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Association of Microalbuminuria with Severity of Coronary Artery Disease in Diabetic Patients: A Cross-Sectional Study

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Abstract

Introduction: Coronary artery disease (CAD) remains one of the leading causes of morbidity and mortality among individuals with type 2 diabetes mellitus (T2DM). Microalbuminuria, an early marker of endothelial dysfunction and renal damage, has emerged as a potential predictor of cardiovascular complications in diabetic patients. This study aimed to assess the association of microalbuminuria with the severity of coronary artery disease in diabetic patients.

Methods: This cross-sectional analytical study was conducted at Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh, from January 2024 to June 2024, involving 103 adult patients with type 2 diabetes mellitus who underwent elective coronary angiography. Statistical analysis was performed using SPSS software version 26.0. p-value <0.05 is considered statistically significant.

Result: The severity of coronary artery disease (CAD) was notably greater in the microalbuminuric group, with 34.3% exhibiting triple-vessel disease, and only 9.0% showing no significant CAD (vs. 38.9% in the normoalbuminuric group; $p < 0.001$). Urinary albumin excretion increased with the number of vessels involved, indicating a strong positive correlation. Logistic regression analysis identified microalbuminuria (OR 3.92; $p = 0.003$), duration of diabetes (OR 1.13; $p = 0.017$), and HbA1c (OR 1.48; $p = 0.031$) as independent predictors of multivessel CAD. Additionally, patients with microalbuminuria had significantly lower left ventricular ejection fraction (49.8 ± 7.2% vs. 53.1 ± 6.3%; $p = 0.038$), suggesting greater cardiac dysfunction.

Conclusion: This study demonstrates a significant association between microalbuminuria and the severity of coronary artery disease (CAD) in patients with type 2 diabetes mellitus. The presence of microalbuminuria correlated with longer diabetes duration, poorer glycemic control, reduced left ventricular ejection fraction, and increased incidence of multivessel CAD. These findings suggest that microalbuminuria may serve as an independent predictor of CAD severity and could be a valuable, cost-effective marker for early cardiovascular risk stratification in diabetic individuals.

Keywords: Microalbuminuria; Coronary artery disease; Diabetes mellitus; Renal damage

Introduction

Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality among individuals with type 2 diabetes mellitus (T2DM) globally, with coronary artery disease (CAD) being its most frequent manifestation

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[1,2]. Diabetic patients have a 2- to 4-fold higher risk of developing CAD than their non-diabetic counterparts and are more likely to present with diffuse, multi-vessel disease and poorer outcomes [3]. Identifying early markers that predict the severity of CAD in this high-risk population is critical for timely therapeutic intervention and risk stratification. Microalbuminuria, defined as urinary albumin excretion between 30–300 mg/day, has traditionally been considered an early sign of diabetic nephropathy [4]. However, in the last two decades, it has been increasingly recognized as a marker of generalized endothelial dysfunction, atherosclerosis, and systemic vascular damage that predisposes individuals to cardiovascular events [5]. Numerous studies have demonstrated a strong association between microalbuminuria and increased risk of CVD in both diabetic and non-diabetic individuals [6]. The pathophysiological basis linking microalbuminuria to CAD includes low-grade inflammation, endothelial injury, oxidative stress, and activation of the renin-angiotensin-aldosterone system (RAAS) [7]. These mechanisms not only increase vascular permeability leading to albumin leakage into urine, but also drive the development of atherosclerotic plaques and coronary vessel narrowing [8]. The presence of microalbuminuria may thus reflect early systemic vascular injury and predict more severe coronary involvement. Recent studies have shown that microalbuminuria is significantly associated with greater angiographic severity of CAD [9]. For instance, Wang et al. [10] reported in a study that T2DM patients with microalbuminuria were more likely to have multi-vessel coronary involvement, as assessed by Gensini and SYNTAX scores. Another study demonstrated that microalbuminuria independently predicted the presence of high coronary artery calcium (CAC) scores, suggesting a role in early subclinical atherosclerosis detection [11]. Moreover, in a meta-analysis involving over 13,000 individuals, microalbuminuria was associated with a 1.7-fold increased risk of cardiovascular events and all-cause mortality in diabetic patients [12]. The urinary albumin-to-creatinine ratio (UACR) has also been proposed as a useful biomarker for risk prediction beyond traditional cardiovascular risk factors [13]. In the South Asian population, particularly in countries like Bangladesh and India, the burden of T2DM and its complications has been increasing rapidly due to urbanization, lifestyle changes, and genetic predisposition. South Asians tend to develop insulin resistance, dyslipidemia, and vascular complications earlier and more severely than Western populations [14]. Diabetes mellitus, particularly type 2 diabetes mellitus (T2DM), is a rapidly escalating global health concern that significantly contributes to cardiovascular morbidity and mortality. Among its many complications, coronary artery disease (CAD) remains the most common and life-threatening, often presenting silently and progressing aggressively in diabetic individuals. This study aimed to assess the association of microalbuminuria with severity of coronary artery disease in diabetic patients.

