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Original Research Article

Cardiac Risk Factors and Cardiovascular Complications Associated with Serum Uric Acid Levels in Type 2 Diabetes Mellitus

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Abstract:

Background and Objectives: Type 2 Diabetes Mellitus (T2DM) is a major global risk factor for cardiovascular disease. Serum uric acid (SUA) has emerged as an important prognostic biomarker linked to oxidative stress, endothelial dysfunction, and vascular inflammation. This study investigated serum uric acid levels in Type 2 Diabetic patients and evaluated their correlation with established cardiovascular risk factors and cardiac complications.

Methods: A cross-sectional observational study was conducted on 80 Type 2 Diabetic patients aged >40 years. Serum uric acid, Fasting Blood Sugar, HbA1c, lipid profile, 12-lead ECG, 2D-Echocardiography, fundoscopy, and renal/urine parameters were evaluated. Elevated serum uric acid was defined as >5.0 mg/dL.

Results: Among 80 diabetic subjects (66.2% males, 33.8% females; mean age 60.2 years), 82.5% (n = 66) exhibited elevated serum uric acid (>5.0 mg/dL). SUA > 5.0 mg/dL was present in 100% of patients with diabetes duration >10 years (p = 0.005), 85.9% of hypertensive patients (p = 0.032), 96.9% of overweight/obese patients (BMI > 24 kg/m², p = 0.004), 91.5% of chronic smokers (p = 0.012), and 84.6% of patients with HbA1c > 6.5% (p = 0.029). Regarding cardiac complications, high SUA (>5.0 mg/dL) was present in 87.23% of Acute Coronary Syndrome (ACS) cases (41/47, p = 0.048), 66.67% of Congestive Cardiac Failure (CCF) cases (6/9, p = 0.048), and 50.0% of Atrial Fibrillation (AF) cases (3/6, p = 0.011).

Conclusion: Elevated serum uric acid (>5.0 mg/dL) correlates strongly with cardiovascular risk factors (hypertension, high BMI, smoking, poor glycemic control, diabetes duration) and major cardiac complications (ACS, CCF, AF) in Type 2 Diabetes Mellitus. SUA > 5.0 mg/dL serves as an important red-flag risk biomarker for cardiovascular monitoring.

Keywords: Type 2 Diabetes Mellitus, Serum Uric Acid, Acute Coronary Syndrome, Hypertension, Body Mass Index, and Endothelial Dysfunction.

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Introduction

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by hyperglycemia, insulin resistance, and progressive pancreatic beta-cell dysfunction. Global epidemiological estimates indicate that over 415 million adults currently suffer from diabetes, with India representing the 'diabetic capital' of the world hosting nearly 69 million diabetic individuals.

Cardiovascular disease (CVD) accounts for up to 65–75% of deaths in diabetic populations, with a 2- to 4-fold increased risk of coronary artery disease, heart failure, and stroke. Uric acid (UA) is the final degradation product of purine catabolism in humans, generated by the action of xanthine oxidase (XO). While historically viewed primarily in the context of gouty arthritis, emerging molecular and clinical evidence highlights uric acid as an active contributor to vascular wall inflammation and oxidative stress. Intracellular urate entry via organic anion transporters triggers endothelial uncoupling, inhibits endothelial nitric oxide synthase (eNOS), stimulates monocyte chemoattractant protein-1 (MCP-1), and induces vascular smooth muscle cell proliferation.

Hyperinsulinemia, hyperglucosuria, and tissue ischemia in T2DM impair renal tubular urate

excretion while stimulating purine degradation. Although epidemiological studies have noted elevated serum uric acid (SUA) in diabetic individuals with cardiovascular events, whether hyperuricemia acts as an independent causative factor or a surrogate risk marker remains a subject of investigation. This study was undertaken to evaluate serum uric acid levels in Type 2 Diabetic patients and analyze their association with major cardiovascular risk factors (hypertension, high BMI, smoking, HbA1c) and cardiac complications (Acute Coronary Syndrome, Congestive Cardiac Failure, Atrial Fibrillation).

