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"ASSOCIATION BETWEEN FASTING BLOOD GLUCOSE LEVELS AND RISK OF VASCULAR COMPLICATIONS IN DIABETES MELLITUS"

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ABSTRACT

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Fasting blood glucose (FBG) is one of the most important laboratory parameters used in the diagnosis and monitoring of diabetes mellitus. Chronic elevation of blood glucose levels contributes significantly to vascular complications, which are the leading causes of morbidity and mortality among diabetic patients. The present study aimed to evaluate fasting blood glucose levels and their association with vascular disease risk among diabetic patients. A hospital-based cross-sectional study was conducted among 100 diabetic patients. Venous blood samples were collected after overnight fasting and analyzed using the Glucose Oxidase–Peroxidase (GOD-POD) method. Results showed that 70% of patients had diabetic-range FBG levels, while 20% were prediabetic and 10% had normal levels. Retinopathy (30%), nephropathy (25%), and neuropathy (20%) were the major complications observed. Higher fasting blood glucose levels were strongly associated with increased vascular complications. Persistent hyperglycemia contributes to endothelial dysfunction, oxidative stress, and formation of advanced glycation end products, leading to vascular damage. The study concludes that regular monitoring of fasting blood glucose and effective glycemic control are essential in preventing long-term diabetic complications and improving patient outcomes.

KEYWORDS: Diabetes mellitus, Fasting blood glucose, Hyperglycemia, Vascular complications, Glycemic control.

1. INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia due to impaired insulin secretion, insulin action, or both. It has emerged as one of the most significant global health challenges, particularly in developing countries. Rapid urbanization, sedentary lifestyle, obesity, unhealthy dietary habits, and genetic predisposition have contributed to the increasing prevalence of diabetes worldwide [1,2].

India has one of the largest diabetic populations globally and is often referred to as the "diabetes capital of the world." The disease imposes a substantial burden on healthcare systems due to long-term complications and associated morbidity and mortality [3].

Classification of Diabetes Mellitus

Type 1 Diabetes Mellitus (T1DM)

Type 1 diabetes results from autoimmune destruction of pancreatic β-cells leading to absolute insulin deficiency. It commonly affects children and adolescents [4].

Type 2 Diabetes Mellitus (T2DM)

Type 2 diabetes is characterized by insulin resistance and relative insulin deficiency. It accounts for approximately 90–95% of diabetes cases and is strongly associated with obesity and sedentary lifestyle [5].

Gestational Diabetes Mellitus (GDM)

Gestational diabetes occurs during pregnancy and may increase the risk of maternal and fetal complications as well as future development of Type 2 diabetes [6].

Fasting Blood Glucose (FBG)

Fasting blood glucose is a widely used diagnostic test performed after 8–12 hours of fasting. It reflects the basal glucose status of the body and is a reliable indicator of glucose metabolism [7].

According to WHO and ADA criteria:

* Normal: <100 mg/dL
* Prediabetes: 100–125 mg/dL
* Diabetes Mellitus: ≥126 mg/dL [1,8]

Persistent hyperglycemia contributes to vascular complications affecting eyes, kidneys, nerves, heart, and blood vessels.

2. Anatomy and Physiology of Glucose Metabolism

Glucose metabolism is essential for maintaining energy homeostasis. Blood glucose levels are regulated through coordinated actions of insulin and glucagon.

Role of Insulin

Insulin is secreted by pancreatic β-cells and lowers blood glucose by promoting:

* Glucose uptake in muscles and adipose tissue
* Glycogenesis
* Lipogenesis
* Protein synthesis
* Inhibition of gluconeogenesis [11]

Role of Glucagon

Glucagon is secreted by α-cells of the pancreas and increases blood glucose by:

* Stimulating glycogenolysis
* Promoting gluconeogenesis [12]

Organs Involved

* Liver
* Pancreas
* Skeletal muscle
* Adipose tissue
* Brain

Disruption in glucose homeostasis results in hyperglycemia and diabetes mellitus [13].

3. Pathophysiology of Diabetes Mellitus

Diabetes mellitus develops due to defects in insulin secretion, insulin action, or both.

Type 1 Diabetes Mellitus

Autoimmune destruction of β-cells leads to absolute insulin deficiency and hyperglycemia [15].

Type 2 Diabetes Mellitus

Type 2 diabetes is characterized by insulin resistance and progressive β-cell dysfunction [17].

Mechanisms Leading to Hyperglycemia

* Decreased glucose uptake
* Increased hepatic glucose production
* Impaired insulin secretion
* Increased lipolysis [19,20]

Biochemical Consequences

Chronic hyperglycemia causes:

* Advanced glycation end product (AGE) formation
* Oxidative stress
* Endothelial dysfunction
* Activation of inflammatory pathways [7,9]

4. Fasting Blood Glucose (FBG)

Principle of Estimation

Glucose Oxidase Method

Glucose is oxidized by glucose oxidase producing hydrogen peroxide, which reacts with chromogens to form a colored compound proportional to glucose concentration [14].