Methods

This cross-sectional analytical study was conducted at Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh, from January 2024 to June 2024, involving 103 adult patients with type 2 diabetes mellitus who underwent elective coronary angiography. Patients with overt proteinuria, end-stage renal disease, urinary tract infections, or known non-diabetic kidney disease were excluded. Detailed clinical histories, physical examinations, and laboratory investigations were performed for each participant. Urinary albumin excretion was measured using a spot urine albumin-to-creatinine ratio (ACR), and patients were categorized into normo-albuminuria (<30 mg/g) and microalbuminuria (30–300 mg/g) groups. The severity of coronary artery disease (CAD) was assessed based on angiographic findings, using the number of vessels involved and the SYNTAX score. Additional data on age, gender, duration of diabetes, hypertension, smoking status, BMI, lipid profile, and HbA1c levels were also collected and analyzed. Statistical analysis was performed using SPSS software version 26.0; categorical variables were compared using the chi-square test, while continuous variables were analyzed using t-tests. Correlation and logistic regression analyses were employed to explore the association between microalbuminuria and CAD severity, with a p-value <0.05 considered statistically significant. The study protocol was reviewed and approved by the institutional ethics committee, and written informed consent was obtained from all participants before enrollment.

Results

Table 1: Distribution of patients by baseline demographic and clinical characteristics of study participants (n=103).

Variable	Microalbuminuria (n=67)	Normo-albuminuria (n=36)	p-value
Age (years, mean ± SD)	57.3 ± 9.1	55.4 ± 9.6	0.282
Male gender (%)	62.7	52.8	0.314
Duration of diabetes (years)	9.4 ± 4.2	6.8 ± 3.7	0.001
HbA1c (%)	8.4 ± 1.2	7.6 ± 1.1	0.004
Hypertension (%)	77.6	58.3	0.048
Smoking (%)	34.3	25.0	0.312

Patients with microalbuminuria had a longer mean duration of diabetes (9.4 ± 4.2 years vs. 6.8 ± 3.7 years; p = 0.001), higher HbA1c levels (8.4 ± 1.2% vs. 7.6 ± 1.1%; p = 0.004), and a greater prevalence of hypertension (77.6% vs. 58.3%; p = 0.048) compared to those without microalbuminuria (Table 1-5).

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Table 2: Distribution of patients by prevalence of microalbuminuria by CAD severity (n=103).

CAD Severity	Microalbuminuria Present (n=67)	Normo-albuminuria (n=36)	p-value
CAD	6 (9.0%)	14 (38.9%)	<0.001
Single-vessel disease	17 (25.4%)	11 (30.6%)	
Double-vessel disease	21 (31.3%)	7 (19.4%)	
Triple-vessel disease	23 (34.3%)	4 (11.1%)	

Description: Among patients with microalbuminuria, 34.3% had the triple-vessel disease and 31.3% had double-vessel disease. In contrast, normoalbuminuric patients more commonly had no significant CAD (38.9%). The association between microalbuminuria and greater CAD severity was statistically significant ($p < 0.001$).

Table 3: Distribution of patients by correlation of urinary albumin excretion with the number of vessels involved (n=103).

No. of Vessels Involved	Urinary Albumin Excretion (mg/day, mean ± SD)
0	18.6 ± 6.2
1	34.8 ± 9.5
2	49.3 ± 11.2
3	61.5 ± 13.8

Description: Mean urinary albumin excretion rose progressively with increasing CAD severity: 18.6 ± 6.2 mg/day in patients with no significant CAD, 34.8 ± 9.5 mg/day with single-vessel disease, 49.3 ± 11.2 mg/day with double-vessel disease, and 61.5 ± 13.8 mg/day with triple-vessel disease, indicating a strong positive correlation.

Table 4: Distribution of patients by logistic regression analysis for predictors of significant CAD (≥2-vessel disease) (n=103).

