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Comparative Study between Ultrasound, Intravenous Urogram and General Urine Examination in the Diagnostic of Urinary Lithiasis

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ABSTRACT

Context: Intravenous the gold standard radiological procedure regarding the diagnosis and the evaluation of patients with urolithiasis. Ultrasound is safe, fast, specific, and non-invasive method to detect both opaque and non-opaque calculi. General urine examination is a simple method for the early detection of suspected patients with urolithiasis.

Objective: To compare the results obtained from KUB, US, IVU and to show whether US plus KUB can replace IVU in the initial evaluation of patients with renal colic due to urinary stone. It also aims to confirm the validity of GUE in case of urinary stones.

Setting: The study was done from May 2018 to May 2019 in the Department of Radiology in Al-Salam General Hospital in Mosul.

Participants: Among (200) patients who were examined, there were (138) male patients (69%) and (62) female patients (31%). Their age ranged from 1 – 65 years.

Outcome Measures and Statistical Analysis: Sensitivity and accuracy for KUB, US, IVU and KUB plus US, in addition to sensitivity and accuracy of GUE and incidence of Microscopical Haematuria were estimated.

Results: Renal stones were found in 138 patients which form (64%), ureteric stones were noticed in 68 patients (33%) while, the least were vesical stones 7 patients (3%).

- Radiopaque stones were found in (179) patients (93%), compared to radiolucnet stones which were found in (14) patients (7%).
- Accuracy of KUB in detecting urinary stones was (81%), for US it was (94%), for IVU it was (98%) and for KUB plus US it was (96%).
- Hydronephrosis was detected in (130) patients, sensitivity of detection of hydronephrosis by IVU was (92%) compared to US that was (88%).
- Accuracy of simple urine examination to detect urinary stones was (80%), while (54%) of patients have Microscopical Haematuria.

Conclusions:
- The present study emphasizes the use of US plus KUB in diagnosing urolithiasis. Both US and KUB were used as an alternative tool for 1VU.
- IVU is the primary radiological method for detecting urinary calculus disease. It remains the gold standard for imaging patients with non-conclusive US finding and to determine the excretory function of the kidney.
- Simple urine examination can be a good predictive method for early detection of urinary stones.

Keywords: x-ray for kidneys, ureters, and urinary bladder (KUB) / intravenous urogram (IVU) / general urine examination (GUE)

INTRODUCTION AND REVIEW OF LITERATURE

Kidney stones (renal lithiasis, nephrolithiasis) are hard deposits made of minerals and salts that form inside your kidneys. renal calculi are common cause of blood in the urine (haematuria), Hematuria is usually present, but up to 15% of kidney stone patients will not demonstrate even microscopic hematuria.[(1)].

The pain with kidney stones is usually of sudden onset ,very severe and colicky (intermittent) not improved by a change in position ,radiating from the back ,down the flank ,and into the groin ,nausea and vomiting are common [(2)]. Kidney stones remain a very common problem, affecting approximately 1 in 10 people at some point in their life [(3)].

The incidence of kidney stones appears to have increased over the last few decades, and although this may be partly explained by improved detection, at least some is due to changes in diet and rising levels of obesity[(4)].

Urinary stones are one of the earliest documented affections of human beings. Many researches were done dealing with the etiology of urinary stones with various conditions which had been suggested as being possible causes of urinary stones ranging from dietary to environmental factors. Early diagnosis of urinary stones is essential particularly during the acute clinical presentation[(5)].

The highest incidence of calculi occurs between the age of thirty and fifty. The 3:1 male to female ratio is unexplained. Three percent of the population forms a stone sometimes during their lives[(6)]. Overall, the incidence of urinary tract stones increased with age, which peaked in the age group of 30–60 years and decreased after wards, Risk factors associated with the formation of urinary calculi can be divided into two main groups, intrinsic or extrinsic factors.

The former one includes age, gender, ethnic and familial backgrounds; while the latter group consists of climate and environment, lifestyle and dietary habits, occupation. The most important factors, determining the prevalence, incidence, recurrence rates and constituent of calculi, are climate and dietary habits[(7)].

