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Characterization of Urinary Tract Stones in Sudanes Population using Multidetector Computed Tomography

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A thesis submitted for partial fulfillment for the requirement of (B.Sc) in radio daignostic technilogy

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الايـة

قال تعالي:

(وَعَسَى أَنْ تَكْرَهُوا شَيْئًا وَهُوَ خَيْرٌ لَكُمْ وَعَسَى أَنْ تُحِبُّوا شَيْئًا وَهُوَ شَرٌّ لَكُمْ وَاللَّهُ يَعْلَمُ وَأَنْتُمْ لَا تَعْلَمُونَ)

[البقرة :216]

Dedication

To;

Our families...

Our collegues…

and our teachers…

Acknowledgment

First of all, we thank Allah the Almighty for helping us complete this project. we thank Dr. Abdelkareem Altayeb , our supervisor, for his help and guidance.

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Abstract

Non-contrast Computed tomography a method for evaluating the stones of urinary system. Together with the measurement of the stone density and size, become an important way of assessing patients with suspected stones.

Our purpose in this study was to evaluate the stones of urinary system in patients who came with indication suspected to have urinary stone(s).

This study was carried out from Augest to October 2015. The study sample was consisted of 120 patient with flank pain and clearly suspected for KUB stone or other pathological problem there. A MDCT KUB was conducted at Khartoum state medical diagnostic center (Antalya diagnostic center).

By the CT KUB we found 100 (83.3%) and 20 (16.7%) patient have stones and patient haven't stone with or without other association respectively. the most affect age group was (40-49), (28), (23.3%). A significant correlation was noted with the number of stones present in each class as no stone , one stone , two or three stones and found it significant at P= 0.039. these patients also showed other associated finding such as hydornephrosis 61 (50.8%), hydroureter 35 (29.2%), obstruction 35 (29.2%) , and cortical thinning 22 (17.6%) respectively. And we also found a significant correlation between the site of stone with the hydronephrosis, hydroureter, obstructive changes and other findings that we considered it in our study at P = 0.006 , P = 0.001, P = 0.000 and P = 0.018 respectively.

The results showed that MDCT KUB can detect the stones of the renal system with its associated morbidity regardless to its site very accurately.

ملخص الدراسة

أجريت هذه الدراسة بواسطة الأشعة المقطعية المحوسبة متعددة الكواشف بغرض الكشف عن حصاوي الجهاز البولي (الكلى , الحالب و المثانة) , و قياس حجم و كثافة هذه الحصاوي.

و كان الغرض الرئيسي لهذه الدراسه هو تقييم حصاوي الجهاز البولي و تقييم المضاعفات المرضيه المصاحبه لها .

أجريت هذه الدراسة في الفترة من أغسطس الى اكتوبر من العام 2015 , جمعت هذه البيانات من مركز أنطاليا الطبي في ولاية الخرطوم . و اعتمدت هذه الدراسة على 120 مريضا يعانون من آلام في اسفل الظهر و هم الأكثر قابليه لفحص الأشعة المقطعية المحوسبة بحيث يعتبر احدى الأعراض المهمة لوجود الحصاوي في الجهاز البولي.

اهم النتائج التي توصلت اليها الدراسه هي ان اكثر المرضى كانوا في الفئة العمرية من 40 الى 49 عاما حيث كان عددهم 28(23.3%) . كما اظهرت الدراسه ان هنالك عدد من المضاعفات ذات العلاقه الواضحه مع وجود الحصاوي , و كان عدد المرضى الذين يعانون من من تضخم الكلى 61 مريضا (50.8%) , اما تضخم الحالب و انسداد مجرى البول فقد كان عددهم 35 مريضا (29.2%).

و خلصت هذه الدراسة الى ان فحص الاشعة المقطعية المحوسبة متعددة الكواشف يعتبر من ادق و اسرع الطرق لتشخيص حصاوي الجهاز البولي و معدل المضاعفات المصاحبه لها .

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List of abbreviations

BMI	Body Mass Index
BUN	Blood Urea Nitrogen
CT	Computerized Tomography
DMS	Data Measurement System
ED	Emergency Department
GE	General Electric
HIV	human immunodeficiency virus
HU	Hounsfield units
IVP	intravenous pyelogram
IVU	intravenous urogram
KUB	kidneys, ureters, and bladde
Max	Maximum
MDCT	Multidetector computed tomography
MHU	MEGA HEAT Unit
Min	Minimum
MRI	Magnetic resonance imaging
NCCT	Non-Contrast Computed Tomography
PACS	picture archiving and communication system
PH	power of hydrogen
PUJ	Pelviureteric junction
SD	Standard Deviation
SFOV	Scan Field Of View
SPSS	Statistical Package for the Social Sciences

US	Ultrasound
VUJ	VesicoUreteric Junction

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Chapter one

1.1 Introduction

The urinary system consist of two kidneys, two ureters, urinary bladder, urethra and prostatic gland. Urinary tract obstruction is one of the commonest causes of renal hydronephrosis and renal failure. The early diagnosis of detects are very important to achieve the suitable treatment. There are several modalities which we use it in diagnosis of urinary tract diseases such as conventional x-ray, computerize tomography, magnetic resonance imaging, nuclear medicine and ultrasound. CT scan are frequently used to evaluate the internal structure of the body as stated by David Sutton et.al 1987. The CT scan of the kidneys for stones is a test that specifically looks for stones in the KUB. This scan is frequently done in the emergency room for patient with sudden onset sharp side and acute pain and have blood in their urine. It is also ordered by outpatient doctors as well for similar symptoms. (Armstrong et.al 2004). Spiral CT KUB is more accurate about 80% to detect small stone (Tagelsir 2010). Nowadays, many clinical centers chose to send cases with accident and emergency cases, urology for CT scan as their first option for easy diagnosis of the symptoms. (Maepel et.al 2013).

Single-slice and multislice spiral CT have forever changed the imaging of renal stone disease. A review of the techniques, findings, complications, and pitfalls involved is timely given that CT is now the imaging method of choice to detect renal stones and diagnose the complications of renal stone disease, acute flank pain is a common complaint of patients seeking emergency medical attention. Renal colic is the most common cause and is usually the major consideration for diagnostic imaging. Plain-film radiographs of the abdomen (often called KUB, for kidney-ureter-bladder) and excretory urograms (also called IVU, for intravenous urogram) are the traditional imaging methods used in the diagnosis of renal stone disease and its complications. Plain radiographs have a sensitivity for stones as low as 45%, however, with a specificity of only 77%. Non-contrast CT has been shown to be more effective than IVP in precisely identifying ureteral stones and is equally effective in determining the presence or absence of ureteral obstruction. Spiral CT has largely replaced plain radiographs and IVP. CT for stones requires no contrast and no patient preparation, and the study is routinely completed in less than 90 seconds (E. Brant et.al 2001).

1.2 Problem of the study

Most of diagnostic modalities of urinary tract (conventional x-ray & ultrasound) don’t give accurate diagnosis for renal system stones, or may lead to misdiagnosis when patient underwent conventional X-Ray for the kidneys, ureters and bladder due to various type of stone and its appearance. Therefore an introduction of MDCT KUB to scan the patient with colic pain may give an accurate result and can provide density data for early management and differentiation of stone accordingly.

1.3. Objectives of the study

1.3.1. The general objective

The general aim of this study was to evaluate the role of spiral computed tomography in the diagnosis of urinary tract stones.

1.3.2 The specific objective

- To measure the sensitivity of spiral CT scan in the diagnosis of urinary tract stones.
- Evaluate the presence of stones in relation to age and gender of the patients.

- To correlate between the site of stone and associated pathological findings.

1.4 Significance of study:

This study was highlighted on evaluation of renal system stones using MDCT scanner, once we need faster and accurate diagnostic modalities in this situation in order to have high diagnostic accuracy in assessing renal stone related to its general characteristic since MDCT has been proposed as an alternative to conventional x-ray (KUB) for the diagnosis of renal stone.

1.5 Overview of the study:

This study was consist of five chapters, chapter one was an introduction introduce briefly this thesis and contained (general introduction about the renal stone, problem of study also contain general, specific objectives, significant of the study and overview of the study). Chapter two was literature review about role of MDCT scanner in diagnosis of urinary tract stones, and other modalities used. Chapter three was describe the methodology (material, method) used in this study. Chapter four was included result of presentation of final finding of study; chapter five included discussion, conclusion and recommendation for stone's prevention in addition to references and appendices.

Charter Two

2.1. Anatomy

The urinary system consists of two kidneys, two ureters, a urinary bladder, and a urethra. The kidneys are retroperitoneal structures of the abdomen, having migrated upward from the pelvis during development. They are maintained in their normal position by intra-abdominal pressure and by their connections with the perirenal fat and renal fascia. (JACK T. STERN, et.al 1997)

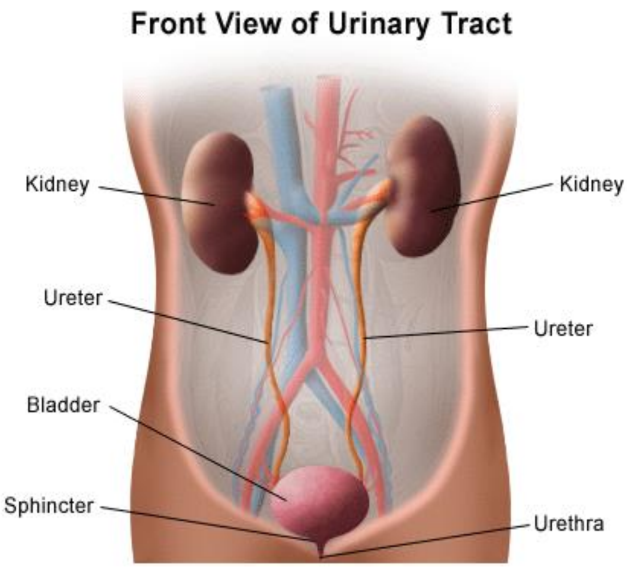

Figure (2.1) showed the structure and component of renal system [22].

The kidney is bean-shaped with a superior and inferior pole. The mid-portion of the kidney is often called the mid-pole. In adults, each kidney is normally 10-12 cm in length, 3-5 cm in width and weighs 150-260 g. The left kidney is usually slightly larger than the right. The kidney has a fibrous capsule, which is surrounded by para-renal fat. The kidney itself can be divided into renal parenchyma, consisting of renal cortex and medulla, and the renal sinus containing renal pelvis, calyces, renal vessels, nerves, lymphatics and perirenal fat. The renal parenchyma has two layers: cortex and medulla. The renal cortex lies peripherally under the capsule while the renal medulla consists of 10-14 renal pyramids, which are separated from each other by an extension of renal cortex called renal columns. Urine is produced in the renal lobes, which consists of the renal pyramid with associated overlying renal cortex and adjacent renal columns. Each renal lobe drains at a papilla into a minor calyx, four or five of these unite to form a major calyx. Each kidney normally has two or three major calyxes, which unite to form the renal pelvis. The renal hilum is the entry to the renal sinus and lies vertically at the anterior-medial aspect of the kidney. It contains the renal vessels and nerves, fat and the renal pelvis, which typically emerges posterior to the renal vessels, with the renal vein being anterior to the renal artery. (JACK T. STERN, et.al 1997)

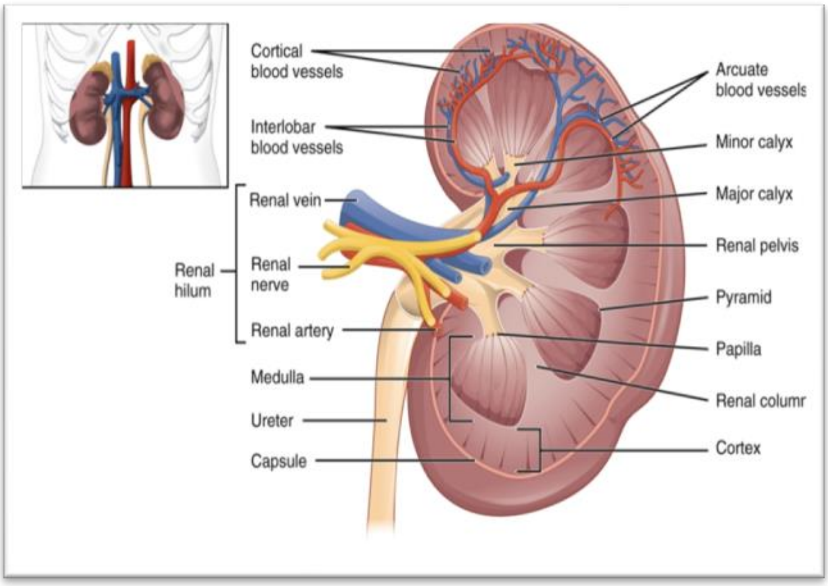

Figure (2.2) showed the internal anatomical structure of the pelvic-calceal system in addition to its nerve and blood supply [23].

The nephron of the kidney is made up of two major parts; the renal corpuscle and the tubules. These are then both sub-divided into various parts and overall it is this structure which allows the kidney to filter the blood and then alter the composition of this filtrate to ensure that waste products are excreted and useful compounds preserved. Renal corpuscle can be subdivided into the glomerulus and the Bowman's capsule. The tubules are split into the proximal tubule, the loop of Henle, the distal tubule and the collecting ducts. (JACK T. STERN, et.al 1997)

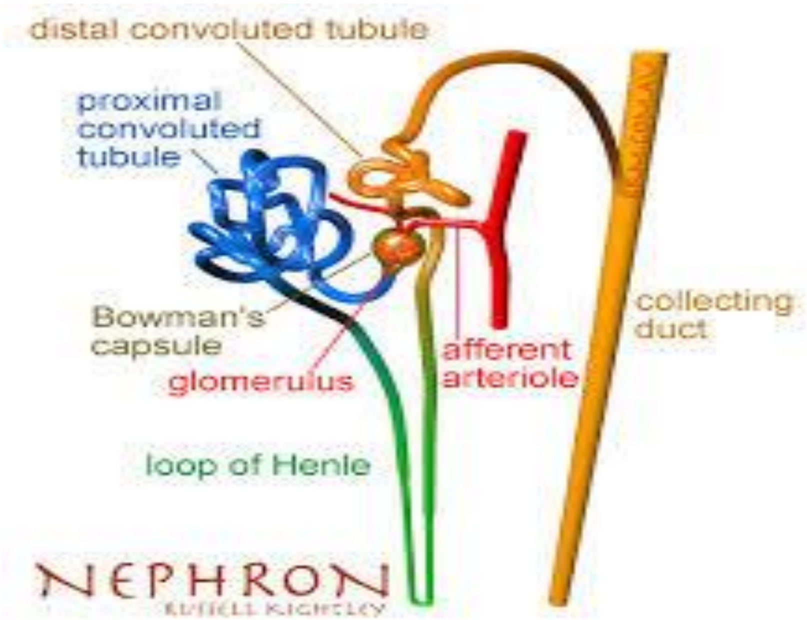

Figure (2.3) showed the internal structure of kidney's functional unit [24].

