

## Evaluation of any relationship between serum calcium and uric acid levels with Computed Tomography (CT scan) Stone Density

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### Abstract

Both of Calcium & uric acid are important in stone formation, There are multiple risk factors for stone formation such as: low fluid intake, hypercalciuria, primary hyperparathyroidism, high salt diet, high animal protein intake. Computed tomography CT is currently used most commonly to predict the type and opacity of stone (stone density) measured in HU. (Hounsfield unit)

A total of 100 adult patients with renal stone, discovered by abdominal ultrasound examination, were chosen, there was no significant difference in the mean stone density in terms of patients' age, gender, and BMI, the patients with high uric acid levels had significantly higher mean stone density when compared to the patients with low or normal levels of uric acid, Patients with high serum calcium levels may have high CT stone density.

**Keywords:** Computed tomography CT; Hounsfield unit HU; Urinary stones

### 1. Introduction

Kidney stone disease typically presents between the ages of 20 and 60 and is more prevalent in hot climates<sup>1</sup>, It affects about 10% of people over their lifetime, incidence increasing with age; 50% will have a recurrence within 5–10 years and 75% within 20 years.<sup>2</sup>, Developed countries have seen rapid increases over the last 30 years, especially in women in whom incidence is now almost equal to that of men <sup>3</sup>, Computed tomography CT is currently used most commonly to predict the type of stone and assess the potential efficacy of extracorporeal shock wave lithotripsy treatment. However, it might also assist urologists to decide which of percutaneous nephrolithotomy, ureterorenoscopic ureterolithotripsy, and medical expulsive treatment should be used to treat a patient.<sup>4</sup>

#### Objective

Both of Calcium and uric acid is important in stone formation, our study to detect any relationship between serum calcium and uric acid levels with CT scan stone density.

### 2. Material and methods

A study was done in period from 1<sup>st</sup> of march 2023 to the end of December 2023, A hundred adult from both sexes between (18-76) year with renal stone (discovered by abdominal ultrasound examination) were chosen, informed

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consent was obtained from all participants, all send to lab. for serum calcium and uric acid levels and also GUE, Also all done abdominal CT scan with UH. stone density measurement.

### 3. Results

A total of 100 adult patients with renal stones were recruited in this study. The age range was 18 to 76, with a mean of  $45.97 \pm 14.63$  years. The highest proportion of the studied patients aged  $> 55$  years (31%), followed by 27% who aged  $< 35$  years. Regarding gender, there were 60% males versus 40% females with a male-to-female ratio of 1.5:1. The calculated BMI had a mean of  $27.25 \pm 4.88$  kg/m<sup>2</sup>, 33% had normal weight while 43% and 24% were overweight and obese, respectively.

According to the CT scan, the mean stone density was  $767.3 \pm 236.7$  HU. There was no significant difference in the mean stone density in terms of patients' age, gender, and BMI ( $P \geq 0.05$ ). As shown in (Table 1).

**Table 1** Comparison of CT stone density according to age, gender, and BMI

	Stone Density (HU) Mean $\pm$ SD	Test Value	P- Value*
Age Group (Years)			
< 35	757.1 $\pm$ 238.3	0.722	0.539
35 – 44	837.6 $\pm$ 287.3		
45 – 54	803.4 $\pm$ 223.1		
$\geq 55$	705.4 $\pm$ 236.7		
Gender			
Male	774.4 $\pm$ 251.1	0.255	0.799
Female	756.8 $\pm$ 218.1		
BMI (kg/m <sup>2</sup> )			
Normal	787.7 $\pm$ 214.5	0.805	0.450
Overweight	794.1 $\pm$ 251.1		
Obese	691.3 $\pm$ 242.6		

\* Significant difference between two means using the Students-t-test, and more than two means using ANOVA test at 0.05 level.

