بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Characterization of Urinary Tract Urolithiasis using Computed Tomography

توصيف حصاوي الجهاز البولي بإستخدام الأشعة المقطعية المحوسبة

A thesis submitted in partial fulfillment for the Requirements of M.Sc. Degree in Diagnostic Radiologic Imaging

by:

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الأية

بسم الله الرحمن الرحيم

صدق الله العظيم

Dedication

To my mother, my family and friends, to every one whom stand beside me and they will be there forever … much of love and respect may Allah save you for me.

ACKNOWLEDGMENT

I am grateful thanks to my god who made all things possible and give me power to do such work, and highly thankful to (collage of medical radiological science) for guidance throughout to completion of this project.

Special thanks to my supervisor Dr: Hussain Ahmed for his great support.

Finally, I would like to thank everybody who helped me in preparing and finishing this study.

Abstract

Kidney stone disease is one of the most common diseases of the urinary system, which ranks third in urology departments after urinary tract infection and prostate disease, and is the most prevalent by 10-15%. This spread has also increased in the last twenty years with a high rate, from the mid-1990s to the beginning of the second millennium.

The study aimed to characterize of urinary system stones by using computed tomography for kidney, ureter and bladder (CT-KUB), and performed in National Ribat university Hospital on 100 patients, they were recommended to have CT-KUB, by computed tomography (Toshiba a (64 slices) machine with slice thickness 5 mm, collimation of 0.3*64 mm, 120 Kvp and 150– 250 mill ampere) for urinary system diseases.

The results of this study showed that the most affected age group are those between (50-59) years, and that males are 57% more likely to have kidney stone disease than women by 43%. This study showed that, the frequency distribution of location of stone, were the mean frequent location was right pelvic kidney with (29%), LT Pelvic kidney stone and LT UPJ Stone with (18%).

The most common site for stones is the right kidney. The repeated kidney stone scale was from (1-50) mm with a density of (200-600) HU, and its type was Calcium Oxalate and Uric Acid.

This study found that the CT device has the full ability to detect and measure the stones and know its type and the main component of it, and that there is a direct relationship between the present of stones with the increase of age, and an inverse relationship between stone size and age.

ملخص الدراسة

يعتبر مرض حصاوي الكلى من اكثر امراض الجهاز البولي انتشارا والذي ياخذ المرتبة الثالثة في اقسام المسالك البولية بعد مرض التهاب الجهاز البولي وامراض البروستاتا, ويعد الاكثر انتشارا بنسبة 10-15%. كما ازداد هذا الانتشار في العشرون عاما الاخيرة بنسبة عالية وذلك من اواسط التسعينات الى بداية الالفية الثانية .

الهدف من هذه الدراسة هو توصيف حصاوي الجهاز البولي بواسطة الاشعة المقطعية المحوسبة . أجريت هذه الدراسة في مستشفى جامعة الرباط الوطني على 100 مريض وتم عمل صورة مقطعية بإستخدام جهاز الأشعة المقطعية (توشيبا 64 شريحة وسمك 5 ملمتر، 120 كيلو فولت و 150-250 ميلي امبير) لأمراض الجهاز البولي.

، وان متوسط المواقع المتكرره هو حوض الكلى اليمنى بنسبة (29%) وبنسبة (18%) في حوض الكلى اليسرى والارتباط بين الحالب الايسر والحوض. أكثر المواقع عرضة للاصابة بالحصاوي هي الكلى اليمنى ومقياس الحصاوي المتكرر كان من (1-50)مم بكثافة مقدارها من (200-600) هاونسفيلد يونيت ونوعها كالسيوم اوكسليت واليوريك اسيد.

هذه الدراسة اوجدت ان جهاز الاشعة المقطعة له المقدرة الكاملة على اكتشاف الحصاوي وقياسها ومعرفة نوعها والمكون الاساسي لها، وأن هنالك علاقة طردية بين ظهور الحصاوي والزيادة في العمر، وعلاقة عكسية بين حجم الحصاوي والعمر .

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Chapter One

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 called a CT KUB or CT urogram. It's a urinary tract CT scan of the kidneys, ureter and bladder. This type of scan can find kidney stones, bladder stones, or ureter blockage in the urinary tract. Advantages of CT-KUB are: quick, easily accessible, identification of calcified urinary system calculi and their sequelae, and assessment of other causes of flank pain if negative for calculus disease. Disadvantage of CT-KUB is exposure to ionizing radiation. 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. (David Sutton 1987)

1.2 Problem of the study:

Composition of renal calculi is difficult to identified by most of image modalities, treatment of urolithiasis effectiveness depends on identification of the composition, size and location of stones of calculus, CT scan is accurate in this.

1.3 Objectives of the study:

1.3.1 The general objective:

This study aims to characterization of urolithiasis by using good imaging application called CT KUB.

1.3.2 The specific objective:

- To characterize using of CT KUB in detection of stone.
- To identify the most affected age group.
- To evaluate the most effected gander and to determine location of stones.
- To evaluate the size and density of stones.

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 CT KUB scan 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.

Chapter Two

Background & Literature review

2-1 Anatomy of urinary system:

The urinary system is composed of: the right and left kidneys, the right and left ureters, the urinary bladder and urethra. (Danish ,2013).

2-1-1 The Kidneys:

The kidneys are two organs of characteristic shape which lie on the posterior abdominal wall, beneath the peritoneum one on either side of the abdomen, their upper poles lie at the level of the upper border of the 12th thoracic vertebra, about 2.5 cm above the highest palpable parts of the iliac crests. The central indentation of the medial border of each kidney, which is called the renal hilum, lies at the level of the trans pyloric plane. However, since the right kidney is slightly lower in position than the left. (Cuyton, et-al. et 2005).

The relation of the kidney, posteriorly the diaphragm, the quadrates lumborum muscles, the psoas muscle and the 12th rib. Anteriorly the relation differs on each side. The right kidney is related, at it's the upper pole to the right suprarenal gland.

The left kidney is related to the upper medial border to the left suprarenal gland, the upper two third is to the lateral of spleen. Medially to this area to the stomach above, the splenic vessels and pancreases below. Laterally is the splenic flexure of the colon. (Cuyton, et-al. et 2005).

The kidneys are enclosed in a thin capsule of fibrous tissue in the un diseased kidney, is easily removed, each kidney has an anterior and posterior surface, a lateral convex border and a medial border which convex above and below, but has a central indentation, the renal hilum through which the renal vessel and the ureter pass. Also the kidney consists of the cortexes which contain approximately

1000,000 units called nephrons, medulla: consist of conical masses, the pelvis of the ureters, divided into two or three branches called the major calyces and these further divides into several smaller branches called minor calyces. (Cuyton, et-al. 2005).

