ESTIMATION AND EFFECT OF FASTING BLOOD GLUCOSE FOR TYPE 2 DIABETES

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Article History: Received: 12.12.2022 **Revised:** 29.01.2023 **Accepted:** 15.03.2023

Abstract

Blood glucose levels are determined via a fasting blood sugar test. Prediabetes, diabetes, and gestational diabetes may all be diagnosed in this straightforward, risk-free, and widely used manner. Impact and prediction of type 2 diabetes based on fasting blood glucose levels were investigated. When dealing with diabetes, it is crucial that blood sugar levels be kept within healthy ranges, and prompt detection and treatment of problems is also crucial.

Keywords: blood, insulin, Type2, glucose, Diabetes.

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DOI: 10.31838/ecb/2023.12.s3.006

1. Introduction

Type 2 diabetes mellitus, sometimes known as "adult-onset diabetes," is a metabolic disorder characterized by high blood glucose levels (AD126 mg/dl) owing to abnormalities in carbohydrate, lipid, and protein metabolism or an insulin deficiency. If a patient's fasting blood glucose is above 126 mg/dl, they are said to be hyperglycemic. The underlying causes of diabetes mellitus, which include both hereditary and environmental factors, are multifaceted. Three major risk factors for developing diabetes include inactivity, obesity, and a personal or family history of the disease.

Common forms of diabetes include Type 1 (T1DM), Type 2 (T2DM), and Gestational Diabetes Mellitus. High blood sugar levels are the consequence of a reduction in insulin production. Type 2 diabetes accounts for almost all cases of the disease. Hormonal changes or insufficient insulin synthesis in late pregnancy might lead to gestational diabetes. After 5-10 years, women who have had gestational diabetes are at an increased risk of developing type 2 diabetes (40-60%).

Diagnostic options for type 2 diabetes are varied. The oral glucose tolerance test (OGTT), a random blood glucose test, and a fasting blood glucose test are all examples of common forms of glucose testing (Table 1). Diagnostic criteria for type 2 diabetes include plasma glucose values of 200 mg/dl after 75 g of oral glucose challenges, plasma glucose levels of 200 mg/dl after random sampling, or fasting plasma glucose levels of 1,126 mg/dl. Before other methods were available, a diagnosis of type 2 diabetes was made by testing plasma glucose levels in a fasting state. When blood glucose levels are increased but not high enough to diagnose type 2 diabetes, a variety of intermediate physiological states exist, including impaired fasting glucose (IFG) and impaired glucose tolerance (IGT); (American Diabetes Association, 2009). (American Diabetes Association, 2009). A plasma glucose value of 140 or higher but less than 200 mg/dl during a 2-hour oral glucose tolerance test (OGTT) is considered to be impaired glucose tolerance, whereas a plasma glucose value of 110 to 125 mg/dl is considered to be impaired fasting glucose (IFG).

Table 1: Criteria for Diagnosis of T2DM

	Fasting plasma glucose (mg/dl)	Oral glucose tolerance test (mg/dl)
Diabetes	≥ 126	≥ 200
Pre-Diabetes	110-125	140-199
Normal	≤ 99	≤ 139

When blood glucose levels are continually high, the body reacts by creating more free fatty acids. This elevation in fatty acid flow is connected with a change in lipid profile, which promotes the development of insulin resistance. Elevated triglyceride, reduced HDL, and increased LDL are the sole hallmarks of diabetes-related dyslipidemia. Elevated levels of modified 6 lipids are associated with an increased risk of developing type 2 diabetes. Abnormal lipid levels are related with an increased risk of cardiovascular disease and are intricately tied to insulin resistance. Insulin and insulin resistance have been associated to reduced HDL cholesterol and higher plasma triglycerides.

As a result, after eating, there is a spike in blood sugar. Insulin resistance, in which muscle cells fail to take up glucose in response to insulin, is caused in part by defects in insulin manufacturing and downregulation of the insulin receptor.

