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Effect of omega-3 fatty acid supplementation on serum fasting glucose and HbA_{1c} levels in type-2 Diabetes Mellitus

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Abstract

Background: Diabetes Mellitus (DM) is a major non-communicable health problem that have effects on glycemic status. Oral omega-3 fatty acid supplementation may improve glycemic status in diabetic patient. **Objective:** To observe the effect of supplementation of omega-3 fatty acid on fasting serum glucose (FSG) and glycosylated hemoglobin (HbA_{1c}) levels in type 2 DM. **Methods:** This prospective interventional study was conducted from January 2017 to December 2017. A total numbers of 52 diagnosed type 2 diabetic patients (type-2 DM) of both sexes were selected with age 40 to 50 years. Among them, 27 type 2 diabetic patient with supplementation of omega 3 fatty acid (2g/day) for 12 weeks was considered as study group. Another 25 type 2 diabetic patients without supplementation of omega 3 fatty acid was considered as control group. The study subjects were selected from Outpatient Department of Endocrinology, Dhaka Medical College Hospital, Dhaka and personal contact from Dhaka city. FSG was estimated by enzymatic colorimetric method and HbA_{1c} was estimated by turbidimetric inhibition immunoassay method. The study parameters were measured at base line and after 12 weeks of study period in both groups. For statistical analysis, Student's paired 't' test and Student's unpaired 't' test were performed as applicable using SPSS for windows version 16.0. **Results:** In this study serum FSG and HbA_{1c} levels were significantly lower ($p < .001$) in diabetic patients after supplementation with omega-3 fatty acid in comparison to that of their baseline value. Again, after 12 weeks, FSG and HbA_{1c} levels significantly decreased ($p < .001$) in omega-3 fatty acid supplemented diabetic patients compared to control group. In control group, there was no significant change in FSG and HbA_{1c} levels between baseline and after 3 months of follow-up. **Conclusion:** From the results of the study, it can be concluded that omega-3 fatty acid may improve serum FSG and HbA_{1c} levels in type 2 diabetic patient and may be helpful to minimize the complications of type-2 DM.

Keywords: DM, Serum FSG, Serum HbA_{1c} and Omega-3 fatty acid.

Introduction

DM is a group of metabolic disease characterized by hyperglycemia resulting from defect in insulin secretion or insulin action or both. The chronic hyperglycemia of diabetes is associated with long term damage, dysfunction and failure of various organs especially the eyes, kidneys, nerve, heart and blood vessel¹. Diagnostic criteria of DM are fasting plasma glucose level ≥ 7.0 mmol/l (126mg/dl) or plasma glucose 2 hours after an oral glucose ≥ 11.1 mmol/L (200mg/dl) and HbA_{1c} $\geq 6.5\%$ ². The prevalence of T2DM is expected to rise from 285 million in 2010 to 438 million by the year of 2030³. Within 2030, the prevalence of DM will be 11.1 million in Bangladesh⁴.

Insulin is the potent anabolic hormone which is essential for appropriate tissue development, growth and maintenance of whole body glucose homeostasis. Insulin regulates glucose homeostasis by increasing the rate of glucose uptake into striated muscle and adipose tissue. In the skeletal muscle, insulin prompts glucose uptake by stimulating translocation of GLUT-4 to plasma membrane⁵. Insulin resistance occurs when the insulin sensitive tissue loses response to insulin. The basic effect of insulin resistance on glucose metabolism is to prevent the uptake and utilization of glucose by most cells of the body. As a result blood glucose concentration increases, cell utilization of glucose falls, utilization of fat increases and free fatty acid level increases in blood⁶.

Omega-3 Fatty acids are a group of polyunsaturated fatty acids consists of alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexanoic acid (DHA). They are found in sea food including fatty fish (e.g. salmon, tuna and trout) and shellfish (e.g. crab, mussels and oysters). The omega 3 fatty acid increases insulin sensitivity, helps in blood clotting, promote fat digestion, improve fertility, acts as a mood elevator and helps in brain development⁷.

