Section A-Research paper
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A Retrospective Study of various Diagnostic Techniques use in radiology department for diagnosis of kidney stone in Rural Areas

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ABSTRACT

Background:

In this observational study, we will determine the appropriate diagnosis for kidney stones in a rural area of western Uttar Pradesh, based on clinical situation, patient body habits, cost, and ionizing radiation tolerance, all of which contribute to determining the appropriate imaging technique for kidney stones. Plain film radiography of the kidney, ureter, and bladder (KUB), ultrasound [KUB], intravenous pyelography, and CT Urography are the most widely used imaging modalities in this observational analysis. We'll go over the fundamentals of each imaging modality, including its sensitivity and specificity, benefits, drawbacks, and cost.

Methods:

The study was conducted on 139 patients (Patient number has calculated based on sample size formula) aged between 12 years to 55 years (Mean age is 21.5 years) of Saifai Diagnostic Center and different departments of Uttar Pradesh University of Medical Sciences (like- Radiology, Urology, Surgery & Emergency). Which are located in Saifai Etawah of western UP.

Medical data over a three-year period of kidney stone patients were collected from the hospital and diagnostic center.These all data were used during research. Different types of diagnostic machine (like: Digital radiography x-ray machine 1000mA & Siemens 500mA X-ray machine, Siemens 300mA for KUB, IVP procedure, 64 Slice MDCT for CTU and USG) were used to find out kidney stone and obstructive uropathy.

Average diagnostic cost of different types of machine procedure and side effect of

Results:

A retrospective observational study of kidney stone was conducted on 250 patients aged between 12 years to 55 years (mean age of 21.5 years).Demographic characteristic history and diagnostic procedure findings of patients were observed between December 2019 and June 2023. Based on different type of diagnosis (KUB, IVP, USG, and CTU&CT Abdomen) andits reports, total 139 out of 250 patients were found to be suffering from kidney stone and obstructive uropathy diseases. Out of these 80 patient (58%) were male and 59 patients (42%) were female.

Conclusion:

Based on the data of Table No. 1, CTU/CT abdomen scan and IVP are the most commonly used radiographic procedures for the diagnosis of kidney stones in rural areas. In both of these, CTU/CT abdomen is given priority. CTU/CT abdomenscanning is considered a well-characterized imaging modality for kidney stones because it is a quick, non-invasive radiological procedure that produces images with excellent resolution as compare to IVP.

Keywords: KUB X ray. Intravenous pyelography, USG Abdomen KUB USG CT Urography Kidney stone

Introduction:

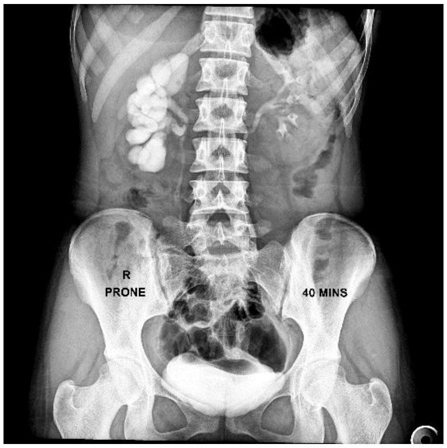
Kidney stones are a frequent occurrence in India, developed and underdeveloped countries. Kidney stones affect 10-12 percent of the population of developed countries. The majority of people suffer kidney stones later in life. Kidney stones are the most prevalent type of stone found in both men and women. Obesity is one of the leading causes of kidney stones. Crystals of calcium oxalate, a high quantity of uric acid, and a lack of citrate in the body are all major causes of kidney stones. Fast food and an increase in calcium intake after lodging of protein, consumption of animal products lead to higher calcium, phosphorous, and oxalate in the urinary tract these are the main reasons for kidney stones. Stones are more common in male people who have diabetes and are obese. Kidney stones mainly lodge themselves in the kidneys. They are made up of a hard collection of salt, minerals, calcium, and uric acid. Kidney stones vary in size. Some are small as they end within a period and pass out through urine while others can grow a few inches or become so large they can take up an entire kidney.