2. Literature Review

JunminWang et al (2021) One of the most common side effects of diabetes, diabetic kidney disease (DKD) is also a major contributor to kidney failure (ESRD). In humans, the onset and progression of DKD has long been a significant clinical challenge, contributing to a rise in morbidity and mortality and causing significant impairment to quality of life. The progression of DKD may be slowed by controlling blood glucose, blood pressure, blood lipids, and altering one's lifestyle. New hypoglycemic drugs like sodium-glucose cotransporter 2 (SGLT2) inhibitors, glucagon-like peptide-1 (GLP-1) inhibitors, and dipeptidyl peptidase-4 (DPP-4) inhibitors have good efficacy in clinical treatment, thanks to years of research into the pathological mechanism and molecular mechanism of DKD. Other recently developed drugs, such as protein kinase C (PKC) inhibitors, advanced glycation end product (AGE) inhibitors, aldosterone receptor (AR) inhibitors, endothelin receptor (ETR) inhibitors, transforming growth factor-β (TGF-β) inhibitors, Rho kinase

(ROCK) inhibitors, and so on, have shown promise in animal or clinical trials for the treatment of DKD. In this study, we organize current therapeutic advancements, the research status of certain developing medications, and possible pharmaceuticals for the treatment of DKD in the future in the hopes of pointing the way toward clinical therapy.

Krairittichai, Udom, et al., (2017) Strict control of blood sugar and maintenance of normal blood pressure levels are two of the standard therapy shown to decrease the progression of diabetic nephropathy in type 2 diabetic patients. Some antihypertensive medications, such angiotensin-converting enzyme inhibitors (ACEI) and angiotensin II receptor blockers, are used to treat diabetic nephropathy (ARB). Non-dihydropyridine calcium channel blockers like diltiazem have been shown in clinical studies to reduce protein loss in the urine of type 2 diabetics. purpose of the studies the purpose of this study is to evaluate the efficacy of diltiazem in combination with ACEI/ARB therapy for the treatment of type 2 diabetics with diabetic nephropathy vs the effectiveness of ACEI/ARB therapy alone. Method and materials: multi-center prospective randomized double-blind placebo-controlled study in outpatient clinics at Rajavithi Hospital (Bangkok) and Ban-phaeo Hospital (Samut Sakhon). Two groups of 50 patients each were randomly assigned to receive either diltiazem (ACEI/ARB + sustained-release diltiazem 120 mg daily; 50 people) or a placebo (ACEI/ARB + diltiazem) in addition to their ACEI/ARB for the treatment of type 2 diabetes, hypertension, and a urine protein to creatinine ratio (UPCr) of >0.3 gm/gm (56 cases). Due to the nature of the analysis, patients who dropped out of the study before it was complete were nevertheless included in the results. After a year of treatment, 78.0% of those given diltiazem were alive, compared to 67.1% of those given a placebo. Both groups had comparable blood pressure, but those on diltiazem also maintained a higher glomerular filtration rate and had less proteinuria (p0.05). After experiencing severe pedal edoema, four diltiazem patients and one placebo patient discontinued their treatment. Combining diltiazem with an ACE inhibitor or ARB may be helpful in reducing proteinuria and protecting renal function in patients with type 2 diabetes and diabetic nephropathy.

Amany Ibrahim (2018) Diabetic nephropathy is the leading cause of kidney failure in developing countries. Reducing proteinuria is crucial in delaying the progression of chronic renal disease. Unfortunately, there is presently no effective therapy for proteinuria that can prevent the progression of renal failure. Studying the effects of pentoxifylline, diltiazem, and rosuvastatin on preventing and slowing the development of nephropathy in streptozotocin-induced diabetic rats was the major aim of this investigation. A total of eighty adult albino rats were randomly assigned to one of four treatment groups: normal, diabetic, or both. One intraperitoneal dose of streptozotocin (65mg/kg, I.P.) was used to induce type 1 diabetes mellitus (DM) in adult male albino rats. Pentoxifylline (40 mg/kg/day, orally), diltiazem (10 mg/kg/day, I.P.), and rosuvastatin (10 mg/kg/day, orally) were administered to non-diabetic rats in Groups 3, 5, and 7 for eight weeks. Pentoxifylline (40 mg/kg per day, orally), diltiazem (10 mg/kg per day, intravenously), and rosuvastatin (10 mg/kg/day, orally) were given to diabetic rats in Groups 4, 6, and 8 for eight weeks. GFR, serum urea, creatinine, urine albumin, volume changes, sodium excretion, potassium excretion, renal blood flow, renal histopathology, and antioxidant enzyme activity were all measured to assess renal function (GSH, superoxide dismutase). Administration of pentoxifylline with rosuvastatin resulted in a substantial decrease in blood creatinine, urea, and urine albumin after eight weeks. Renal perfusion, indicators of oxidative stress, and the glomerular filtration rate were markedly enhanced. It didn't matter whether you took one drug or the other since they were interchangeable. In contrast, diltiazem resulted in just a little improvement above baseline levels. Pentoxifylline and rosuvastatin's beneficial effects on oxidative stress reduce the prevalence of diabetic nephropathy. Adding to this, diltiazem is somewhat beneficial for diabetic nephropathy.