Aims and Objectives

The primary aims and objectives of this research investigation were:

- To measure serum uric acid levels in patients with Type 2 Diabetes Mellitus.
- To investigate the correlation between serum uric acid levels and cardiovascular risk factors (Age, Gender, Duration of Diabetes, Hypertension, BMI, Smoking, HbA1c).
- To analyze the association between serum uric acid levels and specific cardiovascular complications (Acute Coronary Syndrome - ACS, Congestive Cardiac Failure - CCF, Atrial Fibrillation - AF).

Materials and Methods

Study Design and Cohort Selection: This descriptive cross-sectional observational study was conducted on 80 Type 2 Diabetes Mellitus patients aged >40 years presenting to the outpatient and inpatient wards of the Department of General Medicine, BRIMS Bidar from June 2024-june 2025. Written informed consent was recorded from all participating subjects. The study criteria defined as follows

Inclusion and Exclusion Criteria

Inclusion Criteria: Patients aged >40 years diagnosed with Type 2 Diabetes Mellitus according to American Diabetes Association (ADA) criteria (FBS ≥ 126 mg/dL, PPBS ≥ 200 mg/dL, or HbA1c ≥ 6.5%).

Exclusion Criteria: Patients with primary renal failure (serum creatinine > 2.0 mg/dL or end-stage renal disease), renal transplant recipients, hepatic failure, or Type 1 Diabetes Mellitus.

Clinical Assessment and Laboratory Investigations: All patients underwent structured clinical evaluation, anthropometric measurements (height, weight, BMI calculated as kg/m²), and resting blood pressure measurement.

- Glycemic & Metabolic Panel: Fasting Blood Sugar (FBS), Post-Prandial Blood Sugar (PPBS), Glycated Hemoglobin (HbA1c), Fasting Lipid Profile (TC, TAG, HDL-C, LDL-C, VLDL-C), Blood Urea, and Serum Creatinine.
- Serum Uric Acid Measurement: Fasting venous blood samples were analyzed for serum uric acid (reference threshold >5.0 mg/dL defined as elevated in diabetic cardiac risk evaluation).
- Cardiovascular & Diagnostic Imaging: 12-lead Electrocardiogram (ECG), 2D-Echocardiography (evaluating Ejection Fraction, Regional Wall Motion Abnormalities, Left Ventricular Hypertrophy), dilated funduscopy, Troponin I, Chest X-ray, and Abdominal Ultrasonography.

Results

A total of 80 Type 2 Diabetic patients (53 males [66.2%], 27 females [33.8%]; age range 41–75 years) were evaluated. The majority of subjects belonged to the 61–70 age group (42.5%, n = 34), followed by 51–60 years (26.3%, n = 21). Overall, 82.5% of subjects (n = 66) demonstrated elevated serum uric acid (>5.0 mg/dL).

Table 1: Correlation of Serum Uric Acid Status (>5.0 mg/dL vs ≤5.0 mg/dL) with Cardiovascular Risk Factors

Risk Factor Category	Total Cases (n)	SUA ≤ 5.0 mg/dL (n, %)	SUA > 5.0 mg/dL (n, %)	Statistical Test	p-value
Diabetes Duration ≤ 10 yrs	57	14 (24.6%)	43 (75.4%)	Fisher's Exact	p = 0.005 (S)
Diabetes Duration > 10 yrs	23	00 (0.0%)	23 (100.0%)		
Hypertension Present	64	09 (14.1%)	55 (85.9%)	Fisher's Exact	p = 0.032 (S)
BMI > 24 kg/m² (Overweight/Obese)	32	01 (03.1%)	31 (96.9%)	Fisher's Exact	p = 0.004 (S)
Chronic Smoking Present	47	04 (08.5%)	43 (91.5%)	Fisher's Exact	p = 0.012 (S)

