# Benefits of Allopurinol Treatment on Blood Pressure and Renal Function in Patients with Early Stage of Chronic Kidney Disease

Bancha Satirapoj MD*,
Orasa Wirajit MD*, Anuchart Burata MD*,
Ouppatham Supasyndh MD*, Prajej Ruangkanchanasetr MD*

** Division of Nephrology, Department of Medicine, Phramongkutklao Hospital and College of Medicine, Bangkok, Thailand*

***Background:*** *Hyperuricemia has been associated with increased risk of endothelial dysfunction, cardiovascular, and renal disease. Allopurinol is a potent xanthine oxidase inhibitor used in hyperuricemic patients. It has been shown to decrease cardiovascular disease and hypertension. However, studies have reported conflicting evidence on its effects on blood pressure (BP) and estimated glomerular filtration rate (GFR) in chronic kidney disease (CKD) patients.*
***Objective:*** *To demonstrate the effect of allopurinol on BP and estimated GFR in CKD patients.*
***Material and Method:*** *Patients with CKD stage II-III were screened for possible study enrollment. All patients received allopurinol 50 mg once daily for 12 weeks. The main outcomes were to observe the changes of BP and GFR after given treatment.*
***Results:*** *Forty-four patients were eligible with mean age of 70.14±8.50 years and mean estimated GFR of 43.22±14.44 mL/min/1.73 $m^2$. Serum uric acid decreased significantly from 8.11±2.68 to 7.05±2.38 mg/dL (p = 0.012) at the end of the study. Allopurinol had also statistically significant lower systolic BP (137.72±14.72 to 131.34±12.10 mmHg, p = 0.019) and diastolic BP (79.63±11.56 to 75.43±9.80 mmHg, p = 0.037) at 12 weeks when compared to baseline. There was significant increased in GFR after treatment (43.22±14.44 vs. 45.34±16.09, mL/min/1.73 $m^2$, p = 0.029). No serious adverse effects were noted in any of the treated subjects. Two patients (4.5%) in the treatment group had minor skin reaction.*
***Conclusion:*** *The study results confirmed that 12 weeks of allopurinol treatment affects the values of serum uric acid, BP and GFR in early stage of CKD patients who already received standard antihypertensive agents without any significant serious adverse effects.*

***Keywords:*** *Hyperuricemia, Allopurinol, Glomerular filtration rate, Blood pressure*

***J Med Assoc Thai 2015; 98 (12): 1155-61***
***Full text. e-Journal:*** *http://www.jmatonline.com*

Serum uric acid has been implicated in the pathogenesis of hypertension. Hyperuricemia has been observed in 25% of untreated hypertensive subjects, 50% of those on treatment, and 75% to 100% of those with malignant hypertension or renal dysfunction[1]. Population-based studies have also found an increased frequency of hypertension with stepwise increases in serum uric acid levels[2] and there are many studies examine whether an elevated uric acid level predicts the development of hypertension[3-5].

Uric acid induced hypertension and kidney injury in the animal model was mediated by two mechanisms. The first mechanism resulted from uric acid-induced renal vasoconstriction mediated by endothelial dysfunction with reduced nitric oxide levels and by activation of the renin-angiotensin system[6,7]. Later, however, the hyperuricemia causes progressive renal microvascular disease, and once sufficient narrowing of the arteriolar lumen occurs[8]. The initial study suggested that lowering uric acid in the CKD subjects could improve renal function in CKD population.

The xanthine oxidase inhibitor allopurinol improves endothelial dysfunction in patients with type 2 diabetes with mild hypertension[9] and concomitantly with a decrease of serum uric acid levels[10]. Allopurinol, which blocks both uric acid and oxidant formation, can reverse the impaired endothelial nitric oxide production and might decrease blood pressure (BP) level and renal progression in current situation. In the short-term, crossover study of adolescents with newly diagnosed hypertension, treatment with allopurinol resulted in reduction of BP[11]. There are also very few data evaluating the efficacy of uric acid reduction on progression of

***Correspondence to:***
*Satirapoj B, Division of Nephrology, Department of Medicine, Phramongkutklao Hospital and College of Medicine, Bangkok 10400, Thailand.*
*Phone & Fax: +66-2-6444676*
*E-mail: satirapoj@yahoo.com*

CKD[12,13]. The present study was designed to test the hypothesis that administrating allopurinol to decrease serum uric acid levels in hyperuricemic patients with CKD could be of benefit in decreasing BP and slowing the rate of renal disease progression in these patients.