Ahmed, Jawad, et al., (2013) About a third of diabetics get kidney damage called diabetic nephropathy. Microalbuminuria (MIA) is the first sign of diabetic nephropathy and needs regular monitoring to prevent further progression of kidney damage. Drugs used to prevent MIA may delay the onset of renal function impairment. The goal of this study is to evaluate the effect of candesartan, diltiazem, and their combination on MIA in diabetic patients. A total of 104 diabetic patients were analyzed, 64 of whom had microalbuminuria (MUI) and 40 of whom were normoalbuminuric. All of the patients were seen in the outpatient clinics of hospitals in Basrah. After that, we split them up into thirds such that some people in each group would have 8 milligrams of candesartan, some would get 90 milligrams of diltiazem, and some would get both for a whole six months. Patients had their albuminuria, fasting blood sugar, hemoglobin A1c, serum creatinine, serum potassium, total cholesterol, and blood pressure measured at 3 and 6 months. Treatment with candesartan, diltiazem, or both for 3 and 6 months

resulted in statistically significant improvements in MIA relative to baseline. After 3 and 6 months of therapy with candesartan, MIA decreased from a starting mean of 175.8 ±134 g/ml to a mean of 76.7± 57.4 g/ml. Diltiazem decreased MIA from 122.2 ±102.8 g/ml after 3 months to 67.2 ±52.6 g/ml, and from there to 51.0 ± 37.6 g/ml after 6 months. By combining their efforts, they were able to reduce MIA levels from 174.6± 106.4 g/ml to 93.2± 67.2 and 46.1 ±53.0, respectively. All three treatment groups for patients with normoalbuminuric showed a small but statistically significant reduction. All three treatments were successful in reducing blood pressure without causing hypotension. Diabetes patients using candesartan, diltiazem, or both had their albuminuria reduce.

Salahuddin et al., (2021) Proteinuria due to renal diseases has been aggressively combated using a wide range of methods. Both academics and medical professionals are looking at several approaches to find the best one. The goal of this study is to compare the efficacy of Losartan and Diltiazem in treating proteinuria in patients with non-diabetic renal disorders who have been hospitalized to a tertiary care center in Pakistan. This study, conducted in a quasi-experimental fashion at the nephrology department of Pak Emirates Military Hospital in Rawalpindi, is a good example of what this kind of study can do. The period of time from November 2020 to March 2021 is five months. 122 individuals with excessive proteinuria due to non-diabetic renal illness participated in the research. To equally divide them, a lottery was held. Diltiazem at the normal dosage was given to group II, whereas losartan was administered to group I. Patients were classified as responders, half responders, or non-responders after 3 months based on 24-hour urine protein levels. Antiproteinuric medication, age, gender, disease duration, and other factors all affected clinical response. Sixty-five patients (65.6%) were men and just 42 (34.4%) were women. Twenty people in our sample (16.4%) had membranous nephropathy, making it the most common non-diabetic renal illness. Three months after treatment, 30% of patients were in full remission, 50% exhibited a moderate response, and 26% had seen no improvement. Using the chi-square test, we find that there is a positive connection (p0.001) between losartan use and a favorable outcome. Membranous nephropathy, which results in proteinuria, was the most frequent kind of renal illness we saw that was not caused by diabetes. About two-thirds of our patients showed improvement after treatment, with Losartan being more effective than Diltiazem.

3. Methodology

Estimation:
Each group's rats had their tails pricked once a week for blood glucose monitoring using Accu-Chek Active glucose strips to measure fasting blood glucose levels. Specifically, we are using a Glucose Oxidase-Peroxidase (GOD-POD) method.
In those with Diabetes Mellitus, blood glucose levels remain abnormally high for an extended period of time. Hyperglycemia is a common complication of diabetes that may be prevented via careful monitoring and management of blood sugar levels. Glucose levels can only be determined by an enzyme reaction. Blood glucose is often measured using the Glucose Oxidase-Peroxidase (GOD-POD) technique because to its specificity, repeatability, and ease-of-use.
Doses for the rats were determined by looking at the therapeutic range for the medications in humans.
Fosinopril (5mg/kg)
Olmisartan (10 mg/kg)
Glimepiride (0.5mg/kg)
Pioglitazone (2.5mg/kg)
Diltiazem (15mg/kg)