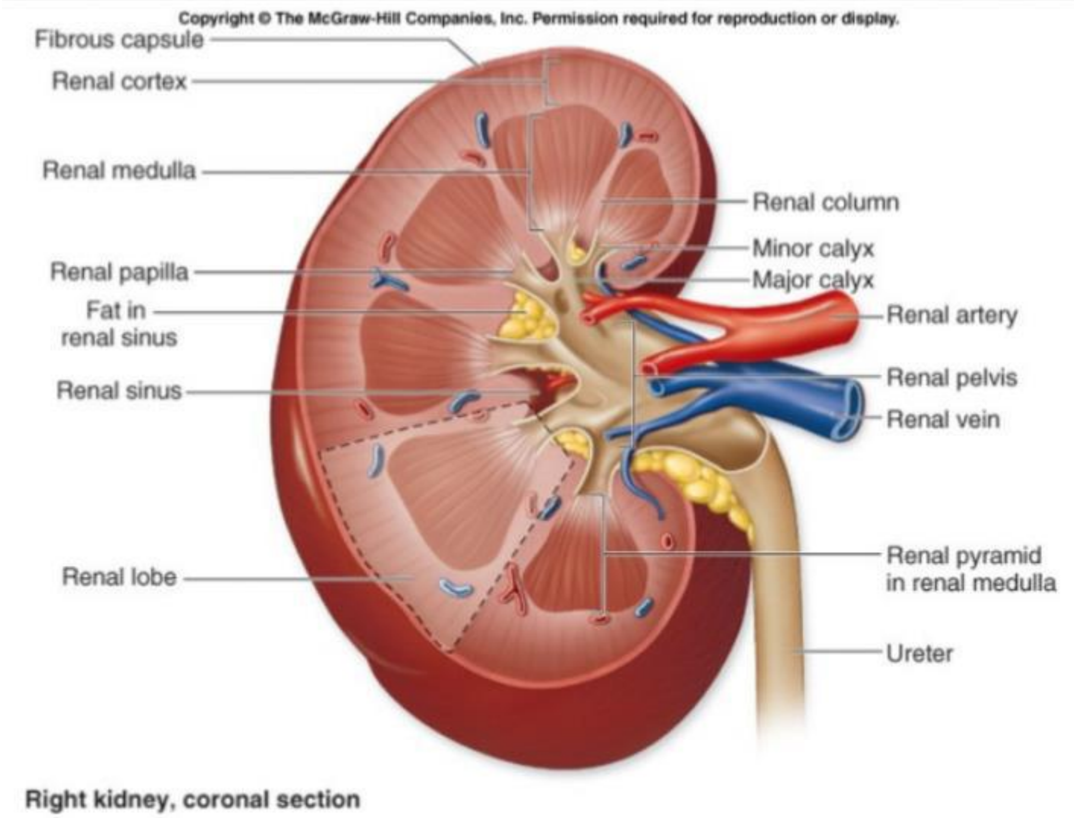


Figure 2-1: Show structure of the Kidney (Snell, 2009)

2-1-2 Ureters:

The ureters are two muscular tubes extend from the kidneys to urinary bladder, each ureters are about 25 cm in length divided in to three parts, the pelvis of ureters The abdominal portion of ureters, the pelvic portion of ureters, the structure of the ureters, the ureters consist of three layers, they an outer fibrous layer continuous with the capsule of the kidney, a muscular layer consists of an outer circular layer and an inner longitudinal layer of smooth muscle fibers.

An inner layer of mucous membrane lies in folds when the ureters is empty but smooth when the ureters is full. The urinary bladder, the urinary bladder act as a reservoir for the urine, and lies in the pelvis behind the pubic symphysis and the pubic bones. When empty lies in the pelvic cavity. When it is full, it rises to the abdominal versa. (Cuyton, et-al et 1983).

Relation of the urinary bladder: -

In male, anteriorly to the symphysis pubic, Superiorly to the part of the sigmoid colon, posteriorly to the rectum. In female: Anteriorly: to the pubic symphysis Superiorly, to the uterus, posteriorly: to the vagina and cervix, the structure of the bladder, the bladder consists of an outer serous coat, a middle muscular coat and amino mucus coat. In male, the urethra is shared with the reproductive system. In female, It's about 4 cm in length. Female urethra consists of a muscular layer, a thin coat of spongy tissue and a layer of mucous membrane. (Cuyton, et-al, 1983)

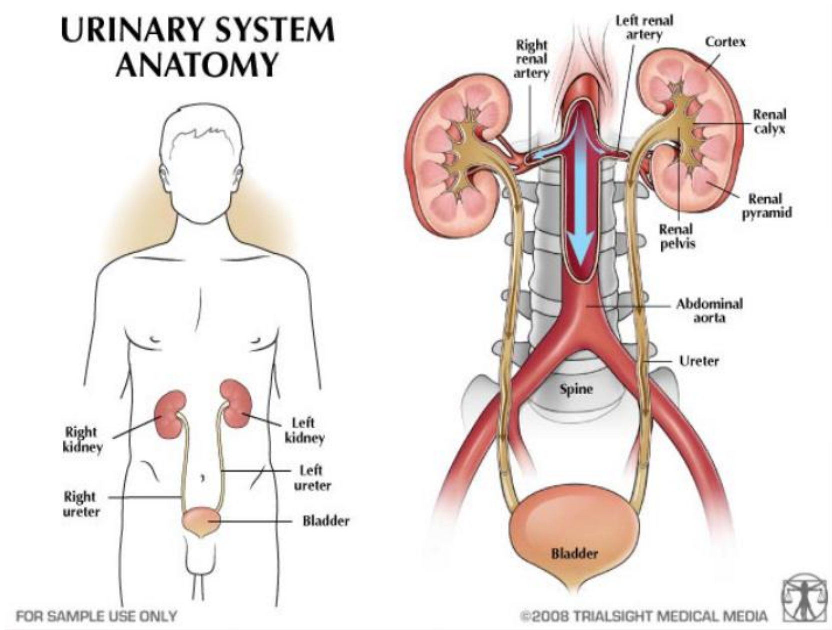


Figure 2-2: Anatomy of Urinary System (Snell, 1956)

2-1-3 Urinary Bladder:

The urinary bladder is a hollow, muscular and distensible or elastic organ that sits on the pelvic floor (superior to the prostate in males). On its anterior border lies the pubic symphysis and, on its posterior border, the vagina (in females) and rectum (in males). The urinary bladder can hold approximately (500 to 530 ml) of urine, however the desire to micturate is usually experienced when it contains about 150 to 200 ml. After the urine enters the bladder from the ureters, small folds in the bladder mucosa act like valves preventing backward flow of the urine. The outlet of the bladder is controlled by a sphincter muscle. A full bladder stimulates sensory nerves in the bladder wall that relax the sphincter and allow release of the urine. However, relaxation of the sphincter is also in part a learned response under voluntary control. The released urine enters the urethra. (Marieb et-al, 1999).

2-1-4 The urethra:

The urethra is a muscular tube that connects the bladder with the outside of the body. The function of the urethra is to remove urine from the body. It measures about 1.5 inches (3.8 cm) in a woman but up to 8 inches (20 cm) in a man. Because the urethra is so much shorter in a woman it makes it much easier for a woman to get harmful bacteria in her bladder this is commonly called a bladder infection or a UTI. The most common bacteria of a UTI is E-coli from the large intestines that have been excreted in fecal matter. Female urethra in the human female, the urethra is about 1-2 inches long and opens in the vulva between the clitoris and the vaginal opening. Men have a longer urethra than women.

This means that women tend to be more susceptible to infections of the bladder (cystitis) and the urinary tract. Male urethra in the human male, the urethra is about 8 inches long and opens at the end of the head of the penis. The length of a male's urethra, and the fact it contains a number of bends, makes catheterization more difficult. (Kyle, 2014).

2-1-5 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).

2-1-6 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).

