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The effects of vitamin C on diabetic patients

Parisa Ghaffari¹, Mehdi Nadiri², Alireza Gharib³ and Foad Rahimi^{4*}

¹Department of Medicine, Kurdistan University of Medical Sciences [KUMS], Sanandaj, Iran

²Department of Pulmonology, Kurdistan University of Medical Sciences [KUMS], Sanandaj, Iran

³Department of Community Health Nursing, Kurdistan University of Medical Sciences, Sanandaj, Iran

⁴School of Nursing & Midwifery, Kurdistan University of Medical Sciences, Sanandaj, Iran

ABSTRACT

Diabetic patients are more at risk for different cardiovascular, neurological, renal, and eye complications than people. Since glucose is replaced competitively in many chemical reactions and prevents and this prevents non-enzymatic glycosylation of proteins- particularly hemoglobin and lipoproteins, it seems that vitamin C is effective in preventing diabetic complications. In the current study, we investigated the effect of supplementary vitamin C on diabetic patients. In a clinical trial, 31 patients [13 males and 17 females] with a mean age of 50.9 ± 4.9 years suffering from type 2 diabetes were selected using convenient sampling. Then they were divided into two groups of case and control. The case group received 800 mg of vitamin C daily for two months and the control group received this amount of placebo. The amounts of glucose, insulin and lipids in the blood of the patients were measured before and after the intervention. Then, data were analyzed using paired and independent *t* tests. There was no significant difference among anthropometric indexes, food intake, and consumed drugs of the subjects during the study. Vitamin C consumption decreased plasma insulin level [28.25 ± 2.37 and 27.8 ± 2.56 , $p < 0.016$] and plasma triglyceride concentration [279.41 ± 194.99 and 212.48 ± 2.18 , $p < 0.03$]. The decrease in the levels of plasma glucose and other lipid profiles was not significant for two months of vitamin C consumption. Conclusion: It seems that more research is required to investigate the impact of vitamin C supplement on glycemic control and blood lipids of diabetic patients.

Keywords: Diabetes, Vitamin C, Blood sugar, Blood lipids

INTRODUCTION

Diabetes mellitus is one the most important and common metabolic disorders all over the world [1]. In 1995, nearly 135 million had this disease and it is expected this number increase to over 300 million patients by 2025 [2]. It seems that glycosilation and oxidative stress are two key important processes in the genesis of diabetic complications and many other disease processes[3]. Considering relatively high amount of glycated proteins, even in some non-diabetic pathological states, this theory has been addressed that oxidative stress interferes in the creation of glycated proteins through increasing reactive oxygen species [ROS] and/or decreasing the levels of antioxidants in body[3]. Chronic oxidative stress stemming from long-lasting increase in blood sugar, particularly after eating, results in a progressive increase in the performance of pancreatic beta cells and, finally, type 2 diabetes [4]. Oxidative stress plays an important role in the progress and outbreak of diabetic complications [4].

Results from animal and human studies show that cellular oxidative damage by free radicals leads to development of microangiopathy and macroangiopathy [5]. Extracellular fluids contains several antioxidants that have interference with oxidative processes [5]. Antioxidants like ascorbic acid, beta-carotene and alpha-carotene protect low density cholesterol [LDL] against oxidative damage [6]. Low contents of antioxidants have been reported

in diabetic patients [7]. Therefore, the use of antioxidants is suggested for these patients. It seems that there is a strong relationship between increase in insulin levels and progress of atherosclerotic lesions [8].

A decrease in plasma insulin concentration and improvement in insulin performance may have suitable impacts on coronary artery disease. Also, studies have illustrated that long-term administration of vitamin C decreases the concentration of plasma insulin and improves lipid profiles [9].

Useful effects are created by vitamin C supplements and amounts existing in food do not have such an effect. Other studies have been conducted which have not reached proper results after vitamin C consumption. Therefore, the objective of this study was to investigate the vitamin C supplement on levels of insulin, glucose, and lipid profiles of patients suffering from type 2 diabetes.