2.1.1 Blood supply:

Blood reaches the kidneys through the renal arteries, which are short and come directly from the abdominal aorta. It divided into several inter-lobar arteries and give rise to the arcuate arteries, which cross the border between the cortex and the medulla of the kidney. From the arcuate arteries many branches radiate into the renal cortex; the inter-lobar arteries, the afferent arterioles arise at right angle from the interlobular arteries and end in the glomeruli. (M.Y. sukar, et al 2000)

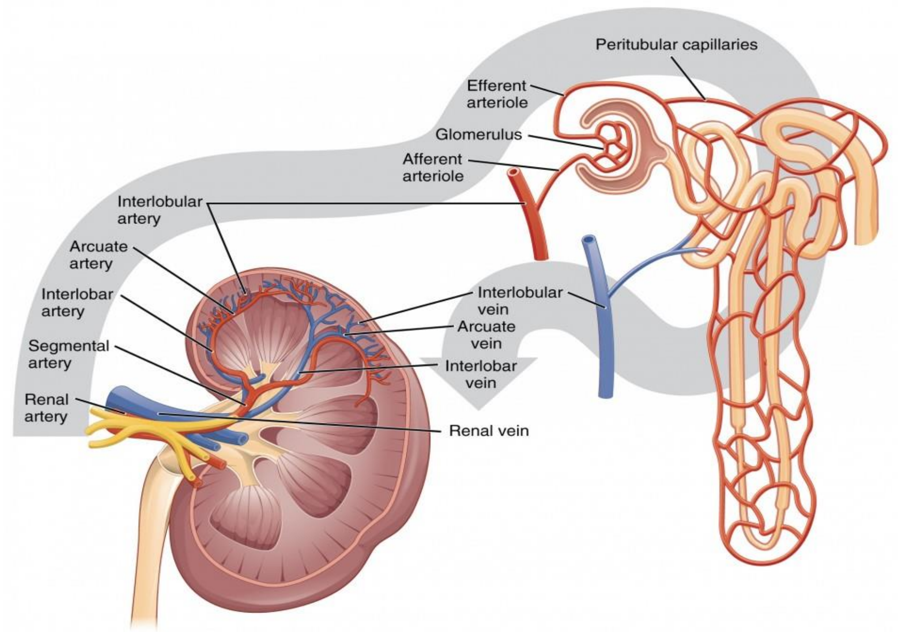

Figure (2.4) demonstrate the blood pathway into and from the kidney [23].

2.2 Physiology

The kidneys play a major role in the control of the constancy of the internal environment. The blood flowing in kidneys is first filtered is call glomerular filtration so that the all blood constituents, except blood cell and plasma protein, go into the micro tubular system. In these tubules, modifications of the filtrate take so that useful substance, including most of the filtered water, are quickly reabsorbed back into the blood. Unwanted substances that escape filtration are actively secreted into the lumen. The final concentration of electrolytes and other constituents of urine are adjusted according to the requirements of the regulation of the extracellular fluid composition. Glomerular filtration, tubular reabsorption and tubular secretion are rightly described as renal mechanisms that allow the kidney to undertake its various homoeostatic functions. Several hormones act on the kidney to enable it to adjust the final composition of urine in response to changes in the internal environment. the special features of renal circulation deserve an early description . These special characteristics are essential for the nephrons to perform their various function. Function of the Urinary system will be summarized in; Regulation blood volume and pressure, regulating plasma concentration of sodium, potassium , chloride and other ions, stabilizing blood PH, conserving nutrients, and Detoxifying poisons with the liver. (M.Y. sukar, et al 2000).

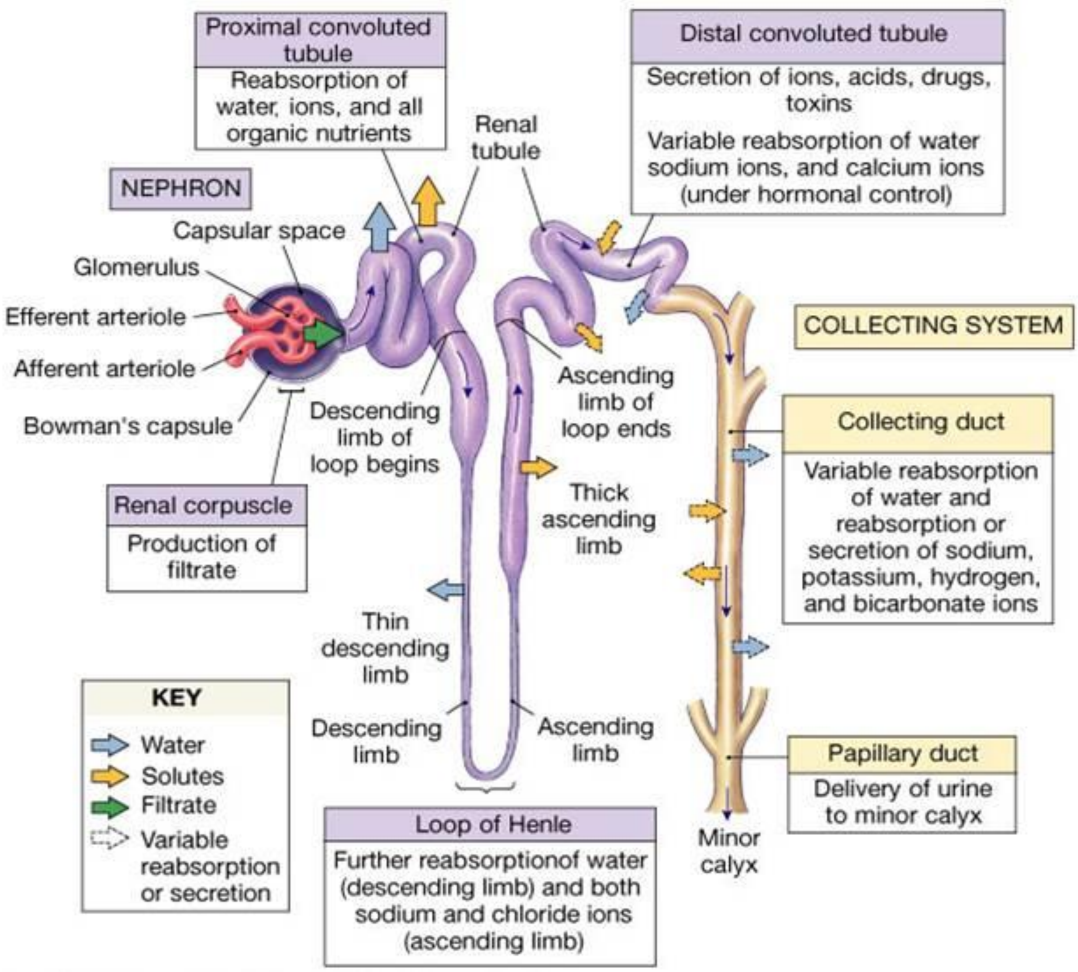

Figure (2.5) demonstrate the nephron structure with its specific function [23].

2.3 pathology of the renal stone:

2.3.1 Types of stone

Not all kidney stones are made up of the same crystals. The different types of kidney stones include: Calcium; Calcium stones are the most common. They can be made of calcium oxalate (most common), phosphate, or maleate. Vitamin C and spinach contain oxalate. Calcium-based kidney stones are most commonly seen in young men between the ages of 20 and 30, Uric Acid, This type of kidney stone is more common in men than in women. They can occur in people with gout or those going through chemotherapy, Struvite, This type of stone is found mostly in women with urinary tract infection. These stones can be quite large and cause urinary obstruction. Cystine; rare type occur in both men and women who have the genetic disorder cystinuria. And other types of stone such as medications like triamterene and acyclovir also can cause stones (Lights et.al 2012).

2.3.2 Risk Factors:

The greatest risk factor for developing kidney stones is making less than one liter of urine per day. This why they are frequently seen in premature infants, who tend to have kidney problems. However, kidney stones are most likely to occur between the ages of 20 and 40. Other risk factors include: ethnicity (Caucasians are more likely to have kidney stones than African-Americans), sex (although kidney stones are most often seen in men, the incidence in women is increasing), past history of kidney stones (once someone has kidney stones, the likelihood of having another episode increases), family history of kidney stones, dehydration (dehydration causes decreased urine flow, which increases risk significantly), obesity, high-protein, salt, or glucose diet, gastric bypass surgery, inflammatory bowel diseases (which can cause increase calcium absorption) and other medical conditions (hyperparathyroidism can cause increase absorption of calcium and phosphorus; renal tubular acidosis can also be a risk factor for kidney stones) (Lights et.al 2012).

2.3.3 Signs and symptoms

Kidney stones are known to cause severe pain. Symptoms of kidney stones may not occur until the stone begins to move down the ureters. The severe pain is called renal colic. Pain may be located on one side of the back or abdomen. In men, pain may radiate to the groin area. The pain of renal colic comes and goes, but is quite intense. People with renal colic tend to be restless. Other symptoms that can be present are: blood in the urine, vomiting, nausea, discolored or foul-smelling urine, chills, fever (Lights et al 2012).

2.3.4 Complication

Stones don't always stay in the kidney. Sometimes, they pass from the kidney into the ureters. Ureters are small and delicate, and the stones may be too large to pass smoothly down the ureter to the bladder. Passage of stones down the ureter can cause spasms and irritation of the ureters as they pass, which causes blood to appear in the urine. Sometimes stones block the flow of urine. This is called a urinary obstruction. Urinary obstructions can lead to kidney infection (pyelonephritis) and kidney damage as stated by Lights et al 2012.

2.3.5 Diagnosing Kidney Stones

Diagnosis of kidney stones requires a complete health history assessment and a physical exam. Other tests include: blood tests for calcium, phosphorus, uric acid and electrolytes, blood urea nitrogen (BUN) and creatinine to assess kidney functioning, urinalysis to check for crystals, bacteria, blood, and white cells and examination of passed stones to determine type. The following tests can rule out obstruction: abdominal X-rays, intravenous pyelogram (IVP), retrograde pyelogram, Ultrasound of the kidney, MRI of the abdomen and kidneys and abdominal CT scan (Lights et al 2012).

2.3.6 Treatment

Treatment is tailored according to the type of stone. Urine can be strained and stones can be collected for evaluation. Drinking six to eight glasses of water a day increases urine flow. People who are dehydrated or have severe nausea and vomiting may need intravenous fluids (Lights et al 2012). Other treatment options include: Medication; Pain relief may require narcotic medications. The presence of infection requires treatment with antibiotics. Other medications include: allopurinol for uric acid stones, diuretics, sodium bicarbonate or sodium citrate and phosphorus solutions. Lithotripsy; Extracorporeal shock wave lithotripsy uses sound waves to break up large stones so they can more easily pass down the ureters into the bladder. This procedure can be uncomfortable and may require light anesthesia. It can cause bruising on the abdomen and back and bleeding around the kidney and nearby organs. Tunnel Surgery (Percutaneous Nephrolithotomy); Stones are removed through a small incision in patient's back and may be needed when: the stone causes obstruction and infection or is damaging the kidneys, the stone has grown too large to pass and pain cannot be controlled. And Ureteroscopy; when a stone is stuck in the ureter or bladder, the doctor may use an instrument called an ureteroscope to remove it. A small wire with a camera attached is inserted into the urethra and passed into the bladder. A small cage is used to snag the stone and remove it. The stone is then sent to the laboratory for analysis as stated by Lights et.al 2012.

