Original Article

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PATTERN OF URINARY TRACT FINDINGS ON HELICAL COMPUTED TOMOGRAPHY IN CASES OF URETEROLITHIASIS

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ABSTRACT

Objectives: To determine the pattern of urinary tract changes in cases of ureterolithiasis as detected on helical computed tomography.

Study Design: Descriptive study.

Settings: Radiology Department Combined Military Hospital Lahore from Jun 2007 to Jan 2008.

Material and Methods: Thirty patients with proven ureterolithiasis on IVU were included. All these patients underwent non contrast enhanced helical computed tomography (CT) scan. Data was analyzed for both quantitative as well as qualitative data and expressed as mean with standard deviation and percentages respectively.

Results: All 30 patients had ureteric calculi. Among our study group the frequency expressed as percentages of various secondary signs of ureterolithiasis were hydroureter 25 (83.33%), hydronephrosis of the affected kidney in 23 (76.67%), nephromegaly 16 (53.33%), periureteral edema 19 (63.33%), perinephric stranding 21 (70%), a difference in attenuation between the kidneys 25 (83.33%) while soft tissue rim sign was present in 14 (46.67%) patients. Only one patient lacked the secondary signs.

Conclusion: Establishing the pattern of secondary urinary tract findings enables a brisk diagnosis in cases of obstructive ureterolithiasis, thus improving the diagnostic capabilities as well as patient outcome.

Keywords: Computed tomography, Secondary signs, Ureteric Calculi.

INTRODUCTION

Flank pain is one of the most common presentations in the emergency setups. In most of the patients reporting with acute flank pain the underlying cause is urolithiasis[1]. However the flank pain can be associated with numerous diseases which are indistinguishable from renal or ureteric colic[2]. Thus the role of imaging is of dire and urgent importance for diagnosing renal colic in the emergency setting for cases of flank pain[3]. According to a study 9%–29% of patients presenting with flank pain may have non-colic diagnosis at unenhanced helical CT. These include adnexal masses, pyelonephritis, appendicitis, and diverticulitis[4].

Nephrolithiasis is a common disease. Excretory urography, sonography, and abdominal radiography were being used prior to the establishment of role of CT for the evaluation of ureterolithiasis[5]. CT proved to be revolutionary as only half of urinary tract calculi are visible in abdominal radiographs and excretory urography[6]. Unenhanced spiral CT has a sensitivity of 100%, specificity of 95% and accuracy of 97% for the evaluation of acute flank pain as compared to conventional radiographs and ultrasound. The use of un-enhanced CT scan renders it to be the method of choice for patients with contraindications for the application of radiopaque material[7]. Newer CT scans have sufficient resolution to determine the secondary findings of the urinary tract, composition and structure of stones. This information about stone composition and structure leads to better management of the patient[8]. A possible disadvantage of use of CT scan was the relative increased radiation dosage. However numerous studies have been undertaken to establish protocols for evaluating the patients with low dose[9]. Thus unenhanced helical CT scan can serve as a primary imaging modality for evaluation of ureterolithiasis.

MATERIAL AND METHODS

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This study was conducted at the department of Radiology, Combined Military Hospital Lahore from Jun 2007 to Jan 2008. A total of 30 patients with proven ureterolithiasis on IVU, were included based on non probability convenience sampling. The following criteria were used.

Inclusion Criteria

All patients with proven ureterolithiasis on IVU reporting to the radiology department and giving written informed consent were included in the study. However, pregnant females, patients with known severe renal infection / renal malignancy, patients with previous renal surgery or trauma were not included in the study.

After seeking permission from concerned authorities and 'Hospital Ethical Committee' the study was commenced. All 30 patients included in the study had proven ureterolithiasis on IVU and underwent unenhanced helical CT using 4 slice Toshiba Helical CT scan XPRESS / GX machine.

Computed Tomography Technique: All the patients were examined in supine position. The scan was performed from the level of the diaphragm to the base of the urinary bladder. Images were obtained with a slice thickness of 3-5 mm, pitch of 1.0:1, a gantry rotation time of 0.5 to 1 second and 2-3 breath holds. A kVP of 120 and mAS of minimum 200 were selected. A window setting of 400 HU and a window level of 40 HU was selected before transferring to the film.

Computed Tomography Diagnostic Criteria: The spectrum of changes in the urinary tract visible on un-enhanced spiral CT scan in cases of ureterolithiasis included the following:

Difference of attenuation values in the affected kidney versus the unaffected kidney: The affected kidney having an attenuation value of about 5 HU less as compared to the unaffected side.