Consumption of fish oil can decrease free fatty acid level, improve insulin sensitivity as well as reduce the incidence of type 2 DM⁸. Poly

unsaturated fatty acid act directly on insulin sensitive tissues, increases number of insulin receptors thus reducing insulin resistance⁹. Omega-3 fatty acid facilitates the action of insulin through various metabolic pathways and improve glycemic status in type-2 DM. It also facilitates the action of insulin through suppression of hepatic lipogenesis and reduces the release of TG from liver and oxidation of fatty acids in liver, thus reduces the complications in type-2 DM¹⁰.

Omega- 3 fatty acid prevents this change by increasing peroxisome proliferator receptor gamma, increasing hepatic uptake and oxidation of free fatty acid in skeletal muscle¹¹. Some author found significant reduction in FSG and HbA_{1c} levels in diabetic patient those are supplemented with fish oil¹². Supplementation of fish oil may improve glycemic status and reduce complications in diabetic patients.

As there is less published data available regarding this topic. Therefore, this study has been designed to observe the effect of the supplementation of omega-3 fatty acid on glycemic status in Bangladeshi type-2 DM patients. It is expected that findings of this study will be helpful for better management and its complication.

Methods

This prospective, interventional study was done by Department of Physiology, Dhaka Medical College, Dhaka from January 2017 to December 2017. The research work was carried out after obtaining ethical clearance from concerned departments, Research Review Committee and Ethical Review Committee of Dhaka medical college, Dhaka. The patients were selected from outpatient department of Endocrinology, Dhaka medical college and personal contact from Dhaka city. At the Beginning of study 60 diagnosed type-2 diabetic patients were randomly selected on the basis of exclusion and inclusion criteria. There were 30 patients of control group and 30 patients of study groups recruited for completion of study. After 6 weeks of study period, 3 patients were dropped out from study group and 5 patients

were dropped out from control group. Finally, total 52 type diabetic patient of both sexes with the age ranging from 40-50 years with FBG 7.0 mmol/l or 126 mg/dl, HbA_{1c} 6.5%, serum TC 200 mg/dl, serum TG 150 mg/dl, BMI <H30 Kg/m² were included in this study. Subjects with history of heart, liver, endocrine disorder, insulin therapy and pregnant women were excluded from this study. For this study, 27 diagnosed type-2 diabetic patients treated with omega-3 fatty acid supplementation were considered as study group and 25 type-2 diabetic patients without oral omega-3 fatty supplementation were selected as control group. The study group again sub-divided into pre-supplementation group and after 12 weeks of supplementation as post supplementation group. The control group was sub-divided as pre and post follow-up group. After selection, the nature, purpose and benefits of the study were explained to each subject and informed written consent was taken from participants. Before taking blood detailed family and medical history were taken. Anthropometric measurement of the subjects was recorded and blood pressure was measured. All the information were recorded in a data schedule. With aseptic precaution, 5 ml of venous blood was collected from ante-cubital vein by a disposable plastic syringe from each subject after overnight fasting for biochemical tests. FSG was estimated by enzymatic colorimetric method and HbA_{1c} was

estimated on turbidimetric inhibition immunoassay method in department of Laboratory Medicine Dhaka Medical College Hospital, Dhaka. Omega-3 fatty acid capsule (2gm) was supplied to study group then they were asked to take orally twice daily for 12 weeks with proper instructions. Subjects were instructed not to change their diet and physical activities during the course of the study. A regular telephonic contact and periodic visit was made to participants because most of them are employee of Dhaka medical college. For statistical analysis, Student's paired 't' test and unpaired Student's 't' test were performed as applicable using SPSS for windows version 16.0. Data were expressed as mean±SE. The *p* value of <0.05 was accepted as level of significance.

Results

In this study no significant difference were observed in age, sex, BMI, systolic and diastolic blood pressure between study and control group (Table 1). In addition, the mean FSG and serum HbA_{1c} levels were almost similar and there was no statistical difference were observed at the beginning of the study. In study group, the mean serum FSG (*p*<.0001) and HbA_{1c} (*p*<0.001) levels were found significantly lower in post supplementation group, than that of pre-supplementation group. Again the mean FSG (*p*<0.001) and HbA_{1c} (*p*<0.001) levels were found

Table I: General characteristics of the patients in both groups (N=52)