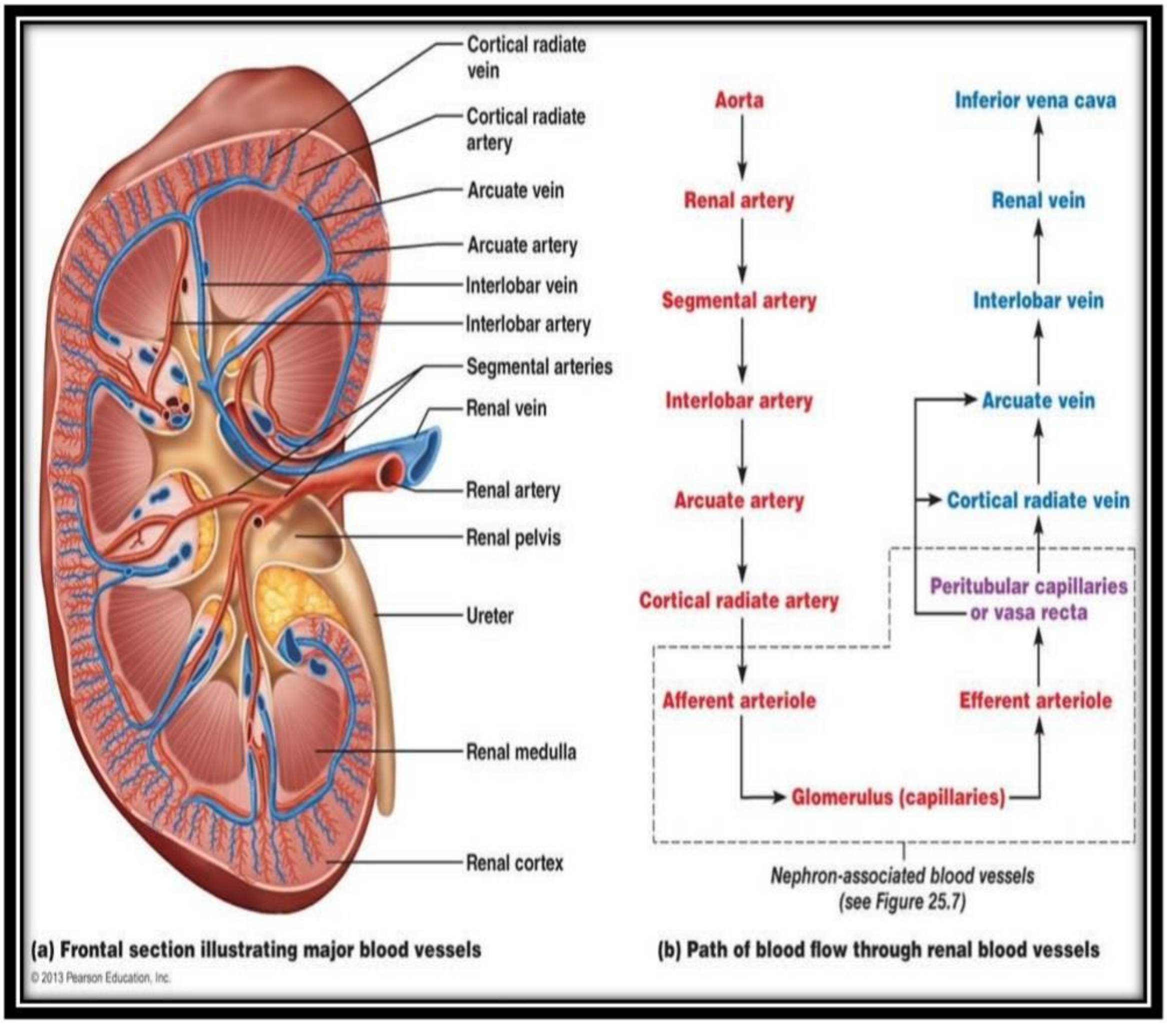


Figure: 2-3 Blood Supply of Kidney. (classes.midlandstech.edu).

2.2 Physiology:

One of the major functions of the Urinary system is the process of excretion. Excretion is the process of eliminating, from an organism, waste products of metabolism and other materials that are of no use. The urinary system maintains an appropriate fluid volume by regulating the amount of water that is excreted in the urine. Other aspects of its function include regulating the concentrations of various electrolytes in the body fluids and maintaining normal pH of the blood.

The kidneys are the most important excretory organ, when the primary function of them 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. (Boron et-al, 2012)

2-2-1 The adrenal gland:

The adrenal glands (also known as suprarenal glands) are endocrine glands that produce a variety of hormones including adrenaline and the steroids aldosterone and cortisol. They are found above the kidneys. Each gland has an outer cortex which produces steroid hormones and an inner medulla. The adrenal cortex itself is divided into three zones: zona glomerulosa, the zona fasciculate and the zona reticularis. The adrenal cortex produces three main types of steroid hormones: mineralocorticoids, glucocorticoids, and androgens. Mineralocorticoids (such as aldosterone) produced in the zona glomerulosa help in the regulation of blood pressure and electrolyte balance.

The glucocorticoids cortisol and corticosterone are synthesized in the zona fasciculata; their functions include the regulation of metabolism and immune system suppression. The innermost layer of the cortex, the zona reticularis, produces androgens that are converted to fully functional sex hormones in the gonads and other target organs. The production of steroid hormones is called steroidogenesis, and involves a number of reactions and processes that take place in cortical cells. The medulla produces the catecholamine adrenaline and noradrenaline, which function to produce a rapid response throughout the body in stress situations. (Britton, 2010).

2-2-2 Nephrons:

A nephron is the basic structural and functional unit of the kidney. The name nephron comes from the Greek word (nephrons) meaning kidney. Its chief function is to regulate water and soluble substances by filtering the blood, reabsorbing what is needed and excreting the rest as urine. Nephrons eliminate wastes from the body, regulate blood volume and pressure, control levels of electrolytes and metabolites, and regulate blood pH. Its functions are vital to life and are regulated by the endocrine system by hormones such as antidiuretic hormone, aldosterone, and parathyroid hormone. (Boron et-al, 2012)

Each nephron has its own supply of blood from two capillary regions from the renal artery. Each nephron is composed of an initial filtering component (the renal corpuscle) and a tubule specialized for reabsorption and secretion (the renal tubule). The renal corpuscle filters out large solutes from the blood, delivering water and small solutes to the renal tubule for modification. (Ganong, 2000)

2-2-3 The glomerulus:

Is a capillary tuft that receives its blood supply from an afferent arteriole of the renal circulation. The glomerular blood pressure provides the driving force for fluid and solutes to be filtered out of the blood and into the space made by

Bowman's capsule. The remainder of the blood not filtered into the glomerulus passes into the narrower efferent arteriole. It then moves into the vasa recta, which are collecting capillaries intertwined with the convoluted tubules through the interstitial space, where the reabsorbed substances will also enter. This then combines with efferent venules from other nephrons into the renal vein, and rejoins with the main bloodstream. (Boron et-al, 2012)

2-2-4 Renal Hormones:

Vitamin D- Becomes metabolically active in the kidney. Patients with renal disease have symptoms of disturbed calcium and phosphate balance. Erythropoietin- Released by the kidneys in response to decreased tissue oxygen levels (hypoxia). Natriuretic Hormone- Released from cardiocyte granules located in the right atria of the heart in response to increased atrial stretch. It inhibits ADH secretions which can contribute to the loss of sodium and water. (Boron.2004)

2-3 Pathology:

The kidneys make urine which contains the waste products of the body. Diseases of the kidney are divided into those that affect the four basic morphologic components: glomeruli, tubules, interstitium, and blood vessels. The glomeruli are the most important structure in the kidney, because it is the first structure which will determine whether the kidney is functioning or not. (Tampor et-al, 2011)

2-3-1 Kidney stones:

Kidney stone (renal calculus or nephrolith) is formed by combination of a high level of calcium with oxalate stone (70%), phosphate stone (15%), urea, uric acid stone (10%)., and cystine stone (1-2%). 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 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 Urinary Tract Infection:

Infections of the urinary tract are common and are often encountered as a complication of obstruction. It characterized by bacteriuria and pyuria (bacteria and leukocytes in the urine. The infection may be symptomatic or asymptomatic, and may affect the kidney (pyelonephritis) or the bladder (cystitis) only. Pyelonephritis consists of upper urinary tract infection with concomitant pelvicalyceal and parenchymal inflammation. Cause is infected urine from lower tract in 80% of adult cases. (Takhar et-al, 2011)

2-3-5 Renal cell carcinoma:

Adenocarcinoma accounts for 85% of renal malignancies. Presenting features include hematuria, weight loss, fevers, anemia, flank pain or an abdominal mass. Direct spread can occur through the capsule into the perinephric fat and the liver. Tumor may extend along the renal vein and involve the IVC and right atrium. Its consist of two types: malignant (renal cell carcinoma, Wilms tumor) and benign (cortical adenoma, renal fibroma, hemangioma). (Rini et-al, 2008)