## Material and Method

This 12-week prospective clinical study was conducted in patients with CKD stage II-III at the outpatient clinic, Phramongkutklao Hospital. The study was approved by the Institutional Review Boards of the Phramongkutklao Hospital. Recruitment began in June 2012 and was completed in August 2013. Treatment protocol patients were ingested allopurinol 50 mg once daily for 12 weeks. If the decision was made that the serious adverse event was likely or possibly due to the treatment protocol, the treatment would be discontinued. The inclusion criteria were age 18 years or older, stable treatment with antihypertensive agents, lipid lowering agents and metabolic controls for at least three months, and no treatment with uric lowering agents within six months before starting the study. Patients with active malignancy, severe heart, lung or liver disease, strokes, chronic infection (e.g., tuberculosis) within one year prior to the study, pregnancy, any immunological or inflammatory disorders, and known history of allopurinol hypersensitivity were excluded from the study. All patients gave informed written consent. All patients were informed to assure that any medications known to interfere with uric metabolism, such as lipid lowering drugs and antihypertensive agents, including dietary intake and daily lifestyle were not changed during the follow-up.

### *Clinical laboratory measurements*

Medical histories and physical examinations were performed on each subject at outpatient clinic. Casual systolic and diastolic BP were measured using a standard mercury sphygmomanometer applied on the same arm after a 10-minute rest in a sitting position. During at least two different visits at one week apart BPs were taken, an averaged BP was calculated to represent the clinical BP reference value.

After an 8-hour overnight fast, all patients underwent routine laboratory tests including assays for plasma levels of total cholesterol, low-density lipoprotein, high-density lipoprotein, triglyceride, creatinine, blood urea nitrogen (BUN), and urine protein creatinine index at baseline, and at the end of the trial.

Concentrations of serum creatinine were measured by an enzymatic assay (Roche Diagnostics GmbH). An estimate of the glomerular filtration rate (GFR) was obtained in adults using the 2009 CKD-EPI creatinine equation and staging according to the Kidney Disease: Improving Global Outcomes (KDIGO) 2012[14].

### *Safety monitoring*

Adverse events that may or may not consider to be related to allopurinol treatment were monitored every four weeks. The patients were questioned in a systematic way about their experiences concerning any adverse events during the previous four weeks. Patients also underwent blood drawing for safety tests that included complete blood counts, and liver function tests. For minor adverse events, allopurinol would be withheld temporarily until symptoms resolved; then allopurinol therapy would be restarted and the patient closely monitored. For serious adverse events, allopurinol therapy would be discontinued at once and terminated the study.

### *Statistical analysis*

The key method of analysis was the comparison of the changes between the baseline and 12-week values in the allopurinol treated group using paired t-tests or Wilcoxon signed ranks test. Statistical analyses were performed using the SPSS version 15 program for Windows (SPSS Inc, Chicago, IL). Measured values of the results were expressed in mean ± standard deviation and median with interquartile range. A $p<0.05$ was considered statistically significant.

## Results

Seventy-four patients with CKD stage II-III were screened for possible study enrollment. Forty-four patients were eligible according to the entry criteria and received allopurinol 50 mg once daily. All of these patients were 100% adherent to the allopurinol prescription based on pill counts. Mean age was 70.14±8.50 years and mean estimated GFR was 43.22±14.44 mL/min/1.73 $m^2$. The underlying diseases included hypertension (100%), dyslipidemia (95.5%), type 2 diabetes (31.2%), gout (18.2%), cerebrovascular disease (6.8%), and coronary heart disease (2.3%). Before allopurinol supplement, major patients were administered calcium channel blocker, beta-blocker, angiotensin converting enzyme inhibitor and angiotensin receptor blocker. Characteristics of the patients were shown in Table 1.

