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Coronary Angiographic Features in Diabetic versus Non-diabetic Acute Coronary Syndrome Patients

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ABSTRACT

Introduction: Cardiovascular disease is the most common cause of morbidity and mortality in patients with diabetes mellitus, and acute coronary syndrome is more frequent and severe in patients with diabetes. **Objectives:** This study aimed to compare the angiographic characteristics of diabetic and non-diabetic patients with acute coronary syndrome to gain better insight into the severity of coronary artery disease and comorbidities in both groups. **Methods:** This retrospective study at the Aster CMI Hospital, Bangalore, included adults (≥18 years) with ACS who underwent coronary angiography. Patients were divided into diabetic and non-diabetic cohorts (68 each) and matched for age, sex, and key comorbidities, excluding those with pre-existing cardiac conditions. Data on demographics, comorbidities, RBS, clinical presentation, and in-hospital outcomes were collected. Coronary lesions were classified as SVD, DVD, TVD, or diffuse, with ≥50% stenosis considered to be significant. Statistical analyses were performed using Student's t-test and multivariable logistic regression, with P<0.05 deemed significant. **Results:** The diabetic population had a higher prevalence of comorbidities (P < 0.01), hypertension, chronic kidney disease, and malignancy. CAG positivity (≥50% stenosis) was found in 82.4% of patients with diabetes and 69.1% of patients without diabetes (P = 0.11). The average blood sugar level was higher in diabetics with positive CAG results, but the difference was not statistically significant. Double-vessel disease was the most common disease in both the groups, with no significant difference between them. **Conclusion:** Patients with Diabetic ACS exhibit a higher comorbidity burden and trends toward more extensive coronary disease. Vigilant diagnostic evaluation, early screening, and individualised management are crucial, particularly given the risk of atypical presentation. Larger prospective multicentre studies including biomarkers, such as HbA1c, are warranted to clarify the impact of diabetes on CAD severity.

KEYWORDS: Acute Coronary Syndrome, Coronary Angiography, Diabetes Mellitus

INTRODUCTION

Cardiovascular disease continues to be the most common cause of morbidity and mortality in patients with type 2 diabetes mellitus (T2DM).[1] Acute coronary syndrome (ACS), including unstable angina, non-ST-elevation myocardial infarction (NSTEMI), and ST-elevation myocardial infarction (STEMI), is significantly more common among diabetic patients who tend to have more severe and widespread coronary artery disease (CAD).[2, 3] Diabetes causes atherosclerosis through several mechanisms including endothelial dysfunction, chronic inflammation, insulin resistance, and lipid derangement.[4, 5] These pathophysiological processes cause an increase in the burden of multivessel and diffuse coronary disease in diabetic patients compared to non-diabetic patients.

A compelling body of evidence indicates that diabetic patients with ACS have a less favourable clinical trajectory, exhibiting elevated rates of recurrent myocardial infarction, heart failure, and mortality irrespective of the chosen revascularization approach.[3, 6, 7] Moreover, diabetic patients

often present with atypical or silent forms of ACS, making early diagnosis and timely intervention challenging. [8, 9]

Coronary angiography(CAG) is still the reference standard for diagnosing and evaluating the severity of CAD and plays an important role in directing revascularization decisions in ACS. [10] While the broader literature extensively documents the increased risk and adverse outcomes associated with CAD in diabetic patients, there is a relative paucity of data specifically comparing the detailed angiographic profiles of diabetic and non-diabetic patients presenting with ACS, particularly in diverse regional settings. A study analysing 621 ACS patients in a low socioeconomic cohort in Bengaluru found an in-hospital mortality rate of 3.2%, with 62% having STEMI and 38% having Non-ST Elevation Acute Coronary Syndrome (NSTE-ACS). Morbidity linked to risk factors like hypertension (39%) and diabetes (37.2%), indicating a substantial burden of coronary artery disease in the region. [11] Outside Bangalore, other districts, such as Hassan and Mysuru, have had alarming increases in cardiac-related deaths, especially in the young and middle-aged groups. These regional trends are primarily due to lifestyle changes, such as increased stress, physical inactivity, smoking, unhealthy diets, and traditional risk factors, such as diabetes and hypertension, rather than external triggers, such as COVID-19 vaccination. This evolving epidemiology justifies the need for region-specific studies evaluating coronary angiographic differences in patients with ACS, with and without diabetes, as diabetes is a well-established risk factor that affects coronary artery involvement, lesion complexity, and patient outcomes.

