بسم الله الرحمن الرحيم

Sudan University of Sciences and Technology

College of Graduate studies

Accuracy of CT in Detecting Site and Size of Renal Stone Compared with Ultrasound

دقة الأشعة المقطعية في كشف موقع وحجم حصاوي الكلى بالمقارنة مع الموجات فوق الصوتية

Thesis Submitted for Partial Fulfillment of M.Sc Degree in Diagnostic Radiological Technology

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March 2016

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

قالى تعالى

(قل هل يستوي الذين يعلمون والذين لا يعلمون)

صدق الله العظيم

سورة الزمر : الآية (9)

Dedication

To my cute little girl Leen

To my family

To my wife for understanding and patience.

To all whom aid me to complete this work.

Acknowledgement

My gratitude and thanks to my supervisor

Dr. Hussain Ahmed Hassan

My gratitude and thanks to extended to all colleagues in General Administration of Medical Services – Accident and Emergency Hospital .CT department.

ABSTRACT

50 patients (36 men and 14 women) with different ages and all of them affected by renal stone.

All patients were selected from military Hospital – CT Department.

The objective of this study is to determine the percentage of CT in detecting site and size of renal stone compared with ultra sound. And to measure the renal stone size in both male and female. Also to identify the role of CT in diagnosis of renal stone size and site.

The CT images were conducted using (TOSHIBA aquilion 64 slices) CT scanner. The scan parameters are (3mm slice, 120 kvp and 225 mAs). And with using the electronic caliper within the scanner the following diameters were measured. The features of CT scanner are:

256 slices in one rotation with 5 mm slice thickness. Coverage of 13 cm in patient axis direction. The patient position is supine. Using CT KUB technique.

Ultrasound machine is GE medical system LOQIC 5 Expert, made by Yocogama medical systems LTD-JAPAN – model 2302650, serial No. 1028924, manufactured April 2005.

Position of the patient is Lie comfortably on his/her back (supine)

Head may rest in a small pillow

To visualize Rt. And Lt, kidneys, applying gel to the Rt and Lt upper abdomen consequently.

Scanning is best performed with the patient holding the breath in.

The study showed that the (age group) of patient's from 21 years to 40 years more affected than the other age group (56%).

The preliminary investigations obtained from this study revealed that the patients participated in this study, men’s with being more affected than women’s in regards with renal stone disease (70%).

The preliminary investigations obtained from this study revealed that the family history of the renal stone cannot cause the disease. Family history Present 16 Pt (32%), not present 34 Pt (68%).

US finding of the LT affected side shows 6 Pt (12%) while the CT show 28 Pt (56%). US finding of the RT affected side shows 6 Pt (12%) while the CT show 15 Pt (30%).

US finding measurement of stone size less than (5mm) in the kidney show 6 stones while the CT shows 13 stones. US finding measurement of stone size more than (5mm) in the kidney show 8 stones while the CT shows 20 stones. US finding measurement of stone size less than (5mm) in the ureter show (zero) while the CT shows 8 stones. US finding measurement of stone size more than (5mm) in the ureter show 1stone while the CT shows 10 stones.

From this study we conclude that the CT more effectiveness in diagnosis of the renal stone site and size than the ultra sound. Booth U/S and spiral CT should be available in emergency department.

CT is the image modality to evaluate the renal stones, as the provides a road map and excellent detail is available regarding to the anatomy, pathology and early diagnosis of urinary system so it's very import factor in the disease management both spiral CT and US were found to be excellent modalities for depicting renal stones, but because of high cost, radiation does and high workload of CT, U/S is the first line choice in diagnosis of renal calculi.

ملخص الأطروحة

أجريت هذه الدراسة علي 50 مريضا (36 من الذكور 14 من الإناث) في أعمار مختلفة وجميعهم يعانون من حصاوي في الكلى . وجميعهم تم إختيارهم من مستشفى السلاح الطبي العسكري بأمدرمان. الهدف من الدراسة هو لتحديد نسبة الأشعة المقطعية في الكشف عن موقع وحجم حصاوي الكلى بالمقارنة مع الموجات فوق الصوتية . ولقياس حجم حصاوي الكلى في العنصر الرجالي والنسائي وأيضا" للتعريف بدور الأشعة المقطعية في تشخيص حصاوي الكلى . تم إجراء جميع فحوصات الأشعة المقطعية بجهاز ماركة (توتشيبا) موديل 64. يتم أخذ الصور والمريض مستلقي على ظهره بإستخدام بروتوكول تصوير الكلية والحالب والمثانه.

جهاز الموجات الصوتية المستخدم هو ماركة (جي إي) ويتم إجراء الفحص بأن يكون المريض مستلقي على ظهره مع إستخدام ماده لزجة (جل) لتوضيح الصورة على الشاشة.

أوضحت الدراسة بأن الأعمار للمرضى من 21 سنة وحتى 40 سنة أكثر عرضة للإصابة بحصاوي الكلى من بقية الفئات العمرية بنسبة (56%) . أوضحت الدراسة بأن فئة الرجال أكثر عرضه للإصابة بحصاوي الكلى من فئة الإناث بنسبة (70%) . أوضحت الدراسة بأن التاريخ المرضي للأسرة لا يكون سبب مباشر في الإصابة بحصاوي الكلى وكانت النسبه (32%) من إجمالي 16 مريض لديهم تاريخ مرضي في الأسرة بينما (68%) من إجمالي 34 مريض ليس لديهم تاريخ مرضي في الأسرة. أوضحت الدراسة أن الموجات الصوتية إستطاعت تشخيص عدد 6 مرضى بنسبة (12%) في جانب الكلية الأيسر بينما استطاعت الأشعة المقطعية تشخيص 28 مريض في نفس الجانب بنسبة (56%) . أوضحت الدراسة بأن الموجات الصوتية استطاعت تشخيص عدد 6 مرضى بنسبة (12%) في جانب الكلية الأيمن بينما استطاعت الأشعة المقطعية تشخيص 15 مريض بنسبة (30%) بنفس الجانب . أوضحت الدراسة بان الموجات الصوتية استطاعت كشف وقياس عدد 6 حصاوي في الكليتين بحجم أقل من 5 مل بينما استطاعت الأشعة المقطعية كشف وقياس 13 حصوة في الكلية بحجم اقل من 5 مل . أوضحت الدراسة بأن الموجات الصوتية استطاعت كشف وقياس 8 حصاوي في الكلية بحجم أكبر من 5 مل بينما استطاعت الأشعة المقطعية كشف وقياس 20 حصوة في الكلية بحجم أكبر من 5 مل. أوضحت الدراسة أن الموجات الصوتية لم تتمكن من قياس أو اكتشاف أي حصوة أقل من 5 مل في الحالب بينما استطاعت الأشعة المقطعية قياس وإكتشاف عدد 8 حصاوي في الحالب بحجم أقل من 5 مل. أوضحت الدراسة بأن الموجات الصوتية استطاعت قياس وكشف حصوة واحدة في الحالب أكبر م 5 مل بينما الأشعة المقطعية استطاعت كشف وقياس عدد 15 حصوة في الحالب بحجم أكبر من 5 مل.

من هذه الدراسة إتضح لنا بأن الأشعة المقطعية أكثر فاعلية من الموجات فوق الصوتية في الكشف عن موقع حصاوي الكلى وقياس مختلف أحجامها.

يراعى أهمية وجود كلا الخيارين الأشعة المقطعية والموجات فوق الصوتية في أقسام الطوارئ بينما يكون الخيار الأول في تشخيص حصاوي الكلى هو للموجات فوق الصوتية وذلك نسبة لتكلفة فحص الأشعة المقطعية العالية ونسبة للتعرض الإشعاعي أيضا.

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3D	Three dimensions
KUB	Kidney Ureter Bladder
IVC	Inferior vena cava
CTU	computed tomographic urography
CTA	computed tomography angiography
MRI	Magnetic Resonance Imaging
2D	two dimensions
CT	Computed Tomography
KVP	Kilo volt Peak
MIP	maximum intensity projection
IVU	intra venous urography
U/S	Ultrasound
LT	Left
RT	Right
WT	Weight

Chapter One

1-1-Introduction:

Kidney stones are hard, rock-like crystals of varying sizes and shapes. They occur when salts in the urine precipitate and form solid materials. Stones can vary in size from as small as a rice grain to as large as an apple or golf ball 5. CT can determine the chemical components of renal stone by using CT number. (Techman JM. 2004).

Urinary stones can be classified according to the following aspects: stone size, stone location, characteristics of stone, etiology of stone formation, stone composition (mineralogy), and risk group forrecurrent stone formation. The size of a stone is usually given in millimeters, using one- or two-dimensional measures. Stones can also be stratified further into those measuring up to 5 mm, > 5-10 mm, > 10-20 mm, and > 20 mm.

A stone can be classified according to its anatomical position in the urinary collecting system at diagnosis. upper calyx, middle calyx or lower calyx, renal pelvis. There are four major types of stones: stones formed from calcium combined with oxalate or phosphate, this is the most common type, struvite stones, which are caused by urine infection, uric acid stones, cystine stones which are rare and hereditary.(Knight KF 2000).

Various factors play a part in increasing the risk of stone formation for some people according to Kidney Health Australia, the range of factors include: Excess calcium, phosphate, oxalate and uric acid in the urine,lack of stone inhibitors in the urine, inadequate hydration, some medications, ongoing urine infection, rare inherited conditions and family history of stone formation.(Techman JM. 2004).

CT has the advantage of providing detailed anatomical information, can identify the size, location of renal stone and their effect to renal system using CT KUB. (Techman JM. 2004).

CT KUBisnon contrast enhanced CT of kidney, ureters and bladder is useful to determine the number and location of urinary tract calculi.

Spiral CT were found to be excellent modalities for depicting renal stones, CT KUB is the first line of choice in diagnosis and measureof renal calculi size and density. (Techman JM. 2004).

CT KUB is diagnostic imaging examination providing comprehensiveevaluation of the upper and lower urinary tractdefine as a diagnostic examination optimized for imaging the kidneys, ureters and bladder.

The examination involves the use ofmultidetector CT with thin-slice imaging. CT has higher diagnostic efficacy for renal stone as compared with other modalities and could be the top examination for patient with suspicion renal stone defect by noted the size and site of stone on the kidney. (MorcoseSK2007)

The Ultrasound considers one of the most important modalities to detect the size and site of renal stone in addition to CT. Ultrasound is a series of high frequency sound waves transmittedinto the body through a device called a transducer. These soundwaves are much higher than the normal range of human hearingcan detect, thus the term “Ultrasound”.Ultrasonic sound waves reflect off of anatomic structures and are returned to the transducer. These signals are then routed to system electronics and analyzed for their strength and anatomic position relative to time and distance traveled. All of this data isthen assigned levels of brightness and grayscale and displayed on a monitor. (Laurel, MD, 1992)

1-2- problem of the Study:

- The size and site of renal stone are detecting more specificby CT than the Ultrasound using CT KUB protocol.

1-3 Objectives of the study:

1-3-1General objectives:

Todetermine the accuracy and percentage of CT KUB in detecting site and size of renal stone comparing with ultrasound.

1-3-2Specific objectives:

- To measure the renal stone size in both male and female.

- To relate CT modalities with Ultrasound in diagnosing of renal stone.

- To identify the role of CT in diagnosis of renal stone size and site.

- To identify the role of CT inidentification of stone components when we applying CT number.

1- 4 Over view of study:

Chapter one consists of introduction, objectives, the scope of study.

Chapter two deal with literature review, anatomy, physiology, pathology computed tomography.

Chapter three it deal with the material and methods.

Chapter four it include result presentation.

Chapter five it deal with the discussion, conclusion, and recommendation.

