Original article

Diagnostic value of scout view CT-KUB in management of lower ureteric calculus

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ABSTRACT

Introduction: Lower ureteric calculus is usually managed on Medical Expulsive Therapy. These patients require periodic imaging studies to monitor stone position and to assess for hydronephrosis. There is high variability in determining the choice of imaging protocols to observe progression of ureteral calculi for follow up. Widespread use of NCCT KUB for initial diagnosis lead to use of scout view of NCCT obtained during NCCT KUB in management of ureteric calculus owing to its reduced radiation dose. These studies recommend that Scout view should substitute baseline KUB radiograph. This study aims to determine the effectiveness of scout view of CT and its ability to assist one in follow up imaging of lower ureteric calculus .The study also compares the imaging modalities used in lower ureteric calculus management with aim to determine the most sensitive imaging modality, with minimal radiation and most cost effective which can be utilised for periodic follow-up imaging.

Methodology: The study was a prospective study involving 125 diagnosed patients of lower ureteric calculus, in Department of Radiology and Surgery of PGIMSR & ESI Hospital, Basaidarapur, Delhi between Jan 2011 to Dec 2013. All the patients were administered either alfuzosin or nifedepine. Diclofenac sodium was given as a standard pain reliever. X-Ray KUB, Ultrasound KUB and NCCT KUB were used for initial investigation. Scout view KUB obtained during NCCT KUB study was analysed. Subsequent follow up was investigated using X-Ray KUB, Ultrasound KUB and in selected cases Low dose targeted NCCT KUB was done. The presence or absence of calculi, location & size of each calculus, HU value and passage of calculus was recorded.

Results: In lower ureteric calculus the overall sensitivity of X-Ray KUB was 68.8% and scout view CT was 29.6%. The study found combination of X-Ray KUB and USG examination has a sensitivity of 94.4% and can be used as an important tool in follow up imaging.

Conclusion: Scout view CT is least sensitive to diagnose lower ureteric calculus. Latest CT Scanners use minimal radiation and very low mAs to generate a scout view hence there is considerable loss in quality of the image and decrease in its diagnostic value. Follow up imaging should be done with combination of X-Ray KUB and USG. This combination is cheaper, easily available and gives less radiation to the patients. Moreover, NCCT KUB remains the choice of initial imaging modality.

Key words- Lower ureteric calculus, Scout view NCCT KUB, NCCT KUB, X-Ray KUB, and Ultrasound KUB.

INTRODUCTION

International statistics show 12% of world population suffers from urolithiasis of which 70% are located in distal ureter (Cervenakovl et al).[1]Current EAU-AUA Guidelines on the Management of Ureteral Calculi recommend that medical expulsive therapy (MET) should be considered as first-line treatment for most patients with ureteral stones whose symptoms are control-led.[2]Patients with suspected ureteric calculi often undergo repeated imaging studies, and patients with urinary calculus disease are at high risk for recurrence[3].

Non-contrast computed tomography (NCCT) has emerged as the most sensitive and specific modality for initial imaging study for calculus. Sensitivity and specificity of NCCT KUB for detection of ureteral calculi Is 98% and 97% respectively. There is high variability in determining the choice of imaging protocols to observe progression of ureteral calculi in follow up.Some studies recommend Scout view CT to identify calculus and as per their study calculus is visualized in 50% of the cases.[4]Scout view CT is automatically produced routinely during CT positioning of patients before axial images are acquired. It covers the KUB region from the xiphoidsternum to the pubic symphysis. Several studies have proposed that the scout view CT will render routine baseline plain KUB radiograph useless.[5] A standard KUB X-ray should be performed only where the stone is not demonstrated on the CT scout as the stone will be seen in 10% of these patients.[4,6]There are several published data that evaluate the sensitivity of scout radiographs in KUB region. [6,7].The aim of this study was to determine the sensitivity of Scout view CT in detecting lower ureteric calculi using CT KUB as a standard reference and comparing it against the recently published series. Factors that may affect the sensitivity of detection on scout radiographs will be evaluated.This study also aims to determine the most desirable imaging modality for follow up.

