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RENAL COLIC PATIENT;

COMPARISON OF UN-ENHANCED HELICAL COMPUTED TOMOGRAPHY, INTRAVENOUS UROGRAPHY AND ULTRASOUND + PLAIN X-RAY"

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ABSTRACT... Objectives: To compare Un-enhanced Helical Computed Tomography (UHCT), Ultrasonography (US) + Plain X-Ray and Intravenous Urography (IVU) in the evaluation of patients with suspected renal colic. **Subjects:** In 70 patients with renal colic US, plain X-ray, IVU and UHCT were performed to demonstrate urinary stones and other relevant pathologies. Patients were then followed-up to stone passage or removal, and the course of clinical symptoms were noted. **Results:** 57 patients had ureteral stones based on stone passage or removal. 13 patients did not have ureteral stones based on failure to recover a stone, disappearance of symptoms, and diagnosis unrelated to stone disease. Un-enhanced helical computed tomography was found to be the most useful method in the demonstration of ureteral stones with a sensitivity of 97%. Reformatted images clearly depicted the intraureteral location of stones in most cases. Spiral UHCT showed renal calculi in 15 patients, USG + KUB in 12 and IVU in 9 patients. **Conclusions:** Non-contrast axial and reformatted spiral CT (UHCT) images were found superior to USG + KUB and IVU in the depiction of ureteral and renal calculi. Reformatted images offer a good alternative to IVU in problematic cases.

Key words: Renal Colic, Un-enhanced Helical Computed Tomography Reformatted Images, Ureteral Calculi. Ultrasonography,Intravenous Urography.

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INTRODUCTION

Acute renal colic is probably the most excruciatingly painful event affecting approximately 1.2 million people each year and accounts for about 1% of all hospital admissions. Climatic conditions of Pakistan favour renal calculi and people living in the South and Southwest have higher incidences of stones than people in other parts of the Pakistan[1,2].

A long list of potential problems can cause flank pain. The most significant disorders are renal tract calculi, pyelonephritis[4], renal abscesses, abdominal aortic aneurysms[3], herpes zoster, muscle pain,[5] papillary necrosis, pleuritis, radiculitis,[6,7] kidney tumours, PUJ obstruction, ureteral strictures, renal infarction[8], appendicitis, renal vein thrombosis, cholecystitis, adrenal tumours and haemorrhage, colon cancer, and splenic infarction. Gynaecological causes of flank pain include ectopic or tubal pregnancy[9], Endometriosis, ovarian cyst rupture or torsion, ovarian vein syndrome[10], and pelvic inflammatory disease. A battery of investigations is required including plain X-ray, ultrasonography, IVU and even CT scan to reach the diagnosis.

In the last decades, alternatives to urography have been proposed in patients with renal colic. In 1992[11], it was suggested to replace urography with KUB and Ultrasonography; in 1995[13] Un-enhanced Helical CT (UHCT) was proposed. CT Urography became popular as single most comprehensive study with the advent of multi detector CT despite of the concerns related to radiation dose and contrast induced nephropathy[27,28]. UHCT has proved to be much more diagnostically accurate than Urography with the advantage of improved accuracy and no contrast related side effects particularly in vulnerable patients[20].

The IVU clearly outlines the entire urinary tract and determines relative renal function. It shows stones causing blockage, whether radiolucent or

opaque evidently. IVU is indicated in case of:

1. Sonographic evidence of hydronephrosis without a stone on plain film.
2. Stone at plain film in the absence of stone or hydronephrosis at ultrasonography.
3. Recurrent colic with negative US and KUB.
4. Interventional or surgical therapy to define precise anatomy.

