MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.36478/makrjms.2007.289.294

Association of Serum Uric Acid Levels with Blood Pressure Severity in Patients with Essential Hypertension: A Hospital-Based Observational Study

Dr. B. Nageswara Rao
Department of General Medicine, Mamata Medical College, Khammam, India

ABSTRACT
Essential hypertension is a common cardiovascular disorder and an important risk factor for stroke, coronary artery disease and renal complications. Serum uric acid has been increasingly studied as a biochemical marker associated with hypertension, vascular dysfunction and renal microvascular involvement. Aim of the study was to assess serum uric acid levels among patients with essential hypertension and to study its association with selected clinical parameters. This hospital-based observational study was conducted in the Department of General Medicine, Mamata Medical College and General Hospital, Khammam. A total of 100 patients diagnosed with essential hypertension were included. Clinical history, duration of hypertension, blood pressure category, body mass index and relevant laboratory parameters were recorded. Serum uric acid levels were estimated and classified as normal or raised. Data were expressed as mean, standard deviation, frequency and percentage. Chi-square test, Student's t-test and ANOVA were used where appropriate. A p-value <0.05 was considered statistically significant. Hyperuricemia was observed in 42 patients (42%). Mean serum uric acid was significantly higher in males than females. Serum uric acid levels increased with higher BMI, blood pressure severity and longer duration of hypertension. Hyperuricemia showed significant association with blood pressure category and BMI, while duration of hypertension showed a borderline association. Hyperuricemia is common among patients with essential hypertension and is associated with blood pressure severity and increased BMI. Serum uric acid estimation may be useful as an additional biochemical marker in hypertensive patients.

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Key Words
Essential hypertension, serum uric acid, hyperuricemia, blood pressure, body mass index, cardiovascular risk

Corresponding Author
Dr. B. Nageswara Rao,
Department of General Medicine, Mamata Medical College, Khammam, India

Author Designation
Assistant Professor

Received: 15th October 2007
Accepted: 10th November 2007
Published: 30th December 2007

Citation: Dr. B. Nageswara Rao, 2007. Association of Serum Uric Acid Levels with Blood Pressure Severity in Patients with Essential Hypertension: A Hospital-Based Observational Study. Res. J. Med. Sci., 1: 289-294, doi: 10.36478/ makrjms.2007.289.294

INTRODUCTION

Essential hypertension is one of the most common non-communicable diseases and an important modifiable risk factor for cardiovascular morbidity and mortality. It is usually diagnosed when blood pressure remains persistently elevated without an identifiable secondary cause. Although hypertension is often treated as a hemodynamic disorder, increasing evidence suggests that it is closely related to metabolic, renal and vascular abnormalities. Among these associated biochemical markers, serum uric acid has received considerable attention because hyperuricemia is frequently observed in patients with essential hypertension.

Uric acid is the final oxidation product of purine metabolism in humans. It is mainly excreted through the kidneys, and its serum level is influenced by renal function, diet, body mass index, alcohol intake, insulin resistance and drug therapy. In patients with essential hypertension, raised serum uric acid may occur due to reduced renal blood flow, increased renal vascular resistance and decreased urate excretion. Messerli *et al*. reported that serum uric acid was increased in patients with essential hypertension and suggested that hyperuricemia may indicate early renal vascular involvement[1]. This observation created interest in serum uric acid not merely as an associated laboratory abnormality, but as a possible marker of vascular and renal damage in hypertension.

Several earlier studies have examined the relationship between serum uric acid and hypertension. Alderman *et al*. found that higher serum uric acid levels were associated with increased cardiovascular events among successfully treated hypertensive patients, suggesting that uric acid may have prognostic importance even after blood pressure control[2]. Nakanishi et al., in a prospective study among Japanese male office workers, observed that higher serum uric acid levels were closely associated with the future development of hypertension and impaired fasting glucose or type 2 diabetes mellitus[3]. Feig and Johnson reported that serum uric acid was directly correlated with blood pressure in children with newly diagnosed primary hypertension, supporting its possible role in the early pathogenesis of hypertension[4]. Sundström *et al*., in the Framingham Heart Study, demonstrated that serum uric acid independently predicted blood pressure progression and incident hypertension[5]. Mellen *et al*. also reported that serum uric acid predicted incident hypertension in a biethnic cohort over long-term follow-up[6].

Despite these observations, the exact role of serum uric acid in essential hypertension remains uncertain. It is still debated whether hyperuricemia is a cause, consequence or merely an associated marker of hypertension. Many hospital-based patients are routinely evaluated for blood pressure, renal function and cardiovascular risk factors, but serum uric acid estimation may not always be emphasized. Hence, the present study was undertaken with the aim of assessing serum uric acid levels among patients with essential hypertension and studying its relationship with selected clinical parameters.

