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Impact of diabetes mellitus on the progression of coronary artery disease: An observational study

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ABSTRACT

Background: Diabetes mellitus (DM) accelerates the progression of coronary artery disease (CAD), increasing the risk of cardiovascular complications and mortality. **Aims and Objectives:** The aims of this study were to evaluate the impact of DM on the progression of CAD over a 2-year period and identify key risk factors and biomarkers associated with adverse cardiovascular outcomes in diabetic patients. **Materials and Methods:** This observational study included 100 participants, divided into two groups: 50 patients with DM and 50 non-diabetic controls. Demographic and clinical characteristics, including age, gender, body mass index (BMI), and baseline CAD characteristics, were recorded. Participants were followed for 2 years to assess the progression of CAD and new cardiovascular events. Risk factors such as hemoglobin A1c (HbA1c) levels, low-density lipoprotein (LDL) cholesterol, and C-reactive protein (CRP) were also measured. Statistical analyses, including multivariate logistic regression, were performed to identify independent predictors of CAD progression. **Results:** The diabetic group had a significantly higher BMI (29.1 ± 4.6 kg/m1 vs. 26.5 ± 3.9 kg/m1r P = 0.01) and prevalence of CAD (80% vs. 60%, P = 0.03). CAD progression was observed in 56% of diabetic patients compared to 30% of controls (P = 0.01). New cardiovascular events occurred in 24% of diabetics versus 12% of controls (P = 0.08). Diabetic patients had higher HbA1c (8.2% ± 1.1 vs. 5.6% ± 0.7, P < 0.001), LDL cholesterol (130.4 ± 25.6 mg/dL vs. 115.8 ± 22.3 mg/dL, P = 0.04), and CRP levels (3.2 ± 1.4 mg/L vs. 1.8 ± 1.0 mg/L, P = 0.001). DM was an independent predictor of CAD progression (OR = 2.9, 95% CI = 1.4–5.8, P = 0.003). **Conclusion:** DM significantly impacts CAD progression, emphasizing the need for aggressive risk factor management in diabetic patients.

Key words: Diabetes mellitus; Coronary artery disease; Coronary artery disease progression; Cardiovascular events

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INTRODUCTION

Coronary artery disease (CAD) remains one of the foremost causes of morbidity and mortality globally, presenting a significant public health challenge.[1] Characterized by the narrowing or blockage of coronary arteries due to atherosclerosis, CAD impairs blood flow to the heart muscle, leading to conditions such as angina, myocardial infarction, and heart failure.[2,3] The global burden of CAD is immense, contributing to millions of deaths each year and substantial healthcare costs.[4] As the prevalence of risk factors such as obesity, hypertension, and sedentary lifestyles continues to rise, the incidence of CAD is expected to increase, further straining healthcare systems worldwide.[5]

Diabetes mellitus (DM), a metabolic disorder characterized by chronic hyperglycemia, is a well-established and

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potent risk factor for the development and progression of CAD. The pathophysiological mechanisms linking DM to CAD are complex and multifaceted.[6] Persistent hyperglycemia in diabetic patients leads to a cascade of deleterious effects, including metabolic disturbances, endothelial dysfunction, increased oxidative stress, and chronic low-grade inflammation.[7] These factors collectively accelerate the process of atherosclerosis, a key underlying mechanism of CAD. Diabetic patients often exhibit a more aggressive form of atherosclerosis, with plaques that are more likely to rupture, leading to acute cardiovascular events.

Despite significant advancements in the management of both diabetes and cardiovascular diseases, the burden of CAD among diabetic patients remains disproportionately high. Diabetic individuals are at a substantially higher risk of adverse cardiovascular events, such as myocardial infarction and stroke, compared to non-diabetic individuals. The presence of diabetes not only increases the risk of developing CAD but also exacerbates its progression, leading to worse clinical outcomes. This heightened risk underscores the need for targeted strategies to manage CAD in diabetic patients more effectively.

Previous research has consistently demonstrated the elevated risk of cardiovascular events and accelerated progression of atherosclerosis in diabetic individuals. However, there is a pressing need for more comprehensive data that elucidate the specific impact of DM on CAD progression in diverse populations. Such data are essential for developing tailored management strategies that address the unique needs of diabetic patients. Understanding the interplay between DM and CAD progression is crucial for devising effective interventions aimed at mitigating cardiovascular risk and improving clinical outcomes in this vulnerable population.