Table 2: Relationship between Serum Uric Acid and Glycemic Control (HbA1c) & Cardiac Complications

Clinical Parameter / Complication	Total Cases (n)	SUA ≤ 5.0 mg/dL (n, %)	SUA > 5.0 mg/dL (n, %)	Statistical Test	p-value
HbA1c > 6.5%	78	12 (15.4%)	66 (84.6%)	Fisher's Exact	p = 0.029 (S)
Acute Coronary Syndrome (ACS)	47	06 (12.8%)	41 (87.2%)	Chi-Square	p = 0.048 (S)
Atrial Fibrillation (AF)	06	03 (50.0%)	03 (50.0%)	Chi-Square	p = 0.011 (S)
Congestive Cardiac Failure (CCF)	09	03 (33.3%)	06 (66.7%)	Chi-Square	p = 0.048 (S)
Hypertensive Heart Disease	12	04 (33.3%)	08 (66.7%)	Chi-Square	p = 0.034 (S)

Discussion

In this cross-sectional study of 80 Type 2 Diabetic patients, 82.5% presented with elevated serum uric acid (>5.0 mg/dL). Serum uric acid demonstrated a strong positive correlation with diabetes duration, reaching 100% prevalence in subjects with disease duration >10 years (p = 0.005).

This supports observations by Yoo et al. and Nakanishi et al. regarding chronic hyperglycemia-induced purine catabolism and progressive microvascular renal ischemia. Serum uric acid correlated significantly with major cardiovascular risk factors:

1. Hypertension: 85.9% of hypertensive diabetic patients had SUA > 5.0 mg/dL (p = 0.032). Uric acid induces renal vasoconstriction, stimulates intracellular RAS, and uncouples eNOS, directly driving vascular resistance.

2. Obesity: 96.9% of patients with BMI > 24 kg/m² exhibited high SUA (p = 0.004). Hyperleptinemia and hyperinsulinemia in obese diabetic individuals decrease renal urate clearance while driving hepatic purine synthesis.

3. Smoking & Glycemic Control: 91.5% of chronic smokers (p = 0.012) and 84.6% of patients with HbA1c > 6.5% (p = 0.029) had elevated SUA, reflecting augmented systemic oxidative stress.

Crucially, serum uric acid > 5.0 mg/dL was strongly clustered in subjects presenting with major cardiac complications:

Acute Coronary Syndrome (ACS): 87.23% of ACS patients (41/47) had SUA > 5.0 mg/dL (p = 0.048). Uric acid accumulates within vulnerable atherosclerotic plaques, promotes LDL oxidation, and enhances platelet hyper-reactivity.

Congestive Cardiac Failure (CCF) & Arrhythmias: 66.67% of CCF cases and 50.0% of Atrial Fibrillation cases exhibited hyperuricemia (p = 0.048 and p = 0.011, respectively). Tissue hypoxia in heart failure upregulates xanthine oxidase activity, increasing both uric acid production and reactive oxygen species generation.

Conclusion

From the findings of this research study, we conclude that:

Serum uric acid levels (>5.0 mg/dL) are significantly elevated in Type 2 Diabetic patients, correlating directly with disease duration and poor glycemic control (HbA1c > 6.5%).

Elevated serum uric acid strongly associates with major cardiovascular risk factors including hypertension (85.9%), high BMI > 24 kg/m² (96.9%), and chronic smoking (91.5%).

Serum uric acid > 5.0 mg/dL is strongly linked to acute and chronic cardiac complications, including Acute Coronary Syndrome (87.2%), Congestive Cardiac Failure (66.7%), and Atrial Fibrillation (50.0%).

Serum uric acid > 5.0 mg/dL represents a valuable, cost-effective red-flag biomarker for cardiovascular risk stratification in Type 2 Diabetes Mellitus.

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