**Table 1.** Characteristics of the study population

| Variables | Total (n = 44) |
|---|---|
| Age (years) | 70.14±8.50 |
| Male | 25 (56.8) |
| Weight (kg) | 68.15±15.35 |
| Underlying disease | |
| Hypertension | 44 (100) |
| Dyslipidemia | 42 (95.5) |
| Type 2 diabetes | 14 (31.8) |
| Gout | 8 (18.2) |
| Cerebrovascular disease | 3 (6.8) |
| Coronary heart disease | 1 (2.3) |
| Antihypertensive agents | |
| Calcium channel blocker | 35 (79.6) |
| Beta-blocker | 19 (43.2) |
| Angiotensin converting enzyme inhibitor | 16 (36.4) |
| Angiotensin receptor blocker | 13 (29.6) |
| Diuretic | 12 (27.3) |
| Alpha-blocker | 10 (22.7) |
| Lipid lowering agents | |
| Statin | 38 (86.4) |
| Fibrate | 2 (4.6) |
| Serum uric acid (mg/dL) | 8.11±2.68 |
| Median urine protein creatinine index (IQR) | 210 (72.7, 772) |
| Blood urea nitrogen (mg/dL) | 21.28±9.21 |
| Serum creatinine (mg/dL) | 1.54±0.65 |
| Glomerular filtration rate (mL/min/1.73 $m^2$) | 43.22±14.44 |
| Systolic blood pressure (mmHg) | 137.72±14.72 |
| Diastolic blood pressure (mmHg) | 79.63±11.56 |

Values expressed as n (%), mean ± SD, or median with interquartile range (IQR)

***Biochemical profiles and BP measurements***

Biochemical profiles were shown in Table 2. Serum uric acid decreased significantly from 8.11±2.68 to 7.05±2.38 mg/dL ($p$ = 0.012) at the end of study. Whereas, lipid profiles and liver enzymes were not significantly different before and after treatment. There was significant decrease in systolic BP from 137.72±14.72 to 131.34± 12.10 mmHg ($p$ = 0.019) and diastolic BP from 79.63±11.56 to 75.43±9.80 mmHg ($p$ = 0.037) after 12 weeks of allopurinol treatment (Fig. 1).

***Renal parameters***

Estimated GFR increased significantly from baseline (43.22±14.44 vs. 45.34±16.09, mL/min/1.73 $m^2$, $p$ = 0.029) (Figure 2), but there was no significant changes in BUN, serum creatinine, urine protein creatinine index after 12 weeks of treatment (Table 2). However, there was a trend toward lower serum creatinine level after treatment, although it did not reach statistical significance ($p$ = 0.09).

***Safety profiles***

During the 12-week study period, two of the original 44 patients (4.5%) were withdrawn prematurely because they developed skin rashes and itching two-three days after the initiation of allopurinol treatment, and the rashes subsided promptly after drug withdrawal. Then, allopurinol therapy was restarted and the patients were closely monitored. No serious complications were observed and serum liver function measurements were normal in all patients receiving allopurinol treatment.

**Table 2.** Outcomes after 12 weeks of allopurinol treatment

| | Baseline | 12 weeks | $p$-value |
|---|---|---|---|
| Serum uric acid (mg/dL) | 8.11±2.68 | 7.05±2.38 | 0.012 |
| Urine protein creatinine index (IQR) | 210 (72.7, 772) | 125.8 (77.8, 931) | 0.658 |
| Blood urea nitrogen (mg/dL) | 21.28±9.21 | 20.13±9.06 | 0.389 |
| Serum creatinine (mg/dL) | 1.54±0.65 | 1.49±0.65 | 0.091 |
| LDL (mg/dL) | 110.79±47.05 | 104.11±32.62 | 0.437 |
| HDL (mg/dL) | 49.67±15.22 | 52.08±18.55 | 0.224 |
| Cholesterol (mg/dL) | 187.00±61.06 | 177.64±42.52 | 0.490 |
| Triglycerides (mg/dL) (IQR) | 148 (82.5, 234) | 128.5 (95, 224) | 0.224 |
| AST (U/L) | 24.86±9.32 | 27.32±14.43 | 0.124 |
| ALT (U/L) | 19.12±8.81 | 20.36±9.54 | 0.381 |