In India's database, kidney stone affects 12% of the population. Renal damage affects 12 percent to 50 percent of the population, and it can result in the loss of a kidney [1]. A common sign of urinary tract stones is pain in the abdomen or backside, as well as pain or burning sensation during urination. Hematuria (blood in the urine), smell in the urine, and a large kidney stone can hamper or stop the flow of urine, cause nausea and vomitingand create a temperature or chills. When a kidney stone moves suddenly pain starts and can change location. The patient's imaging modalities are provided by the doctor based on their clinical condition, patient body habits, cost, and ionizing radiation tolerance, all of which aid in identifying the appropriate imaging technique for the patient

Plain KUB (Kidney ureter bladder):

The initial diagnostic technique to check the urinary system is KUB X-ray. Kidney stone imaging is done with X-rays, which uses invisible electromagnetic energy beams to create images of x-rays that are directed anteriorly to posterior through tissues and into a contra lateral receiver. An X-ray examination of the kidney, ureter, and bladder (KUB) allows for checking the organs of the urinary and gastrointestinal systems. It is used to diagnose urinary diseases and the reason for abdominal pain. When patient who has abdominal flank pain visits the doctor, the patient is advised by the doctor to undergo KUB x-ray. All types of kidney stones are not visible in KUB Abdomen Radiography. Some types of kidney stones are poorly visible in KUB Abdomen radiography; Struvite stones and Cysteine stones, Uric acid kidney stones, and Matrix type kidney stones are not visible in the plain KUB Abdomen x-ray. KUB radiography can also be used to find out the size of the kidney, ureter and bladder. KUB x-ray may be appropriate for those who have gallstones or kidney stones. A KUB study may help in confirming a diagnosis when someone who has swallowed a foreign object; it may also be usedfor detection of kidney stones, tumors, abdominal pain, abdominal gas, Structures of the digestive system, including the intestines and stomach. During a KUB X-ray, the patient is exposed to low doses of radiation. The cost of the KUB x-ray is less when compared to other imaging modalities. The comparatively low ionizing radiation dose compared to CT (0.15 mSv) and inexpensive cost (10% of ultrasonography) of KUB radiography are benefits [2]. The risk of radiation exposure is considered least for KUB x-rays, when compared to the other modalities which operate using x-rays like CT. KUB, CT. Abdomen and Intravenous Pyelography which have more risk of exposure. KUB x-ray requires almost no preparation. KUB x-ray can find stones in the kidneys, ureters and bladder. Especially calcium stones combined with insoluble crystals and other minerals, either calcium oxalate or calcium phosphate, in composition. These stones are easily seen on plain KUB x-ray. KUB radiography was used to perform an intravenous pyelogram, allowing the detection of hydronephrosis and urinary tract obstruction. With the advent of CT as an imaging technique [3], this modality (IVP) was mainly replaced by CT scan. Standard KUB radiography's sensitivity and specificity are currently reported to be 57 percent and 76 percent, respectively [4]. In comparison to CT (0.15 mSv), KUB radiography has a lower ionizing radiation exposure and is less expensive (only 10% of ultrasonography [5])

IVP Intravenous Pyelography:



IVP, also known as intravenous urography, is a diagnostic procedure that involves the injection of intravenous contrast and X-ray imaging of the urinary system. The iodinated contrast is filtered into the collecting system after passing via the renal vasculature, showing the anatomic features on the X-ray image. It's frequently used to assess hematuria and renal stone disease. The urography imaging sequence is created to show certain areas of the urinary system in the best possible way. The urinary system is clearly seen in the oblique view radiograph when filled with contrast media. Only when the procedure, constraints, and fundamental principles of interpretation are recognized can accurate conclusions from the IVP be obtained. In 1906, Fritz Volcker and Alexander von Lichtenberg developed retrograde urethral catheterization for urinary tract imaging. This method proved to beinconsistent and was rarely successful. Intravenous pyelography was developed by Osborne and colleagues in 1923 to see the kidneys, ureter, and bladder. [6]This method was more practical, straightforward, and secure. A significant contribution to medicine was the development of an intravenous technique for viewing the upper urinary system. Due to the limitations of intravenous pyelography ultrasonography computed tomography (CT) and magnetic resonance imaging (MRI) are now widely used for the examination of urinary tract disease.[7] Intravenous pyelography requires contrast media, a radiographic table, X-ray tubes, a monitor, a fluoroscopy machine with an Image intensifier camera and spot film device, an abdominal compression band, and a detector. Indications of IVP are Stones in the kidneys, Stones in the bladder, Prostate enlargement, Cysts in the kidneys, hydronephrosis, Tumors of the urinary tract, Medullary sponge kidney, a congenital abnormality of the small tubes inside the kidneys, structural kidney abnormalities.IVP Contra indication to pregnant women patients with Diabetes and multiple myeloma, generalized allergic conditions, acute chronic failure, Renal disease severe hepatic disease, etc. Injections of contrast media might induce side effects in certain patients, including Nausea, vomiting, Itching, Hives severe reactions are Blood pressure that is dangerously low. a full-body allergic response that can induce breathing problems and other life-threatening symptoms (anaphylactic shock), cardiac arrest, and respiratory, arrest IVP is useful in finding a single problematic stone among a large number of pelvic calcifications, as well as verifying renal function and demonstrating that the second kidney is functioning correctly. The use of IV contrast material, which can cause an allergic reaction or renal failure, and if necessary for several delayed films, can take up to 6 hours, 12 hours, and 24 hours are also its disadvantages. In some patients. Although unenhanced computed tomography has largely superseded intravenous pyelography (IVP) in the assessment of flank pain, IVP may still be useful in patient follow-up. Preliminary views can be used to make adjustments following contrast delivery. The early views are critical because they show the source of the patient's pain and indirectly aid in the detection of additional abdominal illnesses.When the stone is visible the size and position are demonstrated by the imaging system. IVP offers the benefit of identifying renal parenchymal attenuation value on the acute obstruction side and the chronically obstructed side, but it cannot differentiate between acute obstruction and residual abnormalities from prior obstructions. Hence intravenous pyelography was the gold standard for kidney stones yet, IVP is one of the choices of urologists for the diagnosis of kidney stones.

CT SCAN:

For the detection and characterization of urolithiasis, computed tomography (CT) scanning is now the fully independent imaging method of choice. Since its introduction to stone imaging in the 1990s, unenhanced computed tomography (CT) has replaced intravenous urography and radiography as the illegitimate gold standard for the initial and follow-up evaluation of patients with suspected kidney stones. In comparison to other imaging modalities like plain radiography and ultrasound, non-contrast CT has a number of advantages, such as high sensitivity and specificity (>95% and >96%, respectively) for the detection of stones, easy accessibility, faster acquisition speeds, and no requirement for intravenous contrast administration [8, 9, 10].

They absorb substances that are significantly different in composition from renal parenchyma and urine. They emit significantly more radiation and are distinguishable without the use of contrast. CT produces a three-dimensional image of the kidney stone and its surroundings that can be reconstructed from multiple angles.

CT has the highest sensitivity of all the possible modalities for detecting kidney stones, with realistic estimates at 95 [11] When a patient has acute flank pain and is suspected of having an obstructing stone, the ACR estimates that CT has a specificity of 98 percent. Except for some stones caused by the precipitation of protease-inhibitor medications in the urine [12],the composition of stones can also be shown by CT imaging.

Photons travelling from the radiation source to the detector encounter a density of objects, which is referred to as attenuation. Attenuation is quantified using the Hounsfield unit (HU). This scale places water at 0 HU, air at 1,000 HU, and dense bone at 1,000 HU. A stone's kind can be determined by its Hounsfield units because different stone compositions absorb varying quantities of radiation. Stones made of uric acid are typically 200–400 HU, but stones made of calcium oxalate are 600–1,200 HU [13] CT accuracy is a critical factor to consider. Because imaging obese patients with ultrasound are complicated, CT is typically more accurate than ultrasonography; however, no conclusive research comparing the two modalities for imaging kidney stones in obese patients has been done.

