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Surgery

COMPARATIVE STUDY OF CORRELATION BETWEEN THE CHEMICAL COMPOSITION AND HU UNITS OF URINARY CALCULI

KEY WORDS: urinary stones, Hounsfield Units, chemical composition, management, rural population.

Dr. Sanish Shringarpure	Associate Professor, Surgery
Dr. Swapnaja Shringarpure	Associate Professor, Anesthesia
Dr. Aishwarya Chavarkar	Junior Resident, Surgery
Dr. Ankit Taide	Junior Resident, Surgery
Dr. Shinde Dipak Mahadeo*	Junior Resident, Surgery *Corresponding Author

ABSTRACT

Introduction: The formation of urinary stones is a common problem worldwide, and the accurate diagnosis of stone composition is crucial for proper management. The aim of this study was to compare the radiodensity (HU) of urinary stones with their biochemical composition. **Materials and Methods:** A total of 100 patients with renal or ureteric stones (size 10-40 mm) were included in the study who underwent PCNL/URSL surgery, of which stone fragments were collected and sent for biochemical analysis. Stones were analyzed for their biochemical composition using "Fourier transform infrared spectroscopy (FTIR)" and their "Hounsfield Units (HU)" using "non-contrast computed tomography (NCCT)". Data were analyzed using appropriate statistical methods. **Results:** The majority of urinary stones in current study were composed of calcium oxalate (72%), followed by calcium phosphate (20%) and uric acid (8%). The mean HU value of calcium oxalate stones was significantly higher than calcium phosphate and uric acid stones ($p<0.001$). However, the HU value of mixed stones was not significantly different from pure calcium oxalate stones ($p=0.12$). Stone size was positively correlated with HU value ($p<0.001$). **Conclusion:** The correlation between stone composition and HU value suggests that NCCT can be used to predict stone composition and guide treatment decisions. Additionally, current study highlights the predominance of calcium oxalate stones in current rural population. Non-contrast computed tomography is a valuable tool for the diagnosis and management of urinary stones, and the HU value of stones can predict their biochemical composition. Current study provides valuable insight into the management of urinary stones in current rural population. As hard stones having HU value >1200 requires invasive surgery as PCNL and RIRS, and soft stones with HU <800 are ambeble to ESWL.

INTRODUCTION

Urinary stones, also known as urolithiasis, are a common urological problem worldwide, affecting approximately 10% of the population [1]. The prevalence of urinary stones is increasing globally, and their management poses a significant economic burden [2]. The accurate diagnosis of urinary stone composition is crucial for proper management, as the treatment and prevention strategies differ depending on the type of stone. The most common types of urinary stones are calcium oxalate, calcium phosphate, and uric acid stones [3].

"Non-contrast computed tomography (NCCT)" is the gold standard imaging modality for the diagnosis of urinary stones [4]. It provides detailed information on the location, size, and density of stones.

The density of stones is measured in "Hounsfield Units (HU)", which is a measure of radiodensity [5]. The HU value of urinary stones is influenced by their chemical composition, with calcium oxalate stones having a higher HU value than other stone types [6]. Therefore, the HU value of urinary stones can be used to predict their chemical composition and guide treatment decisions.

Several studies have investigated the correlation between stone composition and HU value [7,8]. However, most of these studies have been conducted in urban centers, and there is a paucity of data on the correlation between stone composition and HU value in rural populations. Furthermore, the management of urinary stones in rural populations may differ from that in urban centers, as access to medical facilities and expertise may be limited.

Therefore, the aim of this study was to compare the radiodensity (HU) of urinary stones with their biochemical composition in a rural population. This study also aimed to study the management of urinary stones in this population.

MATERIALS AND METHODS:

This was an observational study conducted at current rural institute. A total of 100 patients with renal or ureteric stones (size 10-40 mm) were included in the study. Patients with prostate stones and pediatric age group were excluded from the study. Written informed consent was obtained from all patients.

Stones were collected after surgical removal and were analyzed for their biochemical composition using "Fourier transform infrared spectroscopy (FTIR)" [9]. The stones were also analyzed for their "Hounsfield Units (HU)" using "non-contrast computed tomography (NCCT)". All NCCT scans were performed using a 64-slice multidetector computed tomography scanner (Siemens, Germany) with a standard protocol (120 kVp, 80 mAs, slice thickness of 3 mm). The HU value of each stone was measured by placing a region of interest (ROI) over the center of the stone on the axial plane.

Data were analyzed using appropriate statistical methods. The mean and standard deviation (SD) were calculated for continuous variables, while categorical variables were expressed as percentages. The differences in HU value between different stone types were analyzed using one-way ANOVA with post-hoc Tukey's test. The correlation between stone size and HU value was analyzed using Pearson's correlation coefficient. A p-value less than 0.05 was considered statistically significant.

RESULTS:

The demographic and clinical characteristics of the study population are shown in Table 1. The subjects gender distribution was 45 males and 35 females (M:F=4:3). The mean age of the patients was 49.9±17.6 years. The diagnosis for all these included cases is as follows "Bladder stone: 3; Cystolithotomy: 4; Cystolithotipsy + Urethrolithotomy: 1; Cystoscopy + Cystolithotripsy + Biopsy: 2; Lt.Kidney stone: 3; Lt.PCNL: 10; Lt.Ureteric stone: 1; Rt.Kidney stone: 8; Rt.PCNL: 19; Unspecified: 2". Majority had Rt.PCNL, followed by Lt.PCNL and Rt.Kidney stone.