Chapter two

2.1 Anatomy:

2.1.1 Anatomy of the urinary system:

The urinary system consists of the paired kidneys and ureters and theSingle bladder and urethra. The kidneys filter the blood andmanufacture urine in the process. The system's remaining organs provide temporary storage reservoirs or transportation channels for urine.The ureters drain urine from the kidneys and conduct it by peristalsis tothe bladder. The urinary bladder provides temporary storage for urine. The single urethra drains the bladder. The triangular region of the bladder, which is delineated by three openings (two ureteral and one urethral orifice), is called the trigone.(West T, 1987).

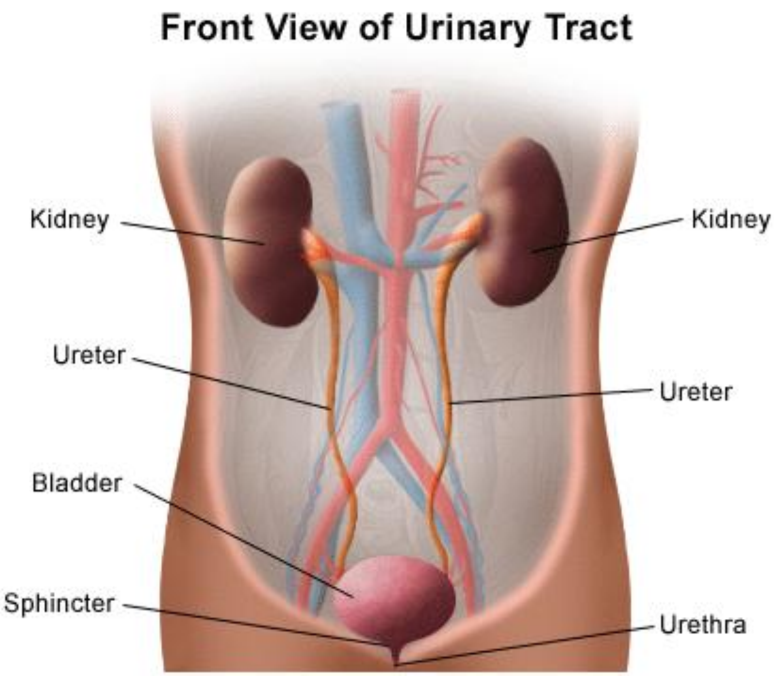


Figure No (2-1) Anatomy of the urinary system(West T, 1987).

2.1.2 Anatomy of the kidney:

Kidneys are paired retroperitoneal organs situated in the posterior part of the abdomen on eachside of the vertebral column. In the human, the upper pole of each kidney lies opposite the twelfththoracic vertebra, and the lower pole lies opposite the third lumbar vertebra. The right kidney isusually slightly more caudal in position. The weight of each kidney ranges from 125 g to 170 g inthe adult male and from 115 g to 155 g in the adult female. The human kidney is approximately 11cm to 12 cm in length, 5.0 cm to 7.5 cm in width, and 2.5 cm to 3.0 cm in thickness. Located on themedial or concave surface of each kidney is a slit, called the hilus, through which the renal pelvis,the renal artery and vein, the lymphatics, and a nerve plexus pass into the sinus of the kidney. Theorgan is surrounded by a tough fibrous capsule, which is smooth and easily removable undernormal conditions. (virtulmedicatlcenter.com).

Two distinct regions can be identified on the cut surface of a bisected kidney: a pale outer region,the cortex, and a darker inner region, the medulla in humans, the medulla is dividedinto 8 to 18 striated conical masses, the renal pyramids. The base of each pyramid is positioned atthe corticomedullary boundary, and the apex extends toward the renal pelvis to form a papilla. Onthe tip of each papilla are 10 to 25 small openings that represent the distal ends of the collectingducts (of Bellini). These openings form the area cribrosa In contrast to the humankidney, the kidney of the rat and of many other laboratory animals has a single renal pyramid and istherefore termed “unipapillate.” Otherwise, these kidneys resemble the human kidney in their grossappearance. In humans, the renal cortex is about 1 cm in thickness, forms a cap over the base ofeach renal pyramid, and extends downward between the individual pyramids to form the renal columns of bertinfrom the base of the renal pyramid, atthecorticomedullary junction, longitudinal elements termed the "medullary rays offerrein" extend intothe cortex. Despite their name, the medullary rays are actually considered a part of the cortex andare formed by the collecting ducts and the straight segments of the proximal and distal tubules (A. Andrew Ray 2010).

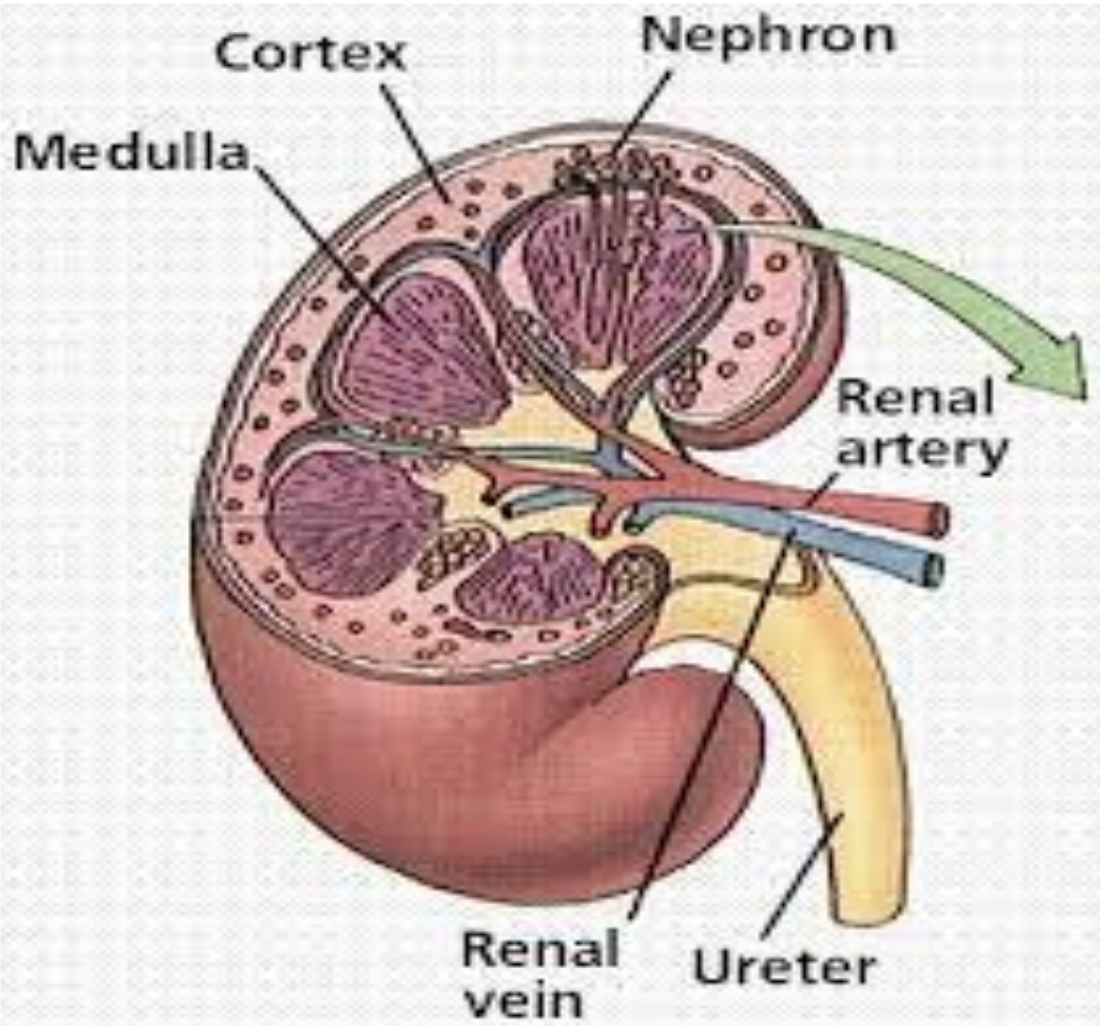


Figure (2-2) Anatomy of the kidney(A. Andrew Ray 2010).

2-1-2-1 THE NEPHRON:

The functional unit of the kidney is the nephron. Each human kidney contains about 0.6 × 106 to 1.4× 106 nephrons, which contrasts with the approximately 30,000 nephrons in each adult ratkidney.The essential components of the nephron include the renal or malpighian corpuscle(glomerulus and Bowman's capsule), the proximal tubule, the thin limbs, the distal tubule, and theconnecting tubule. The origin of the nephron is the metanephricblastema. Although there has notbeen universal agreement on the origin of the connecting tubule, it is now generally believed toderive from the metanephricblastema. The collecting duct system, which includes the initialcollecting tubule, the cortical collecting duct (CCD) in the medullary ray, the outer medullarycollecting duct (OMCD), and the inner medullary collecting duct (IMCD), is not, strictly speaking,considered part of the nephron because embryologically it arises from the ureteric bud. However,all of the components of the nephron and the collecting duct system are interrelated functionally.Two main populations of nephrons are recognizable in the kidney: those possessing a short loop ofHenle and those with a long loop of Henle. The loop of Henle is composed of thestraight portion of the proximal tubule (pars recta), the thin limb segments, and the straight portionof the distal tubule (thick ascending limb, or pars recta). The length of the loop of Henle is generallyrelated to the position of its parent glomerulus in the cortex. Most nephrons originating fromsuperficial and midcortical locations have short loops of Henle that bend within the inner stripe ofthe outer medulla close to the inner medulla. A few species, including humans, also possesscortical nephrons with extremely short loops that never enter the medulla but turn back within thecortex.

Nephronsoriginating from thejuxtamedullary region near the corticomedullaryboundaryhave long loops of Henle with long descending and ascendingthin limb segments that enter theinner medulla. Many variations exist, however, between the two basic types of nephrons,depending on their relative position in the cortex. The ratio between long and short loops variesamong species. Humans and most rodents have a larger number of short-looped than long-loopednephrons.(A. Andrew Ray 2010).

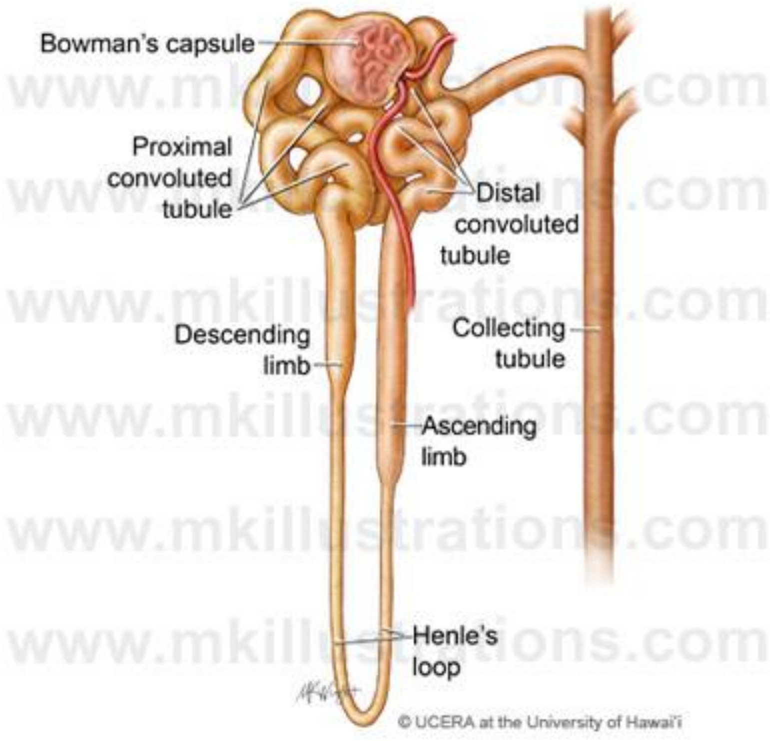


Figure (2-3) The Nephron

2.1.2.2 Blood supply of the kidney:

In the human, as in most mammals, each kidney is supplied normally by a single renal artery,although the presence of one or more accessory renal arteries is not uncommon. The renal arteryenters the hilar region and usually divides to form an anterior and a posterior branch. Threesegmental or lobar arteries arise from the anterior branch and supply the upper, middle, and lowerthirds of the anterior surface of the kidney. The posterior branch supplies more thanhalf of the posterior surface and occasionally gives rise to a small apical segmental branch.However, the apical segmental or lobar branch arises most commonly from the anterior division.No collateral circulation has been demonstrated between individual segmental or lobar arteries ortheir subdivisions. Not uncommonly, the kidneys receive aberrant arteries from the superiormesenteric, suprarenal, testicular, or ovarian arteries. True accessory arteries that arise from theabdominal aorta usually supply the lower pole of the kidney. The anterior half of thekidney can be divided into upper (U), middle (M), and lower (L) segments, each supplied by asegmental branch of the anterior division of the renal artery. A small apical segment (A) isusually supplied by a division from the anterior segmental branch. The posterior half of thekidney is divided into apical (A), posterior (P), and lower (L) segments, each supplied bybranches of the posterior division of the renal artery.(virtulmedicatlcenter.com).