LDL = low-density lipoprotein; HDL = high-density lipoprotein; AST = aspartate aminotransferase; ALT = alanine aminotransferase
Values expressed as mean ± SD or median with interquartile range (IQR)

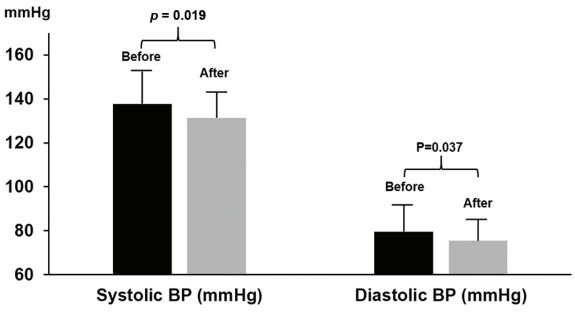


**Fig. 1** Systolic BP and diastolic BP at before and after 12 weeks of allopurinol treatment. There were statistically differences in mean systolic BP and diastolic BP after treatment ($p = 0.019$ and $p = 0.037$).

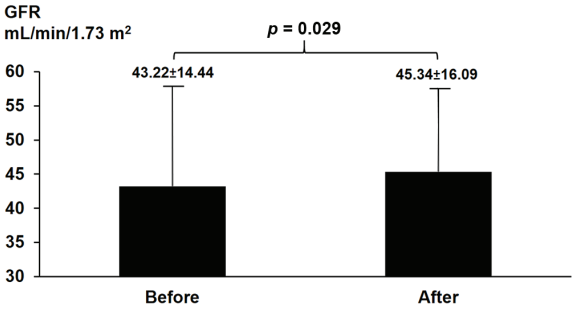


**Fig. 2** Estimated GFR at before and after 12 weeks of allopurinol treatment. There was statistically difference in mean GFR after treatment ($p = 0.029$).

## Discussion

The present study constituted of prospective clinical trial of allopurinol treatment in CKD patients. In CKD patients stage II-III compared to baseline, the low dose allopurinol treatment resulted in decreasing serum uric acid levels, systolic BP, diastolic BP, and increasing in GFR. It also detected the incidence of minor side effects of skin rashes (4.5%). Thus, these findings indicated that allopurinol does not only reduce serum uric acid effectively and safely, but also partly improves hypertension and renal function in patients with early stage CKD.

Hyperuricemia predicts new-onset out-of-office hypertension, and long-term cardiovascular and all-cause mortality[15,16]. Animal models consistently demonstrate the increase in BP under conditions of induced hyperuricemia and this can be blocked or ameliorated by the administration of a xanthine oxidase inhibitor or uricosuric medication[17]. There are limited clinical studies of xanthine oxidase inhibitor with BP. One report, a sample of 30 adolescents with newly diagnosed essential hypertension, were treated with allopurinol, 200 mg twice daily for four weeks versus placebo. Mean change in systolic BP for allopurinol was -6.3 mmHg vs. 0.8 mmHg for placebo and mean change in diastolic BP for allopurinol was -4.6 mmHg vs. -0.3 mmHg for placebo[11]. In hemodialysis patients, after the 12 weeks of allopurinol 100 mg once daily, systolic and diastolic BP also significantly decreased[18]. It is consistent with our findings that systolic BP and diastolic BP decreased in patients with CKD stage II-III after supplement with allopurinol 50 mg once daily for 12 weeks. Therefore, it seems that to ameliorate the hypertensive effect of hyperuricemia, early treatment with allopurinol may be necessary in early stage of CKD.

