Introduction

1.1 Introduction:

Renal calculus remains to be a common presentation in the hospital. It is the third most common urological problem after urinary tract infection and prostate disease with life time prevalence of nephrolithiasis at 10-15%. The prevalence has risen over a 20-year period from the mid 1970's to the mid 1990's. The diagnosis of nephrolithiasis is largely dependent on analyzing the clinical presentation and physical examination. Suspicion is confirmed with radiologic tests, particularly the non-contrast enhanced computed tomography (CT) scan. The advent of non-enhanced CT has not only provided detection and confirmation of calculi, but also accurate detection of its size and location. Non-contrast helical CT scan provides several advantages over the KUB radiograph such as detection of radiolucent calculi, sensitivity for small stones, identification of other causes of flank pain as well as avoidance of any preparation prior to the procedure. Non-contrast helical CT scan has long replaced the plain abdominal radiograph as the gold standard in the diagnosis of nephrolithiasis. However, a KUB radiograph has remained part of the protocol for most clinicians even after a non-contrast helical CT scan is carried out because of its impact in clinical decision making prior to treatment. Due to the higher radiation dose with CT, conventional or digital radiography is being used to monitor the passage of stones if radiographic follow-up is believed to be indicated. (David Sutton 1987)

1.2 Problem of the study:

The efficiency of CT in diagnostic of renal stone in compare with conventional CT is poor to increase this efficiency by use spiral CT and ultrasound don't give accurate diagnosis, or may lead to misdiagnosis when patient underwent conventional X-Ray for the kidneys, ureters and bladder due to various types of stone and its appearance. Therefore, an introduction of CT 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 of the urinary tract stones using spiral-computed tomography.

1.3.2 The specific objective

- To evaluate of the urinary tract stones using spiral computed tomography.
- To evaluate the number, location and shape of stones.
- To evaluate the size and density of stones.
- To evaluate the patients, complain before the exam.

1.4 Overview of the study:

This study was consisting of five chapters, chapter one was an introduction introduce briefly this thesis and contained (general introduction about the renal stone, problem of study also contains 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 future scope in addition to references and appendices.

Literature Review and Pervious Studies

2.1 Anatomy:

The kidneys are retroperitoneal bean-shaped organs that lie in the paravertebral gutters against the posterior abdominal wall. They lie at an oblique orientation, with the upper poles more medial and posterior than the lower poles. They are located on each side of the spine between T12 and L4 and are embedded in perirenal fat; the right kidney is usually slightly lower due to displacement by the liver. Each kidney is composed of an outer cortex and an inner medulla. The renal cortex comprises the outer one third of the renal tissue and has extensions between the renal pyramids of the medulla. The cortex contains the functional subunit of the kidney, the nephron, which consists of the glomerulus and convoluted tubules and is responsible for filtration of urine. (Lorrie, 2007).

The renal medulla consists of segments called renal pyramids that radiate from the renal sinus to the outer surface of the kidney. The striated-appearing pyramids contain the loops of Henle and collecting tubules and function as the beginning of the collecting system. Arising from the apices of the pyramids are the cup-shaped minor calyces. Each kidney has 7 to 14 minor calyces that merge into 2 or 3 major calyces. The major calyces join to form the renal pelvis, which is the largest dilated portion of the collecting system and is continuous with the ureters. The fat-filled cavity surrounding the renal pelvis is called the renal sinus. Surrounding the kidneys and perirenal fat is another protective layer called the renal fascia (Gerota's fascia). The renal fascia functions to anchor the kidneys to surrounding structures in an attempt to prevent bumps and jolts to the body from injuring the kidneys. In addition, the renal fascia acts as a barrier, limiting the spread of infection that may arise from the kidneys. The medial indentation in the kidney is called the hilum; it allows the renal artery and vein and ureters to enter and exit the kidney *(*Lorrie, 2007).

The kidneys can be divided into five segments according to their vascular supply: apical, anterosuperior (upper anterior), anteroinferior (middle inferior), inferior, and posterior the segmental classification helps with surgical planning for partial nephrectomies (Lorrie, 2007).

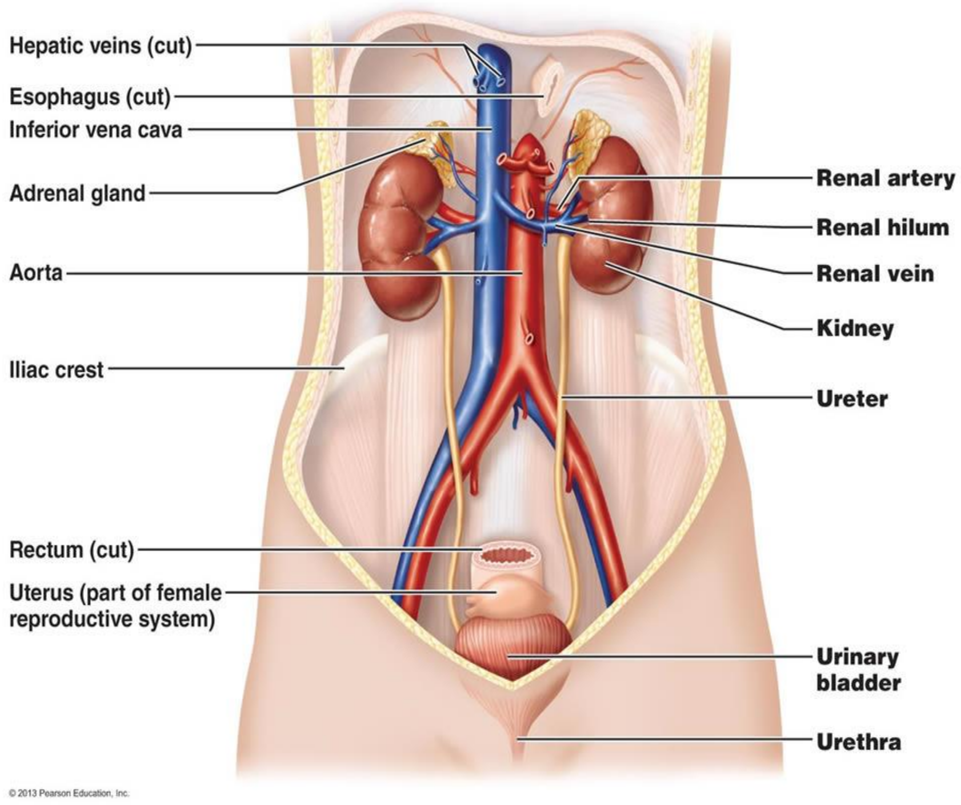
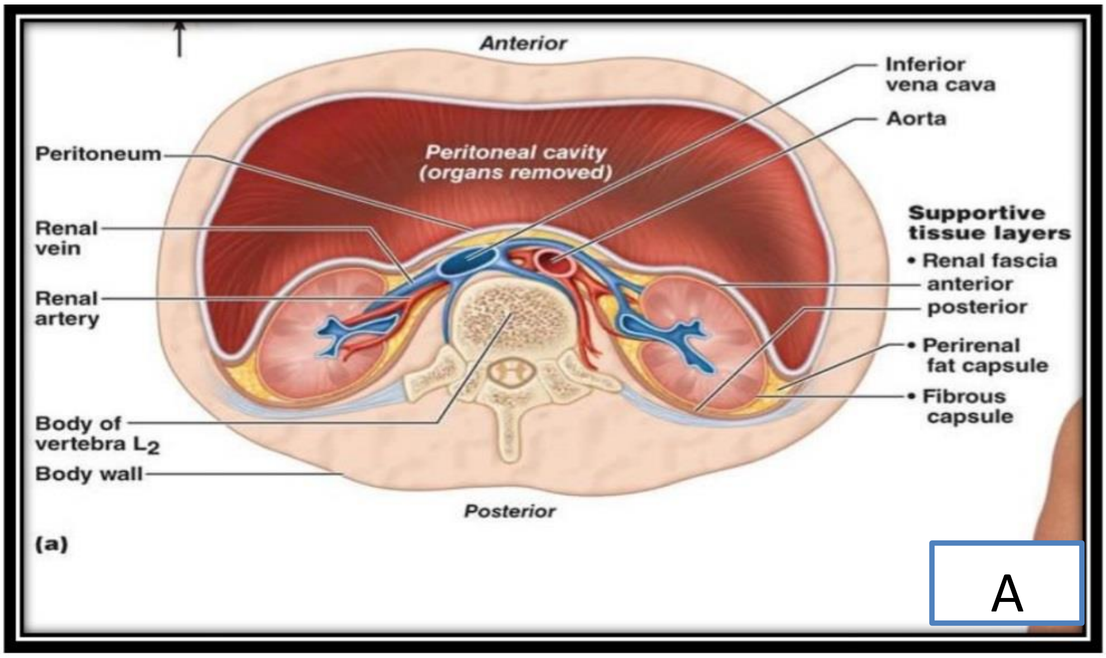


Figure 2.1 Coronal view shows Location and External Anatomy of kidneys. (classes.midlandstech.edu 2010).