There is a high incidence of recurrence rate as high as (40-70%). Hospitalization is 14/1000 population[(8)].
Laboratory and radiological examination are an important approach for conforming the diagnosis[(5)].

Types of Urinary Stones:

The great majority of stones are radiopaque (90%) while about (10%) are radiolucent. They consist of a fibrous matrix of muco-protein covered by crystals of calcium oxalate, calcium phosphate, calcium carbonate, ammonium-magnesium phosphate and urate.

The following are the different types of urinary stones:

1. Calcium Salts: They are the most common urinary stones. They form about (75-85%), either present as calcium oxalate alone or in combination with hydroxyapalite. They are the most radio-dense[(6)].
2. Uric Acid Stones: They account for (5-8%) of all stones. They are usually formed of small and hard crystals of pure uric acid. They are non-opaque[(9)].
3. Cystine Stones: They are very uncommon and less than (1%) of all types. They are usually multiple and bilateral. They are slightly opaque.
4. Struvite Stones (Infectious Stony): They are potentially the dangerous types of stones that form about (10-15%) of urinary stones. They moderately opaque[(9)].
5. Xanthine Stony: They are very rare and non-opaque stones[(10)]. (**Fig. 1**)

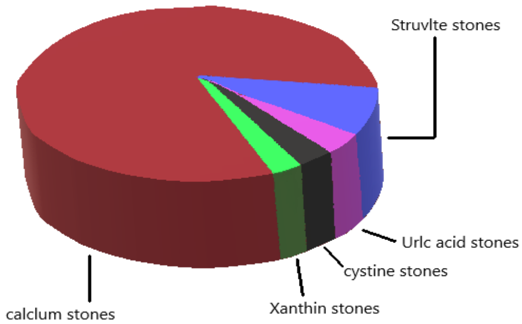


Fig. (1): The Different Percent of Each Type of Urinary Stones, The Relative Difference in the Radiopasity of Each Type

Examination of the Urine:

Urinanalysis is one of the most important and useful urologic tests available. The improper collection, failure to examine the specimen immediately and incomplete examination of the sample may lead to make the examination not informative.

Changes that occur in suspected cases of urolithiasis[11 ,12] include:

1. Colour and Appearance; Cloudy mine is commonly thought to represent pyuria but more often cloudiness is due to large amount of amorphous phosphate.
2. Ph: normal urine is usually acidic; acid urine precipitate uric acid; cystine; calcium oxalate. Alkaline urine precipitate phosphate
3. RBC: Gross urinary bleeding is usually associated with stones.
4. Leukocytes: Pyuria is finding of more than (5-8) WBC/high power field. Urolithiasis can cause pyuria.
5. Crystals: They may be a clue to calculus formation and certain metabolic diseases.

Other urinary tests include **the study of stone constituents**, Patients with recurrent urolithiasis may have an underlying abnormality of excretion of calcium, uric acid, oxalate, magnesium or citrate. Samples of (24) hour urine collections can be tested to determine abnormally high level of each. Whenever a stone is recovered a formal stone analysis is recommended[11, 13]. (**Fig. 2**)

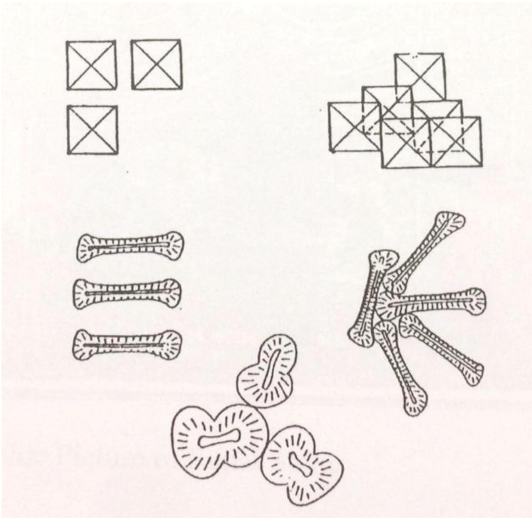


Fig. 2: Shape of Calcium Oxalate Crystal

Urinary Calculi in KUB:

KUB is the most common imaging modality used for the detection of urinary tract calculi[8].