The Un- enhanced helical CT scan is good for the initial diagnosis of a stone, especially in atypical cases or in patients unable to tolerate IV contrast. Without hydronephrosis, CT may not isolate a stone, though secondary signs, such as ureterectasis perinephric/periureteric streaking, tissue rim sign, renal sinus fat blurring and nephromegaly may be present[14,15]. Urinary system anomaliesi.e.ureteropelvicjunction,ureterovesical junction and bladder outlet obstruction; renal and perirenal haemorrhage; duplicated ureter with obstruction and arteriovenous malformation may also be visualized[16]. Conditions of intestinal tract (small bowel obstruction, Crohn's disease, diverticulitis, appendicitis, colitis, volvulus, intussusception, hernia etc.), liver and biliary tree, pancreas, vascular system and adnexa (ovarian masses, endometriosis, hemorrhagic cyst, hydrosalpinx) may also be detected. UHCT detects almost all urinary stones while IVU fails in 31%-48% cases. It identifies renal microcalculi not detectable by plain film, entails less discomfort for the patient and examination time is much shorter. The radiation dose is a little higher when correct parameters are used. Estimated effective dose from an abdomino-pelvic CT and conventional IVU with tomography has been estimated to be between 10-15 mSv and 5-10 mSv respectively in same study[29].

As any density along the expected course of the ureter may not be stone within the collecting system; combining a renal ultrasound with an abdominal radiograph is a reasonable alternative which provides substantial information quickly and inexpensively without the risk of contrast[17]. Ureteric jets on real time or Doppler US rule out obstruction[18]. The elevation of intrarenal resistive index measured on Doppler studies indicates acute renal obstruction on the affected side[19]. However, it does not identify partial or intermittent obstruction. Information about the radiolucency, size, shape, or position of stone and differentiation between intrinsic and extrinsic urinary obstruction is limited. Readings are affected by Pyelosinus extravasation or forniceal rupture, renal failure, diabetic nephropathy, and renal compression[5]. US is highly sensitive in conditions like cholelithiasis, Ac. pancreatitis, Ac. appendicitis and abdomino-pelvic masses that mimic renal colic. In our experience this approach can solve 70% of the cases. The IVU is sometimes preferred by urologists because of its better orientation and superior value in predicting possible stone passage, though these advantages are mostly negated if a KUB radiograph routinely accompanies the CT scan.

IVU should have no more priority in patients with renal colic. The current day approach considers Unenhanced Helical CT or KUB and US followed by CT Urography in unsolved cases[14,20,27].

MATERIALS AND METHODS

Study was carried out at the department of Radiology Military Hospital (MH) and Combined Military Hospital (CMH) Rawalpindi Cantt. where the US, plain X-Ray, IVU and CT scan were performed. Patients of all ages, either sex and all socioeconomic strata with clinical suspicion of renal colic were subjected to plain X-ray, ultrasound KUB, followed by intravenous urography and un-enhanced helical CT scan of KUB area ,with full urinary bladder in the same patients.

Inclusion Criteria

1. All patients with renal colic
2. Patient of either sex or any age group.

Exclusion Criteria

1. Patients with congenital obstruction e.g. PUJ obstruction, conjoined megaureter.
2. Patients with renal failure.
3. History of hypersensitivity to contrast media.
4. Pregnancy.

Equipment & Examination Techniques

1. Schimadzu 600 mA machine was used for plain X-ray in patients after micturition.
2. Aplio (Toshiba) ultrasound machine equipped with 3.5, 5 and 7.5 MHz probes and facility of Doppler was used for evaluation of kidneys, ureters and urinary bladder in multiple anatomic planes.
3. Un-enhanced helical CT of abdomen & pelvis up to pubis was performed by using Toshiba Helical Scanner with a dedicated protocol of 3.0 mm collimation and pitch of 1.5 (100 to 120 KV and 250 mAs). Axial, sagittal, coronal and even oblique reconstruction was done to study the course of ureter.
4. Intravenous urography was performed using Schimadzu 600 mA machine. Patients prepared at night before examination with purgatives like tab. Dulcolax 6x HS. After overnight fast Plain X-Ray KUB and 1, 5, 15 minutes post IV contrast films were acquired with patient in supine position. Compression release and prone films were also acquired and when needed delayed X-Rays also performed. Study completed with X-Rays of urinary bladder area contrast filled and post evacuation film of KUB area.