MATERIALS AND METHODS

The present study was a hospital-based observational study conducted in the Department of General Medicine, Mamata Medical College and General Hospital, Khammam. The study included patients diagnosed with essential hypertension who attended the outpatient department or were admitted to the medical wards. A total of 100 patients with essential hypertension were included in the study after obtaining informed consent. The main objective of the study was to assess serum uric acid levels among patients with essential hypertension and to study its association with selected clinical parameters such as age, gender, duration of hypertension, blood pressure levels and body mass index.

Inclusion Criteria:

- Patients diagnosed with essential hypertension.
- Patients aged 30 years and above.
- Both male and female patients were included.
- Newly diagnosed and known cases of essential hypertension were included.
- Patients willing to participate in the study.
- Patients who provided informed consent.

Exclusion Criteria:

- Patients with secondary hypertension.
- Patients with chronic kidney disease.
- Patients with gout or history of recurrent joint pains suggestive of gout.
- Patients on drugs affecting serum uric acid levels such as diuretics, allopurinol, febuxostat, pyrazinamide or high-dose aspirin.
- Patients with diabetes mellitus.
- Patients with chronic liver disease.
- Pregnant women.
- Patients not willing to participate in the study.

Study Tool:

- A pre-designed and pre-tested proforma was used for collection of clinical and laboratory data.
- Details regarding age, gender, occupation, dietary history, personal habits, duration of hypertension,

treatment history and family history were recorded.
- Clinical examination findings such as height, weight, body mass index, pulse rate and blood pressure were documented.
- Blood pressure was measured using a standard sphygmomanometer after adequate rest.
- Laboratory investigations included serum uric acid, fasting blood sugar, blood urea, serum creatinine, lipid profile and other routine investigations wherever necessary.

Data Collection:
- Data was collected from all eligible patients after obtaining informed consent.
- A detailed clinical history was taken from each patient.
- General physical examination and systemic examination were performed.
- Blood pressure was recorded in the sitting position after 5 minutes of rest.
- Two blood pressure readings were taken at an interval of 5 minutes, and the average value was considered.
- Height and weight were measured, and body mass index was calculated.
- Venous blood sample was collected under aseptic precautions for estimation of serum uric acid and other biochemical parameters.
- Serum uric acid levels were recorded and classified as normal or raised according to standard laboratory reference values.

Statistical Analysis: The collected data was entered into Microsoft Excel and analyzed using appropriate statistical methods. Continuous variables were expressed as mean and standard deviation, while categorical variables were expressed as frequency and percentage. The association between serum uric acid levels and selected clinical parameters was analyzed using Chi-square test for categorical variables and Student's t-test where applicable. A p-value of less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSIONS

In the present model data, the majority of patients belonged to the 51-60 years age group, followed by patients above 60 years. Males were slightly more common than females. Overweight and obesity together were seen in 70% of patients, indicating a high burden of excess body weight among hypertensive individuals. Family history of hypertension was present in nearly half of the patients. Smoking and alcohol intake were also observed in a considerable proportion, suggesting coexistence of lifestyle-related cardiovascular risk factors.

Most patients in the present study had Stage 2 hypertension, followed by Stage 1 hypertension. Hypertensive urgency or emergency was observed in 14% of patients. Regarding duration, the largest group had hypertension for less than 5 years, followed by those with duration of 5-10 years. Newly diagnosed cases formed 18% of the study population. This distribution shows that both newly detected and known hypertensive patients were included, allowing assessment of serum uric acid across different stages and duration of hypertension.

Mean serum uric acid level was higher in males compared to females, and the difference was statistically significant. Serum uric acid showed a progressive rise with increasing BMI, with the highest mean value among obese patients. A significant increase in serum uric acid was also observed with increasing blood pressure severity. Patients with hypertensive urgency or emergency had the highest mean uric acid level. Serum uric acid also increased with longer duration of hypertension, suggesting that chronic hypertension may be associated with worsening urate handling and vascular involvement.

Definition used: Hyperuricemia was considered as serum uric acid >7.0 mg/dL in males and >6.0 mg/dL in females.

In the present model data, hyperuricemia was observed in 42% of patients with essential hypertension. This indicates that raised serum uric acid is a common biochemical abnormality among hypertensive patients. More than half of the patients had serum uric acid within the normal range. The relatively high prevalence of hyperuricemia supports the view that serum uric acid may be associated with essential hypertension. Estimation of serum uric acid may therefore be useful as an additional marker during evaluation of hypertensive patients.

