Chapter one

1.1 Introduction:

The urinary system, also known as renal system, consists ofkidneys, ureters, bladder, and urethra. Each kidney consists of millions of functional units called nephrons. The purpose of the renal system is to eliminate wastes from the body, regulate blood volume and blood pressure, control levels of electrolytes and metabolites, and regulate blood pH. The kidneys have extensive blood supply via the renal arteries which leave the kidneys via the renal vein. Following filtration of blood and further processing, wastes (in the form of urine) exit the kidney via the ureters, tubes made of smooth muscle fibers that propel urine towards the urinary bladder, where it is stored and subsequently expelled from the body by urination (voiding). The female and male urinary system is very similar, differing only in the length of the urethra. **(KUMAR et al, 2012).**

Renal stones are very common worldwide, with a lifetime risk of about 10%. Prevalence of stone disease is much higher in the Middle East. Most stones occur in the upper urinary tract. Most stones are composed of calcium oxalate and phosphate; these are more common in men. Mixed infective stones, which account for about 15% of all calculi, are twice as common in women as in men. The overall male to female ratio of stone disease is 2:1. Stone disease is frequently a recurrent problem. More than 50% of patients with a history of nephrolithiasis will develop a recurrence within 10 years. The risk of recurrence increases if a metabolic or other abnormality predisposing to stone formation is present and is not modified by treatment. Nephrolithiasis is not a benign condition as several observational studies have demonstrated its association with increased risk of ESKD, bone diseases, hypertension and myocardial infarction **(KUMAR et al, 2012).**

All diagnostic ultrasound applications are based on the detection and display of acoustic energy reflected from interfaces within the body. These interactions provide the information needed to generate high-resolution, gray-scale images of the body, as well as display information related to blood flow. Its unique imaging attributes have made ultrasound an important and versatile medical imaging tool. However, expensive stateof-the-art instrumentation does not guarantee theproduction of high-quality studies of diagnostic value. Gaining maximum benefit from this complex technology requires a combination of skills, including knowledge of the physical principles that empower ultrasound with its unique diagnostic capabilities. The user must understand the fundamentals of the interactions of acoustic energy with tissue and the methods and instruments used to produce and optimize the ultrasound display. With this knowledge the user can collect the maximum information from each examination, avoiding pitfalls and errors in diagnosis that may result from the omission of information or the misinterpretation of artifacts. **(Rumack et al. 2011)**

Ultrasonography of the kidneys and bladder has the advantage over x-ray techniques of avoiding ionizing radiation and intravascular contrast medium. In renal to diagnosis it is the method of choice for:Renal measurement and for renal biopsy or other interventional procedures. Checking for pelvicalyceal dilatation as an indication of renal obstruction when chronic renal obstruction is suspected. (In suspected acute ureteric obstruction, unenhanced spiral CT is the method of choice.). Characterizing renal masses as cystic or solid. Diagnosing polycystic kidney disease. Detecting intrarenal and/or perinephric fluid (e.g. pus, blood).Measurement of bladder wall thickness in a distended bladder and to check for bladder tumors and stones the disadvantages of using ultrasonography to assess the urinary tract are: It does not show detailed pelvicalyceal anatomy, It does not fully visualize the normal adult ureter. It may miss small renal calculi and does not detect the majority of ureteric calculi. It is operator-dependent. **(Kumar et al, 2012).** Computed tomography is used as a first-line investigation in cases of suspected ureteric colic. Multislice detector CT has both improved image resolution and allows reconstru tion of the imaging data in a variety of planes. CT is also used to: Characterize renal masses which are indeterminate at ultrasonography. Stage renal tumors.Detect ‘lucent’ calculi (low-density calculi which are lucent on plain films, e.g. uric acid stones) Evaluate the retroperitoneum for tumors, retroperitoneal fibrosis (periaortitis) and other causes of ureteric obstruction. Assess severe renal trauma. Visualize the renal arteries and veins by CT angiography.

The use of unenhanced CT in suspected ureteric colic permits diagnosis of causes of pain other than calculi more readily than does urography. **(Kumar, 2012)**

1.2 Problem of the study:

Ultrasound considered primary examination for urinary system pathology however ultrasound show lack of informationand some practice obstacles, the research is conduct to evaluate ultrasound finding compared to CT finding to show discrepancy of results as CT considered golden method.

1.3 Objectives

1.3.1 The general objective:

To evaluate urinary tract stones using ultrasonography and unenhanced CT KUB.

1.3.2 Specific objective:

- To identify US and CT finding in urinary tract stone.
- To compare between US and CT findings.
- To show effect of stone in urinary tract (evidence of hydronephrosis and hydro ureter).

1.4 Overview of the study

This study is concerned with evaluation of urinary tract stones using ultrasound and unenhanced CT KUB, it falls into five chapters. Chapter one is an introduction, which include problem of the study and statement of the objectives, Chapter two include comprehensive scholarly literature review and anatomical background concerning the previous studies. Chapter three deals with the methodology, where it provides an outline of material and methods used to acquire the data in this study as well as the method of analysis approach. While the results were present in chapter four, and finally Chapter five include discussion of the results, conclusion and recommendation followed by references and appendices.

Chapter Two

2.1 Anatomy:

2.1.1 Anatomy of kidneys:

The kidneys lie high up on the posterior abdominal wall behind the peritoneum, largely under cover of the costal margin. At best only their lower poles can be palpated in the normal individual. Each kidney lies obliquely, with its long axis parallel with the lateral border of psoas major. On its vascular pedicle it lies well back in the paravertebral gutter, so that the hilum, a vertical slit-like depression at the medial border transmitting the renal vessels and nerves and the renal pelvis (the beginning of the ureter), faces somewhat forwards as well as medially. As a result of this slight 'rotation' of the kidney an anteroposterior radiograph gives a somewhat foreshortened picture of the width of the kidney. The normal kidney measures about 12 X 6 X 3 cm (4 X 2 X lin) and weighs about 130 g (4 oz). The hilum of the right kidney lies just below, and of the left just above, the transpyloric plane 5 cm (2 in) from the midline; these are the surface markings of the hila. The bulk of the right lobe of the liver accounts for the lower position of the right kidney. The upper pole of the left kidney may overlie the eleventh rib in a radiograph that of the right kidney seldom ascends so high, though it must be remembered that each kidney moves in a vertical range of 2 cm (about 1 in) during full respiratory excursion of the diaphragm. The kidney possesses a capsule which gives the fresh organ a glistening appearance. All surfaces are usually smooth and convex though traces of lobulation, normal in the fetus, are often seen. Thick rounded lips of kidney substance bound the hilum, from which the pelvis emerges behind the vessels to pass down into the ureter. The suprarenal glands lie somewhat asymmetrically. The right gland, pyramidal in shape, surmounts the upper pole of the right kidney, behind the inferior vena cava and the bare area of the liver, while the left gland, crescentic in shape, is applied to the medial border of the left kidney above its hilum, behind the peritoneum of the posterior wall of the lesser sac. The hilum is separated from the peritoneum, on the right side by the second part of the duodenum and on the left side by the tail of the pancreas. **(Livingstone, 1994)**

2.1.1 Surgical relation of the kidneys:

The posterior relation of both kidney are to the twelfth rib, diaphragm, pleura and lung, and below the rib to quadrates lumborum muscle and psoas muscle. The ilioinguinal and iliohypogastric nerves cross obliquely on front of the quadratus lumborum muscle. The helium of kidney is closely related to the tips of transverse processes of upper lumber vertebrae. On the left side the kidney is covered in covered in front by the spleen and tail of the pancreas, the duodenojejunal flexure and the descending colon, and any of these structures may be densely adherent to the kidney when it is malignant inflamed, and are therefore easily injured during nephrectomy. On the right side lying in front of the kidney are the ascending colon and the second part of the duodenum. Medial to the left kidney lies the aorta; medial to the right one lies the vena cava. Above and medial to each kidney lies its suprarenal. The importance of these surgical relations is that they govern the choice of the surgical route to the kidney, and to some extent, what complications are likely to occur after an operation on it. **(Blandy, 2009).**

2.1.1.2 Internal structure of the kidney:

In a coronal or frontal section of the kidney, three areas can be distinguished. The lateral and middle areas are tissue layers, and the medial area at the hilus is a cavity. The outer tissue layer is called the renal cortex; it is made of renal corpuscles and convoluted tubules. These are parts of the nephron and are described in the next section. The inner tissue layer is the renal medulla, which is made of loops of Henle and collecting tubules (also parts of the nephron). The renal medulla consists of wedge-shaped pieces called renal pyramids. The tip of each pyramid is its apex or papilla. The third area is the renal pelvis; this is not a layer of tissues, but rather a cavity formed by the expansion of the ureter within the kidney at the hilus. Funnel shaped extensions of the renal pelvis, called calyces, enclose the papillae of the renal pyramids. Urine flows from the renal pyramids into the calyces, then to the renal pelvis and out into the ureter. (Figure 2-1).

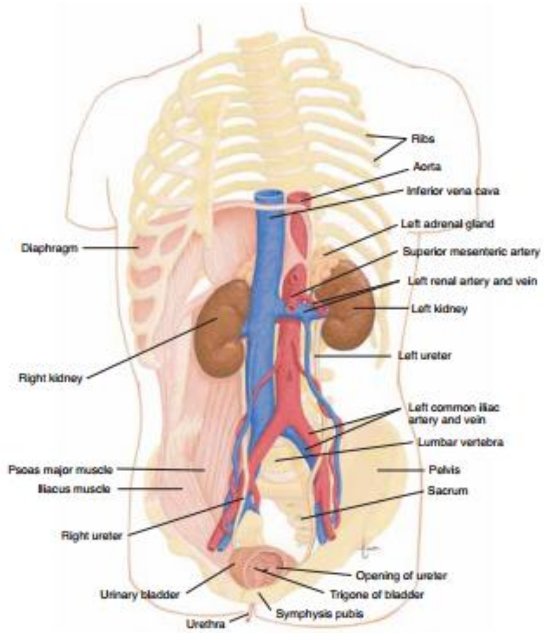

Figure2-1: The urinary system shown in anterior view. **(Sanders 2007)**

2.1.1.3 The nephron:

The nephron is the structural and functional unit of the kidney. Each kidney contains approximately 1 million nephrons. It is in the nephrons, with their associated blood vessels, that urine is formed. Each nephron has two major portions: a renal corpuscle and a renal tubule. Each of these major parts has further subdivisions, which are shown with their blood vessels in (Figure 2-2). **(Sanders 2007)**

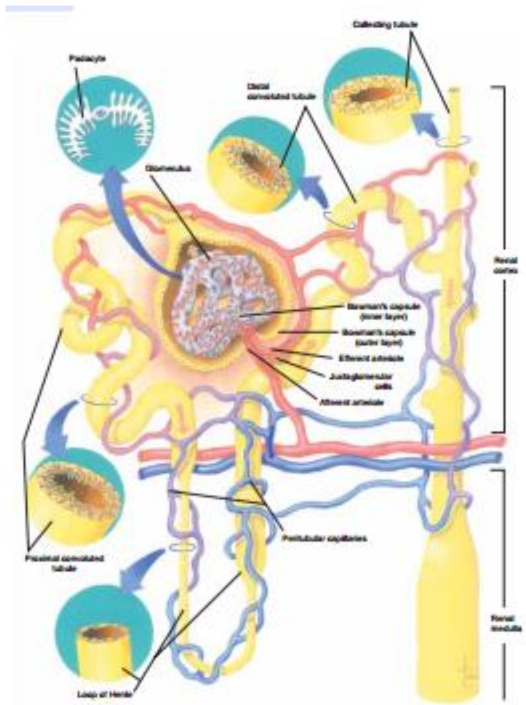

Figure 2-2: Anephron with associated blood vessels. Portion of the nephron have been magnified. **(Sanders 2007)**