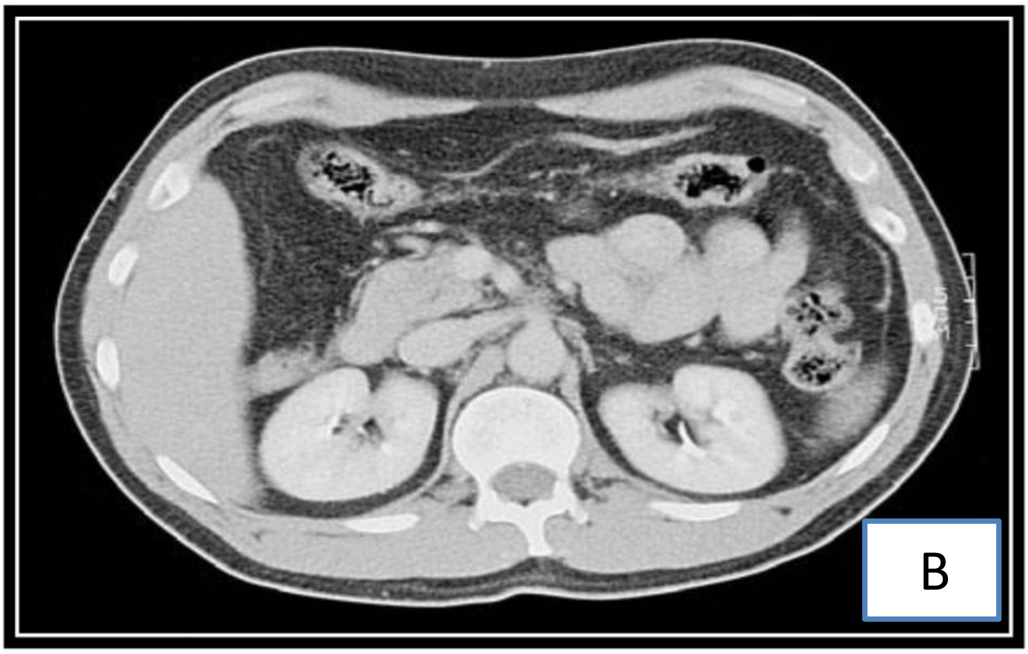
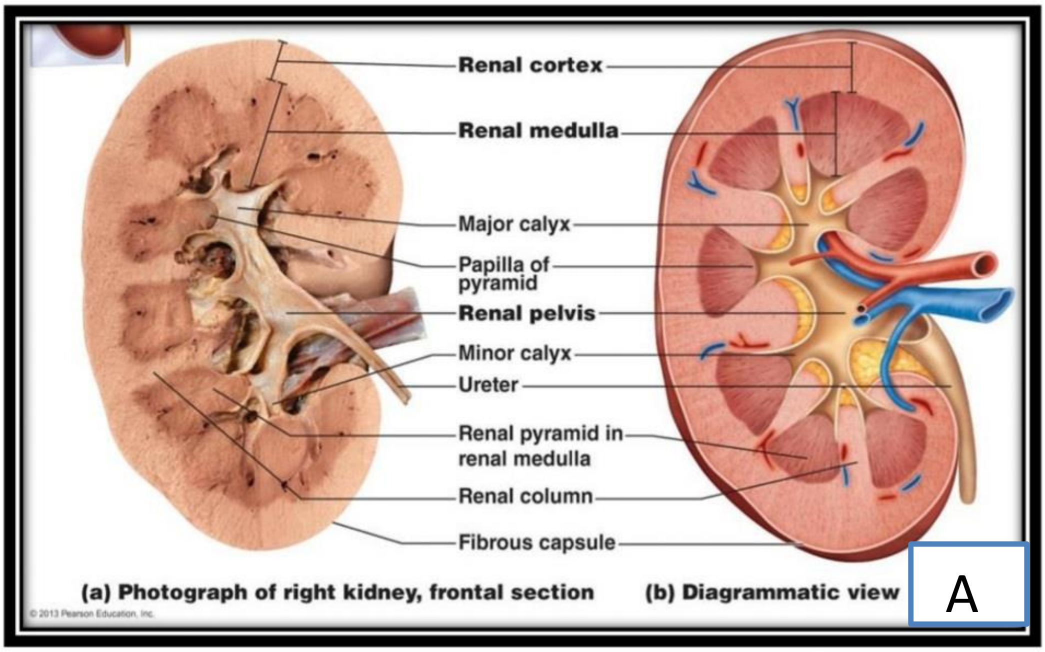


Figure: 2.2: A and B axial view show Location and External Anatomy of kidneys. (classes.midlandstech.edu,2010)



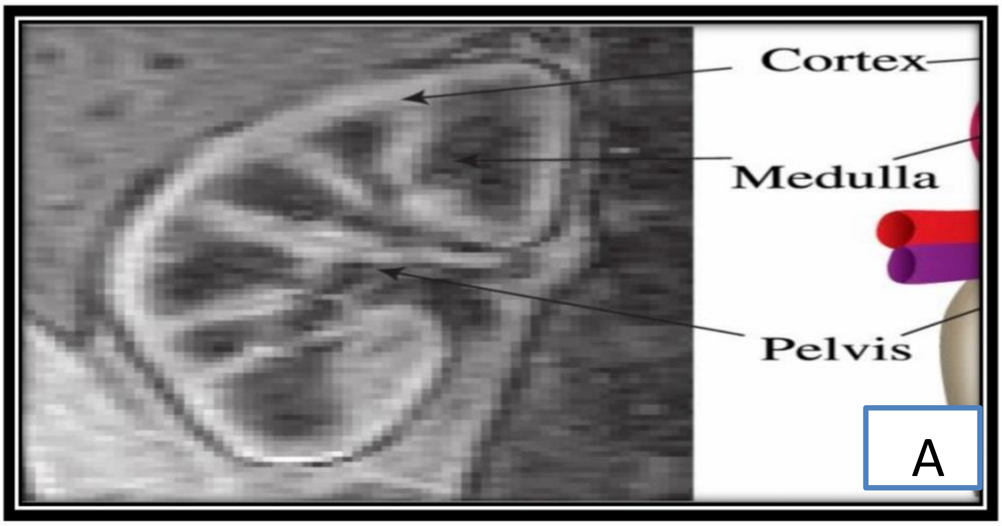


Figure 2-3: A and B show coronal image of internal anatomy of kidney. (classes.midlandstech.edu, 2010).

2.1.1 Relations of the right kidney:

Superiorly and anteriorly: the right suprarenal gland and the liver.

Anteriorly: The second part of the duodenum and the right colic flexure.

Posterior: the diaphragm, cost diaphragmatic recess of the pleura, the 12th rib and muscles of the posterior abdominal wall (Butler et al. 2007).

2.1.2 Relations of the left kidney:

Anteriorly: The left suprarenal gland, the spleen, the stomach, the Pancreas, the left colic flexure, and loops of jejunum. Posteriorly: as for the right kidney (Butler et al.2007).

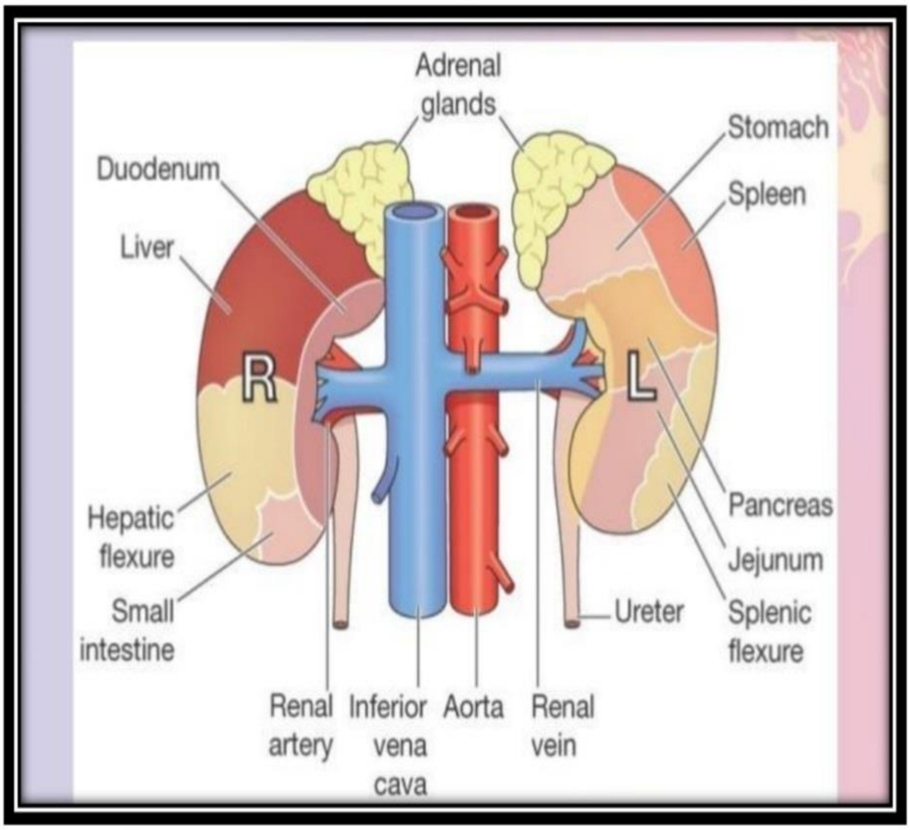


Figure: 2.4 Show anterior view Relations of the kidneys.

(www.studyblue.com, 2011).

2.1.3 Blood supply of the kidneys:

Renal arteries, veins and lymphatic drainage: The right and left renal arteries arise from the abdominal aorta, at approximately the level of the superior margin of L2, immediately caudal to the origin of the superior mesenteric artery, there is usually a single artery supplying each kidney, although there are many anatomical variants, with up to four renal arteries supplying each kidney. The renal artery divides in the renal hilum into three branches. Two branches run anteriorly, supplying the anterior upper pole and entire lower pole, and one runs posterior supplying the posterior upper pole and mid pole. Five or six veins arise within the kidney and join to form the renal vein, which runs anterior to the artery within the renal pelvis . The right renal vein has a short course, running directly into the IVC. The left renal vein runs anterior to the abdominal aorta and then drains into the IVC. Occasionally, the left renal vein runs posterior to the aorta, known as a retro-aortic renal vein. The left renal vein receives tributaries from the left inferior phrenic vein, the left gonadal and the left adrenal vein (Butler et al. 2007). The lymphatic drainage of the kidneys follows the renal arteries to nodes situated at the origin of the renal arteries in the Para-aortic region (Butler et al. 2007).

2.1.4 Nerve supply:

The sympathetic nerves supplying the kidney arise in the renal sympathetic Plexus and run along the renal vessels. Afferent fibers, including pain fibers, travel with the sympathetic fibers through the splanchnic nerves and join the dorsal roots of the 11th and 12th thoracic and the 1st and 2nd lumbar levels (Butler et al. 2007).

