



Correlation of Glycemic Control (HbA1c) with Microvascular and Macrovascular Complications in Type 2 Diabetes Mellitus: An Observational Study in a Tertiary Care Hospital

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Abstract

Background: Type 2 diabetes mellitus (T2DM) is a major metabolic disorder associated with microvascular and macrovascular complications. Glycated hemoglobin (HbA1c) reflects long-term glycemic control and is an important predictor of diabetic complications. This study aimed to evaluate the correlation between HbA1c levels and vascular complications in T2DM patients. **Methods:** A cross-sectional observational study was conducted among 240 patients with T2DM attending a tertiary care hospital. Clinical, biochemical, and complication profiles were recorded. HbA1c was categorized into <7%, 7–8.9%, and ≥9%. Microvascular (retinopathy, nephropathy, neuropathy) and macrovascular complications (CAD, stroke, peripheral arterial disease) were assessed. Statistical analysis included chi-square test and Pearson correlation. **Results:** Mean HbA1c was $8.4 \pm 1.6\%$. Microvascular complications were significantly higher in patients with HbA1c ≥9% (retinopathy 48%, nephropathy 42%, neuropathy 55%). Macrovascular complications (CAD 38%, stroke 14%, PAD 21%) were also significantly associated with higher HbA1c levels ($p < 0.001$). A strong positive correlation was observed between HbA1c and overall complication burden ($r = 0.62$). **Conclusion:** Poor glycemic control is strongly associated with increased risk of both microvascular and macrovascular complications. Early and strict glycemic management is essential to reduce long-term morbidity in T2DM patients.

Keywords: Type 2 diabetes mellitus, HbA1c, microvascular complications, macrovascular complications, glycemic control



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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disease characterized by persistent hyperglycemia due to insulin resistance and relative insulin deficiency. It is associated with long-term complications affecting multiple organ systems.

HbA1c is a reliable marker of long-term glycemic control, reflecting average blood glucose levels over 8–12 weeks. Numerous studies have demonstrated a strong relationship between elevated HbA1c levels and development of diabetic complications.

Microvascular complications include diabetic retinopathy, nephropathy, and neuropathy, while macrovascular complications include coronary artery disease, cerebrovascular disease, and peripheral arterial disease. These complications significantly contribute to morbidity and mortality in diabetic patients.

This study aims to evaluate the correlation between HbA1c levels and the burden of vascular complications in T2DM patients in a tertiary care setting.

MATERIALS AND METHODS

Study Design

Cross-sectional observational study.

Study Setting

Department of Medicine, tertiary care hospital.

Study Population

240 patients diagnosed with T2DM as per ADA criteria.

Inclusion Criteria

- Age >30 years
- Confirmed T2DM >1 year duration

Exclusion Criteria

- Type 1 DM
- Gestational diabetes
- Acute infections or critical illness

Data Collection

- Demographics
- Duration of diabetes
- HbA1c levels
- Fundoscopy for retinopathy

- Urine ACR for nephropathy
- Nerve conduction studies (if required)
- ECG, echocardiography, Doppler studies

Statistical Analysis

- SPSS software
 - Chi-square test for categorical variables
 - Pearson correlation for HbA1c vs complications
- $p < 0.05$ considered significant

RESULTS

Baseline Characteristics

- Total patients: 240
- Mean age: 56.7 ± 11.2 years
- Male: 54%
- Mean duration of diabetes: 8.9 ± 5.1 years
- Mean HbA1c: $8.4 \pm 1.6\%$

HbA1c Distribution

- $<7\%$: 22%
- $7-8.9\%$: 44%
- $\geq 9\%$: 34%

Microvascular Complications

Complication	HbA1c $<7\%$	$7-8.9\%$	$\geq 9\%$
Retinopathy	12%	28%	48%
Nephropathy	10%	26%	42%
Neuropathy	18%	35%	55%

Macrovascular Complications

Complication	HbA1c $<7\%$	$7-8.9\%$	$\geq 9\%$
CAD	14%	25%	38%
Stroke	4%	9%	14%
PAD	6%	12%	21%

Correlation Analysis

- HbA1c vs microvascular complications: $r = 0.68$ (strong positive)
 - HbA1c vs macrovascular complications: $r = 0.54$ (moderate positive)
- Overall complication burden: $r = 0.62$ ($p < 0.001$)

DISCUSSION

This study demonstrates a significant positive correlation between HbA1c levels and both microvascular and macrovascular complications in T2DM patients.

The findings are consistent with landmark studies such as the UKPDS, which established that improved glycemic control significantly reduces microvascular complications. However, macrovascular complications show a more complex relationship influenced by multiple risk factors including hypertension, dyslipidemia, and smoking.

Microvascular complications showed a stronger association with HbA1c compared to macrovascular

complications, indicating that chronic hyperglycemia has a more direct pathogenic role in small vessel damage.

Elevated HbA1c reflects prolonged exposure to glucose toxicity, leading to endothelial dysfunction, oxidative stress, and inflammation, which contribute to vascular damage.

Early intensive glycemic control may therefore reduce long-term complications and improve quality of life in diabetic patients.

CONCLUSION

HbA1c is strongly correlated with both microvascular and macrovascular complications in T2DM. Higher

HbA1c levels are associated with significantly increased risk of diabetic complications. Strict glycemic control should be emphasized to reduce disease burden.

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