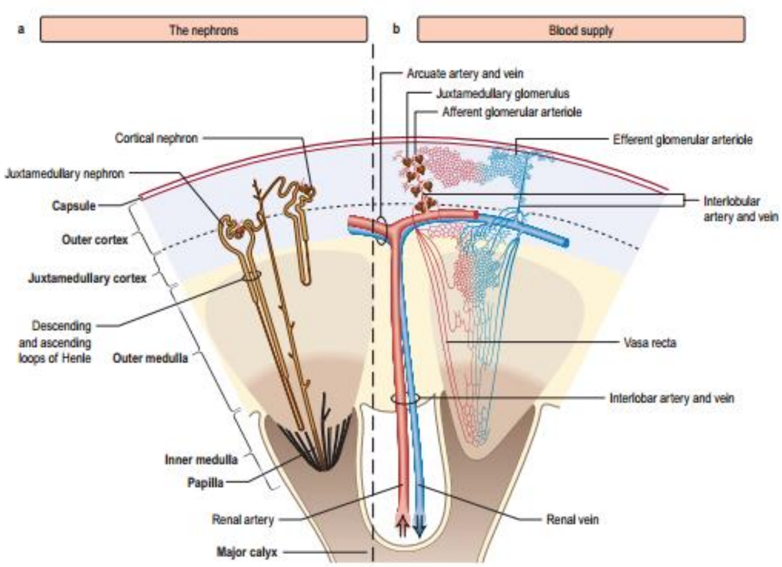

Figure 2-3: Functional anatomy of the kidney. (a) The nephrons. (b) Arterial and venous supply. (After Standring S (ed) 2008 Gray's Anatomy, 40th edn. Edinburgh: Churchill Livingstone). **(Kumar et al, 2012)**

2.1.1.4 Renal Corpuscle:

A renal corpuscle consists of a glomerulus surrounded by a Bowman's capsule. The glomerulus is a capillary network that arises from an afferent arteriole and empties into an efferent arteriole. The diameter of the efferent arteriole is smaller than that of the afferent arteriole, which helps maintain a fairly high blood pressure in the glomerulus. Bowman's capsule (or glomerular capsule) is the expanded end of a renal tubule; it encloses the glomerulus. The inner layer of Bowman's capsule is made of podocytes; the name means "foot cells," and the "feet" of the podocytes are on the surface of the glomerular capillaries. The arrangement of podocytes creates pores, spaces between adjacent "feet," which make this layer very permeable. The outer layer of Bowman's capsule has no pores and is not permeable.

The space between the inner and outer layers of Bowman's capsule contains renal filtrate, the fluid that is formed from the blood in the glomerulus and will eventually become urine. **(Sanders 2007)**

2.1.1.5 Renal Tubule:

The renal tubule continues from Bowman's capsule and consists of the following parts: proximal convoluted tubule (in the renal cortex), loop of Henle (or loop of the nephron, in the renal medulla), and distal convoluted tubule (in the renal cortex). The distal convoluted tubules from several nephrons empty into a collecting tubule. Several collecting tubules then unite to form a papillary duct that empties urine into a calyx of the renal pelvis.
Cross-sections of the parts of the renal tubule are shown in Fig.2.thin the walls of the tubule are, and also the microvilli in the proximal convoluted tubule. These anatomic characteristics provide for efficient exchanges of materials.

All parts of the renal tubule are surrounded by peritubular capillaries, which arise from the efferent arteriole. The peritubular capillaries will receive the materials reabsorbed by the renal tubules; this is described in the section on urine formation. **(Sanders, 2007)**

2.1.1.6 Renal parenchyma:

The solid part of the kidney, where the process of waste excretion takes place.

2.1.1.7 Medulla:

Inner core of the kidney that contains the pyramids, papillae, calyces, pelvis and parts of the nephron not located in the cortex, used for salt, water and urea absorption.

2.1.1.8 Renal Pyramids:

Triangular shaped units in the medulla that house the loops of Henle and collecting ducts of the nephron, site for the counter-current system that concentrates salt and conserves water and urea.

2.1.1.9 Renal Papilla:

The tip of the renal pyramid that release urine intoacalyx.

2.1.1.10 Calyx:

A collecting sac surrounding the renal papilla transports urine from the papilla to the renal pelvis.

2.1.1.11 Renal Pelvis:

It is the collects urine from all of calyces in the kidney. **(Sanders 2007)**

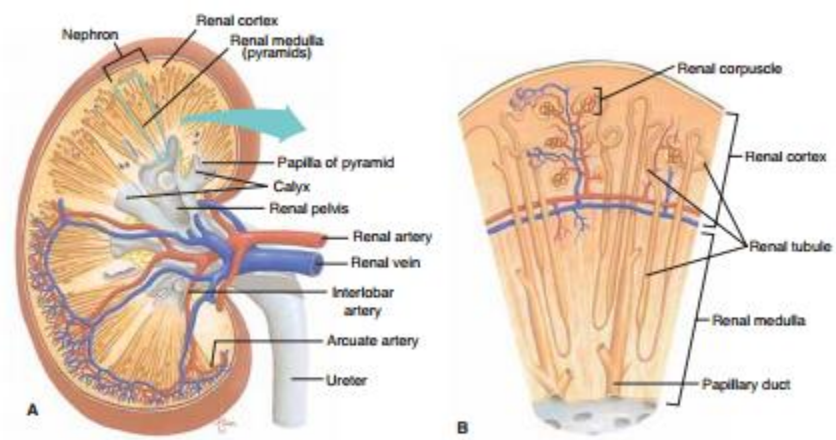

Figure 2-4: (A) Frontal section of the right kidney showing internal structure and blood vessels. (B) The magnified section of the kidney show several nephrons. **(Sanders 2007).**

2.1.1.12 Structure of the collection system:

The renal papillae are covered with a thin cubical epithelium perforated by the openings of the ducts of bellini, but the whole of the rest of the pelvis and calices are lined by transitional epithelium indistinguishable from that which lines the bladder and ureters. The transitional epithelium is surrounded by a strong and supple muscular wall made up of smooth muscle cells that are intimately joined to each other by jig-saw type connection (nexuses) which allow contraction to pass in waves down the calices and into the renal pelvis so actively pumping urine out of the kidney. This peristaltic activity is relatively slow, compared with that of bowel, but it is very efficient, and it manages to go on without needing a nerve supply.To allow the calices to move freely and perform their peristaltic work, they are separated from the parenchyma by a packing of fat which is fluid at body temperature. In practice this sinus fat also contains the larger veins and arteries of the kidney, but fortunately there is a thin layer of connective tissue between the muscle and the sinus fat, which is easily opened up at surgical operations to provide virtually bloodless access right up to the necks of the calices. **(Blandy, 2004)**

2.1.1.13 Blood vessels of the kidney:

The pathway of blood flow through the kidney is an essential part of the process of urine formation. Blood from the abdominal aorta enters the renal artery, which branches extensively within the kidney into smaller arteries. The smallest arteries give rise to afferent arterioles in the renal cortex. From the afferent arterioles, blood flows into the glomeruli (capillaries), to efferent arterioles, to peritubular capillaries, to veins within the kidney, to the renal vein, and finally to the inferior vena cava. There are two sets of capillaries, and recall that it is in capillaries that exchanges take place between the blood and surrounding tissues. Therefore, in the kidneys there are two sites of exchange. The exchanges that take place between the nephrons and the capillaries of the kidneys will form urine from blood plasma.**(Sanders 2007)**

2.1.1.14 Lymph drainage for the kidney:

The lymphatics of the kidney drain to Para-aortic nodes at the level of origin of the renal arteries (L2). The surface of the upper pole may drain through the diaphragm into nodes in the posterior mediastinum. **(Livingstone, 1994)**

2.1.1.15 Nerve supply for renal:

Renal nerves are derived from both parts of the autonomic system. The sympathetic preganglionic cells lie in the spinal cord from T12 to LI segments and they send preganglionic fibers to the thoracic and lumbar splanchnic nerves. The postganglionic cells are in the coeliac, renal and superior hypogastric plexuses and, for the least splanchnic nerve, in the renal ganglion in the hilum of the kidney. They are vasomotor in function. Afferent fibres, including those subserving pain, accompany the sympathetic nerves as for most other viscera. Thus the pathway for the pain of renal colic from a stone in the calyces or renal pelvis may run along blood vessels to the coeliac plexus and thence by the splanchnic nerves to the sympathetic trunk and via white rami communicates to T12-L1 spinal nerves and so into the spinal cord by the posterior nerve roots. The pain may radiate from the back and lumbar region to the anterior abdominal wall and down to the external genitalia. There is some parasympathetic supply from the vagus, of uncertain function, but it is possible that some afferents run with the vagal fibers, and this may explain the nausea and vomiting that may accompany renal pain.

(Livingstone, 1994)

2.1.2 Anatomy of the Ureters:

The ureter is 25 cm (10 in) long. Its points of narrowest caliber are at the pelviureteric junction, at the halfway mark where it crosses the pelvic brim, and at its termination in the bladder mucosa. The ureter passes down on major psoas under cover of the peritoneum and crosses the genitofemoral nerve, being itself crossed superficially by the gonadal vessels. On the right the upper part is behind the duodenum, while lower down it is crossed by the root of the mesentery and by the right colic, ileocolic and superior mesenteric vessels. On the left it is lateral to the inferior mesenteric vessels and is crossed by the left colic vessels and (just before entering the pelvis) by the apex of the sigmoid mesocolon. It leaves the psoas muscle at the bifurcation of the common iliac artery, over the sacroiliac joint, and passes into the pelvis. It adheres to the peritoneum of the posterior abdominal wall when that membrane is stripped up from the psoas fascia. It can be identified from vessels and nerves in the living body by the fact that it is a whitish cord which is non-pulsatile and which shows peristaltic activity when gently pinched with forceps. On the left the apex of the sigmoid mesocolon is the guide to it as it enters the pelvis.

2.1.2.1 Blood supply of ureter:

The upper end is supplied by the ureteric branch of themrenal artery and the lower end by branches from the inferior and superior vesical and middle rectal (and uterine) arteries. The middle reaches of the ureter are supplied by branches from the gonadal artery, and, in many cases, by branches from the common iliac as well. All these vessels make a fairly good anastomosis with each other in the adventitia of the ureter, forming longitudinal channels. The blood supply is endangered if the ureter is stripped clean of its surrounding tissue. The veins of the ureter drain into the renal, gonadal and internal iliac veins.**(Livingstone,1994)**

2.1.2.2 Lymph drainage of ureter:

The lymphatics run back alongside the arteries; the abdominal portion of the ureter drains into para-aortic nodes below the renal arteries, the pelvic portion into nodes on the side wall of the pelvis alongside the internal iliac arteries. **(Sanders 2007)**

2.1.2.3 Nerve supply of ureter:

Although sympathetic fibers from Tl1-L2 segments of the cord reach the ureter via the coeliac and hypogastric plexuses, together with parasympathetic fibers from the pelvic splanchnic nerves, their functional significance is not clear. Intact innervation of the renal pelvis or ureter is not necessary for the initiation or propagation ofperistalsis from the calyceal pacemakers. There are no ganglion cells in or on the ureter. Pain fibers accompany sympathetic nerves, as from the kidney. **(Livingstone, 1994)**

2.1.3 Anatomy of Urinary bladder:

The urinary bladder is a muscular sac below the peritoneum and behind the pubic bones. In women, the bladder is inferior to the uterus; in men, the bladder is superior to the prostate gland. The bladder is a reservoir for accumulating urine, and it contracts to eliminate urine.

