DISCUSSION

NCCT has emerged as the modality of choice in the evaluation of acute flank pain. The basic advantages of NCCT over other imaging methods include high sensitivity and specificity in the detection of ureteral and renal stones, speed, safety, detection of nonurological pathology and cost.[100]

Contradictory findings have been published in the literature regarding the ability of helical CT to accurately assess the chemical composition of renal calculi.[52] These variations can be explained by the use of the different CT scanners, degree of collimation, energy setting, technique, stone size and perhaps interpretation of CT numbers.[100]

The technique of CT scanning plays a role in measuring the HU values of urinary stones, specifically the size of collimation.[58] Saw et al. found that scanning stones that were smaller than the size of collimation subjected them to partial volume inaccuracies which had an impact on the measured HU values. They concluded that using a smaller collimation size permitted better accuracy in the prediction of stone composition.[58] Another parameter in the CT technique is dual energy scanning in which the differences in radiodensity observed by scanning stones at different energies are used for determination of their compositions.[54,101]

In our study, NCCT was performed with a collimation of 3 - 5 mm using single-energy scanning at 120 - 140 kV. The use of 1 mm collimation is clinically impractical in the routine evaluation of acute flank pain. Dual-kilovolt scanning also is not practical, and requires repeated imaging of the patient. [73] As we did not use stones less than 5 mm in our study, the partial volume effect due to collimation was minimalized.

The choice of effective clinical management of urinary tract calculi can be facilitated by knowing the precise chemical composition of the stones and their corresponding fragility. [74, 76]

Indeed, predicting susceptibility to fragmentation in situ before treatment, notably extracorporeal shock wave lithotripsy and endoscopic laser lithotripsy, could be potentially useful.[102] Knowing the composition of these stones can also be useful for patients who are susceptible to dietary management or metabolic intervention.[52]

Typically, pure stones composed of calcium oxalate monohydrate and brushite or cystine are relatively refractory to shock wave lithotripsy and percutaneous ultrasonic lithotripsy, and are more likely to be treated endoscopically whereas uric acid stones are usually treated with oral alkalinization.[69,74,75,76] Calcium oxalate dihydrate and struvite stones usually fragment easily with both shock wave lithotripsy and ultrasonic lithotripsy.[52]

The studies which Motley et al. carried out on 100 patients revealed that 87 patients had calcium stones, 7 uric acid stones, 4 struvite stones and 2 cystine stones. Their HU values were found to be 440 ±262, 270 ±134, 401 ±198, 248 ±0 respectively. They did not find a significant difference between the HU values for these stone types.[55]

Demirel et al., in their studies performed on 87 patients, discovered that 54 patients had calcium oxalate stones, 19 struvite stones and 14 uric acid stones, whose HU values were 812 ±135, 614 ±121 and 413 ±143, respectively.[100] It was possible to distinguish between these three types of stones on the basis of their HU values ($P = 0.001$).

In our study, which was carried out on 100 patients revealed that 46 patients had uric acid stones and 33 calcium stones, 6 cystine stones and 15 calcium –phosphate –urate. Their mean HU values were found to be 604 ±255, 1120±252, 1114 ±303, 1105 ±272 respectively. Mean and Maximum HU values were significantly different among different stone types in homogenous and heterogeneous groups as well as in total cases.

In homogenous group, no calcium based stone had a Mean HU less than 1000 HU and no urate stone had a Mean HU greater than 1000 HU while in heterogeneous group and total cases, No cut off value with 100 % accuracy could be detected in any of stone types.

As regards to Maximum HU in homogenous group, we found that no calcium based stone had Maximum HU less than 1000 HU but few urate stones had Maximum HU greater than 1000 while in heterogeneous group and total cases, No cut off value with 100 % accuracy could be detected in any of stone types.

