CORRELATION OF MICROALBUMINURIA ON THE SEVERITY OF CORONARY ARTERY DISEASE AMONG DIABETIC PATIENTS

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ABSTRACT

Background: Cardiovascular disease is the primary cause of illness and death in those with diabetes mellitus. Microalbuminuria has emerged as a prominent and early predictor of endothelial dysfunction and systemic vascular injury among the numerous markers used to predict cardiovascular risk in this population.

Aim: To assess the correlation between microalbuminuria and the severity of coronary artery disease in patients with type 2 diabetes mellitus.

Methods: This observational, cross-sectional study was carried out over five months, from March 2025 to July 2025, in the cardiology department at Government Sivagangai Medical College, Tamilnadu, India. A total of 125 individuals with type 2 diabetes mellitus, who had coronary angiography to assess suspected or confirmed ischemic heart disease, were included. Individuals with established chronic kidney disease (CKD stage 3 or above), urinary tract infections, or significant proteinuria were excluded. Microalbuminuria was evaluated by the spot urine albumin-to-creatinine ratio (ACR), and individuals were divided into two groups: Group A - Normoalbuminuria (ACR < 30 mg/g) and Group B - Microalbuminuria (ACR 30–300 mg/g) The severity of coronary artery disease (CAD) was assessed using coronary angiographic findings and quantified with the SYNTAX score. Information on demographics, diabetes duration, HbA1c levels, blood pressure, lipid profile, and body mass index (BMI) were documented and examined.

Results: Among the 125 patients, 73 (58.4%) exhibited microalbuminuria. The average SYNTAX score in individuals with microalbuminuria was markedly elevated in comparison to those with normoalbuminuria (23.1 ± 7.4 vs. 14.6 ± 5.8, $p < 0.001$). A positive connection ($r = 0.61$, $p < 0.01$) was identified between urine ACR and SYNTAX scores. Additionally, patients in Group B exhibited a prolonged duration of diabetes, elevated HbA1c levels, and increased average systolic blood pressure.

Conclusion: Microalbuminuria is markedly correlated with heightened severity of CAD in individuals with type 2 diabetes mellitus. Microalbuminuria, being a non-invasive and readily accessible biomarker, can function as an early signal for cardiovascular risk assessment in diabetes patients. Timely identification and intervention may mitigate cardiovascular morbidity in this high-risk demographic.

Keywords: Albumin-to-Creatinine Ratio, Coronary Artery Disease, Microalbuminuria, Type 2 Diabetes Mellitus, SYNTAX Score.

INTRODUCTION

Diabetes mellitus, especially type 2 diabetes, has become a worldwide health issue characterized by rising prevalence and considerable morbidity and mortality.[1]

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The International Diabetes Federation reports that over 530 million individuals globally are affected by diabetes, a number anticipated to increase significantly in the forthcoming decades.[2] Cardiovascular disease, particularly coronary artery disease (CAD), is one of the most severe and life-threatening consequences of diabetes, responsible for over fifty percent of fatalities among diabetic persons. The early identification of people at elevated cardiovascular risk is a crucial aspect of diabetes care.[3]

The pathophysiological processes connecting diabetes and CAD are intricate and multifaceted,

encompassing chronic hyperglycemia, insulin resistance, dyslipidemia, oxidative stress, and endothelial dysfunction.[4] Microalbuminuria has emerged as a prominent biomarker for evaluating cardiovascular risk because to its simplicity, non-invasiveness, and cost-effectiveness in predicting systemic vascular damage.[5]

Microalbuminuria is characterized by urine albumin excretion ranging from 30 to 300 mg/g of creatinine and frequently precedes overt diabetic nephropathy. It indicates initial glomerular damage and is regarded as a proxy indication for widespread endothelial dysfunction.[6] This dysfunction contributes to renal impairment and the advancement of atherosclerosis in significant vascular regions, including the coronary arteries. The presence of microalbuminuria may signify an increased risk of future cardiovascular events, despite the lack of clinically evident nephropathy.[7] Numerous epidemiological studies have established a correlation between microalbuminuria and heightened cardiovascular risk, encompassing myocardial infarction, stroke, and heart failure.

