chapter one

1-1 Introduction

The kidney size of a patient is a valuable diagnostic parameter in urological and nephrologic practice.

While the leading anatomy texts describes the adult kidney as 12 cm long,6cm wide, and 3cm depth ,further review of the literature shows that renal volume varies with age, gender and body mass index .Renal size may be an indicator for the loss of kidney mass and therefore ,kidney function it is valuable in monitoring unilateral kidney disease through comparison with the other, compensatory increased side and for the discrimination between the upper and the lower urinary tract infections. Renal infections, inflammations, nephrology disorders, diabetes mellitus and hypertension are the most important conditions affecting the renal size.

Since the renal size is affected by various factors, it is necessary to first establish the normal values. The information available in the west may not be extrapolated to our population since the renal size may differ between ethnic groups ,while population –based studies are needed to establish normal values for united Arab emirates individuals , in our study we determined the ultrasonographic renal size in a group of individuals with no known renal disease and assessed the effect of age, gender, sex and BMI.

The purpose of this study is to investigate the normal monographic measurements of the kidney in adult volunteers.

The random sample is 50 adult volunteers with different age and sex 20, 30, 40.50.60 years old.

Measuring the length, width and the depth of the kidneys, volunteers are examined in supine , prone and flank positions .Median renal lengths were

11.2 cm on the left side and 10.9cm on the right side, Median renal volumes were 146 cc in the left kidney and 134 cc in the right kidney. Renal size decreased with age .almost entirely because of parenchyma reduction .Renal volume correlated best with total body area. Renal length correlated best with body heigh .The most exact measurements of renal size is renal volume ,which showed the strongest correlation with height, weight, and total body area.

Objectives : In order to establish some preliminary data of our population in U.A.E. we determined to do an ultrasonographic kidney dimensions in individuals without known renal diseases . We assessed whether sex, age ,side and body mass index affect the kidney volume .

Problem of study: I did not find a study of this type is done in U.A.E.

CHAPTER TWO

Literature review

2-1 Anatomy

Kidneys:

2-1-1 Location and description:

The kidneys are bean shaped, retroperitoneal organ that lie on each side of the spine between the peritoneum and the back muscles. The liver displace the right kidney inferiorly, hence it is located lower than the left kidney and has a slightly shorter uretur. The kidneys lie in the lower thoracic and lumber area, between the twelfth thoracic and fourth lumber vertebrae. Each kidney consists of an upper and lower pole, anterior and posterior surface a convex lateral margin and concave medial margin.(Richart.S.Snell.2005)