The mucosa of the bladder is transitional epithelium, which permits expansion without tearing the lining. When the bladder is empty, the mucosa appears wrinkled; these folds are rugae, which also permit expansion. On the floor of the bladder is a triangular area called the trigone, which has no ruga and does not expand. The points of the triangle are the openings of the two ureters and that of the urethra (Fig. 2-5).

The smooth muscle layer in the wall of the bladder is called the detrusor muscle. It is a muscle in the form of a sphere; when it contracts it becomes a smaller sphere, and its volume diminishes. Around the opening of the urethra the muscle fibers of the detrusor form the internal urethral sphincter (or sphincter of the bladder), which is involuntary.

(Sanders 2007)

2.1.3.1 Blood supply of urinary bladder:

The superior and inferior vesical arteries provide most of the arterial blood but there are small contributions to the lower part of the bladder from the obturator, inferior gluteal, uterine and vaginal arteries. The superior vesical vessels often raise a small 'mesentery' of peritoneum running from the side wall of the pelvis to the upper part of the bladder. The veins of the bladder do not follow the arteries. They form a plexus that converges on the vesicoprostatic plexus in the groove between bladder and prostate and which drains backwards across the pelvic floor to the internal iliac veins. There is a similar plexus in the female, communicating with veins in the base of the broad ligament.

2.1.3.2 Lymph drainage of urinary bladder:

The lymphatics of the bladder follow the arteries backwards to internal and external iliac nodes.

2.1.3.3 Nerve supply of urinary bladder:

Parasympathetic fibers which provide the main motor innervation of the bladder reach it via the pelvic splanchnic nerves . Sympathetic fiberscome from LI and 2 segments of the cord via the superior hypogastric and pelvic plexuses. For most of the bladder the sympathetic fibers are vasomotor and probably inhibitory to the detrusor muscle, but as noted above they supply the superficial trigonal muscle and (in the male) the internal sphincter. The sensation of normal bladder distension travels with parasympathetic fibers and in the spinal cord is conveyed in the graciletract, but it appears that bladder pain (e.g. from astone) reaches the spinal cord (lateral spinothalamictract) by both parasympathetic and sympathetic pathways.**(Livingstone, 1994)**

2.1.4 Anatomy of the Urethra:

The urethra (Fig. 2-5) carries urine from the bladder to the exterior. The external urethral sphincter is made of the surrounding skeletal muscle of the pelvic floor, and is under voluntary control.In women, the urethra is 1 to 1.5 inches (2.5 to 4 cm) long and is anterior to the vagina. In men, the urethra is 7 to 8 inches (17 to 20 cm) long. The first part just outside the bladder is called the prostatic urethra because it is surrounded by the prostate gland. The next inch is the membranous urethra, around which is the external urethral sphincter. The longest portion is the cavernous urethra (or spongy or penile urethra), which passes through the cavernous (or erectile) tissue of the penis. The male urethra carries semen as well as urine.**(Sanders 2007)**

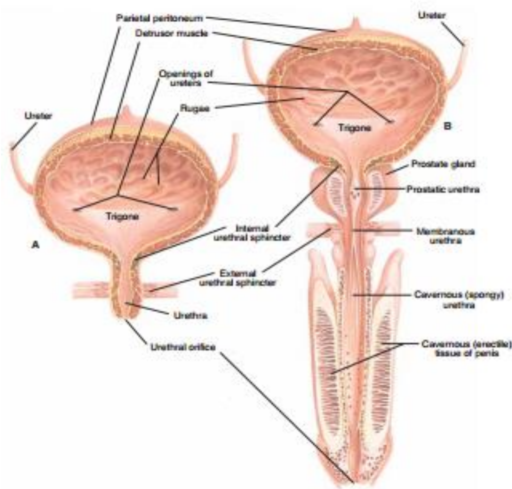

Figure 2-5. (A) Frontal section of female urinary bladder and urethra. (B) Frontal section of male urinary bladder and urethra. **(Sanders 2007)**

2.2 Physiology:

2.2.1 Function of the urinary system:

The kidneys filter blood plasma, separate wastes from useful chemicals, regulate blood volume and pressure, secrete renin and erythropoietin, regulate blood pH, synthesize calcitriol, detoxify free radicals and drugs, and generate glucose in times of starvation. - Metabolic wastes are wastes produced by the body, such as CO2 and nitrogenous wastes. The main human nitrogenous wastes are urea, uric acid, and creatinine. -The level of nitrogenous wastes in the blood is often expressed as blood urea nitrogen (BUN). An elevatedBUN is called azotemia, and mayprogress to a serious syndrome called uremia. Excretion is the process of separating wastes from the body fluids and eliminating them from the body. It is carried out by the respiratory, integumentary, digestive, and urinary systems.**(Saladin, 2004)**

2.2.2 Blood tests and kidney function:

Waste products are normally present in the blood, and the concentration of each varies within a normal range. As part of the standard lab work called blood chemistry, the levels of the three nitrogenous waste products are determined (urea, creatinine, and uric acid).

If blood levels of these three substances are within normal ranges, it may be concluded that the kidneys are excreting these wastes at normal rates. If, however, these blood levels are elevated, one possible cause is that kidney function has been impaired. Of the three, the creatinine level is probably the most reliable indicator of kidney functioning. Blood urea nitrogen (BUN) may vary considerably in certain situations not directly related to the kidneys. For example, BUN may be elevated as a consequence of a high-protein diet or of starvation when body protein is being broken down at a faster rate than normal. Uric acid levels may also vary according to diet. However, elevated blood levels of all three nitrogenous wastes usually indicate impaired glomerular filtration.**(Sanders 2007)**

2.3 Pathology of the urinary system:

2.3.1 Congenital Anomalies of the Kidneys:

2.3.1.1 Polycystic Kidney:

A hereditary disease, polycystic kidney can be transmitted by either parent. It may by associate with congenital cysts of the liver, pancreas, and lung. Both kidneys are enormously enlarged and riddled with cysts. Polycystic kidney is thought to be caused by a failure of union between the developing convoluted tubules and collecting tubules. The accumulation of urine in the proximal tubules results in the formation of retention cysts.

2.3.1.2 Pelvic Kidney:

In pelvic kidney, the kidney is arrested in some part of its normal ascent; it usually is found at the brim of the pelvis (Fig. 2-6). Such a kidney may present with no signs or symptoms and may function normally. However, should an ectopic kidney become inflamed, it may—because of its unusual position—give rise to a mistaken diagnosis.

2.3.1.3 Horseshoe Kidney:

When the caudal ends of both kidneys fuse as they develop, the result is horseshoe kidney (Fig. 2-6). Both kidneys commence to ascend from the pelvis, but the interconnecting bridge becomes trapped behind the inferior mesenteric artery so that the kidneys come to rest in the low lumbar region. Both ureters are kinked as they pass inferiorly over the bridge of renal tissue, producing urinary stasis, which may result in infection and stone formation. Surgical division of the bridge corrects the condition.

2.3.1.4 Unilateral Double Kidney:

The kidney on one side may be double, with separate ureters and blood vessels. In unilateral double kidney, the ureteric bud on one side crosses the midline as it ascends, and its upper pole fuses with the lower pole of the normally placed kidney (Fig. 2-6).

2.3.1.5 Rosette Kidney:

Both kidneys may fuse together at their hila, and they usually remain in the pelvis. The two kidneys together form a rosette (Fig. 2-6). This is the result of the early fusion of the two ureteric buds in the pelvis.

2.3.1.6 Supernumerary Renal Arteries:

Supernumerary renal arteries are relatively common. They represent persistent fetal renal arteries, which grow in sequence from the aorta to supply the kidney as it ascends from the pelvis. Their occurrence is clinically important because a supernumerary artery may cross the pelviureteral junction and obstruct the outflow of urine, producing dilation of the calyces and pelvis, a condition known as hydronephrosis(Figure. 2-5). **(Snell, 2006)**

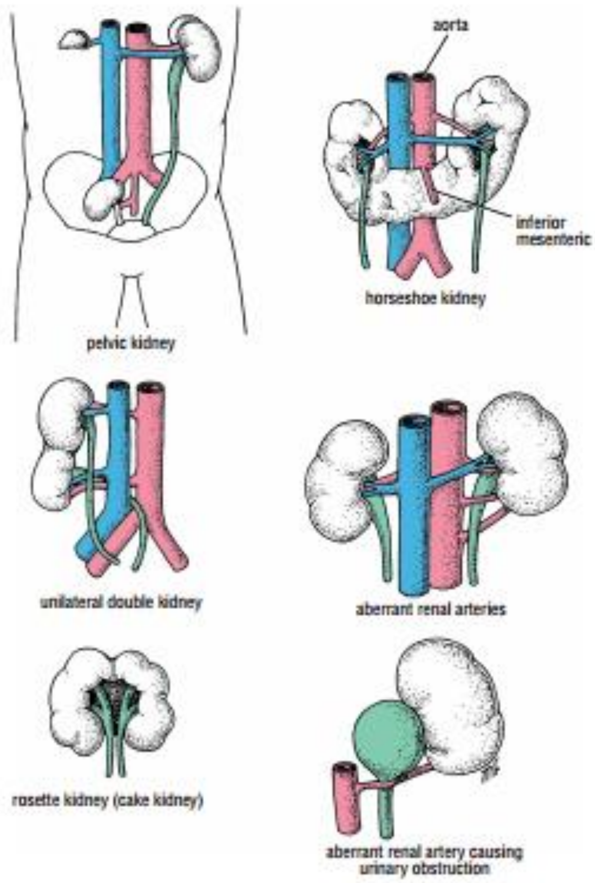

Figure (2-6): Some common congenital anomalies of the kidney. **(Snell, 2006)**

2.3.2 CONGENITAL ANOMALIES OF THE URETERS:

2.3.2.1 Double Pelvis:

Double pelvis of the ureter is usually unilateral (Fig. 2-6). The upper pelvis is small and drains the upper group of calyces; the larger lower pelvis drains the middle and lower groups of calyces. The cause is a premature division of the ureteric bud near its termination.

2.3.2.2 Bifid Ureter:

In bifid ureter, the ureters may join in the lower third of their course, may open through a common orifice into the bladder, or may open independently into the bladder (Fig. 2-6).

In the latter case, one ureter crosses its fellow and may produce urinary obstruction. The cause of bifid ureter is a premature division of the ureteric bud.

Cases of double pelvis and double ureters may be found by chance on radiologic investigation of the urinary tract. They are more liable to become infected or to be the seat of calculus formation than is a normal ureter.

2.3.2.3 Megaloureter:

Megaloureter may be unilateral or bilateral and shows complete absence of motility (Fig. 2-6). The cause is unknown. Because of the urinary stasis, the ureter is prone to infection. Plastic surgery is required to improve the rate of drainage.

