CT IS SUPERIOR TO USG AND RADIOGRAPH IN EVALUATION OF URINARY CALCULI

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ABSTRACT

BACKGROUND

The problem of urolithiasis is on the rise, so also the complications associated with this condition. As mentioned earlier, it is increasingly important to understand calculus as the cause of pain and the complications of calculus disease. From the multitude of imaging options available, we have to choose the optimum imaging modality, which is truly cost effective. The present study is an attempt to define the most important modality for the diagnosis of calculus disease of the urinary tract. As a corollary, we are in a position to derive other statistically important parameters of the condition. We wanted to study the radiological methods namely, X-Ray KUB, USG and CT in the evaluation of renal colic.

METHODS

Ultrasound, CT scan and plain X-ray KUB study were done in 104 patients presenting with symptoms typical of renal colic attending the medical and surgical OPD in Santhiram medical college and general hospital.

RESULTS

The percentage of detection of urolithiasis by X-ray is 60.5%, USG is 71% and CT is 96.1%.

CONCLUSIONS

CT is superior to ultrasound and plain radiography in detecting urolithiasis.

KEYWORDS

Urolithiasis, CT, Ultrasound (USG), Radiograph.

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BACKGROUND

Renal colic is a symptom complex that is characteristic for the presence of upper urinary tract calculi. The reason for excruciating pain is the dilatation of the smooth muscle, which is expressed as colic.

Imaging plays a vital role in diagnostic workup of these patients. Evaluation of urolithiasis, consists of conventional radiography, USG and CT. In most institutions, thin section nonenhanced CT is the main modality for the evaluation of urolithiasis due to its high sensitivity and specificity.

Urolithiasis is a consequence of complex physical processes. The sequence of events leading to urinary stone formation is also as follows. Saturation- supersaturation- nucleation –crystal growth of aggregation- crystal retention and stone formation.[1,2]

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METHODS

Source of Data

Ultrasound, CT scan and plain X-ray KUB study were done in 104 patients presenting with symptoms typical of renal colic attending the medical and surgical OPD in Santhiram medical college and general hospital

Method of Collection of Data

Plain X-ray KUB was taken after bowel preparation and on empty stomach. Films were taken in 500 ma Siemens Klinoscopy-H machine.

Ultrasound imaging was performed in the Department of Radiodiagnosis, Santhiram medical college and general hospital, using real time ultrasound machine (Esaote-Mylab 50X vision) which is equipped with 2.6,3.5 & 5 MHz and HP image point Hz which is equipped with 2 to 10 MHz linear and curvilinear probes.

Patients were examined in empty stomach and full urinary bladder in the supine position.

CT imaging was performed in the Department of Radiodiagnosis Santhiram medical college and general hospital, using Siemens Somatoscope 32 slice machine.

Prior patient preparation was not required. Patients were examined with full urinary bladder in supine position. The coverage area extends from the upper pole of both kidneys to the base of the urinary bladder.

Inclusion Criteria

All patients presenting with symptoms typical of renal colic attending the medical and surgical OPD in Santhiram medical college and general hospital

Exclusion Criteria

Pregnant women.

RESULTS

A total of 104 cases presenting with symptoms suggestive of renal colic are studied and details plain radiography, ultrasound and CT evaluation are analysed-

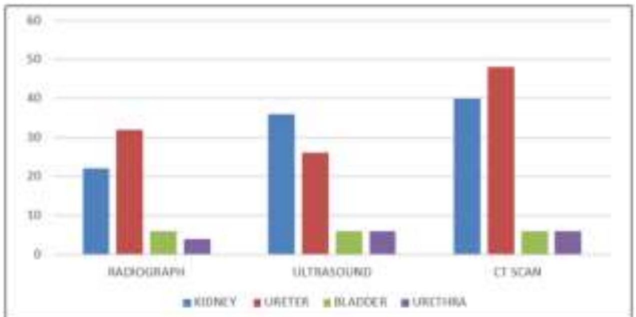
Total number of cases of suspected renal colic	104
Total number of cases of calculus disease	100
Other causes	4
(3 cases of appendicitis, 1 case of ureteric stricture)	

