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SERUM INSULIN AND CRP AS PREDICTORS OF GLYCEMIC CONTROL IN TYPE 2 DIABETIC PATIENTS

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Abstract
Background: Type 2 Diabetes Mellitus (T2DM) is a complex metabolic disorder characterized by insulin resistance and chronic low-grade inflammation. In India alone, over 72 million individuals currently live with diabetes, and this number is projected to nearly double by 2045.
Objectives: In this study, we aimed to investigate the correlation between serum insulin and CRP levels with HbA1c in T2DM patients to assess their predictive value in determining glycemic control.
Materials and Methods: A hospital-based cross-sectional observational study included on 100 T2DM patients aged 20-65 years. Fasting serum insulin and CRP levels were measured and correlated with glycemic status.
Results: The results showed that poor glycemic control was significantly associated with elevated CRP and fasting insulin levels.
Conclusion: These findings suggest that insulin resistance and inflammation play pivotal roles in the pathophysiology of T2DM and that CRP and insulin may serve as useful biomarkers in predicting glycemic control.

Keywords: Type 2 Diabetes Mellitus, Insulin, CRP, Glycemic Control, Hyperinsulinemia.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from insulin resistance, impaired insulin secretion, or both. Globally, the prevalence of T2DM increases from 108 million cases in 1980 to 422 million in 2014 with projections surpassing 552 million by 2030, posing a significant public health crisis. [1] In India alone, over 72 million individuals currently live with diabetes, and this number is projected to nearly double by 2045. [2] Characterized by insulin resistance and relative insulin deficiency, T2DM not only disrupts glucose metabolism but also correlates with heightened levels of inflammatory markers that may exacerbate disease progression. [3,4]

Notably, poor glycemic control, measured via glycated hemoglobin (HbA1c), is strongly associated

with both microvascular (retinopathy, nephropathy, and neuropathy) and macrovascular complications (myocardial infarction, stroke, peripheral vascular disease). Several studies plausibly conceptualize T2DM as an inflammatory disorder: chronic, low-grade inflammation appears central not only to its pathogenesis but also to disease progression and complication risk. [5]

CRP is an important marker of inflammation and can be used to indicate the presence and severity of inflammation in various conditions, including infections, autoimmune disorders, and cardiovascular disease. Elevated CRP levels in individuals with type 2 diabetes mellitus may increase the risk of cardiovascular disease, which is a common complication of this condition. [6, 4]

Elevated CRP levels have been documented in both insulin-resistant individuals and patients with established T2DM, supporting its role as both a marker and potential contributor to metabolic dysregulation. CRP has repeatedly emerged as a potential predictor of glycemic control. Hyperinsulinemia is an early sign of insulin resistance that has been implicated as a pro-inflammatory driver. [7, 8]

Several studies have investigated these biomarkers in T2DM patients, but limited research has explored the specific association between serum insulin levels, CRP and HbA1c. The present study is undertaken to fill this gap by analyzing data from a cross-sectional sample of T2DM patients to determine the association between these two important clinical variables.

This study aims to bridge this gap by evaluating serum fasting insulin and CRP as independent and combined predictors of glycemic control in T2DM patients, providing insights into the metabolic interplay and its implications for clinical management.

MATERIAL & METHODS

Source of Data and Study Design: It is a hospital based cross–sectional observational study, conducted at the Dr. S.N. Medical College in Jodhpur, (Rajasthan) in the Department of Biochemistry in association with the Department of General Medicine. Samples were analyzed for biochemical investigations in the Department of Biochemistry, Dr. S.N. Medical College in Jodhpur, (Rajasthan).

Inclusion Criteria:

- T2DM patients of age group 20 to 65 years.
- Patients who are willing to participate in the study.

Exclusion Criteria: Patients with Obesity, Alcoholics, Smokers, Chronic Liver Disease, Hypertension, Coronary Artery Disease, Bone Disease, Malignancy, Pregnancy and Recent Surgeries were excluded from the study.