Variables Assessed during the Study

1. Calcification
2. Caliectasis: stasis in calices.
3. Hydronephrosis
4. Hydroureter
5. Perinephric Stranding: thickening of perinephric bridging septa between renal fascia and capsule.
6. Periureteric Stranding: strands observed in periureteral space.
7. Renal Calculi
8. Renal Sinus Fat blurring: renal sinus extravasation of urine and/or nflammatory reaction in case of obstruction
9. Renal Size Enlargement: increase in thickness of renal parenchyma or increase in the length of kidney
10. Rim Sign: circumferential rim of soft tissue attenuation surrounding a stone expressing edema and inflammation of ureteral wall.
11. Ureterectasis: focal stasis of urine in ureter
12. Ureteric Calculi
13. Vesical Residue
14. Others like Renal Mass, Cyst, Clot, Kink Ureter, Filling defect, Obstructive Nephrogram and Pyelogram etc.

Study Technique

All the patients presenting in emergency, out-patient department or ward with suspected renal colic were evaluated initially with plain X-Ray abdomen and ultrasonography. Intravenous urography and un-enhanced helical CT were performed later. The mean interval between ultrasound + plain x-ray, IVU and helical CT was 3.0 days ± 2.0 days. Findings of different modalities were observed independently by different radiologists to compare their role in evaluation of renal colic.

Data Collection

Data were collected with the help of comprehensive proforma containing direct and indirect signs of obstruction on all the modalities was compared with follow up outcome and results of surgery, spontaneous passage of stone and subsidence of symptoms on completion of study. Data were analysed using SPSS version 10. Sensitivity, specificity and positive/negative predictive value of each modality were calculated.

RESULTS

Out of seventy patients studied pathology was detected in sixty eight patients on follow up (urological intervention/ stone recovery). Two patients were negative for pathology. UHCT was able to detect the lesion directly or indirectly in sixty six patients with two false negative cases. Its sensitivity was 97%, specificity 100% and positive predictive value 100%. Ultrasound + KUB were able to diagnose sixty three patients with one false positive. This technique was 92% sensitive, 87% specific and with 98% +ve predictive value. IVU could only detect sixty cases with two false positive cases giving 88% sensitivity, 83% specificity and positive predictive value of 96%. Extra-renal pathology in one patient was hydatid cyst right lobe of liver diagnosed on ultrasound

and UHCT mimicking renal colic.

UHCT detected fifty seven ureteral stones with one false positive and no false negative proving to be 100% sensitive, 92% specific and having 98% positive predictive value. Ultrasound supplemented by plain X-ray KUB was able to detect twenty six ureteric stones with two false positive and thirty false negative. This technique had 44% sensitivity, 78% specificity and 89% positive predictive value. IVU was at lower rate of detection with nineteen positive cases. It had 33% sensitivity but 98% specificity and 95% positive predictive value.

UHCT detected fifteen renal stones with no false positive and false negative. Sensitivity and specificity calculated was 100% along with 100% predictive value. Ultrasound + plain X-ray KUB detected twelve out of fifteen renal calculi with 80% sensitivity while specificity and positive predictive value was 100%. IVU detected nine renal stones with two false positives out of fifteen true positive cases. It had 60% sensitivity 98% specificity and 90% positive predictive value.

Signs	USG + KUB	IVU	UHCT
Ureterectasis	40	39	59
Ureteric Calculi	26	19	57
Caliectasis	47	24	49
Rim Sign	0	0	47
Hydroureter	33	33	45
Hydronephrosis	48	44	44
Periureteric Stranding	0	0	37
Sinus Fat Blurring	0	0	18
Perinephric Stranding	0	0	16
Renal Calculi	12	9	15
Calcification	11	4	9
Psoas Outline	0	0	0
Vesical Calculi	0	0	0
Vesical Residue	0	2	0
Others	10	* 19	13

Table-I. Comparison – radiologic signs
**IVU was better in evaluation of ureteral anomalies like tortuous ureter or retro-caval ureter.*

COMPARISON—Percent Signs on UHCT		
Signs	**Our study**	**Dalla Palma et al**
Calcification	15	-
Caliectasis	80	-
Hydronephrosis	72	-
Hydroureter	74	-
Perinephric Stranding	26	36—82
Periureteric Stranding	61	67
Renal Calculi	25	-
Renal Sinus	30	76
Renal Size	12	36—71
Rim Sign	77	50—77
Ureterectasis	97	64—90
Ureteric Calculi	93	94—100

Table-II.

