Original Article

Incidence and prevalence of Uric Acid versus Non-Uric Acid stones in different age groups using Dual Energy CT Scan as a diagnostic tool

Amna akram,[1] Syeda laraib bukhari,[2] Bushra aziz,[3] Muhammad Abdullah,[4] Marya tabassum[5]

Abstract

Objective: To find incidence and prevalence of uric acid versus non-uric acid stones in different age groups using dual energy CT scan as a diagnostic tool.
Study design: It was a A cross-sectional study design.
Place and duration of study: The study was conducted from in Shifa international Hospital (Islamabad, Pakistan) from July 2022 to December 2022.
Material and Methods: A cross-sectional study was conducted at Shifa international Hospital Islamabad, Pakistan. Patients underwent DECT scan of abdomen pelvis and post-processed by Syngovia system were included. The attenuation curve for the stone is plotted on a graph. The red and blue lines superimposed on the graph represent the attenuation curves for UA stones and non-uric acid stones respectively.
Results: Out of 310 patients there were 199(64.2%) males and 111(35.8%) female participants. The average age of the participants was 47.63±17.30 years. A total 201(64.8%) kidney stone participants, Uric acid stones were found in 23(7.4%) participants and non-uric acid stones in 178(57.4%) participants. Stones found were common in age group of 20-60 years with large number of UA stones in age group 41-50 years were 8(3.98%) and non-UA stones in age group 31-40 years were 43(21.39%). Data was analyzed using SPSS software version 23 and p-value was greater than 0.05.
Conclusion: Kidney stones is more common in males as compared to females. UA stones have small size as compared to non-UA acid. Non-Uric acid stones have high prevalence than uric acid stone. High prevalence of kidney stones in age interval of 20-60 Years.
Keywords: Dual energy computed tomography, computed tomography, Uric acid, kidney ureter bladder, Intravenous pyelogram, Picture archival communication system

1. Introduction

Urinary tract stones like kidney stones (also called nephrolithiasis, urolithiasis or renal calculi) are crystallized deposits made up of salt and minerals formed inside of our urinary tract (ureter, bladder or kidney). The chemicals (urea and creatinine) and other materials in our urine were used to create the dense object.(1) Various wastes can be found in urine. Crystals begin to develop when there is too much waste in too little liquid. If not removed from the body by urination, these crystals start to draw in additional elements and combine to form a solid that grows in size. Our kidney, the body's primary antioxidant, often eliminates these toxins in the urine.(2) In healthy individual who are taking large amount of water then these chemicals are washed out that decrease chance of stone formation. The different chemicals that lead to stone formation are oxalate, calcium, cysteine, urate and phosphate. After formation, stone may travel down into ureter or may stay in kidney. Some stones are painless and removed out from body through urine silently, and those which are not removed may cause urinary obstruction and might be painful.(3)

Lecturer at Center of Advanced Studies in Health & Technology,RWP,[1] Lecturer at KMU, Islamabad Campus,[2] Student at Shifa Tameer-e-Millat University, Islamabad,[3] Student at Fazia medical college, Islamabad,[4] Student at Govt graduate college.[5]

Correspondence: Amna akram , Lecturer at Center of Advanced Studies in Health & Technology,RWP **Email:** amna.202akram@gmail.com

found; uric acid stone, which is a crystallized object made from the chemicals in the urine. Stones made up of calcium oxalate, struvite, hydroxyapatite, and cysteine are types of non-uric acid stones.[4] Sign and symptoms may include a number of the following: intense lower backache (posterolateral pain), chronic upset stomach, painful urination, nausea and vomiting, dizziness, and clouded urine with bad smell.[5]

A medical history, physical examination, and some imaging tests can be used to make the diagnosis. A high-resolution computed tomography scan (CT scan) can be used from the kidney to the bladder to determine the shape and size of the stone. And an Xray called a "KUB" can be used to determine the size and location of the stone. The specialists routinely get a KUB -ray to examine whether the stone can be treated with shock waves. But the CT scan is preferred for diagnostic purpose. Intravenous pyelogram (IVP) can also be performed for diagnosis of kidney stones. After administering a dye, a particular type of urinary system X-ray called an IVP is performed. Both children and adults can be treated from urinary tract stone. We advised a patient to drink large amount of water. Without surgical intervention, doctors try to remove stone from body with urine. Patients may also be prescribed medication to aid improve the acidity in their urine.[6]