Hydroureter: The dilatation of any portion or entire ureter distal to pelviureteric junction.

Hydronephrosis: Dilatation of the pelvi-calyceal system.

Perinephric stranding: Increased density or stranding of perinephric fat.

Nephromegaly: An increase of more than 12 cm in the size of the right kidney and 12.2 cm in the size of the left kidney.

Periureteral edema: An increased density of the fat immediately adjacent to the segment of ureter containing the calculus.

Ureteric rim sign: Thickening of the ureteral wall surrounding a small impacted calculus in the ureter due to edema.

Data Analysis Procedure

Data was analyzed using computer package SPSS version 10. Descriptive statistics were used to define the data i.e mean and standard deviation (SD) for quantitative variables while frequency and percentages for qualitative variables. Chi square was applied to relevant data and *p*-value <.05 was considered significant.

RESULTS

A total of 30 patients were included in the study. Among these there were 19 (63.33 %) males and 11 (36.66 %) females. The age of the patients ranged from 21- 64 years with a mean age of 40 yrs (SD±3.2).

All these patients underwent unenhanced helical CT scan abdomen. Ureteric calculi were detected in all the patients. Out of the 30 patients included in the study 18 (60%) had ureteric calculi on the right side and 12 (40%) had ureteric calculi on the left side. The presence of the ureteric calculi in three parts of the ureter in our study group is given in table 1.

The frequencies of various secondary signs of ureterolithiasis detected on unenhanced helical computed tomography are expressed as percentages in table 2.

Only one patient lacked the secondary signs of ureterolithiasis. However the ureteric calculus was seen. Careful assessment and follow up was made to ensure that it was not a phlebolith. Incidentally none of the patients in our study group had any calculus in the contralateral ureter or either of the kidneys.

Table 1: Descriptive statistics of site of ureteric calculus (n = 30)

Site of ureteric calculus	Frequency (%)
Proximal	7 (23.33 %)
Mid	4 (13.33 %)
Distal	19 (63.33 %)

Table 2: Descriptive statistics of the secondary urinary tract signs on CT scan in cases of ureterolithiasis (n = 30)

Secondary Sign of ureterolithiasis	Frequency (%)
Hydronephrosis	23 (76.67 %)
Hydroureter	25 (83.33 %)
Nephromegaly	16 (53.33 %)
Periureteral Edema	19 (63.33 %)
Perinephric stranding	21 (70.00 %)
Soft tissue rim sign	14 (46.67 %)
Decreased attenuation of the kidney	25 (83.33 %)

DISCUSSION

Urinary tract calculi are a common pathology worldwide. Most of the patients report to the emergency department with radiating colicky pain alongwith hematuria[10]. The imaging for the use of urinary tract calculi has evolved and come a long way in the last 5 decades from the combined use of air contrast ascending pyelography, conventional radiography and IVU to the use of un-enhanced CT scan[11,12,13]. Unenhanced CT scan is now the investigation of choice for the patients presenting with flank pain and suspicion of ureteric calculi[14].

The patients in our study were subjected to un-enhanced CT scan from the level of the diaphragm to the base of the urinary bladder. Three anatomical points of narrowing exist in both the ureters at pelvi-ureteric junction, at the point where it crosses the pelvic brim and the intravesical portion. According to this the presence of calculi in our study were divided into the proximal, mid and distal ureter. The predominance of occurrence of the calculi in the distal ureter at the time of diagnosis was also present in the study conducted by Yaqoob et al[15].

The analysis of the secondary signs of obstruction has relevance with the obstruction

Fig. 1: Non-enhanced axial CT scan images of an enlarged left kidney with perinephric stranding.

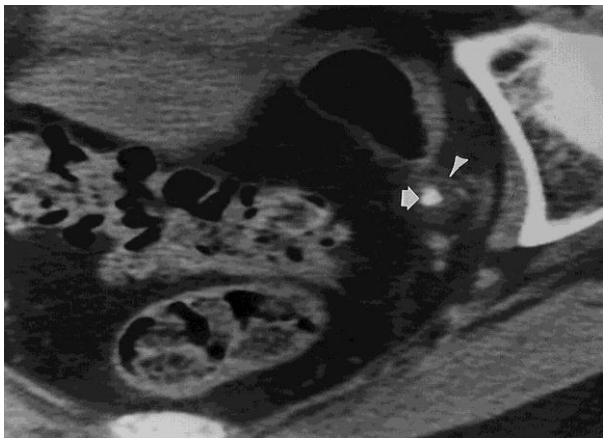

Fig. 2: Non-enhanced axial CT scan image depicting the soft tissue rim sign.

and duration of development of obstruction[16]. In our study one of the most striking secondary sign observed was the dilatation of the collecting system. As this study dealt with ureteric obstruction which is mostly responsible for a unilateral hydronephrosis so comparison of both the sides for this purpose was also a reliable step in ascertaining the hydronephrosis [17,18]. The dilatation of the collecting system is ideally detected in the upper and the lower pole regions appearing as fluid filled areas. In our study 76.6% of the patients had hydronephrosis. Katz et al reported presence of this secondary sign in 69% and Ege et al mentions an 80% occurrence[19,20].

