Efficacy of plain computed tomography (CT) abdomen for urinary stone disease in symptomatic patients.

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ABSTRACT

Objective: To assess the Efficacy of Plain Computed Tomography (CT) Abdomen to identify the frequency of Urinary stone disease in symptomatic Patients.

Study Design: Retrospective descriptive cross- sectional study

Place and Duration: Dow Institute of Radiology, Dow University of Health Sciences, Karachi, Pakistan from 25th February 202 to 15th March 2020.

Methodology: Retrospectively, data of patients underwent non-contrast CT KUB examination, presented with acute flank pain and had CT scan according to thin section plain CT Abdomen protocol were assessed. Findings of urolithiasis, size, site of urolithiasis, hydronephrosis, other incidental findings found were recorded and analysed.

Results: Among total of 485 patients, 45.9% of symptomatic patients was found to have obstructing urinary stones, with majority being located in distal ureter (11.75%), with mean calculus size of 10mm. Stone burden was significantly higher in male population as compared to female population (66.8% vs. 33.1%; p = 0.138). Age stratification showed significant association of stone disease with younger age group [<30yrs] as compared to other age groups. There was a positive correlation between size of ureteric calculus and degree of hydronephrosis. Almost, 15.6% patients had absolutely normal CT scan findings, 38.3% had Incidental CT findings and 8.6% of the subjects were found to have acute conditions mimicking renal colic. Appendicitis 2.3%, Spondylolysis 2.3%, Pelvic Masses 1.4%, PUJO 1.4% and Abdomino-pelvic abscesses 1.2% were the leading significant incidental findings at Plain CT.

Conclusion: The frequency of Urinary stone disease at Plain CT Abdomen in patients presenting with flank pain is found to be 45.9% and 8.6% of the population have other acute abdominal condition.

Keywords: Flank pain, Urolithiasis, Renal colic, Computed Tomography, Stone site, Stone size, Incidental findings.

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INTRODUCTION

Urinary Stone disease is one of the most prevalent urologic diseases in Asia, particularly in Pakistan. Stone is the sixth most common condition requiring surgery in Pakistan[1,2]. Non-contrast computed tomography (CT) abdomen has emerged as a first line investigation in suspected urinary tract obstruction. Computed Tomography of kidneys, ureters and bladder (CT KUB) is extremely sensitive and specific in the diagnosis of stone. It is the urologist road map for planning therapies including variety of endourological interventions like Percutaneous Nephrolithotomy (PCNL), retrograde intra-renal Lithotripsy (RIRL) and shock wave lithotripsy (SWL)[3,4]. A myriad of congenital urinary anomalies can be visible on the scan. A wide spectrum of alternate and additional diagnoses including abdominal solid organ tumors and other significant abdominal conditions such as appendicitis can be suggested on spiral CT performed for suspected acute urinary colic[5,6].

CT KUB is the preferred examination for evaluation of urolithiasis because of its availability, ease of performance, and high sensitivity. It is preferred over IVU because it is more sensitive and non-invasive technique. Stone size and burden, and the degree of urinary obstruction can be directly measured[7,8].

The CT-KUB is the most frequent cross sectional procedure performed at our Institute. More than 6000 scans are performed each year. This article enumerates the stone burden and other differentials of renal colic on imaging. The aim of this research is to enumerate the causes of acute flank pain, in Pakistani

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population on Plain CT Abdomen. After robust search, only few articles are found related to it in the recent local literature. There is a huge interval gap for research on this topic in Pakistan. This provided us strong rationale to conduct this study. So, this retrospective study was conducted with an objective to assess the Efficacy of Plain Computed Tomography (CT) Abdomen to identify the frequency of Urinary stone disease in symptomatic Patients.

METHODOLOGY

This Descriptive Cross- sectional Retrospective study was conducted at Dow Institute of Radiology, DUHS from 25th February 202 to 15th March 2020. The sample size was calculated to be around 207 patients or more by using EPI formula[9] in the Pakistani population (p) with 5% Confidence limits and 95% Confidence Interval. All both in-patient and out-patient data who had non-contrast CT examination due to acute flank and lower abdominal pain were retrieved and included in study. Plain CT Abdomen implies both CT Pyelo- and CT Focused Appendiceal CT (FACT) studies. In our department, the standardized Plain CT Abdomen Protocol used includes Slice thickness: 0.75mm slice thickness, reconstruction interval 0.5mm; Kilo volt milli ampere second; KV/ mAs: 120 KV acquisition /Auto Milli Amperage (MA); tube modulation technique. FOV: Anatomical start point: 1 cm above the liver; Anatomical stop 1cm below the inferior margin of inferior pubic rami). Sagittal and Coronal, Multi-planar reformats (MPR), Curved Planner Reformats (CPR) acquisition; 16, 128 slice Hitachi and Siemens Scanner.