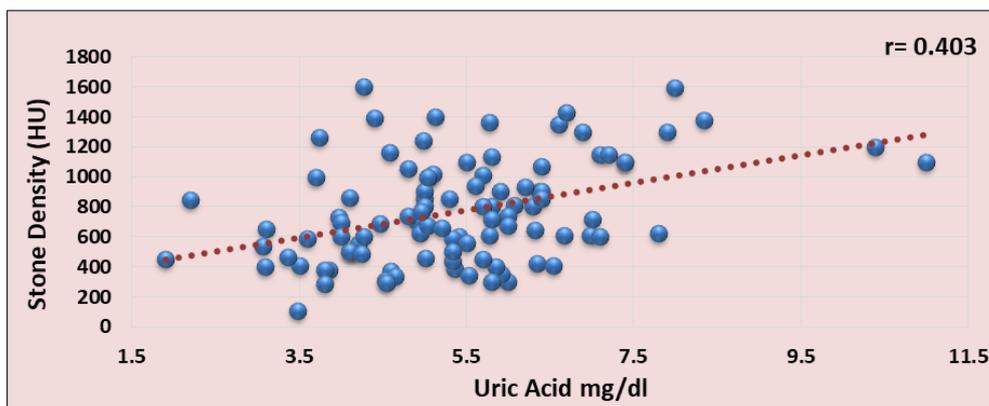
This study found a statistically significant difference in the mean stone density according to the uric acid levels. Multiple comparisons showed that the patients with high uric acid levels had significantly higher mean stone density when compared to the patients with low or normal levels of uric acid (923.7 mg/dl vs 494.1 mg/dl and 775.1 mg/dl,  $P= 0.001$ ) respectively. Although the mean stone density was higher in the patients with high calcium concentrations than those with low or normal levels, this difference was not significant. Further, no significant difference was detected in the stone density according to findings of general urine examination. As illustrated in (Table 2).

**Table 2** Comparison of CT stone density according to biochemical parameters

Biochemical Parameters	Stone Density (HU) Mean $\pm$ SD	Test Value	P- Value*
Uric Acid (mg/dl)			
Low	494.1 $\pm$ 227.4	3.342	0.039
Normal	775.1 $\pm$ 233.1		
High	923.7 $\pm$ 252.8		
Serum Calcium (mg/dl)			
Low	647.3 $\pm$ 283.4	0.896	0.412

Normal	781.1 ± 248.2		
High	814.4 ± 270.6		
General Urine Examination			
Urate	759.8 ± 236.5	- 0.886	0.378
Others	885.67 ± 248.5		

In the Pearson correlation analysis, there was a significant, positive correlation between stone density and uric acid levels ( $r= 0.403$ ,  $P= 0.001$ ) while the stone density was not significantly correlated with the other variables. As shown in (Figure 1) and (Table 3).



**Figure 1** Correlation of stone density with uric acid levels

**Table 3** Correlations of stone density with clinical characteristics

Variable	Stone Density (HU)	
	r	P - Value*
Age (Years)	- 0.128	0.205
BMI (kg/m <sup>2</sup> )	- 0.042	0.682
Uric Acid (mg/dl)	0.403	0.001
Serum Calcium (mg/dl)	0.079	0.432

\*Correlation is significant at the 0.05 level.

### 3.1. Statistical analysis

All analyses were performed using SPSS version 25.0 (IBM Corp.). Kolmogorov–Smirnov and Shapiro–Wilk tests were used to determine the presence of a parametric distribution and they confirmed that the data were normally distributed. Therefore, the significance of the difference between different means (quantitative data) was tested using the Students-t-test for the difference between two independent means, or the ANOVA test for the difference between more than two means. Pearson correlation was calculated for the correlation between two quantitative variables with its t-test for testing the significance of correlation. Pearson correlation was calculated for the correlation between two quantitative variables with its t-test for testing the significance of correlation. The correlation coefficient value ( $r$ ) is either positive (direct correlation) or negative (inverse correlation) with values  $<0.3$  representing no correlation,  $0.3-<0.5$  representing weak correlation,  $0.5-<0.7$  moderate strength, and  $>0.7$  strong correlation. A level of P-value less than 0.05 was considered significant.