		CT calculus									Total	
		Kidney	%	Ureter	%	Bladder	%	Absent	Urethra	%		%
X-ray calculus presence	Yes	22	55	32	64.1	6	100	0	4	80	63	
	no	18		17		0		4	2		41	60.5
Total		40		48		6		4	6		104	

Table 1. Radiograph vs. CT Calculus

		CT Calculus					Total	
		Kidney	Ureter	Bladder	absent	urethra		%
USG Calculus	kidney	33	3	0	0	0	36	97
	ureter	1	25	0	0	0	26	48.1
	bladder	0	0	6	0	0	6	100
	absent	6	20	0	4	0	30	
	urethra	0	0	0	0	6	6	100
Total		40	48	6	4	6	104	

Table 2. Ultrasound vs. CT



Comparison between Radiograph, Ultrasound and CT

In present study, CT imaging is superior to ultrasound (97%) and radiograph (55%) for detection of calculi in kidney. For detection of calculi in ureter CT is superior to radiograph (64%) and ultrasound(48%). Ultrasound has poor rate of detection when compared to radiograph and CT. Radiograph, ultrasound and CT are equally sensitive in detecting calculi in bladder. CT is superior to ultrasound and radiograph in all areas. Ultrasound is more sensitive for detecting renal, bladder and urethra calculi Radiograph is more sensitive for detecting ureter, bladder and urethra calculi when compared to renal calculi.

Figure 1. Plain X-ray KUB Showing Multiple Radio Opaque Densities in Right Lateral Aspect of L2 and L3 Vertebral Bodies

Figure 2. X-ray KUB Showing Vesical Calculus

Figure 3. USG: Calculus in Renal Pelvis. Typical Sonographic Appearance of Calculus

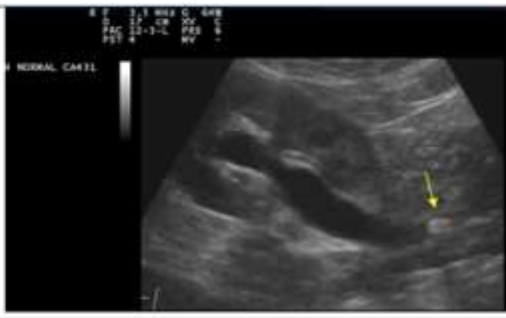


Figure 4. USG: Showing Hydronephrosis Secondary to Calculus in Proximal Ureter

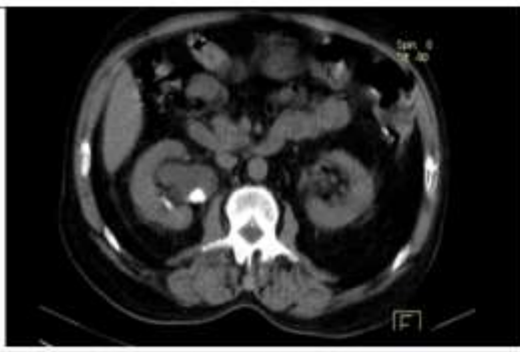


Figure 5. Axial CT: Showing Mild Right Hydro Nephrosis Secondary to Pelvic Calculus

Figure 6. Axial CT Showing Mild Right Hydronephrosis Secondary to Proximal Ureteric Calculus

DISCUSSION

Role of Plain Radiography

According to present study, the percentage of detection of urolithiasis by X-ray is 60.5%. The low detectability rate in present study is probably due to greater incidence of stones of lower density in our locality and also probably because of the less adequate preparation of the patient for X-ray KUB as most of the X-rays were taken as an emergency. Also, as stones less than 2 mm are not considered to be detectable by X-ray. In our study, the highest sensitivity of radiographs was for stones located in the lower ureter and bladder (Fig. 1 & 2). In present study the percentage of detection of renal calculi by radiography is 55%. The percentage of detection of ureter calculi is 64.1%. In our study over radiograph is positive in 63 people- 60.5%.

