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Original Research Article

Study of diastolic dysfunction in diabetic patients and its correlation with microalbuminuria

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ABSTRACT

Background: Diabetes mellitus (DM) increases cardiovascular risk, with diastolic dysfunction (DD) affecting 60% of asymptomatic type 2 DM patients. Microalbuminuria, a marker of endothelial dysfunction, may predict cardiac complications.
Methods: A cross-sectional study was conducted on 250 diabetic adults at the Department of General Medicine, Ganesh Shankar Vidyarthi Memorial Medical College (GSVMMC), Kanpur, from August 2023 to February 2025. Diastolic dysfunction was assessed via echocardiography; microalbuminuria via urine ACR. Statistical analysis (Chi-square, ANOVA, Pearson's correlation) was performed using SPSS, with $p < 0.05$ considered significant.
Results: Among 250 diabetic patients, 72% had diastolic dysfunction-most commonly Grade I (45.2%). Microalbuminuria was present in 88% and increased significantly with worsening diastolic grade, peaking in Grade III dysfunction (ACR 1250.55 mg/g). Type 2 diabetes patients had higher prevalence of both diastolic dysfunction (81.2%) and microalbuminuria (86.7%) compared to Type 1 patients, who showed lower rates (diastolic dysfunction: 23.4%; microalbuminuria: 93.6%). A strong correlation existed between urine ACR, serum creatinine, and diastolic dysfunction severity ($p<0.001$).
Conclusion: Microalbuminuria is prevalent in DM and strongly linked to DD severity, supporting its role in cardiovascular risk stratification. Routine screening and targeted therapies (e.g., SGLT2 inhibitors) may improve outcomes.
Keywords: Diabetes, Diastolic dysfunction, Microalbuminuria, Echocardiography

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia due to defects in insulin secretion or action. Globally, diabetes affects 537 million adults, with projections rising to 643 million by 2030. Cardiovascular diseases (CVDs) are the leading cause of morbidity and mortality in diabetic patients, with diastolic dysfunction—a precursor to heart failure with preserved ejection fraction (HFpEF)—being a critical yet often underdiagnosed complication. Up to 60% of asymptomatic type 2 diabetes patients exhibit diastolic impairment, driven by hyperglycemia, oxidative stress, and endothelial dysfunction.[1-3] Microalbuminuria, an early marker of diabetic nephropathy and systemic endothelial dysfunction, has been linked to diastolic dysfunction, suggesting shared pathophysiological mechanisms. This study explores the correlation between diastolic dysfunction and microalbuminuria in diabetic patients, aiming to assess microalbuminuria's role as an early indicator of cardiac involvement. By elucidating this

relationship, we seek to improve cardiovascular risk stratification and management in diabetes.[4,5]

METHODS

Study design and setting

This was a hospital-based, cross-sectional observational study carried out in the Department of General Medicine at Ganesh Shankar Vidyarthi Memorial Medical College (GSVMMC), located in Kanpur, Uttar Pradesh, India. GSVMMC is a tertiary care teaching hospital serving a large and diverse patient population from both urban and rural settings. The hospital provides access to a wide range of clinical services, allowing recruitment of diabetic patients with varying disease severity and clinical backgrounds. The study was conducted in collaboration with the departments of Cardiology, Radiology, and Pathology to ensure comprehensive evaluation and multidisciplinary inputs.

Study duration

The study was conducted over a period of eighteen months, beginning in August 2023 and concluding in February 2025. This duration allowed for systematic patient recruitment, data collection, quality assurance, and follow-up of test results, ensuring the study captured a representative and adequately sized sample of diabetic individuals within the given timeframe.

Inclusion criteria

Participants included in the study were adult patients aged 18 years and above with a confirmed diagnosis of either type 1 or type 2 diabetes mellitus, based on the American Diabetes Association (ADA) criteria. The diagnosis was established either by documentation in medical records or through current blood glucose and HbA1c levels. Patients with known hypertension were eligible only if their blood pressure was within target levels as defined by the American College of Cardiology/American Heart Association (ACC/AHA) guidelines and managed with stable antihypertensive therapy. The study aimed to evaluate stable ambulatory or admitted patients; therefore, only those who were clinically stable and provided written informed consent were included.

