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ORIGINAL ARTICLE

Assessing Serum Albumin Levels in Patients with uncontrolled Type II Diabetes: A Cross-Sectional Study

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ABSTRACT:

Background: Type II diabetes mellitus (T2DM) is a chronic metabolic disorder associated with long-term complications and metabolic imbalance. While routine glycemic markers like fasting plasma glucose and HbA1c are commonly used to monitor disease control, serum albumin has recently emerged as a potential indicator of systemic inflammation, nutritional status, and glycemic control. **Aim:** To estimate the levels of serum albumin and to find its association with glycemic status among patients with uncontrolled type II diabetes mellitus. **Materials and Methods:** This observational study was conducted on 40 participants, including 20 patients with uncontrolled T2DM and 20 age- and sex-matched healthy controls. Fasting plasma glucose and serum albumin levels were measured using standard laboratory methods. HbA1c was used to confirm glycemic status. Statistical analysis was performed using SPSS version 16.0, and correlation between serum albumin and glucose was evaluated using Pearson's correlation coefficient. **Results:** Patients with uncontrolled T2DM showed significantly lower serum albumin levels compared to controls. A strong negative correlation was observed between serum albumin and fasting glucose levels ($r = –0.609$, $p< 0.01$), indicating that worsening glycemic status is associated with declining albumin levels. **Conclusion:** Serum albumin levels are significantly reduced in uncontrolled T2DM and show a negative correlation with fasting glucose. These findings suggest that serum albumin may serve as a supplementary marker for glycemic control and metabolic stress in diabetic individuals.

Keywords: Serum albumin, uncontrolled diabetes, fasting glucose, type II diabetes mellitus, hypoalbuminemia

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INTRODUCTION

Diabetes mellitus type II (T2DM) is a chronic metabolic disorder characterized by hyperglycemia resulting from insulin resistance and relative insulin deficiency. It has emerged as a major public health concern globally, with rapidly increasing prevalence due to sedentary lifestyle, urbanization, and dietary changes. The World Health Organization estimates that over 422 million people are living with diabetes worldwide, and type II accounts for more than 90% of all diagnosed cases [1]. In India alone, it is projected that over 134 million people will be affected by diabetes by 2045 [2].

Chronic hyperglycemia in T2DM leads to long-term damage, dysfunction, and failure of various organs, including the kidneys, heart, eyes, and nerves. Glycemic control is the cornerstone in preventing such complications, and several biochemical markers such as HbA1c, fasting plasma glucose, and postprandial glucose are routinely used to assess metabolic control. However, emerging evidence suggests that serum albumin, a traditionally overlooked parameter in the diabetic profile, may have important clinical significance in uncontrolled T2DM [3].

Albumin, the most abundant plasma protein synthesized in the liver, plays crucial roles in maintaining oncotic pressure, binding and transporting hormones and drugs, and exerting antioxidant and anti-inflammatory effects [4]. Studies have demonstrated that serum albumin levels are often lower in patients with uncontrolled diabetes, potentially due to increased oxidative stress, low-grade inflammation, and albumin glycation [5,6]. Furthermore, hypoalbuminemia may be associated with poor glycemic control, insulin resistance, and higher cardiovascular risk in diabetic patients [7].

Recent studies have highlighted an inverse relationship between serum albumin levels and HbA1c values, suggesting that albumin could serve as an additional marker for metabolic control in diabetic populations [8]. Moreover, hypoalbuminemia has also been associated with the presence and severity of diabetic complications, including nephropathy and retinopathy, making it a potential indicator of systemic involvement in T2DM [9]. This is particularly relevant in uncontrolled diabetes, where inflammatory and metabolic disturbances are exacerbated [10].

Given the rising burden of uncontrolled diabetes and its complications, there is a growing need to explore and validate alternative biochemical markers that are both accessible and cost-effective. Serum albumin, being a routinely performed test, offers a feasible tool for identifying patients at risk of poor outcomes.

Hence, the present study aims to estimate the levels of serum albumin and to find its association with glycemic status among patients with uncontrolled type

II diabetes mellitus. This investigation may help in establishing albumin as a supportive biomarker for glycemic control and risk stratification in diabetic care.

MATERIAL AND METHODS

A hospital-based observational study was conducted to evaluate serum albumin levels and their association with glycemic status in patients with uncontrolled type II diabetes mellitus. The study was carried out in the Department of Biochemistry at a tertiary care center after obtaining ethical clearance from the Institutional Ethics Committee.