Furthermore, nationwide studies indicate significant heterogeneity in CAD prevalence and risk factors across India, with urban centers like Bangalore exhibiting higher rates of diabetes and hypertension compared to rural areas. [12] This rationale supports the study of Bangalore and the surrounding Karnataka regions, where these metabolic comorbidities significantly affected ACS morphology and management. Adding to this, regional lifestyle and healthcare accessibility factors in South India e.g., dietary habits, cultural practices, and medication adherence may influence the presentation and angiographic features of CAD in diabetic patients. [13, 14] Examining angiographic differences between diabetic and non-diabetic patients with ACS in this population is clinically relevant and can guide specific treatment strategies.

Therefore, this study aimed to compare the clinical and angiographic characteristics of type 2 diabetic and non-diabetic patients with ACS, potentially paving the way for personalised and effective management strategies.

MATERIALS AND METHODS

This retrospective hospital-based study was conducted between January 2022 and December 2023 at the Aster CMI Hospital, Bangalore. Patients of both sexes aged $\geq$18 years who were diagnosed with acute coronary syndrome (ACS) and underwent coronary angiography (CAG) were identified from the hospital records. Two groups, diabetic and non-diabetic patients, were formed and matched by age and sex to minimise confounding factors. Patients with hypertrophic or dilated cardiomyopathy, congenital heart disease, or any known pre-existing cardiac conditions were excluded. The sample size was calculated based on data from Girdhar et al. Using the formula for comparing two proportions with an assumed effect size of 0.2533, significance level (alpha) of 0.05, and power of 90% (beta = 0.10), the standard value (C) was determined to be 10.51.

$$Sample\ Size\ (n) = \frac{p_1\,(1-p_1) + p_2(1-p_2)}{(p_1 - p_2)^2} * C$$

This calculation resulted in a required sample size of 68 patients per group, for a total of 136 patients (68 diabetic and 68 non-diabetic). The confidence interval was set at 95%. [15] While the two groups were comparable in age and sex distribution, other comorbidities such as hypertension and CKD showed baseline differences. To create comparable cohorts, patients were broadly matched for age and sex distribution, which allowed for a fair comparison of coronary angiographic features between the diabetic and non-diabetic groups. However, as strict one-to-one matching for all comorbidities was not feasible in this retrospective design, potential confounding factors, such as hypertension and CKD, were addressed analytically using multivariable logistic regression and subgroup analyses. A sample of 136 patients (68 per group) provided sufficient power (90%) to detect meaningful differences in coronary angiographic features between diabetic and non-diabetic ACS patients, considering the effect size typically found in clinical studies. Ethical clearance was obtained from the Institutional Ethics Committee before data collection. Patient confidentiality was maintained throughout the study period. Appropriate clinical information, such as demographic data; comorbidities, such as hypertension, hypothyroidism, chronic kidney disease (CKD), hepatic failure, and malignancy; random blood sugar (RBS) on admission; clinical presentation; and in-hospital outcomes, were retrieved from patient case files and electronic medical records. Comorbidities were defined using standard clinical criteria. CKD was identified per KDIGO 2012 guidelines as eGFR <60 mL/min/1.73 m^2 for $\geq$3 months or kidney damage (e.g., proteinuria). [16] Hepatic failure was defined by bilirubin >2 mg/dL, INR >1.5, and signs of encephalopathy. [17, 18] Hypothyroidism was diagnosed based on elevated TSH levels with or without low free T4 levels. Malignancy included active or previously diagnosed cancer within five years, and coronary angiograms were assessed by interventional cardiologists. Stenosis $\geq$50% was considered significant as per American College of Cardiology/American Heart Association (ACC/AHA) revascularization guidelines. [19] Disease extent was classified as single-vessel disease (SVD), double-vessel disease (DVD), triple-vessel disease (TVD), or diffuse lesions according to the degree of coronary artery involvement. Data were summarised in Excel and analysed with SPSS version 20 using Student's t-test for continuous variables between the two groups, and a

p-value <0.05 was considered statistically significant.