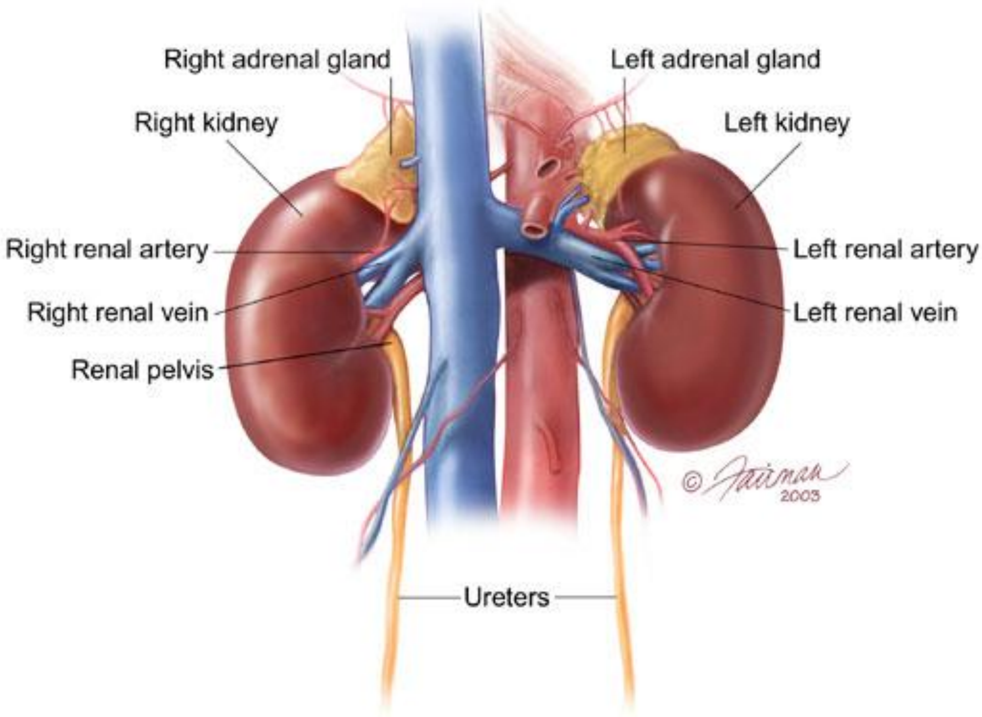


Figure (2-4) Blood supply of the kidney

2.1.2.3 Nerve supply of the kidney:

The nerve supply is the renal sympathetic plexus. The afferent fibers that travel through the renal plexus enter the spinal cord in the 10^{th}, 11^{th}, and 12^{th} thoracic nerves. (slideshare.net).

2.2 Physiology:

2.2.1 Physiology of the kidney:

The urinary system is composed of two kidneys, the functionally filtering apparatus, which connectthrough two tubular structures called ureters to aurinary bladder, which serve as a reservoir forurine. The bladder, controlled by a sphincter,empties into the urethra to eliminate the urine from the body since the organ of most interest in the urinary system is the kidney we are going to concentrate inits structure and function. The working capacity ofthese organs far exceeds the need of a normalorganism to the extent that an animal can functionabsolutely normal with only one quarter of the renalcapacity and can survive with only one tenth.(Chen M.Y 1999).

The main role of the kidneys is to filter thecirculating blood in order to remove from the bodywaste products acquired through direct ingestion orresulting from catabolism of the organism.The removal of these products is meant to avoidtheir accumulation to toxic levels.A second critical role of the kidneys is to regulateand try to maintain within normal levels theextracellular fluid, circulating blood volume and, asa consequence, the blood pressure. This isachieved by regulating the volume of electrolytesand fluid which is excreted in urine and also throughthe production and release of enzymes by therennin angiotensin system, leading to theproduction of vasoactive compounds.In the process of filtering blood, the kidneysregulate the ionic concentration in circulation byeither retaining or excreting, depending on theneeds, ions such as Na+, K+, Cl-, Ca2+, HCO3-,HPO42-.In order to maintain

A narrow physiological intercellular fluid pH the kidney controls the excretion of H+. (Catalano O 2002).

The kidney also has an endocrine role which contributes to several rather important physiological activities. Itcontributes to the regulation of red blood cell through production or erythropoietin. Regulates diuresis through increasedrenal blood flow as a result of production of urodilatin and, calcium absorption through conversion of25-hydroxycholecalciferol to 1, 25-dihydroxycholecalciferol, the active form of Vitamin D3. The kidneys also secreterenin, an enzyme involved in the production of angiotensin II, leading to synthesis and release of aldosterone. (virtulmedicatlcenter.com).

2.3 Pathology:

2.3.1 Pathology of the kidney:

2.3.1.1 Kidney stones:

Kidney stones are gravel-like collections of chemicals that may appear in any area of the urinary system, from thekidney to the bladder. They may be small or large. You may have just one stone or many. Your kidneys filter yourblood and excrete waste products and excess water as urine. They are located on either side of your spine, justabove your waist. Kidney stones are most common in middle-aged people and are 3 times more common in menthan in women. They tend to recur. There are several types of urinary stones, but most stones are calcium stones. They occur when there is too muchcalcium in the urine. If your kidneys don't work properly or if too much calcium is absorbed from your stomach andintestines, you may have excess calcium in your urine. Some calcium stones are caused by too much of a chemicalcalled oxalate that is found in many foods including spinach, rhubarb, leafy vegetables, coffee, chocolate, andtomatoes. Oxalate binds easily with calcium to form a stone. Also, the risk of forming calcium stones increases ifyou have certain medical conditions such as an overactive parathyroid (a gland in that neck that regulates calciumin the body) or inflammatory bowel disease.A second type of kidney stone occurs because you have too much uric acid in your urine. Uric acid stones mightresult if you become dehydrated, for example, during strenuous exercise on a hot day or during an illness. Uric acidstones are common in people who have gout, a disease that causes high uric acid levels in the blood. (Catalano O 2002).

A third type, struvite stones, is also called infection stones because they form in urine that is infected withbacteria.Finally, a rare type of kidney stone is a cystine stone. It occurs if you have the genetic disease called cystinuria.This disease results from a birth defect that causes the kidney to allow too much cystine into the urine. This type ofstone formation is almost always diagnosed during childhood. The symptoms of kidney stones are: severe, crampy pain in your back or abdomen (the most common symptom), nausea and vomiting (sometimes).Sometimes the presence of kidney stones causes a urinary tract infection. If you have a urinary tract infection, yoursymptoms may include fever, chills, sweats, and pain when you urinate. Kidney stones and urinary tract infectioncan cause blood to be in the urine. Usually the blood is seen only with a microscope, but occasionally it is moreobvious. Some people have no symptoms until they pass gravel-like stones in their urine. Others never have anysymptoms, and their stones are found during testing for other problems. it diagnosed either by x-ray of your abdomen , ultrasound or CT scan (computerized tomography). (Chen M.Y 1999).

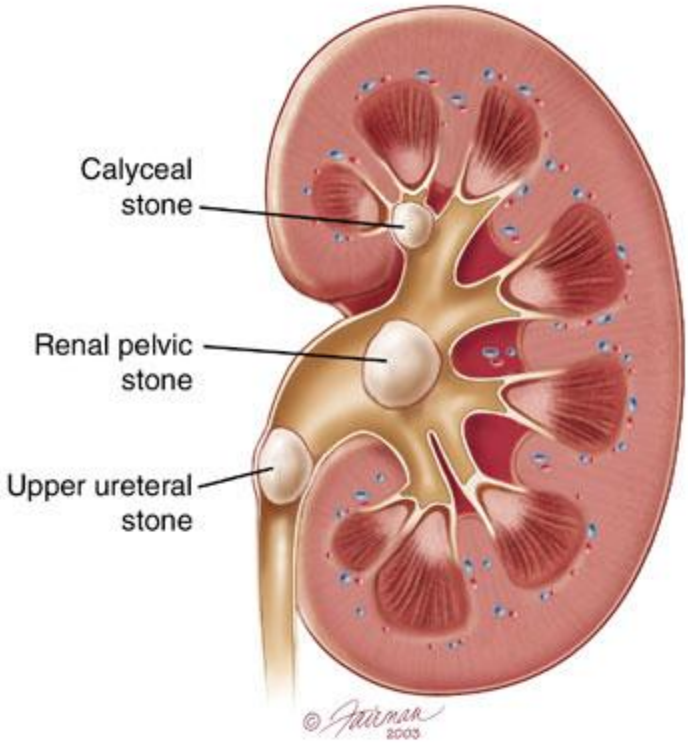


Figure (2-5) kidney stone location and size.

2.3.1.2. Pyelonephritis:

Kidney infections or pyelonephritis are usually caused by germs in the urinary tract. Untreated kidney infections can lead to kidney disease.

2.3.1.3 Kidney cancer:

Is a disease where one or more tumors form in the kidney.

2.3.1.4 Nephrotic syndrome:

Is not a disease, but can be the first sign that a disease is damaging thekidneys. Symptoms include: Protein in the urine, Low blood protein and Swelling.

2.3.1.5 Polycystic kidney disease (PKD):

Is a genetic disorder where many cysts grow in the kidneys. PKD cysts can grow out of control and cause the kidneys to fail.

2.3.1.6 Kidney cysts:

Are pouches of fluid in the kidneys. Unless the cysts cause pain,become very large, or become infected, they usually do not need treatment. Simple kidneycysts are common.(Laurel, MD, 1992, American Institute of Ultrasound in Medicine).

2.4.1. Ultrasound (Sonogram)

Sonography is often used for patients in whom intravenous contrast is contraindicated due to allergy or renal impairment. Sonograms can see the kidney and bladder, but can't see the ureters well. The finding of a dilated kidney on sonography may suggest the presence of obstruction lower downstream within the ureter. Ultrasonography doesn't use radiation, so it is often used to evaluate urinary problems during pregnancy.

2.4.2 Indications

Renal or uretric pain, suspected renal mass (large kidney), Non-functioning kidney on urography haematuria, recurrent urinary infection, trauma, suspected polycystic disease, pyrexia of unknown origin (PUO), postoperative complications, renal failure of unknown origin and schistosomiasis.(A. Andrew Ray 2010).

Figure2.6: shows medical US machine

2.4.3 Preparation of the patient

The patient should take nothing by mouth for 8 hours preceding the examination, if fluid is essential to prevent dehydration, only water should be given. Infants should be given nothing by mouth for 3 hours preceding the examination.

2.4.4 Position of the patient

-Lie comfortable on his/her back (supine), head may be rest in a small pillow, To visualize Rt. and Lt. kidneys apply gel to the Rt. and Lt. upper abdomen consequently. Scanning is best performed with the patient holding the breath in.

2.4.5 For the right kidney:

Supine (as basic), Left posterior oblique, Left lateral decubitus and prone as needed.

2.4.6 For the left kidney:

Right lateral decubitus (as basic) and prone as needed. Note different patient positions should be used whenever the suggested position doesn't give the desired results.

