

Serum Uric Acid as an Adjuvant Marker in Type 2 Diabetic Nephropathy: A Comparative Cross-Sectional Study

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Abstract

Background: Diabetic Nephropathy is a major microvascular complication of type 2 diabetes mellitus (T2DM) and a leading cause of end-stage renal disease (ESRD). Standard markers such as urinary albumin excretion and estimated glomerular filtration rate (eGFR) are widely used, but they may not fully capture early or atypical renal impairment. Serum uric acid (SUA), traditionally linked to gout, has recently been implicated in renal injury and may serve as an adjunct biomarker.

Objective: To compare serum uric acid levels in patients with type 2 diabetic nephropathy and those with T2DM without renal dysfunction, and to examine the relationship between SUA and proteinuria severity.

Materials and Methods: A retrospective cross-sectional study was conducted in 100 adult T2DM patients. Group 1 included 50 patients with diabetic nephropathy, and Group 2 included 50 diabetic patients without renal dysfunction. Laboratory parameters assessed were SUA, fasting blood glucose, HbA1c, serum creatinine, eGFR, and quantitative proteinuria.

Results: SUA levels were significantly higher in Group 1 compared with Group 2 ($p < 0.001$). A positive correlation was observed between SUA concentration and proteinuria severity ($r = 0.47$, $p < 0.001$).

Conclusion: Elevated serum uric acid is associated with diabetic nephropathy and increases stepwise with proteinuria severity. SUA may serve as a practical adjunct biomarker alongside eGFR and albuminuria in the evaluation of renal involvement in T2DM.

Keywords: Serum uric acid; Type 2 diabetes mellitus; Diabetic nephropathy; Proteinuria; Estimated glomerular filtration rate; Renal dysfunction; Biomarker.

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Introduction

Type 2 diabetes mellitus (T2DM) is a global health challenge associated with both microvascular and macrovascular complications. Among these, diabetic kidney disease (DKD), historically termed diabetic nephropathy, is one of the most serious, representing the leading cause of end-stage renal disease (ESRD) worldwide. Approximately 30–40% of individuals with T2DM eventually develop nephropathy, which substantially increases cardiovascular risk, mortality, and healthcare burden. Traditionally, DKD is diagnosed and staged using urinary albumin excretion (microalbuminuria or macroalbuminuria) and estimated glomerular filtration rate (eGFR). However, a subset of patients experience progressive renal decline without preceding macroalbuminuria, a condition recognized as normoalbuminuric DKD. This discrepancy

underscores the need for additional biomarkers that can complement albuminuria and eGFR in identifying renal involvement. Serum uric acid (SUA), the end-product of purine metabolism, has long been associated with gout and nephrolithiasis. Emerging evidence suggests that elevated SUA contributes to renal injury through oxidative stress, endothelial dysfunction, activation of the intrarenal renin–angiotensin system, and pro-inflammatory pathways. These findings raise the possibility that SUA may serve as a clinically useful adjunct marker of diabetic nephropathy. The present study was designed to evaluate and compare SUA levels in patients with T2DM and nephropathy versus those with T2DM but preserved renal function, and to assess the relationship between SUA and proteinuria severity.

Study Design: This was a retrospective, cross-sectional, record-based analytical study conducted in the Department of Biochemistry and Department of General Medicine, Mahatma Gandhi Memorial Medical College, Indore, MP, over a six-month period. The primary aim was to compare serum uric acid (SUA) levels between patients with type 2 diabetes mellitus (T2DM) and nephropathy and those with T2DM but preserved renal function, and to examine the association between SUA and proteinuria severity.

Study Population: A total of 100 adult patients with T2DM who met the eligibility criteria and had complete clinical and laboratory records were included. Participants were divided into two groups of equal size (n = 50 each):

Group 1 (Diabetic Nephropathy): Patients with T2DM and clinical or biochemical evidence of nephropathy, defined by persistent albuminuria/proteinuria and/or reduced eGFR.

Group 2 (Diabetic Controls): Patients with T2DM and normal renal parameters, without albuminuria or chronic renal impairment.

Inclusion Criteria

1. Confirmed diagnosis of T2DM based on standard diagnostic thresholds.
2. Age $\geq$ 18 years.
3. Availability of complete baseline laboratory records, including fasting SUA, serum creatinine, eGFR, fasting blood glucose, HbA1c, and quantitative urine protein/albumin excretion.

Exclusion Criteria

1. Type 1 diabetes mellitus or secondary diabetes.
2. Non-diabetic kidney disease (e.g., glomerulonephritis, polycystic kidney disease, obstructive uropathy).
3. Acute kidney injury or acute systemic illness.

4. History of gout or treatment with hypouricemic agents (allopurinol, febuxostat, probenecid).
5. Use of medications affecting uric acid metabolism (e.g., high-dose aspirin, thiazide diuretics, uricosuric drugs).
6. Malignancy, liver cirrhosis, or active systemic inflammatory states.

Data Collection: Demographic details and laboratory parameters were extracted from patient records. Variables included age, duration of diabetes, SUA, serum creatinine, eGFR, fasting blood glucose, HbA1c, and quantitative proteinuria.