A total of 40 individuals were enrolled for the study, divided equally into two groups: 20 patients with uncontrolled type II diabetes mellitus (cases) and 20 age- and sex-matched healthy individuals with normal fasting glucose and HbA1c levels (controls). Uncontrolled diabetes was defined based on American Diabetes Association criteria as HbA1c levels >7.0% at the time of enrollment.

Inclusion criteria for the case group included patients aged 30–65 years with a known history of type II diabetes mellitus for at least one year and documented poor glycemic control (HbA1c >7.0%). Control subjects were healthy individuals with no known history of diabetes and normal glycemic parameters (HbA1c <5.7%).

Exclusion criteria for both groups included patients with known liver disease, chronic kidney disease, nephrotic syndrome, active infection, malignancy, autoimmune disorders, or those taking albumin or corticosteroid supplementation.

After obtaining written informed consent, a detailed clinical history and demographic profile were recorded. Venous blood samples were collected from all participants after an overnight fast of 8–12 hours. Serum was separated and analyzed for the following parameters:

- Fasting plasma glucose (FPG) – measured using the glucose oxidase-peroxidase method.
- HbA1c – estimated using high-performance liquid chromatography (HPLC).
- Serum albumin – analyzed using the bromocresol green dye-binding method.

All investigations were conducted in the institutional central laboratory following standardized protocols.

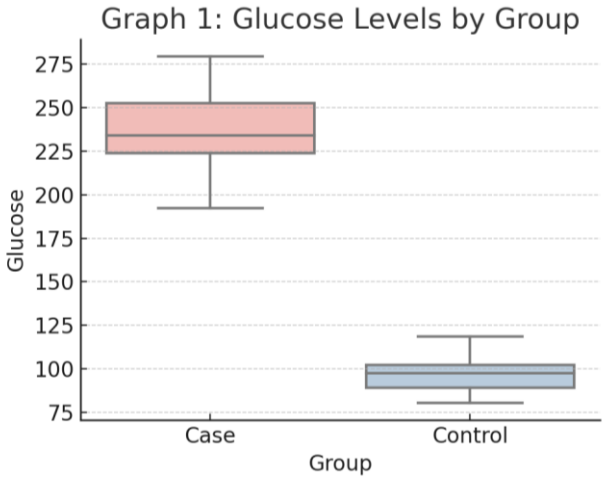
The data were compiled using Microsoft Excel and analyzed using SPSS software version 22.0 (IBM Corp., USA). Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables were presented as frequency and percentage. Comparison of serum albumin levels between cases and controls was done using the independent samples t-test. Correlation between serum albumin and HbA1c levels among diabetic patients was assessed using Pearson's correlation coefficient. A *p*-value of <0.05 was considered statistically significant.

RESULTS

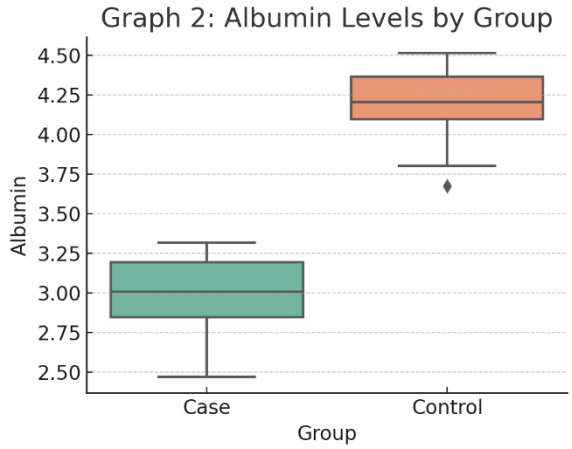
Graph 1 illustrates the distribution of fasting plasma glucose levels between the two study groups—cases (uncontrolled type II diabetes mellitus) and controls (non-diabetic individuals). The boxplot clearly shows that the mean glucose level is significantly higher in the case group compared to the control group, reflecting poor glycemic control among diabetic patients.

Graph 2 displays the distribution of serum albumin levels in both groups. A marked reduction in serum albumin levels is observed among the cases when compared to controls. This supports the hypothesis that hypoalbuminemia is more prevalent in individuals with uncontrolled diabetes, possibly due to inflammation, glycation, and altered hepatic synthesis.