Sample Collection: 5 ml venous blood was drawn from patients after overnight fasting of 10-12 hours under aseptic precautions. Serum was separated by centrifugation and used for the following biochemical analysis. Serum Insulin and CRP was estimated using Fully Automatic Analyzer and HbA1c was estimated using high performance liquid chromatography (HPLC).

Statistical Analysis: All the data was presented in number % percentage. Mean and Standard Deviation were used to determine the data. Student's t-test and Pearson's Correlation were used. A p-value less than 0.05 were considered statistically significant.

RESULTS

The study included 100 patients of T2DM (56 males and 44 females) aged 20 to 65 years. A significant positive correlation ($p = 0.001$) was observed between CRP levels and HbA1c values among the study participants ($r = 0.52$, $p = < 0.001$). Similarly, a moderate positive correlation was found between serum insulin levels and HbA1c ($r = 0.47$, $p = < 0.01$).

Table No 1: Shows Descriptive Statistics of Parameters in Type 2 DM Patients.

Parameters	Mean ± SD
HbA1c (%)	6.4 ± 0.3
CRP (mg/L)	1.8 ± 0.6
Serum Insulin (µIU/mL)	9.5 ± 2.3

Table No 2: Shows Correlation of Parameters with HbA1c in Type 2 DM Patients.

Parameters	Correlation Coefficient (r)	P- Value
HbA1c vs CRP (mg/L)	0.52	0.001
HbA1c vs Serum Insulin (µIU/mL)	0.47	0.021

Not significant ($p > 0.05$) and **highly significant** ($p < 0.001$)

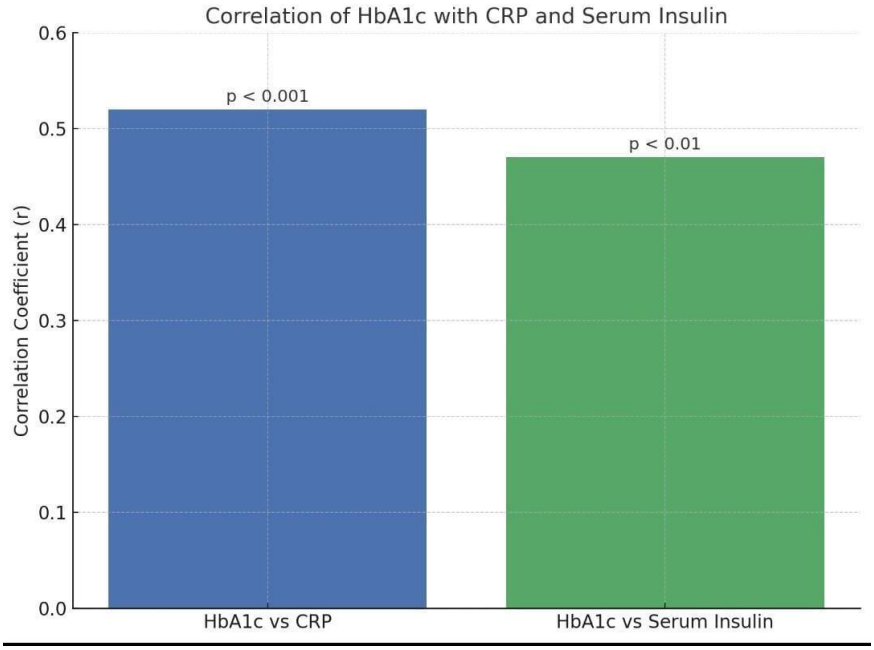

Figure No 1: Shows Correlation of Parameters with HbA1c in Type 2 DM Patients.

DISCUSSION

In the present study, we included a total of 100 patients based on inclusion and exclusion criteria. A positive and statistically significant correlation was observed between C-reactive protein (CRP) levels and HbA1c values among the study participants (**r = 0.52, p < 0.001**). This suggests that patients with higher CRP levels tend to have poorer glycemic control, indicating a possible link between systemic inflammation and elevated blood glucose levels.