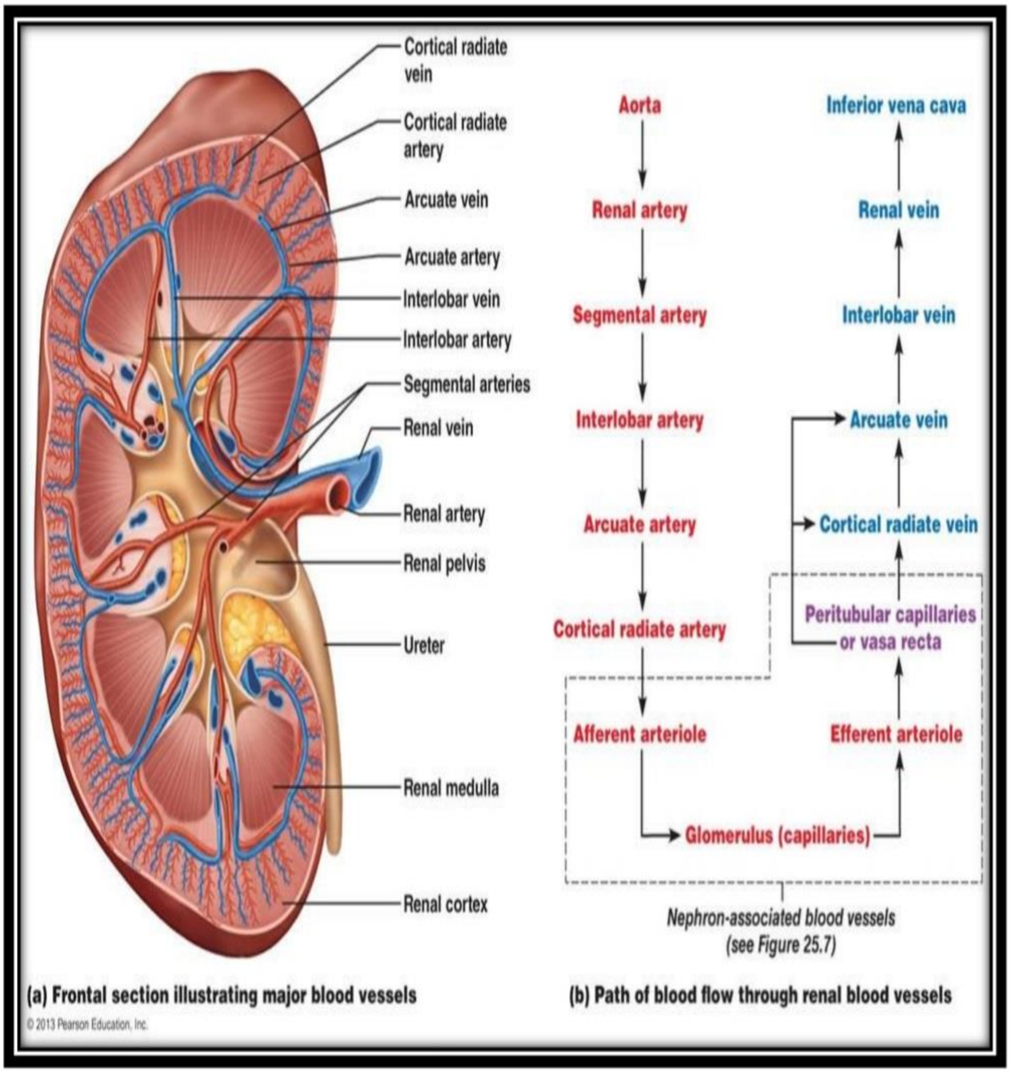


Figure: 2.5: Blood Supply of Kidney. (classes.midlandstech.edu).

2.2 Physiology:

The primary function of the kidneys is to maintain a stable internal environment (homeostasis) for optimal cell and tissue metabolism. They do this by separating urea, mineral salts, toxins, and other waste products from the blood. They also do the job of conserving water, salts, and electrolytes. At least one kidney must function properly for life to be maintained. (Wiki, 2016).

Important roles of the kidneys are: Regulation of plasma ionic composition. Ions such as sodium, potassium, calcium, magnesium, chloride, bicarbonate, and phosphates are regulated by the amount that the kidney excretes. Regulation of plasma osmolarity. The kidneys regulate osmolarity because they have direct control over how many ions and how much water a person excretes. Regulation of plasma volume. Your kidneys are so important they even have an effect on your blood pressure. The kidneys control plasma volume by controlling how much water a person excretes. The plasma volume has a direct effect on the total blood volume, which has a direct effect on your blood pressure. Salt (NaCl) will cause osmosis to happen; the diffusion of water into the blood Regulation of plasma hydrogen ion concentration (pH). The kidneys partner up with the lungs and they together control the ph. The kidneys have a major role because they control the amount of bicarbonate excreted or held onto. The kidneys help maintain the blood Ph mainly by excreting hydrogen ions and reabsorbing bicarbonate ions as needed Removal of metabolic waste products and foreign substances from the plasma. One of the most important things the kidneys excrete is nitrogenous waste. As the liver breaks down amino acids it also releases ammonia. The liver then quickly combines that ammonia with carbon dioxide, creating urea which is the primary nitrogenous end product of metabolism in humans. The liver turns the ammonia into urea because it is much less toxic. We can also excrete some ammonia, creatinine and uric acid. The creatinine comes from the metabolic breakdown of creatine phosphate (a high-energy phosphate in muscles). Uric acid comes from the breakdown of nucleotides. Uric acid is insoluble and too much uric acid in the blood will build up and form crystals that can collect in the joints and cause gout. Secretion of Hormones The endocrine system has assistance from the kidney's when releasing hormones. Renin is released by the kidneys. Renin leads to the secretion of aldosterone which is released from the adrenal cortex. Aldosterone promotes the kidneys to reabsorb the sodium (Na^+) ions. The kidneys also secrete erythropoietin when the blood doesn't have the capacity to carry oxygen. Erythropoietin stimulates red blood cell production. The Vitamin D from the skin is also activated with help from the kidneys. Calcium (Ca^+) absorption from the digestive tract is promoted by vitamin D. (wiki/Human_Physiology2016)

2.3 Pathology:

2.3.1 Kidney stones:

Kidney stone (renal calculus or nephrolith) is formed by combination of a high level of calcium with oxalate, phosphate, urea, uric acid, and cystine. Crystals and subsequently stones are formed in the urine and collected in calyces of the kidney or in the ureter the kidney stone varies in size from a grain of sand to the size of a golf ball and produces severe colicky pain while traveling down through the ureter from the kidney to the bladder. Common signs of kidney stones include nausea and vomiting, urinary frequency and urgency, and pain during urination (Chung et al.2012).

2.3.2 Polycystic kidney disease:

Is a genetic disorder characterized by numerous cysts filled with fluid in the kidney; the cysts can slowly replace much of normal kidney tissues, reducing kidney function and leading to kidney failure. It is caused by a failure of the collecting tubules to join a calyx, which causes dilations of the loops of Henle, resulting in progressive renal dysfunction. This kidney disease has symptoms of high blood pressure, pain in the back and side, headaches, and blood in the urine. It may be treated by hemodialysis or peritoneal dialysis and kidney transplantation (Chung et al. 2012).

2.3.3 Hydronephrosis:

Is a fluid-filled enlargement of the renal pelvis and calyces as a result of obstruction of the ureter. It is due to an obstruction of urine flow by kidney stones in the ureter, by compression on the ureter by abnormal blood vessels, or by the developing fetus at the pelvic brim. It has symptoms of nausea and vomiting, urinary tract infection, fever, dysuria (painful or difficult urination), urinary frequency, and urinary urgency (Chung et al. 2012).

2.3.4 Pelvic kidney:

Is an ectopic kidney that occurs when kidneys fail to ascend and thus remain in the pelvis. Two pelvic kidneys may fuse to form a solid lobed organ because of fusion of the renal anlagen, called a cake (rosette) kidney (Chung et al. 2012).

2.3.5 Horseshoe kidney develops:

As a result of fusion of the lower poles of two kidneys and may obstruct the urinary tract by its impingement on the ureters (Chung et al. 2012).

2.4 CT scanners:

Are complex, with many different components involved in the process of creating an image. Adding to the complexity, different CT manufacturers often modify the design of various components. From a broad perspective, all makes and models of CT scanners are similar in that they consist of a scanning gantry, x-ray generator, computer system, operator's console, and physician's viewing console. Although hard-copy filming has largely been replaced by workstation viewing and electronic archiving, most CT systems still include a laser printer for transferring CT images to film (Lois, 2011).

The three major components of a CT imaging system are the operating console, the computer, and the gantry. Each of these major components has several subsystems. Computed tomography imaging systems can be equipped with two or three consoles. One console is used by the CT radiologic technologist to operate the imaging system. Another console may be available for a technologist to post process images to annotate patient data on the image (e.g., hospital identification, name, patient number, age, gender) and to provide identification for each image (e.g., number, technique, couch position),This second monitor also allows the operator to view the resulting image before transferring it to the physician's viewing console. A third console may be available for the physician to view the images and manipulate image contrast, size, and general visual appearance. This is in addition to several remote imaging stations (Lois, 2011).

The computer is a unique subsystem of the CT imaging system. Depending on the image format, as many as 250,000 equations must be solved simultaneously; thus, a large computing capacity is required. Many CT imaging systems use an array processor instead of a microprocessor for image reconstruction. The array processor does many calculations simultaneously and hence is significantly faster than the microprocessor (Lois, 2011).

The gantry includes the x-ray tube, the detector array, the high-voltage generator, the patient support couch, and the mechanical support for each. These subsystems receive electronic commands from the operating console and transmit data to the computer for image production and post processing tasks (Lois, 2011).

X-ray tubes produce the x-ray photons that create the CT image. Their design is a modification of a standard rotating anode tube, such as the type used in angiography. Tungsten, with an atomic number of 74, is often used for the anode target material because it produces a higher-intensity x-ray beam. CT tubes often contain more than one size of focal spot; 0.5 and 1.0 mm are common sizes. Early CT scanners used recoiling system cables to rotate the gantry frame. Current systems use electromechanical devices called slip rings. Slip rings use a brush like. Apparatus to provide continuous electrical power and electronic communication across a rotating surface. They permit the gantry frame to rotate continuously, eliminating the need to straighten twisted system cables. (Lois, 2011).