MATERIALS AND METHODS

This randomized clinical trial was carried out on 31 diabetic patients referring to a diabetes clinic. The inclusion criteria were: written consent, constant diet, consumption of no vitamin C supplement during the study. The patients suspected of gout, renal failure, kidney stones, thalassemia and pregnancy and lactation conditions were excluded from the study. Moreover, the patients were checked in terms of the consumption of drugs influencing metabolism. First, all patients were given a questionnaire containing demographic information, weight and height, the kind of consumed drug, diet and blood pressure to fill out. Then, they were referred to a laboratory to measure blood cholesterol, HDL, LDL, FBS and TG. Then, the patients were randomly divided into two groups: one group received placebo and the other group received vitamin C. The first group [treatment group] was treated by vitamin C tablets: the patients in this group were given one tablet each meal, breakfast, snacks, lunch, snack and dinner, for three months. At the end of the period, the blood factors were measured again. Data from both groups were analyzed using SPSS version 16, t-test, and chi-square test as well as mean and standard deviation.

RESULTS AND DISCUSSION

From the 40 subjects studied, nine patients were deleted from the study because of lack of drug consumption or lack of regular drug consumption. The mean age of the participants was 51.9 ± 5.92 years. In this study, five patients controlled their diabetes just with diet and 26 of them consumed, blood glucose-lowering medications [glibenclamide and metformin] in addition to diet. The mean of disease duration of the patients was 10.7 ± 4.5 years.

The distribution of the subjects in the two groups studied was equal in terms of confounding factors such as BMI and intake. Also, there was no significant difference in the variables in the two groups over two months of intervention and daily consumption of 800 mg of vitamin C [Table 1].

Table 1: mean and standard deviation of daily nutrients of diabetic patients before intervention

Profile	Placebo [n=14]	Vitamin C [n=17]	P Value
Energy [kcal]	2152.7±548.5	2318±842.8	0.44
Protein [g]	88.9±39.1	80.2±29	0.3
Carbohydrate [g]	261.1±142	287.9±104	0.93
Lipid	91.8±36	72±24.7	0.88
Cholesterol [mg]	345±193	310.7±155	0.75
Vitamin C IU [International Units]	8.56±2.89	8.51±2.82	0.75

Table 2 shows the amount of glycemic and lipid indexes as the groups studied before and after the intervention. This shows that consumption of vitamin C supplement did not result in a significant reduction in lipid profiles level except for triglyceride [$p = 0.03$].

Table 2: the amount of glycemic and lipid indexes in diabetic patients before and two months after vitamin C supplement intake

Variables		Placebo	Vitamin C	P Value
Fasting blood glucose [mg/dl]	Before supplement consumption	174±56.3	179.37±92.90	$p > 0.05$
	After supplement consumption	165±46.7	151.96±70.54	
Serum insulin	Before supplement consumption	26.2±9.3	28.25±2.37	$P = 0.016$
	After supplement consumption	26.8±6.37	26.78±2.56	
Total cholesterol	Before supplement consumption	223±38.31	230.96±47.08	$p > 0.05$
	After supplement consumption	226±42.68	225.13±46.15	
HDL-c [mg/dl]	Before supplement consumption	44±15	43.1±10.28	$p > 0.05$
	After supplement consumption	45.8±12	46.10±10.41	
LDL-c [mg/dl]	Before supplement consumption	153±23.5	165.7±45.71	$p > 0.05$
	After supplement consumption	159±36.4	162.7±45.46	

Paired t-test in the vitamin C group showed that levels of insulin decreased dramatically [$p = 0.016$] compared to before the intervention. At the end of the intervention, there was not a significant statistical difference among the groups studied in plasma insulin level.

In this study, 800 mg of vitamin C was prescribed for type 2 diabetic patients for eight weeks. It was found that the level of insulin and TG did not decline and also it did not have a significant effect on the level of other lipid profiles and blood sugar. After consuming vitamin C, the mean of weight and BMI did not change and this was confirmed by the results of other studies [10].

Epidemiological studies have shown the helpful role of vitamin C on Coronary Heart Disease [CHD]. Gey et al. found that there was a reverse relationship between plasma vitamin C and Ischemic Heart Disease [IHD] [11]. Moreover, a reverse relationship between the concentration of plasma vitamin C and CHD of the smokers consuming vitamin C supplement was found [11].