Exclusion criteria

Patients were excluded from the study if they had evidence of chronic kidney disease (CKD) or end-stage renal disease (ESRD), as these conditions independently affect urinary albumin excretion and cardiac function, thereby confounding the correlation between microalbuminuria and diastolic dysfunction. Similarly, patients with severely uncontrolled hypertension (systolic BP >180 mmHg or diastolic BP >110 mmHg) were excluded due to its direct impact on cardiac remodeling. Additional exclusion criteria included individuals with known structural heart diseases such as coronary artery disease, valvular heart disease, and arrhythmias, as these could lead to secondary diastolic dysfunction. Patients with chronic obstructive pulmonary disease (COPD), chronic liver disease, thyroid disorders, and any active systemic inflammatory or autoimmune diseases were also excluded. Pregnant women, particularly those with gestational diabetes, were not included to avoid variability due to physiological changes of pregnancy.

Data collection and study tool

After informed consent, each patient underwent a thorough clinical evaluation including medical history, duration and type of diabetes, associated comorbidities, treatment history, lifestyle habits, and anthropometric measurements such as height, weight, and BMI. Laboratory investigations included fasting and postprandial blood glucose, HbA1c, serum creatinine, lipid profile, and a spot urine sample for albumin-to-creatinine ratio (ACR). Microalbuminuria was classified as normal (<30 mg/g), microalbuminuria (30–300 mg/g), or macroalbuminuria (>300 mg/g). All samples were processed in the hospital's central biochemistry laboratory using validated and standardized techniques. Diastolic dysfunction was assessed through transthoracic echocardiography performed by trained cardiologists using uniform protocols. Parameters recorded included E/A ratio, E/e′ ratio (tissue Doppler imaging), and left atrial volume index (LAVI), which together allowed grading of diastolic dysfunction into Grade I (mild), Grade II (moderate), and Grade III (severe or restrictive). Echocardiographic machines were regularly calibrated and quality control checks were in place to reduce intra- and inter-observer variability. All data were recorded in predesigned case report forms and later entered into electronic databases for analysis.[6]

Data analysis

All data collected were initially entered into Microsoft Excel and subsequently analyzed using Statistical Package for the Social Sciences (SPSS) software, version 21.0. Descriptive statistics were used to summarize baseline characteristics. Continuous variables such as age, BMI, HbA1c, serum creatinine, and urine ACR were expressed as mean±standard deviation (SD) for normally distributed data or median with interquartile range (IQR) for skewed data. Categorical variables such as gender, type of diabetes, presence of microalbuminuria, and grade of diastolic dysfunction were expressed as frequencies and percentages. To compare proportions between groups, the Chi-square test was employed. For comparison of continuous variables across multiple groups (e.g., between different grades of diastolic dysfunction), one-way analysis of variance (ANOVA) was used. Pearson's correlation coefficient was calculated to examine the strength and direction of association between urine ACR and echocardiographic measures of diastolic dysfunction. A p value less than 0.05 was considered statistically

significant for all analyses. Subgroup analysis was also conducted to evaluate differences between type 1 and type 2 diabetic populations.

Ethical consideration

The study was conducted following approval from the Institutional Ethics Committee of Ganesh Shankar Vidyarthi Memorial Medical College, Kanpur. All participants were informed in detail about the purpose, procedures, potential risks, and benefits of the study in their preferred language. Written informed consent was obtained prior to enrollment, and participation was entirely voluntary. Patient confidentiality was strictly maintained throughout the study by de-identifying data and restricting access to authorized personnel only. The study adhered to the ethical principles outlined in the Declaration of Helsinki and followed all national guidelines for research involving human participants.

RESULTS

Prevalence of diastolic dysfunction

Among 250 diabetic patients, 45.2% had grade I diastolic dysfunction, 25.2% had grade II, and 1.6% had grade III (Figure 1). Type 2 diabetes patients exhibited significantly higher diastolic dysfunction (51.23% grade I, 30.04% grade II) compared to type 1 patients (19.14% grade I, 4.25% grade II) ($p<0.001$) (Figure 2).

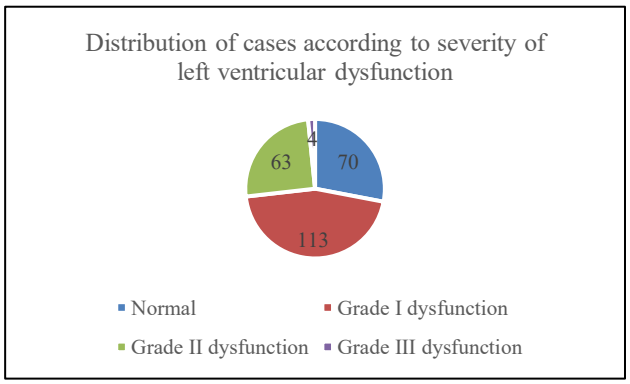

Figure 1: Distribution of cases according to severity of left ventricular dysfunction.