2-4 Imaging used in diagnostic of urinary system

2-4-1 Intravenous Urography (IVU):

An IVU or IVP Intravenous Urogram or pyelogram is a radiological procedure used to visualize abnormalities of the urinary system, including the kidneys, ureters, and bladder by using contrast media. (Bontrager et-al, 1997)

2-4-1-1 Purpose:

To visualize the collecting portion of the urinary system, to assess the functional ability of the kidney, to evaluate the urinary system for pathology or anatomic anomalies. (Bontrager et-al, 1997)

2-4-1-2 Patient preparation:

(may be different from one department to anther), Light evening meal before the procedure, Bowel cleaning laxative, NPO after midnight, Enema on the morning of the examination. (Bontrager et-al, 1997)

2-4-1-3 Procedure:

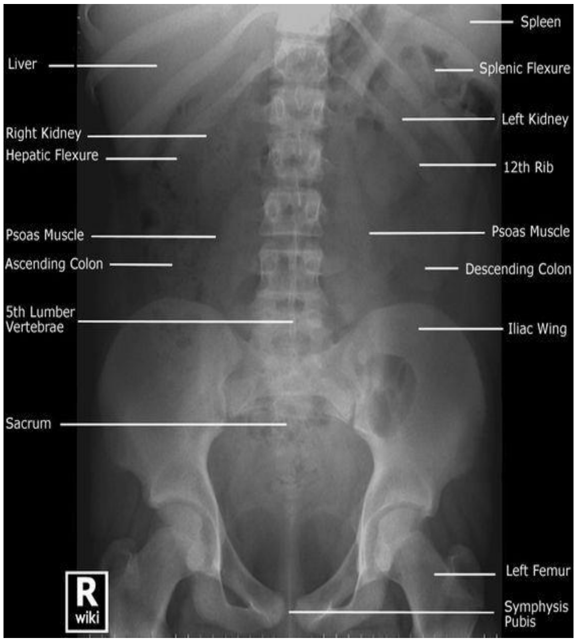
An injection of X-ray contrast medium is given to a patient via a cannula into the vein. The contrast is excreted or removed from the bloodstream via the kidneys, and the contrast media becomes visible on X-rays almost immediately after injection. X-rays are taken at specific time intervals to capture the contrast as it travels through the different parts of the urinary system. This gives a comprehensive view of the patient's anatomy and some information on the functioning of the renal system. (Bontrager et-al, 1997).

2-4-1-4 Sequences:

Table 2-1: show sequences of IVU (Bontrager et-al, 1997)

Preliminary (control) film	(35 x 43cm) supine KUB	Opacities, soft tissue outlines etc
Immediate*	(24 x 30cm)	Nephrograms
5 minute	(24 x 30cm +/- compression)	Pelvicalyceal systems: symmetry, filling
15 minute	35 x 43cm release if compression has been applied)	pelvicalyceal systems and ureters
25 minute	(24 x 30cm) 15° caudal angulation centered 5 cm above upper border of symphysis pubis	Distended bladder
Post-micturition	(24 x 30cm) 15° caudal angulation centered 5 cm above upper border of symphysis pubis	Distal ureteric drainage, bladder emptying

A



B

Figure 2-4 A: X-Ray image for KUB,   B: X-Ray image show Release (25 minute) Film

2-4-2 magnetic resonance imaging [MRI]:

MRI is a test takes pictures of body’s internal organs and soft tissues without using of x-rays or any ionizing radiation. MRI machines use radio waves and magnets to provide detailed images of body organs and soft tissue . MRI can be applied to imaging the urinary system, this application used in the following group of patients: Those who are at risk of contrast media, Those with renal cell carcinoma, Women with chronic urinary tract infection (UTI), and Children. magnetic resonance urography is being used in children and has the advantages that is provides both functional and morphological imaging. However, this requires the use of complex software. (William et-al, 1992)

MRI is also superior in detecting renal cell carcinoma metastases into renal vein. It may also be better when trying to determine whether renal lesion are simply cysts, neoplastic or hematomas. It can also be used in detection of renal artery stenosis. Magnetic renal angiography (MRA). (William et-al, 1992).

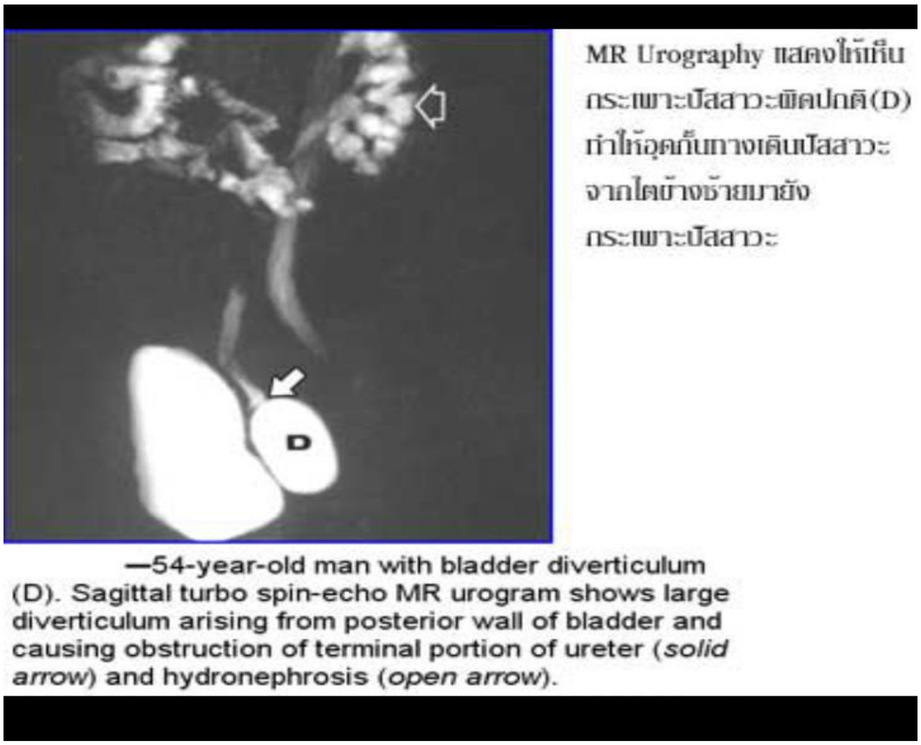


Figure 2-5:MR Urography (William et-al, 1992)

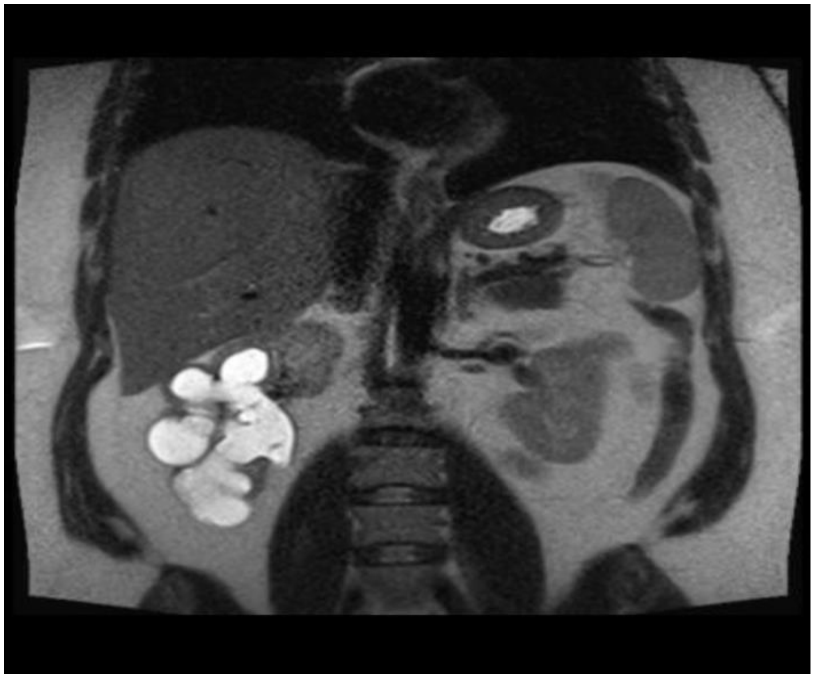


Figure 2-6: MRI coronal section T 1 W image for kidney (William et-al, 1992) .