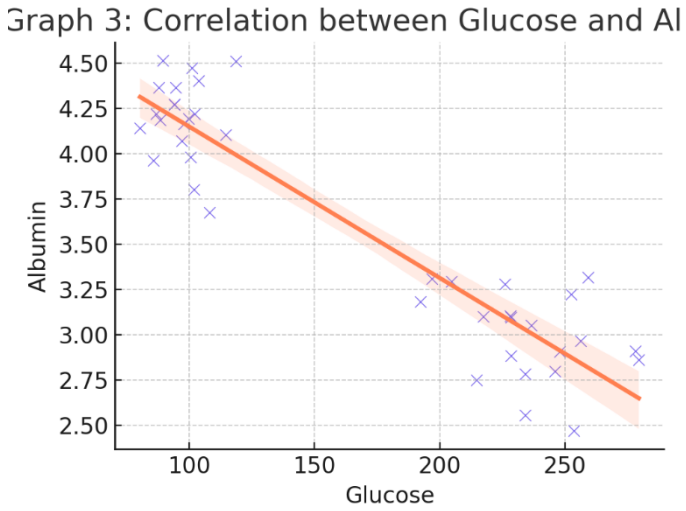
Graph 3 is a scatter plot showing the relationship between serum albumin and fasting plasma glucose levels across all study subjects. A significant negative correlation is observed ($r = -0.609$, $p < 0.01$), indicating that as blood glucose levels rise, serum albumin levels tend to decrease. This inverse association reinforces the potential of serum albumin as a supplementary biochemical marker in assessing glycemic status.



Graph 1: Glucose Levels by Group



Graph 2: Albumin Levels by Group



Graph 3: Correlation between Glucose and Albumin

DISCUSSION

The present study aimed to evaluate serum albumin levels and their correlation with glycemic status in patients with uncontrolled type II diabetes mellitus (T2DM). Our findings revealed significantly lower serum albumin levels in the case group compared to the healthy controls. Moreover, a statistically significant negative correlation ($r = –0.609$, $p < 0.01$) was observed between fasting plasma glucose and serum albumin levels, indicating that as hyperglycemia worsens, serum albumin levels tend to decline.

Hypoalbuminemia in T2DM patients has increasingly been recognized as an early marker of systemic inflammation, poor glycemic control, and microvascular complications. Albumin, beyond its nutritional role, possesses antioxidant and anti-inflammatory properties and acts as a scavenger for free radicals and reactive oxygen species. In a hyperglycemic state, oxidative stress and low-grade inflammation can suppress albumin synthesis in the liver while also increasing capillary permeability, leading to albumin leakage and subsequent hypoalbuminemia [11].

Our findings are in alignment with recent studies that have demonstrated an inverse relationship between serum albumin and glycemic markers such as HbA1c and fasting glucose. Wang et al. observed that serum albumin levels were significantly reduced in patients with poor glycemic control, independent of renal function status, indicating that glycemia itself can modulate albumin synthesis and metabolism [12]. Similarly, Li et al. found that hypoalbuminemia was not only associated with poor glycemic status but also served as an independent predictor of cardiovascular events in T2DM patients [13].

In the present study, the controls maintained normal albumin levels, reinforcing the view that normoglycemia may help preserve hepatic protein synthesis and reduce systemic inflammation. This supports the notion that serum albumin levels might serve as an indirect marker of metabolic stability. A study by Dasgupta et al. suggested that patients with well-controlled diabetes had significantly higher albumin levels than those with uncontrolled diabetes, even when dietary protein intake was comparable [14].

Moreover, the significant inverse correlation found in this study between fasting glucose and albumin levels

may highlight the impact of hyperglycemia-induced glycation and hepatic oxidative damage. Research by Nakamura et al. explained that chronic hyperglycemia may result in non-enzymatic glycation of albumin, altering its structure and function, potentially reducing measurable circulating albumin levels and diminishing its antioxidant capacity [15].

While serum albumin is routinely measured in clinical biochemistry panels, its potential utility as an adjunctive marker in diabetes management is often overlooked. The ease, affordability, and accessibility of this test make it a promising candidate for broader use in screening and monitoring uncontrolled diabetes. However, confounding factors such as malnutrition, hepatic dysfunction, and nephropathy must be considered when interpreting hypoalbuminemia.

CONCLUSION

This study demonstrates that serum albumin levels are significantly reduced in patients with uncontrolled type II diabetes mellitus and are inversely correlated with fasting plasma glucose levels. The findings reinforce the potential role of serum albumin as an adjunctive biochemical marker for glycemic control. Early detection of hypoalbuminemia may help identify patients at higher risk for complications and allow for timely clinical intervention.

Incorporating serum albumin assessment into routine diabetes monitoring protocols may offer a cost-effective and practical tool to support existing glycemic markers, especially in resource-constrained settings. Further large-scale longitudinal studies are needed to validate their prognostic significance and utility in clinical practice.

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