(KUB) plain film radiography is most helpful in evaluating for interval stone growth in patients with known stone disease, and is less useful in the setting of acute stones[14].

Both renal areas should be observed because any abnormal shadow could be renal stone.

Renal calculi can be of various size, shape, density and number. Of it could be unilateral or bilateral. It often takes the shape of a calyx or may form a cast of renal pelvis and calyces-staghorn[15].

If the opaque shadow in a lateral radiograph is superimposed over the body of the vertebrae, it is almost that of a calculus. The shadow lying in front of the vertebral bodies is likely to be extra-renal shadow such as calcified mesenteric lymph node[16].

The shadow of a renal stone has the same down movement as that of renal outline in both deep inspiration and expiration. This is the important point in excluding extra-renal shadows by measuring the distance between the lower poles of the kidney to the opacity. If it remains constant in both conditions the shadow will be intra-renal[17].

Ureteral calculi are sometimes difficult to be diagnosed, especially when they are:

1. Small in size; poor density.
2. Obscured by gas in the intestine or by bony structures.
3. Overexposed or underexposed film[15].

It is believed that ureteral calculi originate in the kidney and then pass into the ureter. Their cause is thus the same as that of renal lithiasis. It is usually associated with abnormalities of the ureter which promote stasis and infection within the lumen as ureterocele, diverticulum and ectopic ureter[8]. The great majority of ureteral calculi are radiopaque careful inspection of the normal course of the meter that will help in the detection of ureteral calculi. Calculi size range from few millimeters to (10) cm in length[13].

Confusing extra ureteric shadow can be:

1. Phlebolith.
2. Calcified mesenteric lymph node.
3. Dense of transverse process or lumbar vertebra or chip # of it.
4. Opaque intestinal content, or retained barium in appendix or diverticulum[17].

Vesical calculi in plain film is easily detected. They are common mainly in males[11].

About (50%) of bladder stones are radiolucent and other half are opaque. A solitary bladder stone is the rule, but there are numerous stones in (25%) of patients[13].

Vesical calculi vary in size from stand to calculi of enormous size. They are often occupy the center of bony pelvis above the symphysis pubis with transverse long axis[15].

While ureteral calculi are the least common from of urinary stones disease, mainly in males, migrant stones are ten times more often than native stones[15],

In a study of (56) patients (54 males and 2 females) with urethral calculi, (32%) had associated urinary calculi[18].

Urinary Calculi in Excretory Urography:

Excreting urography is dependent on renal function and visualizes the urinary tract by concentration of an intravenous injection of organic iodine within the urinary tract.

The radiographic picture of calculi in IVU depends upon the size and location of the stone[13].

Stone may produce an increase or decrease in density of contrast medium or a negative shadow. The most common pathologic condition produced by stone is obstruction, with dilatation of the renal pelvis. The calyces or both[15].

The presence of stone in the renal pelvis causes spasm and contraction of the pelvis. Stone in calyces produces dilatation simply. Stone lodged in the infundibulum of calyx may produce localized hydrocalyx[6].

Branched calculi produce the most dramatic appearance in urogram. They cast part or all of pelvicalyceal system. There is no problem in localizing such calculi, but it may be extremely difficult to estimate renal function[15].

The radiological features of obstruction are[10]:

1. Increasing dense nephrogram.
2. Delay pyelogram.
3. Renal enlargement.
4. Mild-moderate dilatation of the collecting system and ureter.
5. Rarely, spontaneous rupture of the pelvi-calyceal system.

Non-opaque calculi are somewhat difficult to diagnose with IVU. The typical finding of a negative shadow in the midst of opaque material surrounding the stone is diagnostic[19].