Principle:
Trinder's method, upon which the GOD-POD kit is based, involves the reaction of glucose and oxygen to generate gluconic acid and hydrogen peroxide. Protein oxidase (POD) is an enzyme that converts hydrogen peroxide to oxygen and water. When the phenol and 4-Aminoantipyrine absorb the liberated reactive oxygen, a crimson substance called Quinoneimine is formed. By analyzing the fluorescence of Quinoneimine at 505 nm, one may estimate the concentration of glucose in a sample (green filter).

$$\text{Glucose} + O_2 + 112O \xrightarrow{\text{GOD}} \text{Gluconic acid} + 112O_2$$

$$112O_2 + \text{Phenol} + \text{4-Aminoantipyrine} \xrightarrow{\text{POD}} \text{Quinoneimine} + 112O$$

Procedure:
Equipment: Accu-Chek Active glucometer
Specimen: Blood

4. Result And Analysis

Effect on Fasting Blood Glucose (mg/dl):
Glucose levels in the fasting blood were 171± 2.5 mg/dl in streptozotocin-induced type 2 diabetic rats. All of the treatments, both alone and in combination, were effective in reducing the fasting blood glucose (mg/dl) of type 2 diabetic rats. Table shows the average fasting blood glucose (mg/dl) for each group, and Figure provides a visual depiction of this information. Average and standard deviation of fasting blood glucose (mg/dl) before and after pharmacological therapy are shown in Table and Figure, respectively.

Table 2: Mean fasting blood glucose (mg/dl) of different groups at different weeks

Groups			week						
n =6	0	I	II	III	IV	V	VI	VII	VIII
Normal C	79.57	83.87	102.78	102	102.14	97.333	95.12	98.87	102.8
Diabetic C	191.78	171.28	176.12	155.7	157.27	157.17	172.57	174.28	172.11
Olme	164.57	127.82	127.84	117.78	110.28	102.48	115.28	123.39	106.38
Fasino	193.38	138.84	130.41	125.39	115.49	112.27	124.63	132.51	108.79
Olme + Fasino	181.65	153.54	139.29	136.11	123.54	112.18	115.48	138.39	115.23
Dil	165.45	170.34	171.57	173.21	174.28	173.57	172.48	173.24	173.87
Glim	194.37	133.59	134.84	147.47	124.74	124.47	117.27	120.57	131.72
Glim + Dil	184.24	143.58	123.54	110.57	118.45	110.45	101.75	90.71	101.25
Glim + Pio	162.18	128.54	126.58	125.51	125.37	123.97	125.48	126.17	125.34

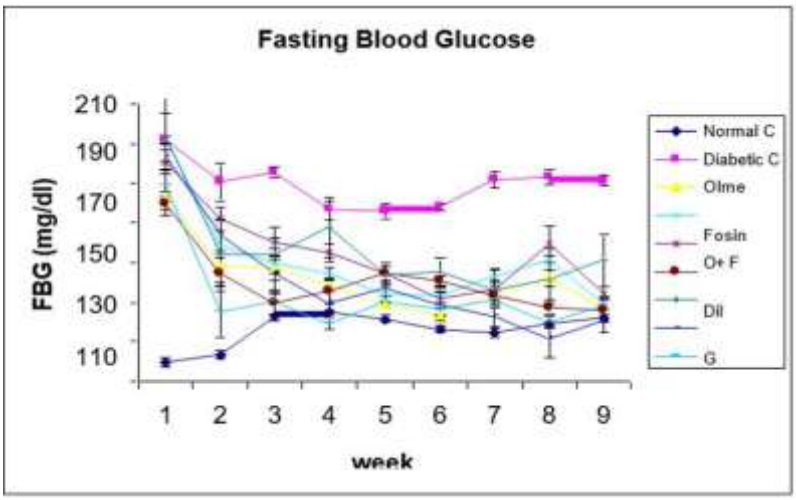

Figure 1: Fasting blood glucose (mg/dl) (Mean ± SEM) of different groups at different weeks

Table 3: Fasting blood glucose (mg/dl) (Mean±SEM) of different groups before and after drug treatment

n =6	Blood Glucose (mg/dl)	Blood Glucose (mg/dl)	Blood Glucose
Groups	Before Treatment	After Treatment	% change
Normal Control	79 ± 2.5	101±2.5	27.5
Diabetic Control	191 ± 2.5	172±2.5	10.9
Olmesartan	164 ± 6	106±5	34.3
Fosinopril	193 ± 12	108±4	43.2
Olme+ Fosino	181 ± 6	113±3.5	36.6
Diltiazem	165 ± 6	104±5	33.9
Glimepiride	194 ± 30	130±13	32.1
Glimepiride + Diltiazem	184 ± 7	101±5.5	45.3
Glimepiride + Pioglitazone	162± 15	108±4	36.0