2.4 Multi detector CT scan:

We use multi-detector CT scanning technology to see areas inside the body with micro-level detail. The multi-detector CT scanner allows us to obtain multiple slices in a single rotation, resulting in images that are of high quality, detail and clarity. Using this technology, we can also acquire data with great speed, so patients spend less time being scanned. In addition, the increased width of the scanning space of this tool makes for a more comfortable, less claustrophobic experience for patients. (S. Ulzheimer et.al 2009)

2.4.1 X-Ray Tube and Generator

State-of-the-art X-ray tube/generator combinations provide a peak power of 60–100 kW, usually at various, user-selectable voltages, e.g., 80 kV, 100 kV, 120 kV and 140 kV. Different clinical applications require different X-ray spectra and hence different kV settings for optimum image quality and/or the best possible signal-to-noise ratio at the lowest dose. In a conventional tube design, an anode plate of typically 160–220-mm diameter rotates in a vacuum housing. The heat storage capacity of anode plate and tube housing measured in Mega Heat Units (MHU) determines the performance level: the bigger the anode plate is, the larger the heat storage capacity, and the more scan-seconds can be delivered until the anode plate reaches its temperature limit. A state-of-the-art X-ray tube has a heat storage capacity of typically 5 to 9 MHU, realized by thick graphite layers attached to the backside of the anode plate. An alternative design is the rotating envelope tube (STRATON, Siemens, Forchheim, Germany, Schardt et al. 2004). The anode plate constitutes an outer wall of the rotating tube housing; it is therefore in direct contact with the cooling oil and can be efficiently cooled via thermal conduction. This way, a very high heat dissipation rate of 5 MHU/min is achieved, eliminating the need for heat storage in the anode, which consequently has a heat storage capacity close to zero. Thanks to the fast anode cooling, rotating envelope tubes can perform high power scans in rapid succession. Due to the central rotating cathode, permanent electro-magnetic deflection of the electron beam is needed to position and shape the focal spot on the anode. The electro-magnetic deflection is also used for the double z-sampling technology of a 64-slice CT system (S. Ulzheimer et.al 2009)

2.4.2 Gantry

Third-generation CT scanners employ the so-called “rotate/rotate” geometry, in which both the X-ray tube and detector are mounted onto a rotating gantry and rotate around the patient. In a MDCT system, the detector comprises several rows of 700 and more detector elements that cover a scan field of view (SFOV) of usually 50 cm. The X-ray attenuation of the object is measured by the individual detector elements. All measurement values acquired at the same angular position of the measurement system form a “projection” or “view.” Typically, 1,000 projections are measured during each 360° rotation. The key requirement for the mechanical design of the gantry is the stability of both focal spot and detector position during rotation, in particular with regard to the rapidly increasing rotational speeds of modern CT systems (from 0.75 s in 1994 to 0.30 s in 2007). Hence, the mechanical support for the X-ray tube, tube collimator and data measurement system (DMS) has to be designed so as to withstand the high gravitational forces associated with fast gantry rotation (~17 g for 0.42 s rotation time, ~33 g for 0.33-s rotation time). (S. Ulzheimer et.al 2009)

2.4.3 Data Rates and Data Transmission

With increasing numbers of detector rows and decreasing gantry rotation times, the data transmission systems of MDCT scanners must be capable of handling significant data rates: a four-slice CT system with 0.5-s rotation time roughly generates 1,000×700×4×2 bytes = 5.6 MB of data per rotation, corresponding to 11.2 MB/s; a 16-slice CT scanner with the same rotation time generates 45 MB/s, and a 64-slice CT-system can produce up to 180–200 MB/s. This stream of data is a challenge for data transmission off the gantry and for real-time data processing in the subsequent image reconstruction systems. In modern CT systems, contactless transmission technology is generally used for data transfer, which is either laser transmission or electro-magnetic transmission with a coupling between a rotating transmission ring antenna and a stationary receiving antenna. In the image reconstruction, computer images are reconstructed at a rate of up to 40 images/s for a 512×512 matrix using special array processors. (S. Ulzheimer et.al 2009)

2.4.4 Imaging Techniques

Also known as CT-KUB, renal stone CT is a spiral CT exam of the urinary tract that is used to diagnose the presence of urinary tract calculi and to detect acute urinary obstruction caused by stones. No oral or IV contrast is administered (E. Brant et.al 2001). Spiral CT is markedly faster than conventional CT, allowing acquisition of a complete data set in a single breath-hold. This speed prevents the miss-registration of slice location that is characteristic of conventional CT. Multislice spiral CT further decreases the time of acquisition, allowing for thinner slice collimation and retrospective reconstruction of thin slices to review problematic areas of interpretation. Data acquisition is continuous from the top of the kidneys through the base of the bladder (mid-liver [T-12] through symphysis pubis) using a maximum of 5-mm collimation with table speed of 5 mm/sec. Slice collimation with multislice CT is usually 2.5 to 3 mm with table speed up to 5 mm/sec. Multislice technique allows slices as thin as 1 mm to be obtained for problem-solving. Scanning can be performed using 2.5-mm collimation with fusion of images for viewing at 5-mm thickness. The thinner slices can be viewed retrospectively without rescanning the patient. Thin slices allow identification of very small stones that may be overlooked with thicker slices. Turning the patient to a prone position permits differentiation of stones impacted at the uretero-vesical junction from stones that have already passed into the bladder. When non-contrast renal stone CT is equivocal, intravenous contrast may be given to clarify the diagnosis. The pyelogram phase of contrast excretion is of most interest. Optimally, the ureters will be contrast-filled. An intravenous injection of 100 cc of 60% contrast is given; power injection is not needed. The renal stone protocol outlined above is repeated with a scan delay of three to five minutes after completion of contrast injection. This prolonged scan delay usually results in filling of both collecting systems and ureters. Thin slices (1 to 3-mm collimation) can be obtained through any area in question (E. Brant et.al 2001).

2.4.5 CT Interpretation

CT may detect stones not evident on standard plain radiographs or IVP, It may also provide an alternative diagnosis for the patient's symptoms, including other urinary pathology, acute appendicitis, diverticulitis, pancreatitis, adnexal masses, or leaking aneurysms. While only about 85% of urinary stones are seen as calcific densities on plain films, CT detects nearly all calculi. Calcium oxalate and calcium phosphate stones are most common (73%) and typically have a CT attenuation of 800 to 1000 HU. Struvite, or magnesium aluminum phosphate, stones (15%) are seen with chronic infection. Their CT attenuation ranges from 300 to 900 HU. Uric acid stones (8%), which are usually radiolucent on plain film, have an attenuation of 150 to 500 HU. Cystine stones (1% to 4%) are moderately radiopaque because of their sulfur content. Calcium may be present in cystine stones, which have attenuation values of 200 to 880 HU, depending on calcium content. High CT attenuation makes stones easy to differentiate from other urinary tract filling defects such as tumors, hematoma, fungus balls, or sloughed papilla. Virtually all stones, even those that are radiolucent on plain-film radiographs, are identified as high-attenuation foci on CT images viewed on soft-tissue windows. Bell reported the mean attenuation of a series of calculi detected on CT as 305 HU with a range of 221 to 530 HU. Ureteral calculi are usually geometric or oval in shape and are seldom completely round. This feature is useful in differentiating stones from phleboliths. The positive predictive value of geometric shape in identifying a calculus has been reported as 100%. The single exception to the high-density appearance of stones on CT is crystalline stones in the urine related to use of protease inhibitors in the treatment of HIV disease. These stones are non-opaque on CT scans but may cause ureteral obstruction. Retrograde ureterogram, contrast-enhanced CT, or IVP demonstrates these stones as tiny radiolucent filling defects in the ureter. (E. Brant et.al 2001).

The burden of stones in the kidneys is easily determined by CT. Stones are seen in the region of the minor calices or medullary pyramids. The stone burden is defined as the number and size of stones present and is used to determine therapy, such as lithotripsy. The tips of the renal pyramids may show high attenuation, especially when the patient is dehydrated. This normal finding of “white pyramids” should not be interpreted as representing renal stones. Non contrast spiral CT has a reported sensitivity of 94% to 98% and specificity of 96% to 98% for acute ureteral obstruction caused by an impacted stone. CT evaluation of acute ureteral obstruction caused by stones includes the following: A stone is demonstrated in the ureter. The most common locations for stone impaction are at the uretero-pelvic junction, where the ureter crosses the pelvic brim, and at the uretero-vesical junction. The ureter is followed on consecutive slices until a stone is identified. Scrolling on the CT monitor is the easiest way to follow the course of the ureter. Knowledge of the anatomy of the ureter and adjacent vessels is crucial for accurate interpretation, the size of the stone is measured and its location precisely reported. Stones smaller than 4 mm nearly always pass spontaneously; stones of 6 mm pass about half the time and those larger than 8 mm rarely pass spontaneously. Size and location are important factors in determining the treatment of stones that do not pass spontaneously. Stones larger than 5 mm and located in the proximal two-thirds of the ureter are more likely to require lithotripsy or endoscopic removal, to confirm a stone in the ureter, look for a tissue rim sign (present in about 76% of cases). The tissue rim sign describes a halo of soft tissue that surrounds stones in the ureter. The soft-tissue rim is the wall of the ureter.

The tissue rim sign may be absent because of bloom effect artifact or a very thin ureteral wall, examination of the CT scout scan is useful for detecting stones and other abnormalities and should be included in every CT interpretation. If the stone is visible on the scout scan, plain radiographs can be used to monitor its passage. Calculi not visible on plain radiographs can be followed, when necessary, with unenhanced CT, Secondary findings of urinary obstruction are common but often subtle. Comparison to the opposite side is highly useful in differentiating preexisting findings from acute obstruction and the obstructed kidney may be enlarged and slightly decreased in CT density because of edema. The pelvi-calyceal system is usually, but not always, mildly dilated. Dilated calyces are best seen at the poles as rounded fluid-filled structures that displace renal sinus fat. Comparison with the opposite kidney is always helpful. Profound dilatation of the collecting system is evidence of chronic, rather than acute, obstruction, Periureteral and perinephric fat stranding occurs secondary to edema produced by obstruction ·The amount of edema present correlates with the severity of obstruction. Unilateral absence of “white pyramids” on the affected side has been described as a subtle sign of obstruction, the ureter is mildly dilated to the level of the stone. Normal ureteral peristalsis produces transient focal areas of dilatation and narrowing. This must be differentiated from diffuse dilatation to the level of obstruction. The ureter below the obstructing calculus is not dilated. Moderate or severe hydronephrosis suggests longer-standing obstruction and should cause suspicion of other causes of ureteral obstruction, Focal perinephric fluid collections may occur secondary to forniceal rupture caused by obstruction and high urine output and axial plane CT images may be reformatted into coronal plane images that resemble IVP images in problematic cases and this procedure is time-consuming and seldom necessary for diagnosis. Some referring physicians may routinely request coronally reformatted images, however, because they resemble the trusted IVP (E. Brant et.al 2001).

2.4.6 Pitfalls in Diagnosis

No imaging test is perfect. A variety of pitfalls complicate interpretation of renal stone CT. An extrarenal pelvis may mimic pelviectasis. Peripelvic cysts can simulate hydronephrosis. Many patients, especially older ones, have preexisting stranding in the peripelvic fat. Comparison with the opposite side is critical to detection of asymmetric stranding, Phleboliths, which are calcifications that originate in thrombi within pelvic veins, commonly mimic stones. Most phleboliths are found in perivesical veins, in periprostatic veins in men, and in periuterine and perivaginal veins in women. They are occasionally seen in gonadal veins that parallel the course of the ureters, most phleboliths are round; they are seldom oval and are never geometric in shape, Visualization of a central lucency is highly characteristic of phleboliths but is less often evident on CT than on plain radiographs. A tail sign represents a tail of non-calcified vein extending from the phlebolith. A tail sign has been reported with 21% to 65% of phleboliths. Phleboliths are lower density than most stones, with a mean attenuation value of 160 HU and a range of 80 to 278 HU. The probability that a calcification represents a phlebolith is 0.03% when mean attenuation is 311 HU or more and atherosclerotic calcifications are occasionally mistaken for ureteral stones. Differentiation is made by carefully examining serial slices and determining if the calcification is in an artery or in the ureter also it is difficult to differentiate preexisting post-obstructive changes from acute obstruction. When signs of ureteral obstruction are present but no stone is evident, consider a recently passed stone, pyelonephritis, stricture or tumor, or protease inhibitor treatment-related stone, Stones passed from the ureter may be identified in the bladder or urethra or may not be seen, always look for evidence of non-urinary causes of flank pain. Unenhanced CT has been reported to be 94% accurate in the diagnosis of appendicitis. Adnexal masses are usually easily detected, and a subsequent contrast-enhanced CT scan may be needed in up to 20% of cases to provide an unequivocal diagnosis. (E. Brant et.al 2001).

2.4.7 Indication Creep:

The quickness and ease of obtaining non-contrast CT for renal stones has resulted in a broadening of indications by referring physicians, especially emergency department physicians. The result is many more studies that are negative for stones but positive for a wider range of other urinary and non-urinary abnormalities, Non contrast CT has substantial limitations for the diagnosis of solid masses in the liver, pancreas, and kidneys, as well as for conditions such as visceral ischemia, infarction, and infection. Radiologists may wish to broaden their use of contrast-enhanced CT to follow a negative or equivocal renal stone CT (E. Brant et.al 2001).

2.5 Previous studies:

Kluner et.al 2006, was aimed to evaluate the diagnostic yields of multislice CT using a radiation dose equivalent to that of conventional abdominal x-ray (KUB). One hundred forty-two patients were prospectively examined with ultrasound and a radically dose-reduced CT protocol (120 kV, 6.9 eff. mAs). Number and size of calculi, presence of urinary obstruction, and alternative diagnoses were recorded and confirmed by stone removal/discharge or by clinical and imaging follow-up. The mean effective whole-body dose was 0.5mSv in men and 0.7 mSv in women. The sensitivity and specificity in detecting patients with calculi was 97% and 95% for CT and 67% and 90% for ultrasound. Urinary obstruction was similarly assessed, whereas CT identified significantly more alternative diagnoses than ultrasound (*P* <0.001). With regard to published data for standard-dose CT, the present CT protocol seems to be comparable in its diagnostic yield in assessing patients with calculi, and its radiation dose is equivalent to that of KUB. Detection of ureteral calculi in patients with suspected renal colic: value of reformatted non-contrast helical CT.

Sommer et.al 1995, he aimed to determine the value of reformatted non-contrast helical CT in patients with suspected renal colic. Thirty-four consecutive patients with signs and symptoms of renal colic were imaged with both non-contrast helical CT and a combination of plain film of the abdomen and renal sonography. Reformatting of the helical CT data was performed on a workstation to create a variety of reformatted displays. The correlative studies were interpreted by separate blinded observers. Clinical data, including the presence of hematuria and the documentation of stone passage or removal, were recorded. Findings on 18 CT examinations were interpreted as positive for the presence of ureteral calculi; 16 of these cases were determined to be true positives on the basis of later-documented passage of a calculus. Thirteen of the 16 cases proved to be positive were interpreted as positive for renal calculi using the combination of abdominal plain film and renal sonography. The most useful CT reformatting technique was curved planar reformatting of the ureters to determine whether a ureteral calculus was present. In this study, non-contrast helical CT was a rapid and accurate method for determining the presence of ureteral calculi causing renal colic. The reformatted views produced images similar in appearance to excretory urograms, aiding greatly in communicating with clinicians. Limitations on the technique include the time and equipment necessary for reformatting and the suboptimal quality of reformatted images when little retroperitoneal fat is present.

Eray et.al 2001, was aimed the diagnostic value of urinalysis and plain films in patients with suspected renal colic presenting to an emergency department (ED). Over a 1-year period, 138 patients presented to the ED during the daytime with suspected renal colic, but for technical reasons the diagnostic modalities used in the study could be completed for only 99 patients, and 34 patients were lost to follow-up. A urinalysis; kidney, ureter, and bladder film; and spiral computed tomography (CT) were performed on each patient. The presence of urinary tract stones was determined by their definite presence on helical CT and/or passage of a stone on clinical follow-up (average follow-up = 3 months). A urinary stone was visualized on spiral CT or passed in the urine in 54 of the patients. Using helical CT findings or passage of a stone as the gold standard, plain radiography had a sensitivity of 69% and specificity of 82%. Urinalysis had a sensitivity of 69% and specificity of 27%. The sensitivity increased to 89% if either test was positive, but the specificity remained low at 27%. The sensitivity and specificity of CT in the diagnosis of urinary stones was 91%. Urinalysis and plain films are much less accurate than helical CT for confirming the diagnosis of acute urolithiasis. Further evaluation of the clinical and cost-effectiveness of helical CT should be done to determine its role in the work-up of these.