2-4-3 Computed Tomography (CT):

Computerized tomography (CT) scanning is useful to get a very detailed 3D image of certain parts of the body. The process begins by taking many different X-ray views at various different angles, which are then combined with the use of computer processing to create cross-sectional images of the bones and soft tissue inside of your body, including tissues inside of solid organ. Ordinary X-ray testing does not show clear images of soft tissue, so doctors often request CT scanning to get a good image of soft tissue including organs, muscles, blood vessels, nerves, and the brain. Sometimes a contrast dye is used as it shows up clearer on the screen. Many organs in your body can be seen during a quality CT scan of the urinary tract.

A Urinary Tract in CT scan of the kidneys, ureters and bladder are called a CT KUB or CT urogram. This type of scan can find kidney stones, bladder stones, or blockage of the urinary tract. Advantages of CT-KUB are: quick, easily accessible, identification of calcified urinary system calculi and their sequelae, and assessment of other causes of flank pain if negative for calculus disease. Disadvantage of CT-KUB is exposure to ionizing radiation. Urogram is an examination used to evaluate the urinary system by using contrast medium, also known as intravenous pyelogram, in conventional X-ray. This technique is still performed for pediatric patients, younger adult and adults' patients. A CT scan of the urinary tract can show infections, cysts, tumors, or obstructions in the urinary tract. It can also show stones in the urinary tract. A urinary tract CT scan can diagnose traumatic injuries. A CT scan of the urinary tract can help a physician find the cause of blood in the urine, blockage of urine, frequent or urgent urination, and inconsistent leakage of urine. (Yuranga et-al, 2011)

Figure 2-7 Computed Tomography machine

2-4-4 Ultrasound:

Imaging of the kidneys can sometimes be useful as gives details about the presences of hydronephrosis, suggesting the stone is blocking the outflow of urine radiolucent stone, which do not appear on CT scans, may show up on ultrasound imaging studies. Other advantages of renal ultrasonography include its low cost and absence of radiation exposure. Ultrasound imaging is useful for detecting stones in situations where x ray or CT are discouraged, such as in children or pregnant woman. Despite these advantage, renal ultrasonography is not currently considered substitute for no contrast helical CT scan in the initial diagnostic evaluation of urolithiasis. (Walsh et-al, 2002)

The main reason for this that compare with CT, renal ultrasonography more often fails to detect small stone (specialyuretral stone) as well as other series disorders that could be causing the symptoms. (Walsh et-al, 2002)

Figure 2-8 ultrasound image for kidney (Walsh et-al, 2002)

2-5 Previous studies:

- In 2016 by Sarofim M and et al they found in Two hundred and fifteen consecutive CT KUB examinations ordered in the ED of a tertiary-care centre for suspected ureteric colic were retrospectively reviewed. This comprised of 134 male (62.3%) and 81 female (37.7%) patients with a mean age of 53 years old. The positive detection rate for ureteric calculi in males was 43.3% compared to a lower rate for females of 29.6% ($p < 0.05$). Almost two-thirds of patients were discharged following CT KUB imaging, and admission rates were significantly higher in those with alternative radiological findings ($p < 0.04$) Alternative radiological findings occurred in 72 patients (33.5%), including 15 patients (7.0%) who had clinically important alternative pathology. The rate of clinically important alternative findings was significantly higher in males than females, 9.7% versus 2.5% respectively ($p = 0.04$). Surgical intervention was more common in patients with alternative radiological findings classified as gastrointestinal (18.2%) compared to non-gastrointestinal (3.6%), however this did not reach statistical significance ($p = 0.07$). In conclusion, significant alternative pathology was identified using CT KUB in 7% of patients with suspected ureteric colic. The low rates of detection of ureteric calculi and significant alternative pathology in female patients suggests a more thorough clinical assessment is warranted to improve their management, prior to ordering investigations with exposure to radiation.

- In 2013 by Gasmallah Hisham and et al Random samples of 50 patients, 35 males (70%) and 15 females (30%), their ages range from 5 to 80 years, were chosen for CT-KUB after lithotripsy. CT-KUB were obtained for all the subject and the stones length, width, computed tomography (CT) number, and they were measured by using computer. The result was, the males were more affect than females and there was linear relationship between the stone length, 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. CT-KUB has great value in detection of calculus as it is accurate without magnification.

Chapter Three

Material & Methods

3-1Material and methods

3-1-1 Material:

CT machine used for collecting KUB CT images was: neusoft 16 slice 120-140 KVP, 320 MAS with 5mm Slice thickness in National Ribat University Hospital.

3-1-2 Sample size

Sudanese patients (57 male – 43 female), patient age range between (10 – 80 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.

3-1-3 Duration and area of study

This study conducted in National Ribat University Hospital in period from September 2019 to February 2020.

3-2 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.

3-3 Image interpretation:

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

3-4 Data collection:

Data collected using data collecting sheet.

3-5 Data analysis:

Data analyzed by EXCEL.

Chapter Four

Results

4.1 Results

Table 4.1 show statistical parameters for all patients

	AGE	Size/mm	HU NUMBER
Mean	43.23	112.82	693.67
Median	42.00	94.49	647.50
Std. Deviation	19.443	81.42	336.60
Minimum	5	5.0	200
Maximum	81	330.7	1919

Table 4.2 show frequency of gender

GENDER	Frequency	Percent
Female	43	43.0
Male	57	57.0
Total	100	100.0

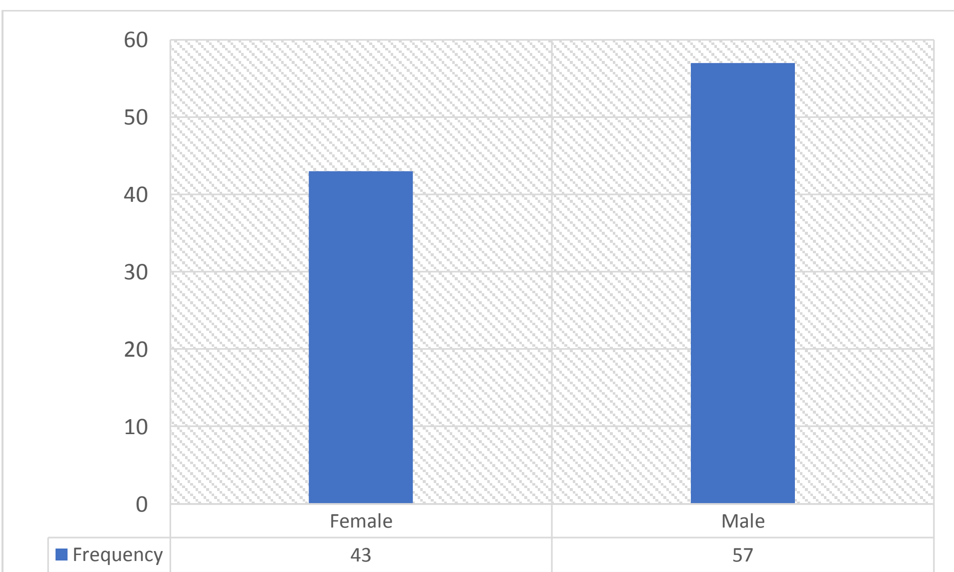


Figure 4.1 show frequency distribution of patients

Table 4.3 show frequency distribution of location

LOCATION	Frequency	Percent
RT Upper Ureter Stone	10	10.0
RT Distal Ureter Stone	5	5.0
RT Pelvic Kidney Stone	29	29.0
LT Pelvic Kidney Stone	18	18.0
LT UPJ Stone	18	18.0
RT UPJ Stone	9	9.0
LT Distal Ureter Stone	7	7.0
LT Lower Ureter Stone	4	4.0
Total	100	100.0