2.4.7 Choice of transducer

Use 3.5 MHz for adults / for the need of deep organs

Use 5 MHz for children and thin adults / no need for penetration

2.4.8 Setting the correct gain

Start by placing the transducer longitudinal central and at the top of the abdomen (the xiphoid angel). Ask the patient to take a deep breath and hold it in. Angle the transducer beam towards the right side of the patient.

2.5 CT scanner

2.5.1 Historical background:

CT was invented in 1972 by British engineer Godfrey Hounsfield of EMI laboratories, England, and independently by South African born physicist Allan Cormack of Tufts University, Massachusetts. Hounsfield was later awarded the Nobel Prize and honored with Knighthood in England for his contributions to medicine and science. The first clinical CT scanners were installed between 1974 and 1976. The original systems were dedicated to head imaging only, but "whole body" systems with larger patient openings became available in 1976. CT became widely available by about 1980. There are now about 7,000 CT scanner installed in the U.S.

and about 30,000 installed worldwide. The first CT scanner developed by Hounsfield in his lab at EMI took several hours to acquire the raw data for a single scan or "slice" and took days to reconstruct a single image from this raw data. The latest multi-slice CT systems can image an entire chest in five to ten seconds and reconstruct the images in a similar time period. During its 25-years history, CT has made great improvements in speed, patient comfort, and resolution. As CT scan times have gotten faster, more anatomy can be scanned in less time. Faster scanning helps to eliminate artifacts from patient motion such as peristalsis. CT exams are now quicker and more patient friendly than ever before. Tremendous research and development has been made to provide excellent image quality for diagnosis confidence at the lowest possible x-ray dose.

2.5.2 Spiral or Helical CT

In all original CT scanners (1974 to 1987), the x-ray power was transferred to the x-ray tube using high voltage cables around an elaborated set of rotated drums and pulleys. The rotating frame (or gantry) would spin 360° in one direction to make an image (or a slice), and then spin 360° back in the other direction to make a second slice. In between each slice, the gantry would come to a complete stop and then reverse directions while the patient table would be moved forward by an increment equal to the slice thickness.

In the mild 1980's, an innovation called the power slip ring was developed so that the elaborate x-ray cable and drum system could be abandoned. The slip ring allows electric power to be transferred form a stationary power source onto the continuously rotating gantry. State of the art CT scanners with slip rings can now rotate continuously and don't have to slow down to start and stop. The innovation of the power slip ring has created a renaissance in CT called spiral or helical scanning.

These spiral CT scanners can now image entire anatomic regions like the lungs in a quick 20 to 30 second breath hold. Instead of acquiring a stack of individual slices which may be misaligned due to slight patient motion or breathing (and lung/abdomen motion) in between each slice acquisition, spiral CT acquires a volume of data with the patient anatomy all in one position. This volume data set can then be computer-reconstructed to provide three-dimensional pictures of complex blood vessels like the renal arteries or aorta. 3D CT images from volume data allow surgeons to visualize complex fractures, for example of facial trauma, in three dimensions and can help them plan reconstructive surgery.

2.5.2.1 "Multi-slice "Spiral CT Scanners

New "multi-slice" spiral CT scanner are now begin developed that can collect multiple slices of data during spiral CT mode and rotate at faster speed .these system can collect more data than previous state-of-the-art spiral CT systems that rotate at slower speed and only collect one slice of data at a time multi-slice CT scanning will allow non-invasive imaging and diagnosis of wider range of condition in less time and with greater patient comfort.

The combination of multi-slice CT and new 3D reconstruction promises to allow veterinarians to see even more than ever before .multi-slice CT systems are at "the cutting edge" in term of speed, patient comfort, and resolution. CT exam are now quicker and more patient friendly than ever before .As CT scan time have gotten faster, more anatomy can be scanned in less time. Faster scanning helps to eliminate artifacts from patient motion such as breathing or peristalsis. (Catalano O 2002).

2.5.3 Component of CT scanner

CT system comprises several components. These basically include: the scanning unit i.e. the gantry, with tube and detector system, patient table, the image processor for image reconstruction and the console.

The console represents the man-machine interface and is designed to be multifunctional. It is the control unit for all examination procedures, and is also used to evaluate the examination results. To enhance the work flow, Siemens has developed a double console capable of performing both functions at the same time.

2.5.3.1 Scanning unit (gantry)

A CT scanning system consists of an X-ray unit, which functions as a transmitter, and a data acquisition unit, which function as a receiver. In commercial CT systems these two components are housed in ring-shaped unit called the gantry.

2.5.3.1.1 X-ray components

2.5.3.1.1.1 Tube

Manufacturers of CT systems use X-ray tubes with variable focal spot sizes. This makes sense, because volumes for which good low-contrast resolution is essential need to be scanned with a large foal spot and high power, where as high resolution images with thin slices requires small focal spot.

Tubes used in modern CT scanners have a power rating of 20-60 kW at voltages of 80-140 kV. The system can, however, be operated at maximum power for a limited time only. These limits are defined by the properties of the anode and the generator. To prevent overloading

of the X-ray tube, the power must be reduced for long scans. The development of multi-row detector system has practically excluded the limitation, since these detector systems make much more efficient use of the available tube power.

2.5.3.1.2 Shielding

Each CT scanner is equipped with grids, collimators and filters to provide shielding against scattered radiation, to define the scan slice and to absorb the low-energy portion of the X-ray spectrum. In this way, both the patient and the examiner are protected.

2.5.3.1.2 Data acquisition components

2.5.3.1.2.1 Detector

The detector system plays a special role in the interaction of the CT components. It converts the incident X-rays of varying intensity to electric signals. The analog signals are amplified by downstream electronic components and converted to digital pulses. Over time, certain materials have proven very effective in the utilization of X-rays. For example, Siemens uses UFC (Ultra Fast Ceramic) detectors which, due to their excellent material properties, dramatically improve image quality.

2.5.3.1.2.2 Multi-row detector

Multi-row detectors utilize radiation delivered from the X-ray tube more efficiently than single-row detectors. By simultaneously scanning several slices, the scan time can be reduced significantly or the smallest details can be scanned within practicable scan times. In the adaptive array detectors used by Siemens, the rows inside the detector are very narrow, becoming wider as they move towards its outer edges in the z direction (longitudinal axis of the body). A combination of collimation and electronic interconnection provides considerable flexibility in the selection of slice thickness. At the same time the space required by the detector septa, and therefore the unused space is minimized.

2.5.3.2 Scanner parameters

2.5.3.2.1 Collimation

The radiation beam emitted by the X-ray tube is shaped using special diagrams also referred to as “Collimators”. A distinction can be made between two types of collimators.

The source collimator is located directly in front of the radiation source - i.e. the X-ray tube.

It reduces the radiation beam to form the maximum required fan beam, thus also determining the emitted dose. The detector collimator, which is directly positioned in front if the detectors, is primarily used to shield the detector against scattered radiation, thus preventing image artifacts.

The collimation and focal size can determine the quality of the slice profile. From the data volume from a multislice scanner images can reconstructed with slice thickness equal or larger than the detector collimation. For example, a 5 mm collimation allows images to be reconstructed with a slice thickness of 5mm or more. The widest range of possibilities in the selection of collimation and reconstructed slice thicknesses is offered in spiral CT using multidetector systems.

2.5.3.2.2 Increment

The increment determines the distance between images reconstructed from a data volume. If an appropriate increment is used, overlapping images can be reconstructed. In sequential CT, overlapping images are obtained only if the table feed between two sequences is smaller than the collimated slice thickness. This, however, increases the patient dose. In spiral CT the increment is freely selectable as a reconstruction parameter, i.e. by selecting the increment the user can retrospectively and freely determine the degree of overlap without increasing the dose. Overlapping reconstruction offer the advantage of better image quality due to lower noise and easier and more accurate diagnosis of small structures. An illustrative example: A 100 mm range was acquired in the spiral mode with 10 mm collimation. After the acquisition, slices of 10 mm thickness can be reconstructed at any point of this range.

If an increment of 10 mm is used, contagious slices of 10 mm thickness are reconstructed every 10 mm. if an increment of 5 mm is used, slices of 10 mm thickness are reconstructed every 5 mm. The slices overlap by 50%. With an appropriate increment an overlap of 90% can be achieved. Modern CT systems allow the reconstruction of slices with arbitrary increments. (L. Ronan 2007).

2.5.3.2.3 Pitch

An important factor in spiral scanning is the table feed per rotation. The larger the table feed, the faster (i.e. with fewer rotations) a body region can be scanned. However, if the table feed is too large, image quality will be impaired. In this context the term “pitches” is used. For single row system the definition Pitch = table feed per rotation/collimation is generally accepted. Experience has shown that a good image quality can be obtained by a pitch between 1 and 2. It should also be noted that the dose can be significantly reduced in single row systems if a pitch factor >1 is applied. In the context of multi-row systems, pitch cannot yet be defined clearly. The ambiguity involved becomes apparent in the following example (SOMATOM Sensation 4):

Collimation 4×2.5 mm, table feed 10mm

First possibility: pitch = 10 mm/4×2.5 mm = 1

Second possibility: pitch = 10 mm/2.5 mm = 4

To avoid misunderstandings, we use “feed per rotation” rather than “pitch” on the user interface.

2.5.3.2.4 Rotation time

Rotation time is the time interval needed for a complete 360º rotation of the tube detector system around the patient. It affects the spiral scan length and thus the coverage of the scan range during a certain period of time. Ultra modern CT systems requires only 0.4 seconds for one rotation.

A short rotation time has the following advantages: A longer spiral scan can be acquired in the same scan time, the same volume and the same slice thickness can be scanned in less time, motion artifacts are eliminated, savings on contrast media through shorter examination times and reduced patient discomfort.

Since less contrast medium is required for shorter examination times or fast acquisition of large anatomical regions a sub second rotation time is recommended. This applies especially, for instance, to constantly moving organs such as the heart.

2.5.3.2.5 mAs

The mAs value (e.g. 100 mAs) is the product of the tube current (e.g. 200 mA) and the rotation time (e.g. 0.5 s). In multi-row CT systems we simplify this equation by using what is commonly called “effective mAs”. This is the product of the tube current and the exposure time for one slice (rotation x collimation/feed per rotation).

The selected mAs and tube voltage determine the dose. The mAs value selected depends on the type of examination. Higher mAs values reduce the image noise, thus improving the delectability of lower contrasts. For visualization of soft tissue, i.e. regions of low contrast, a higher dose and larger slice thickness are required. The abdomen and brain are typical regions of soft tissue contrast. As well as contrast studies of vessels require lower doses and thinner slices.

Siemens CT scanners also feature the CARE dose technical measures package (CARE = combined applications to reduce exposure), which was developed to reduce patient exposure to radiation. This package guarantees shorter examination times, the lowest possible exposure to radiation, and images of excellent qualities. Ultra modern computer technology "monitors" the patient during the entire examination period. During each rotation, the radiation is continuously measured and modulated according to the current attention level.

CARE dose thus makes it possible to vary the radiation dose depending on the patient's anatomy and thus reduce it by as much as 56%. Scanner parameters determine the image quality.

Optimal performance of spiral CT system can be achieved only with an optimal combination of parameters. (L. Ronan 2007).

2.5.4 CT image production

2.5.4.1 Acquisition

In the simplest case, the object (here around cylinder) is linearly scanned by a thin, needle-like beam. This produces a sort of a shadow image (referred to as "attenuation profile" or "projection"), which is recorded by the detector and the image processor. Following further rotation of the tube and the detector by a small angle, the object is once again linearly scanned from another direction, thus producing a second shadow image. This procedure is repeated several times until the object has been scanned for a 180º rotation.