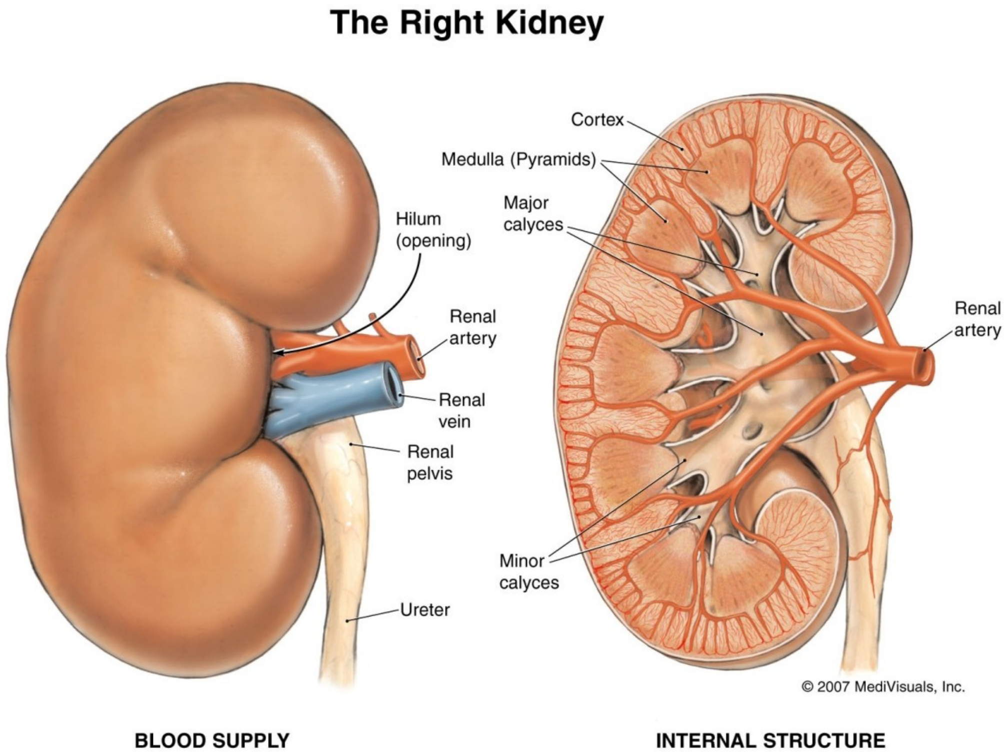


Fig 2-1 shows blood supply

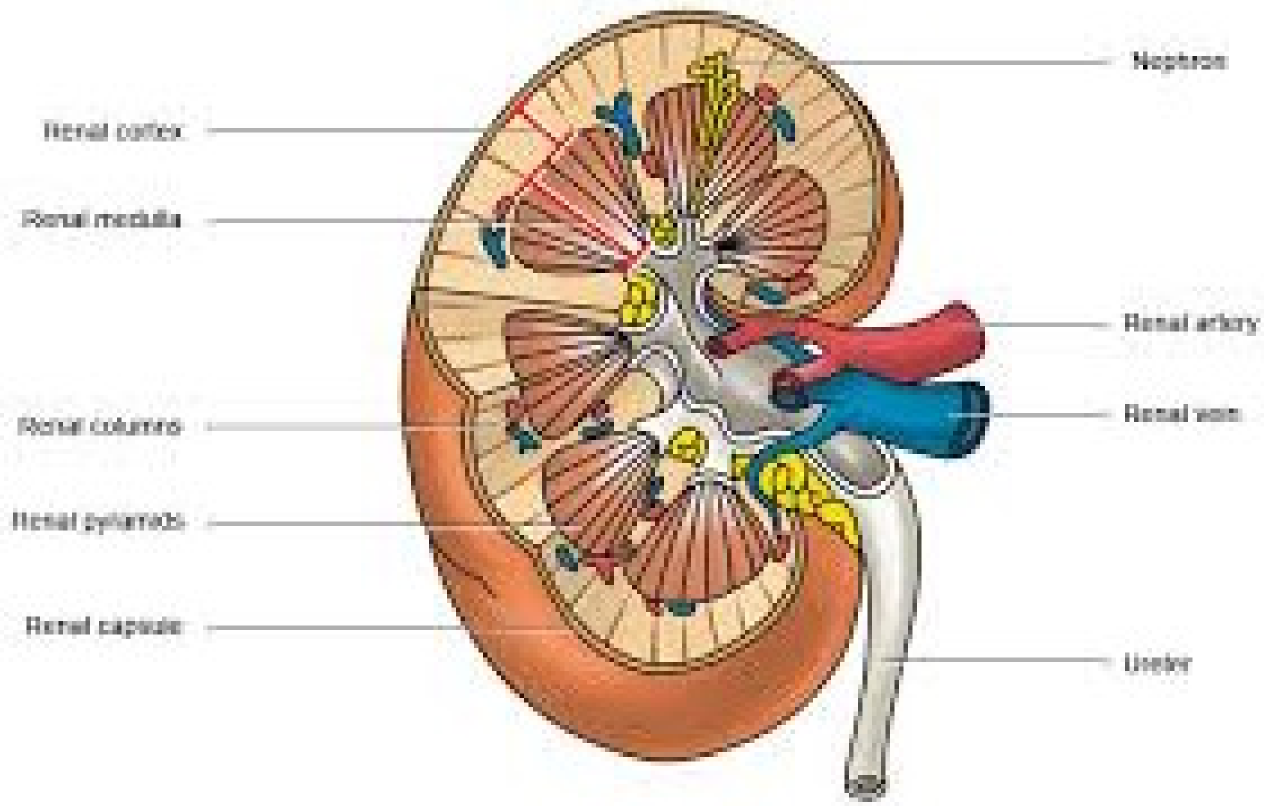


Figure 2-2 shows the kidney structures

The kidney lie high up on the posterior abdominal wall behind peritoneum, largely under the cover of the costal margin, each kidney lies obliquely, with its long axis parallel with lateral border of Poses major. The kidney lies well back in the Para vertebral gutter, so that the hilum , a vertical slit, likes depression at the medial border transmitting the renal vessels and nerve to the renal pelvic. It faces forward as well as medially. The normal kidney measure about (12*6* 3) cm, and weights about 130 grams, The right kidney is 0.5 inch lower than the left kidney; its lower end is 1.5 inches from the iliac crest. The upper pole of the left kidney reaches the 11th rib, while the upper pole of the right kidney reaches the twelfth rib. (Richart.S.Snell.2005)

2-1-2 Covering:

The kidneys have the following coverings:

1. Fibrous capsule; this surround the kidney and closely applied to its outer surface.
2. Peri renal fat; it covers the fibrous capsule.
3. Renal fascia; this is a condensation of connective tissue that lies out side the Peri renal fat.
4. Para renal fat; lie external to renal fascia and is often in the large quantity renal fat, peri renal fat. It supports the kidney and hold it in position . (Richart.S.Snell.2005)

2-1-3 Renal Structure:

Each kidney has a dark brown outer cortex and a light brown medulla. The medulla is composed of about 10 conical structures known as renal pyramids; each having its base facing towards the cortex and its apex is the renal papilla projecting medially. The cortex extends into the medulla between adjacent pyramids as the renal columns. The renal sinus, which is the space within the hilum, contains the upper expanded end of the ureter, the renal pelvis. This divided into two or three major calyces, each of which divided into two or three minor calyces. Each minor calyx is intended by apex of the renal pyramids, the renal papilla. (Richart.S.Snell.2005)

2-1-4 Relationships:

Right kidneys; Anteriorly: the suprarenal gland, the right lobe of the liver, the second part of the duodenum and the right hepatic flexure of the colon. Posteriorly: the diaphragm, the

costodiaphragmiatic recess of the pleura, the twelfth rib, the psoas major muscle, quadratus lumborum and transverses abdominis muscles.

Left kidney: Anteriorly: the suprarenal gland, the spleen, the stomach, the pancreas, the left coil of the j ejunum, quadratus

labarum, and the transverses abdomens Muscle. Posteriorly: the diaphragm, the costodiaphragmatic recess of the pleura, the

eleventh (the left kidney is higher than the right) and the twelfth ribs and the psoas major muscle. (Richart.S.Snell.2005)

2-1-5 Blood supply of kidneys:

2-1-5-1 Artery : one of the pair of large blood vessels that branch off from the abdominal aorta (the abdominal portion of the major artery leading from the heart) and enter into each kidney. (The kidneys are two bean-shaped organs that remove waste substances from the blood and aid in fluid conservation and in stabilization of the chemical composition of the blood.) At the inner concavity of each kidney there is an opening, known as the hilum, through which the renal artery passes. After passing through the hilum, the renal artery divides ordinarily into two large branches, and each branch divides into five. (Richart.S.Snell.2005)

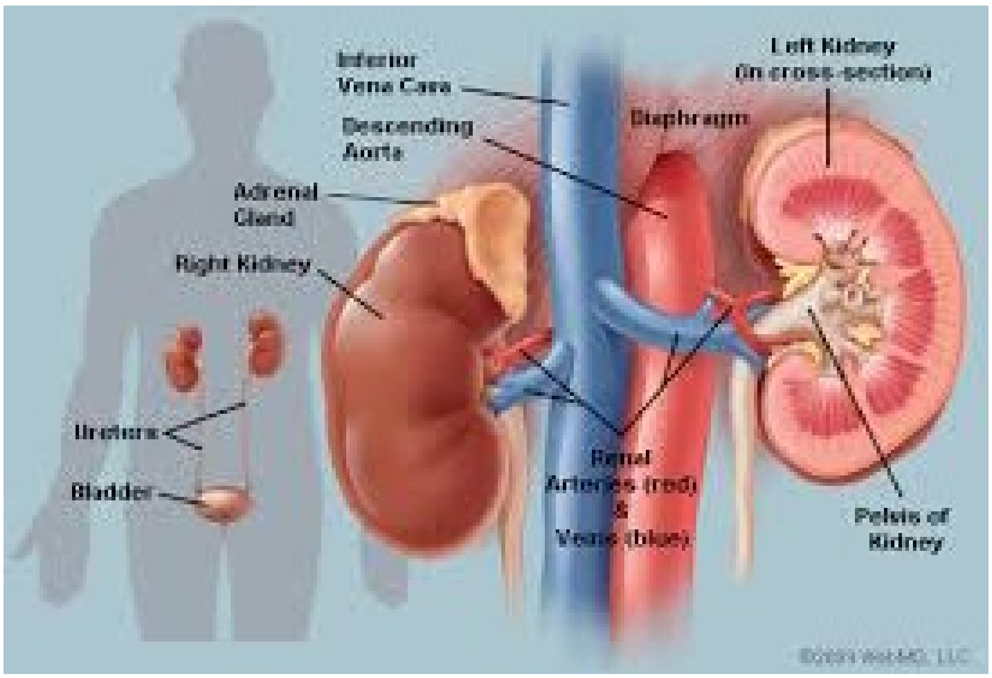
1. 