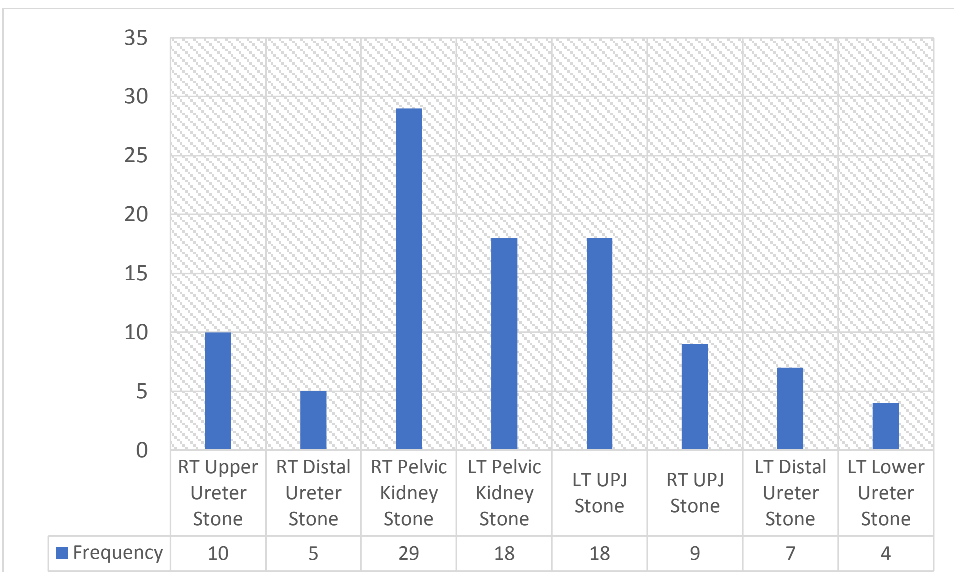


Figure 4.2 show frequency distribution of location

Table 4.4 show frequency distribution of age group

Age Group	Frequency	Percent
1-17	13	13.0
18-29	14	14.0
30-39	16	16.0
40-49	13	13.0
50-59	18	18.0
60-69	16	16.0
70-81	10	10.0
Total	100	100.0

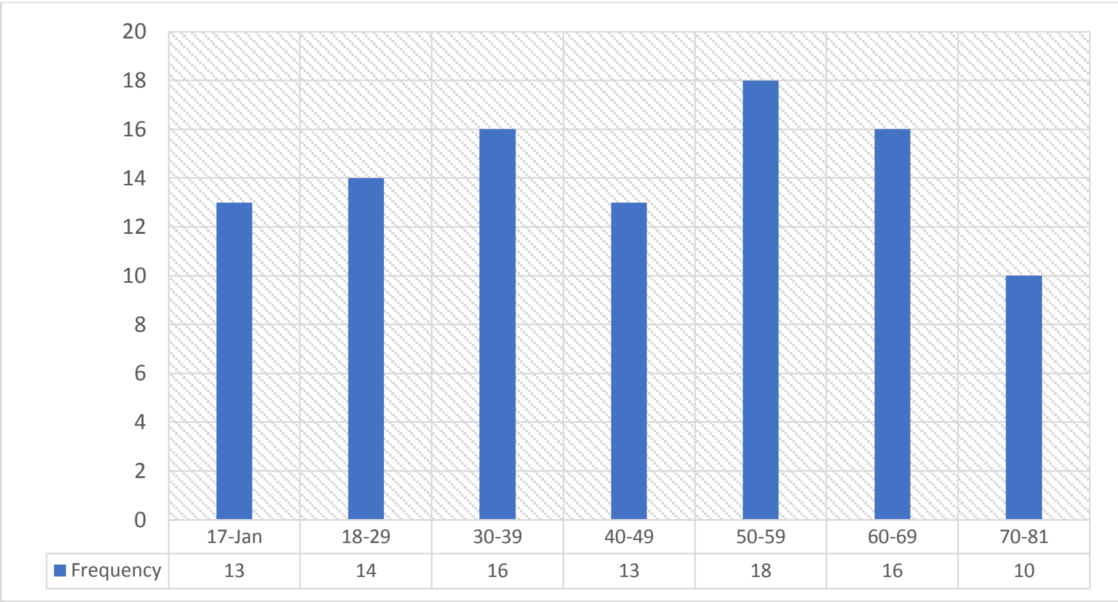


Figure 4.3 show frequency distribution of age group

Table 4.5 show frequency distribution of stone size group

Size Group	Frequency	Percent
1-50	28	28.0
51-100	25	25.0
101-150	18	18.0
151-200	15	15.0
201-250	7	7.0
251-300	7	7.0
Total	100	100.0

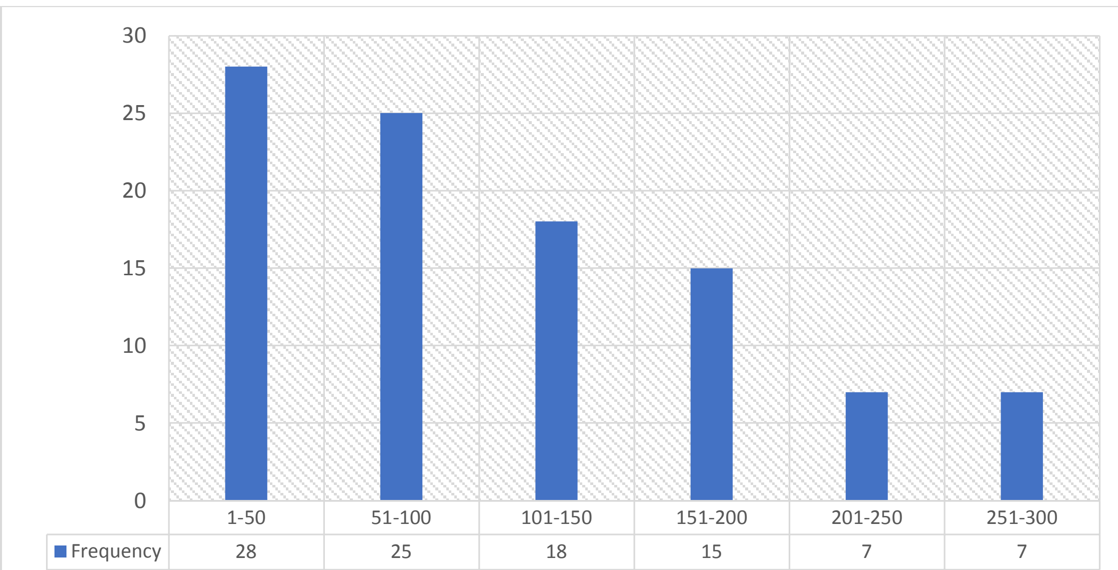


figure 4.4 show frequency distribution of size group

Table 4.6 show correlation between the stone location and size group

LOCATION * Size Group Crosstabulation

LOCATION	Size Group						Total
	1-50	51-100	101-150	151-200	201-250	251-300	
RT Upper Ureter Stone	2	1	4	1	2	0	10
RT Distal Ureter Stone	0	4	1	0	0	0	5
RT Pelvic Kidney Stone	8	4	5	5	4	3	29
LT Pelvic Kidney Stone	3	5	4	3	1	2	18
LT UPJ Stone	8	4	3	2	0	1	18
RT UPJ Stone	3	4	0	1	0	1	9
LT Distal Ureter Stone	3	2	1	1	0	0	7
LT Lower Ureter Stone	1	1	0	2	0	0	4
Total	28	25	18	15	7	7	100