2.5.4.2 Display

The various attenuation profiles are further processed in image processor. In the case of simple back projection, each attenuation profile in the scanning direction is added up in the image memory. This result in a blurred image due to disadvantage of this simple back projection, i.e. each project not only contributes to its own display, but also influences the image as a whole. This already becomes visible after 3 projections. To avoid this problem, each attenuation profile is subjected to a mathematical high-pass filter (also referred to as "kernel") prior to the back projection. This produces overshoot and undershoot at the edges of the object. The mathematical operation is referred to as "convulsion". The convolved attenuation profiles are then added up in the image memory to produce a sharp image.(Catalano O 2002).

2.6 previous Studies

Yilamz et al, (1997) studied: comparison of spiral CT, US and IVU in the detection of ureteral calculi. To compare noncontrast spiral CT, US and intravenous urography (IVU) in the evaluation of patient with renal colic for the diagnosis of uretral calculi. During a period of 17 months, 112 patients with renal colic were examined with spiral CT, US and IVU. Fifteen patients were lost to follow-up and excluded. The remaining 97 patients were defined to be either true positive or negative for ureterolithiasis based on the follow-up data. Sensitivity, specifically, positive and negative predictive value and accuracy of spiral CT, US and IVU were determined, and secondary signs of ureteral stones and other pathologies causing renal colic detected with these modalities were noted. Of 97 patients, 64 were confirmed to have ureteral calculi based on stone recovery or urological intervensions. 33 patients were proved not to have ureteral calculi based on failure to recover a stone and diagnosis unrelated to ureterolithiasis. Spiral CT was found to be the best modality for depicting ureteral stones with a sensitivity of 94% and a specificity of 97%. For US and IVU, these figures were 19, 97, 52 and 94%, respectively. Spiral CT is superior to US and IVU in the demonstration of ureteral calculi in patients with renal colic, but because of its high cost, higher radiation dose and high workload, it should be reserved for cases where US and IVU do not show the cause of symptoms.

PALTAS et al, (2001) researched US vs. CT for the detection of ureteric stones in patients with renal colic. The aim of their study was to compare the accuracy of non-contrast spiral CT with 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 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 uretrolithiasis. CT showed 91% and 95%, respectively.

Pathology unrelated to urinary stone diseases was demonstrated in six patients. Although both modalities 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.

Oner et al (2004) compared spiral CT and US in the evaluation of pediatric urolithiasis. The objective of the study was to determine the value of spiral CT in detecting urolithiasis in pediatric patients and compare its efficacy with US. 29 infants aged between 2 to 94 months with clinical presentation suggestive of urolithiasis and negative or indeterminate plain films were included in the study.

Abdominal US and spiral CT were performed in all patients. Presence, size, and localization of stones were noted for each patient on both CT and US. The diagnosis of urolithiasis was confirmed by passage of stones spontaneously, extracorporeal shockwave lithotripsy (ESWL), surgery, or clinical follow-up. Presence of stones was confirmed in 23 of 29 patients (79%). 8 patients had single stone and the remaining 15 had multiple stones either in a single localization (single kidney or single ureter) or multiple localization. Spiral CT detected 57 stones (45 renal and 12 ureteral). US detected 34 stones (59.6%) in 18 (78.2%) patients. US was able to localize 31 stones (68.8%) in 21 kidneys (75%), and 3 stones (25%) in 11 ureters (27.2%). Spiral CT is very effective in the diagnosis of pediatric urolithiasis. Spiral CT is more efficient than US in imaging pediatric patients with symptoms and signs of urolithiasis, when KUB is inconclusive.

Ronan et al, (2007) compared between U/S and non-contrast helical computer tomography for identification for acute urolithiasis in teaching hospital setting. To compare the diagnostic accuracy of U/S and NCT performed by senior radiology residents for diagnosing acute urolithiasis; and to assess interobserver agreement on tomography interpretations by resident and experience abdominal radiologists prospective study of 52 consecutive patients, Who underwent both US and NCT within and interval of 8 hours, at Hospital Sao Paulo.

U/S scan were performed senior resident and read by experienced radiologists. NCT scan images were read by senior residents, and subsequently by 3 abdominal radiologists. The interobserver variability was assessed using the kappa statics. They found that the: ureteral calculi were found in 40 out of 52 patients (77%). U/S presented sensitivity of 22% and specificity of 100%. When collecting system dilatation was associated, U/S demonstrated 73% sensitivity, 82% specificity. The interobserver agreement in NCT analysis was very high was regard to identification of calculi, collecting system dilatation and stranding of perinephric fat.

U/S have limited the value for identifying ureteral calculi in comparison with NCT, even when collecting system dilatation is present. Residents and abdominal radiologists demonstrated excellent agreement rates for ureteral calculi, identification of collecting system dilatation and stranding of perinephric fat on NCT.

Andrew et al (2010), studied limitations to ultrasound in the detection and measurement of urinary tract calculi which was done to evaluate differences in stone measurement using computed tomography (CT) and ultra sound (U/S). Axial unenhanced helical CT is reference-standard imaging modality for the assessment of urinary tract calculi; however, US is also commonly used. Differences in stone measurement using these techniques are poorly described and contributors to measurement error remain unknown. All patients at institution undergoing both abdominal CT and renal U/S less than 1 month apart since June 2004 were reviewed. Solitary renal calculi were identified on both CT and US in all cases. They identified 71 calculi in 60 patients. Compared with CT; US overestimated stone size and effect that was more pronounced with smaller calculi. The mean stone measurement on CT was 7.4-4.4 mm and on US it was 9.2-4.5 mm (P _ .018).

For stones -5 mm, U/S measurements were a mean of 1.9-1.2 mm greater that CT (P _ .001). U/S and CT measurements were discordant for 60% of stones -5 mm. discordant was associated with US measurement of skin-to-stone distance (P _ .018), but not body mass index (P _ .189) or location within the urinary tract (P _ .161). Review of the literature revealed that U/S has a pooled sensitivity and specificity of 45% and 94%, respectively, for the detection of ureteral calculi and 45% and 88%, respectively, for renal calculi.

As conclusion they found that U/S overestimates stone size in urolithiasis, a finding that may have implications for stone management. Discordance in stone measurement various with size and is greatest in stones -5 mm. US measurement of skin-stone-distance is an important determinant of error in U/S measurement of renal calculi.

Chapter Three

Materials and Methods

3.1. Place & time of the study

This study performed in Department of Radiology in Omdurman military hospital in Khartoum state,(General Administration of Medical Services) Accident and Emergency Hospital.

Period of study 6 months (January 2015 to June 2015)

3.2 Populations

This study included 50 subjects (36 male and 14 female) with age range from 17 to 70 years. Study cases were selected from patient referred to CT department in Omdurman military hospital(Accident and Emergency Hospital) for CT KUB.

3.3 Study variable

The variables that collected from each subject include: gender, age, body, side, site, US finding and CT finding.

3.4 Instrumentation

3.4.1 CT machine

The CT images were conducted using (TOSHIBA aquilion 64 slices) CT scanner. The scan parameters are (3mm slice, 120 kvp and 225 mAs). And with using the electronic caliper within the scanner the following diameters were measured. The features of CT scanner are:

256 slices in one rotation with 5 mm slice thickness.

Coverage of 13 cm in patient axis direction.

Figure 3.1 TOSHIBA Aquilion 64 slices that used in the study

3.4.2 CT KUB technique

3.4.2.1 Indication

Renal colic, suspected renal tumor, suspected renal or pre renal collection and investigation of obstructive uropathy.

3.4.2.2 CT KUB protocol

CT KUB (non contrast enhanced CT of the kidney, ureter and bladder) with useful to determine the number and location of urinary tract calculi. It is used in some centers as primary investigation of renal calculi.

The patient lies supine on CT scanner table.

Scout view is obtained.

A low radiation dose technique is used to scan from the top of the kidney to include the bladder base with slice thickness of 5 mm or less as determined by CT scanner (no use of i.v. contrast) (France A .2009).

3.4.3 U/S machine

GE medical system LOQIC 5 Expert, made by Yocogama medical systems LTD-JAPAN – model 2302650, serial No. 1028924, manufactured April 2005.

3.4.4 Choice of transducer

Use 3.5 MHz for adults.

Curve-linear prob.

Use 5 MHz for children and thin adults.

3.4.5 Setting the correct gain

- Start by placing the transducer longitudinal central and at the top of the abdomen (the xiphoid angle)

- Ask the patient to take a deep breath and hold it in

- Angle the transducer beam towards the right side of the patient.

3.4.6 Abdomen U/S technique

- The patient should take nothing by mouth for 8 hours preceding the examination

- If fluid is essential to prevent dehydration only water should be given

- Infants should be given nothing by mouth for 3 hours preceding the examination

3.4.6.1 Position of the patient

- Lie comfortably on his/her back (supine)

- Head may rest in a small pillow

- To visualize Rt. And Lt, kidneys, apply gel to the Rt. And Lt. upper abdomen consequently.

- Scanning is best performed with the patient holding the breath in.

3.4.6.2 For the right kidney

- Supine (as basic):

- Left posterior oblique:

- Left lateral decubitus and:

- Prone as needed.

3.4.6.3 For the left kidney

- Right lateral decubitus (as basic) and:

- Prone as needed.

- Note different patient positions should be used whenever the suggested position does not give the desired result

Chapter four

Results

This data shows U/S and CT finding included 50 patients analyzed in tables and diagrams which showed below,

Table (4.1) shows the patient's ages in frequency and percentage

Age group in years	Frequency	percentage%
Less than 20	5	10%
21-40	28	56%
41-60	15	30%
More than 60	2	4%
Total cases	50	100%

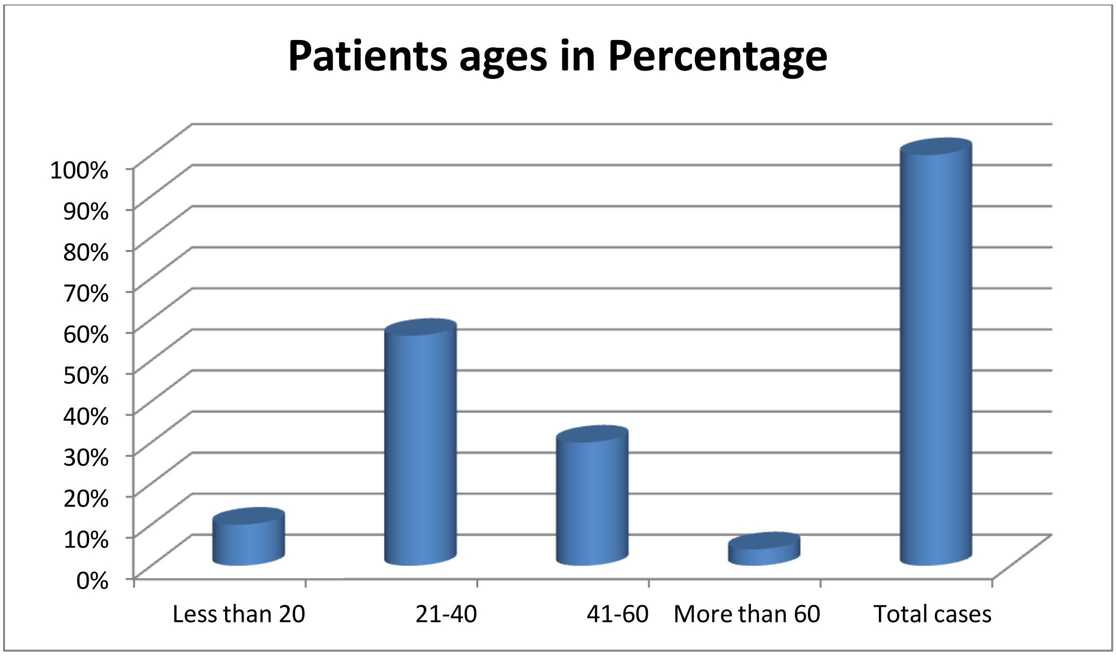


Figure (4.1) shows the patient's ages in frequency and percentage

Table (4.2) shows the patient's gender in frequency and percentage note the males are more than females