Poletti et.al 2007**,** was aimed to compare a low-dose abdominal CT protocol, delivering a dose of radiation close to the dose delivered by abdominal radiography, with standard-dose unenhanced CT in patients with suspected renal colic. One hundred twenty-five patients (87 men, 38 women; mean age, 45 years) who were admitted with suspected renal colic underwent both abdominal low-dose CT (30 mAs) and standard-dose CT (180 mAs). Low-dose CT and standard-dose CT were independently reviewed, in a delayed fashion, by two radiologists for the characterization of renal and ureteral calculi (location, size) and for indirect signs of renal colic (renal enlargement, pyelo-ureteral dilatation, peri-ureteral or renal stranding). Results reported for low-dose CT, with regard to the patients' body mass indexes (BMIs), were compared with those obtained with standard-dose CT (reference standard). The presence of non-urinary tract-related .In patients with a BMI < 30, low-dose CT achieved 96% sensitivity and 100% specificity for the detection of indirect signs of renal colic and a sensitivity of 95% and a specificity of 97% for detecting ureteral calculi. In patients with a BMI < 30, low-dose CT was 86% sensitive for detecting ureteral calculi < 3 mm and 100% sensitive for detecting calculi > 3 mm. Low-dose CT was 100% sensitive and specific for depicting non-urinary tract-related disorders (*n* =6).

Appledorn *et.al 2003,* they was aimed to assess the accuracy of NCCT in estimating ureteral stone size compared with plain abdominal (KUB) films. Forty-eight patients were identified who ureteral stones had seen on NCCT and KUB films performed on the same day. The number of consecutive images on which a ureteral stone was visible on NCCT was multiplied by the reconstruction interval of 5 mm to create a size estimate, which was compared with the measurements of the same stone seen on the KUB film. They found that, the NCCT overestimated stone size by approximately 30% to 50% compared with KUB.

Dundee et al in 2006, was aimed to assess the accuracy of stone size measured on NCCT compared with KUB films. The NCCT and KUB studies obtained from 24 patients (27 stones) presenting to the emergency department at a major metropolitan hospital were analyzed randomly and independently by two urologists and one uroradiologist. The NCCT scans were assessed separately from the KUB films. Only size in greatest dimension and stone location were recorded. The stone size was 2 to 38 mm on NCCT scans and 2 to 46 mm on KUB films. The mean stone size was 6.773 ± 6.146 mm and 7.747 ± 7.866 mm, respectively ($P = 0.0398$; Student's *t*-test). Almost three fourths (70%) of the stones were larger on KUB films than they were on NCCT scans, with a mean difference −0.974 mm (95% confidence interval −5.652, 3.703) for NCCT. Spiral CT underestimates stone size by approximately 12% compared with KUB films**.**

Chen et.al 1999, was aimed to assess whether clinicians had broadened the indications and changed the yield and findings of unenhanced helical CT. One hundred consecutive patients with suspected renal colic or flank pain referred for unenhanced helical CT were selected for this study. We reviewed the original radiographic reports for each patient and recorded the presence of ureteral calculi. Other urinary abnormalities and extra-urinary lesions were also recorded and compared with the results of the previous study. In this study a 56% of the patients who underwent unenhanced helical CT had symptoms of urinary colic, and 44% of patients had unspecified flank pain, compared with 100% of patients with symptoms of urinary colic 1 year earlier. The sensitivity and specificity of unenhanced helical CT in detecting ureteral calculi were 96% and 99%, respectively. Ureteral calculi were identified in only 28% of the patients versus 49% of patients ($p < .01$) 1 year earlier. Extraurinary lesions were identified in 45% of the patients versus 16% ($p < .01$) 1 year before. As clinicians developed familiarity with this technique, the indications for performance of unenhanced helical CT were expanded with a consequent reduction in the rate of detection of stone disease and identification of an increased number of extraurinary lesions, which suggests a demand for emergency abdominal CT studies.

Sourtzis et.al 1999, was aimed to compare unenhanced helical CT and excretory urography in the assessment of patients with renal colic. Fifty-three of 70 consecutive patients with acute signs of renal colic were prospectively examined with unenhanced helical CT, which was followed immediately by excretory urography. Two radiologists who were unaware of the findings independently interpreted these examinations to determine the presence or absence of ureteral obstruction. On all CT scans that had positive findings for ureteral stones or obstruction, they looked for secondary signs of obstruction (perinephric or periureteral fat stranding, ureteral wall edema, ureteral dilatation, and blurring of renal sinus fat). A stone was recovered in 45 of the 53 patients, nine before and 36 after imaging. The latter 36 patients had their stones identified on CT, whereas only 24 patients had their stones identified on excretory urography. Eight patients without stone disease had normal ureters on both CT and excretory urography. Of the 45 patients who had stone disease, 26 had ureteral dilatation on both CT and excretory urography, and 36 patients who recovered a stone after CT had secondary signs of obstruction. Of the nine patients who recovered a stone before CT, three had secondary signs of obstruction. Two patients had periureteral fat stranding, ureteral wall edema, and renal sinus fat blurring. One patient had only ureteral wall edema. 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.

M. Patlas et.al 2014, they aimed to compare the accuracy of non-contrast spiral CT with ultrasound (US) for the diagnosis of ureteral calculi in the evaluation of patients with acute flank pain. 62 consecutive patients with flank pain were examined with both CT and US over a period of 9 months. All patients were prospectively defined as either positive or negative for ureterolithiasis, based on follow-up evaluation. 43 of the 62 patients were confirmed as having ureteral calculi based on stone recovery or urological interventions. US showed 93% sensitivity and 95% specificity in the diagnosis of ureterolithiasis; CT showed 91% and 95%, respectively. Pathology unrelated to urinary stone disease was demonstrated in six patients. Although both modalities were excellent for detecting ureteral stones, consideration of cost and radiation lead us to suggest that US be employed first and CT be reserved for when US is unavailable or non-diagnostic.

M .Kalorin et al 2009, He has been proposed that younger children are less likely to pass renal calculi spontaneously, and that children younger than 10 years are more likely to have an identifiable metabolic abnormality and subsequently a higher risk of recurrence. We report our clinical outcomes in children with urinary calculi, specifically examining these factors. He performed a retrospective review of all pediatric patients diagnosed with renal or ureteral calculi at our institution between 2000 and 2007. Of 150 patients evaluated and treated during this period 80 (86 stones) had sufficient follow-up data to be included. Patients were divided into 2 groups according to age, namely 10 years or younger and older than 10 years. There were 39 patients in the younger group and 41 patients in the older group. Stone size and location, successful passage or intervention, recurrence and 24-hour urine metabolic study results were recorded. Their main result was; of the younger cohort stones were ureteral in 43% and renal in 57%. The opposite trend was seen in older patients, with 69% having ureteral and 31% having renal stones ($p = 0.02$). Mean stone size (greatest dimension) did not differ significantly between the older and younger groups (6.9 mm vs 5.5 mm, $p = 0.17$). Overall stone passage rate was 34% for younger and 29% for older patients ($p = 0.65$). No significant mean size differences in passed stones existed between the groups (3.2 mm vs 2.5 mm, $p = 0.31$). Overall younger vs older ureteral stone passage rate was 37% vs 41% ($p = 0.58$), and for renal stones it was 32% vs 0%. Stones recurred in 7 younger and 6 older patients. Younger children were more likely to present with renal stones, while older children had more ureteral stones. Overall children 10 years old or younger are as likely to pass stones as older children. Renal stones are more likely to be successfully managed expectantly in younger children. Metabolic abnormalities and stone recurrences are observed at similar rates between younger and older children.

Chapter three

3.1. Materials:

The study was executed using multi-detector computed tomography scanner MDCT 8-Slice scanner (0.625mm slices): 8-slice 0.625mm collimation, table feed 10 mm/rotation, effective tube current 685 mAs at 120 kV. Pitch = 10/40 mm collimation = 0.25. Average scan time = 5 s, to scan the patient with flank pain problems with 8-slice, detector array, fan beam shape, CT monitor for controlling scanning and processing. contrast injector (Medrao Toshiba-2ways) for flush contrast media to patient and K-PACS system for diagnosis images and reconstruction and volume rendered purposes in addition to the density data measurement and stone type estimations.

3.2. Methods:

In 120 patients (68 male, 52 female; mean age of 44.16 years) were included. MDCT was performed. The Research Counsel Board-College of Medical Radiological Science approved the research protocols.. Patients were placed in the supine position; Patients were also instructed not to breathe normal and to drink much more fluid before the examination and not to urinate in order to see the full bladder volume and to clearly visualize the associated pathology. CT technical parameters included: matrix 512x512, field of view (FOV) 20 cm; tube current 685 mAs at 120 kV; table feed 10mm/rotation, pitch 10/40mm. Axial images were analyzed, K-PACS system for diagnosis images and reconstruction and volume rendered purposes in addition to the density data measurement and stone type estimations were used. For patient's preparation, patient instructed not to eat 24 hours before the examination time and a cretin food diet was identified to the patient with include all foods not having an oily component also milk component in order to evacuate the large intestine from the fecal masses and the abdominal gases that may interfere with stone and affect the image quality, a 3-5 mm cuts was performed from the level just below the diaphragm to the symphysis pubic in order to visualize the kidneys, ureter, and bladder and its associated morbidity.

3.2.1. Study area:

This study was conducted at Khartoum state medical diagnostic center (Antalya diagnostic center).

3.2.2. Study duration:

This study was carried out from August to october 2015

3.2.3. The study population and sample:

The study sample was consisted of 120 patient with flank pain and clearly suspected for KUB stone or other pathological problem there.

3.2.4. Inclusion criteria:

The study will include all patients with flank pain at age between (4-80years), female or male.

3.2.5. Exclusion criteria:

Pregnancy and patient underwent previous surgical intervention for one kidney (removal) was excluded from this study.

3.2.6. Statistical analysis:

All data were presented as mean±SD values. Data were analyzed by an independent t-test and by correlation analysis with the use of the SPSS (IBM SPSS version 21.0). A value of $P<0.05$ was considered significant.

3.2.7. Data collection:

The data were collect on master data sheet from the diagnostic stations which was include all parameters need for evaluations.

3.2.8. Variables of the study:

Patient gender, Age, number of stones, site, location, density, size, hydronephrosis, hydroureter, obstruction, and other pathological findings (cortical thinning, cortical thickening, renal cyst and lobulation.

3.2.8.1. Example of standard master data sheet was used in data collection

Stone	*Gender*	*Age*	*location*	*site*	*density*	*x-size*	*y-size*	*Hydro-nephrosis*	*Hydro ureter*	*Obstructive*	*other findings*
1	2	14	1	1	430	0.8	0.8	2	0	0	1
1	2	44	1	7	1152	0.6	0.6	2	1	0	4

3.2.19. Ethical issues:

- There was official written permission to Khartoum state diagnostic centers to take the data.
- No patient data were published also the data was kept in personal computer with personal password.

Chapter four

Results

This study was aimed to evaluate the urinary system in patient with flank pain and associated symptoms using kidney ureter and bladder computed tomography.

Table (4.1) Frequency table showed the age classes and number of patient underwent CT KUB examination, in each class

Age classes		Stone				Total
		No stone	One stone	Two stone	Three stone	
Age	1-9	0	2	2	0	4
	10-19	4	5	1	1	11
	20-29	1	8	0	0	9
	30-39	7	10	2	1	20
	40-49	1	17	10	0	28
	50-59	2	10	7	2	21
	60-69	3	13	2	0	18
	70-80	2	7	0	0	9
Total		20	72	24	4	120
Correlation is significant at p=0.039						

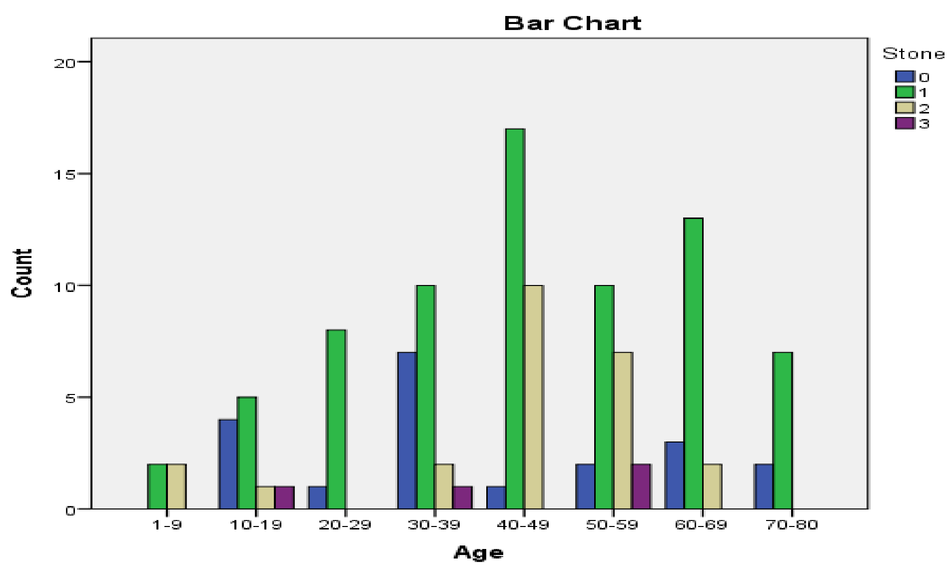

Figure (4-1) showed correlation between the age and the site of stone

Table (4.2) showed the minimum, maximum, the mean and the stander deviation value of the density and the size at X and Y direction

Variables	Min	Max	Mean	Std. Deviation
Density	0.000	1505	602.44	434.085
x-size	0.000	9.000	1.20425	1.312462
y-size	0.000	4.000	0.93875	0.805147

Table (4-3) frequency table showed the number of the patient classed as male and female whose underwent CTKUB examination

Gender	**Frequency**	**Percent (%)**
Male	68	54.4
Female	52	41.6
Total	120	96.0
Missing cases	5	4.0