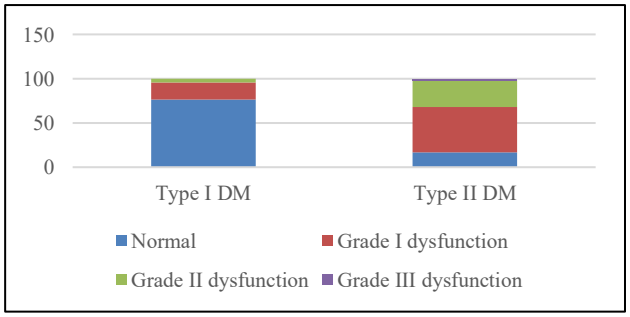

Figure 2: Distribution of cases according to type of diabetes with severity of LVD.

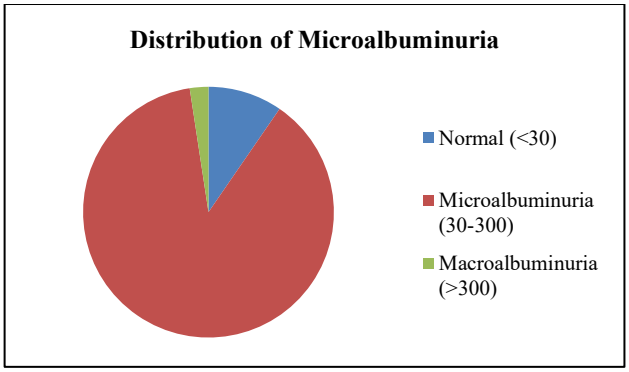

Figure 3: Distribution of cases according to microalbuminuria.

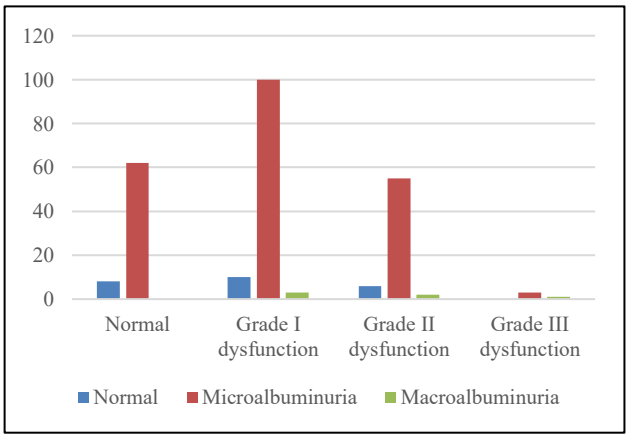

Figure 4: Distribution of cases according to microalbuminuria with severity of left ventricular dysfunction.

Table 1: Demographic characteristics.

Variable	Value
Mean age (in years)	52.66±11.24
Gender distribution	
Male	119 (47.6%)
Female	131 (52.4%)
Types of diabetes	
Type 1	47 (18.8%)
Type 2	203 (81.2%)
Mean duration of diabetes (in years)	9.4±5.8
Mean BMI (Kg/m$^{2)}$	27.3±3.9
Mean HbA1c (%)	8.2±1.5
Known hypertension (controlled)	156 (62.4%)
Mean serum creatinine (mg/dl)	1.16±0.37
Microalbuminuria present	220 (88%)
Mean urine ACR (mg/g)	185.3 (IQR: 102.4–327.6)

Microalbuminuria prevalence

88% of patients had microalbuminuria (urine ACR 30–300 mg/g), while 2.4% had macroalbuminuria (ACR>300

mg/g) (Figure 3). No significant difference in microalbuminuria prevalence was observed between Type 1 (93.61%) and Type 2 diabetes (86.69%) (p=0.111) or between sexes (p=0.630). Large number of participants answered 14 injections 46 (31.9%) followed by 7 injections 22 (15.2%), 5 injections 28 (19.4%). Similarly, about the site of administration for the vaccine to be given was abdomen 91 (65.9%), buttocks 22 (15.9%), shoulder 18 (13.04%), thigh 2 (1.4%), don't know 5 (3.6%).