The existence of hydroureter can be independent of the hydronephrosis as well as coexistent and is immediately proximal to the point of the ureteric calculus. In the studies carried out previously by Yaqoob et al, Katz et al and Smith et al, the incidence of hydroureter

was higher than hydronephrosis[15,17,20]. Even in this study the hydroureter was present in 83.3% of the patients.

The presence of the ureteric stone is accompanied by a localized inflammatory reaction resulting in periureteral edema formation. This was detected after comparison with the contralateral unaffected side. This sign was present in 63.3% of the cases in this study. These values were in accordance with the previous studies carried out by Katz et al (65%) and Ege *at al* (59%)[19].

In cases where obstructive ureterolithiasis is present the affected kidney tends to increase in size. This is in comparison with the contralateral kidney and could occur either in length of the entire kidney or merely an increase in the thickness of the renal parenchyma. Ege et al reported 57.2 % and Smith et al reported 69.7 % of cases having renal enlargement on the affected side[17,19]. Our study showed a pattern of nephromegaly in only 53.3% of the cases.

Perinephric edema formation is represented on CT as perinephric stranding (Fig 1). The percentage of perinephric stranding seen in our study group was 70 %. This value was consistent with the previous studies conducted by Yaqoob et al (66%) and Smith et al (74.3%)[15,17]. Such a finding is also suggestive of perinephric edema[21]. and this sign is significantly associated with hydronephrosis[19]. Out of the 23 patients who had hydronephrosis 19 were positive for perinephric stranding which depicts an element of association between the two.

The soft tissue rim sign is useful in differentiating the ureteric calculi from extra-urinary tract calcifications[22]. The soft tissue rim sign appeared as a halo of decreased attenuation surrounding the calculus and interpositioned between the calculus and the wall. This has been suggested in the previous studies by Kawashima et al and Al-Nakshabandi[22,23]. In our study the soft tissue rim sign (Fig 2) was present in 46% cases. This is similar to findings as reported by Al-Nakshabandi[23]. Another aspect which is mentioned in the previous studies is that soft tissue rim sign requires 4-24 hours to manifest[16,24]. The rim sign is considered to be useful when other secondary signs are not distinct or in cases where only the perinephric stranding exists alongwith this sign[16].

Edema formation in the kidney on the side where a ureteric calculus is impacted is due to increased interstitial fluid. On CT scan this appears as decreased attenuation (Fig 3). It is mostly seen in acutely obstructed kidney[24] and is a reliable secondary sign as mentioned in certain previous studies[15,25]. In our study 83.3 % of the patients were positive for this sign. We observed a minimum difference of 5 HU.

Un-enhanced CT scan has replaced the IVU over the last decade for the diagnosis of ureterolithiasis. According to some studies carried out in the past the CT scan should be employed at pain duration of 6-8 hours[26]. However the current study was carried out to describe the pattern in cases of ureterolithiasis and the association with the duration was not established. In our study the seven secondary signs studied were reliably present. According to decreasing order of incidence they were hydroureter, difference in attenuation of the affected kidney, hydronephrosis, perinephric stranding, periureteral edema, nephromegaly and soft tissue rim sign.

In addition to the advantages of the use of un-enhanced CT scan, a possible disadvantage of use of CT scan was the relatively increased radiation dosage. However numerous studies have been undertaken to establish protocols for evaluating the patients with low dose[9]. Such low-dose helical CT protocols have significantly reduced the dose given to the patients especially in pregnant ladies.

CONCLUSION

Un-enhanced CT scan has evolved as the primary modality for investigation in cases of ureterolithiasis. It is a non-invasive method, lacks any specific preparation and saves time. These aspects are tremendously beneficial for the patients; it has additional benefit of differentiating the ureterolithiasis from other abdominal pathologies mimicking this

condition. Therefore, establishing a pattern of secondary urinary tract findings enables a brisk and precise diagnosis in cases of obstructive ureterolithiasis and ultimately improving the diagnosis in emergency settings as well as the patient outcome.

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