Increased attenuation correlates with an increase in the number of shocks needed and a decrease in success rates, hence CT attenuation can be used to predict responsiveness to shockwave lithotripsy. CT has disadvantages such as price and radiation exposure. Multiple variables. According to Medicare data, the cost of performing a CT scan is around double that of performing a renal ultrasonography scan.

Overall, CT is a very sensitive and specific technology for imaging stones in patients with renal colic, and it is valuable in the emergency room for diagnosis as well as in the operating room because of the better anatomical detail obtained, which aids surgical decision-making. The most major disadvantages are expense and radiation exposure, both of which can be reduced to some extent by using low-dose procedures. The American College of Radiology and the American Urological Association both recommend CT as the first-line examination for adult patients who have symptoms that might indicate a kidney stone. In circumstances where ultrasonography is inconclusive, the EAU recommends using CT to confirm a stone diagnosis. Both medical professionals and patients are concerned about the adverse effects of ionizing radiation exposure from CT scans. Young patients with recurrent urolithiasis who must have multiple CT scans and are therefore at an elevated risk of cumulative radiation exposure should be of particular concern.

Ultrasound:

Urologists mostly prefer Ultrasound in the diagnosis and treatment of kidney stones. KUB radiography is conducted first. Following that, they perform ultrasonography for kidney stones in conjunction with IVP. USG is done before the CT scan of a kidney stone because USG does not contain ionizing radiation and the cost of USG is low in comparison to CT scan. Short bursts of sound energy are transmitted to the patient by a transducer, which produces images that may be obtained by ultrasonography. When flowing through tissues with varying densities and/or acoustic impedances, this energy is transmitted through the tissue as waves that partially reflect back to the source. Images can be produced based on wave amplitude and travel durations by detecting the reflected waves with a transmitter. The term "B-mode" or "brightness" refers to the common grayscale image. Cook and Lytton were first invented using a B-mode scanning probe to localize a kidney stone and guide their Nephrolithotomy. Ultrasonographyvs. unenhanced computed tomography in renal colic.[22] Ultrasonography is a commonly used imaging modality in assessing the urinary tract. It has several advantages over other imaging modalities, including its noninvasiveness and unsurpassed safety because of the lack of radiation and intravenous contrast. As a result, a renal ultrasound (US) is commonly recommended as the initial study in the evaluation of children and pregnant women with suspected urolithiasis. Other advantages include low cost, excellent resolution, and wide availability [23]. Before ultrasonography for kidney stones, we used Plain Kidney ureter Bladder plain Radiography and Intravenous pyelography, but in recent times CT scans and ultrasonography are considered to be easily detected, and radiolucent kidney stones also. Edell, Zegel, Pollack, and Colleagues demonstrated the use of ultrasonography images for radiolucent uric acid and matrix stone. Both stones are not seen in plain KUB Radiography [24, 25]. Ultrasound will become more important for the modern urologist because it reduces the amount of radiation exposure as compare to CT scans and fluoroscopy. Ultrasound technology has advanced significantly over the previous [26]. Furthermore, compared to NCCT, prospective studies have shown that a KUB and ultrasound combination can have equivalent sensitivity and specificity [27].

Study Design and Data Collection:

Inclusion Criteria

•Includes all male and female patients 12 years to 55 years of age (except infants, very young children and pregnant women who were more responsive during use of contrast media and harmful ionizing radiation, pregnant women for whom USG was used to check for kidney stones and children who were not support during the IVP procedure)

• Patients of various departments of UPUMS like OPD department, IPD department, Surgery department, Urology department, Radiology department who have symptoms of abdominal pain, blood in urine, severe pain in back and lower abdomen, nausea and vomiting (symptoms of kidney stones have been included.