RESULTS

The age-wise distribution of the patients revealed that in the diabetic group (n = 68), there were two patients (2.9%) in the age group 21-30 years, two patients (2.9%) in the age group 31-40 years, five patients (7.4%) in the age group 41-50 years, eighteen patients (26.5%) in the age group 51-60 years, twenty-six patients (38.2%) in the age group 61-70 years, and fifteen patients (22.1%) in the age group > 70 years. In the non-diabetic population (n = 68), there were three patients (4.4%) in the age group 31-40 years, four patients (5.9%) in the age group 41-50 years, twelve patients (17.6%) in the age group 51-60 years, twenty-two patients (32.4%) in the age group 61-70 years, and twenty-seven patients (39.7%) in the age group >70 years. The mean age of diabetic patients was 63.25 ± 12.41 years and that of non-diabetic patients was 62.78 ± 10.88 years. There was no significant difference in sex distribution between the two groups. Among 68 patients (n = 68), 42 (61.8%) were male and 26 (38.2%) females. Similarly, among the non-diabetic patients (n = 68), 37 (54.4%) were male and 31 (45.6%) were female.

Patients in the diabetic group had a higher rate of comorbid conditions, with hypertension, CKD, hepatic failure, malignancy, and hypothyroidism being more frequent in the diabetic group than in the non-diabetic group. The distribution of comorbidities between the two groups was statistically significant (P < 0.01) (Table 1). In the diabetic group, 56 patients (82.4%) and 47 patients (69.1%) in the non-diabetic group showed positive CAG results, with no statistically significant difference between the two groups (P = 0.11) (Table 2).

Co-morbidities other than diabetes	Diabetic (n = 68)	Non-Diabetic (n = 68)
Hypertension	23 (33.8%)	12 (17.6%)
Hypothyroidism	2 (2.9%	3 (4.4%)
Chronic kidney disease	4 (5.9%	0 (0.0%)
Hepatic failure	3 (4.4%	0 (0.0%)
Malignancy	3 (4.4%	0 (0.0%)
No co-morbidities	33 (48.5%	53 (77.9%)

p value < 0.01 = Significant

Table 1: Distribution of other comorbid conditions

The higher mean RBS levels were noted in the diabetic patients with positive CAG results (114.6 ± 10.78 mg/dl) than in those with negative CAG results (108.9 ± 12.3 mg/dl). In the non-diabetic population, the mean RBS was 98 ± 5.6 mg/dl in patients with positive CAG results and 96 ± 4.5 mg/dl in those with negative CAG results. However, the difference in RBS scores between the groups was not statistically significant (P = 0.14).

CAG Findings	Diabetic (n = 68)	Non-Diabetic (n = 68)
Positive CAG	56 (82.4%)	47 (69.1%)
Negative CAG	12 (17.6%)	21 (30.9%)

Table 2: Distribution of CAG outcome between the two groups

In the diabetic group, 30 (53.57%) patients with positive CAG findings had a higher prevalence of comorbid conditions, such as hypertension, CKD, and malignancy, than non-diabetic patients (11 / 23.45%). The distribution of comorbidities between the two groups was statistically significant (P < 0.01) (Table 3). Double-vessel disease (DVD) was the most frequent angiographic finding in both the diabetic (n=28, 50.0%) and non-diabetic (n=21, 44.7%) groups; however, no correlation was observed between the two groups (Figure 1).