Calculi in dilated tortous ureter may be in location that appear to be outside the course of normal ureter. Calculi in duplication anomalies of the ureter may become difficult diagnostic problem as appear to lie outside the urinary tract[19]. The major disadvantage of IVU is the risk of allergic reactions or impaired renal function due to intravenous (IV) contrast[20].

Urinary Calculi in Ultrasonography:

Ultrasonography is a low-cost imaging modality that does not rely on ionizing radiation[14].
The primary advantage of US is that it is independent of renal function[13]. (**Fig. 3**)

Fig. 3: Normal Picture of Kidney by US

It can detect both radiopaque and radioluceut stones. It may even offer a relative indication for their composition[20]. Calculus appear as a markedly echogenic structure with prominent "acoustical shadowing" [8].

Staghorn calculi within dilated collecting system may be a source of confusion.

To distinguish this finding from another lesion as hydronephrosis or cystic lesion, one should notice the prominent acoustic shadow posterior to the dense calculi[21]. (**Fig. 4**)

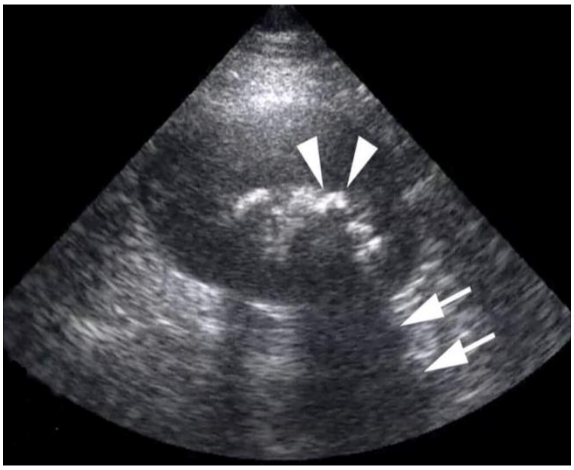


Fig. 4: Sonographic Picture of Renal Stone

Sonography can also determine matrix stone which cannot be visualized on the plain film[20]. It can also detect "milk of calcium" stone in renal caliceal diverticulum which appears as a gravity-dependent echogenic shadow in cystic renal lesion[22,23].

It is possible now to localize renal calculus intraoperatively precisely by sonography, and provide guidance for stone extraction, and ensure that all stones have been removed[24, 25].

US is not a sensitive method for detecting renal calculi, because the stone may not be visible within the echogenic structures of renal sinus[10].

It is difficult to define the normal ureter by US although at certain times segment of it, usually the upper third or distally just behind the bladder, may become recognized. The dilated meter may often be imaged satisfactorily[21].

The major limitation to the use of US in evaluating colic is the difficulty m visualizing the middle third of ureter, particularly if ureteral dilatation is not present(25). The sonographic criteria for a uretric stone are that of urinary tract obstruction which is either at kidney level – hydronephrosis – and/or at ureteric level – ureterectasis –(9). (**Fig. 5**)

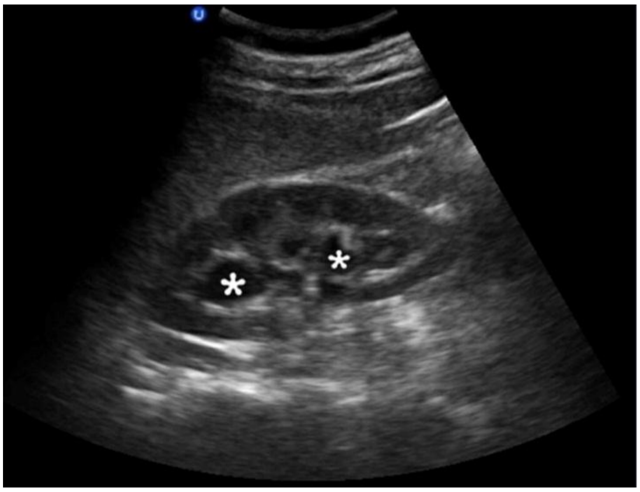


Fig. 5: Sonographic Picture of Moderate Hydronephrosis Due to Lower Down Obstruction

The false negative rate for the detection of hydronephrosis by sonography is very low (2%), but the false positive rate for a normal pelvis mistaken for mild hydronephrosis is quite high (26%)(21).
Trans-rectal ultrasonic visualization of ureteral calculi gives high percentage of accuracy (100%) in comparison to the (25%) by trans-abdominal US(25).