The Computed tomography has developed into an important imaging technique in everyday practice. It was the first method to obtain non-invasive images of the human bodies inside that were undetectable by the superposition of various anatomical structures. A succession of X-rays is turned around a particular body part during a CT scan to make cross-sectional images that are then delivered by a computer. The best accurate diagnosis is regularly made with CT of the abdomen without contrast, however doing so exposes patients to ionizing radiation.[7]

Dual energy computed tomography (DECT) is upgrading in CT scan, in which we use both high and low energy x-rays to form the image. So dual energy CT scan is used for different types of test and procedures and have additional advantages over standard CT. In DECT, we use two different types of x-rays to form two image datasets of the same body parts, through which we can identify the changes in attenuation between different material on basis of energy dependent. Each material has specific attenuation. Low energy spectrum and high energy spectrum demonstrate the change in attenuation between images and also provide information of material composition. For diagnosis of urinary tract stone, CT scan without contrast is the gold standard. It considered low dose protocol so it decreases risk of radiation exposure to patient and increase diagnostic quality, which is more helpful to those individual especially adult or young who require multiple CT scan for recurrent disease.[8]

Imaging of kidney stones is a crucial diagnostic tool and the first step in deciding on the therapeutic choices for the management of ureteral stones. Numerous criteria, such as the clinical environment, the patient's body habits, the cost, and their tolerance to ionizing radiation, are important for choosing the best imaging method for this. Although there are many imaging modalities available, plain film radiography of the kidney, ureter, and bladder (KUB) and computed tomography (CT) are the most often utilized clinical modalities. Ultrasonography does not use radiation but traditionally had a lesser specificity and sensitivity than CT. This study involves to find how dual energy CT differentiate between uric acid and non uric acid kidney stone.[9]

2. Materials & Methods

A cross-sectional study was performed in Shifa international Hospital (Islamabad, Pakistan) between July 2022 and December 2022 in E1 Radiology department in patients that underwent DECT scan of Abdomen Pelvis. Open epi software Version 3.01 has been used to calculate the sample size. The prevalence of uric acid stone was 28% in Pakistan), keeping the

population size as 1 million and confidence level 95% (with alpha error 5%). Calculated sample size was 310. Patients underwent DECT scan of Abdomen pelvis without contrast and postprocessed in Syngovia system were included in this study Patients underwent DECT scan of Abdomen Pelvis but not postprocessed in Syngovia system were not included in this study. Data was analyzed using SPSS software version 23.

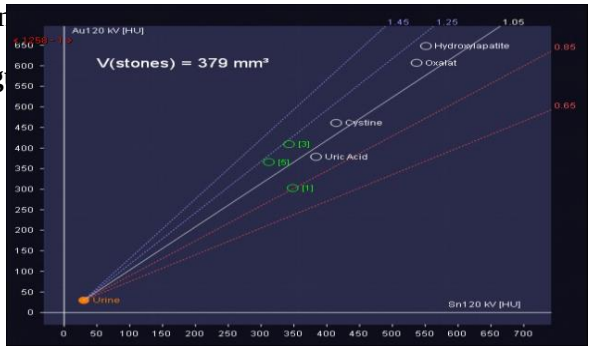
Institutional review Board and Ethics Committee (IRB & EC) Shifa international Hospital, approved our study. Patients having kidney stones or having symptoms of flank pain, burning micturition, dysuria, hematuria and abdominal Pain were advised by their respective doctors to undergo dual energy CT scan for evaluation of the location, size, diameter and type of stones present within the urinary tract of patients The procedure was explained and the informed consent was obtained from the patients by technologists before starting the procedure. All patients were imaged using a Siemens Somatom definition edge 128-slice scanner following a standardized dual-energy protocol. Patient lies supine on the table. Laser localizer set at the level of xyphoid process above and symphysis pubis below to include whole urinary tract. The Field of view (FOV) was considered 361mm. Maximum tube voltage and tube Current to which the patient exposed were AuSn120 and 640 respectively depending upon the thickness of the patient. Scan time of DECT scan was 11.56 seconds and rotation time of CT gantry was 0.33s. as shown in the Table 1. After performing the DECT scan Image data was transferred to Syngovia system Siemens Somatom definition EDGE for for post-processing. Questionnaire forms were filled by viewing CT scan of patients as well as searching our radiology Database and Picture archiving communication system (PACS) workstation.