2.3.2.4 Postcaval Ureter:

The right ureter may ascend posterior to the inferior vena cava and may be obstructed by it (Fig. 2-6). Surgical rerouting of the ureter with reimplantation of the distal end into the bladder is the treatment of choice. **(Snell, 2006)**

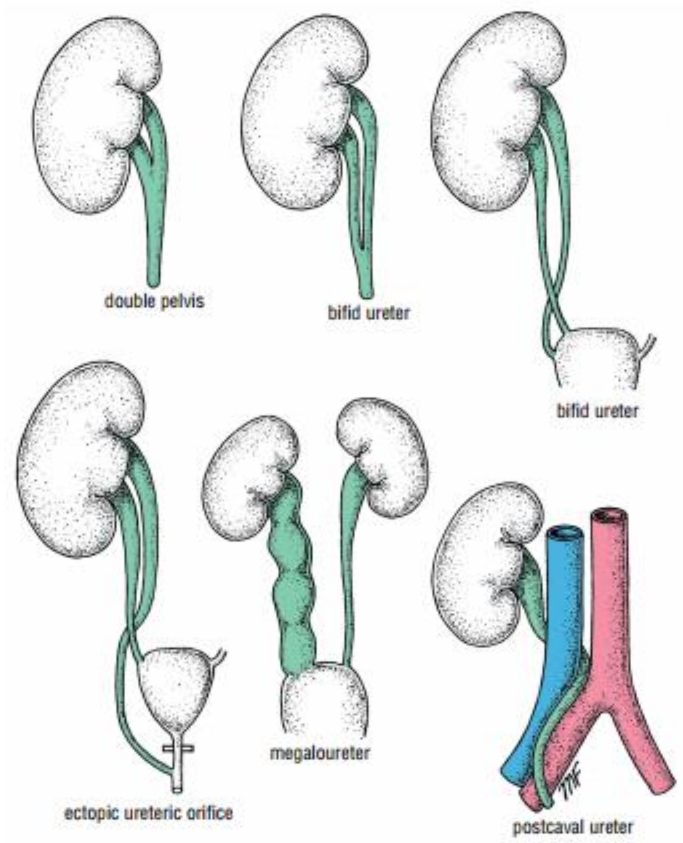

Figure (2-7): Some common congenital anomalies of the ureter. **(Snell, 2006)**

2.3.3 Renal Colic:

The renal pelvis and the ureter send their afferent nerves into the spinal cord at segments T11 and 12 and L1 and 2. In renal colic, strong peristaltic waves of contraction pass down the ureter in an attempt to pass the stone onward. The spasm of the smooth muscle causes an agonizing colicky pain, which is referred to the skin areas that are supplied by these segments of the spinal cord, namely, the flank, loin, and groin. When a stone enters the low part of the ureter, the pain is felt at a lower level and is often referred to the testis or the tip of the penis in the male and the labium majus in the female. Sometimes ureteral pain is referred along the femoral branch of the genitofemoral nerve (L1 and 2) so that pain is experienced in the front of the thigh. The pain is often so severe that afferent pain impulses spread within the central nervous system, giving rise to nausea. **(Snell, 2006)**

2.3.4 Hydronephrosis:

Hydronephrosis is the term used to describe dilatation of the renal pelvis and calyces associated with progressive atrophy of the kidney due to obstructive to the out flow of urine. Even with complete obstruction, glomerular filtration persists for some time because the filtrate subsequently diffuses back into the renal interstitium and perirenal spaces, where it ultimately returns to the lymphatic and venous systems. **(Robbins and Carton, 2005).**

2.3.5 Hydro ureter (ureteric dilatation):

This occurs progressively with chronic obstruction of the upper tract: the ureteric muscle becomes at first hyper trophic and then, later, floppy and atonic. To some extent, this dissipates the pressure rise within the ureter caused by obstruction. **(Bullock, et al. 1993)**

2.3.6 Stones:

2.3.6.1 Pathological process of stones:

Stones may be single or multiple and vary enormously in size from minute, sand-like particles to staghorn calculi or large stone concretions in the bladder. They may be located within the renal parenchyma or within the collecting system. Pressure necrosis from a large calculus can cause direct damage to the renal parenchyma, and stones regularly cause obstruction, leading to hydronephrosis. They may ulcerate through the wall of the collecting system, including the ureter. A combination of obstruction and infection accelerates damage to the kidney.

2.3.6.2 Clinical features:

Most people with urinary tract calculi are asymptomatic. Pain is the most common symptom and may be sharp or dull, constant, intermittent or colicky. When urinary tract obstruction is present, measures that increase urine volume, such as copious fluid intake or diuretics, including alcohol, make the pain worse. Physical exertion may cause mobile calculi to move, precipitating pain and, occasionally, haematuria. Ureteric colic occurs when a stone enters the ureter and either obstructs it or causes spasm during its passage down the ureter. This is one of the most severe pains known. Radiation from the flank to the iliac fossa and testis or labium in the distribution of the first lumbar nerve root is common. Pallor, sweating and vomiting often occur and the patient is restless, trying to obtain relief from the pain. Haematuria often occurs. Untreated, the pain of ureteric colic typically subsides after a few hours. When urinary tract obstruction and infection are present, the features of acute pyelonephritis or of a Gram-negativesepticaemia may dominate the clinical picture.

Vesical calculi associated with bladder bacteriuria present with frequency, dysuria and haematuria; severe introital or perineal pain may occur if trigonitis is present. A calculus at the bladder neck or an obstruction in the urethra may cause bladder outflow obstruction, resulting in anuria and painful bladder distension.

2.3.6.3 Causes and pathogenesis:

There are four main types of calculi: (1) most stones (about 70%) are calcium containing, composed largely oxalate mixed with calcium phosphate; (2) another 15% are so-called triple stones or strutive stone, composed of magnesium ammonium phosphate; (3) 5% to 10% are uric acid stones; and (4) 1% to 2% are made up cysteine.

2.3.6.3.1 Calcium oxalate stones: are associated in about 5% of patients with both hypercalcemia and hyper calciurea caused by hyperparathyroidism, diffused bone disease and other hypercalcemia. About 55% have hypercalciurea without hypercalcemia. This is caused by several factors, including hyperabsorbtion of calcium from intestine, an intrinsic impairment in renal tubular reabsorption of calcium or idiopathic fasting hypercalciurea with normal parathyroid function. The mechanism of stone formation in this setting involves “nucleation” of calcium oxalate by uric acid crystals in collecting ducts.

2.3.6.3.2 Magnesium ammonium phosphate stones: are formed largely after infections by urea-splitting bacteria, which convert urea to ammonia. The resultant alkaline urine causes the precipitation of magnesium ammonium phosphate salts. These form some of largest stones, as the amount of urea excreted normally are huge. Indeed, so-called staghorn calculi occupying large portion of renal pelvis are almost always a consequence of infection.

2.3.6.3.3 Uric acid stones: are common in patient with hyperuricemia, such as gout, and disease involving rapid cell turnover, such as luekemias. In contrast to radio-opaque calcium stones, uric acid stones are radiolucent.

2.3.6.3.4 Cysteine stones: are caused by genetic defects in the renal reabsorption of amino acids, including cysteine, leading to cystinurea. Stones form at low urinary PH.**(Robbins et al, 2005)**

2.3.6.4 Kidney stones:

Kidney stones, or renal calculi, are crystals of the salts that are normally present in urine. A very high concentration of salts in urine may trigger precipitation of the salt and formation of crystals, which can range in size from microscopic to 10 to 20 mm in diameter. The most common type of kidney stone is made of calcium salts; a less common type is made of uric acid.

Kidney stones are most likely to form in the renal pelvis. Predisposing factors include decreased fluid intake or over ingestion of minerals (as in mineral supplements), both of which lead to the formation of a very concentrated urine. The entry of a kidney stone into a ureter may cause intense pain (renal colic) and bleeding. Obstruction of a ureter by a stone may cause backup of urine and possible kidney damage. Treatments include surgery to remove the stone, or lithotripsy, the use of shock waves to crush the stone into pieces small enough to be eliminated without damage to the urinary tract. A recent study links lithotripsy with an increased risk of diabetes or hypertension later in life, though the mechanisms that would bring about these conditions have not yet been discovered. **(Livingstone, 1994)**

2.3.6.5 Ureteric Stones:

There are three sites of anatomic narrowing of the ureter where stones may be arrested, namely, the pelviureteral junction, the pelvic brim, and where the ureter enters the bladder. Most stones, although radiopaque, are small enough to be impossible to see definitely along the course of the ureter on plain radiographic examination. An intravenous pyelogram is usually necessary. The ureter runs down in front of the tips of the transverse processes of the lumbar vertebrae, crosses the region of the sacroiliac joint, swings out to the ischial spine, and then turns medially to the bladder. **(Snell, 2006)**

2.3.6.6 Migratory stones:

In most cases a ureteral stones move only on way (down) in a ureter. In the occasional case, however, stones seem to change position and move up and down the ureter freely. In one film the may be in the lower part of the ureter, while in a later film they may be in the upper part or even in renal pelvis. Although in most cases this means dilated ureter, cases encountered in which there appears to be little or no ureterectasis. **(Bullock, et al. 1993)**

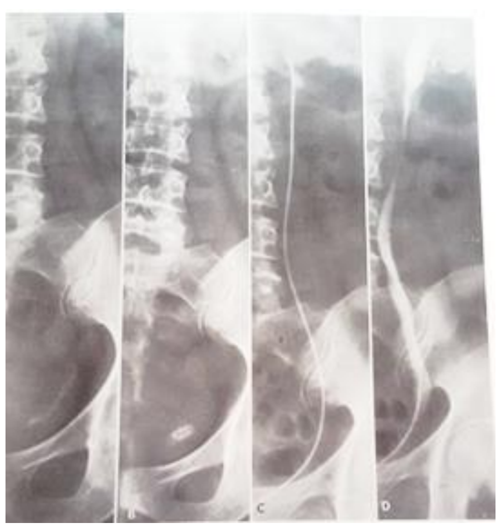

Figure 2-8: migratory ureteral calculi and B, plain films made in same day show multiple calculi low in left ureter with different distribution in each film. C, plain film with opaque catheter in ureter (made 2 day later). Calculi are now in upper part of ureter and renal

pelvis. D, retrograde pyelogram shows atrophic kidney with typical vertical pelvis. Calculi are in pelvis. **(Bullock, et al. 1993)**

2.4 Diagnosis:

2.4.1 Laboratory Investigations:

2.4.1.1 A mid-stream specimen of urine for culture: Is anon-contaminated clean catch mid-stream urine specimen is collected.

2.4.1.2 Serum urea: The normal range of urea nitrogen in blood or serum is 5 to 20 mg/dl, or 1.8 to 7.1 mmol urea per liter. **(Hosten, 1990)**

2.4.1.3 Serum Creatinine (GFR): The normal serum creatinine (^{s}Cr) varies with the subject's body muscle mass and with the technique used to measure it. For the adult male, the normal range is 0.6 to 1.2 mg/dl, or 53 to 106 µmol/L by the kinetic or enzymatic method, and 0.8 to 1.5 mg/dl, or 70 to 133 µmol/L by the older manual Jaffé reaction. For the adult female, with her generally lower muscle mass, the normal range is 0.5 to 1.1 mg/dl, or 44 to 97 µmol/L by the enzymatic method.**(Hosten, 1990)**

2.4.1.4 Calcium levels: Normal values range from 8.5 to 10.2 mg/dL. Normal value ranges may vary slightly among different laboratories. Some laboratories use different measurements or may test different specimens. Talk to your doctor about the meaning of your specific test results**. (Dugdale, 2013)**

2.4.2 Radiographic investigations:

2.4.2.1 Plain abdominal X-ray:

A plain radiograph of the abdomen is valuable to identify renal calcification or radiodense calculi in the kidney, renal pelvis, line of the ureters or bladder Plain abdominal X-ray and excretion urography are still used widely for diagnosis, although unenhanced helical (spiral) CT is the best diagnostic test available. Ureteric stones can be missed by ultrasound.