Fig2-3 shows longitudinal section of the urinary system and relation with great vessels

2-1-5-2 Veins: There are two renal veins, a left and a right. They branch off of the inferior vena cava and drain deoxygenated blood from the kidneys. As it enters the kidneys, each vein separates into two parts. Each branch connects to a certain location. The posterior vein assists in draining the posterior section of the kidney, while the anterior assists the anterior part. These veins also are responsible for draining blood from the ureter, which moves urine away from the kidneys to the urinary bladder. These veins should not be confused with the renal aorta. Unlike veins, the renal aorta delivers oxygenated blood to the kidneys. To simplify, aorta carry blood to the kidneys while veins move the blood away. There are two main diseases often associated with renal veins. If a clot or a thrombus develops, a condition called renal vein thrombosis (RVT) results. Symptoms include a diminished flow of urine while urine volume stays consistent. Treatment would require either anticoagulants and/or clot-removing surgery. Another issue includes nutcracker syndrome (NCS), which involves the one of the renal veins becoming compressed between abdominal aorta and the superior mesenteric artery. (Richart.S.Snell.2005)

Lymphatic drainage:

Renal lymphatic plexuses among the tubules in both cortex and medulla are arranged around the blood vessels, especially the veins. Lymphatic vessels run from the plexuses into a dense **basal network** over the base of the **pyramids**, where the channels from the cortex join with those from the medulla to reach the region of the calyceal **fornix** (From there, the lymphatics run with the blood vessels around the **calyceal necks** to the **renal sinus**, where they empty into several large **valved collectors** lying on the surface of the **pelvis** and accompany the **renal vein** out of the hilum to terminate in a few nodes along the renal vessels and in the aortic nodes. (Tarig.hakim.2008)

2-1-5-2 Nerve supply: Nerve supply to the kidney

Renal nerves

A very large number of autonomic nerves, primarily with vasomotor activity, come from widespread sources to a focus in the **renal plexus.** Four to eight renal branches arise from the **celiac plexus** on each side and, at first, run cephalad to the renal vessels and then pass ventral to them as the nerves approach the renal plexus. And **least splanic nerves** provide nerve supply to the kidney, usually indirectly, partly via the **aortorenal ganglion** and partly through the **celiac ganglion.** Branches to the renal plexus also arise from the **second lumbar sympathetic ganglion** and run directly to the kidney or by way of the **posterior renal ganglion.** Other branches come from the upper parts of the aortic plexus. Finally, branches pass from the lower part of the aortic plexus to the renal plexus, with or without communication with the **superior hypo gastric plexus**. (Tarig.hakim.2008)

2-2 Histology

Renal histology studies the structure of the kidney as viewed under a microscope. Various distinct cell types occur in the kidney, including:

- Kidney glomerulus parietal cell
- Kidney glomerulus podocyte
- Kidney proximal tubule brush border cell
- Loop of Henle thin segment cell
- Thick ascending limb cell
- Kidney distal tubule cell
- Kidney collecting duct cell
- Interstitial kidney cell.

2-3 Embryology:

The kidneys are developing from a common mesodermal ridge intermediate mesoderm. Three slightly overlapping kidney systems are formed in cranial to caudal sequence during intrauterine life; the prone pherosis which is rudimentary and non functional, neso nephros may function for short time during the early fetal period, and metanephrosis which is from the permanent kidney. (Tarig.hakim.2008)

2-3-1 Normal variants:

2-3-1-1 Dromedary hump:

Either kidney, but more commonly the left, can demonstrate a lateral bulge at its mid portion. If the internal architecture is normal, the variant is not clinically significant. Sonographically Dromedary humps appear the same as normal renal cortex.

2-3-1-2 Renal column hypertrophy:

It is a common anatomic variant and is a double layer of renal cortex that is folded toward the center of the kidney, displacing a portion of the renal sinus. The echo texture is exactly the same as the adjacent renal cortex. (Tarig.hakim.2008)

2-3-1-3 Double collecting system:

Is very common cause of unilateral renal enlargement. The ultrasound scan. demonstrates a large cortical area between two renal sinuses and an enlarge kidney.

2-3-1-4 In complete duplications:

Is most common and involves two complete renal pelvis with fusion of ureters so only one ureters into the bladder. The bladder insertion site is normal. Since non dilated ureters are seldom seen on u/s.

2-3-1-5 Complete duplication: -

Consists of two renal pelvis and two ureters will have and ectopic insertion to the bladder.

2-3-1-6 Horse shoe kidney:

Is the most common renal fusion anomaly. The lower poles of the kidneys fuse, and this fused area is called the isthmus. The blood supply is abnormal and often is from regional vessels. Their abnormal position after impairs drainage resulting in higher incidence of infection, obstruction and stone formation. Sonographically Horse shoe kidney appears as normal renal cortex.

2-3-1-7 Renal ectopia:

An ectopic kidney is a kidney located out side the renal bed. Most ectopic kidneys are located in the pelvis and are called pelvic kidneys. An abnormal kidney position causes the ureter to be bent to some degree. This also impairs the flow of urine and is associated with infection and calculus. Ectopic kidneys often exhibit ureteropelvic junction obstruction and calculi. Ectopic kidney doesn’t receive their blood supply from usual source but from regional vessels which are common or internal iliac arteries

2-3-1-8 Congenital ectopic kidney:

Is due to failure of the kidney to ascend from its fetal pelvic location where as ptosis of the kidney is due to trauma which has torn the supporting attachments of the kidney and permitted the kidney to fall. Ptosis is associated with a redundant whereas ectopia is associated with ureter of normal length for its location in the body. A redundant ureter is a ureter that is too long for the position of the kidney relative to the urinaly bladder.

2-3-1-9 Crossed fused Ectopia:

In this case both kidneys are found on the same side. In 85% to 90% of cases, the ectopic kidney will be fussed to other kidney .Usually the lower pole of the ectopic kidney. The pelvic of ectopic kidney is directed interiorly. The ectopic ureter crossed mid line and inserted on the connect side of the bladder. Sonographically: -

The fused kidneys have a normal transverse diameter but are unusually long. There is often notch defect at the fusion point. There are two separate renal sinuses and pelvis and the ureteropelvic junction are normally located the opposite kidneys are absent.

2-4 Physiology

The kidneys play a major role in the control of the internal environment The blood flowing in the kidney is first filtered by the glomerulus, so that all the blood constituents, except blood cells and plasma protein, go into the micro tubular system, in these tubules, filtration take place so that useful substances, including most of filtrate water, are quickly reabsorbed(tubular reabsorption) back into the blood un wanted substances that escaped filtration are actively secreted into tubular lumen (tubular secretion) the final concentration of electrolytes and other constituents of urine is adjusted according the requirement of the regulation of extra cellular fluid composition.

Glomerulur filtration, tubular reabsorption, and tubular secretion are rightly described as renal mechanism that allows the kidney to under take its various homeostatic functions. Several hormones especially anti diuretic hormones act on the kidney to enable it to adjust the final composition of the urine in response to internal environment.