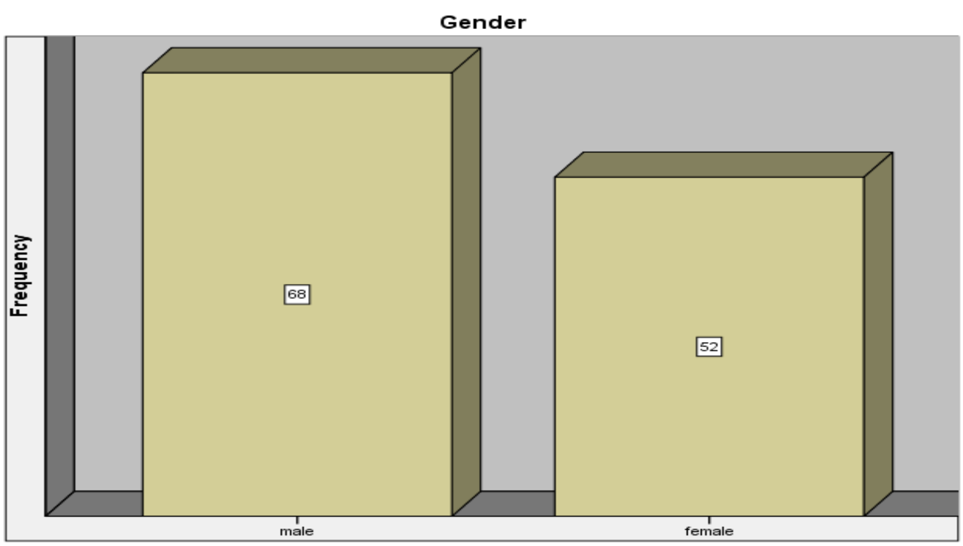

Figure (4-2) showed the frequency of the patients underwent CT KUB in each gender

Table (4-4) frequency table show the number of the stone in each side of RT, LT or Both sides of kidneys ureters and bladder

Location	Frequency	Percent (%)
Normal	20	16.0
RT side stone	41	32.8
LT side stone	41	32.8
both side stone	18	14.4
Total	120	96.0
Missing cases	5	4.0

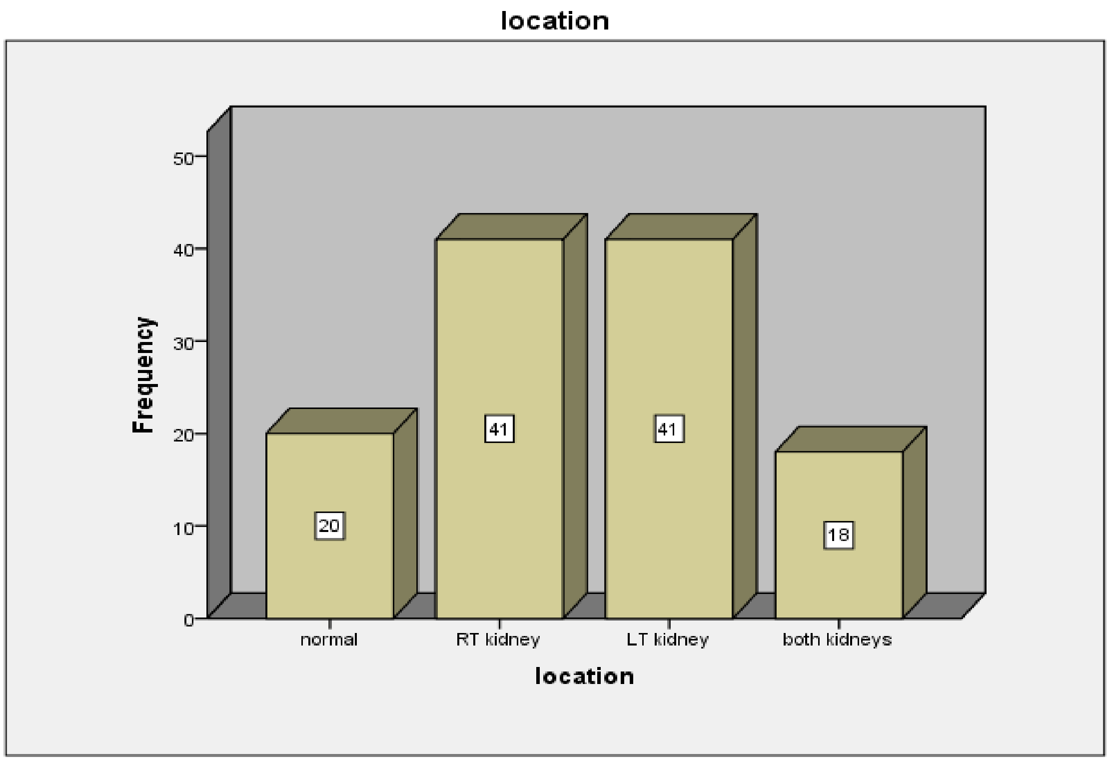

Figure (4-3) showed the frequency distribution of the stone in each location

Table (4-5) frequency table showed the number of each other pathological problem with or not associated with presence of stone(s).

Other CT-KUB finding	Frequency	Percent (%)
No other finding	78	62.4
cortical thinning	22	17.6
cortical thickening	11	8.8
Cyst	8	6.4
Lobulation	1	.8
Total	120	96.0
Missing cases	5	4.0

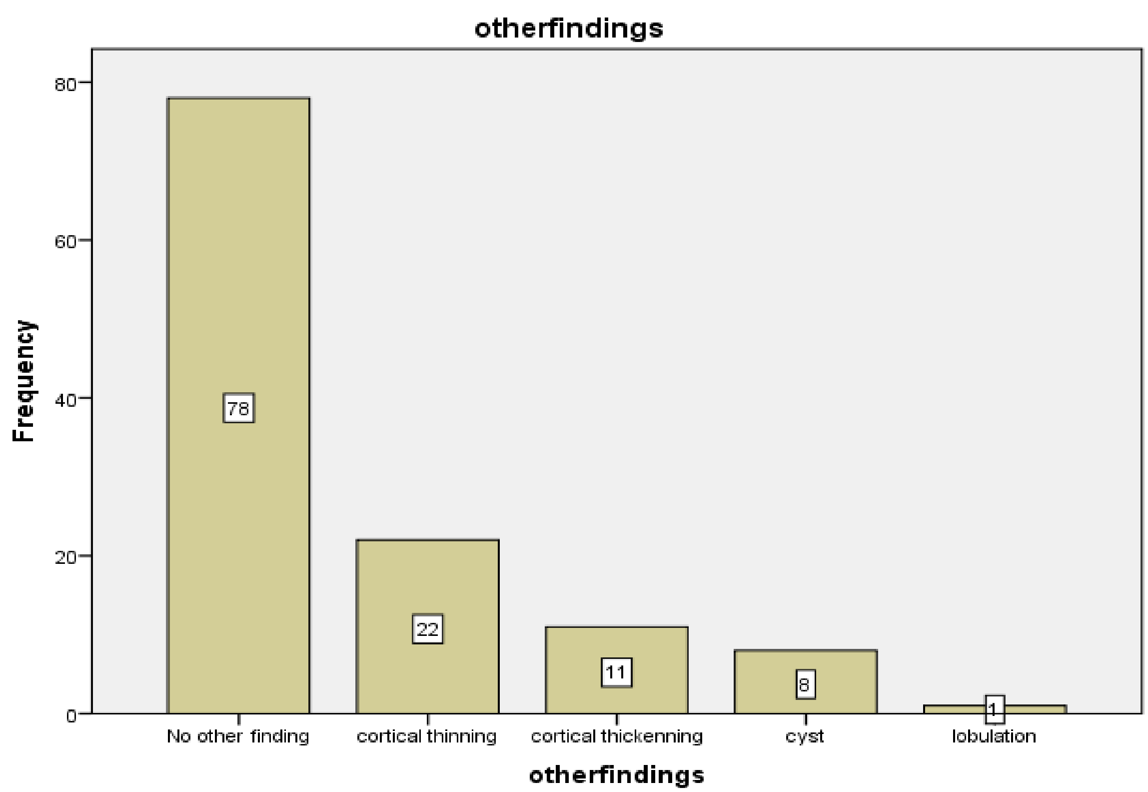

Figure (4-4) showed the frequency distribution for other pathological finding rather than presence of stone

Table (4-6) showed the cross tabulation between site of the stone and degree of hydronephrosis

Site of the stone(s)	Hydronephrosis			
	normal finding	mild	Moderate	Sever
No stone	18	0	2	0
Upper pole of the kidney	1	0	1	0
Middle pole of kidney	8	4	0	0
Lower pole of the kidney	14	1	5	1
Upper ureter	2	1	3	2
Middle ureter	2	2	2	1
Lower ureter	4	2	8	1
PUJ	2	0	3	2
Renal pelvis	5	7	8	2
VUJ	2	0	3	0
Total	58	17	35	9
Correlation is significant at p=0.006				

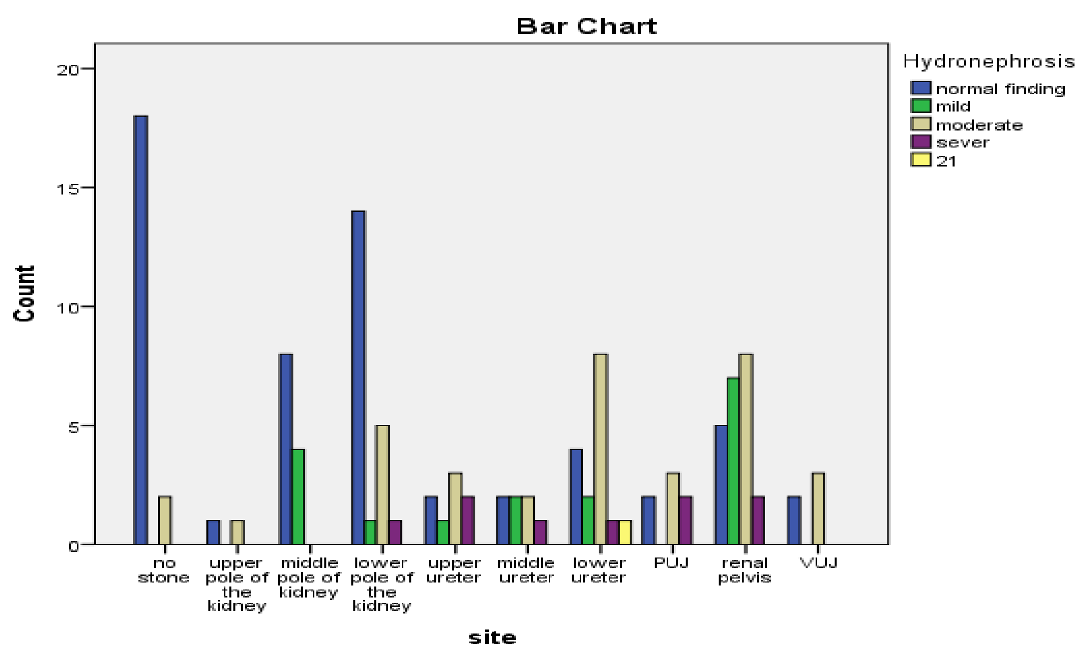

Figure (4-5) showed the correlation between the site of the stone and the degree of hydronephrosis

Table (4-7) showed the cross tabulation between site of the stone and the availability of hydroureter

Site of the stone		Hydroureter		Total
		normal ureter	Positive	
Site	No stone	18	2	20
	Upper pole of the kidney	2	0	2
	Middle pole of kidney	9	3	12
	Lower pole of the kidney	18	3	21
	Upper ureter	4	4	8
	Middle ureter	2	5	7
	Lower ureter	6	10	16
	PUJ	5	2	7
	Renal pelvis	19	3	22
	VUJ	2	3	5
Total		85	35	***120***
Correlation is significant at p=0.001				

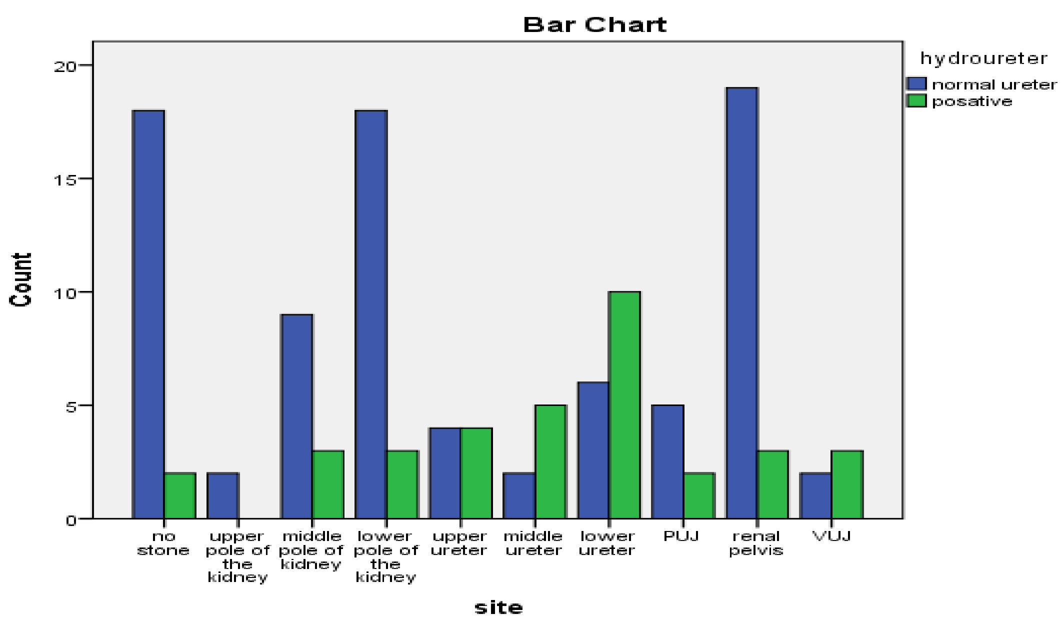

Figure (4-6) showed the correlation between the site of the stone and the presence of hydroureter

Table (4-8) showed the cross tabulation between site of the stone and the availability of obstructive change