Motley et al. postulated that as stone size increases, so does the HU value and put forward the concept of Hounsfield unit density (HU/stone size) to eliminate the effect of stone size. There was less overlap noted when comparing the HU densities of the stones studied, and no non calcium stone had an HU density greater than 76 HU/mm. Using one-way analysis of variance, significant differences were noted between the mean HU density of calcium (105 ± 43) and uric acid (50 ± 24) stones (P = 0.006).No differences were found between the calcium stones and cystine stones. [55]

In our study, we found less overlap noted when comparing the HU densities of the stones studied in homogenous group as well as in total cases, significant differences were noted between the mean HU density of uric acid (33±19) and calcium (112±46) stones (p <0.001), uric acid (33±19) and cystine (111±30) stones ($p < 0.001$), uric acid (33±19) and mixed (55±36) stones ($p < 0.001$).No differences were found between the calcium stones and cystine stones.

In heterogeneous group, no significant difference was noted among the stone types based on HUD.

In our study, we also found less overlap noted when comparing the Max HU/size of the stones studied in homogenous group as well as in total cases, significant differences were noted between the mean Max HU/size of uric acid (42±25) and calcium (120±48) stones ($p < 0.001$), uric acid (42±25) and cystine (133±49) stones($p < 0.001$), uric acid (42±25) and mixed (74±46) stones($p < 0.001$).No differences were found between the calcium stones and cystine stones.

In heterogeneous group, no significant difference was noted among the stone types based on Max HU/size.

Motley et al and Nakada et al. argue that uric acid and calcium oxalate stones can be distinguished by assuming the cut off value to be 80. (55,103) In contrast, Atici et al. reported that a cut off value of 80 failed to enable distinction between calcium oxalate, calcium phosphate or struvite stones based on HUD and when the ratio- of the maximum stone density to stone size was compared with regard to stone type in his study, no significance was observed among the stone types.(104)

In our study, a cut off values 80 and 85 for HUD and MaxHU/size respectively were 100% accurate to distinguish between uric acid and calcium stones and between uric acid and cystine stones in homogeneous group only, NO pure calcium or cystine stone had HUD less than 80 and no urate stone had HUD greater than 80, but failed to enable distinction between uric acid and calcium stones in total cases.

SUMMARY

Urolithiasis is a significant source of morbidity, affecting all geographical, cultural, and racial groups of human beings. The lifetime risk of urolithiasis is about 10 to 15% in the developed world, but can be as high as 20 to 25% in the Middle East. The increased risk of dehydration in hot climates, coupled with a diet 50% lower in calcium and 250% higher in oxalates compared to Western diets, accounts for the higher net risk in the Middle East. Uric acid stones are more common than calcium-containing stones in the Middle East region.

The introduction of multidetector CT in 1998 has opened up new prospects for CT in the imaging of urolithiasis. Advances in multidetector CT technology that allow the acquisition of isotropic volume data, and concurrent advances with respect to postprocessing algorithms and imaging workstations that allow multiplanar and three-dimensional evaluation of these isotropic data sets, have empowered radiologists to meet the greater expectations of urologists in the assessment of stone disease. Identification of the number, size, and location of calculi and determination of the presence of hydronephrosis (ie, obstruction) are routinely made with multidetector CT

In addition, multidetector CT helps in the assessment of stone fragility and composition with use of attenuation measurements and characterization of internal structure.

The work aims to correlate between Multidetector computed tomography radiodensity and determination of urinary tract stone composition.

The study was conducted on 100 patients with known urinary tract calculi, referred from to the Genitourinary surgery outpatient clinic to the Department of Radiodiagnosis at Alexandria Main University Hospital for Multidetector computed tomography evaluation of urinary tract stone composition.