MATERIALS AND METHODS

The study was a prospective study carried out in Radiology and Surgery department of PGIMSR & ESI Hospital, Basaidarapur, New Delhi. 125 diagnosed patients of lower ureteric calculus on medical expulsive therapy were investigated. Inclusion criteria was 1) distal ureteric calculus of size 10mm or less 2) age between 18 to 50years .Exclusion criteria was 1) bilateral ureteric calculus 2) concomitant calculus on the same side 3) severe hydronephrosis 4) ureteric stricture 5) benign prostatic hypertrophy 6) Urinary tract infection 7) Diabetes mellitus 8) postural hypotension 9) BP less than 100 mm systolic

All patients were assessed by a structured Performa for epidemiological and clinical details. Investigations to be performed were explained to each patient and written consent was taken. Routine urine examination and KFT was done in each case.

Initial Radiological investigations performed were 1) NCCT KUB 2) Scout View CT 3) X-Ray KUB 4) Ultrasound-KUB in all cases. NCCT KUB were examined using 64 slice Philips CT Scanner Brilliance (Philips Medical Systems, the Netherlands) with 5 mm section thickness. CT was performed from the lower chest to the symphysis pubis with no oral or intravenous contrast medium administered. All Scout View were produced using the manufacturer's default setting at 120 kVp and 1mAs. X-Ray KUB was performed on 800mA digital radio fluoroMARS-80Allengers (Chandigarh, India) .USG KUB was done in Nemio-XG 580Toshiba, and IE-33 Philips (Philips Medical systems, Netherlands). Observations were then made in terms of location, size and mean Hounsfield units of the calculus. Calculi were measured in an axial plane on CT KUB themaximum cross-sectional diameters were recorded. The mean Hounsfield units for each calculus were measured by placing the cursor over the calculus. Their X-Ray KUB was examined. Scout View obtained during NCCT were also analysed. When the observers analysed the plain radiographs and Scout View they were blinded to the NCCT findings. Ultrasound KUB was performed with full bladder. Size of the calculus if visualized was recorded. Status of kidneys and ureters noted.

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The patients having distal ureteric calculus were put on medical expulsive therapy. All Patients received diclofenac sodium as a standard pain reliever. Therapy was stopped if 1) stone was expelled during the study 2) patients developed side effects like postural hypotension, giddiness or palpitation. 3) Developed signs and symptoms of back pressure on kidneys.

Follow up radiological investigation: All patients were sent home and assessed every week until spontaneous stone passage or intervention. The follow-up consisted of a genitourinary history with the emphasis on pain, narcotic requirements, stone passage or recovery, physical examination and urine analysis. Patients were assessed by USG KUB at every visit. The interval to stone passage was estimated for each patient. The stone status was evaluated by a plain abdominal film in 2 weeks along with USG. Targeted low dose protocol NCCT KUB was done at 6 weeks if the calculus is not identified on plain radiography and USG. The time from the initial episode of colic to the incidence of stone passage was recorded for each patient.

STATISTICAL ANALYSIS

The data were analysed using SPSS v.16.0 descriptive data. Sensitivity was calculated at the 95% confidence interval. P-value 0.05 was considered significant.

OBSERVATIONS AND RESULTS

The study showed male predominance of urolithiasis. Out of 125 patients 80 patients were male(64%) and 45 were female(36%) with male to female ratio of 1.78:1.The most common age group was 31-40 years (39%) with mean age of 31 years(ANOVA test). 79(63%) patients presented with right sided pain and right sided calculi.

X-Ray KUB Demonstrated calculus in 86(69%)and Scout film of NCCT demonstrated calculus in only 37patients (29%).All calculus which were positive on scout film were also positive on X-Ray KUB.Ultrasound KUB demonstrated calculus in 61(49%) however inclusive of indirect signs (hydronephrosis & hydroureter) 93 patients (74%) were detected on USG. NCCT KUB was taken as gold standard and demonstrated calculus in 125 patients (100%) [Table1]. Most of the calculi in our series were of size 6.1 to 8 mm (39/125;-31.20%).The next in frequency were calculi of size 4.1 to6 mm (36%).Mean size of ureteric calculus was 6.26 to 6.50 mm [table 2].HU values ranged from 220 to1560 [Table 3] . In the 86 KUB positive kidney stones the mean kidney stone diameter was 7 mm (2-10 mm), in HU range 621-820 HU. In the KUB positive and Scout view negative kidney stones (49 patients) mean kidney stone diameter was 4 mm (2-9 mm), mean 738 HU.