## 4. Discussion

Stone growth starts with the formation of crystals in supersaturated urine which then adhere to urothelium, thus creating the nidus for subsequent stone growth, recent theories focus on the role of cell surface molecules which favour

or inhibit crystal adhesion<sup>(5,6)</sup>, Urothelial injury and repair after a stone episode may increase surface expression of these molecules to favour further crystal adhesion<sup>(7,8)</sup>

There is multiple risk factors for stone formation such as: Low fluid intake, Hypercalciuria<sup>(9)</sup> primary hyperparathyroidism<sup>(10)</sup>,deactivating vitamin D receptor (VDR) polymorphisms<sup>(11)</sup> and activating fibroblast growth factor (FGF) 23 polymorphism<sup>(12,13)</sup>, A high salt diet increases urinary calcium output<sup>(14,15)</sup>, oxaluria<sup>(16,17)</sup>, low calcium intake<sup>(18,19,20,21)</sup>,Hypocitraturia<sup>(22)</sup>,High animal protein intake<sup>(23,24)</sup>,Enteric hyperoxaluria<sup>(25)</sup>, Primary hyperoxaluria<sup>(26,27)</sup>

Abdominal CT can assess the density of the stone in Hounsfield units (HU). The HU, or Hounsfield density have been used to predict the type and opacity of stones during diagnosis, and the efficacy has been assessed using methods including extracorporeal shock wave lithotripsy (ESWL)<sup>(28,29,30,31,32,33)</sup>, percutaneous nephrolithotomy (PCNL)<sup>(34,35,36)</sup>,ureterorenoscopic ureterolithotripsy (URSL)<sup>37</sup>, and medical expulsive treatment (MET)<sup>38</sup>. Sir Godfrey Newbold Hounsfield first introduced the principle to quantify the amount of X-rays that pass through or are absorbed by tissues, and developed the resulting radiodensity scale. CT images are made up of pixels, each of which has a gray scale value from 1 (black) to 256 (white). This value corresponds to the amount of X-rays that pass through the structure, and can be measured and expressed in Hounsfield units (HU). HU have since been used to evaluate and quantify tissues and fluids. When the radiodensity of water is defined as 0, fat has a negative HU, and blood and other tissues have a positive HU. Using this method it is possible to differentiate 256 shades of gray that are indistinguishable to the naked eye,<sup>39</sup>.

Our study show incidence of stone more in age group more than 55yr old and more on male than female, goes with similar study, Fadhil Y.S.(2022)<sup>40</sup>, also show high renal stone incidence on over weight and obese patients similar to study done by Michelle J. Semins, Andrew D. Shore, Martin A. Makary, Thomas Magnuson, Roger Johns, and Brian R. Matlaga, 2009,<sup>(41)</sup>

Our study showing high CT stone density on patient with high serum uric acid goes with other study done Jong Chan Kim,<sup>(1)</sup> Kang Su Cho,<sup>(2)</sup> Do Kyung Kim,<sup>2</sup> Doo Yong Chung,<sup>1</sup> Hae Do Jung,<sup>3</sup> and Joo Yong Lee<sup>(1,\*42)</sup>

Also high calcium goes with high CT stone density similar to study done by Abdallah Saud Alharb Assessment of Hounsfield Units and Factors Associated with Fragmentation of Renal Stones by Extracorporeal Shock Wave Lithotripsy: A Computerized Tomography Study

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## 5. Conclusion

- Patients with high serum uric acid levels showing high CT stone density
- Patients with high serum calcium levels may have high CT stone density
- Age, gender and BMI have no any relationship to CT stone density

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## Compliance with ethical standards

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### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

### *Statement of informed consent*

Informed consent was obtained from all individual participants that were included in the study.

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