All of this information supported the researchers hypothesize “antioxidant theory for preventing CHD”. Based on this theory, antioxidants protect LDL cholesterol from peroxidation through unsaturated fatty acids with a few dual band and its products like aldehydes [12].

The current study presents documents showing that the consumption of vitamin C supplement in patients is an effective way to improve TG [but not LDL cholesterol]. Lack of a change in plasma cholesterol level towards other studies can be attributed to the amount of vitamin C intake and the duration of the study, because other studies have used pharmacological doses and very long duration.

It seems that a change in plasma LDL cholesterol, which is an important factor in forming foam cells in the vessel wall, requires longer duration of vitamin consumption and a period of two months to make suitable changes in the level of LDL cholesterol is not enough. It is known that a change in LDL cholesterol concentration is mainly because of a change in plasma free radicals contents [13]. Thus, it seems that in the current study vitamin C was not able to make a change in the level of plasma free radicals during two months with a dose of 400 international units [IU] per day. However, a decreasing change in the concentration of plasma TG can be attributed to the improvement of insulin performance or a decrease in the plasma insulin.

Despite a decrease in plasma TG, we did not see a significant increasing change in HDL cholesterol concentration. Reducing effect of vitamin C on plasma TG concentration may be due to the increase in lipoprotein lipase activity [14]. Studies on the effect of vitamin C on coronary artery diseases show a significant decrease in plasma TG concentration in the vitamin C group in comparison with the placebo group [15]. Furthermore, in another study by this researcher, it was found that vitamin C consumption caused a significant decrease in the level of plasma TG in the elderly. A decrease in the mean of LDL cholesterol was not seen after consuming vitamin C [16]. Moreover, studies show that intake of vitamin C supplement did not result in a decrease in plasma cholesterol in women suffering from coronary heart disease [16].

In a study conducted on diabetic patients in 2009, it was showed that the consumption of 600 mg of vitamin C supplement during three months does not lead to a significant decrease in blood cholesterol content [17]. On the other hand, the study of vitamin C effect on atherosclerosis showed that vitamin C is a key factor for delaying oxidation of LDL cholesterol and preventing proliferation of smooth muscle cells and aggregation and sticking of platelets together [18].

In type 2 diabetic patients, usually the concentration of plasma insulin increases and this increase is considered as one of the risk factors of cardiovascular diseases [19]. The results of previous studies showed a decrease in plasma insulin concentration. Beneficial effect of vitamin C on plasma insulin concentration is related to decreasing changes in the ratio of reduced glutathione to oxidized glutathione, which improves the activity of β -cells of islet of Langerhans and decrease the amount of insulin secretion. Therefore, it can be said that vitamin C supplements increasing reduced glutathione improves the physical conditions of plasma membrane, in reality the activity of as a glucose transmitter via insulin [19].

Lack of a change in fasting blood glucose content was another result of this study. Intake of vitamin C made no significant decrease in the fasting blood glucose [20]. On the other hand, studies conducted in 1993 and 1995 showed a significant decrease in blood glucose content. However, in another study, in which the rate of glucose metabolic clearance and hepatic glucose output were detected in addition to fasting blood glucose, reported an opposite result that after consuming vitamin C the amount of these variables improved.

In fact, the results of this study showed that the consumption and transmittance of glucose improved in the body, though a significant decrease in glucose concentration was not seen. Since in this study, the patients were not given dietary advice and the aim was to investigate the effect of vitamin C on paraclinical variables without a change in the diet of the patients, it can be said that diet is not considered as an effective intervention.

CONCLUSION

In view of the importance of vitamin C on health and disease and considering that in the conducted studies, adverse effects have not attributed to the high doses of vitamin C, more research is required to investigate the effect of vitamin C on blood glucose concentration and other paraclinical variables. The limitations of the current study were the low number of participants and short duration of the study, which without doubt, had a noticeable effect on the results of the study.

It is suggested that a more comprehensive study considering exact conditions of the research and also various groups under diets and different doses of vitamin C are needed in order to investigate the effects of vitamin C consumption on clinical parameters of patients suffering from type 2 diabetes. As a general result, it seems that in patients suffering from type 2 diabetes vitamin C may decrease the concentrations of plasma insulin and serum TG, which are risk factors of cardiovascular diseases.

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