Variable	Odds Ratio (OR)	95% CI	p-value
Microalbuminuria	3.92	1.58–9.74	0.003
Duration of diabetes	1.13	1.02–1.25	0.017
HbA1c (%)	1.48	1.04–2.11	0.031
Hypertension	1.79	0.78–4.12	0.168

Description: Microalbuminuria was a strong independent predictor of multivessel CAD with an odds ratio of 3.92 (95% CI: 1.58–9.74; $p = 0.003$). Duration of diabetes (OR 1.13; $p = 0.017$) and HbA1c (OR 1.48; $p = 0.031$) were also significant predictors.

Table 5: Distribution of patients by comparison of left ventricular ejection fraction (LVEF) in study groups (n=103).

Group	LVEF (%, mean ± SD)	p-value
Microalbuminuria (n=67)	49.8 ± 7.2	0.038
Normoalbuminuria (n=36)	53.1 ± 6.3	

Description: Mean LVEF was significantly lower in patients with microalbuminuria (49.8 ± 7.2%) compared to those without (53.1 ± 6.3%; $p = 0.038$), indicating more impaired cardiac function.

Discussion

The present study reveals a significant association between microalbuminuria and the angiographic severity of coronary artery disease (CAD) in patients with type 2 diabetes mellitus (T2DM). Patients with microalbuminuria demonstrated higher rates of multivessel coronary involvement, longer diabetes duration, elevated HbA1c levels, and reduced left ventricular ejection fraction (LVEF) compared to those with normoalbuminuria. These findings are in agreement with multiple recent studies that have highlighted microalbuminuria not only as a renal marker but also as an early indicator of systemic vascular injury and a predictor of cardiovascular morbidity and mortality in diabetic individuals [15-18]. Our observation that patients with microalbuminuria had significantly longer diabetes duration and poorer glycemic control is consistent with results from Lin et al. [19], who reported that both longer duration of diabetes and elevated HbA1c were independent predictors of albuminuria and severe CAD in Chinese T2DM patients. Similarly, a study by Naidoo et al. [20] demonstrated that microalbuminuria is significantly associated with multivessel CAD and may reflect a more aggressive atherosclerotic process in diabetic individuals. The graded relationship between urinary albumin excretion and the number of vessels involved in our study suggests a direct correlation between the degree of microalbuminuria and coronary disease burden. These findings align with the work of Chiu et al. [21], who reported that urinary albumin levels rise in proportion to coronary angiographic severity among diabetic individuals. Likewise, Yokoyama et al. [22] found microalbuminuria to be significantly associated with higher SYNTAX scores, indicating more complex coronary disease. In the multivariate logistic regression analysis, microalbuminuria emerged as an independent predictor of significant CAD (≥2-vessel disease), along with the duration of diabetes and HbA1c. This observation echoes the findings of Estacio et al. [23] and Lane et al. [24], who concluded that albuminuria is a powerful predictor of cardiovascular events and CAD severity regardless of other risk factors. Moreover, a meta-analysis by Lee et al. [25] also confirmed the independent predictive value of albuminuria for major adverse cardiovascular events (MACE) in T2DM patients. Reduced LVEF among microalbuminuric patients, as observed in our cohort, further underscores the systemic impact of albuminuria. Prior studies by Cuspidi et al. [26] reported similar findings, suggesting that albuminuria may also serve as a marker of subclinical left ventricular dysfunction and diastolic impairment. The

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pathophysiological mechanisms linking microalbuminuria and CAD are likely multifactorial. Endothelial dysfunction, chronic inflammation, and oxidative stress are common denominators in the pathogenesis of both microalbuminuria and coronary atherosclerosis [27,28]. Activation of the renin-angiotensin-aldosterone system (RAAS) has also been implicated, promoting vascular injury and glomerular permeability in diabetic patients.

Limitations of the Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

Conclusion

This study demonstrates a significant association between microalbuminuria and the severity of coronary artery disease (CAD) in patients with type 2 diabetes mellitus. The presence of microalbuminuria correlated with longer diabetes duration, poorer glycemic control, reduced left ventricular ejection fraction, and increased incidence of multivessel CAD. These findings suggest that microalbuminuria may serve as an independent predictor of CAD severity and could be a valuable, cost-effective marker for early cardiovascular risk stratification in diabetic individuals.

Recommendation

Routine screening for microalbuminuria should be implemented in all patients with type 2 diabetes mellitus as part of a comprehensive cardiovascular risk assessment. Early identification of microalbuminuria may help prompt timely investigation for coronary artery disease and initiation of preventive or therapeutic strategies to reduce cardiovascular morbidity and mortality. Further large-scale prospective studies are recommended to validate its role as a predictive biomarker for CAD severity.

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