In diabetic patients, microalbuminuria signifies renal impairment and may also signify subclinical atherosclerosis and microvascular inflammation, which exacerbate the course and severity of CAD.[8] Despite this apparent correlation, the degree to which microalbuminuria correlates with the structural severity of CAD as evaluated by coronary angiography remains little investigated in numerous clinical environments, particularly in low- and middle-income nations.[9]

Coronary angiography continues to be the definitive method for identifying CAD and evaluating its severity. The SYNTAX score, based on angiographic data, is a validated metric that measures the complexity and severity of coronary lesions. It offers a thorough evaluation of CAD severity and is extensively utilized in clinical decision-making. Linking microalbuminuria with SYNTAX scores may provide significant insight into the systemic effects of microvascular alterations and enhance cardiovascular risk stratification in diabetic patients.[10,11]

Considering the significant prevalence of diabetes and CAD, especially within South Asian communities where these disorders typically emerge sooner and with greater severity, there is an urgent necessity to ascertain dependable indicators of CAD severity. Through the establishment of this link, we aim to enhance the efficacy of microalbuminuria as a predictive marker, consequently advocating for its incorporation into cardiovascular risk assessment methods for diabetic populations.

AIMS AND OBJECTIVES

- To assess the correlation between microalbuminuria and the severity of coronary artery disease in patients with type 2 diabetes mellitus.

MATERIALS AND METHODS

This cross-sectional observational study was conducted over five months, from March 2025 to July 2025, at the Department of Cardiology at Govt. Sivagangai Medical College, Sivagangai. A total of 125 individuals with type 2 diabetes were included in the study. Patients were assessed according to clinical suspicion or established history of ischemic heart disease and were arranged for diagnostic coronary angiography. Eligible participants were chosen via successive sampling.

Inclusion criteria comprised adults aged 35 to 75 years with a confirmed diagnosis of type 2 diabetes mellitus for a minimum of one year, who were undergoing elective coronary angiography to assess stable angina, abnormal stress test outcomes, or atypical chest pain indicative of ischemic heart disease. Only patients exhibiting stable clinical circumstances and intact renal function were considered to eliminate confounding variables that could affect the urinary albumin excretion rate.

Individuals with established chronic kidney disease stage 3 or greater (estimated glomerular filtration rate < 60 mL/min/1.73 m²), significant proteinuria (urine albumin > 300 mg/g creatinine), acute or chronic urinary tract infections, recent febrile episodes, systemic infections, or inflammatory and autoimmune disorders were excluded. Furthermore, individuals who commenced angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin receptor blockers (ARBs) within the preceding three months were excluded due to the established effect of these medications on urine albumin excretion.

Clinical and demographic data were gathered by a standardized questionnaire and a review of medical records. This encompassed age, sex, length of diabetes, hypertension status, smoking history, body mass index (BMI), familial history of cardiovascular disease, and medication usage. Blood pressure and anthropometric data were documented during the clinical appointment.

Venous blood specimens were obtained for laboratory analyses, including fasting blood glucose, HbA1c, serum creatinine, and lipid profile. Microalbuminuria was assessed by the spot Urine albumin-to-creatinine ratio (ACR) obtained from a first-morning midstream urine specimen. Patients were subsequently classified into two groups according to their ACR values: normoalbuminuria (ACR < 30 mg/g) and microalbuminuria (ACR 30–300 mg/g).

All enrolled patients later underwent coronary angiography utilizing standard procedures through radial or femoral artery access. Two seasoned interventional cardiologists independently assessed the angiograms without knowledge of the patients' ACR status. The severity of CAD was evaluated

utilizing the SYNTAX grading system, which considers lesion complexity, location, and the extent of stenosis.

All gathered data were inputted into a database and analyzed utilizing SPSS version 25.0. Continuous variables were presented as mean ± standard deviation (SD), and group comparisons were conducted using independent t-tests or Mann-Whitney U-tests, contingent upon data distribution. Categorical variables were analyzed using chi-square or Fisher's exact tests. A p-value less than 0.05 was considered statistically significant.

OBSERVATION AND RESULTS

A total of 125 patients with type 2 diabetes mellitus scheduled for coronary angiography were enrolled in this study. Based on the urine albumin-to-creatinine ratio (ACR), patients were divided into two groups: Group A (normoalbuminuria, ACR < 30 mg/g) with 52 patients (41.6%) and Group B (microalbuminuria, ACR 30–300 mg/g) with 73 patients (58.4%).

Patients with microalbuminuria were older, had a longer duration of diabetes, higher HbA1c levels, and higher systolic blood pressure compared to normoalbuminuric patients, suggesting worse metabolic and cardiovascular risk profiles.