The present findings supported and extended previous investigations to demonstrate that administration of allopurinol reduced the risk factors for CKD and end stage renal disease[19-21]. Animal model also demonstrated that microvascular renal disease resulted from direct effects of uric acid, the urate was shown to enter into the vascular smooth muscle cell where it caused cell proliferation, activated the local renin-angiotensin system, and stimulated the production of various inflammatory mediators including C-reactive protein and monocyte chemoattractant protein-1[22]. There are very few data evaluating the efficacy of uric acid reduction on progression of CKD. One report in 48 hyperuricemic patients with normal renal function treated with allopurinol 300 mg once daily showed the serum uric acid decreased from 8.0 to 5.5 mg/dL and calculated GFR increased from 79 to 92 ml/minute[12]. Another group performed a study randomizing 54 patients with CKD stage II-IV and serum uric acid >7.6 mg/dL to allopurinol therapy or control groups. Allopurinol therapy significantly decreased serum uric acid levels in hyperuricemic patients with mild to moderate CKD and preserved kidney function during 12 months of therapy compared with controls[13]. Recent study also reported that allopurinol decreased C-reactive protein and slowed down the progression of renal disease in 113 patients with GFR <60 ml/minute[23]. Although, our results did not demonstrate significant changes in BUN and serum creatinine after 12 weeks of treatment, but there was a trend toward lower serum creatinine level and a significant higher GFR that were sensitive and standard marker for changing renal function.

Increased risk of severe, even life-threatening, reactions have been reported to be more common in patients with CKD and occurred in 1 of 25 patients limited the use of allopurinol in the CKD population

because of skin allergy[13]. The present study found only minor skin reaction in two subjects. However, the present study included a relatively small number of patients, nonrandomized control and short-term study should not be construed to suggest that allopurinol is without adverse effects because the study was not designed to make such evaluation.

In conclusion, allopurinol therapy significantly decreases serum uric acid levels in CKD patients. Its use is safe and helps control BP and preserve kidney function during 12 weeks of therapy. The superiority of allopurinol for the BP and renal function in patients with CKD should be further assessed by a larger number of patients and longer treatment period.

**What is already known on this topic?**

Hyperuricemia has been associated with increased risk of hypertension, cardiovascular and renal disease. Allopurinol is a potent xanthine oxidase inhibitor used in hyperuricemic patients. It has also been shown to decrease cardiovascular disease and hypertension. However, studies have reported conflicting evidence on its effects on blood pressure and renal function in CKD patients.

**What this study adds?**

Low dose allopurinol therapy (50 mg/day) significantly decreases serum uric acid levels in CKD patients. Its use is safe and helps control blood pressure and preserve kidney function during 12 weeks of therapy. The superiority of allopurinol is for the blood pressure and renal function in patients with CKD.

**Acknowledgements**

The authors wish to acknowledge the contributions of the following individuals to the present study, staffs in Division of Nephrology and Biomedical Clinical Research Center in Phramongkutklao Hospital. The present study was supported by the Department of Medicine, Phramongkutklao Hospital and College of Medicine.

**Potential conflicts of interest**

None.