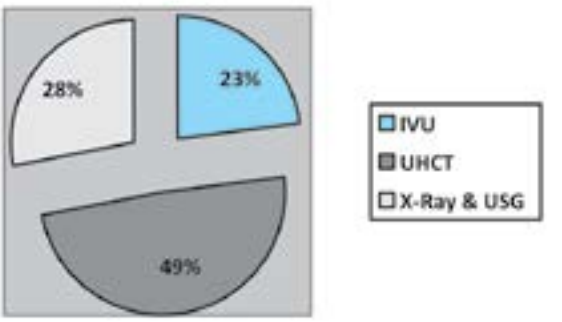


Fig-1. Average of signs detected

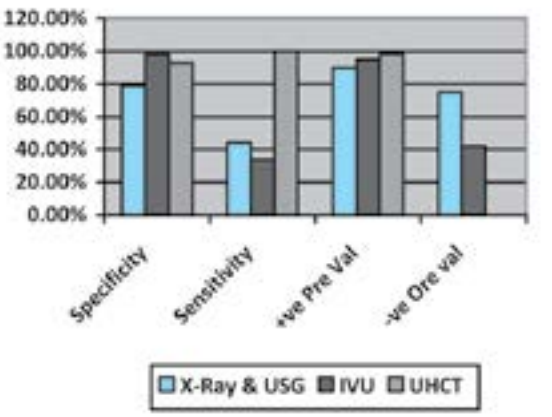
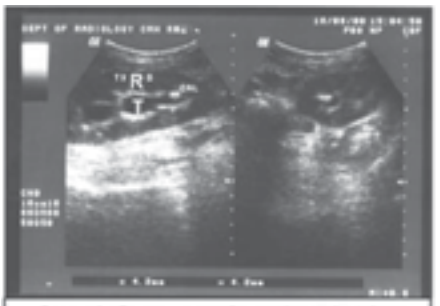
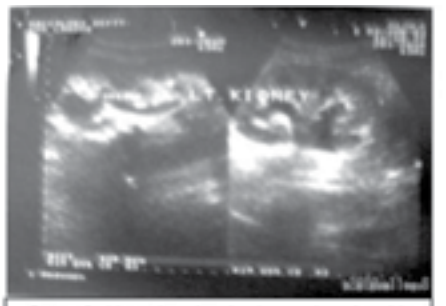


Fig-2. Comparison: ureteric calculus detection



Case-1: Sonogram of a patient showing hydronephrosis and a small lower pole stone



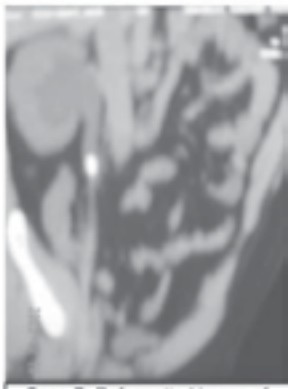
Case-2: Use showing hydronephrosis with hydroureter visible in proximal part

Case-3: A pelvic phlebolith on UHCT. Note "comet tail" and no lucent centre

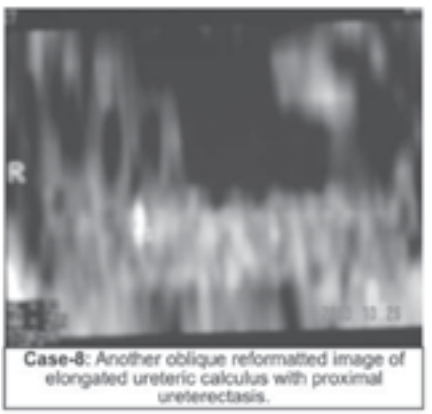
Case-4: Phlebolith with a lucent centre on plain film of pelvis