Table 1: Baseline Demographic and Clinical Characteristics

Parameter	Group A (n=52)	Group B (n=73)	p-value
Age (years)	56.2 ± 8.1	58.7 ± 7.5	0.048 *
Male, n (%)	34 (65.4%)	49 (67.1%)	0.84
Duration of diabetes (years)	6.2 ± 3.1	9.1 ± 4.5	<0.001 *
HbA1c (%)	7.2 ± 0.9	8.1 ± 1.1	<0.001 *
Systolic BP (mmHg)	128 ± 12	138 ± 14	<0.001 *
Diastolic BP (mmHg)	82 ± 9	85 ± 10	0.072
BMI (kg/m²)	26.4 ± 3.2	27.1 ± 3.5	0.21
LDL Cholesterol (mg/dL)	98.5 ± 21.3	104.7 ± 25.6	0.09
Smoking history, n (%)	18 (34.6%)	29 (39.7%)	0.56
Hypertension, n (%)	21 (40.4%)	39 (53.4%)	0.15

* Statistically significant at $p < 0.05$

Microalbuminuric patients had significantly higher triglycerides and lower HDL cholesterol, indicating a more atherogenic lipid profile compared to normoalbuminuric patients.

Table 2: Comparison of Biochemical Parameters

Parameter	Group A (n=52)	Group B (n=73)	p-value
Serum Creatinine (mg/dL)	0.89 ± 0.12	0.92 ± 0.15	0.18
Estimated GFR (mL/min/1.73m²)	92.4 ± 10.3	88.9 ± 12.7	0.06
Total Cholesterol (mg/dL)	178.5 ± 32.4	185.7 ± 38.9	0.29
Triglycerides (mg/dL)	142.3 ± 41.6	158.2 ± 44.7	0.04 *
HDL Cholesterol (mg/dL)	42.7 ± 8.1	39.8 ± 7.4	0.02 *

* Statistically significant at $p < 0.05$

Microalbuminuric patients had significantly higher mean SYNTAX scores, with a larger proportion showing moderate to severe CAD, compared to patients without microalbuminuria.

Table 3: Comparison of microalbumin level with CAD Severity

Parameter	Group A (n=52)	Group B (n=73)	p-value
Mean SYNTAX Score	14.6 ± 5.8	23.1 ± 7.4	<0.001 *
SYNTAX Score Categories:			
Low (≤22), n (%)	43 (82.7%)	26 (35.6%)	<0.001 *
Intermediate (23–32), n (%)	9 (17.3%)	34 (46.6%)	
High (≥33), n (%)	0 (0%)	13 (17.8%)	

* Significant at $p < 0.05$

Longer duration of diabetes was associated with higher SYNTAX scores in both groups, but microalbuminuric patients had consistently higher scores at every duration category.

Table 4: Comparison of SYNTAX Score with duration of diabetes

Duration of Diabetes	Group A SYNTAX Score Mean ± SD	Group B SYNTAX Score Mean ± SD	p-value

<5 years	11.5 ± 4.2	19.7 ± 5.1	<0.001 *
5-10 years	15.8 ± 5.7	23.5 ± 6.4	<0.001 *
>10 years	18.1 ± 6.2	28.7 ± 7.2	<0.001 *

* Significant at $p < 0.05$

A strong positive correlation was observed between urinary ACR and SYNTAX score. This implies that as microalbuminuria increases, the severity of CAD also tends to increase. The Multivariate Regression Analysis revealed that microalbuminuria**,** HbA1c, and duration of diabetes were independent predictors of higher SYNTAX scores ($p < 0.05$).

DISCUSSION

This study evaluated the correlation between microalbuminuria and the severity of CAD in 125 individuals with type 2 diabetes mellitus (T2DM) undergoing coronary angiography. Participants were categorized into two groups according to urine albumin levels: normoalbuminuria (Group A) and microalbuminuria (Group B).

Patients in the microalbuminuria group were often older and had a more prolonged course of diabetes than those without microalbuminuria. These findings align with other research indicating that diabetic complications exacerbate with increasing age and extended disease duration. Prolonged hyperglycemia leads to vascular damage, which subsequently increases the risk of microalbuminuria and coronary atherosclerosis. Elevated HbA1c values in Group B signify suboptimal glycemic regulation, a well-established risk factor for both microvascular and macrovascular problems. The observed correlation between increased systolic blood pressure and microalbuminuria underscores the significance of hypertension in endothelial dysfunction and the advancement of vascular disease in diabetics.

Analysis of lipid profiles indicated that patients with microalbuminuria exhibited a more atherogenic pattern, defined by elevated triglyceride levels and reduced HDL cholesterol. This dyslipidemic profile, characteristic of diabetes, expedites atherosclerosis. Despite Group B exhibiting elevated LDL cholesterol levels, the disparity was not statistically significant. These lipid abnormalities likely exacerbate endothelial damage and contribute to more severe CAD.