As the x-ray beam passes through the patient it is attenuated to some degree. To create an x-ray image we must collect information regarding the degree to which each anatomic structure attenuated the beam. In CT, detectors used to collect the information. The detector array comprises detector elements situated in an arc or a ring, each of which measures the intensity of transmitted x-ray radiation along a beam projected from the x-ray source to that particular detector element. Detectors can be made from different substances, each with their own advantages and disadvantages (Lois, 2011).

All new scanners possess detectors of the solid-state crystal variety. Detectors made from xenon gas have been manufactured but have largely become obsolete as their design prevents them from use in MDCT systems (Lois, 2011).

High-frequency generators are currently used in CT. They are small enough so that they can be located within the gantry. Generators produce high voltage and transmit it to the x-ray tube. CT generators produce high kV (generally 120–140 kV) to increase the intensity of the beam, which will increase the penetrating ability of the x-ray beam and thereby reduce patient dose. In addition, a higher kV setting will help to reduce the heat load on the x-ray tube by allowing a lower MA setting. Reducing the heat load on the x-ray tube will extend the life of the tube (Lois, 2011).

The patient lies on the table (or couch, as it is referred to by some Manufacturers and is moved within the gantry for scanning. The process of moving the table by a specified measure is most commonly called incrimination, but is also referred to as feed, step, or index. Helical CT table incrimination is quantified in millimeters per second because the table continues to move throughout the scan. The degree to which a table can move horizontally is called the scan able range, and will determine the extent a patient can be scanned without repositioning. The specifications of tables vary, but all have certain weight restrictions (Lois, 2011).

On most scanners, it is possible to place the patient either head first or feet first, supine or prone. Patient position within the gantry depends on the examination being performed (Lois, 2011).

2.5 Previous studies:

Study done by (**Kluner et.al 2006**), 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.

Study done by (**Sommer et.al 1995**), aimed to determine the value of reformatted noncontrast 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.

Another study done by (**Eray et.al 2001**), aimed to the diagnostic 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.

Another study done by **(Osman et al 2011)** aimed to using computerized tomography The main finding of study are found that, 72% of urinary tract stones are found in male, while 28% in female patient, and most of stones are present in the kidneys in both male and female (56%), follows by lower ureter stone (24%), then upper ureteric stones (16%), and urinary bladder stones (4%). the main type of stones is whewellite (calcium oxalate monohydrate) (36%). From this study can conclude that, male have more potential to get urinary tract stones than female, also most of the stones are small in size, and CT KUB used as tool to determine the types of stone.

Another study done by **(Ahmed, et al 2013)** aimed to study relationship between the stone lengths, width, area, CT number with age. CT number can characterize the stone type and CT-KUB has accuracy 100%, the sensitivity 100%, and the specificity equal zero. There is significant correlation between age of the patient and stone size (correlation significant 0.934) as well as between the size and stone density (correlation significant 0.920). CT-KUB has great value in detection of calculus as it is accurate without magnification.

Another study done by **(Alhassan et al 2016)** aimed to evolution of renal stones using computerized tomography, the study showed that 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 to cause hydronephrosis. Furthermore, the most common site of ureteric stones was middle ureter 71.4%. Also 29.2 of stones are presented with obstructive changes and the upper ureter showed the most common sit for stones that cause 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.

Another study done by (**Poletti et.al 2007**), aimed to compared 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, pyeloureteral dilatation, periureteral 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).

Material and methods

3.1. CT system

CT machine used for collecting KUB CT images was: GE optima 16 slice 120-140 KVP, 350 MAS in AL-Zaytouna specialist Hospital.

3.2 Sample size

Sudanese patients (72 male – 28 female), patient age range between (1 - 80 100 years), underwent computed tomography examination of CT KUB study include any patient attends to CT department for CT KUB with evaluation of disease processes and excluded patients with congenital abnormality associated with the renal system.

3.3 Duration and area of study

This study conducted in Al-Zaytouna hospital in period from October 2019 to December 2019.

3.4 Variables of the study

Age, gender, site of stones, number of stones, shape of stones, size of stones, CT number of stones, patient complain and final diagnosis.

3.5 Methods of scanning

CT KUB: No Preparation of patients, the positioning is supine and scout AP. First write full ID patient then lying patient supine on C T couch feet first and his hands above head move the cutch up until to center of axially line and then to enter cutch centered from the top of the kidneys usually at above the level TI 12 to the symphysis pubis, then scout view or plain next axial cut (2 to 5) mm with interval 5mm perform or less. The reconstructions of C T K.U.B with I-mm to 3-mm increments through a limited region with interval at less 0.1 mm. There was in different phase Axial, Sagittal, Coronal and Oblique to visualize the kidneys anatomical structures and pathology e.g. stone.

3.6 Image interpretation:

All cases in the study requested for CT KUB, the renal calculi detection by CT Technician then confirmed and diagnosed by Radiologist.

3.7 Data collection:

Data collected using data collecting sheet.

3.8 Data analysis:

Data analyzed by EXCEL.

3.9 Ethical approval:

The study granted an ethical approval from the hospital and radiology department. The collected data used for scientific research only, no patient data were published also the data was kept in personal computer with personal password.

Results

Table (4.1): shows gender distribution:

Gender	Frequency	Percent
Male	72	72.0
Female	28	28.0
Total	100	100.0

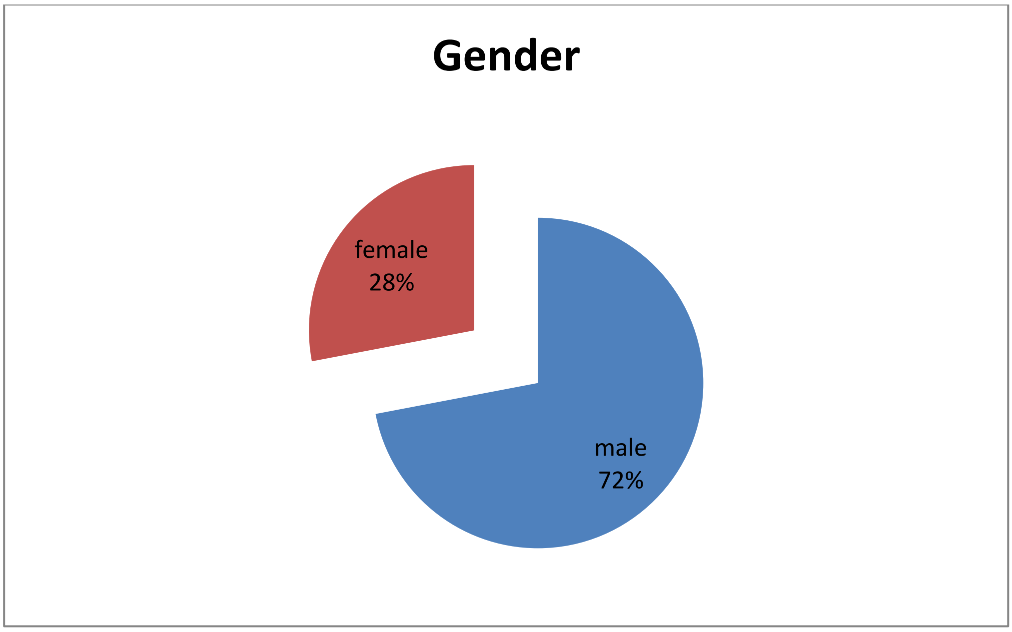


Figure (4.1): shows the gender distribution

Table (4.2): Shows ages distribution:

Age by years	Frequency	Percent
1-20	13	13.0
21-40	28	28.0
41-60	36	36.0
61-80	23	23.0
Total	100	100.0

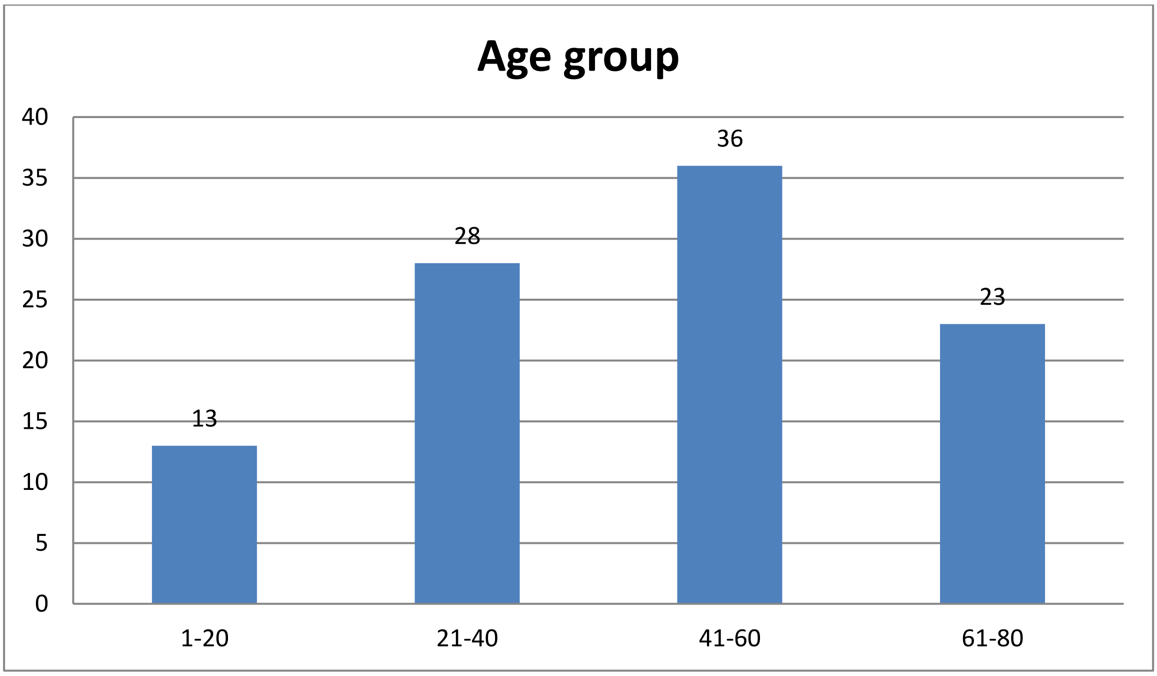


Figure (4.2): shows the age distribution

Table (4.3): shows division of stones according to number

Number	Frequency	Percent
One Stone	66	66.0
Multiple Stone	34	34.0
Total	100	100.0