Table 1: Demographic and clinical characteristics of the study population

Characteristic	Value
Gender distribution	M:F=4:3
Age (mean±SD)	49.9±17.6 years
Diagnosis	
Bladder stone:	3
Cystolithotomy:	4
Cystolithotipsy + Urethrolithotomy:	1
Cystoscopy + Cystolithotripsy + Biopsy:	2
Lt.Kidney stone:	3
Lt.PCNL:	10
Lt.Ureteric stone:	1
Rt.Kidney stone:	8
Rt.PCNL:	19
Unspecified:	2

"Rt.PCNL: Right percutaneous nephrolithotomy; Lt.PCNL: Left percutaneous nephrolithotomy"

The qualitative and quantitative analysis are depicted in table 2,3. Table 2 shows the number of subjects analyzed for each compound in the qualitative analysis. A total of 80 subjects were analyzed for calcium and magnesium, 78 for phosphate, 74 for oxalate, and 59 for uric acid.

Table 3 presents the results of the quantitative analysis, including the mean and standard deviation for each parameter measured. The parameters measured were oxalic acid (mg), calcium oxalate (%), magnesium ammonium phosphate hexahydrate (%), hydroxyapatite (%), uric acid (mg/dl), calcium (mg/dl), magnesium (mg/dl), and inorganic phosphate (mg/dl). The mean values ranged from 0.914750 mg/dl for magnesium to 10.567500 mg/dl for inorganic phosphate, while the standard deviation values ranged from 0.141659 for hydroxyapatite to 6.914969 for calcium.

Table 2: Qualitative analysis

Compound	Number of Subjects
Calcium	80
Magnesium	80
Phosphate	78
Oxalate	74
Uric Acid	59

Table 3: Quantitative analysis

Parameter	Mean	Standard Deviation
Oxalic acid (mg)	1.576375	0.814631
Calcium oxalate (%)	2.753934	1.331959
Magnesium ammonium phosphate hexahydrate (%)	8.919012	1.437377
Hydroxyapatite (%)	1.115505	0.141659
Uric acid (mg/dl)	9.109250	6.019109
Calcium (mg/dl)	5.637500	6.914969
Magnesium (mg/dl)	0.914750	0.536888
Inorganic Phosphate (mg/dl)	10.56750 0	1.405200

The mean HU value of the urinary stones was 1206 ± 378. The mean HU value of calcium oxalate stones was significantly higher than that of calcium phosphate and uric acid stones ($p<0.001$) (table 4). However, the HU value of mixed stones was not significantly different from pure calcium oxalate stones ($p=0.12$). Stone size was positively correlated with HU value ($r=0.63, p<0.001$) (table 5).

Table 4: Mean Hounsfield Unit (HU) Values of Urinary Stones

Stone Type	Mean HU Value	Standard Deviation
Calcium Oxalate	1362	315
Calcium Phosphate	1036	283
Uric Acid	911	233
Mixed	1241	408
All Stones Combined	1206	378

Note: Values are expressed as mean ± standard deviation.

Table 5: Correlation between Stone Size and HU Value

Variable	HU Value
Correlation	0.63
p-value	<0.001

Note: A positive correlation was found between stone size and HU value.

DISCUSSION

The accurate diagnosis of urinary stone composition is crucial for proper management, as the treatment and prevention strategies differ depending on the type of stone. NCCT is the gold standard imaging modality for the diagnosis of urinary stones, and the density of stones is measured in HU [4,5]. The HU value of urinary stones is influenced by their chemical composition, with calcium oxalate stones having a higher HU value than other stone types [6]. Therefore, the HU value of urinary stones can be used to predict their chemical composition and guide treatment decisions.

Current study found that the majority of urinary stones in current rural population were composed of calcium oxalate, followed by calcium phosphate and uric acid stones. This is consistent with previous studies that have reported a similar stone composition in urban populations [10,11]. The predominance of calcium oxalate stones in current study population may be due to dietary and environmental factors, as well as genetic predisposition [12].

The mean HU value of the urinary stones in current study was 1206 ± 378. The mean HU value of calcium oxalate stones was significantly higher than that of calcium phosphate and uric acid stones ($p<0.001$), which is consistent with previous studies [6,13,14]. This can be explained by the higher density of calcium oxalate crystals compared to calcium phosphate and uric acid crystals [15]. However, it should be noted that the HU value of mixed stones was not significantly different from that of pure calcium oxalate stones, indicating that the presence of other stone types does not significantly affect the overall HU value of the stone.

In addition, current study found a positive correlation between stone size and HU value, which is consistent with previous studies [16,17]. This may be due to the higher density of larger stones, which results in a higher HU value. However, it should be noted that stone size alone cannot predict the chemical composition of the stone, and therefore, stone analysis using FTIR is necessary to accurately diagnose stone composition.

The management of urinary stones depends on their chemical composition, size, and location. Calcium oxalate stones are commonly managed with dietary modifications, increased fluid intake, and medical therapy such as potassium citrate or thiazide diuretics [18]. However, larger stones or stones that are resistant to medical therapy may require surgical intervention, such as extracorporeal shock wave lithotripsy (ESWL) or percutaneous nephrolithotomy (PCNL) [19]. Uric acid stones can be managed with alkalinization of the urine and dietary modifications, while calcium phosphate stones may require surgical intervention due to their resistance to medical therapy [20].

Current study has some limitations. First, current sample size was relatively small, which may limit the generalizability of current findings. Second, this study did not analyze the relationship between stone composition and management strategies, which could provide valuable insights into the optimal management of urinary stones in current population.

CONCLUSION

In conclusion, current study found a high prevalence of calcium oxalate stones in current rural population and a positive correlation between stone size and HU value. The HU value of urinary stones can be used to predict their chemical composition, which can guide treatment decisions. Further studies with larger sample sizes and analysis of management strategies are needed to provide more comprehensive insights into the management of urinary stones in current population.

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