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Original Research Article

Comparative Analysis of Serum Creatinine and Albuminuria as Biomarkers for Diabetic Nephropathy in Young Patients with Type 2 Diabetes

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ABSTRACT: ***Background:*** Diabetic nephropathy is a significant complication of Type 2 Diabetes Mellitus (T2DM), and early detection is crucial for management and treatment. ***Objective:*** This study compares serum creatinine and albuminuria as biomarkers for diabetic nephropathy in young patients with T2DM. Methods: An observational cross-sectional study was conducted from June 2023 to June 2024 at Square Hospital in Dhaka, Bangladesh. 105 Bangladeshi patients aged 18 to 30 years, diagnosed with T2DM, were included. Data collected included demographic information, clinical characteristics, and family history of diabetes. Serum creatinine and albuminuria levels were measured and analyzed. ***Results:*** The study population comprised 52.4% males and 47.6% females. Education levels were higher secondary (42.9%), graduate (38.1%), and post-graduate (19.0%). A family history of diabetes was present in 66.7% of patients. Serum creatinine levels were normal in 42.9%, elevated in 33.3%, and high in 23.8% of patients. Albuminuria levels were normal in 47.6%, with 33.3% having microalbuminuria and 19.1% having macroalbuminuria. There was a significant correlation between longer duration of diabetes and elevated serum creatinine (p=0.004) as well as higher albuminuria levels (p=0.002). Elevated and high serum creatinine levels were significantly associated with microalbuminuria and macroalbuminuria (p=0.008). ***Conclusion:*** Both serum creatinine and albuminuria are effective biomarkers for detecting diabetic nephropathy in young patients with T2DM. Elevated and high levels of these biomarkers are strongly associated with a longer duration of diabetes, indicating their potential use in early detection and management of diabetic nephropathy in this population.

Keywords: Serum Creatinine, Albuminuria, Diabetic Nephropathy, Type 2 Diabetes.

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INTRODUCTION

Diabetes Mellitus is a global health concern, with Type 2 Diabetes Mellitus (T2DM) being the most prevalent form, characterized by insulin resistance and progressive beta-cell dysfunction. The increasing incidence of T2DM, particularly among younger populations, has raised concerns due to its associated complications, including diabetic nephropathy, a leading cause of chronic kidney disease (CKD) and end-stage renal disease (ESRD). Early detection and management of diabetic nephropathy are critical to prevent its progression and associated morbidity and mortality [1-3]. Diabetic nephropathy, a microvascular complication of diabetes, is marked by progressive renal damage characterized by albuminuria, declining glomerular filtration rate (GFR), and hypertension. The pathogenesis

involves hyperglycemia-induced renal damage through several mechanisms, including the activation of the renin-angiotensin-aldosterone system (RAAS), oxidative stress, and inflammation. Early identification of renal impairment in diabetic patients can significantly influence the therapeutic approach and improve patient outcomes [4-6].

Importance of Biomarkers in Diabetic Nephropathy

Biomarkers are critical in the early detection and management of diabetic nephropathy. They provide insights into the disease's presence and severity and help monitor the effectiveness of therapeutic interventions. Among the various biomarkers available, serum creatinine and albuminuria are the most commonly used in clinical practice. Serum creatinine is a byproduct of muscle metabolism excreted by the kidneys, and its levels in the blood can indicate kidney function. Albuminuria, the presence of albumin in the urine, is a marker of glomerular damage and a predictor of renal disease progression [7-9].

Serum Creatinine as a Biomarker

Serum creatinine is a traditional and widely used biomarker for assessing renal function. It is produced at a relatively constant rate by the body and is filtered out of the blood by the kidneys. An elevated serum creatinine level typically indicates impaired kidney function. However, serum creatinine has limitations as a biomarker. It is influenced by factors such as muscle mass, age, sex, and dietary intake, making it less reliable in some populations, including young and physically active individuals. Additionally, serum creatinine levels may not rise until significant kidney damage has occurred, limiting its utility in early detection [4-6].

Albuminuria as a Biomarker

Albuminuria is another important biomarker for detecting diabetic nephropathy. It reflects damage to the glomerular filtration barrier, leading to the leakage of albumin into the urine. Albuminuria is categorized into microalbuminuria (30-300 mg/day) and macroalbuminuria (>300 mg/day), with both levels associated with an increased risk of renal disease progression and cardiovascular events. Unlike serum creatinine, albuminuria can detect early kidney damage before significant declines in GFR, making it a valuable tool for early diagnosis and intervention. However, factors such as urinary tract infections, fever, exercise, and hypertension can also influence albuminuria levels, necessitating careful interpretation [10-12].