Obstructing Urinary Stone (OUS) implies Calculus in the kidney or ureter causing proximal dilatation of the urinary tract. Non-Obstructing Urinary tract Stone is a Calyceal calculus of 4-5mm that usually passes spontaneously without intervention, with conservative measures. Secondary signs of obstruction include Hydro-uretero-nephrosis, thickening of peri-renal fascia, with peri-nephric and peri-ureteric fat stranding. Incidental CT findings include clinically significant finding and non-significant findings abdominal findings. The scans were re-evaluated at workstation by two Academic Radiologists at Digital Imaging and Communications in Medicine (DICOM) viewer. Images were viewed in soft tissue window settings. The size of the calculus was measured in long axis (mm). Secondary signs of obstruction and the degree of hydronephrosis were assessed in each case.

Based upon the sample population, patients were divided into 3 groups i.e. Obstructing Urinary Stone (OUS), Incidental CT findings and Normal CT examination. Mild hydronephrosis (grade 1): prominence of the pelvis with blunting of the calyces. Moderate hydronephrosis (grade 2): ballooning of the calyces with preserved renal parenchyma +/- mild cortical thinning. Severe hydronephrosis (grade 3): blunting of the calyces with complete loss of renal parenchyma. Incidental Findings on Imaging were recorded. Observed imaging data was recorded on Microsoft excel sheet, retrieved from Health Care management system (HMIS PACS).

Data Analysis: Statistical software SPSS-20 was used for data analysis. Descriptive statistics were explored using mean and standard deviation for quantitative data and frequency as well as percentage for qualitative variables. Age stratification was done for the stone burden of population in the specific age range. Chi square test was applied to test the association of age and the incidental findings in symptomatic population. Fisher exact test was applied to examine association of gender with and without OUS population. Correlational analysis was performed for association between degree of hydronephrosis and size of ureteric calculus. A p value of <0.05 was considered to be statistically significant.

RESULTS

During the study, 970 collecting systems were examined in 485 patients, out of them, 237 collecting systems were found to be obstructed, due to calculus. Obstructing Urinary Stone (OUS) were found in 223 (45.97%), Incidental CT findings in 186 (38.3%) and normal CT exam were found in 76 (15.6%) patients. There were 294 (60%) male and 191 (40%) female patients. Mean age is 37 years with S.D. of +/-14.92 and age range of 3-82 years (Figure-1). A high burden of urinary stone was found in our symptomatic population (53.6%; p-value: 0.013).

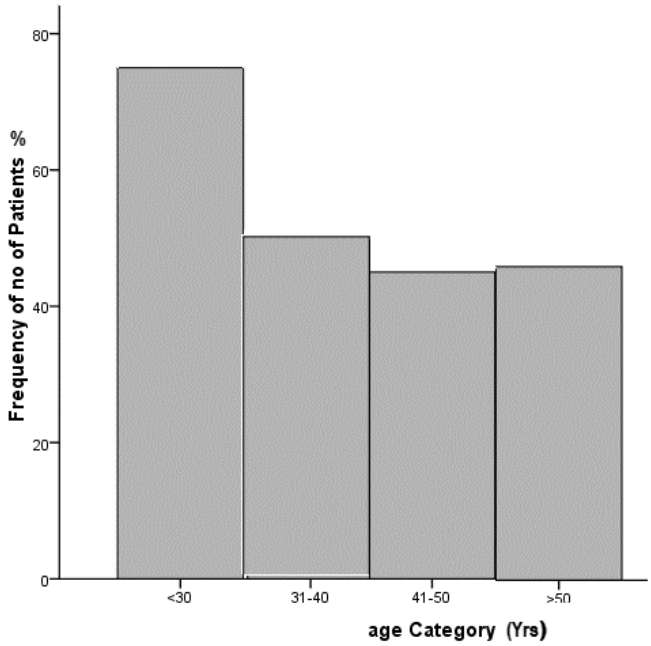

Figure-1: Histogram shows different age categories in the OUS population (N=485)

In majority of population, stone disease is focal, unilateral and allocated on right side (R=125, L=98, bilateral. There was significant association of gender (male> female) with OUS population on Fisher's exact test; p-value=0.082. Age stratification shows significant association of stone disease with younger age group [<30yrs] as compared to other age groups [31-40], [41-50] and [>50]; p=0.021.

The sites of obstructing stone in descending order were distal ureter (n= 57, (25.6%), VUJ (n= 55, 24.6%), Proximal ureter (n= 26,11.6%), Renal pelvis (n= 26,11.6%), mid ureter (n= 13,5.8%), and PUJ (n= 13, 5.8%) (Figure-2).