DISCUSSION

The AUA-EAU [American Urological Association (AUA) in collaboration with the European Association of Urology (EAU)] Guidelines on the Management of ureteric calculi recommend that patients on Medical Expulsive Therapy “should be followed with periodic imaging studies to monitor stone position and to assess for hydronephrosis.”[2,8]

NCCT KUB is the best imaging modality as it has high sensitivity (98%) and specificity (97%). It also gives quick diagnosis and more information. In our study NCCT KUB was included in the initial investigation and taken as gold standard. Some studies have shown that low-dose CT in patients with Body Mass Index less than 30 is recommended to limit the potential long term effects of ionising radiation [9,10,11,12,13].In our study low dose protocol targeting the site of interest was done only in follow up imaging in selected caseswhere calculus was not located by X-Ray KUB and USG.Images in our study showed that Low dose protocol gave inferior contrast and is

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suitable only for follow up and cannot be used for initial diagnosis.

X-Ray KUB is inexpensive, quick, and helpful in follow up of progression of radiopaque calculi.A large clinical study from Johns Hopkins University by Jackman et al concluded that "plain abdominal radiograph is more sensitive than scout CT for detecting radiopaque nephrolithiasis".[14] In follow-up of patients with calculi, plain abdominal radiographs should be performed .Urologist require a KUB radiograph in all patients of renal colic to know the exact size and shape of a stone, its position, fluoroscopic appearance, surgical orientation, and relative radiolucency . X-Ray KUB is useful for monitoring the progress of the calculus in follow-up. Initial X-Ray KUB is also helpful in establishing a baseline for follow-up studies, and for visualization of the surgical orientation.

Studies have suggested the inclusion of CT scout radiographs for the management of renal and ureteric calculus. Studies have shown sensitivity of the scout view in detecting renal calculi to be between 40 to 49% .Sensitivity of 49% of Chu et al [5] is similar to 47% of Assi et al [7] and 40% of Ege et al .[6]Recent studies of Johnston et al [14] showed that the sensitivity of scout radiographs was 47% and Yap et al have shown that the sensitivity of CT scout view is between 42% and 52%.[15]In our study the manufacturer default setting for scout view was 1mAs and 120KVP and radiation dose of 3.8 mGy. All latest CT Scanners have reduced the mAs in scout view in attempt to reduce the radiation dose to the patients. But this also decreases the image quality hence its ability to detect lower ureteric calculus. Hence there is decreased sensitivity in detecting stones along with decreased radiation. In our study only 37 calculi were located on scout view with low sensitivity of 29.60% and NPV of 1.14. Calculus less than 2 mm and HU value less than 420 could not be located on scout view [Table 3]. The reason for our lower sensitivity was because our study was limited to lower ureteric calculus as compared to previous studies where renal and all ureteric calculi were included in the study.Another reason is previous studies were done in older scanners which had higher mAs for scout view hence better image quality. There are several factors that determine the visibility of the calculi on CT scout radiographs. The radiation factors used, mean size of the calculus, Hounsfield unit of calculus and location of the calculus. Our study showed smaller size (>2mm) and HU value less than 420 is similar to result for size and HU value in other studies. Statistically significant difference from the previous studies arose due to 1) location of the calculus as this study was limited to lower ureteric calculus and 2) difference in the default manufacturer setting for scout view 3) bowel gases also hindered visualization of calculus. Thus implying manufacturer setting for scout view is an important variable that has to be considered when interpreting a CT scout radiograph.

Ultrasound is dependent on operator's skill and calculus location. [16,17,18]Most of the studies report rates of approximately 30% detection rate butMiddleton et al reported 91% stone detection rate.[19] Diagnostic criteria include direct visualization of the stone, hydroureter more than 6 mm in diameter and hydronephrosis.[20]

Renal ultrasonography and X-Ray KUB in combination have reported sensitivities of 58-100% and specificity of 37.2-100%. [21-24]Studies have [25] recommended the use of repeated CT scans to follow patients with ureteral calculi. NCCT offers the most sensitive and specific imaging modality for following ureteric calculi. However, patient radiation exposure is increased as compared to other imaging studies. Two recent studies showed that some patients received high radiation doses