The location of the distal ureter in men is between the water filled condom of the rectum and the tonic filled bladder in women provides an ideal sonic window for the distal ureteric calculi by trans-rectal US(25).

Bladder calculi, like calculi elsewhere, are strongly echogenic and highly reflective of ultrasonic beam. They are usually seen in association with bladder outlet abstention, and neurogenic disease resulting in bladder dysfunction(21). (**Fig. 6**)

Fig. 6: Sonographic Picture of Vesical Stone

Urinary Stones in CT and MRI:

Unenhanced CT examination allows rapid, contrast medium free and anatomically accurate diagnosis of urinary tract calculi. CT provides information distinct from that obtained by IVU or arteriography. The image bears a resemblance to a transverse anatomic section(13).

All stones have a high attenuation value, and a differentiation of stone within the normally attenuation renal sinus is easy(10).

CT-imaging can also provide information regarding the composition of stones, the Hounsfield unit (HU) is a measurement of attenuation ,in this scale water is given the value of 0 HU air is -1000 HU ,and dense bone is 1000 HU. Uric acid stones are typically 200-400 HU, whereas calcium oxalate stones are 600-1200 HU.

Overall, CT is highly sensitive and specific technique for imaging stones in patients presenting with renal colic[14].
MRI at the present time is not the modality of choice in evaluating urolithiasis. Motion and poor resolution in comparison with all other imaging techniques place MRI at a distinct advantage.

On T_1 and T_2 weighted images, calculi appear hypo-intense dark compared with the surrounding structures[8].

Aims of the Study

- To compare the results obtained from KUB, US, and IVU and to show whether US plus KUB can replace 1VU in the initial evaluation of patients with renal colic due to renal stone.
- To confirm the importance of doing GUE for the early detection of urinary stone disease.