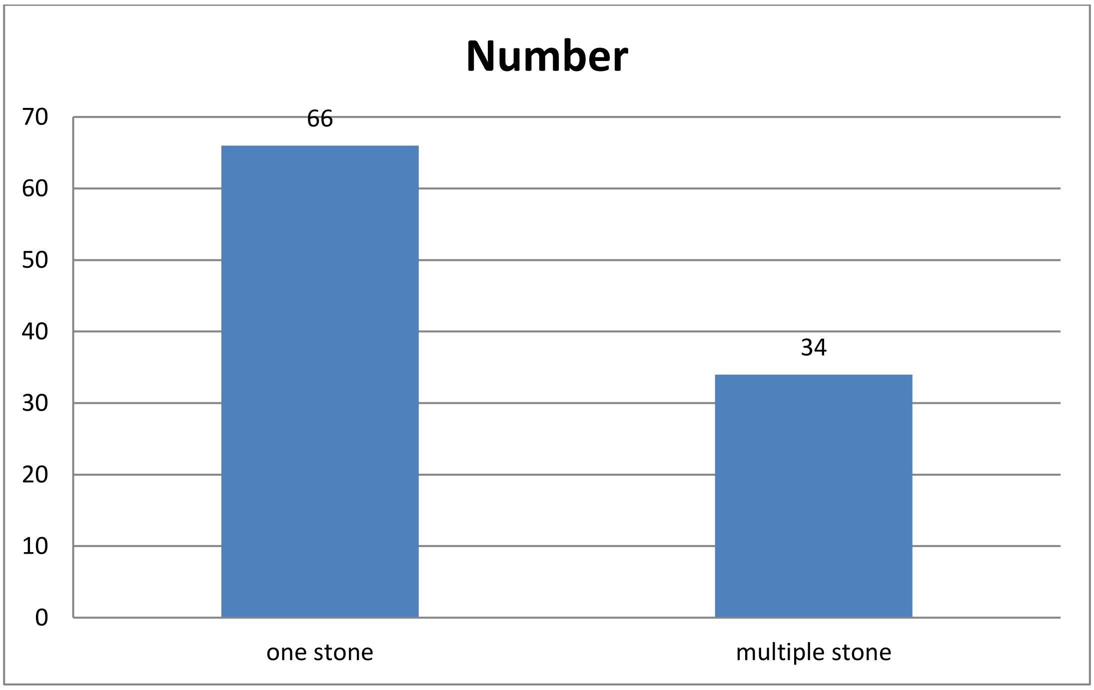


Figure (4.3): shows the number of stones

Table (4.4): shows outlines of stones

Shape	Frequency	Percent
Regular	93	93.0
Irregular	7	7.0
Total	100	100.0

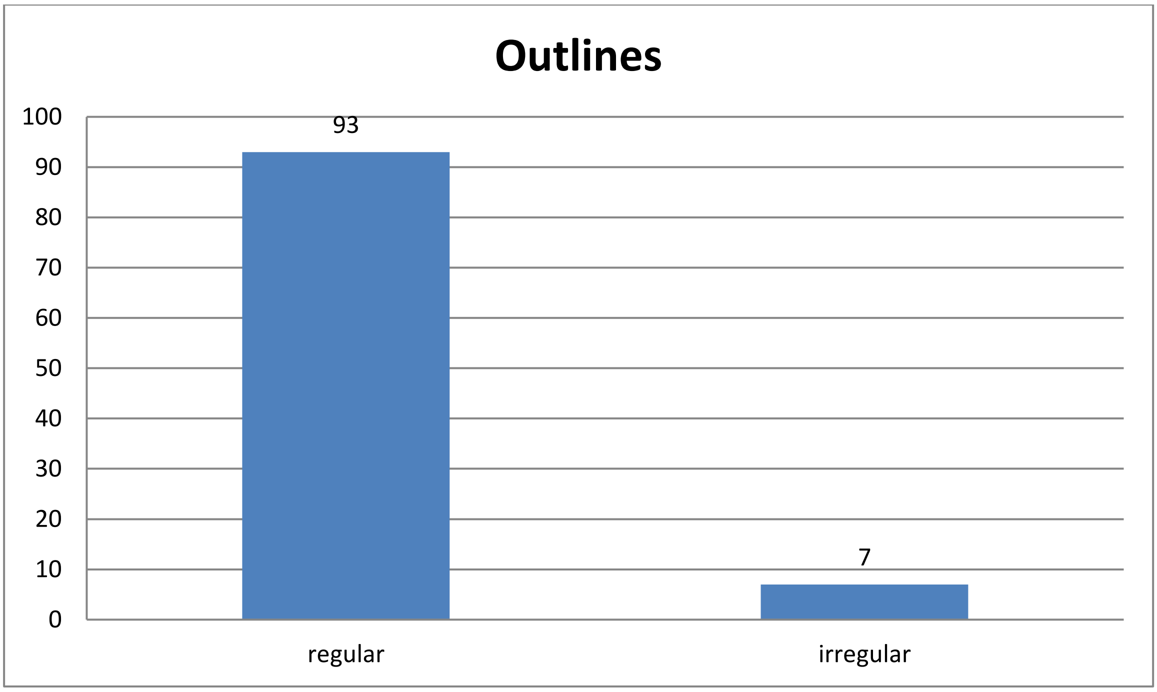


Figure (4.4): shows the outlines of stones

Table (4.5): shows location of stones when they are on right site:

RT site	Frequency	Percent
Upper	7	14
Middle	18	28
Lower	26	44
Renal pelvic	7	14
Total	**58**	**100**

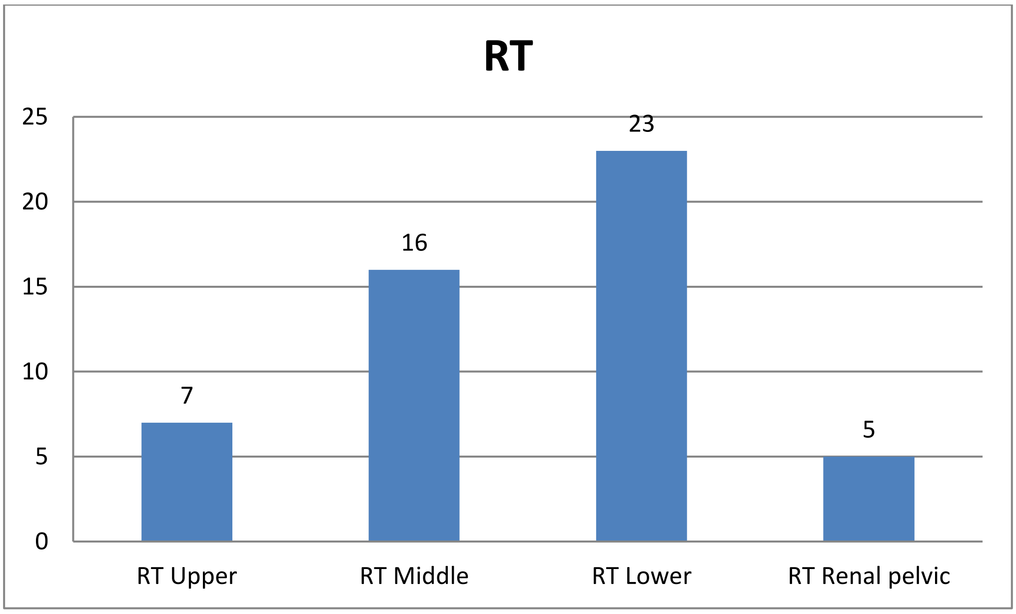


Figure (4.5): shows location of stones when they are on right site.

Table (4.6): shows location of stones when they are on left site

LT site	**Frequency**	**Percent**
Upper	1	3
Middle	9	29
Lower	15	48
Renal pelvic	6	19
Total	**31**	**100**

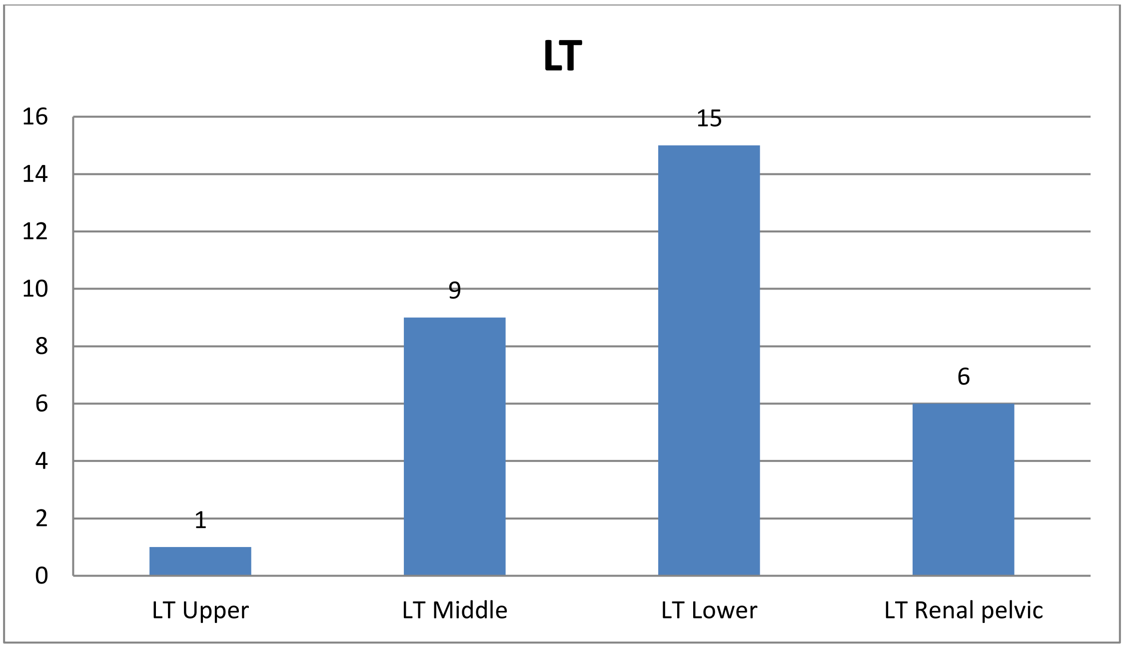


Figure (4.6): shows location of stones when they are on left site.