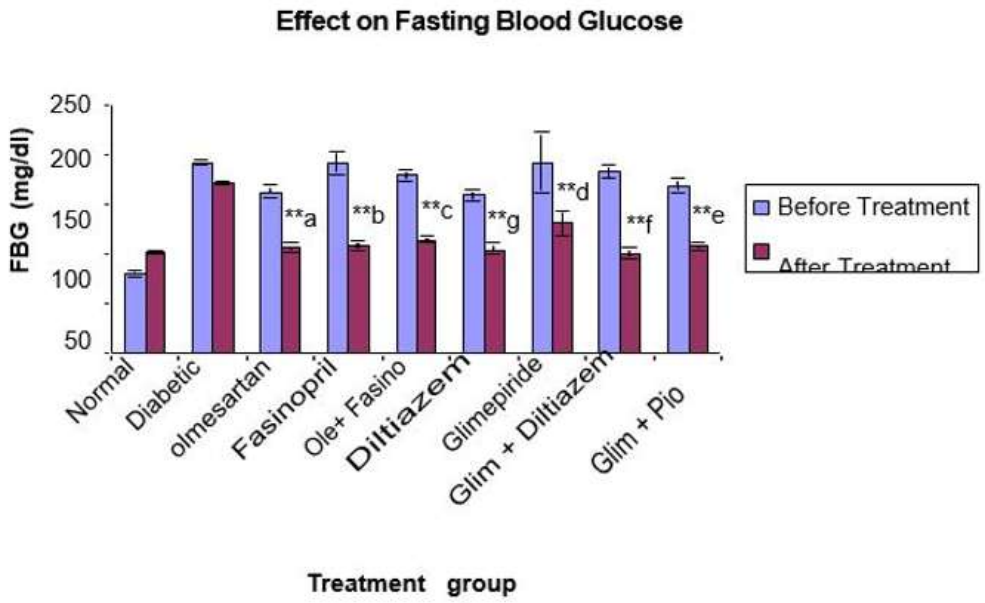

Figure 2: Fasting blood glucose (mg/dl) (Mean±SEM) of different groups before and after drug treatment

Blood glucose levels before and after drug administration were compared in two groups (control and treatment). The normal state, D: Olmesartan (a), Fosinopril (b), Fosinopril and Olmesartan (c), Diltiazem (d), Glimepiride (e), and Glyburide (f) are all blood pressure drugs in Controlling Diabetes. "P+G," which stands for "pioglitazone plus glimepiride," The following notation is used to contrast the drug-free and drug-affected states of letters a through g: MeanSEM; n=6; **P0.01; G+D: Glimepride+Diltiazem (t-test).

The goal of treating type 2 diabetes is to maintain normal fasting blood glucose levels. Fasting blood glucose levels were shown to be significantly ($P<0.01$) lower in diabetic mice treated with monotherapies and their combination treatments of Olmesartan, Fosinopril, Olmesartan + Fosinopril, Diltiazem, Glimepiride, Glimepride + Diltiazem, and Glimepride + Pioglitazone.

Olmesartan's antidiabetic benefits may be explained by the fact that it blocks the inhibitory impact of angiotensin II on insulin signal transduction, hence improving glucose metabolism. Olmesartan, being a partial PPAR- agonist, stimulated the receptor at a level only 25% as high as that reached by complete agonists like the thiazolidinedione medicines. Two complete PPAR-agonists with structural similarity to ARB drugs are rosiglitazone and pioglitazone. Fosinopril reduces blood sugar levels via enhancing glucose metabolism and negating angiotensin II's inhibitory impact on insulin signal transduction and first-phase insulin production. Increased insulin

synthesis and improved peripheral insulin sensitivity are responsible for glimepiride's beneficial effects on fasting blood glucose.

5. Conclusion

Long-term diabetes has emerged as a serious public health threat since it damages every organ in the body. Moreover, Fasting Plasma Insulin was used to assess insulin sensitivity, and normal levels were found for every medication and treatment combination tested. Diabetic nephropathy in type 2 diabetics is best treated with either Diltiazem+Glimepiride or Olmesartan+Fosinopril. Increased insulin synthesis and improved peripheral insulin sensitivity are responsible for glimepiride's beneficial effects on fasting blood glucose.

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