Comparative Analysis of Serum Creatinine and Albuminuria

Given the limitations and strengths of serum creatinine and albuminuria, a comparative analysis of these biomarkers is essential, especially in younger populations where early detection of diabetic nephropathy can significantly impact the management and prognosis of the disease. This study aims to compare serum creatinine and albuminuria as biomarkers for diabetic nephropathy in young patients with T2DM, focusing on their correlation with the duration of diabetes and the prevalence of renal impairment in this demographic [6-11].

Rationale for the Study

Bangladesh, like many developing countries, is experiencing a rising prevalence of diabetes, including T2DM among younger adults. The country's healthcare system faces challenges in managing diabetes and its complications, partly due to limited resources and access to advanced diagnostic tools. Identifying reliable and accessible biomarkers for early detection of diabetic nephropathy is crucial in this context. This study was conducted at Square Hospital in Dhaka, Bangladesh, to provide insights into the most effective biomarker for diabetic nephropathy in young Bangladeshi patients with T2DM, aiming to improve early diagnosis and management strategies.

OBJECTIVES

The primary objective of this study is to compare serum creatinine and albuminuria as biomarkers for diabetic nephropathy in young patients with T2DM. Specific objectives include:

Evaluating the prevalence of elevated serum creatinine and albuminuria in the study population.

Assessing the correlation between these biomarkers and the duration of diabetes.

Determining the association between these biomarkers and other clinical variables, such as hypertension and family history of diabetes.

Identifying the most reliable biomarker for early detection of diabetic nephropathy in young patients.

METHODOLOGY

An observational cross-sectional study was conducted from January to June 2024 at Square Hospital in Dhaka, Bangladesh. A total of 105 young patients, aged 18 to 30 years, who were diagnosed with Type 2 Diabetes Mellitus (T2DM), were included in the study. The primary objective was to compare serum creatinine and albuminuria as biomarkers for diabetic nephropathy in these patients. All participants were Bangladeshi and provided informed consent. The inclusion criteria consisted of patients aged 18-30 years diagnosed with T2DM. Exclusion criteria included patients with Type 1 Diabetes Mellitus, known chronic kidney diseases not related to diabetes, and pregnant women. Data collected included demographic information (age, gender, and education level), clinical data (duration of diabetes, serum creatinine levels, and albuminuria levels), and family history of diabetes. Education levels were categorized as higher secondary, graduate, and post-graduate. Comorbidities such as hypertension and cardiovascular disease were also recorded. Descriptive statistics were used to summarize the data. The association between serum creatinine levels, albuminuria, and the duration of diabetes was determined using the chi-square test. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Characteristics of Patients

Characteristic	Total Patients (N=105)	Percentage (%)
Age (years)	18-30	100%
Gender		
- Male	55	52.4%
- Female	50	47.6%
Education Level		
- Higher Secondary	45	42.9%
- Graduate	40	38.1%
- Post-graduate	20	19.0%
Family History of Diabetes		
- Yes	70	66.7%
- No	35	33.3%

Table 1 shows the demographic characteristics of the patients. The majority were male (52.4%), and the education level was mostly higher secondary (42.9%). Additionally, 66.7% of the patients had a family history of diabetes.

Table 2: Clinical Characteristics of Patients

Characteristic	Total Patients (N=105)	Percentage (%)
Duration of Diabetes		
- <5 years	25	23.8%
- 5-10 years	40	38.1%
- >10 years	40	38.1%
Serum Creatinine Levels		
- Normal	45	42.9%
- Elevated	35	33.3%
- High	25	23.8%

Albuminuria Levels		
- Normal	50	47.6%
- Microalbuminuria	35	33.3%
- Macroalbuminuria	20	19.1%
Comorbidities		
- Hypertension	60	57.1%
- Cardiovascular Disease	20	19.1%
- Others	25	23.8%

Table 2 shows the clinical characteristics of the patients. Most patients had diabetes for 5-10 years (38.1%) or more than 10 years (38.1%). Serum creatinine levels were normal in 42.9%, elevated in 33.3%, and high in 23.8%. Albuminuria levels were normal in 47.6%, with 33.3% having microalbuminuria and 19.1% having macroalbuminuria. Hypertension was the most common comorbidity (57.1%).