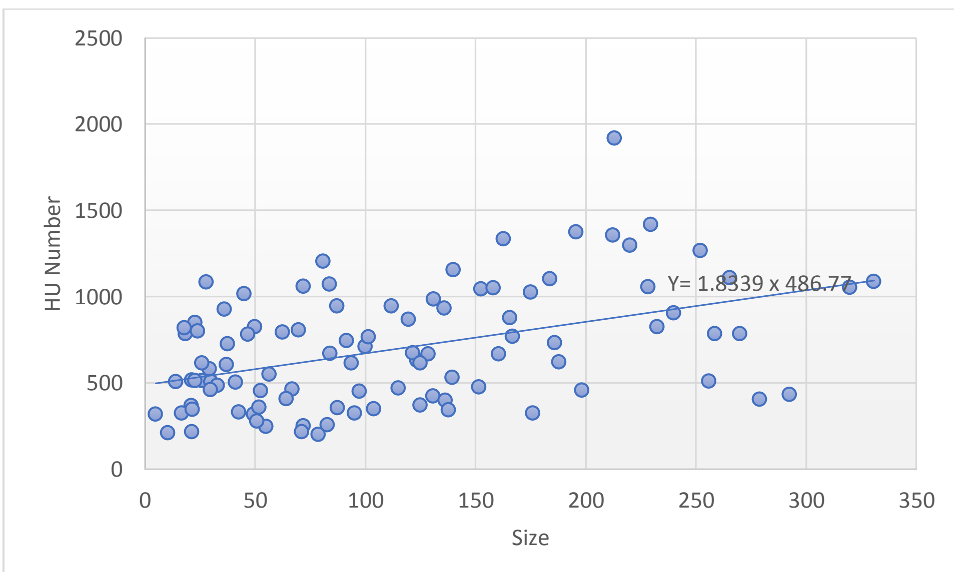


Figure 4.5 correlate between the HU number with stone size

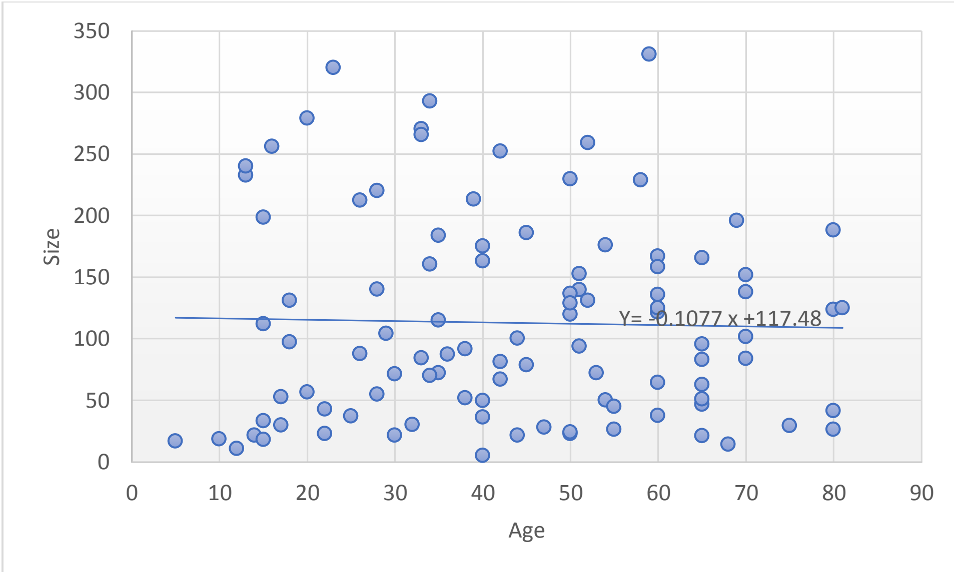


Figure 4.6 show correlate between the stone size with patients age

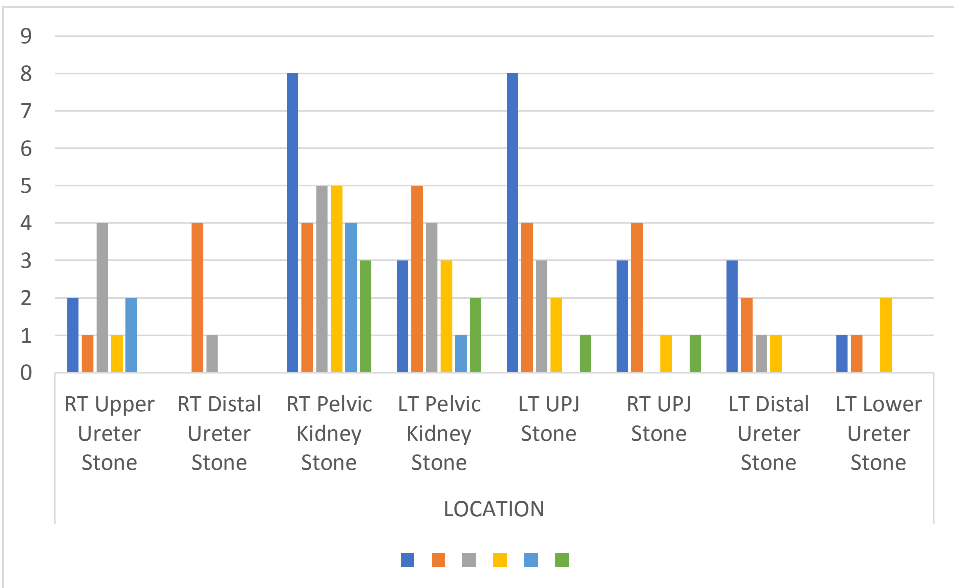


Figure 4.7 show correlate between the location stone with stone size group

Table 4.7 show categories of stone based on HU number

HU Number Group	Frequency	Percent
200-400	22	22.0
401-600	22	22.0
601-800	22	22.0
801-1000	13	13.0
1001-1200	13	13.0
1201-1400	6	6.0
1401-1600	1	1.0
1801-2000	1	1.0
Total	100	100.0

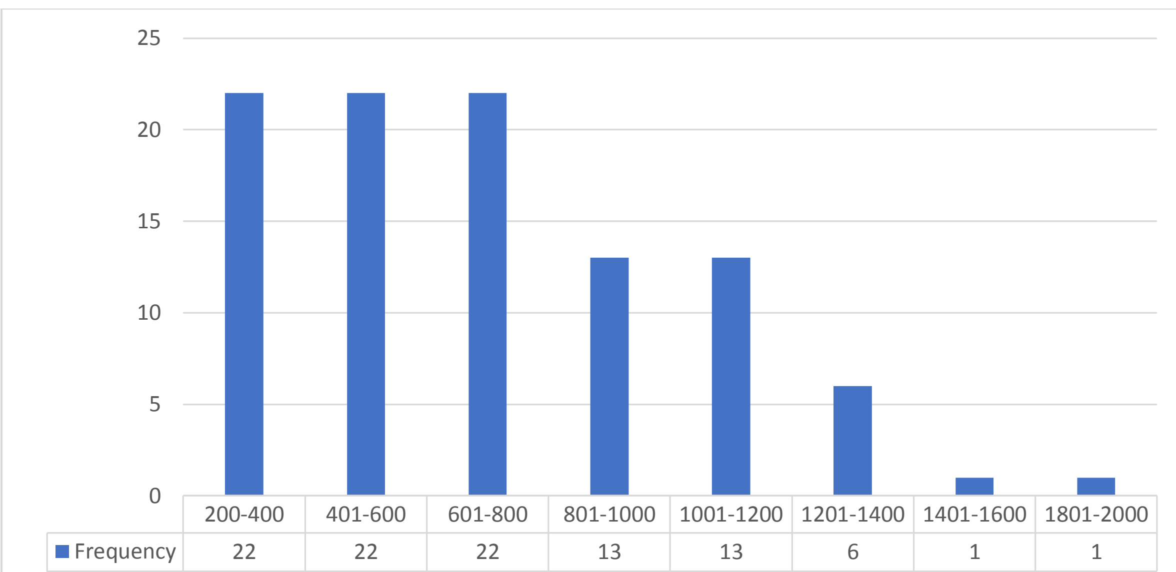


Figure 4.8 show frequency distribution of HU number

Chapter Five

Discussion, Conclusion and Recommendations

5-1 Discussion:

The aim of this study was to show the diagnosing of Renal system urolithiasis by Computed Tomography Images, in order to assess the renal size, site, CT number. 100 patients with variable age were investigated in National Ribat University hospital in period from September 2019 to February 2020.