Case-5: Radiopaque calculus in the line ureter on plain x-ray

Case-6: IVU - hydronephrosis with hydroureter (left)

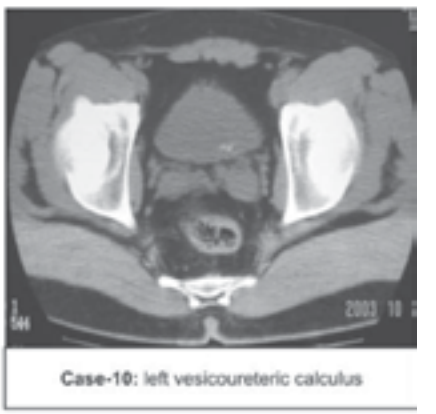


Case-7: Reformatted image of UHCT. A calculus in proximal ureter is clearly seen.



Case-8: Another oblique reformatted image of elongated ureteric calculus with proximal ureterectasis.

Case-9: A calculus in pelvic part of left ureter on UHCT which was not visible on plain film

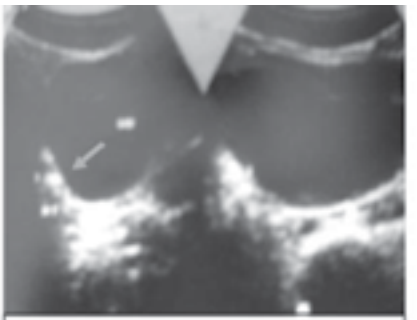


Case-10: left vesicoureteric calculus

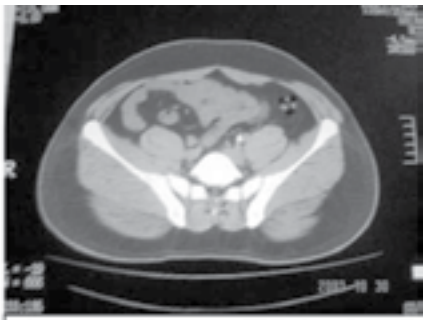
DISCUSSION

UHCT is preferred by many radiologists for evaluation of patients with renal colic because its sensitivity is established. UHCT enjoys clear advantages over USG + KUB or IVU. In 1995 Smith et al. compared it directly with IVU in patients of acute flank pain and found it more effective than IVU in precisely identifying ureteric stones and equally effective as IVU in the determination of the presence or absence of ureteric obstruction[13]. The speed of exam completion, the lack of need for IV contrast injection, as well as the ability to detect non stone disease as the causes for the patient's symptoms and other findings suggestive of Ureteric obstruction were the advantages. Katz et al. in a review of 54 positive scans for ureteric obstruction noted that in addition to the stone common findings included hydronephrosis, hydroureter, perinephric soft tissue changes and periureteral edema. Only 2 patients had no evidence of at least one of these findings[29]. Levine et al. helped further define the weakness of the plain radiograph/IVU paradigm by looking at the ability to detect a ureteral calculus in an

Case-11: USG showing a calculus at mid ureter obstructing proximal tract (arrow)

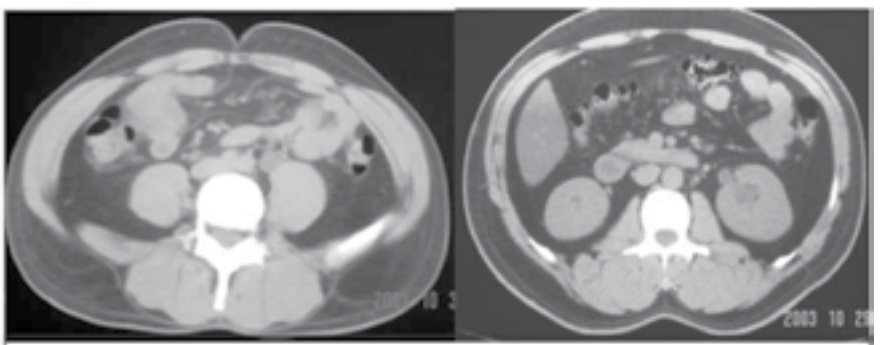


Case-12: Left vesico-ureteric calculus with posterior acoustic shadowing (arrow) on USG