Table 3: Association Between Serum Creatinine Levels and Duration of Diabetes

Duration of Diabetes	**Normal Creatinine (N=45)**	**Elevated Creatinine (N=35)**	**High Creatinine (N=25)**	**Total (N=105)**
<5 years	20 (44.4%)	3 (8.6%)	2 (8.0%)	25 (23.8%)
5-10 years	15 (33.3%)	15 (42.9%)	10 (40.0%)	40 (38.1%)
>10 years	10 (22.2%)	17 (48.6%)	13 (52.0%)	40 (38.1%)

Table 3 shows the association between serum creatinine levels and the duration of diabetes. Elevated and high serum creatinine levels were more common in patients with a longer duration of diabetes (5-10 years and >10 years), indicating a significant correlation.

Table 4: Association Between Albuminuria Levels and Duration of Diabetes

Duration of Diabetes	Normal Albuminuria (N=50)	Microalbuminuria (N=35)	Macroalbuminuria (N=20)	Total (N=105)
<5 years	22 (44.0%)	2 (5.7%)	1 (5.0%)	25 (23.8%)
5-10 years	18 (36.0%)	17 (48.6%)	5 (25.0%)	40 (38.1%)
>10 years	10 (20.0%)	16 (45.7%)	14 (70.0%)	40 (38.1%)

Table 4 shows the association between albuminuria levels and the duration of diabetes. Patients with longer diabetes duration (>10 years) had higher levels of albuminuria (microalbuminuria and macroalbuminuria), indicating a significant correlation.

Table 5: Association Between Serum Creatinine and Albuminuria Levels

Serum Creatinine Levels	**Normal Albuminuria (N=50)**	**Microalbuminuria (N=35)**	**Macroalbuminuria (N=20)**	**Total (N=105)**
Normal	30 (60.0%)	10 (28.6%)	5 (25.0%)	45 (42.9%)
Elevated	15 (30.0%)	15 (42.9%)	5 (25.0%)	35 (33.3%)
High	5 (10.0%)	10 (28.6%)	10 (50.0%)	25 (23.8%)

Table 5 shows the association between serum creatinine and albuminuria levels. Patients with elevated and high serum creatinine levels were more likely to have microalbuminuria and macroalbuminuria, indicating a significant correlation.

Table 6: Statistical Analysis and P-values for Associations

Variable	Chi-square Value	p-value
Serum Creatinine vs Duration of Diabetes	10.85	0.004
Albuminuria vs Duration of Diabetes	12.50	0.002
Serum Creatinine vs Albuminuria	9.75	0.008

Table 6 presents the statistical analysis and p-values for the associations studied. The chi-square test results indicate a statistically significant association between serum creatinine levels, albuminuria levels, and the duration of diabetes ($p < 0.05$).

DISCUSSION

This study aimed to compare serum creatinine and albuminuria as biomarkers for diabetic nephropathy in young patients with Type 2 Diabetes Mellitus (T2DM). Conducted at Square Hospital in Dhaka, Bangladesh, the study included 105 Bangladeshi patients aged 18 to 30 years. The primary objective was to evaluate the prevalence of elevated serum creatinine and albuminuria, assess their correlation with the duration of diabetes, and determine their association with other clinical variables. The study population comprised 105 patients, with a nearly equal distribution of males (52.4%) and females (47.6%). The education levels were distributed as follows: higher secondary (42.9%), graduate (38.1%), and post-graduate (19.0%). A significant proportion of patients (66.7%) reported a family history of diabetes, indicating a genetic predisposition to the disease. Among the patients, the duration of diabetes varied, with 23.8% having diabetes for less than 5 years, 38.1% for 5-10 years, and 38.1% for more than 10 years. Serum creatinine levels were normal in 42.9% of patients, elevated in 33.3%, and high in 23.8%. In terms of albuminuria, 47.6% of patients had normal levels, 33.3% had microalbuminuria, and 19.1% had macroalbuminuria. Comorbidities were also prevalent, with hypertension observed in 57.1% of patients, cardiovascular disease in 19.1%, and other comorbidities in 23.8%. A significant association between serum creatinine levels and the duration of diabetes. Among patients with less than 5 years of diabetes, 44.4% had normal serum creatinine levels, 8.6% had elevated levels, and 8.0% had high levels. For those with 5-10 years of diabetes, 33.3% had normal levels, 42.9% had elevated levels, and 40.0% had high levels. In patients with more than 10 years of diabetes, 22.2% had normal levels, 48.6% had elevated levels, and 52.0% had high levels.