Gender	Frequency	Percentage %
Male	36	70%
Female	14	30%
Total cases	50	100%

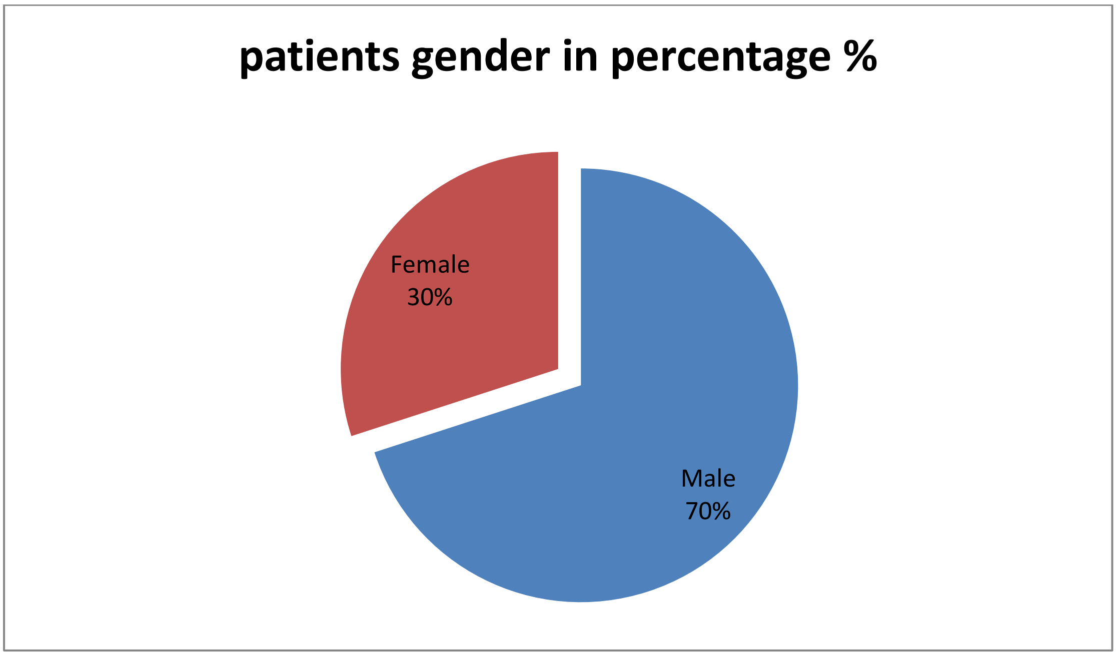


Figure (4.2) shows the patient's gender in frequency and percentage, note the male are more than females

Table (4.3) shows the frequency and percentage of the presence of family history among the patients

Family history	Frequency	Percentage%
Present	16	32%
Not present	34	68%
Total cases	50	100%

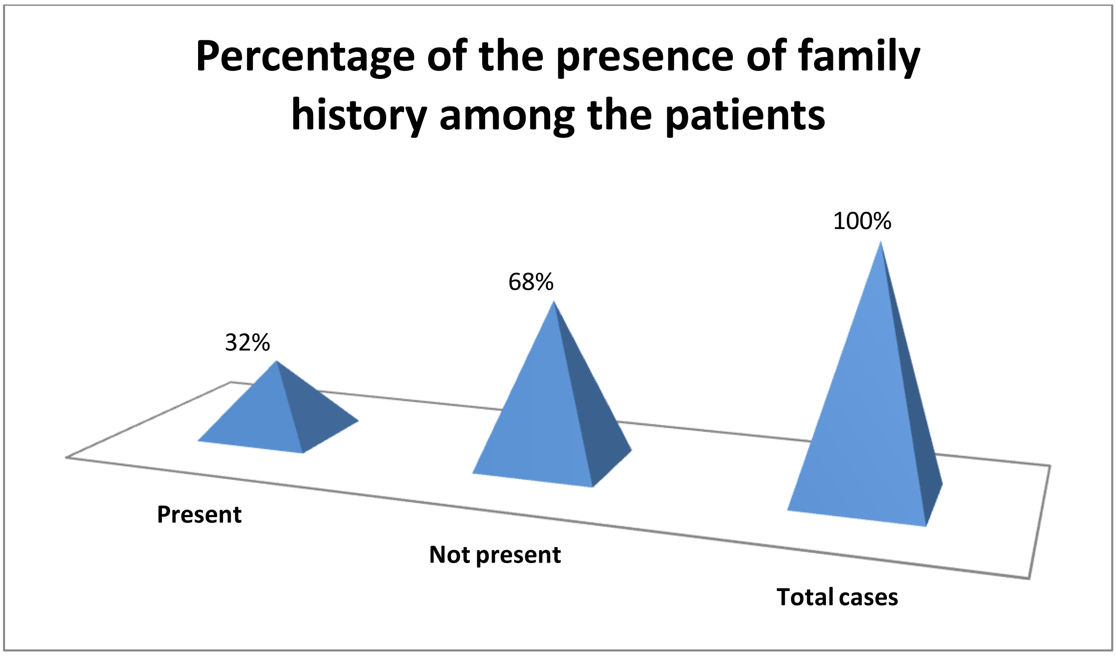


Figure (4.3) shows the frequency and percentage of the presence of family history among the patients