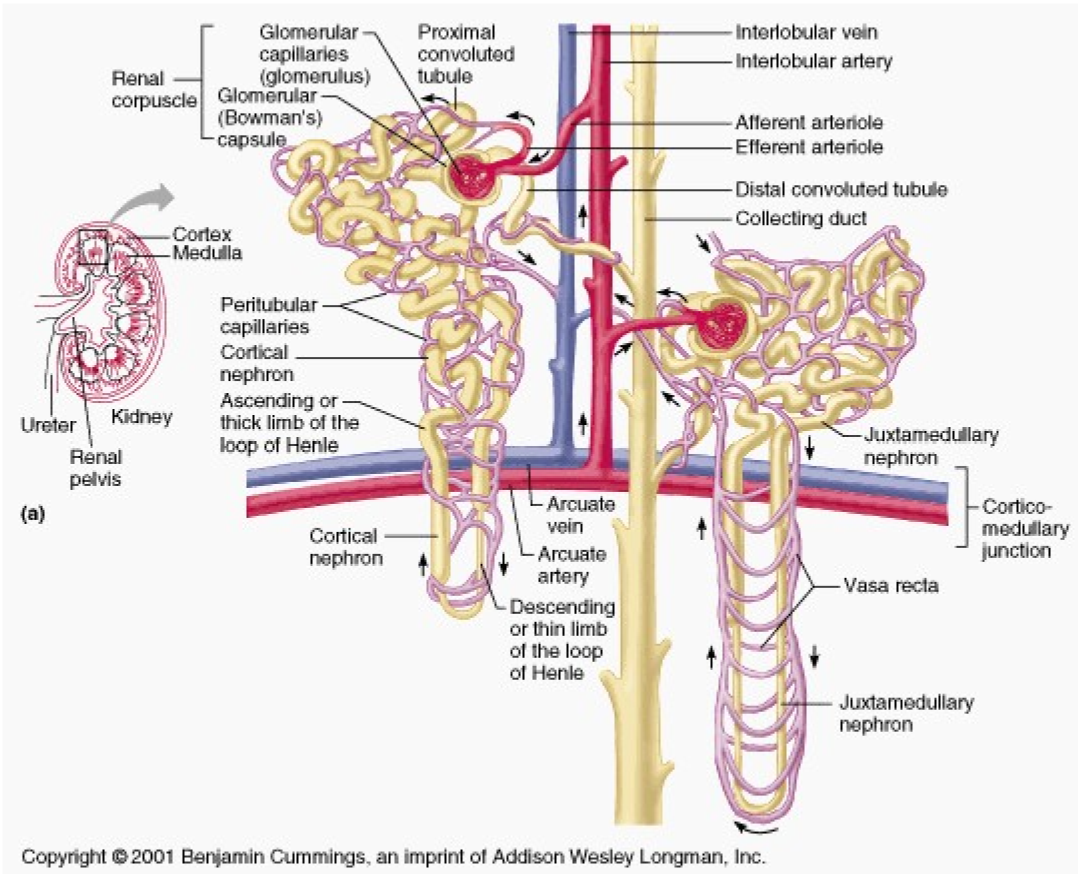


Fig 2-4 shows the nephron

2-4-1 The nephron:

Are the functioning unites of the kidney, there are about 1.3 million nephrons in each kidney the glomerulus is a tuft of capillaries covered by fibrous capsule (Bowman's capsule). It's supplied by afferent arterioles and drainage efferent .its diameter is about 200um and its function is filtration. All glomeruli are found in the cortex, most of them are located in the juxtaposition to the medulla, and accordingly there are two types of nephrones:

Cortical nephrons: is about 28% of all nephrons, their glomeruli are found higher up in the cortex, and characterized by short loop of henle.

Juxtamedullary nephrons: about 15% of all nephrons, their glomeruli are located close to the medulla, and characterized by

long loop of henle. They play important role in concentration of urine. The tubules are specialized for reabsorption and secretion, they include: proximal convoluted tubule, loop of henle, distal convoluted tubule, and collecting duct. (Tarig.hakim.2008)

2-4-2 Function of the kidneys:

- The removal from the body of waste products of protein metabolism, such as urea uric acid, creatinine , phosphates and sulpher.
- Control of extra cellular fluid (by excretion of more or less water in the urine).
- Control of extra cellular fluid electrolytes (by regulation of electrolyte excretion in the urine).
- Control of extra cellular fluid osmolarity by regulation of sodium and water excretion).
- The maintenance of acid-base balance by the body (control of pH).
- The removal of toxic substances and drugs from the body.
- Metabolic functions including the maintenance of blood pressure (long term effect), red blood cell production and calcium metabolism.

- Endocrine function: - synthesis and secretion of erythropoietin - activation of vitamin D - and release
  - of refine enzyme. (Tarig.hakim.2008)

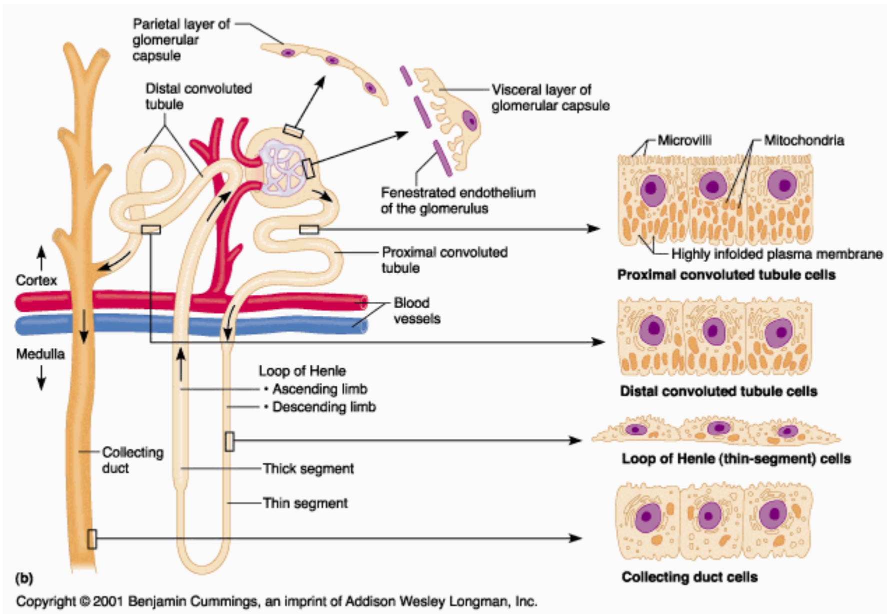


Fig2-5 shows the histology of the renal unit

Physiology of the kidney

The kidneys perform the first four of these functions by the production of urine. The urine consists mainly of water and contains urea, uric acid, creatinine, sodium chloride, potassium, calcium, phosphates and sulphate. Normally 1-2 liter of urine is produced per day.