Aims and objectives

The study aims to compare the progression of CAD between diabetic patients and non-diabetic controls over a 2-year follow-up period. It will assess and compare demographic and clinical characteristics, including age, gender, body mass index (BMI), and baseline CAD features, between the two groups. Key risk factors such as hemoglobin A1c (HbA1c) levels, low-density lipoprotein (LDL) cholesterol, and C-reactive protein (CRP) will be measured and analyzed to identify their association with CAD progression. In addition, multivariate logistic regression analysis will be performed to pinpoint independent predictors of CAD progression, with a particular focus on the role of DM and its associated risk factors.

MATERIALS AND METHODS

Study design

This observational study was conducted to evaluate the impact of DM on the progression of CAD. The study was carried out over a 2-year period from July 2022 to June 2024 at the Government Medical College, Mahmudabad.

Study population

The study included a total of 100 participants, divided into two groups: Sample size was calculated using an effect size of 0.5, power of 80%, and a significance level of 0.05. The required sample size was 50 participants per group to detect significant differences in CAD progression.

- Diabetic group: 50 patients diagnosed with DM
- Control group: 50 non-diabetic individuals serving as controls.

Inclusion criteria

- Adults aged 40–70 years
- Diagnosed with CAD at baseline
- Able to provide informed consent.

Exclusion criteria

- History of other significant chronic diseases
- Acute infections or inflammatory conditions
- Pregnant women.

Data collection

Demographic and clinical characteristics were recorded at baseline for all participants. The following data were collected:

- Demographics: Age and gender
- Clinical characteristics: BMI and baseline CAD characteristics (e.g., number of affected vessels).

Baseline assessment

CAD characteristics

It documented through angiography reports, including the number of affected vessels.

Laboratory measurements

Blood samples were taken to measure HbA1c levels, LDL cholesterol, and CRP.

Follow-up

Participants were followed up for a period of 2 years. During this period:

CAD progression

Assessed through follow-up angiography or non-invasive imaging techniques.

New cardiovascular events

It documented, including myocardial infarction, stroke, or any revascularization procedures.

Statistical analysis

Descriptive statistics were calculated to determine the mean and standard deviation for continuous variables, and frequencies and percentages for categorical variables. Comparative analysis between the diabetic and control groups was conducted using independent t-tests for continuous variables and Chi-square tests for categorical variables. To identify independent predictors of CAD progression, multivariate logistic regression was performed, taking into account factors such as DM, HbA1c levels, LDL cholesterol, and CRP levels.

Ethical considerations

The study was approved by the Institutional Ethics Committee (GMCM/IEC/2022/08) of Government Medical College, Mahmudabad. Informed consent was obtained from all participants. All data were anonymized to maintain participant confidentiality.

RESULTS

Demographic and clinical characteristics

The study comprised 100 participants, divided into two groups of 50 each: One with DM and a control group without DM. Table 1 presents the demographic and clinical characteristics of both groups. The mean age of the diabetic group was 58.4±10.2 years, slightly higher than the control group's 56.8±9.5 years (P=0.34). Gender distribution was comparable between the groups (30 males and 20 females in the diabetic group vs. 32 males and 18 females in the control group, P=0.68). The BMI was significantly higher in the diabetic group (29.1±4.6 kg/m²) compared to the control group (26.5±3.9 kg/m², P=0.01).

Baseline characteristics of CAD

Baseline characteristics related to CAD are summarized in Table 2. The prevalence of CAD was significantly higher in the diabetic group (80%) compared to the control group (60%, P=0.03). In addition, the mean number of affected vessels was higher in the diabetic group (2.3±0.9) compared to the control group (1.7±0.8, P=0.002) (Figure 1).

Progression of CAD

The progression of CAD over a mean follow-up period of 2 years is detailed in Table 3. The progression rate of CAD was significantly higher in the diabetic group, with 56% showing disease progression compared to 30% in the control group (P=0.01). Furthermore, 24% of diabetic patients experienced new cardiovascular events during the follow-up period, compared to 12% in the control group (P=0.08) (Figure 2).

Risk factors and biomarkers

Risk factors and biomarkers relevant to the study are presented in Table 4. The diabetic group had a mean HbA1c level of 8.2%±1.1, indicative of poor glycemic control, compared to the control group's 5.6%±0.7 (P<0.001). LDL cholesterol levels were significantly higher in the diabetic group (130.4±25.6 mg/dL) compared to the control group (115.8±22.3 mg/dL, P=0.04). Similarly, the mean CRP level, an inflammatory marker, was significantly elevated in the diabetic group (3.2±1.4 mg/L) compared to the control group (1.8±1.0 mg/L, P=0.001) (Figure 3).