Table (4.4) shows finding of affected side by U/S in percentage

Affected side	Percentage%
Left	12%
Right	12%
Both	20%
Nil	56%

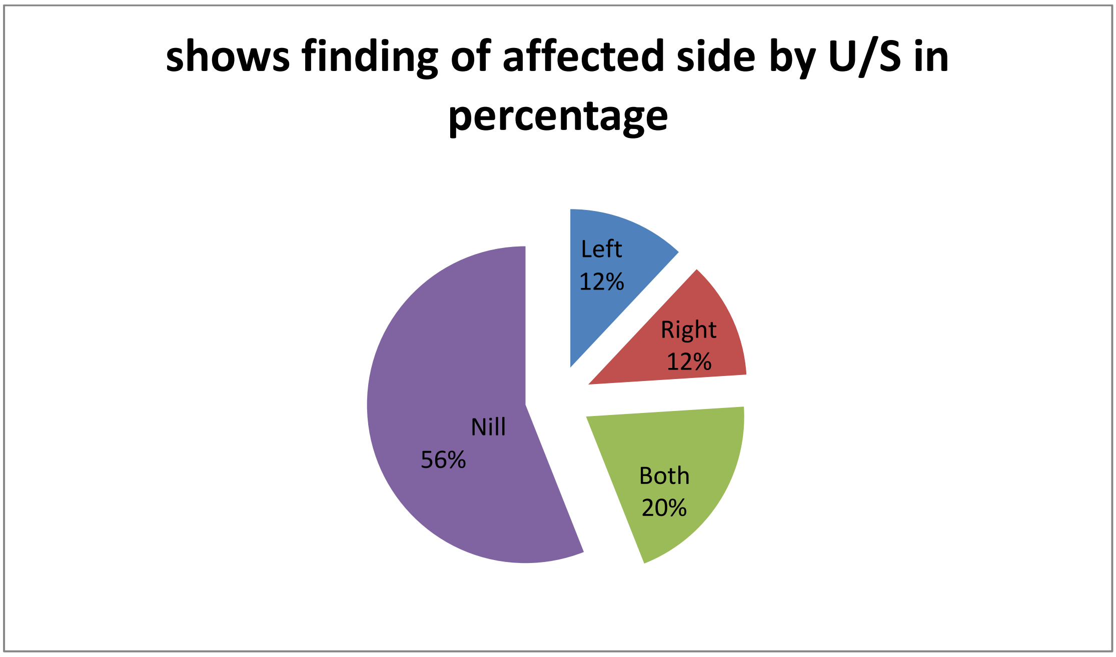


Figure (4.4) shows finding of affected side By U/S in percentage

Table (4.5) shows affected side by CT in percentage

Affected side	Percentage%
Left	26%
Right	8%
Both	28%
Nil	38%

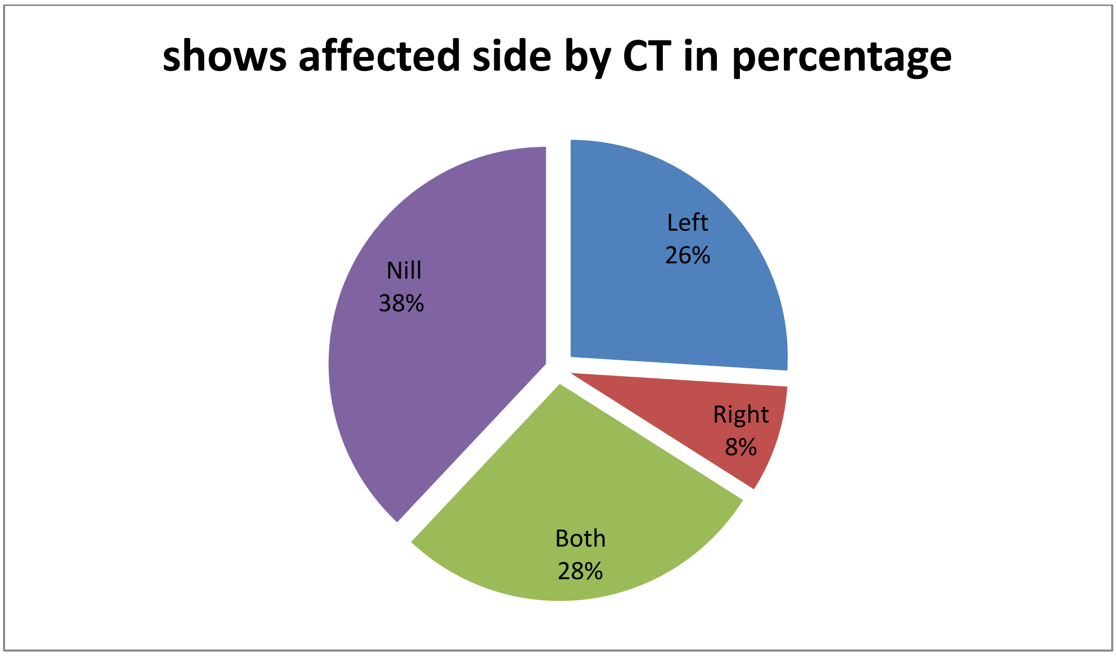


Figure (4.5) shows affected side by CT in percentage

Table (4.6) shows site of the stone by U/S percentage

Site of stone	Percentage%
Kidney	36%
Ureter	6%
Nil	58%

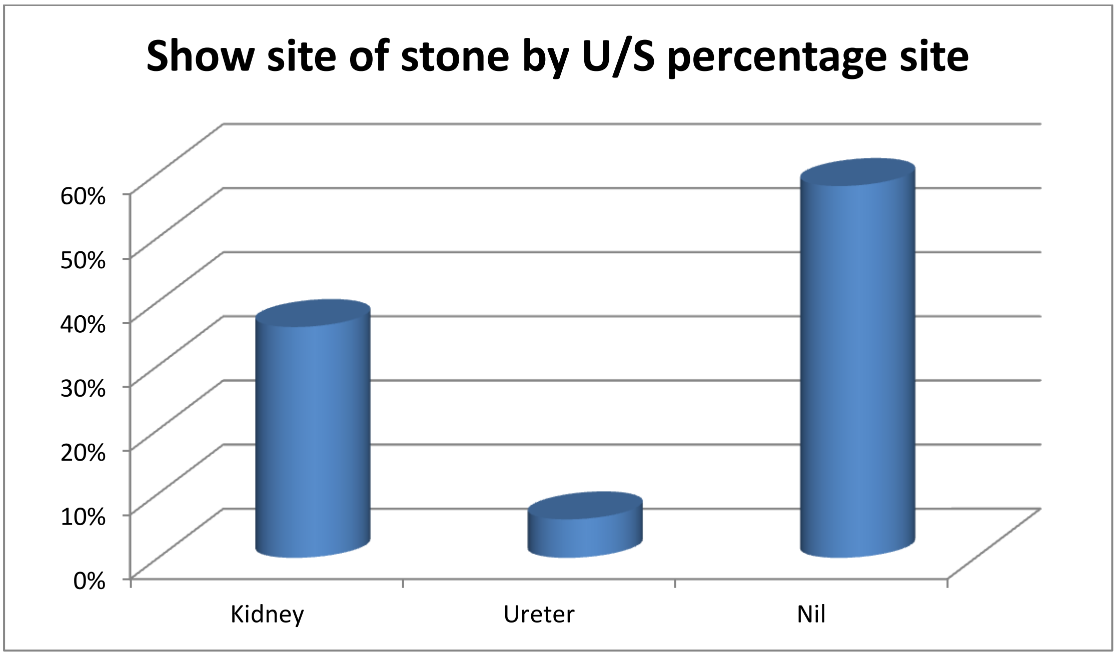


Figure (4.6) shows site of the stone by U/S in percentage

Table (4.7) shows site of the stone by CT in percentage

Site of stone	Percentage%
Kidney	44%
Ureter	18%
Nil	38%

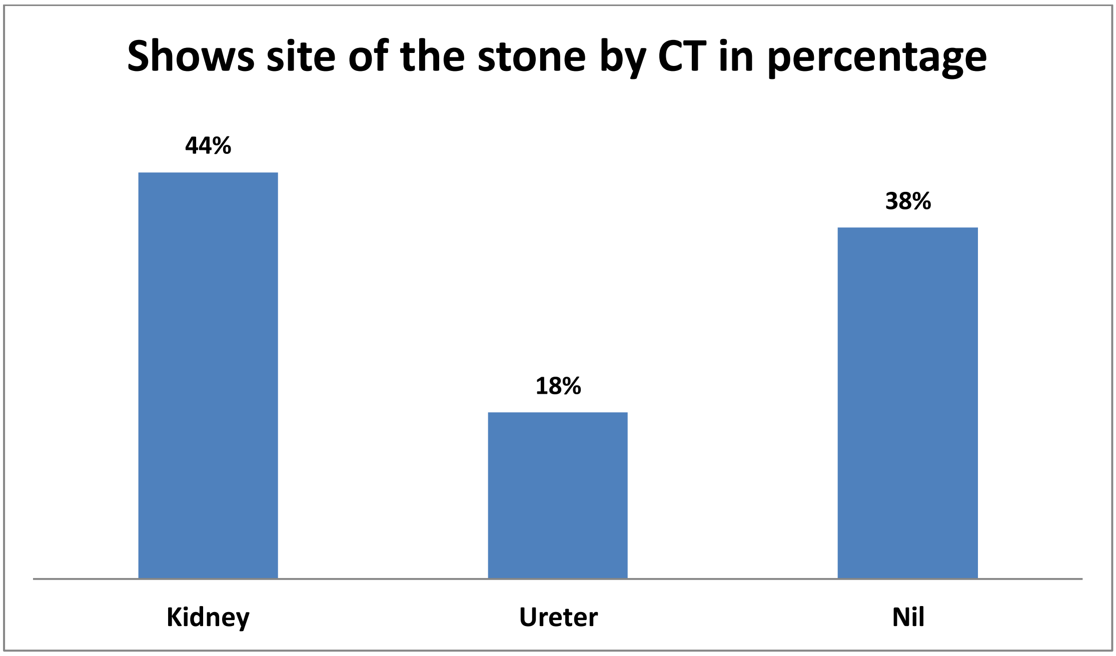


Figure (4.7) shows site of the stone by CT in percentage

Table (4.8) shows measurement of stone size by U/S in mm

Site of stone	Less than 5mm	More than 5mm
Kidney	2 stone	9 stone
Ureter	0 stone	2 stone

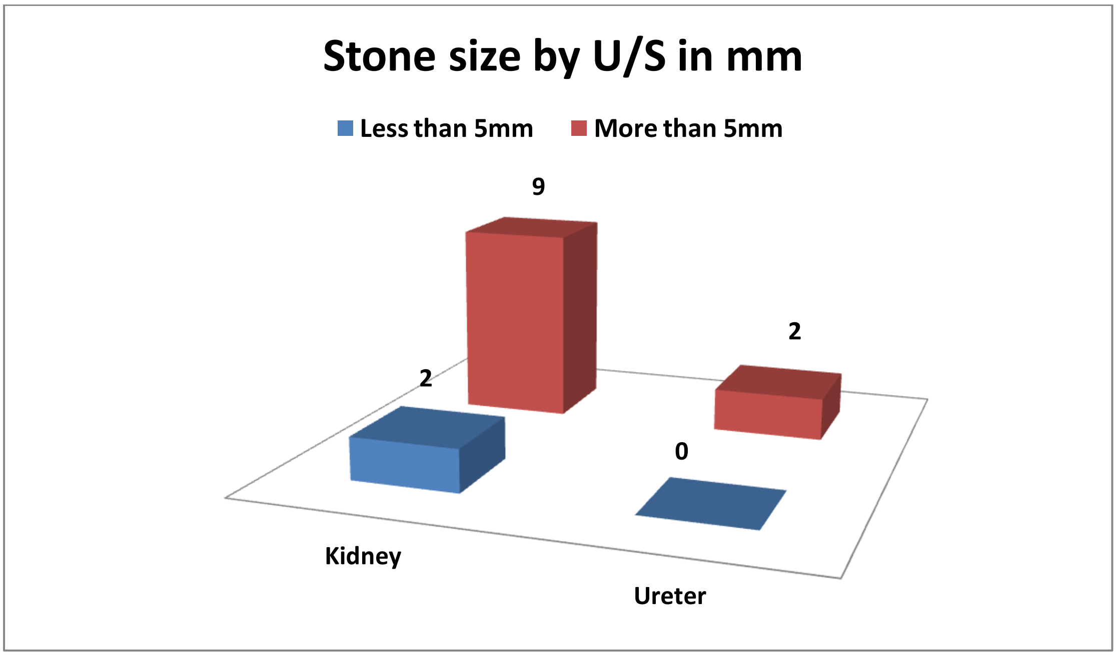


Figure (4.8) shows measurement of stone size by U/S in mm

Table (4.9) measurement of stone size by CT in mm

Site of stone	Less than 5mm	More than 5mm
Kidney	8 stone	13 stone
Ureter	1 stone	8 stone