Hexokinase Method

Considered the reference method due to high specificity and accuracy [13].

Procedure

1. Overnight fasting for 8–12 hours
2. Collection of venous blood
3. Transfer into fluoride/oxalate tube
4. Plasma separation
5. Estimation using GOD-POD method

Clinical Significance

FBG is useful for:

* Diagnosis of diabetes
* Monitoring glycemic control

* Screening high-risk individuals
* Predicting vascular complications [8]

5. Vascular Complications of Diabetes

Microvascular Complications

Diabetic Retinopathy

Chronic hyperglycemia damages retinal blood vessels causing vision impairment [10].

Diabetic Nephropathy

Persistent hyperglycemia causes glomerular damage leading to renal failure [13].

Diabetic Neuropathy

Nerve damage due to prolonged hyperglycemia results in sensory and autonomic dysfunction [4].

Macrovascular Complications

Coronary Artery Disease

Accelerated atherosclerosis increases risk of myocardial infarction.

Stroke

Diabetes increases risk of cerebrovascular accidents.

Peripheral Artery Disease

Reduced blood flow to limbs can result in ulcers and gangrene [16].

Mechanisms of Vascular Damage

* AGE formation
* Oxidative stress
* Endothelial dysfunction
* Polyol pathway activation
* Protein kinase C activation [7,9]

6. Review of Literature

Several studies have established a strong relationship between elevated fasting blood glucose and vascular disease risk.

Brownlee (2001) described the biochemical pathways linking hyperglycemia to vascular complications [7].

The UK Prospective Diabetes Study (UKPDS) demonstrated that poor glycemic control increases the risk of cardiovascular and microvascular complications [8].

Stratton et al. reported that increased glycemic levels significantly elevate cardiovascular risk [9].

The Diabetes Control and Complications Trial (DCCT) showed that intensive glycemic control reduces complications in diabetic patients [14].

7. Aim and Objectives

Aim

To study the relationship between fasting blood glucose levels and vascular disease risk.

Objectives

* To measure fasting blood glucose levels in diabetic patients
* To assess vascular complications
* To correlate FBG levels with disease severity

8. MATERIALS AND METHODS

Study Design

Hospital-based cross-sectional study.

Study Population

100 diagnosed diabetic patients attending a clinical laboratory.

Inclusion Criteria

* Diagnosed diabetic patients
* Age >30 years
* Willing participants

Exclusion Criteria

* Non-diabetic individuals
* Pregnant women
* Patients with severe systemic illness

Sample Collection

Venous blood was collected after overnight fasting.

Method of Analysis

FBG estimated using the GOD-POD method.

Statistical Analysis

Data analyzed using percentages and mean values.

9. RESULTS

Table 1: Distribution of Fasting Blood Glucose Levels.

Category	**Number of Patients**	**Percentage**
Normal	10	10%
Prediabetic	20	20%
Diabetic	70	70%

Interpretation

Most patients exhibited diabetic-range fasting glucose levels indicating poor glycemic control.

Table 2: Distribution of Vascular Complications.

Complication	**Number of Patients**	**Percentage**
Retinopathy	30	30%
Nephropathy	25	25%
Neuropathy	20	20%
No Complication	25	25%

Interpretation

Retinopathy was the most common complication followed by nephropathy and neuropathy.

10. DISCUSSION

The present study demonstrated a significant association between elevated fasting blood glucose levels and vascular complications.

The majority of patients had poor glycemic control, and complications were more common among patients with FBG ≥126 mg/dL.

These findings are consistent with UKPDS and DCCT studies which demonstrated that persistent hyperglycemia increases vascular risk [8,14].

The study confirms that early diagnosis and effective glycemic control can significantly reduce complications.

Limitations

* Small sample size
* Single-center study
* Short duration
* Limited biochemical parameters

11. CONCLUSION

The study concludes that fasting blood glucose is a reliable indicator of glycemic status and an important predictor of vascular disease risk in diabetic patients. Elevated FBG levels are strongly associated with microvascular and macrovascular complications. Regular monitoring and strict glycemic control are essential to prevent long-term complications and improve patient outcomes.

12. Recommendations

* Regular monitoring of fasting blood glucose
* Lifestyle modification and exercise
* Early diagnosis and treatment
* Patient education programs
* Monitoring HbA1c, lipid profile, and blood pressure

13. Limitations

* Small sample size
* Single-center design
* Short study duration
* Limited biochemical markers assessed

14. Future Scope

* Large multicenter studies
* Inclusion of HbA1c and inflammatory markers
* Long-term follow-up studies

* AI-based prediction models for complications

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