Variables		Obstructive		Total
		No obstruction	Positive	
site	no stone	20	0	20
	upper pole of the kidney	2	0	2
	middle pole of kidney	11	1	12
	lower pole of the kidney	18	3	21
	upper ureter	3	5	8
	middle ureter	1	6	7
	lower ureter	11	5	16
	PUJ	5	2	7
	renal pelvis	11	11	22
	VUJ	3	2	5
Total		85	35	120
Correlation is significant at P=0.000				

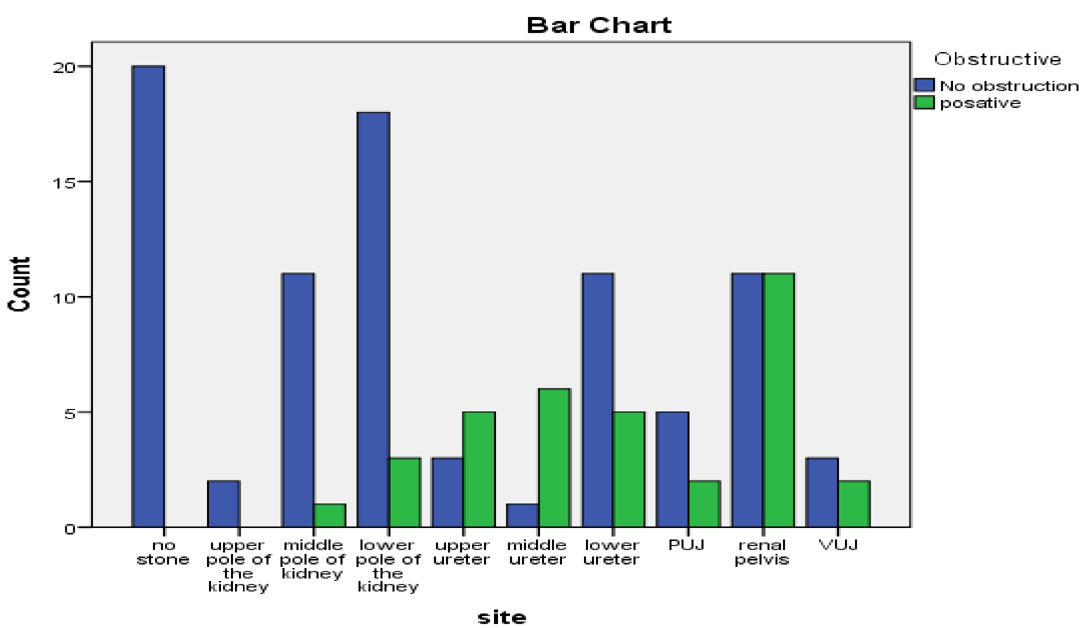

Figure (4-7) showed the correlation between the site of the stone and the presence of the obstructive

Table (4-9) showed the cross tabulation between the degree of hydronephrosis and the availability of the obstructive

Variables	Obstructive		Total
	No obstruction	Positive	
normal finding	50	8	58
Mild	9	8	17
Moderate	23	12	35
Sever	3	6	9
Total	85	35	120

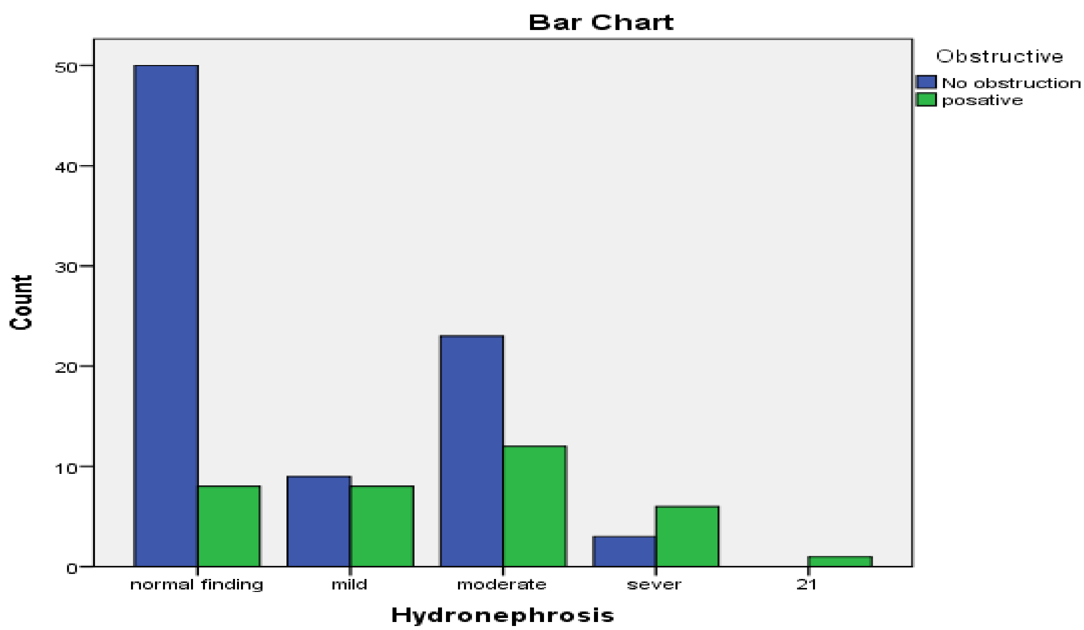

Figure (4-8) showed the correlation between the degree of hydronephrosis and the presence of the obstructive

Table (4-10) showed the cross tabulation between the availability of the hydroureter and the obstructive

Variables		Obstructive		Total
		No obstruction	Positive	
Hydroureter	normal ureter	66	19	85
	positive	19	16	35
Total		85	35	120
Correlation is significant at P=0.05 level.				

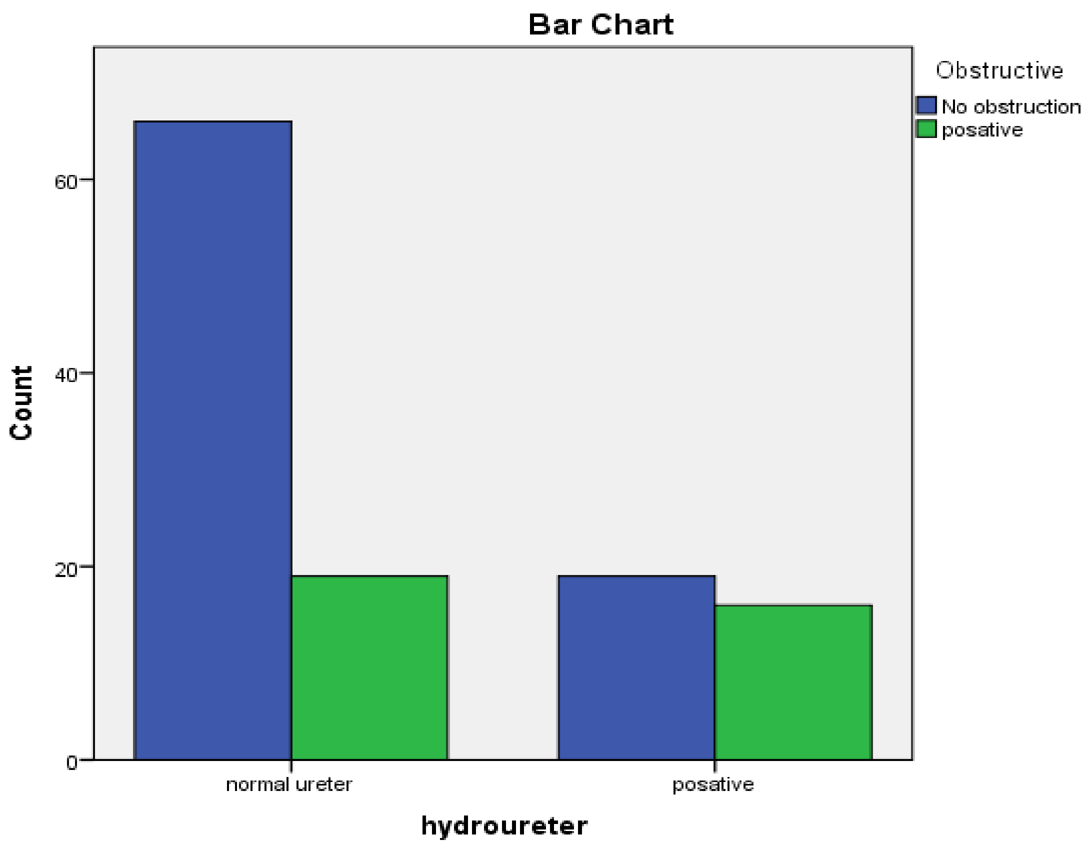

Figure (4-9) showed the correlation between the presence hydroureter according to presence of the obstructive

Table (4-11) showed the cross tabulation between the site of the stone and the other findings present

Variables		Other Findings					
		No other finding	cortical thinning	cortical thickening	Cyst	lobulation	Total
Site	No stone	19	0	1	0	0	20
	upper pole of the kidney	0	1	0	1	0	2
	middle pole of kidney	9	0	1	2	0	12
	lower pole of the kidney	13	4	1	3	0	21
	upper ureter	3	2	2	1	0	8
	middle ureter	6	1	0	0	0	7
	lower ureter	7	5	3	1	0	16
	PUJ	4	2	0	0	1	7
	renal pelvis	13	7	2	0	0	22
	VUJ	4	0	1	0	0	5
Total		78	22	11	8	1	120
Correlation is significant at p=0.018							

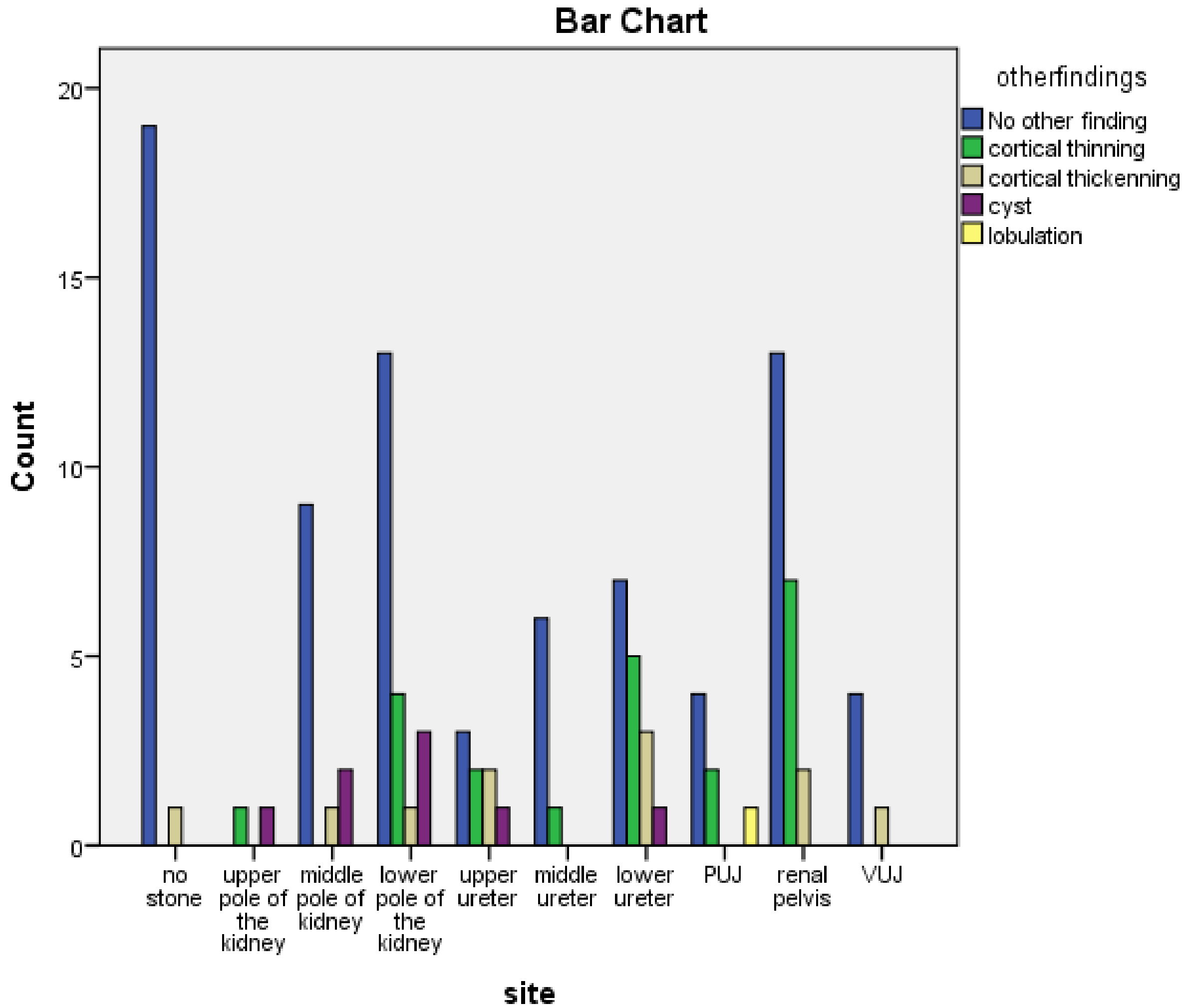

Figure (4-10) showed the correlation between the site of the stone and other pathological findings present

Chapter five

5.1. Discussion

This study was aimed to evaluate the role of spiral computed tomography in the diagnosis of urinary tract stones in order to assess the stone related to its size, number, and associated morbidity. 120 patients with flank pain and clearly suspected for KUB stone were investigated in Antalya Diagnostic Center. In period from August 2015 to October 2015. From these 120 patient we found that 20 (16.7%) patients showed normal CT KUB except two patient have moderate hydronephrosis and cortical thickening, this possible due to other causes rather than the presence of stone, while the other 100 patient having renal stone(s) and other associated finding, table (4.1).

Spiral MDCT KUB is a superior modality rather than the conventional modalities such as conventional KUB x-ray and ultrasound because it provide density data measurement for all tissue, this study also measure the amount of CT number for relative stones which had the minimum, maximum, mean and stander deviation as (0.00), (1525), (602.44), and (434.058) respectively. The dimensionality of the stone in both length and width were evaluated also which have (0.00), (0.00), (9.0), (4.0), (1.20425), (0.93875), and (1.312462), (0.805147). For X-dimension and Y-dimension respectively. The zero value was coming from the patient who haven't stone, table (4-2). Non- contrast CT is a useful modality for diagnosis of patients presenting with renal colic but whose results are negative or equivocal on KUB and US as stated by Takashi et.al 2005.