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when NCCT was used for follow-up of ureteric stones. [26,27] Both studies suggest that every effort should be made to use low-dose NCCT for follow-up imaging. Recent studies have shown excellent sensitivity (95%) and specificity (97%) for detecting stones with a low-dose CT protocol (30 mAs) compared to a standard dose protocol (180 mAs) in patients with a BMI of <30.[28] In our study Low dose CT protocol had very inferior image quality and not very useful in initial diagnosis of lower ureteric calculus. It can be utilized during follow up whenever calculus is not localized on USG & X-Ray KUB. The studies regarding the follow-up of ureteric calculi are low and there is limited information in the retrieved articles. Renal ultrasonography and MRI in spite of its lower sensitivity, is the preferred initial imaging modality for children and pregnant women because of radiation concerns.[29-32]Low-dose CT should be considered if renal ultrasonography is not diagnostic for children in whom a ureteric calculus is still suspected.[33,34]

Our study showed that though ultrasonography (USG) is not very sensitive for direct calculus visualization (61/125) 48.80%, but along with other signs of calculus like hydroureter and hydronephrosis its sensitivity is increased to (93/125) 74.40%. USG combined with X-Ray KUB (sensitivity 94.4%) was superior to USG combined with Scout view CT (sensitivity 76 %).Therefore this combination should be used for follow up. USG and X-Ray are cheaper, easily available and can better utilization of our resources.

In those patients who have a radiolucent stone, a low-dose NCCT can assess stone progression and the degree of hydronephrosis.

CONCLUSION

Scout view CT is not sensitive to accurately demonstrate lower ureteric calculus. Our study shows that ultrasonography combined with plain KUB offers the very good combination of sensitivity/specificity with minimal radiation exposure as it can assess the calculus position as well as degree of hydronephrosis. It should be used in follow imaging. It also significantly reduces cost as compared to NCCT imaging.

However, if sonography and KUB fail to demonstrate hydronephrosis or persistent calculus, further imaging by low-dose NCCT limited to the area of interest may be done.

Summary

Scout view CT and X-Ray KUB has low sensitivity and specificity on its own. When X-Ray KUB is used along with USG its sensitivity for calculus is improved. It is also useful in monitoring the progression of a calculus. This combination is cheaper, gives less radiation and optimum resource utilization. NCCT KUB is quick, more informative and superior in sensitivity and specificity and should be used for initial investigation.

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Table 1-SENSITIVITY AND SPECIFICITY OF VARIOUS IMAGING MODALITIES (NCCT as gold standard)

S no	Investigation	No of cases	Sensitivity	Specificity	PPV	NPV
1	X-Ray KUB	86	68.80	100	100	2.56
2	Scout CT	37	29.60	100	100	1.14
3	USG KUB	93	74.40	100	100	3.13
4	USG+X-Ray KUB	118	94.40	100	100	14.29
5	USG & Scout CT	95	76	100	100	3.33

Table 2- SIZE OF THE LOWER URETERIC CALCULUS
(NCCT-Non-contrast computerised tomography, KUB- kidney ureter bladder, USG-Ultrasonography)

S.No.	Calculus size	NCCT	X-Ray KUB	Scout view CT	USG
1	1-2 mm	3	1	0	1
2	2.1-4 mm	21	9	3	15
3	4.1-6 mm	36	18	4	19
4	6.1-8 mm	39	32	7	8
5	8.1-10 mm	26	26	23	18
TOTAL		125	86	37	61

Table 3-HOUNSEFIELD VALUE OF THE CALCULUS

S No	H U Value	NCCT	NCCT %	X-Ray KUB	X-Ray KUB %	Scout View	Scout View %
1	220 – 420	21	16.8 %	8	6.4 %	0	0 %
2	421 -620	25	20 %	14	11.2 %	1	0.8 %
3	621 – 820	42	33.60 %	27	21.6 %	4	3.2 %
4	821 -1020	8	6.40 %	8	6.4 %	6	4.8 %
5	1021 – 1221	9	7.20 %	9	7.2 %	6	4.8 %
6	1221 – 1420	16	12.80 %	16	12.8 %	16	12.8 %
7	1420 - above	4	3.20 %	4	3.2 %	4	3.2 %

Figure 1: 40-year-old male with right lumbar & pelvic pain diagnosed with right lower ureteric calculus. Dose protocol in CT scout and NCCT KUB are displayed. The calculus (white solid arrow) seen in NCCT scan KUB was not visualised in CT scout film.