Parameters	Study group (n=27)	Control group (n=25)
Age (years) ^a	45.90±3.80	44.92±3.75
Sex (%) ^b		
Male	18 (66.7%)	11 (44 %)
Female	9 (33.3%)	14 (56%)
BMI (kg/m ²) ^a	25.03±2.27	25.87±1.75
Systolic BP ^a (mmHg)	119.07±7.08	121.79±4.47
Diastolic BP ^a (mmHg)	79.63±6.26	80.00±0.00
Duration of disease ^a (years)	5.43±1.50	5.35±1.57

Results were expressed as mean ± SD. a=Unpaired Student's 't' test was performed to compare between the groups. b= Chi Square test was performed to compare male and female between the groups. The test of significance was calculated and *p* value <0.05 was accepted as level of significance. N= total number of subjects, n = number of subjects in each group ns= non-significant */**/**= significant. T2DMS=Type 2 DM with supplementation T2DM=Type 2 DM without supplementation

Table II: Serum FSG and HbA_{1c} levels in different groups (N=52)

Parameters	Study group (n=27)		Control group (n=25)	
	Pre supplementation	Post supplementation	Pre-follow-up	Post follow-up
FSG(mg/dl)	8.96±1.18	6.83±0.49**	8.86±0.95	8.78±0.78##
HbA _{1c} (mg/dl)	6.82±0.68	5.30±0.71*	6.90±0.66	6.84±0.60##

Results are expressed as mean ± SD. a=Paired student's t test was performed for comparison within groups and b=unpaired t test was performed to compare between groups. *p* value < 0.05 was accepted as level of significance. N= total number of subjects, n = number of subjects in each group, FSG= Fasting Serum Glucose, HbA_{1c}= Glycated Hemoglobin, T2DMS=Type 2 DM with supplementation. T2DM=Type 2 DM without supplementation. (*= T2DMS baseline vs T2DMS after 12 weeks of supplementation;#= T2DMS after 12 weeks vs T2DM after 12 weeks); (* *p*<.01, ***p*<.001;#*p*<.01,## *p*<.001).

significantly lower in study group compared to control group. In control group, there was no significant difference in mean FSG and HbA_{1c} between pre and post follow-up group.

Discussion

In the present study, the mean serum FSG, mean HbA_{1c} were significantly lower in patients of T2DM after supplementation with omega-3 fatty acid in comparison to that of their baseline value. Again, after 12 weeks, mean FSG and HbA_{1c} levels significantly decreased in type-2 diabetic patients supplemented with omega-3 fatty acid in comparison to that of diabetic control group without omega-3 fatty acid. Almost similar results were observed by different researchers of different countries¹³⁻¹⁶. On the contrary, there were no significant difference in glycemic status in patients after supplementation of omega-3 fatty acid in comparison to that of their baseline values and diabetic control group who were not supplemented with omega-3 fatty acid¹⁷. There were a history of less physical activity in the study subjects that might be contributed the result of those study. Literature review suggested that, when serum TG level rises, it decreases the binding of insulin with its receptor through releasing some inflammatory mediator from liver that decreases insulin receptor signaling activity. Omega-3 fatty acid directly acts on insulin sensitive tissues, they increases number of insulin receptor⁹. Diet rich with omega-3 fatty

acid improves insulin receptor, insulin receptor substrate-1, Tyrosine kinase activity and GLUT-4 transporter in muscle. So that dietary supplementation of polyunsaturated fatty acid reduces fasting blood glucose and glycated hemoglobin in type-2 diabetic patient¹⁸.

In the present study serum-FSG and HbA_{1c} levels decreased in patients with T2DM after supplementation of omega-3 fatty acid in comparison to their baseline value and control group. Omega-3 fatty acid supplementation plays a key role in insulin signaling activity as a result serum FSG level decreases and it also decreases HbA_{1c} by increasing permeability of GLUT-4. This facilitates insulin sensitivity in type-2 diabetic patient.

Conclusions

After analyzing the results of the study, it can be concluded that supplementation of omega-3 fatty acid can improve serum FSG and HbA_{1c} levels in patients with type-2 DM. Therefore, omega-3 fatty acid containing food may be helpful to minimize the complications in type-2 DM.

Conflict of Interest: None

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