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ROLE OF VITAMIN C IN TYPE 2 DIABETES MELLITUS

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Abstract

INTRODUCTION: Diabetes Mellitus is influenced by genetic and environmental factors and it is characterized by chronic hyperglycemia, altered insulin secretion, and insulin resistance. Vitamin C is an essential micronutrient with potent antioxidant properties and it can protect important biomolecules from oxidation by participating in oxidation-reduction reactions and it is readily oxidized to dehydroascorbic acid, which in turn is reduced back to ascorbate. In T2DM patients Vitamin C levels are usually low as blood glucose may compete with vitamin C for uptake into cells due to its structural similarity to the oxidised form, and increased oxidative stress may deplete antioxidant stores.

MATERIAL AND METHODS: This was a prospective, double-blinded, 12-week study. A total of 100 T2DM patients were included in the study and were divided randomly in to 2 groups of 50 each (study group and placebo group). Glycated haemoglobin (HbA1c) was determined in EDTA blood by standard methods. Fasting glucose was measured in blood collected in fluoride oxalate tubes. The vitamin C concentration of the processed samples was determined. Drug (Vitamin C and Placebo) was issued to patients for duration of thirty days at a time. Patients were asked to bring the unused drugs and container during the follow-up. All patients were maintained on their usual dietary pattern while limiting their consumption of vitamin C-rich foods throughout the study.

RESULTS: Mean age in Vitamin C group was 44.23 ± 6.58 while in placebo group was 43.75 ± 5.54. There were 31 male and 19 female in Vitamin C group. In Placebo group male and female were 30 and 20respectively. No statistical significance was observed in both the group. At 12 weeks fasting blood sugar levels were decreased by -21.45 ± 3.78 in patients receiving Vitamin C while in placebo group reduction was -6.41± 2.87. Post meal blood sugar was reduced by -22.77 ± 2.45 in vitamin C group while in placebo it was -7.44± 3.78.

CONCLUSION: Supplementation of Vitamin C to T2DM patients can effectively reduce the blood glucose levels and HbA1C levels and regular assessment of Vitamin C levels are necessary in T2DM patients.

Introduction

Diabetes mellitus (DM) is one of the major metabolic disorders associated morbidity and mortality due to microvascular complications like retinopathy, nephropathy, and neuropathy and macrovascular complications like Myocardial infarction, peripheral vascular disease, and stroke and economic cost. DM is also

characterized by oxidative stress, inflammation, and insulin resistance[i]. Studies have shown that there is a role of of free radical-mediated pathology in diabetes mellitus[ii].DM is influenced by genetic and environmental factors and it is characterized by chronic hyperglycemia, altered insulin secretion, and insulin resistance[iii]. Diabetes is one of the largest emerging global health emergencies with 415 million people between the ages of 20 and 70 worldwide estimated as having diabetes in 2015 and Type 2 DM (T2DM) accounts for at least 90% of all cases of diabetes[iv].

Vitamin C is an essential micronutrient with potent antioxidant properties and it can protect important biomolecules from oxidation by participating in oxidation-reduction reactions and it is readily oxidized to dehydroascorbic acid, which in turn is reduced back to ascorbate. Vitamin C is naturally present in fruit and vegetables, is often added as a preservative to foods/beverages, and is also used as a dietary supplement. As vitamin C is water-soluble, it has a relatively short half-life in the body due to rapid renal clearance and a regular and adequate intake is required to prevent deficiency. Vitamin C is often added as a preservative to foods and beverages, is naturally present in fruit and vegetables and can be used as a dietary supplement[v].

In T2DM patients Vitamin C levels are usually low as blood glucose may compete with vitamin C for uptake into cells due to its structural similarity to the oxidised form, and increased oxidative stress may deplete antioxidant stores[vi]. Studies shows that due to supplementation of vitamin C there is an improvement in blood glucose level and glycosylated hemoglobin (HbA1c).

MATERIAL AND METHODS

This was a prospective, double-blinded, 12-week study. A total of 100 T2DM patients were included in the study and were divided randomly in to 2 groups of 50 each (study group and placebo group). Block randomization technique was used for random allocation of study drugs, that is, vitamin C and placebo with blocks of size 4 in equal proportions to ensure uniform allocation ratio (1: 1).Present study was approved by Institutional Ethics Committee of K.M. Medical College and Hospital, Mathura (UP).

The inclusion criteria were patients from Outpatient Department with fasting blood glucose level in the range of 126 to 250 mg/dL. At the study appointment, participant's demographic and physical activity questionnaires were completed. Anthropometric data were collected including the body mass index (BMI) and waist and hip circumference. Patients were excluded if unable to give informed consent, medical history of inflammatory bowel disease, those who had undergone a previous bowel resection.