Table 4.1 show statistical parameters for all patients were the mean ±SD, for the detects age was 43.23 ±19.44, size kidney stone 112.82 ±81.42 and HU number 693.67 ±336.60.

Table 4.2 show frequency distribution of adults, were the patient gender was investigated and the study revealed that the most affected gender was male with frequency of (57%), and female patients with (43%) as show in figure (4.1). This result was in line with Hisham A.Y.G In 2013, which stated that the predominant gender was male as 35 patient men and 15 women have renal stone.

Table 4.3 show frequency distribution of location of stone, were the mean frequent location was right pelvic kidney with (29%), LT Pelvic kidney stone and LT UPJ Stone with (18%) as show in figure (4.2).

Table 4.4 show frequency distribution of age group, in adults the study shows that the most affected age groups are those between (50-59) years, but the children are also capable of forming renal stones as show in age groups between (1-17) figure (4.3).

Table 4.5 show frequency distribution of size group, the study show that the must frequent size groups was (1-50 mm) by 28% and (51-100mm) by 25% as show in figure (4.4).

Table 4.6 show correlation between the stone location and size group, for group size (1-50mm) the mean frequented location was 8 patients found in RT pelvic kidney stone and LT UPJ stone, when in group (51-100mm) found in 5 patient in LT pelvic kidney stone ,in group (101-150mm) and (151-200mm) found 5 patient in RT pelvic kidney stone, (201-250mm) 4 patient in RT pelvic kidney stone and (251- 300mm) 3 patient in RT pelvic kidney stone as show in figure (4-7).

Figure (4-5) show the correlate between the HU number with stone size, were the rate of change for HU number increase by rate 1.8339 for each stone size which is positive relation.

Figure 4.6 show correlate between the stone size with patients age, were the rate of change for stone size decrease by rate -0.1077 for each patient age which is inverse relation.

Table (4-7) show frequency distribution of HU Number, its show that the most frequent HU Number group was (200-400), (401-600) and (601-800) by 22% as show in figure (4.8).

5-2 Conclusion:

The aim of this study was to show the diagnosing of Renal system urolithiasis by Computed Tomography Images, in order to assess the renal size, site, CT number. 100 patients with variable age were investigated in National Ribat University hospital in period from September 2019 to February 2020.

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 (57%). Also, the most affected age group is (50-59) with the number of stones that present in right side more than those at the left side of the urinary tract. Majority of CT number have positive relation which its increase by rate 1.8339 for each stone size, the stone size with patients age, were the rate of change for stone size decrease by rate -0.1077 for each patient age which is inverse relation and the most frequented size between (1-50 mm) with density between (200-600) HU respectively.

5-3 Recommendations:

- Drinking more water is the best way to prevent kidney stones. If it doesn't the urine output will be low. Low urine output means the urine is more concentrated and less likely to dissolve urine salts that cause stones.
- The most common type of kidney stone is the calcium oxalate stone, leading many people to believe they should avoid eating calcium. The opposite is true. Low-calcium diets may increase the kidney stone risk and the risk of osteoporosis.

- 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.

- 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. Also comparing between the role of U/S scanning and other diagnostic tools e.g. IVU and CTU.

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Appendix 1

Figure (A-1) 25y female, CT-KUB coronal section, soft tissue window, Right kidney stone

Figure (A-2) 40y male, CT-KUB axial section, soft tissue window, Left kidney stone

Figure (A-3) CT-KUB sagittal section, soft tissue window, ureteric stone

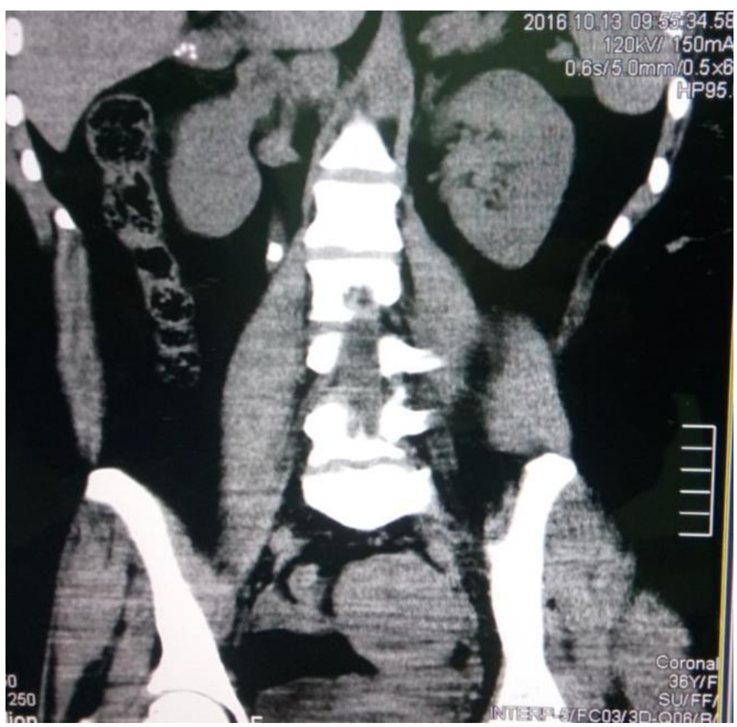

Figure (A-4) CT-KUB coronal section, soft tissue window, right upper uretic stone

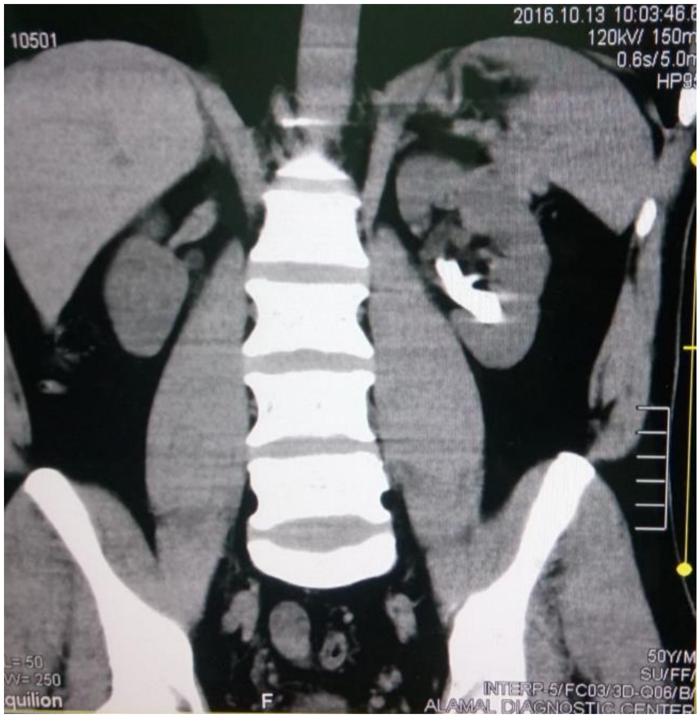

Figure (A-5) CT-KUB coronal section, soft tissue window, left kidney stone

Figure (A-6) CT KUB, sagittal section, soft tissue window image show LT staghorn stone