Pure uric acid stones are radiolucent. Mixed infective stones in which organic matrix predominates are barely radiopaque calcium-containing and cystine stones are radiopaque. Calculi overlying bone are easily missed. Staghorn calculi may be missed if the plain abdominal X-ray carried out before contrast injection during urography is not inspected. Uric acid stones may present as a filling defect after injection of contrast medium. Such stones are readily seen on CT scanning.

Excretion urography is carried out during the episode of pain; a normal urogram excludes the diagnosis of pain due to calculous disease. **(Robbin et al, 2005)**

Figure2-9: staghorn calculus. X-ray appearance before and after contrast on the right side is identical owing to a staghorn calculus in non-functioning right kidney. **(Robbin et al, 2005)**

2.4.2.2 Computed tomography:

Since the first CT scanner was developed in 1972 by Sir Godfrey Hounsfield, the modality has become established as an essential radiological technique applicable in a wide range of clinical situations.

CT uses X-rays to generate cross-sectional, two-dimensional images of the body. Images are acquired by rapid rotation of the X-ray tube 360° around the patient. The transmitted radiation is then measured by a ring of sensitive radiation detectors located on the gantry around the patient (Fig. 1.1). The final image is generated from these measurements utilizing the basic principle that the internal structure of the body can be reconstructed from multiple X-ray projections. Early CT scanners acquired images a single slice at a time (sequential scanning). However, during the 1980s significant advancements in technology heralded the development of slip ring technology, which enabled the X-ray tube to rotate continuously in one direction around the patient. This has contributed to the development of helical or spiral CT.

In spiral CT the X-ray tube rotates continuously in one direction whilst the table on which the patient is lying is mechanically moved through the X-ray beam. The transmitted radiation thus takes on the form of a helix or spiral. Instead of acquiring data one slice at a time, information can be acquired as a continuous volume of contiguous slices. This allows larger anatomical regions of the body to be imaged during a single breath hold, thereby reducing the possibility of artifacts caused by patient movement.Faster scanning also increases patient throughput and increases the probability of a diagnostically useful scan in patients who are unable to fully cooperate with the investigation. **(hussainpassu, 2004).**

2.4.2.2.1 CT for renal system:

Because the kidneys actively concentrate contrast medium within the parenchyma, most renal abnormalities are best seen on CT after intravenous contrast medium administration. Unenhanced CT is performed to demonstrate calcifications and calculi that may be obscured by contrast agent. Multi detecter helical CT (MDCT) is optimal for renal evaluation and is the current technique of choice.

2.4.2.2.2 Renal stone disease in CT:

MDCT has forever changed the imaging of renal stone disease. CT is now the imaging method of choice for detection of renal stones and diagnosis of the complications of renal stone disease. Conventional radiographs have a specificity of only 77% for stone detection. Conventional radiographs and intravenous pyelograms (IVPs) have been replaced by helical MDCT. CT for stones requires no contrast and no patient preparation. With MDCT the study is routinely completed in seconds. CT may also provide an alternate diagnosis for the patient’s symptoms including other urinary pathology, acute appendicitis, diverticulitis, pancreatitis, adnexal masses, and leaking aneurysms. **(Richard et al 2015).**

2.4.2.2.3 CT Appearance of Urinary Stones:

Whereas only about 85% of urinary stones are seen as calcified densities on conventional radiographs, CT detects nearly all calculi. Calcium oxalate and calcium phosphate stones are most common (73%) and typically have a CT attenuation of 1200 to 2800 HU. Struvite stones (magnesium aluminum phosphate; 15% of renal stones) are seen with chronic infection. Struviteattenuation ranges from 600 to 900 HU. Uric acid stones (8%), which are radiolucent on conventional radiographs, have an attenuation of 200to 450 HU. Cystine stones (1% to 4% of cases) are moderately radiopaque because of their sulfur content. Calcium may be present in some cysteine stones. Cystine stones have attenuation values of 200 to 1100 HU, depending on their calcium content. High CT attenuation makes stones easy to differentiate from other urinary tract lesions such as tumors, hematoma, fungus balls, and sloughed papilla.

Virtually all stones, even those that are radiolucent on conventional radiographs, are identified as high-attenuation foci on CT images viewed with soft-tissue windows. The threshold size for stone detection by CT is approximately 1 mm.

Ureteral calculi are usually geometric or oval in shape. They are seldom completely round. This feature is useful in differentiating stones from phleboliths. It has been reported that the positive predictive value of geometric shape in identifying a calculus is as high as 100%.

The single exception to stones being of high attenuation on CT is crystalline stones in urine related to the use of protease inhibitors (indinavir,Crixivan®) in the treatment of human immunodeficiency virus disease. These stones are of soft-tissue attenuation on CT scans but may cause acute ureteral obstruction. Contrast-enhanced CT demonstrates these stones as tiny filling defects in the collecting system or ureter.

The burden of stones in the kidneys is easily determined by CT. Stones are seen in the region of the minor calyces or medullary pyramids. The stone burden is defined as the number and size of stones present. Stone burden is used to determine therapy such as lithotripsy.

The tips of the renal pyramids are of high attenuation when the patient is dehydrated This normal finding of *whitepyramids* should not be interpreted as representing renal stones. **(W.Richard et al 2015).**

2.4.2.2.4 CT technique (Stone protocol):

Renal stone CT (called CT-KUB, denoting CT of kidneys, ureters, and bladder) is noncontrast MDCT of urinary tract used to diagnose the presence of urinary tract calculi and to detect urinary obstruction caused by stones.

No oral contrast or IV contrast administered. Data acquisition is continuous from the top of the kidneys through the base of bladder (mid-T12 level through the symphysis pubis) using collimation of 0.625 to 2.5mm. Image may be viewed at a slice thickness of 1.25 to 2.5 mm. thin slices allow identification of very small stones that may be over loocked with thicker slices. Turning the patient to prone position will allow differentiation of stones impacted at the ureterovesical junction (UVJ) from stones that have already passed into the bladder.**(Richard et al 2015).**

CT-KUB is the best diagnostic test available. Ureteric stones can be missed by ultrasound.
CT-KUB (CT of kidney, ureter and bladder) is carried out during the episode of pain; a normal CT excludes the diagnosis of pain due to calculous disease.

The CT-KUB appearances in a patient with acute left ureteric obstruction are shown in Figure (2-5). **(Kumar et al, 2012)**

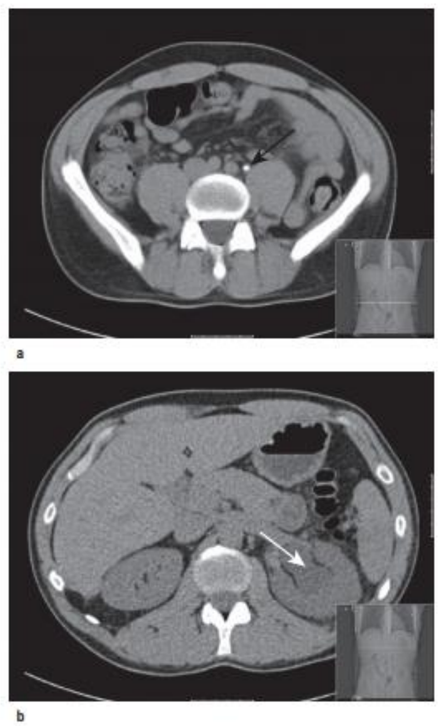

Figure (2-10) CT-KUB in ureteric stone obstruction. (a) Left ureteric calculus. (b) A dilated renal pelvis (arrow) proximal to the ureteric stone in (a). **(Kumar et al, 2012)**

Pure uric acid stones are radiolucent and show as a filling defect after injection of contrast medium if excretion urography is performed. Such stones are readily seen on CT scanning (Figure2-10). Mixed infective stones in which organic matrix predominates are barely radiopaque. The urine of the patient should be passed through a sieve to trap any calculi for chemical analysis.

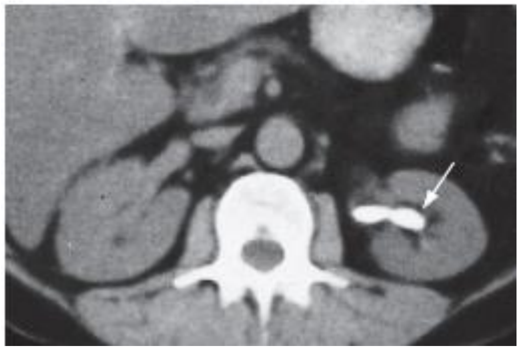

Figure 2-11: CT scan, showing a uric acid stone, which appears as a bright lesion in the left kidney (arrow). **(Kumar et al, 2012)**

2.4.2.3 Ultrasound:

2.4.2.3.1 Ultrasound Physics:

All diagnostic ultrasound applications are based on the detection and display of acoustic energy reflected from interfaces within the body. These interactions provide the information needed to generate high-resolution, gray-scale images of the body, as well as display information related to blood flow. Its unique imaging attributes have made ultrasound an important and versatile medical imaging tool. However, expensive stateof-the-art instrumentation does not guarantee the production of high-quality studies of diagnostic value.

Gaining maximum benefit from this complex technology requires a combination of skills, including knowledge of the physical principles that empower ultrasound with its unique diagnostic capabilities. The user must understand the fundamentals of the interactions of acoustic energy with tissue and the methods and instruments used to produce and optimize the ultrasound display. With this knowledge the user can collect the maximum information from each examination, avoiding pitfalls and errors in diagnosis that may result from the omission of information or the misinterpretation of artifacts.

Ultrasound imaging and Doppler ultrasound are based on the scattering of sound energy by interfaces of materials with different properties through interactions governed by acoustic physics. The amplitude of reflected energy is used to generate ultrasound images, and frequency shifts in the backscattered ultrasound provide information relating to moving targets such as blood. To produce, detect, and process ultrasound data, users must manage numerous variables, many under their direct control. To do this, operators must understand the methods used to generate ultrasound data and the theory and operation of the instruments that detect, display, and store the acoustic information generated in clinical examinations. **(Rumack et al 2011)**

2.4.2.3.2 Ultrasound Technique:

The ability to visualize organs of the genitourinary tract by ultrasound depends on the patient's body habitus, operator experience, and scanner platform. The patient should fast a minimum of 6 hours before the examination to limit bowel gas. High-frequency probes should be used for patients with a favorable body habitus.

The Kidney: The kidneys should be assessed in the transverse and coronal plane. Optimal patient positioning varies; supine and lateral decubitus positions often suffice, although oblique and occasionally prone positioning may be necessary (e.g., obese patients). Usually, a combination of subcostal and intercostal approaches is required to evaluate the kidneys fully; the upper pole of the left kidney may be particularly difficult to image without a combination of approaches.

The Ureter: The proximal ureter is best visualized using a coronal oblique view with the kidney as an acoustic window. The ureter is followed to the bladder, maintaining the same approach. A nondilated ureter may be impossible to visualize because of overlying bowel gas. Transverse scanning of the retroperitoneum often demonstrates a dilated ureter, which can then be followed caudally with both transverse and sagittal imaging. In women, a dilated distal ureter is well seen with transvaginal scanning.