Table 1: Basic parameters of Dual energy CT scan

Technical parameters	Values
Tube potential, Kilovolt peak (kVp)	AuSn 120
Tube Current (mAs)	640
Rotation Time(s)	0.33
Field of view	361mm
Reconstruction slice thickness (mm)	1.5mm
Scanning time	11.56
Location	Dome of liver to symphysis pubis
Pitch	0.35
Window	Abdomen
Reconstruction type	Axial

Data was post-processed automatically by the Syngovia system, a dual-energy software built into the CT scanner. The area of interest (i.e., the stone) is first identified by the technologist. The attenuation curve for the stone is then plotted on a graph showing the attenuation values for high and low peak kilovoltage as the x-axis and y-axis respectively. The red (dotted line below the solid line) and blue (dotted line above the solid line) superimposed on the graph represent the attenuation curves for UA stones and non-UA stones, respectively (Figure 1). The software also characterizes stones by labelling UA stones in red color and non-UA ston

Fig



3. Results

Out of 310 patients there were 199(64.2%) males and 111(35.8%) female participants as shown in Figure 3. The average age of the participants was 47.63±17.30 years. Mean age of participants having uric acid stone was 47.26±13.80 years and non-uric acid stone was 46.40±16.76 years. Consisting of total 201(64.8%) kidney stone participants, uric acid stones were found in 23(7.4%) participants and non-uric acid stones in 178(57.4%) participant. Uric acid stones found in male participants were 14(4.51%) and in female were 9(2.90%). Non-uric acid stones found in male participants were 119(38.3%) and in female were 59(19.03%) as shown in figure 3.

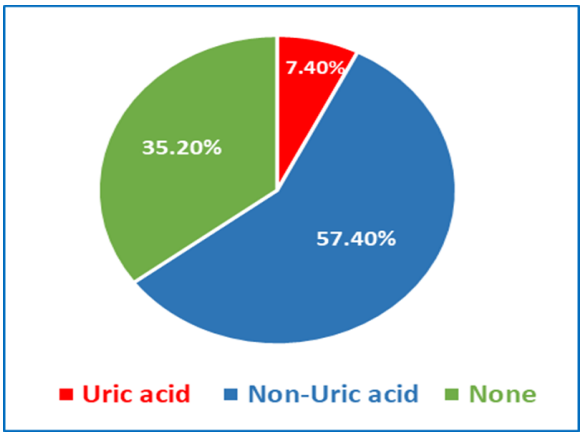


Figure 2: Percentage of UA and Non-UA stones in participants

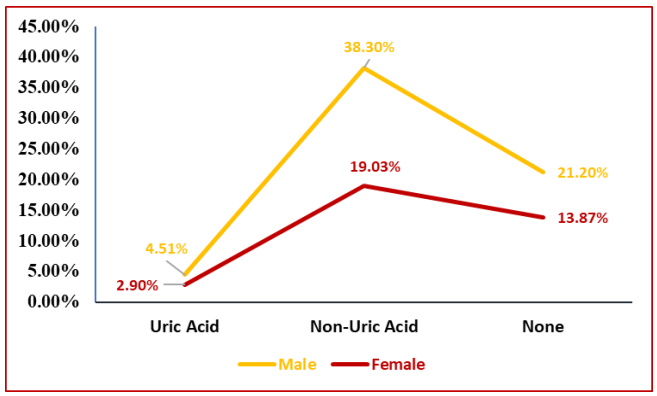


Figure 3: Gender-wise distribution of renal stones

Mean size and stone location included (i) at level of right kidney was 9.8±18.6mm (ii) at level of left kidney was 13.4±17.1mm (iii) at level of bladder was 3.95±0.99mm (iv) at level of right ureter was 10.8±18.8mm (v) at level of left Ureter was 8.9±9.3mm as shown in table 2. Stones mainly found in kidneys were 119(59.20%), in ureters were 78(38.80%) and in bladder were 4(2.0%). Most common location of stone was right ureter in participants with uric acid stone 10.1(9.38%) and non-uric acid stone 51(25%). Least Common location of stone was bladder in participant was 4(2.0%). Other location and type of stone found in participant are shown in Table 2.