Co-morbidity	Diabetic with Positive CAG (n = 56)	Non-Diabetic with Positive CAG (n = 47)
Hypertension	19 (33.9%)	10 (21.3%)
Hypothyroidism	1 (1.8%)	1 (2.1%)
Chronic kidney disease	4 (7.1%)	0 (0.0%)
Hepatic failure	3 (5.4%)	0 (0.0%)
Malignancy	3 (5.4%)	0 (0.0%)
Total	30 (53.6%)	11 (23.4%)

Table 3: Distribution of comorbidity with CAG positive cases among the two groups

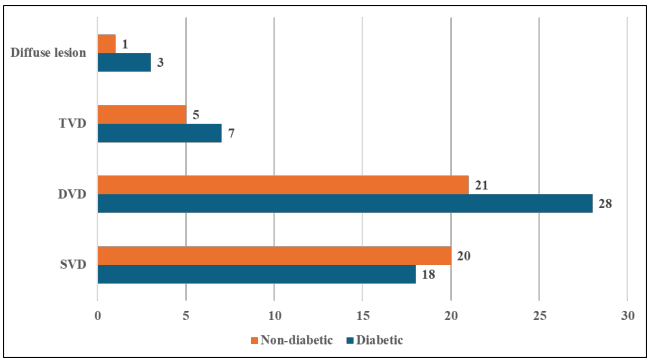

Figure 1: Distribution of vessel involvement between both the groups

DISCUSSION

This study aimed to compare the clinical and angiographic presentations of diabetic and non-diabetic patients with suspected CAD. These results are largely consistent with those of a previous study in support of a higher comorbidity burden and increased CAD extent in patients with diabetes. In this study, diabetic patients had a mean age of 63.25 ± 12.41 years, slightly higher than non-diabetics (62.78 ± 10.88 years), consistent with Gupta et al., who reported mean ages of 61.1 ± 9.6 and 59.7 ± 11.5 years. [20] Similarly, Othende et al. reported the mean diabetic age of 58 ± 8.7 years. [21] The diabetic group was slightly more male-dominated (61.8% vs. 54.4%), but this difference was not statistically significant, consistent with Gupta et al. and Sareddy et al., who also reported a male preponderance without significant gender-related outcome differences. [20, 22] The older age of diabetic patients may reflect longer exposure to cardiovascular risk factors such as hyperglycaemia, dyslipidaemia, and hypertension. Although gender distribution was similar, studies like the Framingham Heart Study indicate that diabetes diminishes the cardioprotective effect in premenopausal females, making gender a less significant factor in diabetic CAD. [23]

The present study found much higher frequency in diabetics than non-diabetics in hypertension (33.8% vs. 17.6%), kidney disease (5.9% vs. 0.0%), hepatic failure (4.4% vs. 0.0%), and malignancy (4.4% vs. 0%) (P < 0.01). Results are also congruent with Gupta et al., who detected a higher occurrence in diabetics of hypertension (71.1% vs. 45.5%) and CKD (3.0% vs. 1.7%). [20] Othende et al. also had hypertension (58.6%) and dyslipidemia (88.0%) in large proportions in ACS patients with diabetes. [21] This clustering of comorbid conditions in diabetics also reflects the systemic nature of diabetes and its pervasive vascular effects. [24, 25] Hypertension and CKD, both have synergistic impacts on cardiovascular outcomes. [26] Endothelial dysfunction, oxidative stress, and chronic inflammation likely contribute to this overlap. Hepatic impairment and malignancy may indicate advanced metabolic disease or treatment-related toxicity, although further studies are required. Positive CAG results were higher in diabetics (82.4%) than non-diabetics (69.1%), though not statistically significant (P = 0.11), consistent with Girdhar et al., who reported 81.3% versus 56%, respectively. [15] Girdhar et al. also detected increased TVD (32.8% vs. 27.1%) and diffuse lesions (9.8% vs. 0.0%) among diabetics. [15] Although not statistically significant, this clinically highlights that diabetes increases obstructive and complex multivessel CAD, often favouring CABG over percutaneous intervention (BARI 2D). [27, 28]

Double-vessel disease was most common in both groups (50.0% diabetic vs. 44.7% non-diabetic), with TVD in 12.5% vs. 10.6%. Mukhopadhyay et al. reported higher vessel involvement and greater prevalence of TVD, diffuse, and left main disease in diabetics, confirming a trend toward more complex CAD. [29] Similarly, Lichumo et al. also identified multivessel disease in 51% of diabetics compared to 23% of non-diabetics. [30] High rates of DVD and TVD in patients with diabetes highlight both macrovascular and possible microvascular diseases, complicating management and prognosis. Diabetics with positive CAG had higher RBS (114.6 ± 10.78 mg/dl vs. 108.9 ± 12.3 mg/dl), though not statistically significant, a trend also noted in non-diabetics. Sareddy et al. and Mukhopadhyay et al. identified poor glycaemic control and longer diabetes duration as key determinants of extensive CAD. [22, 29] Although RBS differences were not significant, long-term glycaemic control (HbA1c) and chronic hyperglycaemia more strongly predict CAD severity by promoting endothelial dysfunction and plaque instability. [31]