**References**

1. Cannon PJ, Stason WB, Demartini FE, Sommers SC, Laragh JH. Hyperuricemia in primary and renal hypertension. N Engl J Med 1966; 275: 457-64.
2. Satirapoj B, Supasyndh O, Chaiprasert A, Ruangkanchanasetr P, Kanjanakul I, Phulsuksombuti D, et al. Relationship between serum uric acid levels with chronic kidney disease in a Southeast Asian population. Nephrology (Carlton) 2010; 15: 253-8.
3. Nakanishi N, Okamoto M, Yoshida H, Matsuo Y, Suzuki K, Tatara K. Serum uric acid and risk for development of hypertension and impaired fasting glucose or Type II diabetes in Japanese male office workers. Eur J Epidemiol 2003; 18: 523-30.
4. Sundstrom J, Sullivan L, D'Agostino RB, Levy D, Kannel WB, Vasan RS. Relations of serum uric acid to longitudinal blood pressure tracking and hypertension incidence. Hypertension 2005; 45: 28-33.
5. Taniguchi Y, Hayashi T, Tsumura K, Endo G, Fujii S, Okada K. Serum uric acid and the risk for hypertension and Type 2 diabetes in Japanese men: The Osaka Health Survey. J Hypertens 2001; 19: 1209-15.
6. Mazzali M, Hughes J, Kim YG, Jefferson JA, Kang DH, Gordon KL, et al. Elevated uric acid increases blood pressure in the rat by a novel crystal-independent mechanism. Hypertension 2001; 38: 1101-6.
7. Sanchez-Lozada LG, Tapia E, Santamaria J, Avila-Casado C, Soto V, Nepomuceno T, et al. Mild hyperuricemia induces vasoconstriction and maintains glomerular hypertension in normal and remnant kidney rats. Kidney Int 2005; 67: 237-47.
8. Watanabe S, Kang DH, Feng L, Nakagawa T, Kanellis J, Lan H, et al. Uric acid, hominoid evolution, and the pathogenesis of salt-sensitivity. Hypertension 2002; 40: 355-60.
9. Butler R, Morris AD, Belch JJ, Hill A, Struthers AD. Allopurinol normalizes endothelial dysfunction in type 2 diabetics with mild hypertension. Hypertension 2000; 35: 746-51.
10. Melendez-Ramirez G, Perez-Mendez O, Lopez-Osorio C, Kuri-Alfaro J, Espinola-Zavaleta N. Effect of the treatment with allopurinol on the endothelial function in patients with hyperuricemia. Endocr Res 2012; 37: 1-6.
11. Feig DI, Soletsky B, Johnson RJ. Effect of allopurinol on blood pressure of adolescents with newly diagnosed essential hypertension: a randomized trial. JAMA 2008; 300: 924-32.
12. Kanbay M, Ozkara A, Selcoki Y, Isik B, Turgut F, Bavbek N, et al. Effect of treatment of hyperuricemia with allopurinol on blood pressure, creatinine clearence, and proteinuria in patients

with normal renal functions. Int Urol Nephrol 2007; 39: 1227-33.
13. Siu YP, Leung KT, Tong MK, Kwan TH. Use of allopurinol in slowing the progression of renal disease through its ability to lower serum uric acid level. Am J Kidney Dis 2006; 47: 51-9.
14. Andrassy KM. Comments on 'KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease'. Kidney Int 2013; 84: 622-3.
15. Bombelli M, Ronchi I, Volpe M, Facchetti R, Carugo S, Dell'oro R, et al. Prognostic value of serum uric acid: new-onset in and out-of-office hypertension and long-term mortality. J Hypertens 2014; 32: 1237-44.
16. Feig DI. Serum uric acid and the risk of hypertension and chronic kidney disease. Curr Opin Rheumatol 2014; 26: 176-85.
17. Satirapoj B. Uric acid and kidney disease. R Thai Army Med J 2010; 63: 81-6.
18. Jalalzadeh M, Nurcheshmeh Z, Mohammadi R, Mousavinasab N, Ghadiani MH. The effect of allopurinol on lowering blood pressure in hemodialysis patients with hyperuricemia. J Res Med Sci 2012; 17: 1039-46.
19. Feig DI, Kang DH, Johnson RJ. Uric acid and cardiovascular risk. N Engl J Med 2008; 359: 1811-21.
20. Satirapoj B, Supasyndh O, Nata N, Phulsuksombuti D, Utennam D, Kanjanakul I, et al. High levels of uric acid correlate with decline of glomerular filtration rate in chronic kidney disease. J Med Assoc Thai 2010; 93 (Suppl 6): S65-70.
21. Hsu CY, Iribarren C, McCulloch CE, Darbinian J, Go AS. Risk factors for end-stage renal disease: 25-year follow-up. Arch Intern Med 2009; 169: 342-50.
22. Johnson RJ, Rodriguez-Iturbe B, Kang DH, Feig DI, Herrera-Acosta J. A unifying pathway for essential hypertension. Am J Hypertens 2005; 18: 431-40.
23. Goicoechea M, de Vinuesa SG, Verdalles U, Ruiz-Caro C, Ampuero J, Rincon A, et al. Effect of allopurinol in chronic kidney disease progression and cardiovascular risk. Clin J Am Soc Nephrol 2010; 5: 1388-93.