Table (4.7): shows location of stones when they are on both sites.

Both site	**Frequency**	**percent**
Upper	2	18
Middle	5	45
Lower	2	18
RT=lower LT=mid	1	9
RT=mid LT=upper	1	9
Total	**11**	**100**

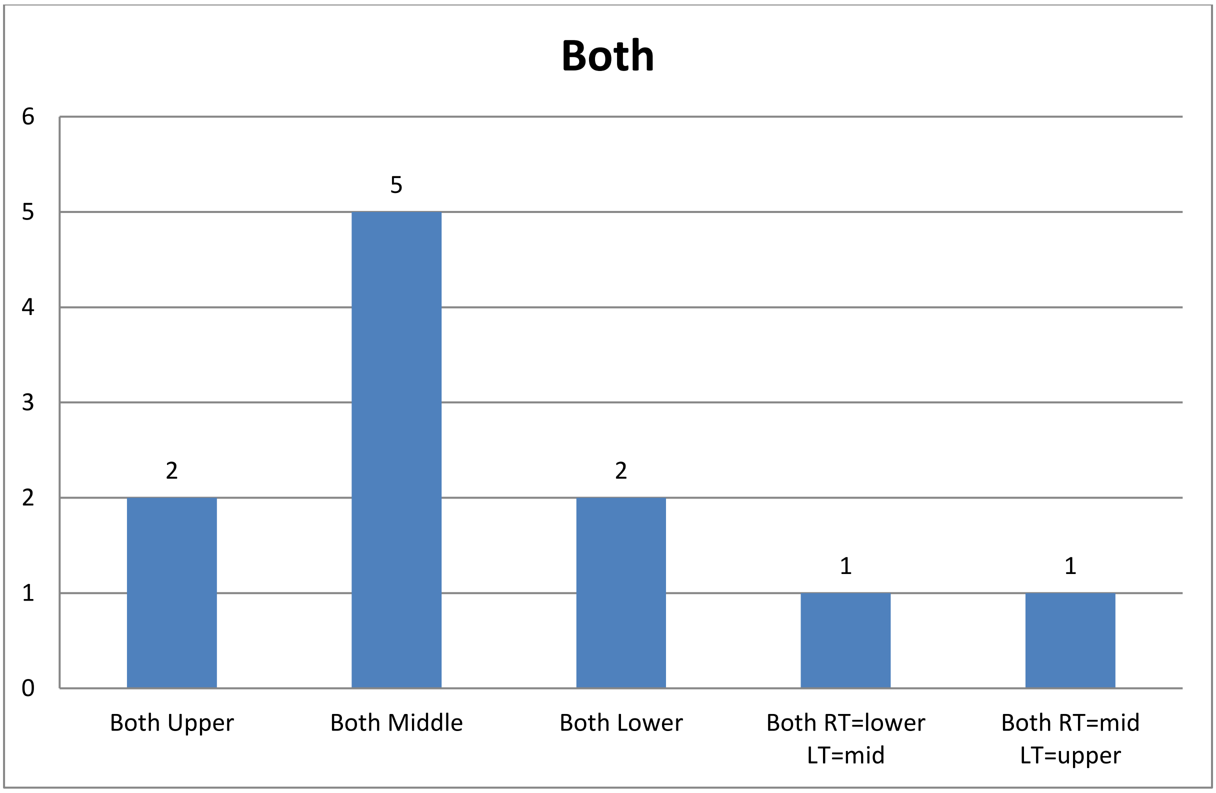


Figure (4.7): shows location of stones when they are on both sites

Table (4.8): shows density of stones according to their CT number

CT number (HU unit)	Frequency	Percent
100-400	31	31.0
401-700	22	22.0
701-1000	16	16.0
1001-1300	22	22.0
1301-1600	8	8.0
1601-1900	1	1.0
Total	100	100.0

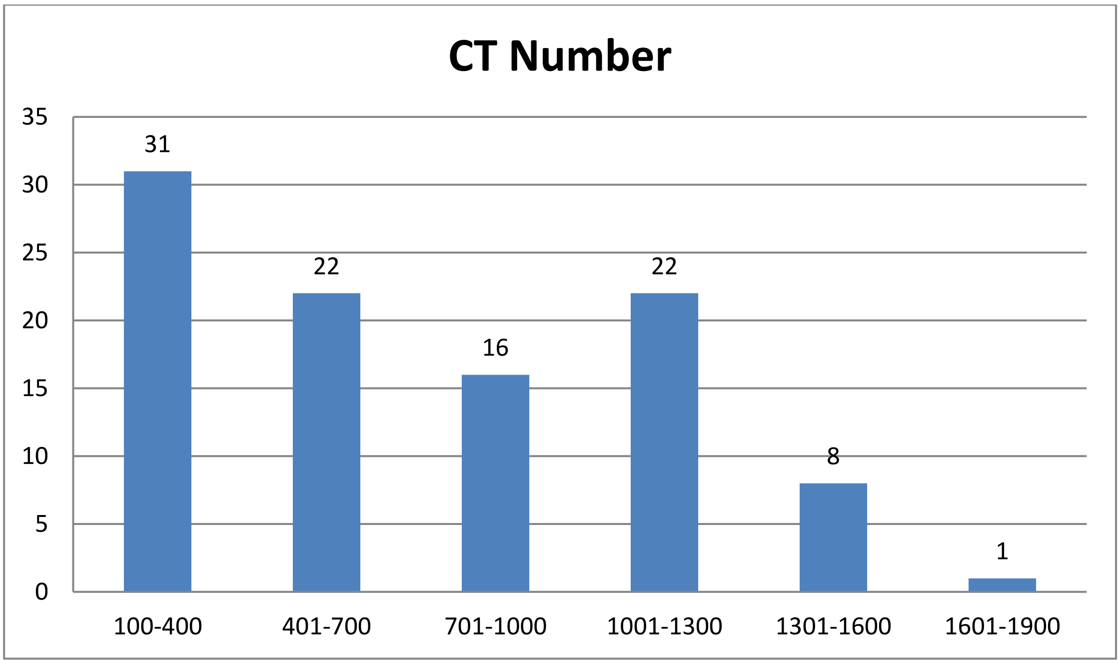


Figure (4.8): shows density of stones according to their CT number

Table (4.10): shows minimum, maximum, mean and standard deviation of stones density according to their CT number

	N	Minimum	Maximum	Mean	Std. Deviation
CT Number (HU unit)	100	109	1657	714.09	409.908

Table (4.11): shows size of stones

Size (mm)	Frequency	Percent
1-200	98	98.0
201-400	1	1.0
401-600	0	0.0
601-800	0	0.0
801-1000	0	0.0
1001-120	1	1.0
Total	100	100.0

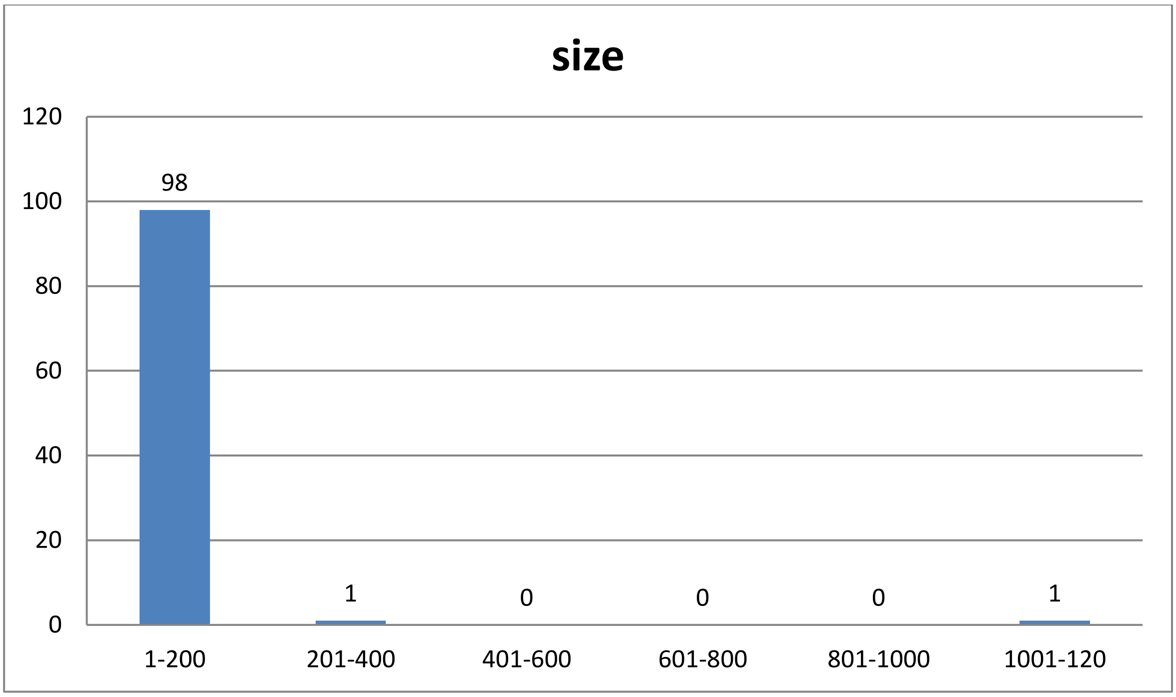


Figure (4.9); shows size of stones

Table (4.11): shows minimum, maximum, mean and standard deviation of stones size

Size (mm)	N	Minimum	Maximum	Mean	Std. Deviation
	100	.16	1021.20	27.9848	106.63972

Table (4.12): shows patients complain when came to do CT KUB

Patient complain	Frequency	Percent
Pain	91	91.0
Oliguria	7	7.0
Pain + oliguria	2	2.0
Total	100	100.0