Correlation between diastolic dysfunction and microalbuminuria

Mean microalbuminuria levels increased with LV dysfunction severity: 132.73 mg/g (normal), 179.37 mg/g (Grade I), 200.31 mg/g (Grade II), and 1250.55 mg/g (Grade III) (p<0.001) (Figure 4). Patients with grade III dysfunction had significantly higher serum urea (82.97 mg/dl) and creatinine (3.02 mg/dl) (p≤0.001), indicating concurrent renal impairment.

DISCUSSION

The present study highlights a significant association between diastolic dysfunction and microalbuminuria in patients with diabetes mellitus. Out of 250 diabetic individuals evaluated, 72% exhibited varying grades of diastolic dysfunction, with Grade I being the most prevalent. This finding underscores the high burden of subclinical cardiac involvement in diabetes, even among asymptomatic patients. It supports the concept that myocardial relaxation abnormalities can occur early in the disease course due to chronic hyperglycemia, oxidative stress, and metabolic derangements. Microalbuminuria was observed in 88% of the study population, and its severity showed a statistically significant correlation with the grade of diastolic dysfunction. The albumin-to-creatinine ratio (ACR) was markedly elevated in patients with Grade III dysfunction, suggesting a shared pathophysiological mechanism involving endothelial dysfunction, myocardial fibrosis, and activation of neurohormonal pathways such as the renin-angiotensin-aldosterone system.[7]

Patients with type 2 diabetes had a higher prevalence of both diastolic dysfunction and microalbuminuria compared to those with type 1 diabetes. This may reflect the greater impact of insulin resistance, obesity, and longer duration of undiagnosed hyperglycemia in type 2 diabetes, which contribute to structural and functional myocardial changes. These results are in agreement with previous clinical observations that Type 2 diabetes is more strongly associated with diabetic cardiomyopathy and renal impairment.[8] The association between microalbuminuria and diastolic dysfunction has been well recognized in earlier studies, and our findings further substantiate this link. In particular, the very high ACR levels seen in patients with Grade III dysfunction suggest that significant albuminuria may be a surrogate marker of advanced subclinical heart failure. This reinforces the role of albuminuria not only as a renal marker but also as a predictor of cardiovascular risk. Although the prevalence of microalbuminuria was comparable between males and females, the correlation between albuminuria and diastolic dysfunction appeared stronger in male patients. This may indicate gender-specific differences in cardiac remodeling and disease progression, potentially influenced by hormonal and genetic factors. These differences warrant further investigation in larger, prospective studies.[9] The clinical implications of our findings are considerable. Early identification of diabetic patients with both microalbuminuria and diastolic dysfunction provides an opportunity for timely intervention. Routine screening for ACR and echocardiographic assessment of diastolic function should be considered in comprehensive diabetes management. The use of cardio-renal protective agents such as SGLT2 inhibitors may offer dual benefits by targeting common underlying mechanisms.[10,11]

Despite the strength of our findings, the study has some limitations. It was a single-center, cross-sectional analysis, which limits the ability to establish causal relationships or observe progression over time. The lack of advanced diagnostic tools such as cardiac MRI or biomarkers like NT-proBNP may have restricted the sensitivity of cardiac evaluation. Furthermore, factors such as physical activity, diet, and medication adherence, which could influence cardiac or renal outcomes, were not quantified in this study.

Nonetheless, this study adds to the growing evidence supporting the interconnected nature of diabetic heart and kidney disease. It emphasizes the importance of integrating cardiovascular and renal assessments in routine diabetic care to improve early detection and outcomes.

CONCLUSION

This study provides strong evidence of a significant association between diastolic dysfunction and microalbuminuria in patients with diabetes mellitus, particularly in those with Type 2 diabetes. The increasing severity of diastolic dysfunction with rising levels of albuminuria underscores their shared pathophysiological mechanisms and clinical interdependence. By demonstrating that microalbuminuria can serve as an early, accessible marker for subclinical cardiac dysfunction, this study advances current understanding by reinforcing the need for integrated cardiovascular and renal risk assessment in diabetic care. These findings support the incorporation of routine echocardiography and urine ACR screening into standard diabetes management protocols to enable earlier detection, better risk stratification, and timely intervention to prevent progression to overt heart failure and kidney disease.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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