Site: In kidney- positive in 22 people- 55%. In ureter- positive in 32 people- 64.1%. In bladder- positive in 6 people- 100%. In urethra- positive in 4 people- 80%

Role of Ultrasound

According to our study ultrasound is found to be most sensitive for detecting calculi in renal area (Fig. 3) and in the vesicoureteric junction. In present study the sensitivity for calculi in renal area is 97%. The sensitivity of ultrasound for ureteric calculi was found to be low (48.1%) in our study. The most difficult portion to visualize is the mid of the ureter, due to interference from bowel gas. The sensitivity of ultrasound for urinary bladder calculi was found to be high (100%) in our study. It might be probably due to large size (>4 mm). USG is positive in 74 people –71.15%

Site: kidney- positive in 36 people- 97%, Ureter- positive in 26 people- 48.1%. Bladder- positive in 6 people- 100%, Urethra- positive in 6 people- 100%

Role of CT

In our study out of 104 patients with renal colic CT detected calculi in 100 patients. The sensitivity was found to be 96.1%. Advantages of CT being easily available, speed, ease of image acquisition and ability to detect extra-urinary pathologies.[3,4,5,6,7] Dual energy CT is a new technique to know the composition of calculus by assessing stone attenuation at two different kVp levels. It improves characterization of renal stone composition beyond that achieved with single-energy multidetector CT acquisitions with basic attenuation assessment with advanced postprocessing techniques. It is useful in detecting calculi concealed by the opacification of the collecting system. Dual energy CT has also been able to predict the success of extracorporeal shock wave lithotripsy.

Value of Reformatted Images

Coronal and sagittal reformatted images of 3 mm thickness are routinely acquired and are an indispensable part of the stone CT protocol. Integration of multi-planar reformatted images with routine axial scans during image interpretation enables precise evaluation of the entire urinary tract and location of the impacted stones. They also improve the detection of small stones, particularly at the renal poles, and facilitate the differentiation of extrarenal calcifications from urinary stones

CT Signs

Ninety-nine percent of urinary calculi are visible on non-contrast CT. On CT almost all stones are opaque but vary considerably in density. Calcium stones (oxalate & phosphate) have attenuation value of 400-650 HU, Uric acid stones have attenuation value of 150-200 HU, cystine stones have attenuation value of 112-220 HU. Struvite (Magnesium ammonium phosphate) stones are opaque but variable in attenuation usually 225-400 HU. Protease inhibitor (Indinavir) stones (15-30 HU) are radiolucent and are usually undetectable on non-contrast CT.[8,9] These stones are detected on contrast enhanced CT in delayed phase, characterized by a filling defect in the ureter.

Ureteric calculi >1 mm are detected on non-contrast CT with specificity as high as 100%. The most definitive sign on CT is calculus within the lumen of ureter.[4,10] Secondary signs include hydroureteronephrosis, perinephric fat stranding and periureteral oedema.[5,11] The positive prediction value of perinephric fat stranding is 98% for the detection of ureteral calculi.

Extra-uinary abdominal calcifications, commonly phleboliths may mimic ureteric calculi. Two signs are useful in differentiating ureteric calculus from phlebolith: "comet tail sign" and "soft tissue rim sign."[11,12]

Comet tail sign refers to a tail of soft tissue extending from a calcification, representing the thrombosed parent vein. This sign strongly favours phlebolith with a positive predictive value of 98%. Soft tissue rim sign favours ureteric calculus which appears as calcific density with surrounding soft tissue rim which represents oedematous ureteric wall. Phleboliths have central lucency in contrast to calculi which are uniformly dense.

CONCLUSIONS

From our study, plain radiograph was found to be more sensitive in detecting calculi of size greater than 5 mm. Ultrasound showed a greater sensitivity in detecting renal, vesical and vesicoureteric junction calculi. In our study, the results showed CT to be superior to ultrasound and plain radiography in detecting urolithiasis. Non-contrast CT is the most accurate imaging modality for urolithiasis owing to high sensitivity, specificity, accurate stone sizing, and the ability to evaluate non stone related pathologies.

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