Statistical Analysis: Continuous variables (e.g., age, duration of diabetes, SUA, creatinine, eGFR) were expressed as mean $\pm$ standard deviation (SD) or median (interquartile range), depending on distribution. Categorical variables (e.g., gender, proteinuria severity categories) were summarized as frequencies and percentages.

- **Inter-group comparisons:** Independent Student's t-test for normally distributed continuous variables; Mann-Whitney U test for non-normally distributed data.
- **Categorical comparisons:** Chi-square (χ^2) test.
- **Correlation analysis:** Pearson's correlation coefficient and Spearman's rank correlation were used to assess the relationship between SUA and proteinuria.

A p-value < 0.05 was considered statistically significant.

Results

The comparative demographic and biochemical profiles of the 100 study participants are presented below. Age and gender distributions were well-matched between Group 1 and Group 2 without statistically significant baseline differences ($p > 0.05$).

Table 1: The comparative demographic and biochemical profiles

Parameter / Variable	Group 1 (Nephropathy) (n = 50)	Group 2 (No Nephropathy) (n = 50)	P-Value
Age & Demographics	Matched Baseline	Matched Baseline	$p > 0.05$ (NS)
Serum Uric Acid (SUA)	Significantly Elevated	Normal / Low Range	$p < 0.001$
Proteinuria Severity	Moderate to Severe	Minimal / Absent	$p < 0.001$
SUA Correlation with Proteinuria	$r = 0.47$ (Positive)	Baseline Reference	$p < 0.001$

Discussion

This study demonstrates that serum uric acid (SUA) levels are significantly elevated in patients with type 2 diabetic nephropathy compared with diabetic patients without renal dysfunction. Furthermore, SUA showed a positive correlation with proteinuria severity, indicating that higher uric acid concentrations are associated with more

advanced renal involvement. These findings are consistent with previous reports and meta-analyses that identify hyperuricemia as an independent risk factor for the progression of diabetic kidney disease.

The clinical implication of these results is that SUA may serve as a useful adjunct biomarker in the evaluation of diabetic nephropathy. While

albuminuria and eGFR remain the standard measures, SUA provides additional information, particularly in cases where renal decline occurs without preceding macroalbuminuria. The observed stepwise increase in SUA with proteinuria severity supports its potential role in disease staging and risk stratification. The pathophysiological mechanisms linking elevated SUA to renal injury are well described in the literature. Uric acid has been shown to impair endothelial nitric oxide activity, activate the intrarenal renin–angiotensin system, and promote oxidative stress and inflammatory pathways. These processes contribute to glomerulosclerosis and tubulointerstitial fibrosis, thereby accelerating renal damage in patients with

diabetes. Despite these promising associations, several limitations must be acknowledged. The retrospective, single-center design and moderate sample size restrict the ability to establish causality or generalize findings broadly. Additionally, SUA levels can be influenced by metabolic factors such as obesity, dyslipidemia, and metabolic syndrome, which were not fully controlled in this study. Overall, the results support the consideration of SUA as an adjunct marker in diabetic nephropathy. However, prospective studies with larger populations and longer follow-up are required to confirm its clinical utility and to clarify whether interventions targeting uric acid can alter disease progression.

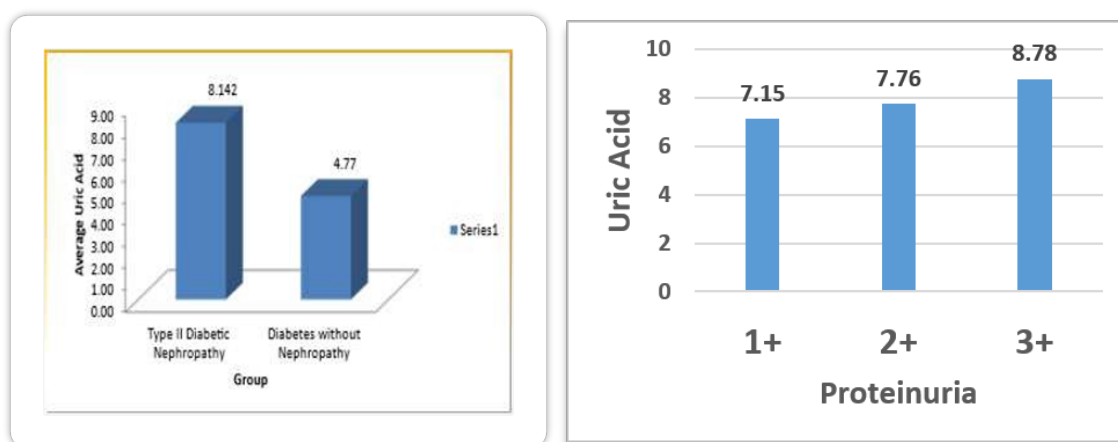


Figure 1: Uric Acid

Conclusion

This study demonstrates that serum uric acid (SUA) levels are significantly elevated in patients with type 2 diabetic nephropathy compared with diabetic patients without renal dysfunction. Moreover, SUA shows a positive correlation with proteinuria severity, rising stepwise as proteinuria increases. These findings suggest that SUA may serve as a practical adjunct biomarker, complementing established measures such as eGFR and albuminuria in the evaluation of renal involvement in T2DM.

Given the retrospective, single-center design and moderate sample size, the results should be interpreted with caution. Larger, prospective studies are warranted to confirm the utility of SUA in risk stratification and disease monitoring.

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