At the end of the three months, blood samples were collected from the patients to measure the FBG, two hours PPBG, and HbA1c.

2.1. Statistical Analysis

All data are expressed as mean ± standard deviation (S.D.M.). Parametric statistical analysis was performed using unpaired Student's t-test to compare the mean values of quantitative variables among the groups. The minimal level of significance was identified at $P < 0.05$.

3. Results

Table 1. The fasting blood glucose (FBG), two hours postprandial blood glucose (PPBG) and glycosylated hemoglobin (HbA1c) for the control diabetic group, and diabetic group after being given vitamin C

Groups	N[1]	FBG (mg/dl)[2]	PPBG (mg/dl)[3]	HbA1c (mg/dl)[4]
(A) control	50	78	100	5
(B) Diabetic	50	145*	200*	8.5*
(C) Diabetic group after being given vitamin C	50	110*	150*	7*

*unpaired t-test, $P < 0.05$, was used for the statistical comparisons between the two groups.

Key to abbreviations:

[1]: Number of patients

[2]: Fasting blood glucose

[3]: Two hours postprandial blood glucose

[4]: Glycosylated hemoglobin

The obtained results showed that the diabetic group recorded a significantly higher level of FBG, two hours PPBG and HbA1c compared to the control group.

The obtained results showed also that subjecting the patients to vitamin C for three months led to a significant decrease in the FBG, two hours PPBG and, and HbA1c compared to the results previously recorded without being given the vitamin C.

Table 1 showed that the diabetic group recorded an increase in the FBG with 86% (mg/dl) compared to the control group. It also showed that the two hours PPBG increased in the diabetic group by about 100% (mg/dl) compared to the control group. Moreover, it showed that the HbA1c also increased in the diabetic group with 70% (mg/dl) compared to the control group.

Additionally, Table 1 showed that the diabetic group after being given vitamin C for three months recorded a decrease in the FBG, two hours PPBG, and HbA1c with 25, 20 and 12% (mg/dl), respectively compared to the levels it recorded before without being given vitamin C.

4. Discussion

The objective of the present study is to investigate the effect vitamin C given orally together with the anti diabetic drugs on the FBG; two hours PPBG and HbA1c.

The results of the study showed that oral supplementation of 1000 mg vitamin C per day when given to type II diabetic patients with the oral anti diabetic drugs may exert an adding marvelous effect on decreasing the FBG; two hours PPBG, and HbA1c. The results of this study are in agreement with the previously published data showing betterment in glycemic control with vitamin C supplementation [7,8] compared to the one without its supplementation. It is difficult to say whether this beneficial effect of ascorbic acid supplement could be attributed to its effect on the underlying disease or correction of the inadequate vitamin C status. The exact mechanism by which vitamin C brings about these changes is not known yet. It is well documented that there is an increased production of damaging free radicals in type II DM patients. This is beside the glucose autooxidation, protein glycosylation, formation of advanced glycation end products, and polyol pathway all which are involved in the generation of the oxidative stress, implicated in the origin of type II DM [9]. The protection against such damage can be offered by the free radical-scavenging antioxidants as vitamin C.

The increased demand for vitamin C by the diabetic patients may be to compensate for the increased oxidative stress or due to the decreased levels of plasma vitamin C which usually observed in type II DM patients [10]. There is an inverse relationship between plasma ascorbic acid and DNA damage in type II DM patients indicating that poorly controlled diabetic subjects might benefit from increased dietary vitamin C [11]. Ascorbic acid supplementation for diabetic subjects may provide a simple means of preventing and ameliorating the complications of diabetes [11]. The results of the study are consistent with the work of Srivatsan et al., [12] who stated that supplementation of 1000 mg of ascorbic acid per day for two weeks had significantly reduced erythrocyte sorbitol and red cell sorbitol and might provide a simple, safe, and effective means for preventing and ameliorating chronic complications of diabetes [12].

Craven et al., [13] stated that the improvement of glycemic control done by vitamin C was mainly initiated by a beneficial effect of this antioxidant on β cells. Yet there may be a possibility that the antioxidant treatment

could have exerted an influence on target tissues other than the β cells such as muscle and fat. It is postulated that the antioxidant treatment has beneficial effects on preservation of β cell function in the diabetic patients, although the effects may not be exerted totally through its direct action on β cells. Also, regardless of its influence on insulin sensitivity, the antioxidant treatment indeed reduced blood glucose levels [13].

Hence, vitamin C reduced glucose toxicity and contributed in part to the prevention of a decrease of β cell mass and insulin content. Another explanation proposed for reduction of blood glucose level is that plasma vitamin C levels seem to play a key role in the modulation of insulin action in the diabetic patients. Vitamin C-mediated increase in insulin action is mainly due to an improvement in non oxidative glucose metabolism [13].

Sridulyakul et al., [14] reported that the significant decrease which was noted in the HbA1c in patients supplemented with vitamin C could be attributed to the competition of vitamin C with glucose for the reaction with amino groups on the hemoglobin beta chain. Further explanation proposed that the increase of serum antioxidant glutathione may be the cause for the decrease of glycosylated hemoglobin after long-term ascorbic acid supplementation [15].

Many studies stated that the normal dietary vitamin C intake was found to be of no use in diabetes control and in reducing the risk of diabetes in future. Many researchers used higher doses than normal dietary intake of vitamin C and proved that higher doses will be needed for glycemic control [16,17].