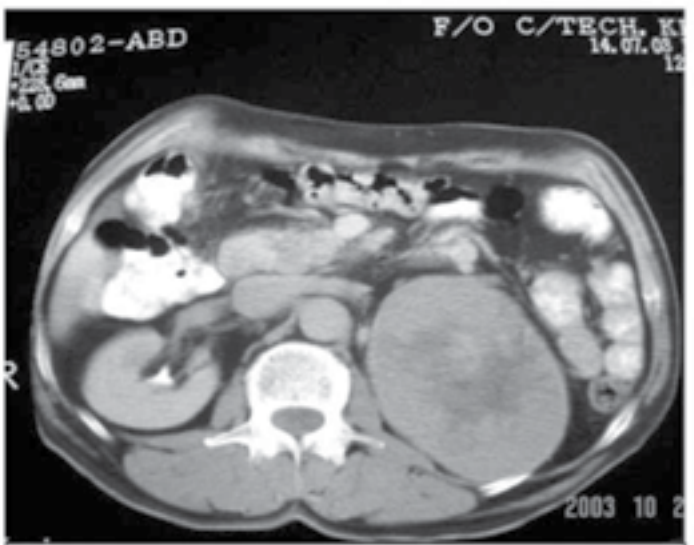


Case-13: Tissue rim around an obstructing ureteric calculus on axial UHCT

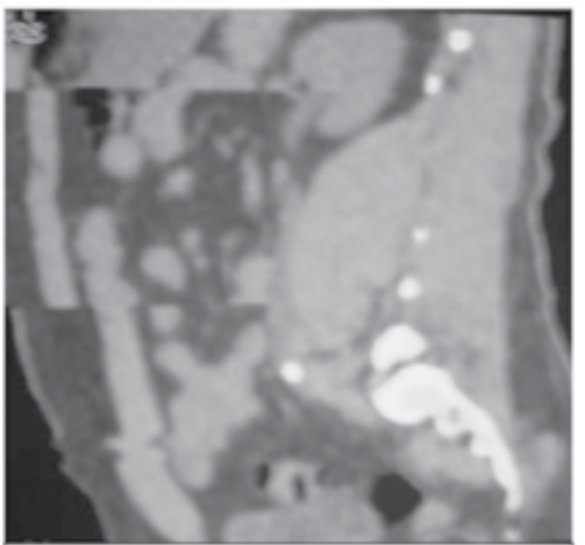
Case-14: Reformatted image showing ureteric calculus with proximal dilatation.



Case-15: Axial scans showing peri-ureteric stranding with hydronephrosis and hydroureter



Case-15: Renal tumour in a patient presenting with clot colic. Hyperdense clots in UB on UHCT were mimicking mass on USG and IVU



Case-16: Reconstructed image showing a mid ureteral calculus causing obstruction

unblinded retrospective study with sensitivity of 59% leading to conclusion that plain radiography is of limited value in patients with acute flank pain and they can directly undergo un-enhanced helical CT; plain radiographs need not be obtained first24. Sourtziz et al. stated that compared with excretory urography, unenhanced helical CT is better for identifying ureteral stones in patients with acute ureterolithiasis. Secondary CT signs of obstruction, including renal sinus fat blurring, were frequently present even when the stone was eliminated before imaging[25]. Another article reviewed 106 adult patients suspected of having ureterolithiasis who had both a non-contrast CT

scan as well as a urogram. Of the 75 patients proven to have stone disease CT was correct in 72 of the 75 cases. Urograms were correct in 65 of the 75 patients. Based on these results Miller et al. concluded that NCCT can accurately diagnose ureterolithiasis in patients presenting with acute flank pain. NCCT is significantly better than IVU in determining the presence of urolithiasis"[26].