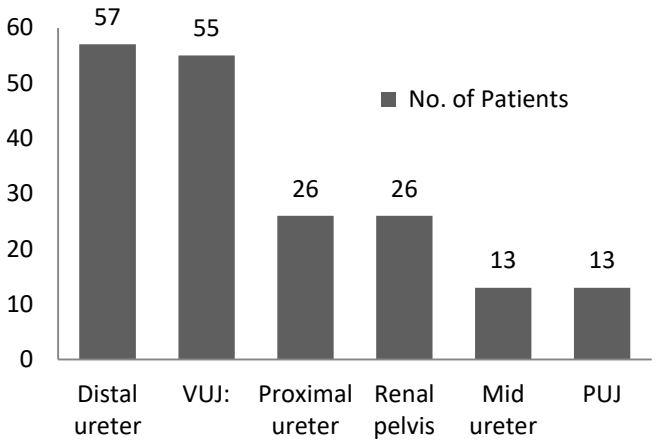

Figure-2: Bar chart shows frequencies of site of obstructing calculus in the OUS population (n=485).

The mean size of calculus is 10 mm assessed via average of longest 2D dimensional measurement. Where bilateral and multiple obstructing calculi were seen, the size of the largest calculus was recorded. No statistically significant association was found between size of calculus and secondary signs of obstruction (p value=0.996). The largest calculus is of stag horn shape, seen in renal pelvis measures up to 48mm. 11 kidneys were found to be completely atrophied from long standing irreversible parenchymal damage due to obstruction. 9 kidneys were mal-rotated (Fig-3). Calyceal non obstructing calculi were found in (154 subjects) 31.7% of population that were expected to be excreted spontaneously; majorities were located in lower pole calyx on left side. Out of 223 patients with OUS, secondary signs of obstruction were seen in 87 patients. There was a positive relation (Figure-3) between the severity of hydronephrosis and mean size of calculus in the ureter on Pearson Correlation; r=0.89.

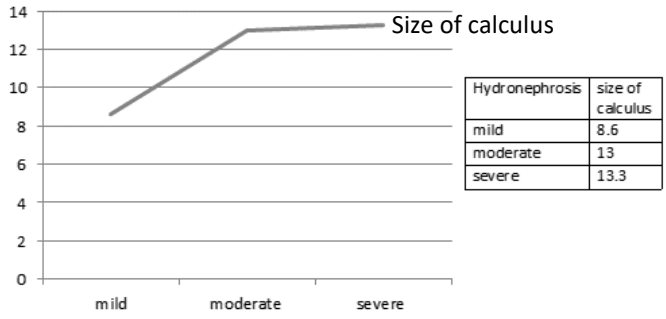

Figure-3: Line chart shows positive correlation of degree of hydronephrosis with mean size of calculus (mm) in OUS population.

Regarding patients with Incidental CT findings, 42 patients (8.6 %) were found to have acute conditions mimicking renal colic.. Of 11 patients (2.2%) with spondylolysis, 6 (1.2 %) had Spondylolesthesis, Appendicitis in 11 (2.3%), 7 (1.4%) had adnexal mass and Fibroid causing proximal ureteric dilatation, 7 (1.4%) had Pelvi-Ureteric Junction Obstruction (PUJO) without obstructing calculus and 6 (1.2%) patients had Abdomino-pelvic abscesses at different origin. Regarding the Ancillary incidental findings on the CT scan, fatty liver 17 (3.5%) and Cholelithiasis 12 (2.5%) were the most common CT findings in the population. There was a significant association of female gender with gall stones (p= 0.000). Renal cortical cysts 22 (4.5%) and colonic diverticulosis 8 (1.6%) were the most frequent benign non-significant findings. Lumbar spondylosis 55 (11.3%), lumbosacral transitional vertebra 13 (2.7%) was commonly observed in axial skeleton (Table-I).

Table-I: Age Stratification and Gender Distribution for OUS population (n=223). Categorical distribution of other Positive CT findings mimicking renal colic in population (n=42).

AGE	No. of patients with OUS (n=223)	*p-value	No. of patients without OUS	Other Positive CT Findings	Frequency of patients (n)
<30	78 (34.9%)	0.012	98	Spondylolysis	11 (2.3%)
30-40	52 (23.3%)		85	Appendicitis	11 (2.3%)
41-50	45 (20.0%)		35	Pelvic Masses	7 (1.4%)
>50	48 (21.5%)		44	PUJO*	7 (1.4%)
				Abdomino-pelvic abscesses	6 (1.2%)

GENDER	No. of patients with OUS (n=223)	No. of patients without OUS	*p-value
Male	149 (66.8%)	158 (60%)	0.082
Female	74 (33.1%)	104 (40%)	
Total	223	262	

DISCUSSION

Unenhanced CT is an excellent modality with many advantages and high sensitivity for evaluation of nephro-uretero-lithiasis. Reddy et al[10] observed that maximum patients presented with ureteric calculi (40%) followed by renal calculi (18.8%). Our data were comparable to the Nadeem et al[9] research who noticed that positive yield of CT for urolithiasis 64%, rate of incidental/alternate findings was 15% and 21% were negative, whereas in our study, it was 45.9%, 38.3% and 15.6% respectively for these three categories.