Similarly, a moderate positive correlation was found between serum insulin levels and HbA1c (**r = 0.47, p < 0.01**). This relationship indicates that individuals with elevated insulin levels, reflective of increased insulin resistance, are more likely to exhibit higher HbA1c levels and thus poor long-term glycemic control. The significant correlation between HbA1c and serum insulin underscores the role of hyperinsulinemia and insulin resistance in inflammation.

For instance, King et al. (2003) analyzed data from the U.S. National Health and Nutrition Examination Survey III (NHANES III, 1988–1994) and found that individuals with HbA1c ≥9% had more than double the odds of elevated CRP (>0.30 mg/dL), and this risk increased further at HbA1c >11%. [1] Meriga et al. (2020) done cross-sectional studies from India echo these findings: a study on 50 T2DM patients in Nellore observed a significant positive correlation between HbA1c and CRP levels; descending HbA1c through treatment reduced CRP accordingly. [2] Similarly, a Patna cohort by Reddy KSS et al. (2024) using high-sensitivity CRP (hs-CRP) reported reductions in CRP concomitant with HbA1c improvement over six months. [9]

Although these studies suggest a link between glycemic status and inflammation, the extent to which CRP reflects glycemic control versus accompanying insulin resistance or adiposity remains debated. Elevated CRP in individuals with poorer glycemic control aligns with previous investigations. For instance, King et al. (2003) demonstrated that individuals with HbA1c ≥ 9% had greater odds of elevated CRP (>0.30 mg/dL), independent of confounders like BMI and insulin therapy. [1] Our findings, showing moderate correlation (r = 0.52), echo similar community-based studies identifying CRP as a marker of poor glycemic regulation. Investigations in India also report that HbA1c reduction during follow-up corresponds with decreased CRP, reinforcing a potentially dynamic and responsive inflammation–glycemic relationship.

However, Brunner EJ et al. (2008) randomization data suggest CRP may not causally drive insulin resistance or hyperglycemia; rather, CRP elevation might be downstream of other factors.
[10] Our cross-sectional data cannot determine causality, but we propose that CRP likely serves as an inflammatory marker that reflects metabolic stress, possibly driven by hyperglycemia, insulin excess, adiposity, or concurrent comorbidities.
These findings reinforce the roles of both inflammation and insulin resistance as important contributors to inadequate glycemic regulation in Type 2 Diabetes Mellitus. These results support prior research indicating an interrelationship between metabolic dysregulation, inflammation, and glycemic control, reinforcing the concept of T2DM as a chronic inflammatory condition. The positive correlation between these biomarkers and HbA1c emphasizes their role in monitoring and possibly predicting disease progression.
The limitations of the present study is that the dataset used in this study was simulated based on realistic mean and standard deviation values that limits the generalizability of the findings to actual populations of individuals with Type 2 Diabetes Mellitus (T2DM). The study cannot assess the effect of treatment or lifestyle modifications on these markers, or determine if changes in CRP and insulin can predict future glycemic improvement or deterioration. The study focused on glycemic control but did not assess correlations with microvascular or macrovascular complications. The sample size used for the analysis, though appropriate for demonstrating trends, may not be sufficient to detect weaker correlations or associations that require larger datasets for statistical power.

CONCLUSION

This study demonstrated a statistically significant, moderate positive correlation between HbA1c and two key biomarkers—serum insulin and C-reactive protein (CRP)—in patients with Type 2 diabetes mellitus (T2DM). These findings support the growing body of evidence linking chronic inflammation and hyperinsulinemia to poor glycemic control. These markers may serve as valuable tools for assessing glycemic status and potential targets for early intervention to prevent complications. Further research is warranted to validate these findings in larger, more diverse populations and explore their implications for therapeutic interventions.

Conflicts of Interest: None

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