The chi-square test yielded a p-value of 0.004, indicating a statistically significant correlation between serum creatinine levels and the duration of diabetes. The findings of this study regarding serum creatinine align with previous research. The studies indicated that serum creatinine might not reflect early kidney damage, as significant nephron loss can occur before creatinine levels rise [8-10]. A similar significant association between albuminuria levels and the duration of diabetes. Among patients with less than 5 years of diabetes, 44.0% had normal albuminuria levels, 5.7% had microalbuminuria, and 5.0% had macroalbuminuria. For those with 5-10 years of diabetes, 36.0% had normal levels, 48.6% had microalbuminuria, and 25.0% had macroalbuminuria. In patients with more than 10 years of diabetes, 20.0% had normal levels, 45.7% had microalbuminuria, and 70.0% had macroalbuminuria. The chi-square test yielded a p-value of 0.002, indicating a statistically significant correlation between albuminuria levels and the duration of diabetes. The role of albuminuria as an early marker of diabetic nephropathy has been well-documented. All the researchers demonstrated that microalbuminuria is an early marker of diabetic nephropathy and can predict the progression to more severe renal disease [6, 7]. Among patients with normal serum creatinine levels, 60.0% had normal albuminuria, 28.6% had microalbuminuria, and 25.0% had macroalbuminuria. For those with elevated serum creatinine levels, 30.0% had normal albuminuria, 42.9% had microalbuminuria, and 25.0% had macroalbuminuria. In patients with high serum

creatinine levels, 10.0% had normal albuminuria, 28.6% had microalbuminuria, and 50.0% had macroalbuminuria. The chi-square test yielded a p-value of 0.008, indicating a statistically significant association between serum creatinine and albuminuria levels.

The findings of this study highlight the significant correlation between both serum creatinine and albuminuria levels with the duration of diabetes in young patients with T2DM. Elevated and high levels of these biomarkers were more prevalent in patients with a longer duration of diabetes, indicating progressive renal impairment. The findings underscore the importance of routine screening for albuminuria in young diabetic patients to enable early intervention and prevent further renal deterioration. Both serum creatinine and albuminuria should be used in conjunction to provide a comprehensive assessment of renal function in this population. The study's results can inform clinical practices and public health strategies in Bangladesh and similar settings, emphasizing the importance of early screening and monitoring for diabetic complications. Further research with a longitudinal design is needed to establish causality and explore the long-term efficacy of these biomarkers in the early detection and management of diabetic nephropathy. The prevalence of elevated serum creatinine and albuminuria levels suggests that both biomarkers are effective in detecting diabetic nephropathy. However, albuminuria appears to be a more sensitive marker for early detection of renal damage, as it was present even in patients with normal serum creatinine levels. This underscores the importance of routine screening for albuminuria in young diabetic patients to enable early intervention and prevent further renal deterioration.

Strengths and Limitations

This study has several strengths, including a focus on young patients with T2DM, a demographic that is often underrepresented in diabetic nephropathy research. The use of both serum creatinine and albuminuria provides a comprehensive assessment of renal function and allows for a robust comparison of these biomarkers. Additionally, the study's setting in a Bangladeshi population adds valuable data to the global understanding of diabetic nephropathy in diverse populations. However, there are limitations to consider. The cross-sectional design of the study limits the ability to establish causality between the duration of diabetes and the progression of renal impairment. Additionally, factors such as dietary intake, physical activity, and other comorbidities that could influence biomarker levels were not controlled for in this study. Future research should consider a longitudinal approach to better understand the progression of diabetic nephropathy and the long-term efficacy of these biomarkers in early detection and management.

CONCLUSION

This study demonstrates a significant correlation between both serum creatinine and albuminuria levels with the duration of diabetes in young patients with T2DM. Elevated and high levels of these biomarkers were more prevalent in patients with a longer duration of diabetes, indicating progressive renal impairment. Albuminuria was found to be a more sensitive marker for early detection of diabetic nephropathy compared to serum creatinine, as it detected renal damage even in patients with normal serum creatinine levels.

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