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Role of Vitamin-C Supplementation in Type II Diabetes Mellitus

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ABSTRACT

Introduction: Diabetes Mellitus is affected by genetic and environmental influences and is characterized by impaired insulin secretion, insulin resistance and chronic hyperglycemia. Vitamin-C levels are typically small for T2DM patients because blood glucose may compete with Vitamin-C for cell absorption due to its structural similarity to the oxidized form and increased oxidant stress may deplete antioxidant stocks. Vitamin-C, an essential micronutrient with potent antioxidant properties, can protect important biomolecules from oxidation by participating in oxidation-reduction reactions and is readily oxidized to dehydroascorbic acid, which is then reduced to ascorbate again.

Material and Methods: In this prospective study, 412 patients were included who were diagnosed with T2DM and were randomly divided into two groups of 206 each (the study group and control group). Standard methods for evaluating glycated hemoglobin (HbA1c) have been used in ETDA(Ethylenediaminetetraacetic acid) blood. Glucose for fasting was measured in blood. Vitamin-C and placebo were administered to patients for three weeks at a time. During follow up, patients were advised to bring unused drugs and containers. All patients had their regular dietary pattern preserved through constraining their intake of foods, which are rich in Vitamin-C.

Results: There were total 206 patients were included as study group and control group, respectively. 123 were males among 206 patients in Vitamin-C group while 83 were females. In control group 120 were males and 86 were females among 206 controls. The mean age of cases in Vitamin-C group is noted to be 45.77 ± 7.66 while in control group it is 43.33 ± 5.64 . The mean post meal blood sugar has significantly decreased in cases administered with Vitamin-C compared to controls. In group, B saw a significant decrease in fasting blood sugar levels and HbA1c. Plasma Vitamin-C levels had a significant increase in study group.

Conclusion: Vitamin-C supplementation can substantially reduce level of HbA1c as well as blood glucose in T2DM patients.

Key Words: HbA1c, Vit-c, T2DM, DM, Vitamin-C

INTRODUCTION

Diabetes is one of the fastest growing challenges in 21st century. The number of adults living with diabetes has tripled in last 20 years. According to international diabetes federation diabetes Atlas, it has been noted that 463 million adults in age group 20 to 79 years are living with diabetes¹. At least 90% of cases of diabetes are accounted for T2DM among all cases with disease.

Due to micro vascular complication like nephropathy, neuropathy, retinopathy and macro vascular complications like stroke, peripheral vascular disease and myocardial infarction Diabetes Mellitus is one of the major risk factors associated with morbidity and mortality². It is shown that free radical-

mediated pathology plays an important role in Diabetes Mellitus^{3,4}.

Nutrients act as an important source in disease prevention and health care. Nutrients with vitamins are very important for cardiovascular health (i.e. vitamin B1), nerve function (i.e. vitamin B6 and vitamin B12), development of red blood cells (vitamin B12 and folate), coagulation (vitamin K) among other functions⁵. Decreased metabolic rates have been shown to correlate with an elevated body mass index (BMI) and increased obesity prevalence⁶

Vitamin-C acts as an antioxidant. The intrinsic relation between Vitamin-C and glucose is of concern to diabetes⁷. Oxidant stress can lead to disrupted glucose metabolism

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and hyperglycemia⁸. Vitamin-C is an essential micronutrient with powerful antioxidant properties which can prevent essential biological molecules from oxidation by engaging in oxidation reduction reactions and therefore is easily oxidized to dehydroascorbic acid, which then in fact reduces back to ascorbate. Vitamin-C occurs naturally in fruits and vegetables and is also used as an additive to foods or drinks. Vitamin-C is water soluble and therefore has a comparatively short half-life in body. Regular and sufficient consumption of Vitamin-C is needed to prevent deficiency due to fast renal excretion⁹.

The amounts of Vitamin-C in T2DM patients are relatively low as blood sugar level may compete with Vitamin-C for absorption into cells due to the structural resemblance to oxidized type, and elevated oxidant stress decrease antioxidant stores¹⁰. Vitamin-C supplementation has improved blood glucose levels and many studies even reported glycosylated hemoglobin (HbA1c).

MATERIAL AND METHODS

In this prospective study setting, 412 T2DM were included, which were divided into two groups. This research was conducted in conjunction with Dept. of Biochemistry, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Wardha & Dept. of General Medicine, Zydus Medical College and Hospital for over 1 year. 206 patients were randomly allocated as cases and controls. Cases were administered with Vitamin-C. Block randomization technique was used for Vitamin-C and control blocks.

Inclusion criteria: Patients visiting outpatient department having blood glucose level ranging from 126 to 250mg/dL have been included in the study.