5. Conclusion

It can be concluded that oral supplementation of vitamin C as an adjuvant with anti diabetic drugs may be of particularly attractive therapeutic effect in the treatment of type II DM. Studies with a larger sample size and longer follow-up period together with measurement of other related antioxidant levels may be needed to yield more beneficial data on the role of the antioxidant system in the clinical course of type II DM.

Statement of Competing Interests

The authors have no competing interests.

References

[1] Mesallamy, H. E., Suwailem, S., and Hamdy N. Evaluation of C-reactive protein, endothelin-1, adhesion molecule (s), and lipids as inflammatory markers in type 2 diabetes mellitus patients. *Mediators of Inflammation*, 2007: 1-7. 2007.

[2] Bianchi, C., Miccoli, R., Daniele, G., Penno, G., and Del Prato S., "Is there evidence that oral hypoglycemic agents reduce cardiovascular morbidity/mortality? Yes. *Diabetes Care*, 32: S337-S341. 2009.

[3] Fadupin, G.T., Akpoghor, A. U., and Okunade, K. A. A comparative study of serum ascorbic acid level in people with and without type 2 diabetes in Ibadan, Nigeria. *African Journal of Medicine and Medical Sciences*, 36: 335-339. 2007.

[4] Ardekani, M. A., and Ardekani, A. S. Effect of vitamin C on blood glucose, serum lipids & serum insulin in type II diabetes patients. *Indian Journal of Medical Research*, 126: 471-474. 2007.

[5] Sargeant, L. A., Wareham, N. J., Bingham, S., Day, N. E., Luben, R. N., Oakes, S., Welch, A., and Khaw, K. T. Vitamin C and hyperglycemia in the European Prospective Investigation into Cancer--Norfolk (EPIC-Norfolk) study: a population-based study. *Diabetes Care*. 23: 726-732. 2000.

[6] Davies, M. B., Austin, J. A., Partridge, D.A. *Vitamin C: Its Chemistry and Biochemistry*. The Royal Society of Chemistry, 1991. p. 48.

[7] Heitzer,T., schling, T., Krohn, K.. Oxidative stress and risk of cardiovascular events in patients with coronary disease. *Circulation*. 104: 2673-2678. 2001.

[8] Sridulyakul, P., Chakraphan, D., Patumraj, S. Vitamin C supplementation could reverse diabetes-induced endothelial cell dysfunction in mesenteric microcirculation in STZ-rats. *Clinical Hemorheology and Microcirculation*. 34: 315-321. 2006.

[9] Ardekani, M. A., Mohiti, J., Amirchaghmaghi, E., and Modarresi, M. The effect of vitamin C supplementation on insulin level, HbA1c and blood glucose in type 2 diabetic patients. *Journal of Kerman University of Medical Sciences*. 11: 12-18. 2006.

[10] Bonnefont-Rousselot, D., Bastard, J. P., Jaudon, M. C., and Delattre, J. Consequences of the diabetic status on the oxidant/antioxidant balance. *Diabetes and Metabolism*. 26: 163-176. 2000.

[11] Vincent, T. E., Mendiratta, S., May, J. M. Inhibition of aldose reductase in human erythrocytes by vitamin C. *Diabetes Research and Clinical Practice*. 43: 1-8. 1999.

[12] Srivatsan, R., Das, S., Gadde, R., Manoj-Kumar, K., Taduri, S., Rao, N., Ramesh, B., Baharani, A., Shah, K., Kamireddy, S. C., Priyatham, G., Balakumaran, T. A., Balakumaran, S. S., Kamath, and A., Rao, A. Antioxidants and lipid peroxidation status in diabetic patients with and without complications. *Archives of Iranian Medicine*. 12: 121-127. 2009.

[13] Craven, P. A., DeRubertis, F. R., Kagan, V. E., Melhem, M., and Studer, R. K. Effects of supplementation with vitamin C or E on albuminuria, glomerular TGF-β, and glomerular size in diabetes. *Journal of the American Society of Nephrology*. 89: 1405-1414. 1997.

[14] Sridulyakul, P., Chakraphan, D., Patumraj, S. Vitamin C supplementation could reverse diabetes-induced endothelial cell dysfunction in mesenteric microcirculation in STZ-rats. *Clinical Hemorheology and Microcirculation*. 34: 315-321. 2006.

[15] Szaleczky, E., ózsef Prechl, J., Ruzicska, E., Feher, J., Braun, L., Banhegyi, G., Csala, M., Mandl, J., and Somogyi, A. Reduction of glycated hemoglobin levels by long term, high dose ascorbic acid supplementation in healthy and diabetic patients. *Medical Science Monitor*. 4: 241-244. 1998.

[16] Montonen, J., Knekt, P., Järvinen, R., Reunanen, A. Dietary antioxidant intake and risk of type 2 diabetes. *Diabetes Care*. 27: 362-366. 2004.

[17] Czernichow, S., Couthouis, A., Bertrais, S., Vergnaud, A. C., Dauchet, L., Galan, P., Hercberg, S. Antioxidant supplementation does not affect fasting plasma glucose in the supplementation with antioxidant vitamins and minerals (SU.VI.MAX) study in France: association with dietary intake and plasma concentrations. *American Journal of Clinical Nutrition*. 84: 395-399. 2006.