All patients included in the study were subjected to the following:

- **Complete history taking.**
- **Thorough Clinical examination.**
- **Non-enhanced Multidetector computed tomography**

The CT was performed using six detector multi-slices CT Somatome Emotion 6 (Siemens ,Germany)

e. Patient preparation

No specific patient preparation was requested except fasting for 6 hours before performing the procedure to avoid nausea and vomiting that might occur, no specific premedication was needed.

f. Patient position

The patients laid down on the couch in the supine position, head first with the arms elevated above the head.

g. Non contrast CT

Initially a topogram was obtained in the antero-posterior view extending from lower chest down to upper thighs, with the patient lying supine, then the scans were performed by using a standard stone viewing protocol (breath holding technique at 120-140 kv, 79-260mA, series from the 11th thoracic vertebra to lower symphysis pubis was taken with a slice thickness 1.4-2.5mm range, a beam pitch 0.8 and a reconstruction increment of 1.25-1.75.

h. Post processing

The conventional 2D axial images were viewed on a Siemens syngo workstation.

The image analysis of each scan was carried out in two separate evaluating sessions by two staff radiologists who were blinded to the chemical composition of the calculi.

Bone window (window width (WW) 1.500 and the window level (WL) 300). The slice was magnified four fold, for each calculus, a region of interest was created overlying the calculus on the slice in which it was seen at its largest diameter.

For homogenous stones, the region of interest was created at the centre of the stone in which it was seen at its largest diameter, the Hounsfield unit was measured of an area 2 mm on average. For heterogeneous stone, the region of interest was created all over the stone in order to involve both high and low attenuation areas within the stone where it was seen at its largest diameter.

On the basis of these results, the maximum HU, the minimum HU and mean HU value were recorded.

Hounsfield unit density (HUD) was also calculated for each stone by taking the mean HU for each stone and dividing it by the largest transverse diameter of the stone.

Next, Maximum HU/size was calculated for each stone by taking the maximum HU for each stone and dividing it by the largest transverse diameter of the stone.

Hounsfield unit values were compared with the chemical composition of the stone.

All stones were analyzed at chemical pathology department at Institute of Medical Research, Alexandria University, Egypt. Stones composed of 97% or more of single component were considered pure.

The results showed a study population with a total of 100 patients, 80 men and 20 women ranging in age from 8-65years.

The patients were distributed according to homogeneity of stones into two groups;

1. Homogenous group represent 59% of cases.
2. Heterogeneous group represent 41% of cases.

Homogenous group shows higher mean HU values as compared with Heterogeneous group regarding Minimum HU, Mean HU, Maximum HU, HU density and Maximum HU/size.

The stone size according to maximum transverse diameter ranged from 7 to 37 mm (mean 14.7) in homogenous group and 10 to 30 mm (mean 22.6) in heterogeneous group

Stone analysis revealed 46 urate, 33 calcium, 6 cystine and 15 calcium phosphate urate stones in total cases.

The homogeneous group revealed 18 urate, 26 calcium, 6 cystine and 9 calcium phosphate urate stones. While the heterogeneous group revealed 28 urate, 7 calcium, and 6 calcium phosphate urate stone.

We found that 89 of the stones were located in the kidney, 7 in ureter, and 4 in urinary bladder where 78 stones were located in the left kidney and 11 in the right kidney, distributed as following 36 in the renal pelvis, 15 in upper calyx, 16 in middle calyx and 22 in lower calyx. All of the 7 ureteric stones were located in right ureter, 4 in upper third and 3 in lower third.

- **In homogenous stones**

1. The Mean HU of less than 1000 referred to urate stones and the Mean HU of more than 1000 referred to calcium based stones.
2. The measurement of HU density (HUD) and Maximum HU/size are more informative regarding the chemical type of stone only in homogenous stones and not in heterogeneous stones.
3. A cut off value of 80 in HU density (HUD) can differentiate between urate, calcium and cystine stones. Generally, the urate stones had HUD of less than 80 while calcium and cystine stones had HUD of more than 80.
4. A cut off value of 85 in Maximum HU/size can differentiate between urate, calcium and cystine stones. Generally, the urate stones had Max. HU/size of less than 85 while calcium and cystine stones had Max. HU/size of more than 85.

- **In heterogeneous stones**

Less overlap was found when comparing Mean and Maximum HU of the stones; however no cut off value could be obtained.