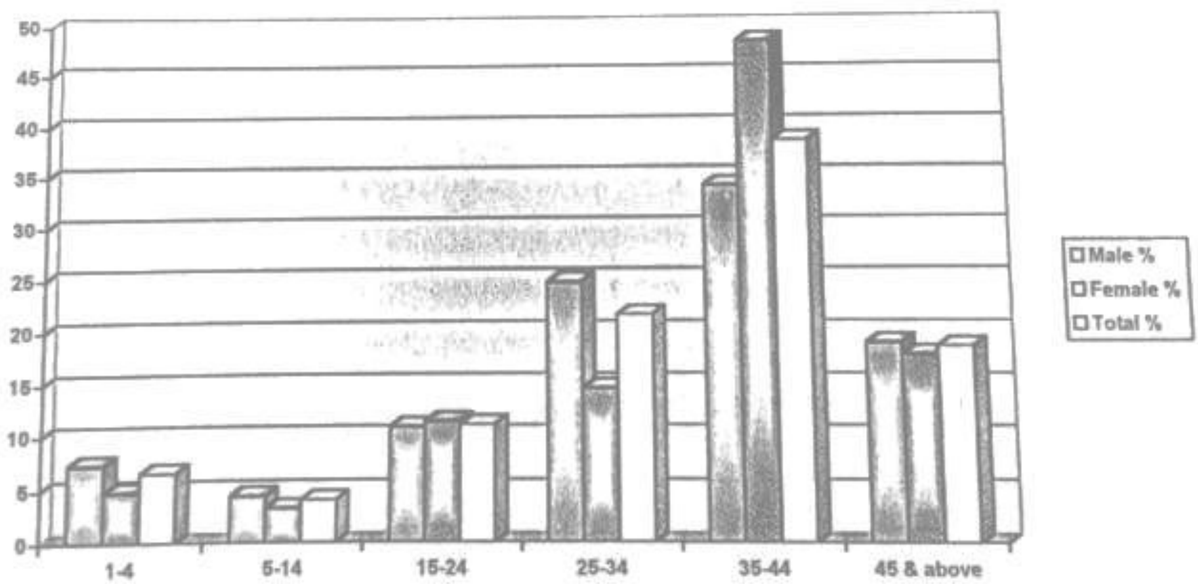
PATIENTS AND METHODS

Form September 2016 to June 2017, hundreds of patients with different urological complaint were attended to x-ray department at Al-Salam Teaching Hospital. (200) of these patients proved to have urinary calculus diseases GUE, KUB, US and IVU were done for these (200) patients. GUE was performed by doing qualitative tests for sugar, protein, pH and microscopical examinations of the deposits of urine after centrifugation for five minutes. KUB in supine position was taken after advising the patient to take some sort of mild laxatives at night before the examination.

IVU was performed with standard dose of organic iodine contrast 1cc/kg. Three films exposed at 5, 10, 15 minutes after the contrast medium was given. In case of renal failure delay film after 12, 24 hours was done. US was performed using digital real time sector scanner type B and 3.5 MHZ transducer with autism, ultrasonic transmission. (200) patients were examined by US in supine and prone position. The kidney and adjoining ureter were examined for the presence of stone, the degree of dilatation of pelvi-calyceal system and the echogenecity of parenchyma and the presence of detectable parenchymal calcification. Assessment of validity of US plus KUB in comparison to IVU was done using surgery or follow-up patient in lithotripsy unit.

RESULTS

This study includes examination of (200) patients by doing GUE, KUB, US and IVU as a method of investigation for their urinary stones. Patients age varies form (1) year up to (65). The majority of stones occur at age range from (35) to (45) years, in (77) patients (38.5%). (138) males were included in this study (69%) and (62) females (31%) shown as **histogram** on page 20.



Histogram: 1: Shows Distribution of Age and Sex of Patients included in the Study

Recurrent stone detected in (31) patients (I 5.5%), patients detected to have single stone (136) (68%) while patients with multiple stone were (64) (32%). Radiopaque stones form the majority of stones in this study were (186) (93%) while radiolucent stones are less evident, (14) patients (7%).

The majority of stones were noticed at kidneys level in (138) patients while stones in the ureter were detected in (68) patients. The least was the vesical stone in (7) patients (**Table I**).

Table 1: Distribution of Urinary Stones Detected by KUB, US and IVU

Site	Pat. No.	Right	Left	Bilateral	%
Renal stones	138	71	45	22	64
Ureteric stones	68	35	33		33
Vesical stones	7				3

Table 2: Accidental Pathological Changes in the Urinary Tract

Pathology	Pat. No.	%
Polycystic kidney	1	0.5
Medullary sponge kidney	2	1
Hoarse shoe kidney	2	1
Renal cyst	7	3.5
Dupplication	8	4
Vesical diverticulum	1	0.5
PUJ obstruction	3	1.5
Pyelonephritis	20	10

During this study, accidental pathological changes in the urinary tract were detected (**Table II**).

KUB was truly positive in (162) patients while it was falsely negative in (20) patients. False positive results found in (18) patients so accuracy of detection of stones in KUB is (81%).

US finding true-positive results obtained in (188) patients with false negative results in (12) patients and no false positive; accuracy is (94%). IVU finding true-positive results were seen in (196) patients with false negative results only in (4) patients; accuracy is (98%). Good results were obtained by adding the results of KUB plus US. True-positive results were in (192) patients with false-negative results only in (3) patients; accuracy is (96%) (**Table III**).