The Bladder and Urethra: The bladder is best evaluated when it is moderately filled; an overfilled bladder causes patient discomfort. The bladder should be scanned in the transverse and sagittal planes. To better visualize the bladder wall in women, transvaginal scanning may be helpful. If the nature of a large, fluid-filled mass in the pelvis is uncertain, voiding or insertion of a Foley catheter will clarify the location and appearance of the bladder relative to the fluid-filled mass. The urethra in a woman can be scanned with transvaginal, transperineal, or translabialsonography. **(Rumack et al 2011)**

2.5 Previous studies:

In 2013, Moawia Gamerddin et al, Characterization of Renal Stones by Computed Tomography and Ultrasound, included 50 subjects (35 males (70%) and 15 females (30%)), their ages range from 15 to 72 years old with symptoms of renal stones The most affected age group ranged from 21-40 years old 56 %, most patients were affected in the both sides, with no history of renal stones in their families most of the stones lodged in the kidneys (36%) and at the ureters (8%).Both spiral CT and U/S were found to be excellent modalities for depicting renal stones, CT and U/S are the first line of choice in diagnosis of renal calculi.

In 2000 by assi and et al the result of this study to demonstrated that Sensitivity of CT scout radiography and abdominal radiography for revealing ureteral calculi on helical CT: implications for radiologic follow-up if a stone was identifiable on the initial CT scout (topogram, scanogram etc.) then it would be visible on KUB. AS 13% of stones that will be visible on a KUB are not identified on the scout, another 2000 study utilises a technique of measuring the Hounsfield Unit (HU) value of stone. If the stone's value is below 200 HU it will not be visible on the KUB, if it is between 200__300 HU ,it may be visible, and if the stone is greater than 300 HU then it will definitely be visible on the KUB.

Myers MTet al, study of unenhanced helical CT in the evaluation of the urinary tract in children and young adults following urinary tract reconstruction comparison with sonography, found that CT is superior to sonography for the detection of urinary tract calculi and renal scarring. CT will demonstrate abdominal wall hernias that are unsuspected.

In 2015, Song Y et al, Can ureteral stones cause pain without causing hydronephrosis?In patients with ureteral stones and colic, nearly 11 % do not demonstrate any hydronephrosis and a majority (nearly 71 %) will demonstrate only mild hydronephrosis. Stone diameter appears to be related to degree of hydronephrosis, whereas age, gender, and stone location are not. The lower incidence of hydronephrosis for small stones causing renal colic may explain the lower diagnostic accuracy of ultrasound when compared to CT for detecting ureteral stones.

In 1996, AJR Am J Roentgenol. Unenhanced helical CT of ureteral stones: incidence of associated urinary tract findings. In patients with ureteral calculi imaged with unenhanced CT for acute renal colic, associated findings included hydronephrosis, hydroureter, perinephric soft-tissue changes, and periureteral edema. These common findings provided supportive evidence that an acute obstructive process was present.

3. Materials and Methods

3.1 materials:

3.1.1 Study design:

Retrospective, descriptive and analytical study.

3.1.2 Patients and sampling:

There were 109 cases were scanned by ultrasound and CT, all cases had come to the department suffering from loin pain or suspected have urinary tract stone.

Any pregnant female had been excluded from computed tomography emaination.

3.1.3 Study area and period:

This study was conducted from September 2015 till March 2016, from Elribat university hospital.

3.1.4 The equipment used included:

3.1.3.1 Ultrasound machine:

Ultrasound machine (Siemens) German of following features:

Convex transducer of 3.5 MHz frequency, Sony printer with thermal papers and cotton.

3.1.3.2 CT machine:

Ct machine used was Germany Siemens machine, 16 slice, with digital printer using thermal films, in addition to automatic injector for contrast medium.

3.2 The Methods:

3.2.1 Data collection:

The data collected using "data collecting sheet" which designed to involve especially for the study, CT KUB images, and U/S images variable was: gender, age, ultrasound finding, Computed Tomography finding, number of stone, site, right or left, Stone size, Hydro nephrosis, Hydro ureter, Hounsfield Unit, and kidney size.

The data were collected from Elribat university hospital archiving department, all the image had been reported radiological department's consultants.

3.2.2 Methods of Analysis:

The collected data was analysed using Office Excel 2007 statistical analysing program.

3.2.3 Technique:

3.2.3.1 For U/S:

Firstly as preparation for patients before the exam, patient had come fasting and full bladder to use the bladder as window.

Patients were examined in the supine position, and ultrasound coupling gel was applied. Choice of transducer: -Use 3.5 MHz for adults, curvilinear probe, 5 MHz for children and thin adults. 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, then turn patient to the left side to see left kidney, then complete scanning for ureters and bladder.

3.2.3.2 For CT KUB:

CT KUB (non-contrast enhanced CT of kidney, ureter and bladder) is useful to determine the number and location of urinary tract calculi. Its usually did not need previous patient preparation. Using the following parameter: KVP: 120, mAs: 180 slice thickness is firstly 5 mm. It is used in some centers as primary investigation of renal calculi. The patient lies supine on CT scanner table. For centering use laser alignments that the longitudinal alignment at the median sagittal plain, transverse alignment at xiphoid process and horizontal one with the mid axillary line. Then scout view was 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 then for reconstruction use 2 mm thin slice to give more fine details.

3.2.4 Ethical Considerations:

The patients to be scanned were selected according only to our inclusion criteria. The patient had already come to U/S department to do the exam then for more details and specific diagnosis by using CT KUB, No patient identification or individual patient detail is published.

3.2.5 Limitations of the study:

- This study was limited by the available time, which caused small size of sample.
- Technical limitations because of the variable placental locations, and different body habits of patients.

4. Results:

After applying the previously stated Methodology; and the application of regression analysis, the results of analyzing the whole data were as follows:

Table 4-1: descriptive table shows mean and standard deviation:

	Mean	Standard deviation
Age	38.4	15.8
Stone width	14.1mm	15.1 mm
Hounsfield number	578.5	505.0

Table 4-2: descriptive table represent the frequency of affected gender:

Gender	Frequency	Percent
Male	76	69.7
Female	33	30.3
Total	109	100.0

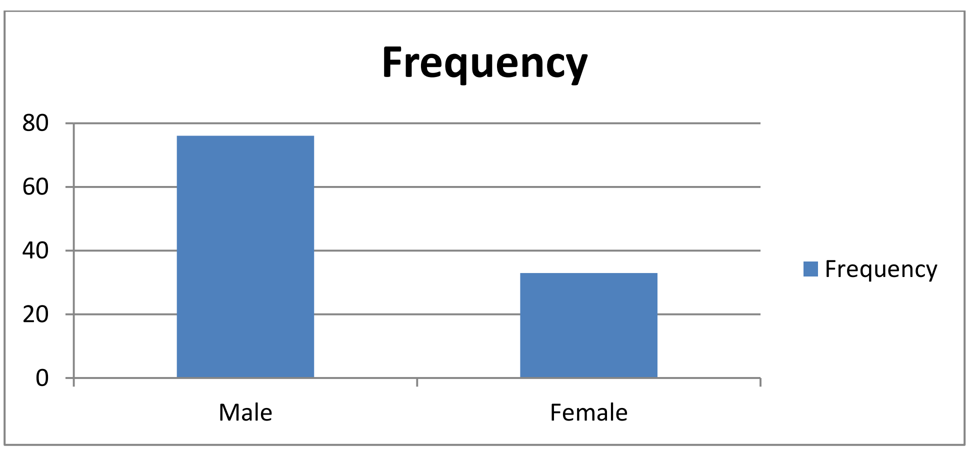

Figure (4-1): show gender distribution of cases 69.7 % male and 30.3 % female.

Table 4-3: descriptive shows ultrasound finding frequency:

Ultrasound finding	Frequency	Percent
renal stone	84	77.1
urethral stone	1	.9
UB stone	4	3.7
uretric stone	20	18.3
Total	109	100.0

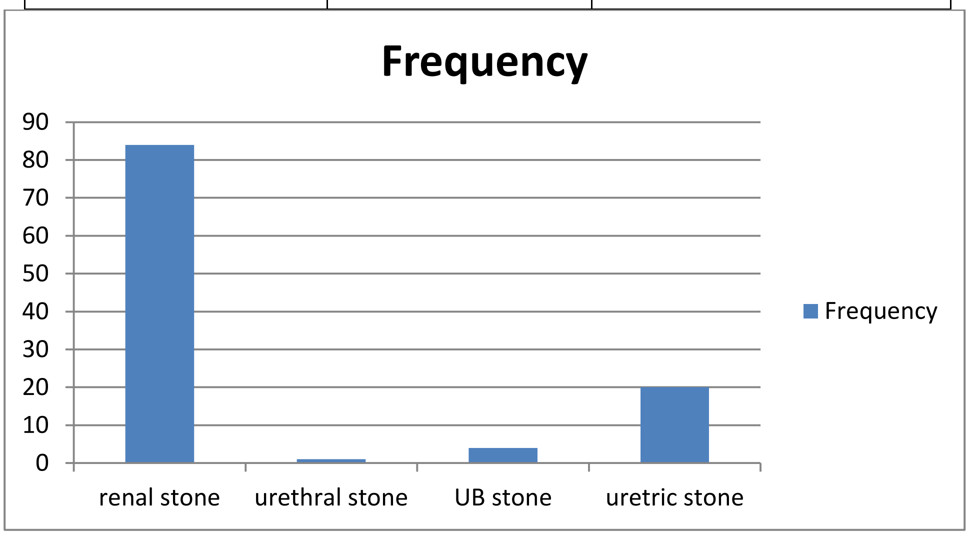

Figure (4-2): show frequency of ultrasound findings.

Table 4-4: represent frequency of CT finding:

CT finding	Frequency	Percent
Normal	15	13.8
renal stone	71	65.1
urethral stone	1	.9
UB stone	7	6.4
ureteric stone	15	13.8
Total	109	100.0

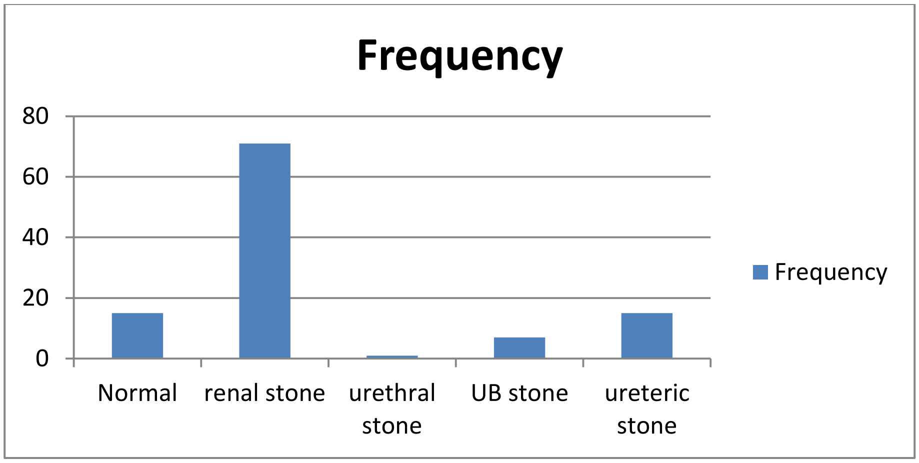

Figure (4-3): show frequency of CT findings.