BMI is calculated by weight in kilograms divided by height in metres square. Venous blood samples were collected after a 12–hour fast. Glycated haemoglobin (HbA1c) was determined in EDTA blood by standard methods. Fasting glucose was measured in blood collected in fluoride oxalate tubes. The vitamin C concentration of the processed samples was determined. Drug (Vitamin C and Placebo) was issued to patients for duration of thirty days at a time. Patients were asked to bring the unused drugs and container during the follow-up. All patients were maintained on their usual dietary pattern while limiting their consumption of vitamin C-rich foods throughout the study.

Results were expressed as Mean ± standard Deviation (SD) Group differences were ascertained by either paired or unpaired t-test. Relationship between variables was determined by means of either Pearson's or Spearman's correlation coefficient depending on distribution of the data. Chi-square test was used for analysis of demographic data. P values less than 0.05 was considered as statistically significant.

RESULTS

A total of 100 T2DM patients were included in the study and were randomized into group A (Vitamin C) and Group B (Placebo) of 50 each.

Table 1: Demographic variables of each group

Variables	Group A (Vitamin C)	Group B (Placebo)	P value
Age (mean ± SD) years	44.23 ± 6.58	43.75± 5.54	NS
Male	31	30	NS
Female	19	20	

NS Not significant

Mean age in Vitamin C group was 44.23 ± 6.58 while in placebo group was 43.75 ± 5.54. There were 31 male and 19 female in Vitamin C group. In Placebo group male and female were 30 and 20 respectively. No statistical significance was observed in both the group.

Table 2: changes in blood sugar levels and HbA1c after 12 weeks

Parameter	Vitamin C group	Placebo group	P value
Fasting blood sugar	-21.45 ± 3.78	-6.41± 2.87	< 0.0001
Post meal blood sugar	-22.77 ± 2.45	-7.44 ± 3.78	< 0.0001
HbA1c	-0.67 ± 0.08	-0.01 ± 0.01	< 0.0001
Plasma vitamin C *(µmol/L)	4.85 ± 2.22	0.12 ± 0.10	< 0.001

At 12 weeks fasting blood sugar levels were decreased by -21.45 ± 3.78 in patients receiving Vitamin C while in placebo group reduction was -6.41± 2.87. Post meal blood sugar was reduced by -22.77 ± 2.45 in vitamin C group while in placebo it was -7.44± 3.78.

There was a significant reduction of Fasting blood sugar, Post meal blood sugar level and HbA1c, in vitamin C group. There was a significant increase in vitamin C level in group receiving vitamin C.

DISCUSSION

Fasting blood glucose and dietary vitamin C intake are significant independent predictors of plasma vitamin C concentrations[6].It has been shown that the uptake of dehydroascorbic acid, the oxidized form of vitamin C, by the glucose transporters could be competitively inhibited by elevated blood glucose levels[vii]. Due to which complications like diabetic microvascular angiopathy due to RBC fragility, as erythrocytes lack the sodium-dependent vitamin C transporters and are dependent on the glucose transporters for the uptake of vitamin C[viii]. Our study also showed that vitamin C levels are inversely proportional to blood glucose levels. T2DM patients with a higher weight are prone to vitamin C inadequacy and are known to require higher intakes of vitamin C in order to reach adequate plasma concentrations[ix]. Also oxidative stress which may be caused by vitamin C deficiency leads to alterations in signalling pathways and to potential tissue damage[x].

Physiologically high concentrations of ascorbic acid can directly inhibit erythrocyte aldose reductase and provide a rationale for the use of oral vitamin C supplements in diabetes[xi].

In a study by Et al it was shown that supplementation with 500 mg/day vitamin C in diabetic patients had no changes in FBG and HbA1c ascompared with placebo. This may be due to use of low dose of vitamin C used in this study[xii]. Our study showed that there was significant reduction in the blood glucose levels in Vitamin C group as compared to placebo group and significantreduction in serum HbA1cwas noted in patients supplemented with vitamin C for 12 weeks. Similar results were shown by P Sridulyakul et al in their study on Vitamin C supplementation could reverse diabetes-induced endothelial cell dysfunction in mesenteric microcirculation in STZ-rats[xiii]. Also it has shown that the increase of serum antioxidant glutathione and the decrease of glycosylated haemoglobin after long-term ascorbic acid supplementation are related to each other[xiv].

CONCLUSION

Supplementation of Vitamin C to T2DM patients can effectively reduce the blood glucose levels and HbA1C levels and regular assessment of Vitamin C levels are necessary in T2DM patients.

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