The volume depends upon the fluid intake and the amounts of fluid lost by sweating and in the stool. Increased fluid loss due to increased sweat production or gastro intestinal losses diarrhea & vomiting . (Tarig.hakim.2008)

2-4-3 Renal blood flow:

The renal blood flow is 1-2 liter per minute this is about 20-25 % of the cardiac out put; it's directed mainly to the cortex (90% to the cortex and 10% to the medulla. This low blood flow to the medulla maintains its high osmolarity. The renal blood flow is auto regulated (i.e. it is maintained constant in spite of the change in main arterial pressure between 80-180 mmHg) this is due to myogenic response or hormonal factors (e.g. angiotensin).

2-4-4 Glomerulus filtration:

It is the transportation of fluid and crystalloid from glomerular capillaries to bowman space. The blood entering the glomeruli is under high pressure and, at rest, up to 25% of the cardiac out put flows through the kidneys .the fluid filtered in to the Bowman's capsule is plasma minus the plasma protein and ‘cells. The fluid filtered at the glomerulus is altered during its passage down the tubules by removal of some of its constituents and by the addition of some others. The processes involved are, respectively, reabsorption and secretion .Thus the fluid which enters the ureter is very different in composition from that which was filtered at the glomerulus. By the processes of reabsorption and the secretion the composition of the extra cellular fluid is kept constant. (Sukkar. 2000)

2-4-5 Reabsorption:

Some of the constituents of the fluid which is filtered at the glomerulus are reabsorbed into the blood stream. This process may be active or passive, active transport requiring energy expenditure. For example, Glucose is present in the glomerular filtrate but is normally absent from the urine. The glucose is completely reabsorbed from the glomerular filtrate and returned to the blood stream by the action of the cells of the proximal convoluted tubule, i.e. it is actively reabsorbed .Urea on the other hand, passes out of the tubule back in to the blood by diffusion, i.e. it is passively reabsorbed. Sodium chloride is actively and virtually completely reabsorbed by the renal tubule, the reabsorption in the distal tubule occurring under the control of aldosterone.

Approximately 5-6 liters of fluids are filtered at the glomerulus in each hour, but only 1-2 liters of urine are produced every 24 hours. Therefore nearly all the water filtered must be reabsorbed from the renal tubules. The reabsorption of water occurs at such a rate as to keep the osmotic pressure (osmolality) of the body fluids constant. The rate of reabsorption of water from the tubule is controlled by the secretion of Anti diuretic hormone (ADH) from the posterior pituitary gland. The loop of henle dips deep in to the medulla of kidney, where there is a high osmotic pressure due to active transport of sodium out of the tubule at the point .ADH is increases the permeability of water to distal tubular cells and the cells lining the collecting ducts .Water therefore

passes in to the area of high osmotic pressure i.e. out of the renal tubule. (Sukkar. 2000)

2-4-6 Secretion:

The cells of the tubules remove potassium and hydrogen ion from the venous blood and secrete them in to the tubules .The secretion of the hydrogen ions into the tubules causes the production of acid urine. Since metabolic processes generate a great deal of hydrogen ions i.e. acidity, this function of the kidney is very important in maintaining the correct PH of extra cellular fluids. Tubular secretion is the method by which the kidney rids the body of drugs such as penicillin.

2-4-6 The Kidney and the production of red blood corpuscles:

The kidney is the main sources of the hormone Erythropoietin, which increases the rate of red cell production .patients with renal failure are anemic and patients with renal cell carcinoma have an increased number of thread cells

2-4-7 The kidneys and the blood pressure:

Cells in the region of the glomerulus produce an enzyme rennin, which converts angiotensin2 in. the blood to aniotensinl. A further enzyme causes the oroduction of angiotensin2 from angiotensini .Angiotensin2 is powerful constrictor of blood vessels and arises the arterial blood pressure by this action. It also stimulates the production of aldosterone, the sodium retaining hormone, from the zona glomerulosa of the adrenal cortex. The secretion of rennin is stimulated by a fall in the blood pressure within the kidney or by a fall in the plasma sodium concentration.3

2-4-8 The Kidney and calcium metabolism:

The kidney is the site of formation of 1, 25.dihy-droxycholecalciferol the most active of vitamin D. The most important of this renal metabolite is to increase calcium absorption from the intestine especially to meet the demands of growth, pregnancy and location.

2-4-9 Renal clearance:

Defined as the volume of plasma, which is completely cleared of substance per unite time. The efficiency of the glomerulus may be investigated by studying the clearance of creatinine, a product of protein metabolism. Creatinine is filtered at the glornerulus and is then neither reabsorbed from nor secreted into renal tubule. Certain other substances, such as the radiological contrast agents sodium diazotrizat (Hypaque) aid lohexal (Omnipaque), are not only filtered but are also secreted into the tubules. The high iodine content of these drugs makes them radio-opaque and this allows them to be used to visualize the renal tract on radiographs. The clearance of such substances is equal to the renal blood flow. So it can be used for;

1. Measurement of glomerular filtration.
2. Measurement of renal blood flow.
3. Assessment of renal function.

2-5 Laboratory tests related to kidney function:

2-5-1 Serum creatinine:

Is nitrogenous compound formed as an end product of muscle metabolism. It is formed in small amount in the muscle, passed into the blood stream and excreted in the urine. Blood creatinine level measure renal function, normally it is produced in regular consistently small amount, therefore an elevation means a disturbance in renal function, so renal impairment is virtually the only cause of creatinine elevation. (Tarig.hakim.2008)

2-5-2 Blood urea nitrogen (BUN):

Urea is the end product of protein metabolism and is readily excreted by the kidney; there for the blood urea concentration normally is fairly low. Blood urea nitrogen level, measures renal function, the BUN level rises when the kidneys ability to excrete urea is impaired, it is also rises with reduced renal blood flow as with dehydration and urinary tract obstructions, elevated level of BUN may lead to mental confusion, disorientation and coma. (3)

2-6 ultrasonography of the kidney

2-6-1 Normal renal sonography and techniques:

ultraSonography is used for anatomy, intra venous urography for anatomy and function, and nuclear medicine for function. Evaluation the kidney with u/s is non invasive approach. It delineates retroperitoneal masses or fluid collection such as haematomas or abscesses, it’s also rules out the hydronephrasis and fluid filled structure like cysts. It determines the renal size and parenchymal details, detect also upper ureter and renal congenital abnormalities. (Crown.Elizabeth.2008)

2-6-1-1 Patient preparation:

Patient fasting six hours prior exam with drinking water to fill the bladder before examination. When the patient is over hydrated, the internal collecting system will become distended but if the patient is dehydrated renal pelvic will be collapsed.