The problem area in UHCT is pelvic region where phleboliths mimic ureteric calculi in patients without hydroureter. The typical comet tail sign aids in differentiation between the two. Lucent centre is not visible in UHCT in phleboliths[27]. The other features which support ureteric calculi are Ureterectasis, rim sign and elongated shape of the ureteric calculi. In IVU the lucent calculi may not be visible but the indirect signs of obstruction like hydronephrosis, hydroureter, hold up of contrast (ureterectasis) and forniceal dilatation lead to the diagnosis. In USG ureters can not be visualised in complete course due to bowel gas. If combined with plain X-Ray KUB, radiopaque calculi in the course of ureter with signs of obstruction on USG point to the diagnosis.

In our study the results of USG + KUB were found superior to those of IVU as Study carried out by Dalla Palma et al gave results in favour of UHCT with the sensitivity of 100% while IVU and ultrasound + KUB with sensitivities of 52% and 70% respectively[14]. Haddad M.C. has given even better results with ultrasound + KUB. Yalmaz et al in a study compared US, IVU with UHCT. The sensitivity was found 19%, 52% and 94% in order of respect with specificities 94% and 97%[21]. A study by Patlas et al showed sensitivity of 91% for UHCT and 93% for ultrasonography. The specificity in this study was 95% for both modalities. They suggested that ultrasound should be employed first and UHCT should be reserved for unresolved cases[22]. Ryu et al compared the sensitivity and specificity of UHCT and IVU. According to this study UHCT was 96% sensitive and 100% specific while IVU was 61% sensitive and 89% specific for ureteral stones. Nazim A. et al gave results of UHCT in incidental diagnosis of urinary stones with sensitivity of 99% and specificity 98%[23]. Remer et al compared average time and direct technical cost of ultrasound + KUB and UHCT. The conclusion provided by him is that within reasonable time ranges, combined ultrasound and plain radiography cannot be cost equivalent to spiral CT.

USG and UHCT can easily diagnose extra urinary conditions like cholelithiasis and appendicitis etc. which are missed on IVU. IVU and USG cannot differentiate between clot and small radiolucent calculi, but they can be easily picked on UHCT as we found cases of clot colic and radiolucent calculi in some of our patients. Although the UHCT is relatively more expensive modality but it has revolutionized the treatment because it is less time consuming giving less discomfort to the patient and reduces the average hospital stay thus reducing overall health expenses. IVU takes much time with additional risk of IV contrast medium and delayed images may be required to complete the study. USG is operator dependent with false positive results and cannot visualise ureter in complete course. It is also difficult to perform in obese patients. Very small stones (less than 4.0 mm) are easily missed in USG. The risk of radiation exposure in spiral CT according to some authors is equivalent to rather less than that of IVU. High pitch (1 to 1.6) and thin collimation (3 mm to 5 mm) is a good compromise between radiation exposure and image resolution. Different direct and indirect signs on UHCT in our study given in table-II are almost the same as found in study by Dalla Palma et al.

CONCLUSIONS

UHCT is superior in diagnosis of renal colic to the USG + KUB and IVU. It is rapid and more effective way of investigation in emergency. USG + KUB are alternative in situation where UHCT is not available or where it is contraindicated. IVU should be reserved for unsolved cases or where surgical decision making needs full map of the genitourinary tract. Following protocols are suggested on the basis of our study: -

1. UHCT should be the first investigation in cases of renal colic because[28]:
   i. It detects almost all urinary calculi.

ii. It identifies non obstructing micro calculi undetectable on plain films.
iii. It is able to recognise alternative or associated urinary and extra urinary conditions.
iv. It gives less discomfort to the patient and is fastest cost effective modality not requiring contrast medium.
2. USG + KUB are very good alternative where UHCT is not available giving results slightly lower than UHCT. It can be first modality of investigation in patients where UHCT is contraindicated.
3. IVU should be no more be a first priority and it should be considered where USG + KUB or UHCT are unable to give the desired results or advised by the surgeon if required for decision making in surgery.

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