Diabetics with positive CAG had significantly higher comorbidities—hypertension (33.9%), CKD (7.1%), hepatic failure (5.4%), and malignancy (5.4%)—compared to non-diabetics, aligning with Gupta et al. and Sareddy et al. on worse outcomes with comorbidity clustering (P < 0.01). [20, 22] Comorbidity clustering in diabetics, including CKD and liver disease, elevates CAD risk, may alter clinical presentation, and necessitates multimodal management. [32] Although not directly measured in this study, a meta-analysis by Tabowei et al. showed that diabetic ACS patients were less likely to report chest pain (OR 0.43, 95% CI 0.30–0.63, P<0.001) and more likely to present with atypical symptoms such as shortness of breath (OR 1.49), neck pain (OR 1.62), and anxiety (OR 2.20). [8] These findings highlight the need for heightened suspicion for ACS in diabetic patients, as silent or atypical myocardial ischemia often due to cardiac autonomic neuropathy can delay diagnosis and worsen outcomes, supporting early non-invasive or angiographic assessment; Gupta et al. also reported higher cardiovascular (HR 2.38, CI 1.13–5.02) and all-cause mortality (HR 1.85, CI 1.06–3.22) in diabetics, confirming their elevated risk. [20]

Previous studies show that diabetic patients have a higher prevalence of severe CAD, including multivessel involvement and greater thrombus burden. [29, 33] Recognizing these distinctions is essential for personalized treatment, as diabetic patients with ACS often present with more complex coronary lesions, and elevated HbA1c levels correlate with greater vessel involvement, underscoring the need for early intervention, close monitoring, and tailored management. [34]

Studies have shown that diabetic individuals are more likely to experience severe forms of CAD, including double and triple vessel disease, which aligns with the present study results regarding CAG positivity rates and disease severity. [35] The present study findings suggest that despite the higher prevalence of comorbidities in diabetic patients, the rates of CAG positivity indicate a significant burden of CAD that necessitates timely and effective management strategies for this vulnerable population. [35] These findings emphasize early detection and tailored interventions in diabetic patients, as their higher incidence of complex CAD lesions may limit the effectiveness of standard treatments. [35] The present study underscores the need for clin-

icians to address the unique challenges in ACS patients with diabetes by implementing individualised treatment plans for their higher risk of severe CAD.

LIMITATIONS

This single-centre, retrospective, cross-sectional study with a limited sample size restricts generalisability and may introduce selection bias because patients undergoing angiography may not represent the broader CAD population. Baseline imbalances, such as differences in age, comorbidities, and disease severity, could have influenced outcomes. Missing data on diabetes duration, HbA1c level, and treatment strategies further limit the assessment of glycaemic control, chronicity, and management impact. These factors highlight the need for future prospective studies with larger, more representative populations, and comprehensive metabolic and treatment data.

CONCLUSION

In this study, patients with diabetes had a higher prevalence of comorbidities than those without diabetes. While double-vessel disease was the most frequent finding in both groups and triple-vessel disease rates were numerically higher in patients with diabetes, these differences did not reach statistical significance. Similarly, the overall CAG positivity rate was higher in patients with diabetes, but the difference was not statistically significant. These findings highlight trends toward greater coronary artery involvement in patients with diabetes, although definitive conclusions regarding severity should be drawn cautiously. Given the established cardiovascular risk in diabetes, vigilant diagnostic evaluation and timely management are important, especially considering the possibility of atypical presentations. Individualised strategies and early screening may help optimise the outcomes. Future prospective, multicentre studies with larger and more diverse populations, longer follow-up, and inclusion of additional biomarkers (e.g., HbA1c and inflammatory markers) are warranted to further clarify the relationship between diabetes and CAD severity.

DISCLOSURES

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