2-6-1-2 Patient position:

The examination begins with the patient in the supine position or decubitus position scans are performed in the sagital and transverse planes from the anterior approach using the liver and spleen as acoustic windows for the right and lefl kidney respectively.

Scanning is also done in deep suspended aspiration. Start with longitudinal scan over the right upper abdomen and then follow with transverses scan. Next, rotate the patient to the left lateral decuibitus position to visualize the right kidney in the coronal view. To visualize the left kidney, scan the left upper abdomen in a similar sequence, if the left kidney can not be seen usually due to excess bowel gas, try the right lateral decubitus position. If the kidney cannot be imaged adequately, scan through the lower intercostals spaces. Turn the patient prone and apply enough gel to the left and right renal areas and perform longitudinal and transverses scan. Both kidneys can be also examined with the patient sitting or standing erect, when examining any part of renal, compare both kidneys in different projection. Variations in size counter and internal echogenicity may indicate abnormality.

For adults use 3.5 MHZ transducer, children and thin adults use a 5.0 MHZ start by placing the transducer over the right upper abdomen, then angle the beam as necessary and adjust the time gain compensation (TGC) with adequate sensitivity setting to allow uniform acoustic pattern, thus obtaining the best image of renal parenchyrna. Gain is amplification of the reflective ultrasound waves by the unit. The near gain control amplifies echoes returning from tissue above the focal point of the beam. While the far gain control amplifies echoes returning from beyond the focal point of the beam. E.g. echoes coming from deeper tissues need more amplification. These controls can be adjusted to allow the proper comparison of echogenicity at different level.

Renal detail may be obscured if there is significant amount at perirenal Fat, hepatocellular diseases, gall bladder stones, rib interface or other abdominal masses, or collection of fluid between the liver and kidney. When scanning the kidney it is better to identify the renal capsule, the cortex, the medulla sinus, upper ureter, renal arties and vein.

The kidneys are imaged by U/S as organs with smooth outer contours surrounded by highly echogenic perirenal fat. The renal capsule appears as a bright echogenic line surrounding the cortex which is homogonous with smooth counter, its echogenicity is moderated (mid to lower level echoes). In an even texture that is less echogenic than the normal liver or spleen but more echogenic than the adjacent renal medullary pyramids. The renal contains the pyramids which appear as triangular or blunted hypo echoic to an echoic areas (it should not be mistaken for renal cyst or tumors).

Fig 2-6 shows the normal kidney ultrasound

Ultrasound of Normal kidney

It is easier to visualize the pyramids in children and young adults; the central echo complex (the renal sinus) is imaged as a very highly hyper echoic (very echogenic) area, normally occupying a bout one third of the kidney and includes the collecting system (pelvis and calyces) and renal vessel . It is the most part of the kidney and has greater echogenicity due to the fat deposition. The sinus is surrounded by the parenchyma (the area from the renal sinus to outer renal surface) whose thickness is 11-18mm in male and 11-16 mm in female. The pelvis is not visualize unless there is urine filled when it appear anechoic it is scanned through the renal sinus in an anterior transverses vein. .

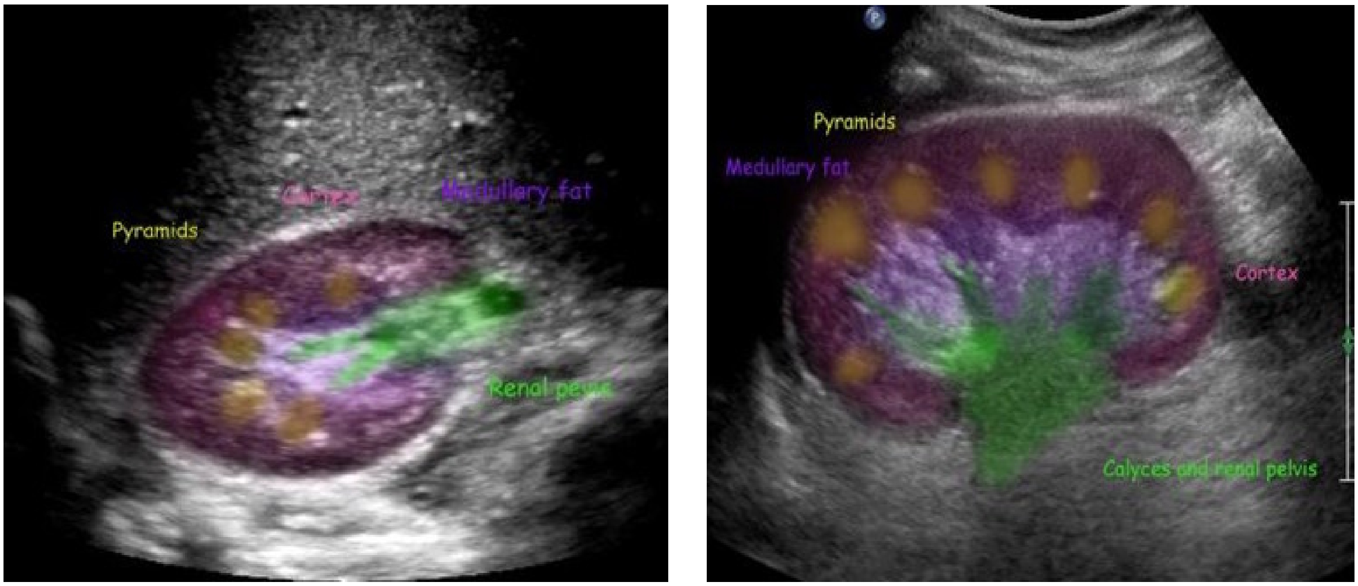


Fig 2-7 shows the normal longitudinal & cross-section of the kidney

The renal arteries and veins are best seen at hilum. They enter the kidney at different levels and may be multiple. The accurate vessels are demonstrated as intense specular echoes in cross section or oblique section at the cortico-medullary junction. The renal arteries are best seen in supine and lateral decuibitus views. The right renal arteiy can be seen in a longitudinal scan as a circular structure posterior to the inferior vena cava. The right renal vein extends from the central renal sinus directly in to the IVC. Both vessels appear as tubular structures in the transverse plan the renal arteries have an echo free central lumen with highly echogenic borders that consist of vessel wall and the surrounding retroperitoneal fat and connective tissue. They lie posterior to the veins and can be demonstrated with certainly if their junction with the aorta is seen. The left renal artery flows from the posterior-lateral wall of the aorta to the central renal sinus. An extra renal pelvis may be seen as a fluid filled structure medial to the kidney on transverse scans.

Differentiation of the normal variant from obstruction is made by noting the absence of intra sinus distention of the renal pelvis and infundibula. Dilatation of the collecting system has also been noted in pregnancy (the right kidney is generally involved with mild degree of hydronephrosis which reverts to normal after delivery). Normally in the non hydrated subject the renal pelvis is collapsed and therefore not demonstrated on the scan.