Table 3: Comparison between the Results Obtained by KUB, US, IVU, US + KUB in Urinary Lithiasis

Method of Detection	Pat. No.	Sensitivity %	Accuracy %
KUB	162	89	81
US	188	93.7	94
IVU	196	97.7	98
US + KUB	192	98	96

From all number of patients, (138) patients had renal stones; KUB was able to detect (119) patients, no sensitivity was (93%), US detected (131) patients, sensitivity was (95%), IVU detected (136) patients, with sensitivity (99%), while KUB plus US gave excellent results (100%) (**Table IV**).

Table 4: Comparison between the Results Obtained by KUB, US, IVU, US + KUB in Renal Stones

Method of Detection	Pat. No.	Sensitivity %
KUB	119	93
US	131	95
IVU	136	99
US + KUB	138	100

(68) patients included in this study were estimated to have ureteric stone, (43%) of these stones occur at the lower third. KUB was able to detect (63) patients, so sensitivity was (92%). US confirm the presence of stones in (29) patients only, so it had low sensitivity (42%), while IVU can detect (66) patients, so sensitivity was (97%) (**Table V**).

Table 5: Comparison between the Results Obtained by KUB, US, IVU, US + KUB in Renal Stones

Method of Detection	Upper 1/3	Middle 1/3	Lower 1/3	Total	Sensitivity %
KUB	21	13	29	63	92
US	9	2	18	29	42
IVU	23	14	29	66	97

Hydronephrosis was detected in (130) patients. Sensitivity of detection of hydronephrosis by IVU was (92%) compared to US result that was (88%).

The findings of GUE included (200) patients. (154) of those patients were found to have urinary crystals and cast mainly calcium oxalate. The sensitivity was (82%) and the accuracy (80%). Microscopical haematuria was detected in (108) patients while patients with negative haematuria were (92). So, (54%) of patients had haematuria.

DISCUSSION

Urolithiasis is the third most common affection of the urinary tract after infection and disease of the prostate.
IVU with tomography remain the gold standard procedure for imaging the urinary tract[6].

It should be the first imaging study chosen for evaluation of the urinary tract. It is specifically indicated when the suspected diagnosis is urinary tract calculi[13]. However, combined abdominal radiography and sonography may be used for stones detection and demonstration of the obstruction[6].

US examination is safe, fast, need no ionized radiation and with non-invasive character. It may be considered the most beneficial for paediatric and pregnant patients[26].

The examination is obviously independent of renal function which is uniquely helpful in severe renal failure where calculus disease may be the cause of obstructive uropathy[22].

It is useful in the diagnosis of small stones near the uretero-vesical junction, and in excess of intestinal gases. It can detected both radiopaque and radiolucent stones[26].

US has a valuable role in the serial evaluation of stone former patients with a history of recurrent urinary tract infections related to obstruction[27].

Negative US examination does not exclude the presence of urolithiasis. Most ureteral and renal calculi less than (3 mm) in diameter are difficult or impossible to detect[8].

Sonography is an operator-dependent technique. It is unsuccessful and difficult in the visualization of the middle portion of the ureter, and unsuccessful in the identification of acute obstruction without hydronephrosis and poor functional information[25].

In our study, the sensitivity of KUB in the detection of urinary stones was (89%) with accuracy of (81%). These low results are due to the failure to detect radiolucent stones in addition to the technical faults. Radiopaque stones were detected in (93%) of the patients while radiolucent stones form (7%). The incidence of opaque stones in the textbooks are about (90%) and for lucent stones are (10%).

Real time US demonstrated an overall accuracy of detection of urinary stones of about (94%). Accuracy in the detection of hydronephrosis was (88%). The cause of this low percentage is in the area of mild hydronephrosis which may be seen normally, in addition to the difference in the experience of the sonographer.

The sensitivity of IVU in the detection of urinary stones was (97.7%) with accuracy of (98%) because the ability to detect lucent stones, especially in the mid-ureter where US was failed[6].

Sensitivity in detecting hydronephrosis was (92%) due to failure in detection in case of renal failure. Sensitivity of US plus KUI3 in the detection of urinary stones was (98%) and accuracy of (96%). These good results are obtained because both examinations will cover radiolucent stones by US and stones in the ureter by KUB. US plus KUI3 should be the examination of first choice in most circumstances. This is particularly in vague abdominal pain[27].