Table 1: Demographic and clinical characteristics

Characteristic	Diabetic group (n=50)	Control group (n=50)	P-value
Age (years)	58.4±10.2	56.8±9.5	0.34
Gender (M/F)	30/20	32/18	0.68
BMI (kg/m²)	29.1±4.6	26.5 ± 3.9	0.01

BMI: Body mass index

Table 2: Baseline characteristics of coronary artery disease (CAD)

Characteristic	Diabetic group (n=50)	Control group (n=50)	P-value
Prevalence of CAD (%)	80	60	0.03
Number of affected vessels	2.3±0.9	1.7±0.8	0.002

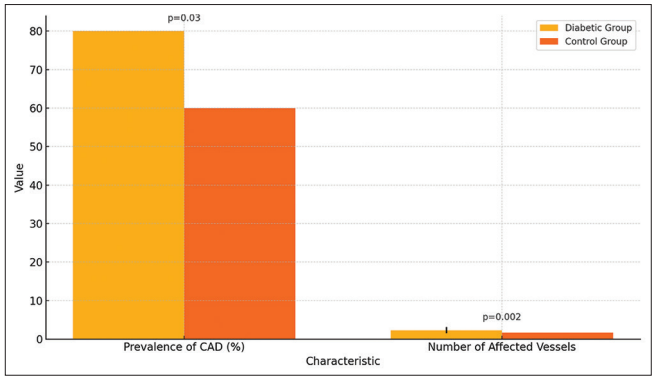

Figure 1: Baseline characteristics of coronary artery disease

Multivariate logistic regression analysis

Multivariate logistic regression analysis (Table 5) identified DM as an independent predictor of CAD progression (OR=2.9, 95% CI=1.4–5.8, P=0.003). Elevated HbA1c levels and higher LDL cholesterol were also significant predictors of CAD progression (P<0.05).

DISCUSSION

This observational study investigated the impact of DM on the progression of CAD over a 2-year period. The study included 100 participants, divided into a diabetic group and a control group, and yielded several significant findings:

Table 3: Progression of coronary artery disease

Characteristic	Diabetic group (n=50)	Control group (n=50)	P-value
Follow-up period (years)	2	2	-
Progression rate (%)	56	30	0.01
New cardiovascular events (%)	24	12	0.08

Table 4: Risk factors and biomarkers

Characteristic	Diabetic group (n=50)	Control group (n=50)	P-value
HbA1c levels (%)	8.2±1.1	5.6±0.7	<0.001
LDL cholesterol (mg/dL)	130.4±25.6	115.8±22.3	0.04
C-reactive protein (CRP) (mg/L)	3.2±1.4	1.8±1.0	0.001

HbA1c: Hemoglobin A1c, LDL: Low-density lipoprotein

Table 5: Multivariate logistic regression analysis

Predictor	Odds ratio	95% Confidence interval	P-value
Diabetes mellitus	2.9	1.4–5.8	0.003
HbA1c levels	1.5	1.1–2.1	0.02
LDL cholesterol	1.2	1.0–1.5	0.04

HbA1c: Hemoglobin A1c, LDL: Low-density lipoprotein

Higher CAD progression in diabetics

The diabetic group exhibited a substantially higher rate of CAD progression (56%) compared to the non-diabetic controls (30%). This underscores the aggressive nature of CAD in diabetic patients (Chen et al.,[8] 2023; Alemayehu et al.,[9] 2023).

Increased cardiovascular events

Diabetic patients experienced a higher, though not statistically significant, rate of new cardiovascular events (24%) compared to controls (12%). This trend suggests that diabetic individuals are more prone to adverse cardiovascular outcomes (Abu Tailakh et al.,[10] 2021; Khan et al.,[11] 2023).

Elevated risk factors

Diabetic patients had higher levels of HbA1c, LDL cholesterol, and CRP, which are indicative of poor glycemic control, elevated lipid levels, and increased systemic inflammation, respectively (Jarab et al.,[12] 2023; Schäfer et al.,[13] 2024).

Independent predictors of CAD progression

Multivariate logistic regression analysis identified DM as an independent predictor of CAD progression. Elevated HbA1c and LDL cholesterol levels were also significant predictors, highlighting their role in disease advancement (Chen et al.,[8] 2023).