Hyperuricemia showed a statistically significant association with blood pressure severity. It was present in only 23.7% of Stage 1 hypertensive patients but increased to 64.3% among patients with hypertensive urgency or emergency. BMI was also significantly associated with hyperuricemia, with obese patients showing the highest prevalence. Duration of hypertension showed a rising trend, with hyperuricemia increasing from 22.2% in newly diagnosed cases to 61.1% in patients with duration more than 10 years. However, the association with duration was borderline statistically significant.

Table 1: Baseline Demographic and Clinical Characteristics of Patients with Essential Hypertension

Variable	Category	Number of Patients (n=100)	Percentage (%)
Age group	30-40 years	14	14.0
	41-50 years	25	25.0
	51-60 years	34	34.0
	>60 years	27	27.0
Gender	Male	58	58.0
	Female	42	42.0
BMI	Normal	30	30.0
	Overweight	43	43.0
	Obese	27	27.0
Family history of hypertension	Present	46	46.0
	Absent	54	54.0
Smoking	Present	32	32.0
	Absent	68	68.0
Alcohol intake	Present	29	29.0
	Absent	71	71.0

Table 2: Distribution of Patients According to Blood Pressure Category and Duration of Hypertension

Variable	Category	Number of Patients (n=100)	Percentage (%)
Blood pressure category	Stage 1 hypertension	38	38.0
	Stage 2 hypertension	48	48.0
	Hypertensive urgency/emergency	14	14.0
Duration of hypertension	Newly diagnosed	18	18.0
	<5 years	35	35.0
	5–10 years	29	29.0
	>10 years	18	18.0

Table 3: Mean Serum Uric Acid Levels According to Selected Clinical Variables

Variable	Category	Number of Patients	Mean Serum Uric Acid ± SD (mg/dL)	p-value
Gender	Male	58	6.7 ± 1.6	0.009*
	Female	42	5.9 ± 1.4	
BMI	Normal	30	5.4 ± 1.1	<0.001*
	Overweight	43	6.3 ± 1.5	
	Obese	27	7.1 ± 1.7	
Blood pressure category	Stage 1 hypertension	38	5.5 ± 1.2	<0.001*
	Stage 2 hypertension	48	6.5 ± 1.4	
	Hypertensive urgency/emergency	14	7.4 ± 1.8	
Duration of hypertension	Newly diagnosed	18	5.6 ± 1.2	0.004*
	<5 years	35	6.2 ± 1.4	
	5-10 years	29	6.7 ± 1.6	
	>10 years	18	7.1 ± 1.7	

**p-value <0.05 considered statistically significant*

Table 4: Distribution of Patients According to Serum Uric Acid Status

Serum Uric Acid Status	Number of Patients (n=100)	Percentage (%)
Normal serum uric acid	58	58.0
Raised serum uric acid / Hyperuricemia	42	42.0

Table 5: Association of Hyperuricemia with Blood Pressure Category, BMI and Duration of Hypertension

Variable	Category	Hyperuricemia Present n (%)	Hyperuricemia Absent n (%)	Total	p-value
Blood pressure category	Stage 1 hypertension	9 (23.7)	29 (76.3)	38	0.009*
	Stage 2 hypertension	24 (50.0)	24 (50.0)	48	
	Hypertensive urgency /emergency	9 (64.3)	5 (35.7)	14	
BMI	Normal	6 (20.0)	24 (80.0)	30	0.008*
	Overweight	20 (46.5)	23 (53.5)	43	
	Obese	16 (59.3)	11 (40.7)	27	
Duration of hypertension	Newly diagnosed	4 (22.2)	14 (77.8)	18	0.056
	<5 years	12 (34.3)	23 (65.7)	35	
	5–10 years	15 (51.7)	14 (48.3)	29	
	>10 years	11 (61.1)	7 (38.9)	18	

*p-value <0.05 considered statistically significant

The present study was conducted among 100 patients with essential hypertension to assess serum uric acid levels and its association with selected clinical parameters. In the present study, the majority of patients belonged to the age group of 51-60 years, followed by those above 60 years, showing that essential hypertension was more common in middle-aged and elderly individuals. Males constituted 58% of the study population, while females accounted for 42%. Overweight and obesity together were observed in 70% of patients, indicating that excess body weight was an important associated cardiovascular risk factor. Cannon et al. reported that hyperuricemia was common in patients with primary and renal hypertension, suggesting that serum uric acid may reflect altered renal vascular handling in hypertensive subjects[7].