Exclusion criteria: Patients of inflammatory bowel disease medical history and patients who have had prior resection of the intestines were included from study.

Data on physical activity and demography was collected at start of the study along with body mass index (BMI) of patients, circumference of waist and hip.

Computation of BMI was done by taking ratio of weight in kilograms to height in square meters. After meals, venous blood samples were obtained 12 hours or 12 hours fasting. In EDTA blood glycated haemoglobin (HbA1c) has been calculated using standard methods. Fasting glucose has been measured through blood samples collected by oxalate fluoride tube. Vitamin-C concentration of extracted samples was calculated. During the study, patients received their regular dietary regimen while still limiting their consumption of food rich in Vitamin-C.

Mean \pm standard deviation (SD) has been used to express

results. Differences in groups were analyzed by using unpaired or paired t-test. Based on the distribution of data, relationship between variables was measured by Pearson's or Spearman's correlation coefficient. Chi-square test analysis was performed to determine demographic data. Results were considered statistically significant at p-value below 0.05.

RESULTS

Table 1: Demographic data

Gender	Group A (Control)	Group B (Vitamin-C)
Male	120	123
Female	86	83
Total	206	206

Patients were randomly assigned to groups with 206 patients in each group mentioned in the table above. There were 123 males and 83 females in group administered with Vitamin-C whereas control group comprised of 120 males and 86 females.

Table 2: Mean age of patients

Variables	Group A (Control)	Group B (Vitamin-C)
Age (mean \pm SD) years	43.33 \pm 5.64	45.77 \pm 7.66

The average age of patients in group A is noted to be 43.33 \pm 5.64 and in group B it is 45.77 \pm 7.66.

Table 3: Blood sugar and HbA1c after 3 weeks

Parameter	Group A (Control)	Group B (Vitamin-C)	P-value
Post meal blood sugar	-7.89 \pm 2.63	-20.67 \pm 2.98	P < 0.01
Fasting blood sugar	-7.54 \pm 4.87	-21.38 \pm 3.44	P < 0.01
Plasma Vitamin-C *(μ mol/L)	0.18 \pm 0.08	5.39 \pm 2.25	P < 0.01
HbA1c	-0.06 \pm 0.02	-0.59 \pm 0.07	P < 0.01

In this study it has been observed that the mean post-meal blood sugar has significantly decreased in group, which was administered with Vitamin-C compared to control group. Fasting blood sugar is observed to have a significant decrease in group B. It has been observed that there has been a significant reduction in HbA1c in group B, which was given Vitamin-C supplements compared to group A which was control group. Plasma Vitamin-C levels had a significant increase in study group.

DISCUSSION

Normal dietary consumption of Vitamin-C has been studied in detail in some studies but observed to be of no use in managing diabetes and in lowering the risk of prospective diabetes. Many researchers used higher amounts of Vitamin-C intake than usual doses and demonstrated that glycemic management requires larger doses^{11,12}.

The inclusion of Vitamin-C supplementation to standard therapy was tested in 70 patients diagnosed with T2DM treated with metformin and were randomized to 500 mg Vitamin-C twice a day for 12 weeks or placebo. Those given Vitamin-C were reported to have lower levels of HbA1c, fasting and post-meal blood glucose compared to placebo considering all metformin treatments¹³.

Health problems like diabetic micro vascular angioplasty due to RBC vulnerability, because erythrocytes lack carriers of sodium-dependent Vitamin-C and therefore are relying on carriers of glucose that actually take up Vitamin-C. Fasting blood glucose and Vitamin-C daily consumption are significant predictive factors of Vitamin-C plasma levels¹⁴. Oxidative stress, which can be caused by a deficiency of Vitamin-C, also contributes to changes in signaling pathways and possible damage to the tissue¹⁵. Glucose carriers have been shown to be able to prevent the absorption of dehydroascorbic acid, the oxidized form of Vitamin-C, through elevated blood glucose levels competitively¹⁶. In this study, analysis showed a significant decrease in blood glucose levels in Vitamin-C group relative to the control group and a significant decrease in serum HbA1c in Vitamin-C supplemented patients over 21 days.

In their research on supplementation of Vitamin-C, P Sridulyakulet et al¹⁷ found similar findings which could reverse the deficiency of endothelial cells caused by diabetes in mesenteric microcirculation in STZ rats. It has also been demonstrated that the increase in serum antioxidant glutathione as well as drop in glycosylated hemoglobin following long term ascorbic acid supplementation are interrelated¹⁸.

CONCLUSION

Levels of Vitamin-C are lower among people with T2DM and thus the nutritional needs or need for supplementation of Vitamin-C may be higher in diabetic patients. Supplements of Vitamin-C can significantly reduce levels of blood glucose and HbA1c in type 2 diabetes patients.

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