Also we found 41 patients have stones at the right side of the urinary tract (32.8%) and equal to patients who have stones at the left side no factor can affect the presence of the stone on its side according to this thesis. While there were 18 patient (14.4%) have stones at both sides, and the renal pelvis showed the higher site for renal stones 22% (22 patients from 100).

The incidence of renal stone was clearly found to be higher in male rather than the female (68) (54.4%), (52) (41.6%) respectively, and the most affected age group from both sex was (40-49) (23.3%), this may be due to different patient habits including water or other causes as stated by Gamerddin et.al 2013. In Sudanese population the problem of uncleaned water still having a majority in increasing the incidence of renal system stones as general. A person's chi-squire test was used to investigate the relations between the age, site and the associated morbidity. A significant correlation was noted between the age group and number of stone in each class at P =0.039; the groups age were (1-9), (10-19), (20-29), (30-39), (40-49), (50-59), (60-69) and (70-80) showed number of patients with no stone, one stone, two stones and three stones as (0), (2), (2) and (0), (4), (5), (1) and (1), (1), (8), (0) and (0), (7), (10), (2) and (1), (1), (17), (10) and (0), (2), (10), (7) and (2), (3), (13), (2), and (0), and (2), (7), (0), and (0) respectively. From these correlation we noted that the most affected age group may having one or multiple stones 17 and 10 for one and two stone classes as in table (4-1).

A correlation was created to investigate the relationships between the site of the stone in each location within the urinary system in order to test its effect according to its site; these sites was patient with no stone, upper pole of the kidney, middle pole of kidney, lower pole of the kidney, upper ureter, middle ureter, lower ureter, PUJ, renal pelvis and VUJ having a frequency distribution of 20 (16.7%), 2 (1.7%), 12 (10%), 21 (17.5%), 8 (6.7%), 7 (5.83%), 16 (13.3), 7 (5.8%), 22 (18.3%) and 5 (4.17%) respectively. Frequency of hydronephrosis, hydroureter, and obstruction were 61 (50.8%), 35 (29.2%), 35 (29.2%) respectively.

There were two patient have stones at the upper pole of the kidney one of them had moderate hydronephrosis and the other patient hadn't any of these association.

Stones of the middle pole of the kidney showed hydronephrosis, hydroureter and obstruction as 4 (33.3%), 3 (25%), 1 (8.3%). While Stones of the lower pole of the kidney showed it as 7 (33.3%), 3 (14.9%), 3 (14.9%) respectively. Stones of the ureters showed hydronephrosis, hydroureter and the obstruction as 6 (75%), 4 (50%), 5 (62.5%) for the upper ureter, 5 (71.4%), 5 (71.4%), 6 (85.7%) for the middle ureter and 11 (68.7%), 10 (62.5%), 5 (31.2%) for the lower ureter respectively. Also 5 (71.4%) stones at the PUJ cause hydronephrosis, and 2 (28.6%) cause both hydroureter and obstruction. Stones of renal pelvis that caused hydronephrosis were 17 (77.8%), 3 (13.6%) caused hydroureter and 11 (50%) caused obstruction. While the stones of VUJ that caused hydronephrosis and hydroureter were 3 (60%) and 2 (40%) caused obstruction. From these statistical association we noted the presence of stone in the renal pelvis and PUJ having strong correlation within hydronephrosis as well the ureteric stone can cause obstruvtion and lead to both hydroureter and hydronephrosis. And these correlation between the site of stone(s) and the hydronephrosis , the hydroureter and obstruction are significant al P = 0.006 , P = 0.001 and P = 0.00 respectively, as in tables (4-6), (4-7) and (4-8) , figures (4-5), (4-6) and (4-7).

The relation between the obstruction with the hydronephrosis and the hydroureter are clearly showed strong correlation that investigated for 61 patient had hydronephrosis with different degree (mild, moderate and sever) 26 (42.6%) of them showed obstructive changes. and there were 58 patient hadn't hydronephrosis but 8 (13.8%) of them have obstructive changes; may be the obstruction was not sever enough to produce hydronephrosis. And there were 35 patient have hydroureter, 16 (45.7%) of them showed obstructive changes, and from 85 patient who hadn't hydroureter there were 19 (22.4%) patients with obstructive, this correlation is significant at P = 0.05. Table (4-9), (4-10) theses obstructive changes may lead to many co morbidities associated with its site such as flank pain or renal function deficiency; Ahmed A et al 2005 stated that in patients with renal impairment due to ureteral obstruction, non-contrast CT has superior diagnostic accuracy for detecting calculus causes of obstruction. In this study we also looked for the presence of the cortical thinning, cortical thickening , renal cyst and lobulation that can be associated with stones and we found the frequency of the incidence of each were 22 (17.6%), 11 (8.8%), 8 (6.4%) and 1 (0.8%) respectively. And from the correlation between them and the site of stone which is significant at P = 0.018, the patient with stone of the upper pole of the kidney showed cortical thinning and renal cyst as 1 (50%), 1 (50%) respectively. The patients with stone of the middle pole of the kidney showed cortical thickening, and renal cyst as 1(8.3%), 2 (16.7%) respectively, and the patients with stone of the lower pole of the kidney showed cortical thinning , cortical thickening , and renal cyst as 4 (19.05%), 1 (4.8%), 3 (14.3%) respectively, and the patients with stone of the upper ureter showed cortical thinning, cortical thickening , and renal cyst as 2 (25%), 2 (25%), 1 (12.5%) respectively, and the patients with stone of middle ureter showed renal cyst as 1 (14.3%) respectively, and the patient with stone of the lower ureter showed cortical thinning , cortical thickening , and renal cyst as 5 (31.2%), 3 (18.7), 1 (6.25%) respectively, and the patients with stone of the PUJ showed cortical thinning and lobulation as 2 (28.6%), 1 (14.3%) respectively. The patient with stone of the renal pelvis showed cortical thinning and cortical thickening as 7 (31.8%), 2 (9.09%) respectively, and the patients with stone of the VUJ showed cortical thickening as 1(20%). And this correlation is significant at P=0.018, table (4-11), figure (4-10). These pathological finding are strongly related to the site and the presence of the stone such as cortical thinning (renal pelvic stones), hydroureter (middle ureteric stone), hydronephrosis (renal pelvic stone), and also the obstructive changes strongly related to the upper ureteric stone which may be positive or negative related to the size of the stone.

5.2. Conclusion:

Single-slice and multislice spiral CT have forever changed the imaging of renal stone disease. A review of the techniques, findings, complications, and pitfalls involved is timely given that CT is now the imaging method of choice to detect renal stones and diagnose the complications of renal stone disease, acute flank pain is a common complaint of patients seeking emergency medical attention. this study was investigate the accuracy of CT KUB in detection and diagnosing of renal system stone. The general aims of this study was to evaluate the role of spiral computed tomography in the diagnosis of urinary tract stones in order to exclude the most type of stone related to its size and density measurements. 120 patients who complain of flank pain and have high risk to have renal stone , with different age and gender presented to Khrtoum state diagnostic center (Antalya diagnostic center) to perform CT-KUB examination , in period from August 2015 to October 2015.

From this study we found the CT KUB has the ability to detect stones of the urinary tract accurately. And most of these stones appear in male (54.4%). Also the most affected age group is (40-49) with the number of stones that present in right side equal to those at the left side of the urinary tract. The renal pelvis showed the common site for stones 18.3%. Stones of the ureters are more likely to produce hydroureter and hydronephrosis. 50.8 % of stones are associated with hydronephrosis, 27.9% mild, 57.4% moderate and 14.7% sever, and stones of the renal pelvis showed the most common site of stones cause hydronephrosis. 29.2% of stones cause hydroureter and the most common site for stones cause hydroureter is the middle ureter 71.4%. Also 29.2 of stones are demonstrate obstructive changes and the upper ureter showed the most common sit for stones cause obstruction.

These pathological finding are strongly related to the site and the presence of the stone such as cortical thinning (renal pelvic stones), hydroureter (middle ureteric stone), hydronephrosis (renal pelvic stone), and also the obstructive changes strongly related to the upper ureteric stone which may be positive or negative related to the size of the stone

5.3. Recommendations:

- To reduce the risk of urinary tract stones formation . we advised to drink plenty of water during the day.
  we also advised to purify and disinfect drinking water to prevent the formation of urinary tract calculi. review your doctor when feeling any pain or abnormal urinary symptoms. Lifestyle changes may be reduce formation of urinary tract calculi such as Eat fewer oxalate-rich foods if the patient tend to form calcium oxalate stones, Choose a diet low in salt and animal protein and Continue eating calcium-rich foods, but use caution with calcium supplements. Medications can control the amount of minerals and acid in the urine and may be helpful in people who form certain kinds of stones. The type of medication prescribes will depend on the kind of kidney stones. Conducting of future study about comparison between plan KUB, CT KUB, MRU and US imaging.

References:

1. David Sutton .Textbook of Radiology and Imaging .4th edition. New York. Churchill Livingstone, 1987
2. Jack T. Stern, Stern and Luci Betti. Core Concepts in Anatomy. 1st edition . philadelphia. Lippincott-Raven, 1997

3. M. Y. Sukkar, M. S. M. Ardawi, H. A. El Munshid. Concise Human Physiology, 2nd Edition. Wiley-Blackwell, 2000

4. Stefan Ulzheimer and Thomas Flohr , Multislice CT: Current Technology and Future Developments. 3ed edition. Springer Berlin Heidelberg, 2009.

5. Peter Armstrong, Martin Wastie, Andrea G. Rockall. Diagnostic imaging.52ed edition. Wiley, 2004

6. http://www.ajronline.org/doi/abs/10.2214/ajr.165.3.7645461

7. http://journals.lww.com/jcat/Abstract/2006/01000/Does_Ultra_Low_Dose_CT_With_a_Radiation_Dose.8.aspx

8. http://www.ajronline.org/doi/abs/10.2214/ajr.165.3.7645461

9. http://www.sciencedirect.com/science/article/pii/S0735675702422280

10. http://www.ajronline.org/doi/abs/10.2214/AJR.06.0793

11. http://online.liebertpub.com/doi/abs/10.1089/089277903772036127

12. http://online.liebertpub.com/doi/abs/10.1089/end.2006.20.1005

13. http://www.ajronline.org/doi/abs/10.2214/ajr.173.6.10584780

14. http://www.ajronline.org/doi/abs/10.2214/ajr.172.6.10350278

15. http://www.birpublications.org/doi/abs/10.1259/bjr.74.886.740901

16. http://www.sciencedirect.com/science/article/pii/S0022534709000755

17. http://www.sciencedirect.com/science/article/pii/S002253470563234X

18. http://www.researchgate.net/profile/Moawia_Gameraddin2/publication/262560078_Characterization_of_Renal_Stones_by_Computed_Tomography_and_Ultrasound/links/0f317537f86f692ff2000000.pdf

19. http://www.sciencedirect.com/science/article/pii/S0022534705621544

20. http://www.healthline.com/health/kidney-stones#Overview1
21. http://www.diagnosticimaging.com/dimag/legacy/db_area/archives/2001/0106.ct.di.shtml

22. https://www.google.com.sa/search?hl=ar&biw=1366&bih=651&site=imghp&tbm=isch&sa=1&q=urinary+system&oq=urinary+system&gs_l=img.3...211586.216774.0.217247.14.14.0.0.0.0.0.0..0.0....0...1c.1.64.img..14.0.0.deXQcSbotRQ

23. https://www.google.com.sa/search?hl=ar&site=imghp&tbm=isch&source=hp&biw=1366&bih=651&q=kidney+and+nephron+anatomy&oq=kidney+and+nephron+anatomy&gs_l=img.3...7164.19243.0.19641.26.26.0.0.0.0.576.576.5-1.1.0....0...1ac.1.64.img..25.1.574.c5dh7Ncd03E

24. https://www.google.com.sa/search?hl=ar&biw=1366&bih=651&site=imghp&tbm=isch&sa=1&q=ct+kub-renal+stone&oq=ct+kub-renal+stone&gs_l=img.3...135619.137999.0.139026.6.6.0.0.0.0.0.0..0.0....0...1c.1.64.img..6.0.0.jAVjS6smU5s

Appendix (A)

Table (5.1) Master data sheet was used in data collection and analysis:

NO	Age	Gender	Stone	site	location	Density (HU)	Size (cm)	Hydro-nephrosis	hydroureter	Obstructive uropathy	Clinical indication	Us Findings	Other findings
1	14	F	+	1	RT	430	.8	2	-	-	RT renal stone	_	Cortical thinning
2	44	F	+	7	RT	1152	.6	2	+	-	-	-	Small LT kidne with cortex lobulation
3	34	M	+	2	LT	471	0.7x 0.3	-	-	-	-	-	-
4	56	F	+	3	LT	874	1.7× 1	_	-	-	-	-	-
5	12	M	+	6 8 3	LT LT RT	409 974 379	.8 1.1 .6	2 - -	+ - -	-	-	-	-
6	37	M	+	8	RT	530	2.5× 3.2	1	-	+	-	-	Cortical thinning
7	40	M	+	3 3	RT LT	563 700	2.1 1.3	2 2	-	-	-	-	Cortical thinning
8	42	F	+	6	LT	809	.5	-	+	+	-	-	Cortical thickening
9	42	M	+	6 3	LT LT	1348 1037	1.1 1.6	2 -	+ -	-	-	-	-
10	40	M	+	4 8	RT RT	877 411	1.7 .04	2	+	-	-	-	Cortical thickening
11	33	M	+	3	LT	348	.4	2	+	-	-	-	-
12	50	M	+	3	LT	264	1.5	-	-	-	RT renal stone		RT,L T simple cysts
13	53	M	+	1 8	RT LT	998 1124	1 2.5	- 3	- -	- +	-	-	LT cortical

													thinning
14	48	M	+	6 9	LT RT	1016 835	1.1 1.7	2 3	+ -	+ -	-	-	LT cortical thickness
15	69	M	+	8	LT	1335	2.6	3	-	+	_		Cortical thinning ,enlarged prostate, Rt renal cyst
16	38	M	+	5 1	RT RT	441 235	.08 .06	-	+	-	-	-	-
17	43	F	+	6	RT	1030	.8	2	-	-	-	-	Cortical thinning
18	40	M	+	2 3	LT LT	362 403	1 7	-	-	-	-	-	Lumber scoliosis
19	13	M	+	3	LT	291	.6	-	+	-	bilateral renal stone	-	-
20	55	M	+	3	RT	1158	1.1	-	-	-	-	-	Rt kidney compensat ory hypertrop hy
21	47	M	+	8 6	RT RT	775 212	2.1 .4	-	-	-	-	-	-
22	10	F	+	4	RT	1004	1.4 x 1	3	-	-	-	-	Cortical thinning
23	36	F	+	7	RT	630	1.2x 0.5	-	-	-	-	-	-
24	50	M	+	4	LT	970	1 x 0.8			+	Renal stone	-	-
25	67	F	+	8	LT	619	6.6x 4	2	-	+	-	-	-
26	26	M	+	8	LT	1344	2.8x 2.4x	1	-	-	-	-	-