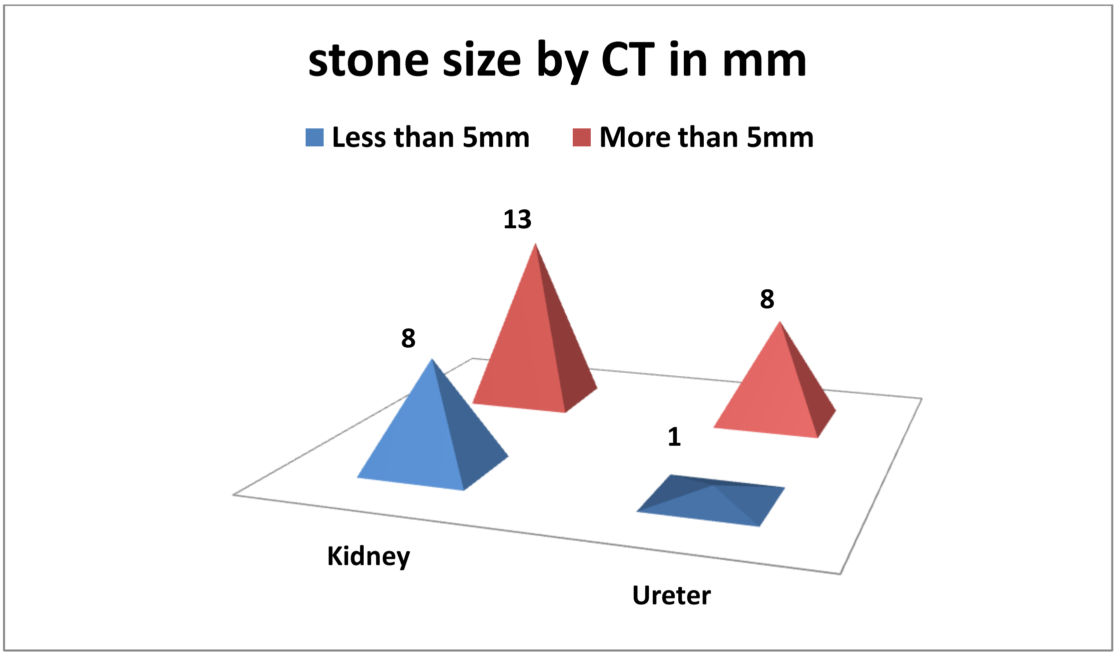


Figure (4.9) measurement of stone size by CT in mm

Table (4.10) shows CT versus US in measurement of stone size in kidney

Modality	Less than 5mm	More than 5mm
U/S	2 stone	9 stone
CT	8 stone	13 stone

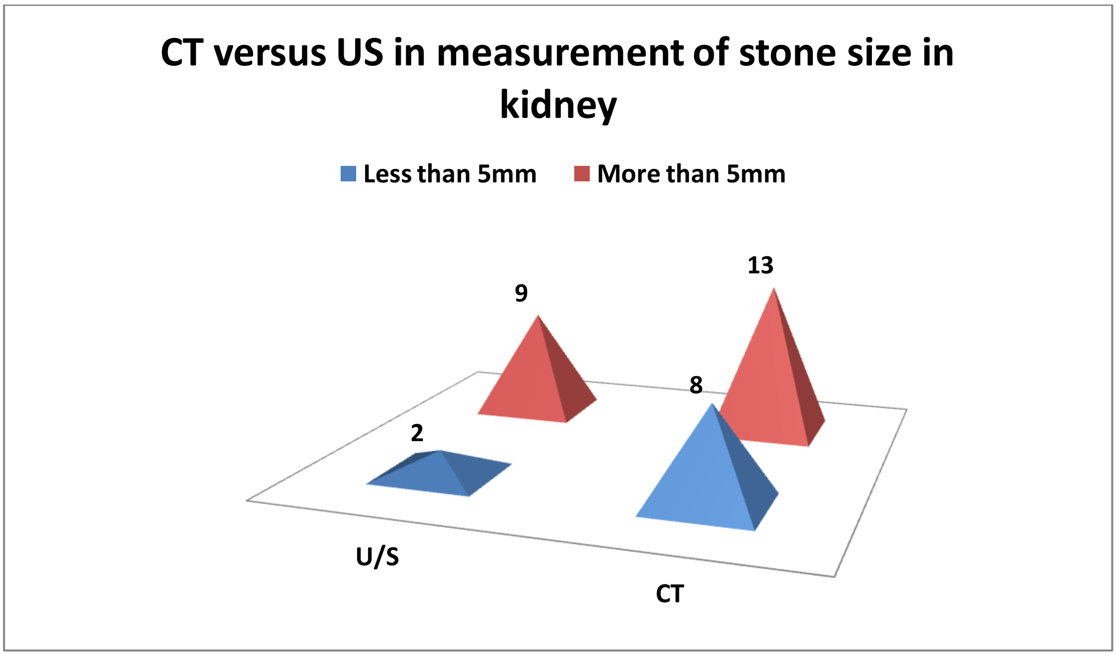


Figure (4.10) shows CT versus US in measurement of stone size in kidney

Table (4.11) shows CT versus US in measurement of stone size in ureter

Modality	Less than 5mm	More than 5mm
U/S	0 stone	2 stone
CT	1 stone	8 stone

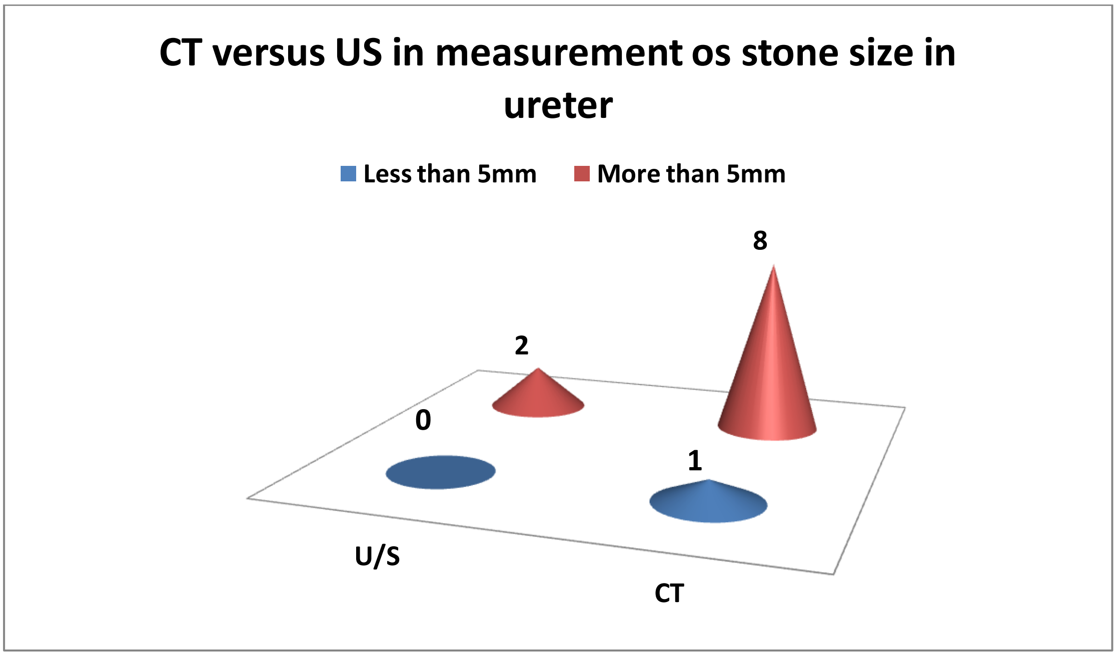


Figure (4.11) shows CT versus US in measurement of stone size in ureter

Chapter five

Discussion, conclusion, and recommendation

5-1 Discussion

Recent studies have shown that contrast spiral CT is an excellent method for demonstrating renal stones in patients with suspected renal colic (Vieweg J., et al 1998) showed non-contrast CT to be more effective than IVU in identifying ureteral stones. In another comparative study, (Smergel E., et al 2001) noted that reformatted, noncontrast spiral CT images were suprerior to a combination of US and plain abdominal radiography for ureteral calculi

In the current study, a comparison was made between spiral CT and US in 50 patients, with comparable results for the two modalities in the demonstration of real calculi in some cases it was difficult ot measure stone size by CT and US (figure (4.15)).

The visualization of renal stone with CT and US technique was obtained, the consecutive CT an US scans from 50 patients were separated into urinary system and were evaluated; each image was analyzed separately

The characteristics of the all variable in the sample studied were described as frequencies and percentages

The present result agree with studied done by (Yilamz et al, (1997), PATLAS et al, (2001) and Oner et al (2004).

56% of patients in studied sample are aged from 21-41 years old and they are mostly affected by renal stone, while 34% of patients are over 40 years these shown in table (4.1).

US finding shows that both sides are more affected in sample studied by percentage of 20% than either side RT by 12% and LT by 12% percentages. This appeared in table (4.4). While CT finding shows that both side are more affected in sample studied by percentage of 28% that either side RT by 8% and LT 26% percentages. This appeared in table (4.5).

In table (4.6) 36% of total cases are affected in the kidney, while Ureter obtained a lower proportion (6%) respectively.

The sensitivity of CT more efficient than US. This demonstrated in table (4.9).

Those above present results were confirmed and agree with previous studies done by (Ronan et al, (2007) AND Andrew et al (2010)).

Lastly, when we are perform the two images planes (axial, direct coronal) that is proper technique because by two views can obtain accurate diagnose and any pathological changes appear clearly

US, which is universally available, non0invasive, inexpensive and radiation free, is preferred by some radiologists as the initial method for evaluation of the renal stones. However, US is considered to be of limited value in demonstrating pathological conditions of the ureter (Myers M. T., et al 2001).

All patients with ureterolithiasis described here some degree of hydroureter, hence US was able to follow the ureter to the level of the stone and demonstrate the exact nature of the obstructing lesion. An intraluminal echogenic focus with acoustic shadowing was clearly depicted in all cases.

Technical problems might occur in assessing the urter when the stone in the middle third, an area obscured by bowel gas so this problem solved by compressing the area to examined and changing the patient's position.

Dallapalma (strouse P.J., 2002) evaluated 120 patients with renal colic using US and plain radiographs, and achieved 95% sensitivity but only 67% specificity US was classified as positive for ureteric colic in the study when calculi or hydronephrosis were present.

In this study, CT and US were equally sensitive in detecting renal calculi. In the study by Sommer et al, there were false negative US examinations owing to lack of significant hydronephrosis detectable on the examination (Niall O., et al 1999). In this study US was also accurate in depicting stones in cases of minimal hydronephrosis.

5-2 Conclusion:

This modern equipment CT has diagnosing function and resulting in good high technical properties and this powerful procedure must be one important interest of our planning to progress and develop our medical services in the Sudan.

CT is the image modality to evaluate the renal stones, as the provides a road map and excellent detail is available regarding to the anatomy, pathology and early diagnosis of urinary system abnormalities so it's very important factor in the disease management both spiral CT and US were found to be excellent modalities for depicting renal stones, but because of high cost, radiation does and high workload of CT, U/S is the first line choice in diagnosis of renal calculi.

5-3 Recommendations:

In this study there are some points in a form of recommendations as follows:

- U/S and spiral CT should be available in emergency unit
- U/S should be performed as first line of diagnosis in all cases and CT should be reserved for cases where US fails to provide diagnostic information
- Well trained radiologist and technologist are important for well medical service management
- To keep the exposure as law as reasonable
- The clinical centers of radiological examinations should have great care about the staff i.e. caring about routine training and attendance of seminars as well as to have knowledge about the new models of equipments related to the fields
- The radiological imaging tools must be offered in rural areas to play its role in early detection of renal diseases to avoid fatal complication.

References:

A. Andrew Ray , Daniela Ghiculete , Kenneth T.Pace, and R. John D,A Honey , Limitations to Ultrasound in the Detection and Measurement of Urinary Tract Calculi , UROLOGY 76 (2), 2010.

Catalano O, Nunziata A, Altei F, et al. Suspected ureteral colic: primary helical CT versus selective helical CT after unenhanced radiography and sonography. A JR Am J Roentgenol. 2002;178: 379-387.

Chen M.Y., Zagoria R.Y.: Can noncontrast helical computed tomography replace intravenous urography for evaluation of patients with acute urinary tract colic? J Emerg Med, 1999, 17: 299-303.

Dunnick RN, Sandler CM, Newhouse JH, et al. Textbook of Uroradiology, 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2001:178-194.

Fielding J.R., Steele G., Fox L.A., Heller H., Loughlin K.R.: Spiarl computed tomography in the evaluation of acute flank pain: a replacement.

Flank pain: value of unenhanced helical CT. AJR, 1996,166: 97-101. For excretory urography. J Urol, 1997, 157: 2071.

France A.: Agide to radiological procedures .Hourcoutpuplisher 2001. 139,140.

http://www.dilipraja.com/stone.htm

http://www.virtualmedicatcentre.com/anatomy.asp?sid=14&title=urinary-system-(renal-system) accessed on 30-9-2011.

http://www.acoustic output measurement /and labeling standard diagnostic ultrasound /equipment, Laurel, MD, 1992, American Institute of Ultrasound in Medicine.

http://www.virtualmedicatcentre.com/anatomy.asp?

http://www.slideshare.net/ananthatiger/urinary_tract-

3830919accessed on 1 - 9 - 2011.

L. Ronan.; S. Menasce;.Faintuch; J. Ferreira; D.IBekhor; D. Ariel; V.Ortiz; P. Choyke; J.Szejnfeld ,Comparison between ultrasound and noncontrast helical computed tomography for identification of acute ureterolithiasis in a teaching hospital setting , Sao Paulo Med.J. vol. 125 no.2 Sao Paulo Mar, 2007.

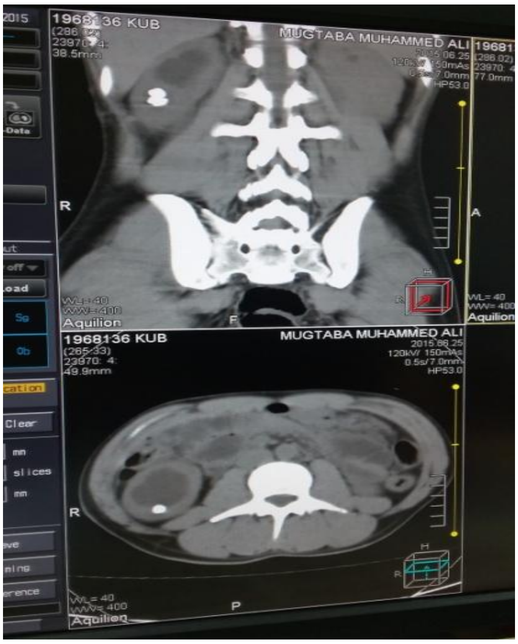
Morcos SK CT Urography: technique, indications and limitations. CurrOpinUrology , 2007,17:56–64.

Teichman JM. Clinical practice. Acute renal colic from urethral calculus. N Engl J Med, 2004;350:684-693.

West T, Dean M. Basic Anatomy and Physiology for Radiographer, 3d Edition, 1987; 164: 87-103.

Appendences

Appendix (1)



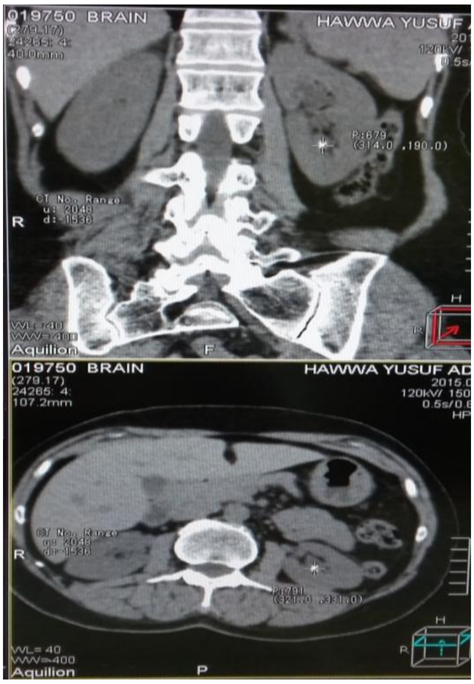
(A)

(B)

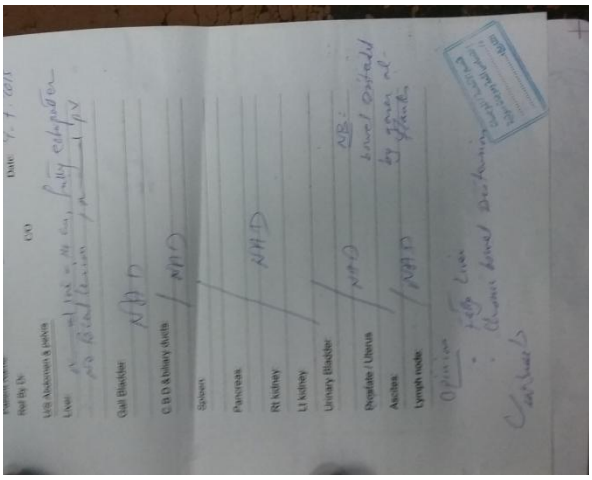
(A) CT coronal and axial sections show RT renal stone in the lower pole.

(B) U/S finding show (RT) renal stone in the lower pole

Appendix (2)



(A)



(B)

(A) CT coronal and axial sections show (LT) renal stone.

(B) U/S finding show normal (LT) renal appearance no stone notice.