Table 2: Characteristics of renal stones

Parameters	Uric Acid	Non-Uric Acid	Total	p-value
Mean Size mm (SD)				
Right Kidney	7.6(7.1)	10.3(20.3)	9.8(18.6)	0.662
Left Kidney	7.4(4.8)	13.6(17.4)	13.4(17.1)	0.619
Bladder			3.9(0.99)	
Right Ureter	10.1(9.38)	10.9(20.1)	10.8(18.8)	0.911
Left Ureter	9.3(4.1)	8.8(9.7)	8.9(9.3)	0.938

4. Discussion

Nephrolithiasis is a chronic disease with increasing prevalence all over the world and mostly common in industrialized, developed countries. It is associated with physical inactivity, hot climate, overweight, animal protein, less intake of fluids, systemic diseases.[10]

In this study, prevalence of UA stone and non-UA stone using DECT scan was studied in Pakistani people living in Islamabad and Rawalpindi. Regarding relation to the age, a study conducted by Ahmed et al., in Pakistan reported that high prevalence of kidney stones was in 30-50 years of age among people of southern Punjab.[11] Another study done by Bhatti et al., in Pakistan concluded that prevalence of stones is common in age group of 20-50 year.[12] In our study, prevalence of kidney stones was highest in age group of 20-60 years.

p-value of 0.514 shows that there was no significant association of age with type of stone found.

According to results of a study conducted in Karachi by Iqbal et al., renal calculi were most common among total cases with urinary tract stones with male predominance (64.8%).[13] In our study male participants were 64. 2% and females were 35.8%. Prevalence of kidney stones in male participants was high as compared to females due to stone forming effects of Sex hormones. Androgens increases the level of deposition of calcium oxalate crystal in kidneys while estrogen decreases the risk of stone formation by lowering calcium and calcium oxalates saturation.[14] Another reason for high prevalence among males is increased muscle mass in comparison to females, more metabolic waste production and excretion from kidney increases chance of stone formation. However, p-value of 0.525 shows no significant association of gender with type of stone found.

Patients with symptomatic stones usually present with flank pain that may radiate to the abdominal or inguinal areas. Vieweg et al., Used Computed tomography (CT) in the diagnosis of acute flank pain in patients with suspected stone disease and determined that CT has become the standard method to evaluate patients with acute flank Pain.[15] Another study conducted by stothers et al concluded that the most common symptom was flank pain seen in 89% of the patients with Renal calculi.[16] In our study a significant association was seen in flank pain and stone found in urinary tract with P-value 0.007. The most common symptom seen was flank pain in 201(64.8%) of participants.

Stones found mainly in kidneys were 59.20% and in ureters were 38.80%. Stones least found in bladder were only 2.0%. If the stones are able to enter the bladder, it is usually easy to urinate from the bladder. In rare cases, in patients with dysuria, stones can become lodged in the bladder and become larger, causing pain and difficulty urinating.

A study conducted by Rukhsar et al., in PIMS hospital Islamabad, Pakistan and reported that prevalence of uric acid stone was 12.5%.[17] In our study estimated prevalence was 7.4% which is close to this study. UA stones have low prevalence. Widely used drugs such as aspirin, losartan, diuretics, may increase urate elimination Uric acid stone formation decreases by decreasing dietary purine consumption and by pharmacological inhibition of uric acid formation by allopurinol.[18] UA stones have small size as compared to non-UA and therefore easily urinate and pass out of the body. Low prevalence of stone disease in old age people may be due to deaths at earlier stages.

DECT is superior to conventional CT in differentiating UA stones from non-UA stones, with numerous studies reporting sensitivities and specificities approaching > 95%.Hypothesis was DECT may be an effective technique for measuring urinary tract stones proved as false. DECT scan had accurately differentiated UA and non-UA stones in our study but did not differentiate further types of non-uric acid stones. In future research they should investigate how to differentiate non uric acid stone types.

Conclusion:

It was concluded Non-Uric acid stones have high prevalence than uric acid stone. UA stones have small size as compared to non-UA acid and more prevalence in male as compared to female.

Disclosure & Conflict of Interest:

The authors have no conflict of interest. This research didn't receive any specific grant from funding agencies in the public, commercial or not for profit sectors.

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