Table 4-5: number of stones:

Number of stone	Frequency	Percent
0	14	12.8
1	72	66.1
2	8	7.3
3	5	4.6
4	3	2.8
5	5	4.6
6	1	.9
7	1	.9
Total	109	100.0

Table 4-6: Site of stone:

Site of stone	Frequency	Percent
None	15	13.8
upper pole	12	11.0
middle pole	4	3.7
lower pole	34	31.2
renal pelvis	20	18.3
Urethera	1	.9
Bladder	9	8.3
Ureter	14	12.8
Total	109	100.0

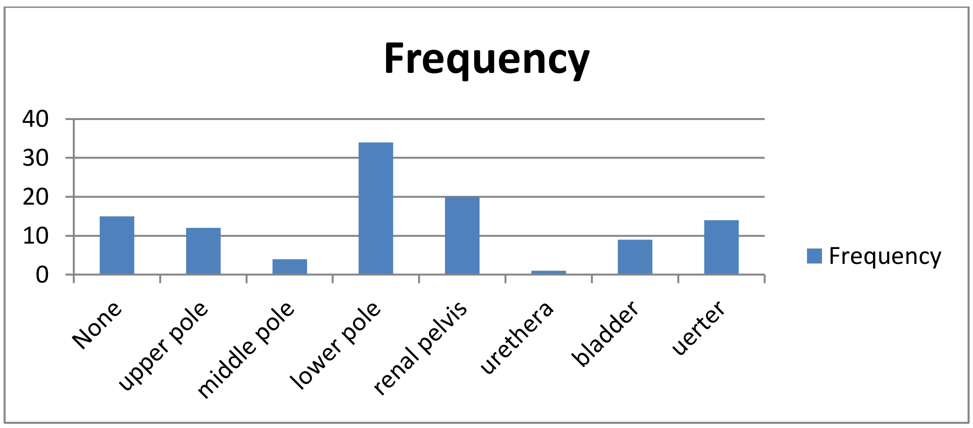

Figure (4-4): show the frequency of stone site.

Table 4-7: site of stones RT and LT:

Site Rt or Lt		Percent
Non	14	12.8
Rt	47	43.1
Lt	43	39.4
Bladder	4	3.7
Urethera	1	.9
Total	109	100.0

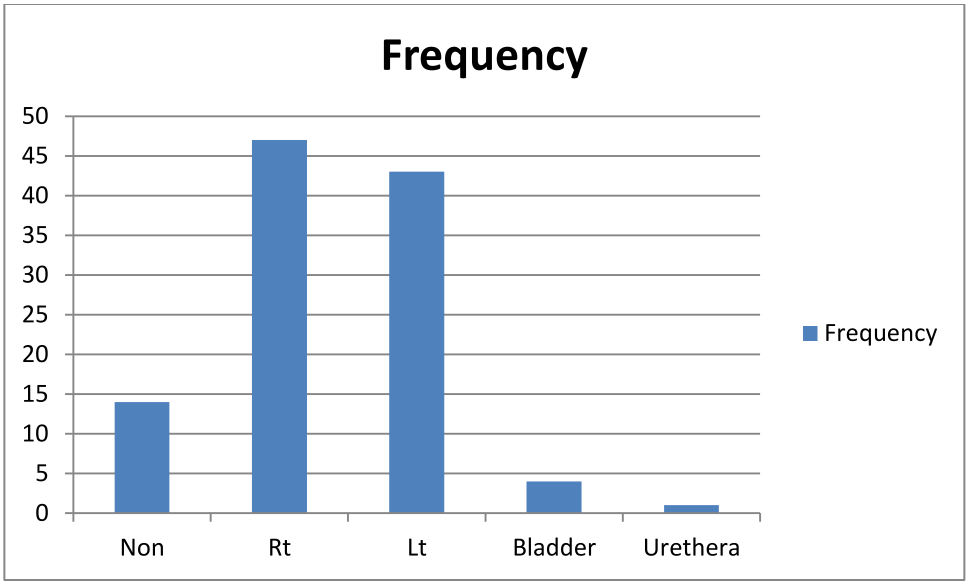

Figure (4-5): show frequency of location of stones.

Table 4-8: descriptive table show the evidence hydronephrosis:

Hydronephrosis	Frequency	Percent
Non	64	58.7
Mild	26	23.9
Moderate	14	12.8
Sever	5	4.6
Total	109	100.0

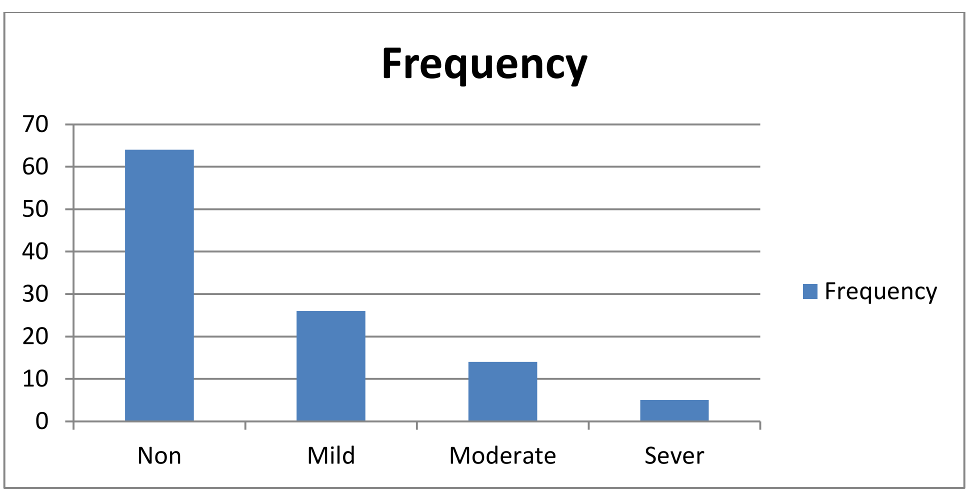

Figure (4-6): show evidence of hydronephrosis frequency.

Table 4-9: descriptive table show the evidence hydro ureter:

Hydroureter	Frequency	Percent
Non	97	89.0
Mild	10	9.2
Moderate	2	1.8
Total	109	100.0

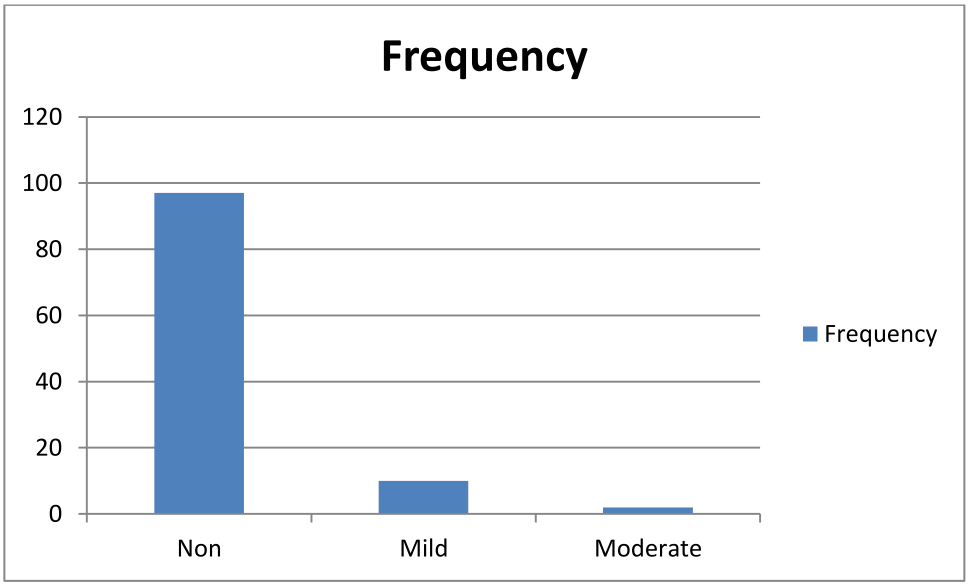

Figure (4-7): show frequency of hydro ureter.

Table 4-10: descriptive table show effect on kidney size:

kidney size	Frequency	Percent
Normal	99	90.8
Large	7	6.4
Small	3	2.8
Total	109	100.0

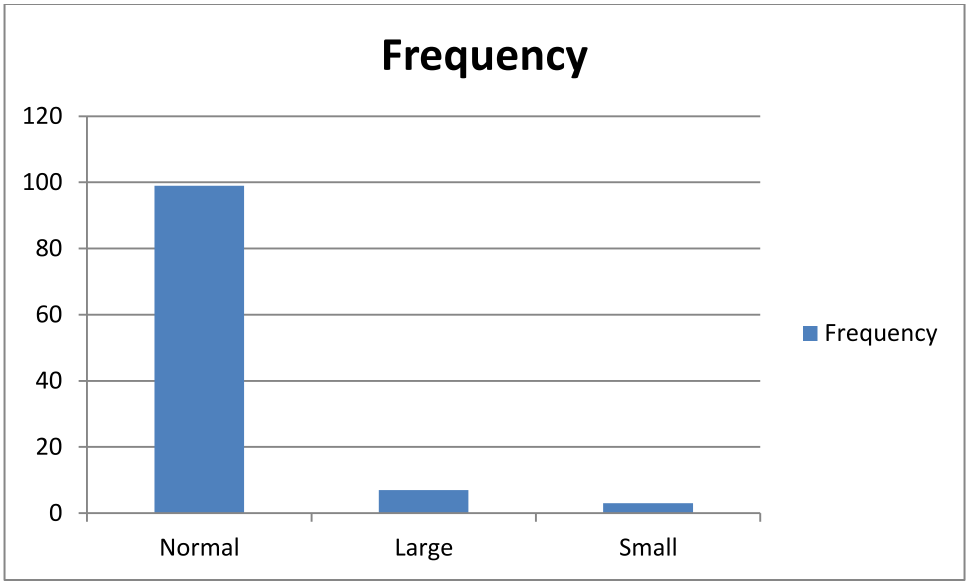

Figure (4-8): show effect of stones in kidney size

5. Chapter five

5.1 Discussion:

This study was descriptive analytical study was conducted to evaluation of urinary tract stone using ultrasound and unenhanced computed tomography for kidney ureter and bladder (CTKUB) , the study was carried out from September 2015 till march 2016 took 109 patients all of them from Elribat Hospital.

Concerning on (table 4-1) the mean age of affected patients which were arranged from 6 to 67 years old, and their mean was found to be 38.4 ± 15.8.

From table (4-1) which presented that stones show in CT Hounsfield number found to be at average mean is 578.5± 505.0, however the maximum Hounsfield number was 3394 and minimum Hounsfield number was 181 account stone.

From table (4-2) the mean of the affected gender was found to be 76 male patients out of 109 patients 69.7% (which is close related to study done by **(Mawia Gamereldein et al 2013)** who found that the most affected age was 21-41 and the male was 70%), and 33 female patients 30.3%, that is means that most affected gender is male.

From table (4-3) which showed ultrasound findings; there were 84 patients out of 109 patients had renal stone 77.1 %, there was 1 patient had urethral stone 0.9%, there were 4 patients had urinary bladder stone 3.7%, there were 20 patients had ureteric stone was found 18.3%, that means that the most affected site with urinary stone using ultrasound is the kidney.

However in table (4-4) CT finding found that renal stone were 65.1%, there was 1 patient had urethral stone 0.9%, urinary bladder stone was 3.7%, and ureteric stone was found 18.3% where the discrepancy ultrasound is operator dependent in order 13.8 % was found to be normal. This is mean ultrasound demonstrate stone in all patient but in CT there were 15 patients normal and there were no stones appears, this may be due to in ultrasound unwell training operator or may be some times there are some calcification appears like stone that may leads to misdiagnosis.