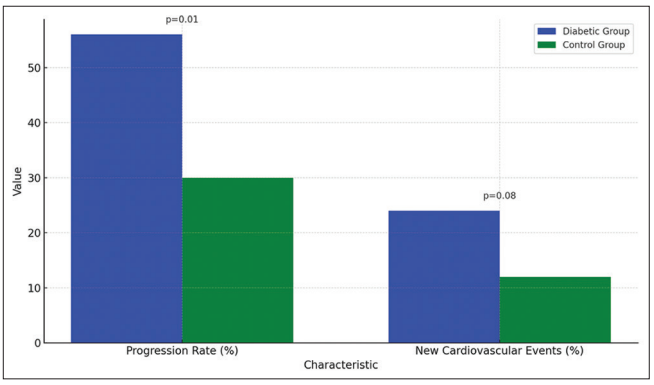

Figure 2: Progression of coronary artery disease

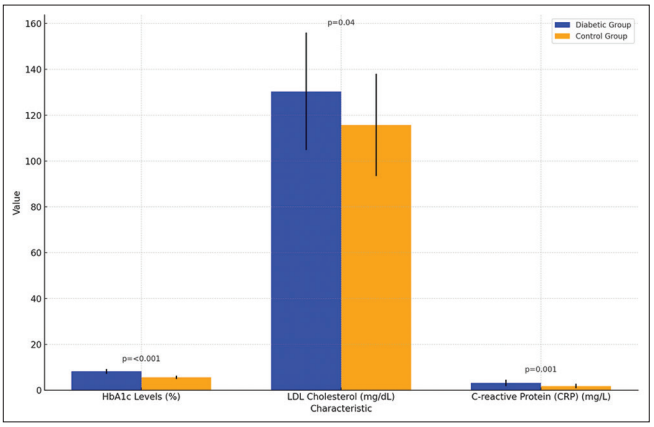

Figure 3: Risk factors and biomarkers

The findings of this study underscore the significant impact of DM on the progression of CAD, reinforcing the well-documented relationship between these two conditions. Diabetic patients are at greater risk of accelerated atherosclerosis due to multiple pathophysiological mechanisms, including chronic hyperglycemia, endothelial dysfunction, and persistent inflammation. These factors contribute to the rapid progression of atherosclerotic plaques, increasing the likelihood of cardiovascular events.

The significantly higher rate of CAD progression in diabetic patients can be attributed to chronic hyperglycemia, which promotes the formation of advanced glycation end-products (AGEs). AGEs modify the function of various proteins, leading to endothelial dysfunction and increased vascular permeability. Furthermore, hyperglycemia induces oxidative stress, exacerbating vascular inflammation and contributing to the destabilization of atherosclerotic plaques (Mohamad et al.,[14] 2023).

Clinical implications

The significantly higher rates of CAD progression and cardiovascular events among diabetic patients underscore the need for aggressive management of risk factors

such as blood glucose, lipid levels, and inflammation. This necessitates interventions that include lifestyle modifications, pharmacotherapy, and regular monitoring. Healthcare providers should develop personalized treatment plans for diabetic patients, considering their elevated risk for CAD progression, which involves frequent assessments and tailored interventions to manage diabetes and associated cardiovascular risk factors. In addition, early detection of CAD in diabetic patients through routine screening and imaging can facilitate timely interventions, potentially slowing disease progression and improving outcomes.

Limitations of the study

The relatively small sample size may limit the generalizability of the findings. Larger studies are needed to confirm these results. Conducted at a single medical college, the findings may not be applicable to broader populations with different demographics and healthcare settings. Although multivariate analysis was performed, unmeasured confounding factors may still influence the results.

CONCLUSION

This study highlights the substantial impact of DM on the progression of CAD, underscoring the need for vigilant risk factor management in diabetic patients. Elevated HbA1c, LDL cholesterol, and CRP levels were significant predictors of CAD progression, emphasizing the importance of comprehensive care strategies. By addressing these risk factors through personalized treatment plans and early interventions, healthcare providers can improve cardiovascular outcomes for diabetic patients, ultimately reducing the burden of CAD in this vulnerable population.

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Authors Contribution:
YR- Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript; **PS-** Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript, revision of manuscript; **SG-** Review of literature and preparing first draft of manuscript. Statistical analysis and interpretation. Revision of manuscript.

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