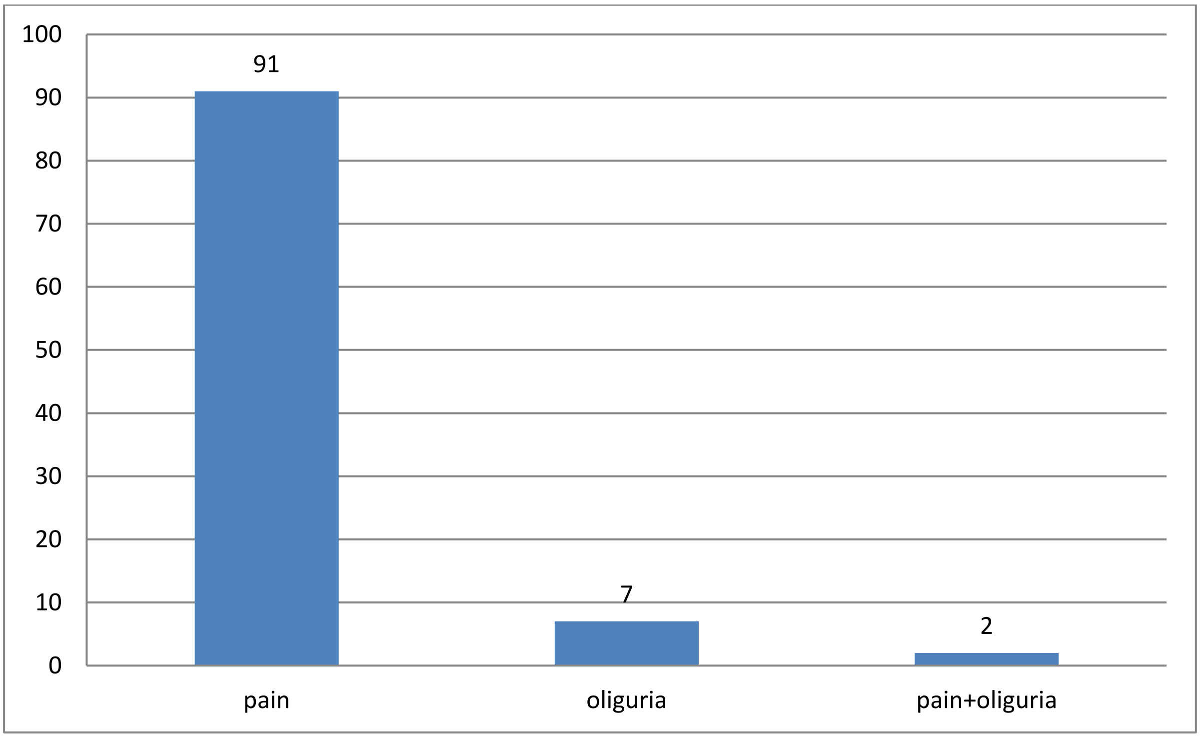


Figure (4.12): shows patients complain when came to do CT KUB

Discussion, Conclusion and Recommendations

5.1 Discussion:

The aim of this study was to evaluate the role of spiral computed tomography in the diagnosis of urinary tract stones in order to assess its size, site, number, shape and density. 100 patients with flank pain were investigated in Al-Zaytouna hospital in period from October 2019 to November 2019.

The patient gender was investigated and the study revealed that the most affected gender was male with frequency of (72%), and female patients with (41%) table (4.1) figure (4.1). This result was in line with Poletti et.al 2007, which stated that the predominant gender was male as 87 patient men and 38 women have renal stone.

The study shows that the most affected age groups are those between (41-60) years but it also shows that the children are also capable of forming renal stones table (4.2) figure (4.2). This result in line with Alhassan et al 2016, which stated that the most affected age group, is (40-49) years.

The study shows that most patients have single stones rather than multiple stones (66%) (34%) respectively table (4.3) figure (4.3). and most of these stones are regular in shape rather than irregular in shape (93%) (7%) respectively table (4.4) figure (4.4).

The site of the stones were categorized into the right, left and bilateral; right kidney is affected more than the left kidney (58%) (31%) respectively with only (11%) on both sites table (4.5) (4.6) (4.7) figure (4.5) (4.6) (4.7). This result not agree with alhassan et al 2016, which stated that the number of stones in right side equal to those at the left side of the urinary tract.

The study shows that most of the stones density are in the range between (100-1300) HU about (91%) of cases with only (9%) above that, the minimum and maximum density of stone was detected has CT number of (107) (1657) HU respectively with the mean of (714.09) HU table (4.8) (4.9) figure (4.8).

The study also shows that most of the stones have size between (1-200) mm about (98%) of cases with only (2%) greater than this , the minimum and maximum size was detected is (0.16) (1021.20) mm respectively with the mean of (27.9848) mm table (4.10) (4.11) figure (4.9).

Most of patients complain were just loin pain, about (91%) of cases while about (9%) were suffering from other symptoms like oliguria or loin pain with oliguria table (4.12) figure (4.10).

Spiral MDCT KUB is a superior modality rather than the conventional modalities such as conventional KUB x-ray and ultrasound because it provides density data measurement for all tissue, this study also measures the amount of CT number for relative stones.

5.2 Conclusion:

Single-slice and multislice Spiral CT had 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 investigated the accuracy of CT KUB in detection and diagnosing of renal system stone. The general aims of this study were 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. 100 patients who complain of flank pain and have high risk to have renal stone, with different age and gender presented to Khartoum state hospital (Al-Zaytouna hospital) to perform CT-KUB examination, in period from October 2019 to November 2019. From this study, we found the CT KUB has the ability to detect stones of the urinary tract accurately. In addition, most of these stones appear in male (72%). Also, the most affected age group is (41-60) with the number of stones that present in right side more than those at the left side of the urinary tract. Majority of stones have density between (100-1300) HU unit, size between (1-200) mm and most of them have regular outlines.

5.3 Recommendation:

• Prevention of urinary tract stones may include a combination of lifestyle changes and medications.

• Lifestyle changes can be Drink water throughout the day, eat fewer oxalate-rich foods if the patient tends 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.

- CT Operators must optimize the patient dose to reduce patient cancer risks. Should be uses the best strategies available for reducing radiation dose to allow for mAs reduction in relation to the patient's size and weight. Such as weight with fixed tube current scanning.
- Continuous training is important for improving the techniques and protocols used in CT.
- Further studies should be carried out in this field on many aspects such as increasing the number of patients, to show the relation between signs and symptoms of stones and patient age and weight. Further studies should be carried out in this field on analysis of stone components. Further studies should be carried out in this field for comparing between the role of U/S scanning and other diagnostic tools e.g. IVU and CTU.

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Appendix (A)

Figures of CT KUB images showing the stone in different planes

Figure (A-1) 25 old years female CT image show RT staghorn stone and multiple LT kidney stones in coronal Plane