• All the patients which doctor referred to radiology department of UOUMS and Saifai Diagnostic center for further diagnosis with help of different type of machine like KUB x-ray, KUB ultrasound, and intravenous pyelography and CT urography.

• Images retrieved from the database available in UPUMS/Saifai Diagnostic center were reviewed by principal investigator and confirmed after consensus.

Exclusion criteria

- Patients with a history of blood pressure, coronary artery disease, diabetes, multiple myeloma, sickle cell anemia, and history of any drug reaction.
- Patients aged below 12 years and after 55 years.
- Pregnant female patients.

Study area:

The present study was conducted at various departments of UPUMS as well as at Saifai Diagnostic Center which is located at Saifai, Etawah district of western UP. Department details of UPUMS are mentioned below.

1. Department of Radiology UPUMS, Saifai, Etawah, U.P.
2. Department of Urology UPUMS Saifai, Etawah, U.P.
3. Department of Surgery UPUMS Saifai, Etawah, U.P.
4. OPD & IPD
5. Emergency department

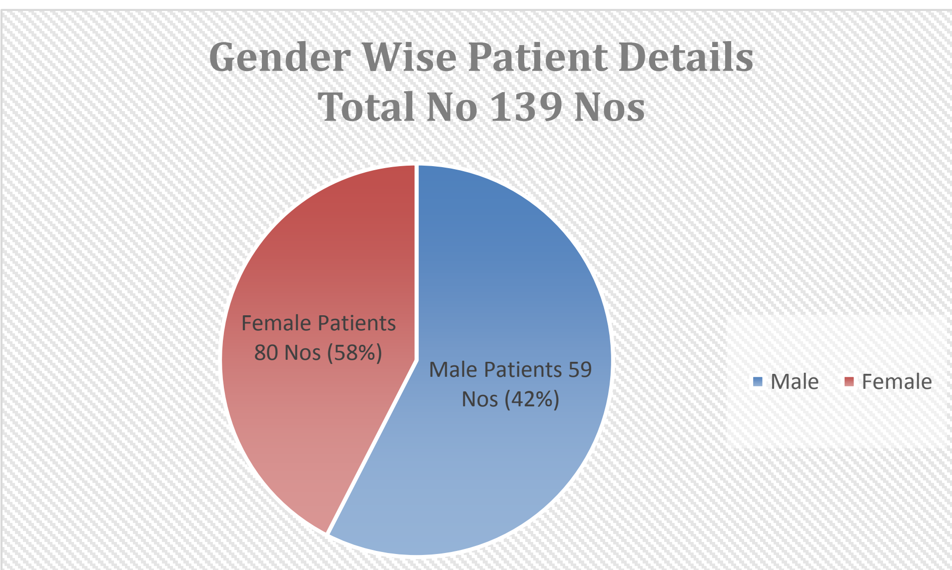
Method;

Sample size:

1. A total of 250 patients were included in the study in which 139 patients were suffering from kidney stones.
2. 2. Patients from different departments with abdominal pain, blood in urine, severe pain in back and lower abdomen, nausea and vomiting (suspected symptom of kidney stone) are included.
3. Formula of sample Size:
   Sample size (n) = Z^2 P (1-P) / E^2Where by
   Z – Value from standard normal distribution corresponding to desired confidence level (Z=1.96)
   P – Prevalence of kidney stones in India 10% (P) =10%
   Based on confidence level 95%, E- Error margin will be 5%
   From this formula the sample size was calculated as follows:
   N= $(1.96)^{2}$ X 10 X (100- 10) / $(5)^2$
   = 3457.44 / 25=139
   Sample size will be 139 patients

Result:

Based on different type of diagnosis (KUB, IVP, USG, and CTU & CT Abdomen) and its reports, 250 patients suspected of having kidney stones were studied to collect data of 139 patients with kidney stones between the ages of 12 and 55 (mean age 21.5 years). In which 80 patient (58%) were male and 59 patients (42%) were female.for this, Demographic characteristics history and diagnostic procedures findings of all 250 patients were observed between December 2019 and June 2023.