Ather et al[5] studied 4000 CT scans, performed for acute flank pain and a total of 153 clinical conditions (3.8%) had been identified causing flank pain secondary to calculus and obstruction. There were 9.9% who had an alternate cause of flank pain or an incidentally detected condition on CT scan. Another comparative study was conducted locally[11] to estimate the accuracy of ultrasound, intravenous urography (IVU) and plain CT KUB in the diagnosis of ureteric stone concluded that Plain CT KUB compared with IVU had a higher detection rate for ureteric stone. In contrary to it where only 15 patients underwent CT, we enumerate the significantly high number of CT KUB patients in our research.

Robert and colleagues[12] studied 126 patients to evaluate the utility of contrast-enhanced computed tomography (CECT) for patients with suspected uncomplicated renal colic (URC) and no abnormalities on non-enhanced computed tomography (NECT). They find that NECT is sufficient for screening patients with suspected URC and if leukocytosis and low renal function are

present, stronger consideration may be given to CECT. Regarding CT KUB's, there is another group of researchers focusing on incidental findings. Khan et al studied 899 patients who are undergoing CT and concluded that the overall incidence of incidental findings was 14%, whereas it was 38% in our study. Apart from urolithiasis, they found both genitourinary findings and extra-genitourinary findings, in which renal, ovarian cyst, appendicitis were the most frequent findings[13]. Another international study showed series of 233 consecutive Plain CT examinations, the incidence of incidental diagnosis was 12%; 64% scans had ureteral calculi, 75 examinations went normal[14]. In one recent study of 248 patients with ureteral stones and colic, 11 % do not demonstrate hydronephrosis (HN) and a majority (71 %) demonstrated only mild HN. Stone diameter appeared to be related to degree of HN- compatible to our study, whereas age, gender, and stone location are not[15]. During literature review, we declare reservations regarding one recent study, in which total of 219 patients were enrolled into Registry for Stones of the Kidney and Ureter, US[16] to compare the measured stone burden recorded between urologists and radiologists. Their conclusion is that significant variation exists between urologic and radiologic CT interpretations of stone burden. In the current hospital setup, Radiology generated report is trusted by Urologists.

There were few limitations in our study that the follow up imaging for each patient was not included to avoid complexity of data. Plain CT scan has a major limitation in identifying 'Superimposed Infection' secondary to obstructing calculus which closely mimics secondary signs of obstruction. Abdominal fat stranding is seen in both conditions. Lastly, the thin section CT abdomen protocol was implied in the current research which imparts a high radiation dose to the patients up to 10 mSv. In comparison, Low dose CT (LDCT) is a new CT technique[17] that incorporates low mAs acquisition protocol of up to 20-40 mAs without hampering the diagnostic yield of the images. On the positive side, it reduces the ionizing dose to the patient from 10mSv up to 3mSv. It also increases the tube life of the scanner significantly up to 4 times. In this regard, Rob et al[18] in meta-analysis of low dose CT KUB for detection of urolithiasis. The effective radiation dose of ultra-low-dose (ULD CT) and low-dose CT KUB (LD CT) were radiation dose ≤1.9 and <3.5 mSv, respectively. ULD CT and LD CT had a sensitivity of 90-100% and a specificity of 86-100% across all studies. Similar results were evident from Weinric et al study[19] that LDCT reached a sensitivity of 94.1%, a specificity of 100.0%, and an accuracy of 95.1% for the detection of Urolithiasis. Gervaise has described behavioral and technological factors in reducing CT radiation dose[20]. Limiting the scan coverage area and the usage of low 80 KVP in protocol are straightforward and effective ways to reduce the dose. In the near future, we plan to implement this protocol for dual benefit of machine and patients. This would require further training and Experimental Analysis.

CONCLUSION

The frequency of Urinary tract stones at Plain CT Abdomen in patients presenting with flank pain is found to be 45.9% and 8.6% of the population have other acute abdominal condition. It was evident from our study that plain CT Abdomen is highly efficacious for the assessment of Urinary stone disease.

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AUTHOR'S CONTRIBUTION

Amjad S: Conceived idea, Designed research methodology, Manuscript writing, Final critical review of manuscript
Mahnoor H: Data collection, Manuscript writing, Data analysis, Literature review

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