The renal pelvis is influenced by bladder distention, diuretics and the state of hydration. Distention of the renal pelvis is seen in 50% of non hydrated and in 90% in hydrated subjects examined with a full bladder. The normal renal pelvis in the hydrated patients is between 2-14 mm. if two separated collection of renal sinus fat are identified a double collecting system should be suspected ability to visualize the kidney close not mean that it is functioning. To assess renal function use contrast urography, arachio-nuclide study or laboratory test, injury to kidney may result in tempbrary loss of function. Normal ureters are not always seen. They should be sought where they leave the kidney at the hilum.They may be multiple and are often seen in the coronal projection generally,

echogenicity from higher to decreasing order is: renal sinus, spleen, liver, renal cortex renal medulla In adult “fig 2-05. The thickness of the renal parenchyma decrease at about 10% per decade after 20 years of age. The cortico-medullary ratio is 1:1.6 up to 30 years old; 1:1.2 up to 50 years old 1: 1 above 50 years old with thinning of cortex with age. The overall size decreases with age and only apparent in the elderly. The fetal kidney size in cm. equals the gestational age in weeks plus or minus 3rnm.infantile kidneys are large compared to overall body size “typically 4-5cm long at birth” and may be imaged from 12-14 weeks on wards but clearly seen after 16 weeks. (P.E.S Palmer 1995)

In transverse section they appear hypo echogenic, circular structures on either side of the spine. Within them can bee seen the strongly echogenic renal pelvis. The capsule is also echogenic. The renal papillae are hypo echoic and can appear large. Some dilatation of the renal pelvis” less than 5mm”.may some times be seen but it is normal finding. It is important to assess renal size by comparing the renal circumference with the abdominal circumference. The normal ratio being 0.27-0.3 the fetal urinary bladder can be recognized as a small avoid cystic structure within the fetal pelvis as early as 14-15 weeks. The normal urinary production at 22 weeks in 2m1 per hour, where as at full term it is 26ml per hour until the age of 6rnonth.

Neonatal kidney differ acoustically from adult kidneys in that .The difference between cortex and medulla is less marked in the infant pyramids are relatively, hypo echoic and may resemble cysts cortex is less echogenic than Liver parenchyma. For the first 3 years of life. Its pyramid appear large because the cortex is relatively thin and hyper echoic .During the first year of life the cortex gradually develops to assume the adult corticomedullary proportion. The pediatric renal sinus is poorly echogenic because it contains little fat.

Fat deposition and accumulation occurs gradually to achieve adult proportions by about age 10 years, the majority of infants have a slight separation of the central echo complex reflecting the presence of a small amount of urine of un known cause. There is no absolute measurement to separate normal distension from hydronephrosis 10mm separation is considered the upper limit of normal unlike in adult practice detection of children with vesico ureteric reflux is important and may only be reflected by minor separation the central sinus echoes without renal searing. Normal renal length of pediatric kidney is determined using this guide:Renal length (over one year) in cm 6.79+ (0.22* age in years). In. those less than one year=4.98+ (0.155*age in months'. Asymmetry in renal lengths exceeding 5mm in infant and 10mm(P.E.S Palmer 1995)

2-7 Pathology

2-7-1 Congenital Diseases:

Approximately 10% of individuals have congenital abnormality of the urinary tract. Some are hereditary.

Congenital renal diseases may be:

Malformation related to the volume of renal tissue formed or its differentiation. Anatomical abnormalities of position of vascular or ureteric connections. Metabolic lesions such as enzyme defects which affect tubular transport.

2-7-2 Congenital mega calices:

Congenital mega calices develop as result of an abnormality in the number and timing of divisions in the ureteral bed. Calices are increases in size and number and medullary thickness is decreased, where as cortical thickness is normal, except in mild reduction in concentration ability. However, patients may develop stones and infection as a result of stasis. The sonographic appearance of large, clubbed calices extending into medullary region may mimic hydronephrosis or renal papillary necrosis, contrast radiography and clinical finding will help differentiate between these entities. (David Sutton. Volume 2 - 2002)

2-7-3 Uretro pelvic junction obstruction:

Uretro pelvic junction obstruction is a common congenital anomaly that rarely result in renal failure, unless it is sever or bilateral. In many cases, UPJ obstruction may go undiagnosed until adulthood even if discovered late, surgical repair may preserve renal function. Other genito urinary tract anamolies are frequently associated with PUJ obstruction, particularly a contra lateral multi cystic dysplastic kidney. Sonographically: early in life show pelvo calectasis with an abrupt cut off of the pelvis dilation at the PUJ. Long standing cases detected in adults may present as a cystic mass without discemable renal parenchyma., In some cases differentiation of severe long standing PUJ obstruction from multi cystic dysplastic kidney may impossible.7’9’.

Conditions affecting the volume of renal tissue:-

2-7-4 Bilateral agenesis of the kidney “Patter—syndrome”:

Is not compatible with independent life, it occurs in 0.04% of all pregnancies. Children with this condition have a characteristic appearance-low —set ears, there is always a reduced volume of amniotic fluid due to absent of fetal urine. The most likely cause is a failure of the ureteric bud to develop, there are development abnormalities also of other’ tissues derived from the mesonephrous,e,g bladder and genetelia . how ever, the commonly associated spinal cord abnormalities and pulmonary hyperplasia suggest that the defect is more generalized

Unilateral agenesis of a kidney undergoes marked hypertrophy and is subsequently prone to infections and trauma. Children with this condition often do not survive long because of associated multiple developmental abnormalities, including congenital heart disease, spina bifida and menengomyocele. In renal hyperplasia the kidney is abnormally small but not other wise malformed. Hypoplastic kidneys are prone to infection or stone formation. . (David Sutton. Volume 2 - 2002)

2-7-5 Disorders of differentiation:

Renal dysplasia is a cause of cystic kidney which may present in child hood as an abdominal mass requiring surgical excision if only to exclude malignant tumor (e.g. Nephroplastoma). The lesion is characterized by islands of undifferentiated mesenchyme or cartilage within the parenchyma. If the lesion is unilateral the prognosis is good.

2-7-6 Anatomical abnormalities: -

Ectopic kidney forms in an abnormal site, usually the pelvis, and may be associated with intestinal mairotation. The principal clinical importance lies in their presenting as a suspicious pelvic mass, and in the risk of infection due to the ureteric kinking that often comprises this condition. Horse shoe kidney results from fusion of the two nephrogenic blastomas during fetal life. The majority are fused at the lower pole. The condition is not rare and renal function is usually normal. There may be a susceptibility to infection and stone formation. the duplication of vessels or ureters is not uncommon, achieving clinical significance either when an anomalous polar artery passing anterior to the ureter causes ureteric obstruction, or during renal transplantation.