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Based on counseling and medical histories, 25 patients (18%) out of 139 patients were referred for IVP, 18 patients (13%) were referred for ultrasonography (in which most patients were children, pregnant women and old age of more than 55 years) and 96 patients (69 %) were referred for CT urography and CT abdomen. Data refer to Table no-1

Table No- 1:Distribution of the patients according to their age group and diagnostic procedures

S.NO.	Patients Age Group	Total Patients (No)	IVP	USG	CTU / CT Abdomen
2	20-30	10	1	0	7
3	20-30	32	9	3	22
4	30-40	50	10	5	35
5	40-50	33	4	0	23
6	50-55	14	1	10	10
Total Patients Nos		**139**	**25**	**18**	**96**
Total Patients in %		**100%**	**18%**	**13%**	**69%**

Table 2 -Distribution of the patient for imaging modalities by doctor according to their clinical condition and ionizing radiation tolerance

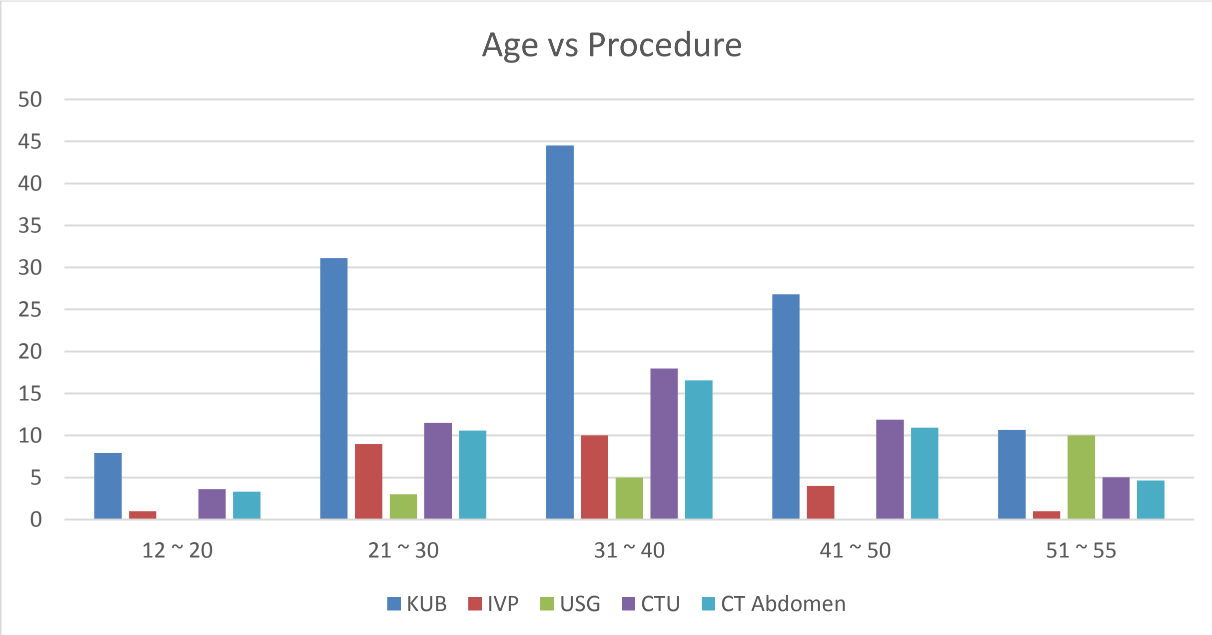

Table 3- Comparison of sensitivity and specificity of different imaging modalities for kidney stone

Imaging modality	Sensitivity %	Specificity%
KUB	57% [25]	76 %[25]
IVP	66.6%	82.5%
CT	95(ref[12])	98[12]

DISCUSSION:

One of the most prevalent issues in developing nations and the rest of the world that affects the urinary system is kidney stones. Kidney stones are more likely due to certain medical issues which include an excessively high-fat diet, poor nutrition, the inclusion of oxalate crystal-containing foods, an extremely high protein diet, and post-surgery abnormalities. Different factors like metabolic, environmental and dietary onesalso play a role in kidney stone formation.**Author 1.Yasir Andrabi ,2 Manuel Patino ,3 Chandan J Das, 4 Brian Eisner ,4Dushyant V 5 Avinash Kambadakone wrote in 2015 July –sep 2015 Advance in CT Scan imaging forurolithiasis**Unenhanced computed tomography (CT), which was initially developed for stone imaging in the 1990s, has now supplanted intravenous urography and radiography to become the de facto gold standard for the initial and follow-up evaluation of patients with suspected kidney stones. In comparison to other imaging modalities like plain radiography and ultrasound, non-contrast CT has a number of advantages, such as high sensitivity and specificity (>95% and >96%, respectively) for the detection of stones, easy accessibility, faster acquisition speeds, and no requirement for intravenous contrast administration. [8, 9, 10]

Author wrote in 2016 Aug 31 an over view of kidney stone imaging techniques 1Wayne Brisbane 2 Michael R Bailey 3 Mathew D Sorensen Additionally, CT imaging can reveal details about the makeup of stones. The density of items that photons travelling from the radiation source to the detector meet is described by attenuation. The attenuation is measured in Hounsfield units (HU). Water is given a value of 0 HU, air is 1,000 HU, and dense bone is 1,000 HU on this scale. Given that different stone compositions absorb different quantities of radiation, a stone's Hounsfield units can be used to identify its type. Calcium oxalate stones range in size from 600 to 1,200 HU15, but uric acid stones are commonly 200 to 400 HU.[13]

Author write in Apr 2017 David T ZOU1Manont Auasawachintchit 2Kazumi Taquchi 3 Thomas Chi in Ultrasound use in Urinary stone: Adapting Old Technology for a Modern Day Diseases Before ultrasonography for kidney stones, we used Plain Kidney ureter Bladder plain Radiography and Intravenous pyelography, but now a day's CT scans and ultrasonography are considered to be easily detected, and Radiolucent kidney stones also. Edell, Zegel, Pollack, and Colleagues demonstrated the use of ultrasonography images for radiolucent uric acid and matrix stone. Both stones are not seen in plain KUB Radiography [24, 25].

Conclusion:

Greater knowledge of the condition has been made possible by advancements in diagnostic methods. The treatment of individuals with kidney stones involves the use of radiological techniques in a significant way. KUB Radiography, Intravenous pyelography, USG Abdomen, CT Urography in diagnosis and distribution of patients for imaging modalities by doctors to examine patients according to their clinical condition, patient's body habits, cost, and ionizing radiation tolerance all help determine the appropriate imaging technique for the patient. In this review, we'll be going over the basics of each imaging modality, including its sensitivity and specificity. All types of kidney stones are not visible in KUB Abdomen Radiography; some types of kidney stones are poorly visible in KUB Abdomen radiography like Struvite stones and Cysteine stones, uric acid kidney stones, and Matrix type kidney stones are not visible in the plain KUB Abdomen x-ray. Although Ultrasonography was once the take method for locating and diagnosing calculus, especially in pregnant women, the shortage of radiologists now makes it difficult to screen patients using USG. Ureteric stone detection by USG was similarlyunsatisfactory. Doctors advise other imaging modalities in a rural area with higher sensitivity and specificity IVP, CT urography .When the stones are visible the size and positions are demonstrated by the imaging system. IVP offers the benefit of identifying renal parenchymal attenuation value on the acute obstruction side and the chronically obstructed side, but it cannot differentiate between acute obstruction and residual abnormalities from prior obstructions. Hence intravenous pyelography was the gold standard for kidney stones yet, IVP is one of the choices of urologists for the diagnosis of kidney stones. The emerging technological innovation nowadays IVP is largely replaced by CT scan abdomen CT urography in clinical practice. area CT scan is considered well characterized imaging modalities for kidney stones because it is fast, non-invasive radiological procedure that give image with excellent resolution.

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