A notable finding was the markedly elevated mean SYNTAX score in microalbuminuric patients (23.1 ± 7.4) relative to those without microalbuminuria (14.6 ± 5.8). The SYNTAX score, which denotes the complexity and severity of coronary lesions, signifies a heightened disease burden and forecasts poorer outcomes. The increased percentage of individuals in intermediate and high SYNTAX categories in Group B reinforces the association between microalbuminuria and more intricate CAD. This underscores that microalbuminuria serves as an early indicator of diabetic nephropathy and a proxy for extensive endothelial dysfunction and systemic atherosclerosis.

Subgroup analysis based on diabetes duration revealed that microalbuminuric patients continuously exhibited elevated SYNTAX scores across all categories, indicating that microalbuminuria independently contributes to the severity of CAD beyond the length of the condition. The robust positive correlation between urine ACR and SYNTAX score ($r = 0.61$, $p < 0.001$) substantiates that elevated albuminuria levels are intricately linked to more severe CAD. This endorses the prospective application of urine ACR as a non-invasive biomarker for stratifying cardiovascular risk in diabetes individuals. Multivariate regression study found microalbuminuria, HbA1c, and diabetes duration as independent predictors of elevated SYNTAX scores, highlighting their collective contribution to the progression of complicated CAD in type 2 diabetes mellitus.

From a pathophysiological standpoint, microalbuminuria indicates endothelial dysfunction, heightened vascular permeability, and systemic inflammation processes that expedite atherogenesis. Chronic hyperglycemia produces oxidative stress and activates pro-inflammatory pathways that compromise the endothelium, promoting plaque formation and development. Consequently, the existence of microalbuminuria may reflect these underlying mechanisms, presenting as more severe coronary pathology.[7]

Evidence from previous studies supports these findings. Jha PK et al.[12] reported that among 90 non-diabetic CAD patients, those with microalbuminuria had significantly higher SYNTAX scores (median 28 vs. 21, $p < 0.001$) and a greater prevalence of double- and triple-vessel disease. Hepat S et al.[13] found triple-vessel CAD in 79.4% of patients with microalbuminuria compared with only 3% in those without, a highly significant difference ($p < 0.01$).

Paudel N et al.[14] demonstrated a 73% prevalence of microalbuminuria in non-diabetic ACS patients, with the highest rates in NSTEMI (81.9%), followed by STEMI (63.1%) and unstable angina (55%), again statistically significant ($p = 0.04$). Similarly, Elsawasany MA et al.[15] observed greater CAD severity among microalbuminuric patients, while Lin X et al.[16] reported that elevated uACR markedly increased the risk of both cardiovascular and all-cause mortality in CAD patients, irrespective of diabetes status.

Shreef AS et al.[17] found significantly higher SYNTAX and Gensini scores in microalbuminuric patients ($p = 0.001$), with positive correlations between age, diabetes duration, hypertension, and

UACR. Monin A et al.[18] also showed that higher levels of albuminuria were associated with greater CAD burden (SYNTAX score p = 0.006), more diffuse disease, and a higher prevalence of chronic total occlusions (p = 0.042).

Together, these findings highlight microalbuminuria as a powerful predictor of CAD severity. It reflects underlying endothelial injury and systemic atherosclerotic processes, making it a valuable biomarker for identifying diabetic patients at high cardiovascular risk.

LIMITATIONS

The study was performed at a single center with a relatively small sample size and a restricted follow-up period, potentially impacting the generalizability of the findings. Subsequent research including larger cohorts and prospective methodologies is necessary to determine causal links and assess the effects of therapies aimed at microalbuminuria on CAD outcomes.

CONCLUSION

Microalbuminuria and the degree of CAD in individuals with type 2 diabetes mellitus were significantly correlated, according to this study. Patients with an increased urine albumin-to-creatinine ratio demonstrated inferior metabolic and cardiovascular risk profiles, characterized by prolonged diabetes duration, suboptimal glycemic management, and elevated blood pressure. Microalbuminuria had a substantial correlation with elevated SYNTAX scores, signifying more extensive and intricate CAD. Microalbuminuria, HbA1c, and diabetes duration were identified as independent markers of CAD severity.

The findings indicate that microalbuminuria serves as a significant non-invasive indicator for identifying diabetic patients at elevated risk of advanced coronary atherosclerosis, highlighting the necessity for early screening and proactive therapy to avert cardiovascular problems in this demographic.

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