Concerning on table (4-5) which showed that the number of stone by CT was found to be solitary stone 66.1% and its most sites were found at lower pole, that is means that the most found urinary tract stone is solitary stone and the less percentage represented here is multiple stones.

By looking for table (4-7) which showed that the most common site of stone found to be at right kidney and less are at urethra.

From Table (4-8) which shows those Hydro nephrosis common types were found to be mild hydro nephrosis about 23.9 % and normal patients were 58.7% which is means that it’s not necessary to found hydro nephrosis with every stone found in urinary tract.

From table (4-9) which present that Hydroureter were found to be mild type with 9.2 % and the normal patients were 89%, so hydro ureter it’s not one of common findings associated with urinary stone except in specific cases (big ureteric stones for example). **(AJR Am J Roentgenol, 1996).**

Concerning on table (4-10) which present that Kidney size was found to be unaffected and shown normal by 90.8%.Which means that the stone rarely affecting the kidney size.

5.2 Conclusion:

This study concludes that:

Ultrasound is primary method to evaluate urinary tract stones, however sensitivity is less to evaluate ureteric stone and is give false negative finding that is compared to CT.

Ultrasound is safe, noninvasive and cheaper method, but it is operator dependent, that affect in determine size, measurements and position of urinary tract stones.

CT was found in this research has more sensitive to detect urinary tract stones where ever (in any part of urinary tract), in addition to it can give more information about the surrounding anatomy to the area of stone, and it does not give false negative finding.

CT KUB can be used as tool to determine component of stones by using Hounsfield number.

Male has more potential to get urinary tract stone more than female.

The most common site of urinary tract stones in the kidneys.

The most found urinary tract stone is solitary stone and the less percentage represented here is multiple stone.

Using CT KUB the location and size of the stone within the ureter can be precisely determined its better compared to ultrasound.

The most common sites of stone can lead to each type of hydronephrosis are lower pole stone and renal pelvis.

5.3 Recommendations:

More researches are recommended using IVU is investigation to evaluate ureter patency compared to ultrasound and CT.

Ultrasound is operator dependent; more training and CPD are advised to raise sensitivity and reported of stones in ultrasound practicener.

Use multiple medical imaging modalities and investigation to evaluate renal stone beyond ultrasound method in order to increase the quality to detect stones.

CT GST Effective-Z analysis is recommended to analysis of stone component.

The author recommended that the government should be increasing the specialist hospitals for urology diseases because they increased in Sudanese now a day.

Further studies should be carried out in this field on many aspects such as increasing the number of patients, to show the relation between signs and symptoms of stones and patient age and weight.

Further studies should be carried out in this field on analysis of stone components.

Further studies should be carried out in this field for comparing between the role of U/S scanning and other diagnostic tools e.g. IVU and CTU.

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Appendices:

Appendix 1: CT and U/S images from sample of the study:

Image1: scout view of CT for 45 years old male patient, the image shows bilateral renal stone.

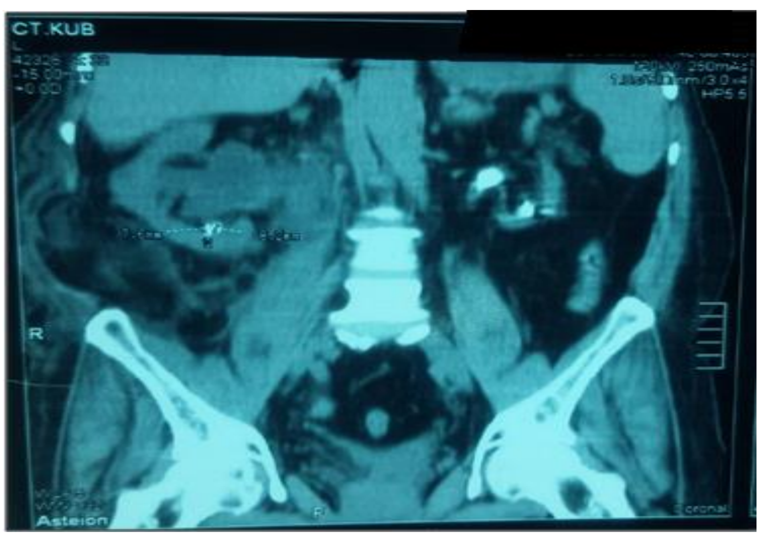

Image 2: CT KUB for 42 years old male patient suffering from lion pain, the image shows bilateral renal stone with RT hydronephrosis.

Image 3: axial CT-KUB for female 49 years old suffering from heamatourea, shows multiple urinary bladder stones.

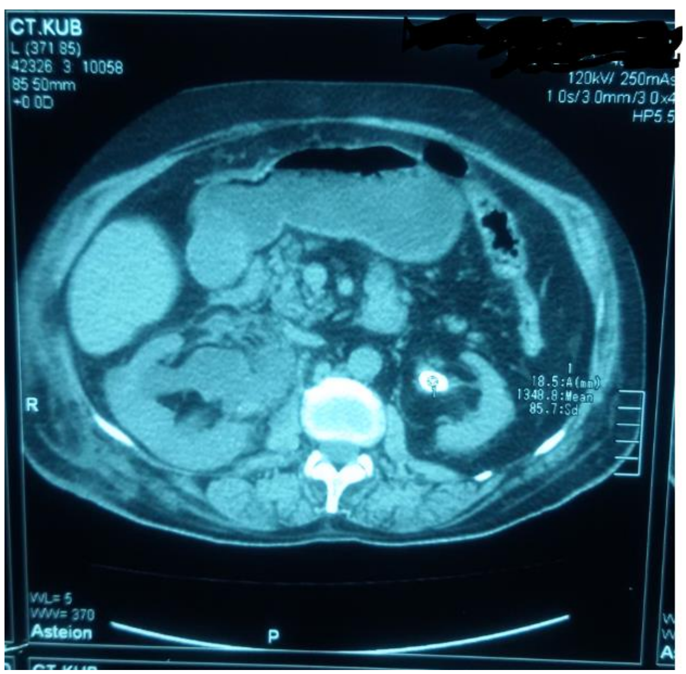

Image 4: axial CT –KUB for male 43 years old suffering from lion pain, image shows LT renal stone in renal pelvis.

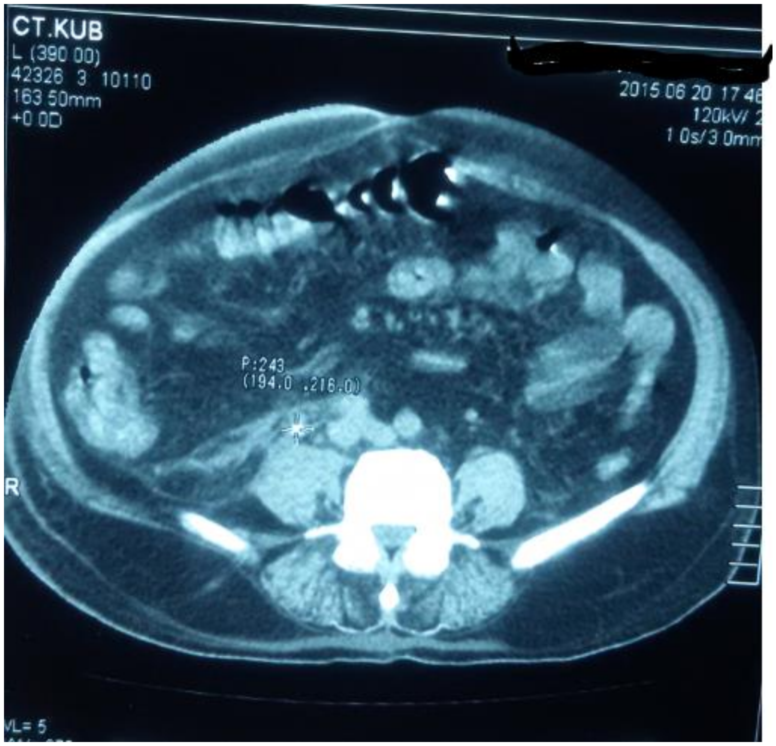

Image 5: axil CT-KUB for female 25 years old, suffering from lion pain, the image shows RT ureteric stone.

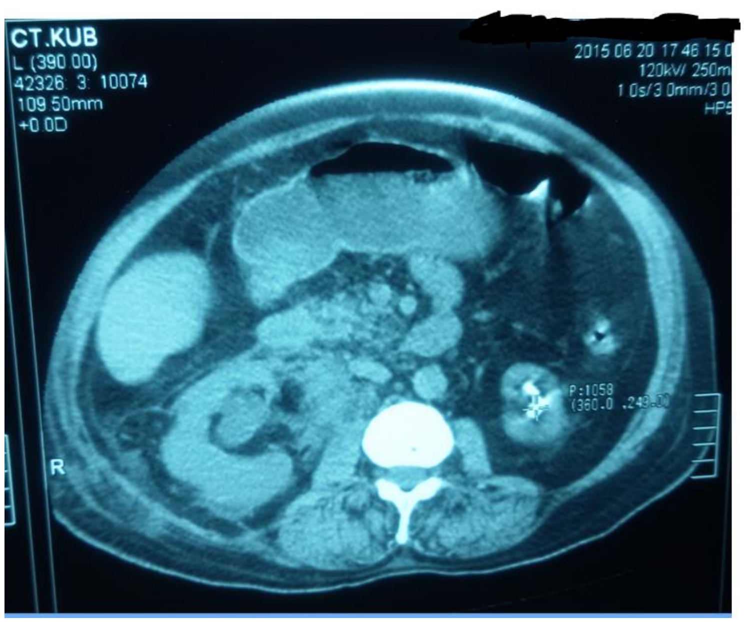

Image 6: axial CT-KUB for 70 year old male suffering from lion pain, the image shows LT renal stone and RT renal hydronephrosis

Image 7: coronal CT-KUB for 65 years old female patient, the image shows there are RT ureteric stones.

Image 8: transvere ultrasound image for 34 years old female patient, the image shows RT renal stone.

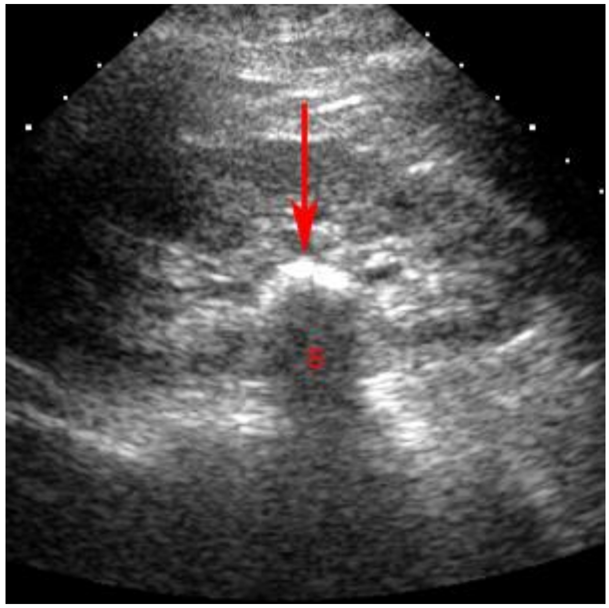

Image 9: transverse ultrasound for 18 years old female patient the image Shows that: Solitary renal stone produces a bright echogenic focus in the renal sinus and casts an acoustic shadow (S).

Appendix 2: Data collection sheet

NO	gender	age	US finding	CT finding	NO stone	site	RT or LT	Stone size	Hydro nephrosis	Hydro ureter	CT number	Kidney size