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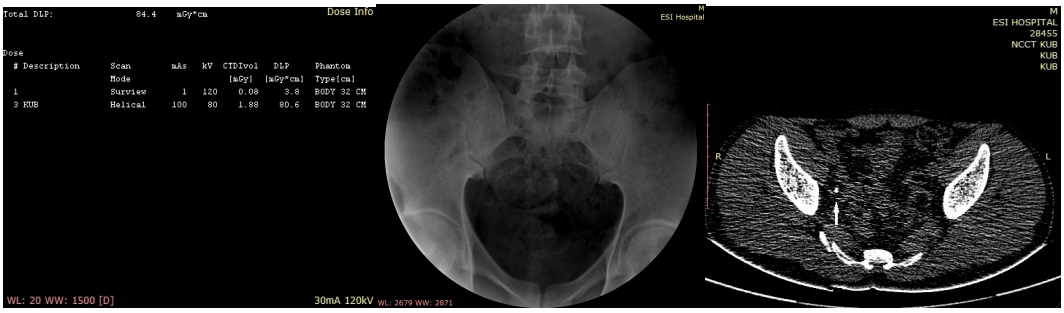

Figure 2: 35-year-old male with right lower lumbar pain diagnosed with right lower ureteric calculus. Dose protocol in CT scout and NCCT KUB are displayed. The calculus (white solid arrow) seen in NCCT scan KUB was not visualised in CT scout film.

Figure 3: 25-year-old male with right lower lumbar pain diagnosed with right lower ureteric calculus. The calculus (white solid arrow) seen in NCCT scan KUB was not visualised in CT scout film and low dose NCCT KUB.

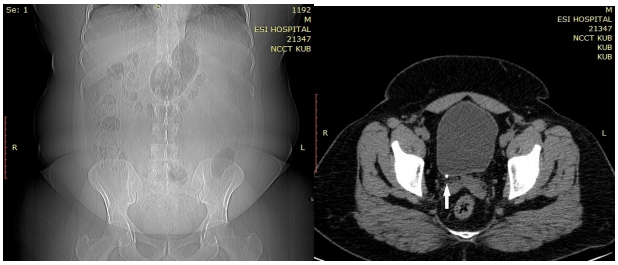

Figure 4: 19-year-old male with right lower lumbar pain diagnosed with right lower ureteric calculus. The calculus (white solid vertical arrow) is visualized in NCCT scan KUB, however not seen in CT scout film.

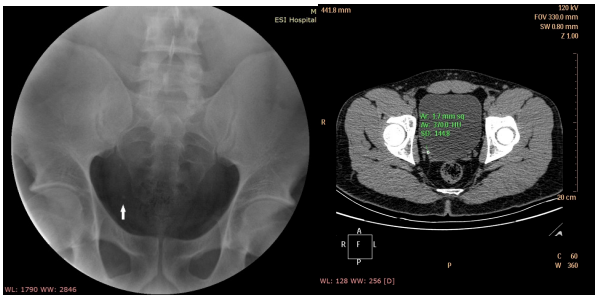

Figure 5: 28-year-old male with right lower lumbar pain diagnosed with right lower ureteric calculus. The calculus (white solid vertical arrow) is visualized in both CT scout film and NCCT scan KUB. NCCT KUB shows calculus of higher density (370HU).

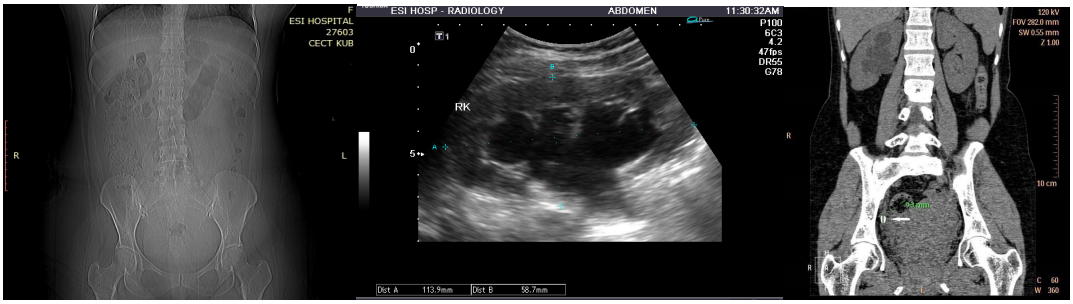

Figure 6: 40-year-old female with right lower lumbar pain diagnosed with right lower ureteric calculus. The calculus could not be visualised on NCCT scout film. Ultrasonography detected right moderate hydro-uretero-nephrosis, however lower ureteric calculus was difficult to visualise due to bowel gases. The calculus (white solid horizontal arrow) is easily visualized in NCCT-KUB reformatted coronal image.

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