Regarding position of stones, our results support the use of US plus KUB as first step in diagnosing renal stone, because both exams give excellent results (100%) sensitivity, while in case of ureteric stones our results are still with the gold standard IVU which gives (97%) sensitivity, while US gives low sensitivity (42%).

Different studies were done to assess the sensitivity and accuracy of plain abdominal film, intravenous urogram and sonographic examination of patients with urinary calculus diseases.

In a prospect, study of (60) patients, by Boyd (1996), KUB was able to detect ureteric calculus with sensitivity of (95%)[(28)].

Mutazindwa (1997) concluded that IVU remains the gold standard for the imaging of acute renal colic due to ureteric calculi. US plus KUB should be reserved for contrast medium risk patients and those in whom radiation is relatively contraindicated. IVU detect ureteric calculi in (141) patients, with the accuracy of (94%)[(29)].

Vrtiska (1992) showed that US detected the presence of renal stones in (77) patients out of (83) patients. US missed stone measured (2 min) or less[(30)]. Soyer (1990) showed in a prospective study of (31) patients that US correctly diagnosed urinary stones with sensitivity of (96.3%)[(31)].

Dalla-Palma (1993) showed that the sensitivity of KUB plus US in detecting ureteric calculi is (95%)[(32)].
Deyoe (1995) concluded that the overall sensitivity of combined US plus KUB analysis was (84%) and accuracy was (88%)[(33)] (**Table 6**).

Table (6): Difference in the Ability of KUB, IVU, US, US + KUB in the Detection of Urinary Calculi Compared with Other Studied

Author	Year	Total No.	KUB	%	IVU	%	US	%	KUB+US	%	Comment
Boyd – R.	1996	60	56	95							Ureteral Calculi
Mutazindawa	1997	150			141	94					Ureteral Calculi
Vristka. Tj.	1992	83					77	93			Renal Calculi
Soyer P.	1990	31					30	96.3			Renal Calculi
Dalla-Palma	1993	105							98	95	Ureteral Calculi
Deyoe, LA	1995	32							28	88	Renal Calculi
Present Study	2016	200	162	85.5	187	98	179	94	183	96	Urinary Calculi

Analyzing GUE finding, the sensitivity was detected to be (82%), and accuracy (80%) depending on the presence of microscopical cast or crystals, while incidence of haematuria was calculated to be (54%). Other studies were done regarding urine examination validity in urolithiasis. Al Kassar and Al-Sahli (1997) studied (300) patients and compared radiological findings with GUE findings; sensitivity was (89.3%)[(7)].

In detecting microscopical haematuria Press (1995) analyzed (140) patients with urinary lithiasis. The incidence of negative haematuria was found to be (14.5%)[(28)].

Little (2000) in a prospective study of (200) patients noticed that (32%) of patients had microscopical haematuria[(34)] (**Table 7**).

Table 7: Comparison of the Results of this Study with Results of Others Regarding GUE

Author	Year	Pat. No.	Sensitivity %	Mic. Haematuria %
M. H. Alkassar H. H. Alsalih	1997	300	89.3	
Press SM	1995	140		85.5
Little MA	2000	200		32
The Present Study	2016	200	82	54

So our study is unique in the detection of sensitivity and accuracy of KUB, US, IVU and US plus KUB regarding urolithiasis diagnosis, in addition to detecting sensitivity and accuracy of GUE, and the incidence of haematuria in urolithiasis.

CONCLUSIONS

- The present study emphasizes the use of US plus KUB in diagnosing urolithiasis. Both US and KUB were used as an alternative tool for IVU.
- IVU is the primary radiological method for detecting urinary calculus disease. It remains the gold standard for imaging patients with non-conclusive US finding and to determine the excretory function of the kidney.
- Simple urine examination can be a good predictive method for early detection of urinary stones.

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