							1.9						
27	69	M	+	2	LT	470	.12x .06	-	-	-	LT lion pain	-	Enlarged Prostate
28	40	M	+	5	RT	77	.04	1	+	-	-	RT hydro- nephrosis and hydro- Ureter	
29	55	M	+	3 7 4	RT RT LT	494 786 598	0.8 x 0.6 2.0 x 1.2 0.7 x 0.7	2 2	- +	- -	- -	-	-
30	76	M	+	4	RT	806	.07x .08	2	+	+	-	-	Enlarged Prostate
31	51	F	+	8 3	RT RT	1273 414	1.3 1.1	1	-	+	-	-	Cortical thickness
32	48	F	+	6	LT	110	4.5x 1.5	2	+	-	-	-	Cortical thinning
33	62	M	+	8	RT	700	1	-	-	-		-	GB stones , RT lumber hernia
34	42 ,	M	+	4 3	RT RT	512 607	1.4 1.1	3	-	-	-	-	Cortical thickness
35	45	F	+	6	LT	184	.03			+			
36	64	M	+	9	RT	214	.04	2	+				Cortical scarring
37	70	M	+	8	LT	1175	2.2	2	-	+			LT cortical thinning ,

													RT simple cyst
38	12	F	+	6	RT	130	1.8	1	+	+	-	-	RT Cortical thickness RT ovarian cyst
39	69	F	+	8	RT	664	1.5	-	-	+	-	-	Cortical thinning
40	25	F	+	3	RT	182	.02	2	-	-	-	-	Cortical thinning , ovarian cyst
41	74	M	+	3	LT	972	1.2	-	-	-	-	-	-
42	49	M	+	6	RT	125	1.6	2	-	-	-	-	-
43	40	M	+	1 3	RT LT	697 827	.5 1						Bilateral pylonephritis & cortical scarring
44	24	F	+	2	LT	1015	17x.05.	+	+	-	-	-	-
45	32	F	+	8	LT	914	.05	1	-	-	-	-	-
46	70	F	+	8	RT	478	1.5	1	-	-	-	-	-
47	43	F	+	3 3	LT RT	1449 1071	2.5x1.07 .6x1.4	- 2	- -	+ -	LT lion pain & RT renal stone	-	RT simple renal cyst Bilateral lower ureteric wall calcification
48	65	F	+	3	LT	435	1.4	-	-	-	-	-	Mid focal obstruction

49	45	M	+	8 3	RT LT	394 1124	.9×. 07 1.1× 1.2	-	-		+	-	-
50	35	M	+	6 3	LT LT	418 498	.9 .7	2	+	-	-	-	-

Appendix (B)

Figures of CT KUB images showing the stone in different planes

Figure (5-1) show RT staghorn stone and multiple LT kidney stones in coronal plane [25]

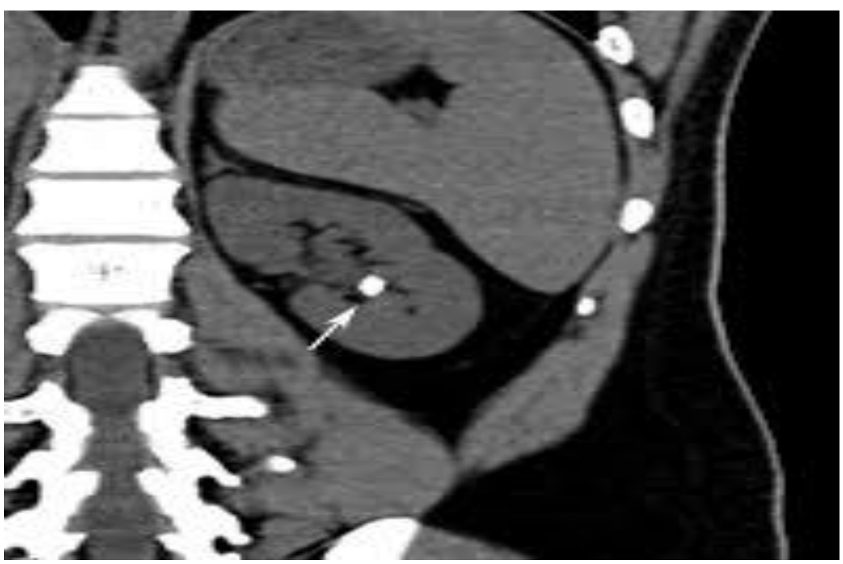

Figure (5-2) showed LT kidney stone in sagittal reconstruction plane [24].

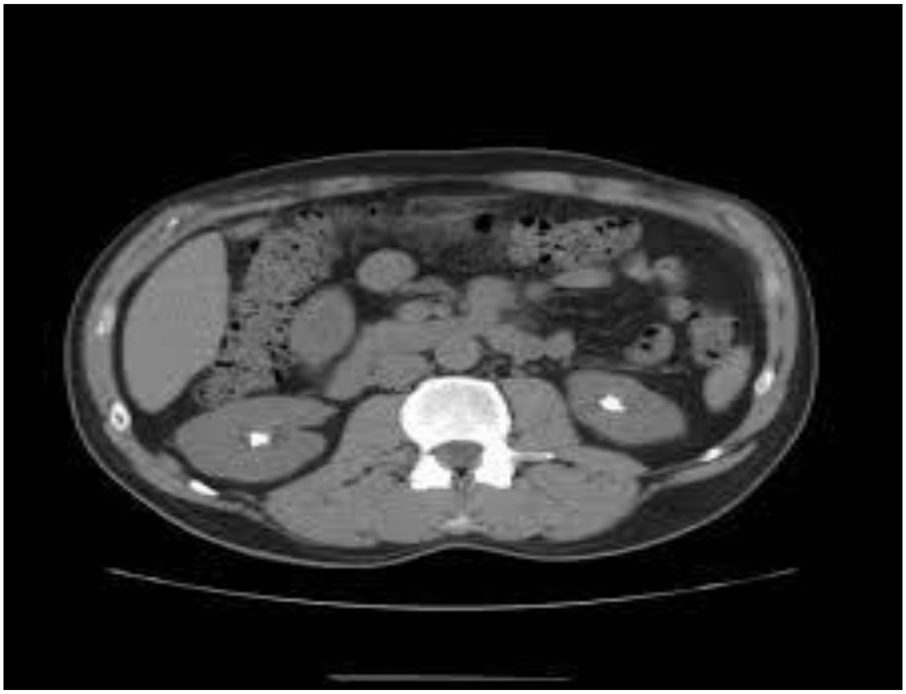

Figure (5-3) showed bilateral kidneys stones in axial plane [24].

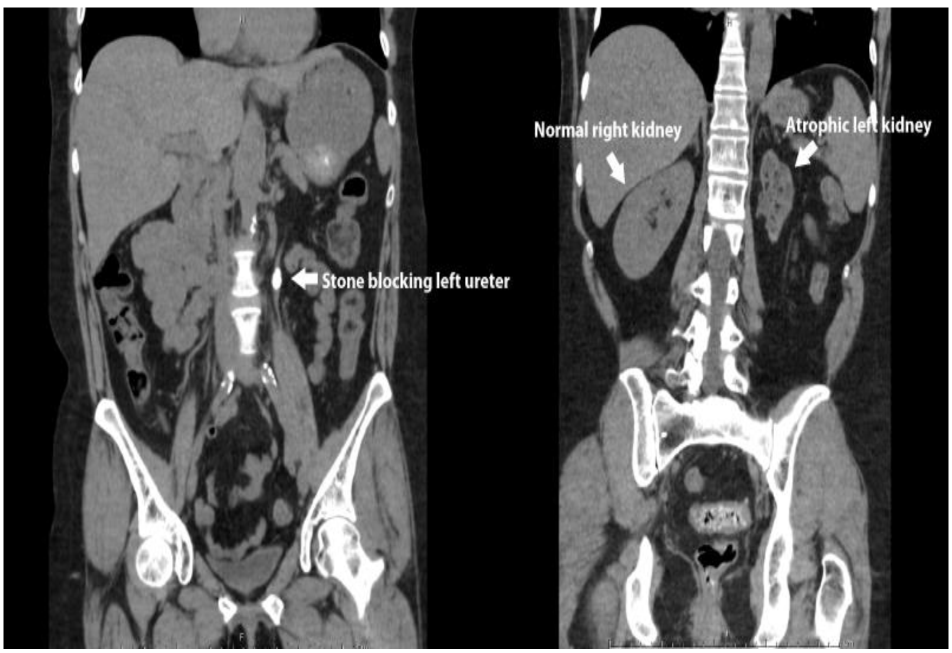

Figure (4-5) showed LT ureteric stone in coronal reconstruction plane [24].

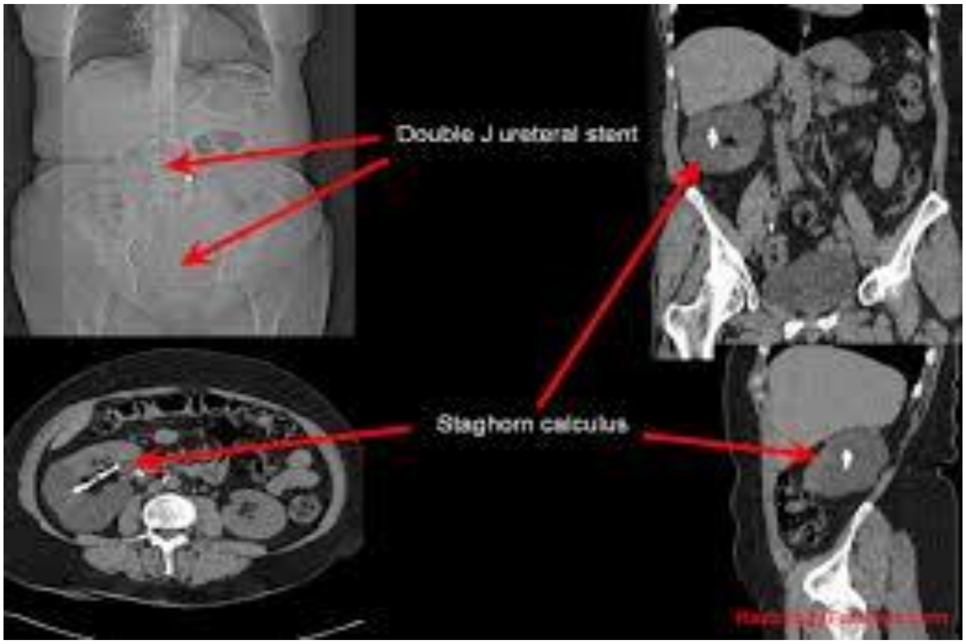

Figure (5-5) showed RT kidney stone in the scout , axial, coronal and sagital view [24].

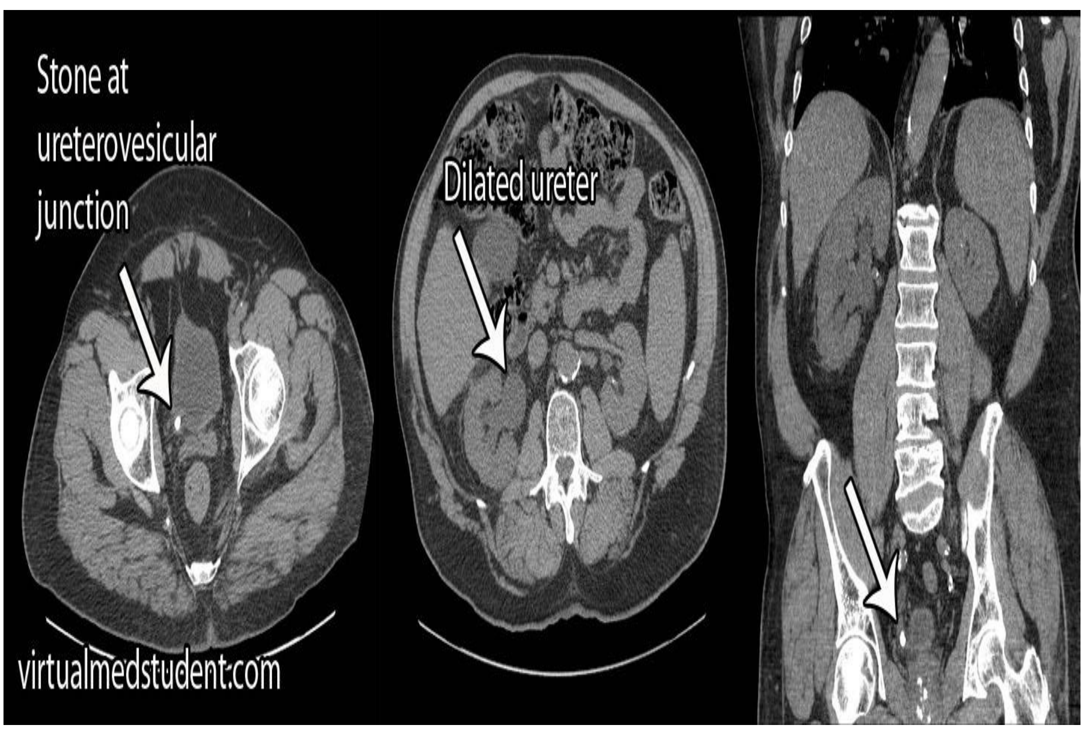

Figure (5-6) showed RT uretero-vesicular junction stone associated with hydroureter [24].