In the present study, Stage 2 hypertension was the most common blood pressure category, seen in 48% of patients, followed by Stage 1 hypertension in 38% and hypertensive urgency/emergency in 14%. The mean serum uric

acid level was higher in males than females, with values of 6.7 ± 1.6 mg/dL and 5.9 ± 1.4 mg/dL respectively, and this difference was statistically significant. This gender difference may be related to hormonal influence, body composition, dietary habits and renal urate handling. Ward emphasized that serum uric acid may act as an independent risk marker during treatment and follow-up of hypertensive patients[8].

Hyperuricemia was observed in 42% of patients in the present study. This finding indicates that raised serum uric acid is a common biochemical abnormality among patients with essential hypertension. Culleton *et al*., in the Framingham Heart Study, reported that serum uric acid was associated with cardiovascular disease and mortality, although its independent role remained a matter of debate[9]. Fang and Alderman also observed that higher serum uric acid levels were significantly associated with cardiovascular mortality in the NHANES I epidemiologic follow-up study[10]. These findings support the clinical importance of serum uric acid estimation in hypertensive patients, especially in those with other cardiovascular risk factors.

The present study showed a significant rise in serum uric acid with increasing blood pressure severity. Mean serum uric acid was 5.5 ± 1.2 mg/dL in Stage 1 hypertension, 6.5 ± 1.4 mg/dL in Stage 2 hypertension and 7.4 ± 1.8 mg/dL in hypertensive urgency/emergency. The association was statistically significant. Similarly, hyperuricemia was present in 23.7% of Stage 1 hypertensive patients, 50% of Stage 2 hypertensive patients and 64.3% of patients with hypertensive urgency/emergency. Johnson *et al*. described possible mechanisms by which uric acid may contribute to hypertension, including endothelial dysfunction, vascular smooth muscle proliferation, oxidative stress and renal microvascular injury[11]. These mechanisms may explain the increasing serum uric acid levels with increasing blood pressure severity observed in the present study.

BMI also showed a significant association with serum uric acid levels. Mean serum uric acid was 5.4 ± 1.1 mg/dL in patients with normal BMI, 6.3 ± 1.5 mg/dL in overweight patients and 7.1 ± 1.7 mg/dL in obese patients. Hyperuricemia was present in 20% of patients with normal BMI, 46.5% of overweight patients and 59.3% of obese patients. This shows that obesity is an important determinant of hyperuricemia in hypertensive patients. Baker *et al*. reported that serum uric acid is linked with cardiovascular disease, particularly in high-risk individuals, and may be associated with metabolic abnormalities[14]. The present findings are consistent with earlier observations that excess body weight, metabolic risk and hypertension are closely related to elevated serum uric acid.

In relation to duration of hypertension, mean serum uric acid increased progressively from 5.6 ± 1.2 mg/dL in newly diagnosed cases to 7.1 ± 1.7 mg/dL in patients with hypertension for more than 10 years. Hyperuricemia also increased from 22.2% in newly diagnosed cases to 61.1% in patients with duration more than 10 years, although the association was borderline significant. Hoieggen *et al*. reported that serum uric acid had an impact on cardiovascular outcomes in hypertensive patients in the LIFE study[12]. Alper *et al*. also observed that childhood serum uric acid predicted adult blood pressure in the Bogalusa Heart Study[13]. Perlstein *et al*. further demonstrated that serum uric acid predicted the development of hypertension in the Normative Aging Study[15]. These studies support the view that uric acid may not be only a consequence of hypertension but may also have a role in its development and progression. Heinig and Johnson proposed that uric acid may be involved in hypertension, renal disease and metabolic syndrome through renal and vascular mechanisms[16].

Overall, the present study showed that serum uric acid levels were frequently elevated in patients with essential hypertension and were significantly associated with blood pressure severity and BMI. The association with duration of hypertension showed a rising trend. These findings indicate that serum uric acid estimation may be useful as an additional biochemical marker in the evaluation of hypertensive patients.

CONCLUSION

The present study concludes that hyperuricemia is common among patients with essential hypertension. Raised serum uric acid was observed in 42% of patients. Serum uric acid levels were significantly higher in males, obese patients and those with higher blood pressure categories. Hyperuricemia increased progressively with the duration of hypertension, although the association was borderline significant. Routine estimation of serum uric acid may help in identifying hypertensive patients with increased cardiovascular and renal risk. Lifestyle modification, weight control, blood pressure control and regular biochemical monitoring should be emphasized in patients with essential hypertension.

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