## ประโยชน์ของยา allopurinol ต่อความดันโลหิต และการทำงานของไตในการรักษาผู้ป่วยไตเรื้อรังระยะต้น

บัญชา สถิระพจน์, อรสาต์ วีระจิตต์ม, อนุชาติ บุระตะ, อุปถัมภ์ ศุภสินธุ์, ประเจษฎ์ เรืองกาญจนเศรษฐ์

**ภูมิหลัง:** ภาวะยูริกในเลือดสูงสัมพันธ์กับการเกิดพยาธิสภาพของหลอดเลือด โรคหัวใจและหลอดเลือด และโรคไต ยา allopurinol ออกฤทธิ์ยับยั้งการทำงานของเอนไซม์ xanthine oxidase ใช้รักษาผู้ป่วยที่มีภาวะยูริกในเลือดสูง ยากลุ่มนี้มีรายงานสามารถลดอัตราการเกิดโรคหัวใจและหลอดเลือด และความดันโลหิตสูงได้ อย่างไรก็ตามหลักฐานการศึกษามีความขัดแย้งกันถึงบทบาทของยาต่อระดับความดันโลหิต และอัตราการกรองของไตในผู้ป่วยโรคไตเรื้อรัง

**วัตถุประสงค์:** เพื่อแสดงประสิทธิภาพของยา allopurinol ต่อระดับความดันโลหิต และอัตราการกรองของไตในผู้ป่วยโรคไตเรื้อรัง

**วัสดุและวิธีการ:** ผู้ป่วยโรคไตเรื้อรังระยะ 2 และ 3 ถูกคัดกรองเข้าการศึกษา ผู้ป่วยทุกรายจะได้รับยา allopurinol 50 มิลลิกรัม ต่อวัน นาน 12 สัปดาห์ ผลการศึกษาหลักคือ ติดตามการเปลี่ยนแปลงของระดับความดันโลหิต และอัตราการกรองของไตหลังการรักษา

**ผลการศึกษา:** ผู้ป่วยโรคไตเรื้อรัง 44 ราย อายุเฉลี่ย 70.14±8.50 ปี และอัตราการกรองของไตเฉลี่ย 43.22±14.44 มิลลิลิตร/นาที ต่อ 1.73 ตารางเมตร ระดับยูริกในเลือดลดลงจาก.11.00±2.68 เป็น 7.05±2.38 มิลลิกรัม/เดซิลิตร อย่างมีนัยสำคัญทางสถิติ $p = 0.012$ หลังจบการศึกษา ยา allopurinol สามารถลดความโลหิตขณะหัวใจบีบตัวจาก 137.72±14.72 เป็น 131.34±12.1 มิลลิเมตรปรอท อย่างมีนัยสำคัญทางสถิติ $p = 0.019$ และลดความดันโลหิตขณะหัวใจคลายตัวจาก 79.63±11.56 เป็น 75.43±9.8 มิลลิเมตรปรอท อย่างมีนัยสำคัญทางสถิติ $p = 0.037$ นอกจากนี้ยายังสามารถเพิ่มอัตรากรองของไตจาก 43.22±14.44 เป็น 45.34±16.09 มิลลิลิตร/นาที ต่อ 1.73 ตารางเมตร อย่างมีนัยสำคัญทางสถิติ $p = 0.029$ โดยไม่พบผลข้างเคียงร้ายแรงใด ๆ พบเพียงผู้ป่วย 2 ราย หรือร้อยละ 4.5 ที่มีอาการผื่นแพ้ยาแบบไม่รุนแรง

**สรุป:** การศึกษานี้ยืนยันว่า การรักษาด้วยยา allopurinol เป็นระยะเวลา 12 สัปดาห์ มีประสิทธิภาพลดยูริกในเลือด ลดความดันโลหิต และเพิ่มอัตรากรองของไตในผู้ป่วยไตเรื้อรังระยะต้นที่ได้รับการรักษาตามมาตรฐานด้วยยาควบคุมความดันโลหิตสูงอยู่เดิม โดยไม่พบผลข้างเคียงร้ายแรงใด ๆ