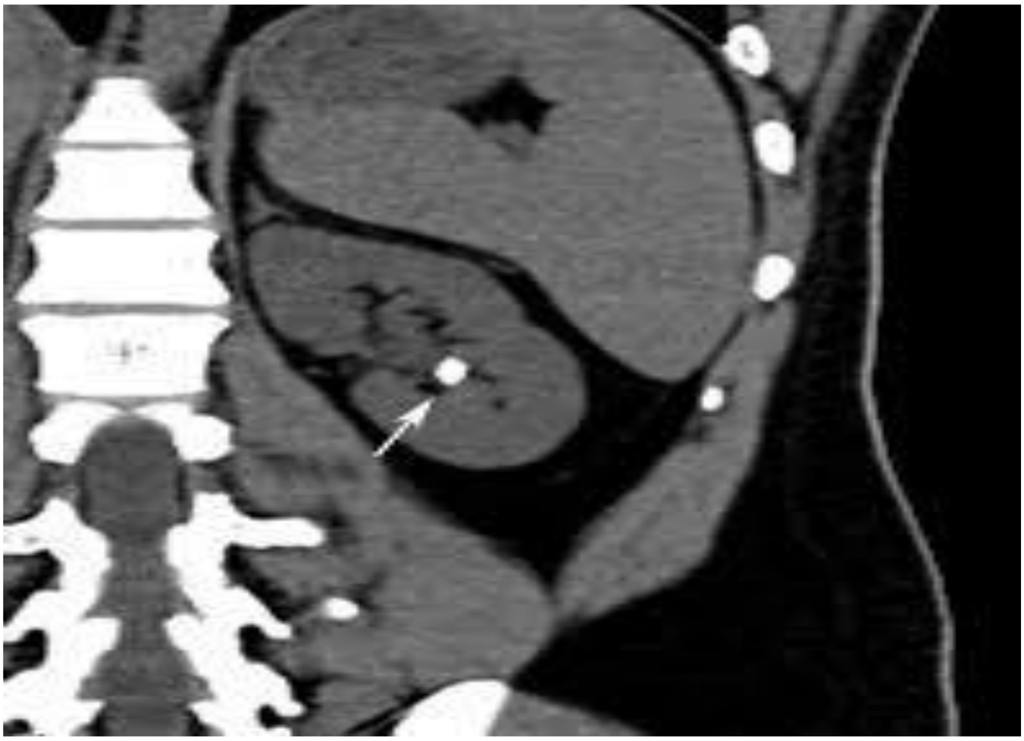

Figure (A-2) showed LT kidney stone in sagittal reconstruction plane

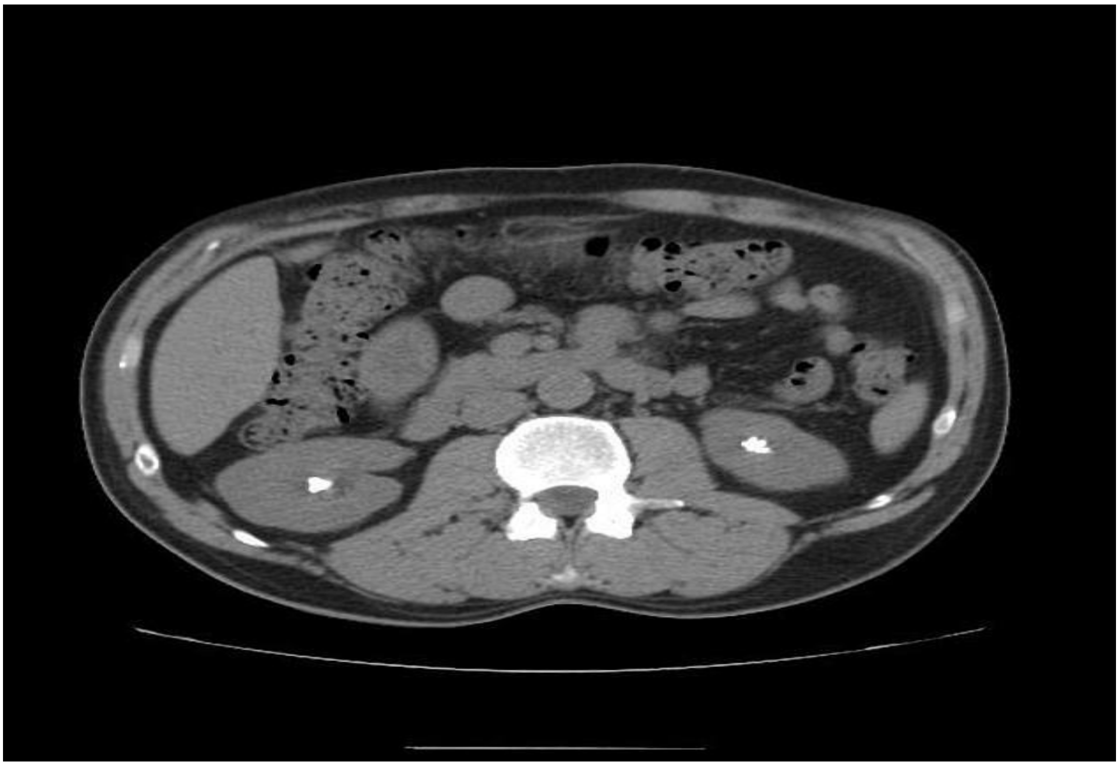

Figure (A-3) showed bilateral kidneys stones in axial plane

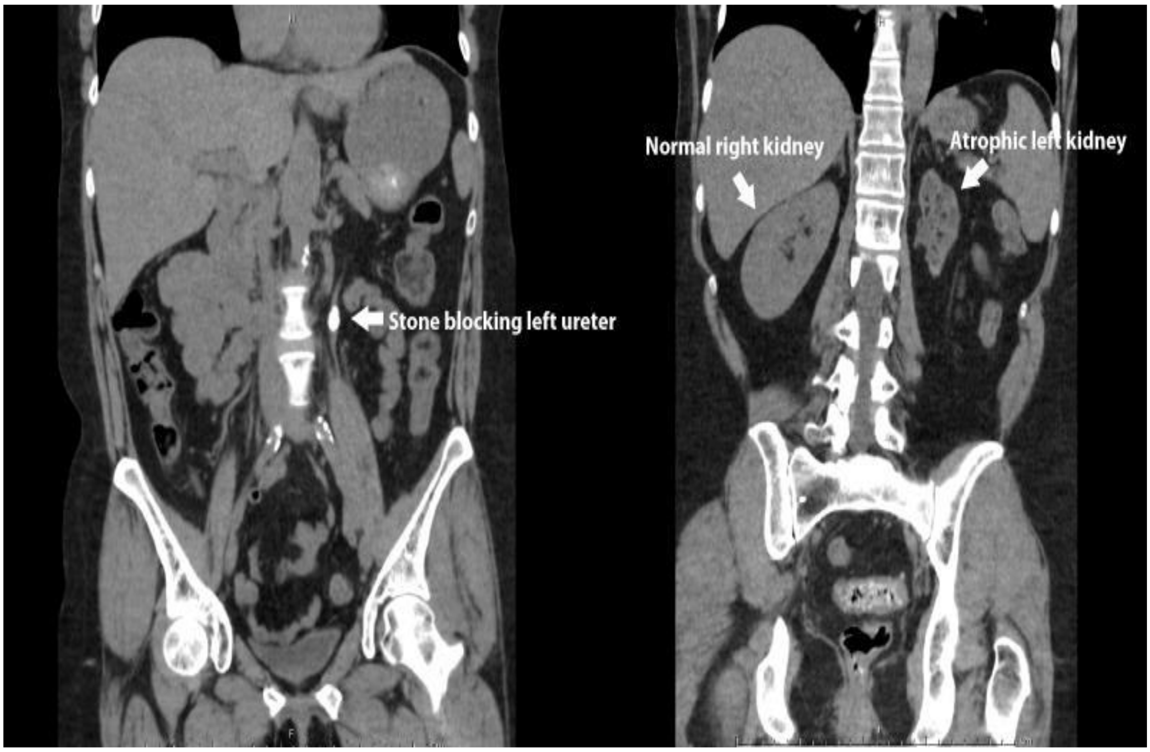

Figure (A-5) showed LT ureteric stone in coronal reconstruction plane

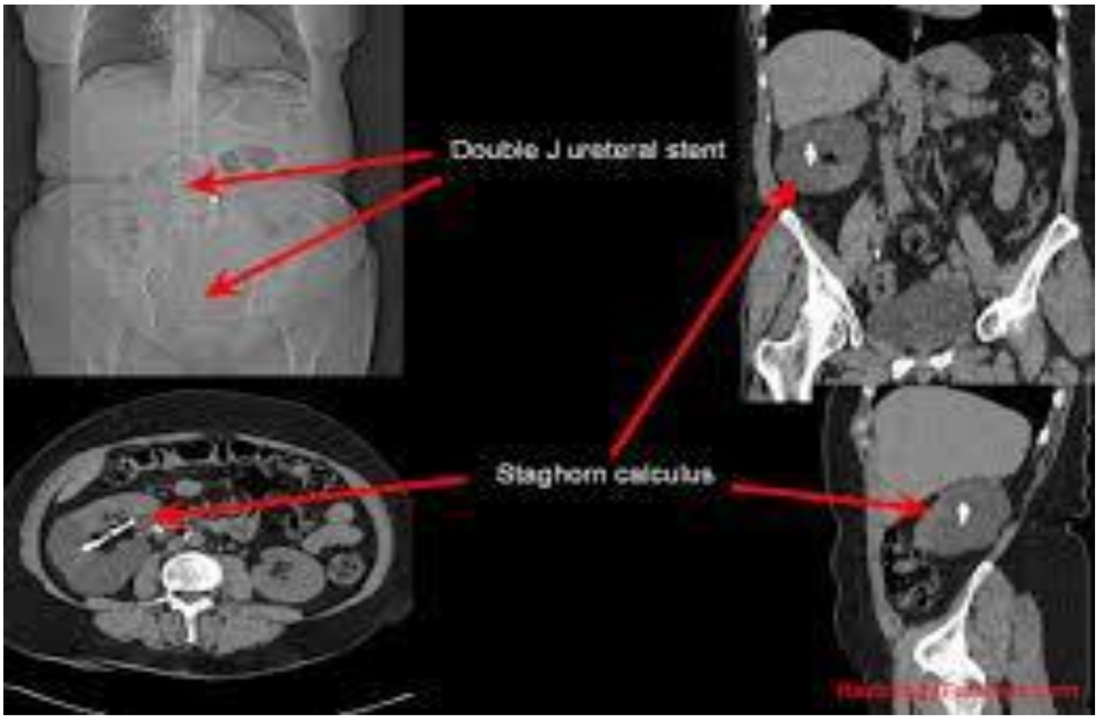

Figure (A-6) showed RT kidney stone in the scout, axial, coronal and sagittal view

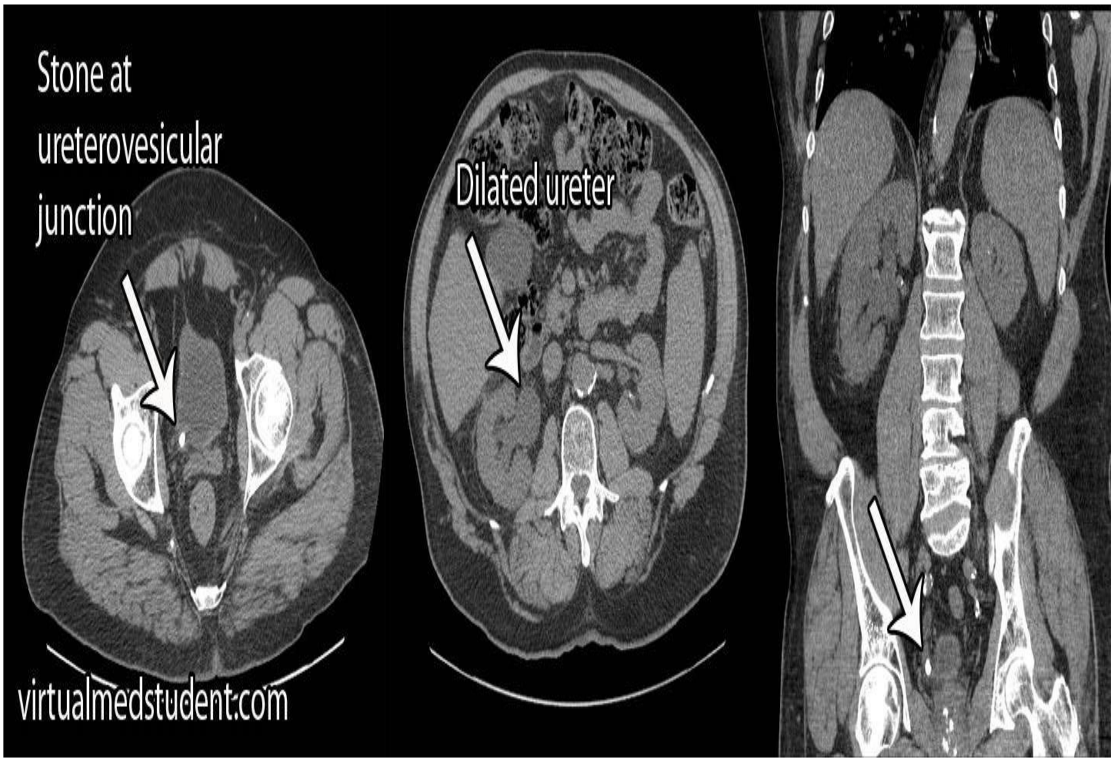

Figure (A-7) showed RT uretero-vesicular junction stone associated with Hydroureter.

Appendix (B)

Table (5.1) Data collection sheet:

No	Gender	Age	Patient Complain	Stones				
				Site	Size	Shape	Number	CT number