2-7-7 Metabolic malformation:

Cyst in urea results from defective tubular reabsorption of several amino acids including cystine , lysine , ornithine and arginine the precise enzyme defect is unknown , but some patient also have impaired Intestinal transport cystine crystal are found in the urine and calculi may develop, the disease is inherited as an autosomal recessive.

Renal tubular acidosis type (1) is probably due to a defect in the enzyme system which enables hydrogen ions to be exchanged for bicarbonate in the proximal tubule, there is loss of bicarbonate and failure to acidity and concentrate the urine, Renal function is otherwise but there is a tendency to form stones and develop infections this condition is inherited as autosomal dominant gene, although an identical deficiency may be acquired as a result of tubular damage .

Abnormalities in the kidney that can be detected by sonography include parenchyma or medical disease, obstructive uropathy, space, occupying lesions and renal vein thrombosis, abnormalities for size, shape and position are easily detected. Renal agenesis is suspected after through search in the abdomen and pelvic for ectopic organ, Duplication and mairotation can be shown

2-7-8 Space occupying lesions:

Ultrasound is most common investigation performed to diagnosis masses suspected in sonographic examination. Its accuracy in detecting cystic versus solid lesions is nearly 100%.

2-7-9 Renal cysts and cystic disease:

A simple and benign cyst is thin, walled and anechoic with distal enhancement. Cyst may be cortical or central in passion, when central they should be differentiated by their discrete shadow as compared to confluent shadows of hydronephrosis in poly cystic disease, the cyst are multiple and the kidney is large, there is often similar involvement of the liver, spleen, or pancreas. The symptoms of this abnormality usually renal failure do not develop before middle age. Medularly cystic disease is an autosomal recessive disease that remains silent until renal failure, cyst is confined to medulla and the kidney is small, Dysplastic multi cystic disease. Is unilateral the affected kidney in non functioning and there for bilateral disease is fatal, Hemorrhagic cyst and hematomas show both echo free and echogenic features with debris, fluid level.

2-7-10 Renal abscess:

Has variable echogenicity, generally hypo echoic with internal echoes there may be gas pocket within the abscess causing distal shadows.

2-7-Renal mass:

Renal cell carcinoma willims tumor and transitional cell carcinoma gives focal lesions lymphomas and leukemic infiltration, generalized enlargement of the kidney with an increase in echogenisity and diminished pelvicaliceal shadows.

2-7-12 Diffuse parenchymal lesion and renal failure:

Small kidneys with parenchymal abnormalities occur in echogenic glomerulonephritis, chronic pyelonephritis and renal vascular disease. renal failure due to mechanical renal disease increase the cortical echogenisity to level similar to or higher than those of adjacent liver or spleen, both acute and chronic glornerulonephritis give higher echogenicieties the later is characterized by small kidney loss of cortico medulary differentiation.

2-8 Hydronephrosis:

Is the separation of renal sinus echoes by interconnected fluid filled areas. In patient with progressive obstruction the renal parenchyma is compressed. If the hydronephrosis is suspected, on the ultrasound we should evaluate the bladder. if its full, post void longitudinal scan of each kidney should be done to show that hydronephrosis has disappeared or remained the same, at the level of the obstruction we should sweep the transducer back and forth, In two planes to see if a mass or stone can be distinguished.

There are three grades of hydronephrosis grade 1 entails small separation of the calceal pattern, also known as splaying. so we have to rule out a Para pelvic cyst" The septation may be numerous" or renal vessels' in the Para pelvic area" color flow is extremely useful. An extra renal pelvis would protrude out side of the renal area, so we would not confuse this pattern probably with hydronephrosis. . (David Sutton. Volume 2 - 2002)

2-8 Previous studies:

A study done in Pakistan , ultrasonographic renal size in individuals without known renal disease the study is carried in Aga Khan University –

Karachi. Published in JPSA Journal Of Pakistan medical association) published in 2000) The study population were 194 –male 98-females were 96 They come to find , Mean renal size in Pakistani population are significantly smaller than reference values available in literature from American and European population. Left kidney is significantly larger than the right ,the renal sizes are seen bilaterally in males as compared to females . A direct relationship between BMI and the renal size is in Pakistani population .

Iraqi study done in Sulimaniya University in 2013-2014 study of the renal size in ultrasound of unknown renal diseases. The study includes 450 , 239 females 211 males . They found the results are nearer to the studies done in other nearby countries . They come to a conclusion that the BMI, ethnic ,and environment are the main factors affecting the renal size .

The Indian study by jawahar lal institute of post graduate medical Education and researchs .The study is carried in 2012 for the kidney size in patients of unknown kidney diseases.The participants in this study were 140-- 71-females -69 males .Their findings : There is a significant gender differences were observed in the breadth but not the length They did not find a significant difference between the left and right renal length ,in age above sixty the length is decreased bilaterally .

CHAPTER THREE

Methodology

3-1 Type of study:

This is a descriptive analytical study deals with the patients who came to the department for abdominal ultra sound investigation.

3-2 Area of study :

Kalba hospital sharjah medical district UAE.

3-3 Duration of the study : I started to collect the data in October 2014 until april 2015 .

3-4 Population of the study:

All patients complain of abdominal pain and found to be normal by ultrasound examination.

3-5 Method of study : Each patient is scanned to be evaluated, when he or she is found to be normal, then scan he or she for the kidney volume after explaining the purpose of the study.

3-6 Sampling of study :

They are 50 adult patients referred to the ultrasound department for abdominal scan who found to be normal.

3-7 Instrument:

Siemens Actuson 500 X ultrasound machine ranged in frequency (3,5&10 MHz).

3-8 Data source:

From direct ultrasound scanning of the population of study.

From data sheet.

Request forms .

3-9 Data analysis:

The data were analyized by the computer and protected by a pass word.

3-10 Data storage:

The data collected during the study were stored in the computer and protected by a pass word.

All data collection sheets were protected in a private cabinet.

3-11 Ethical issue:

There is no any patients name or individual patient`s details throughout the study.

Chapter four

Result :-

This study was carried out on 50 patients who are found to be of un known renal diseases were examined with the following results according to the age , sex & BMI.

The following tables and graphs shows summary of the results including distrubuation of the age ,sex and BMI.

Correlation has been performed for all. It is found that the right kidney length between 10.2 to 11.2 cm ,the mean value is 10.5 cm.The left kidney length varies from 10.4 to 11.8 cm with mean value of10.8cm. The right kidney mean volume is 105 cc while the the left one is 118cc ,this is seen in the tables 4-1 & 4-2 .

Table 3 shows the relation between the BMI and the kidney volume which is significant as it is less than.05 .the higher BMI the greater is the volume. In graph 4-1& 4-2 it shows the correlation between the kidney volume and sex which is significant , the volume in males is more than in females, while the age is negatively significant with the volume of the kidneys .

Table 4-1 shows a descriptive study of the factors age ,sex &kidney volumes.

Descriptive Statistics

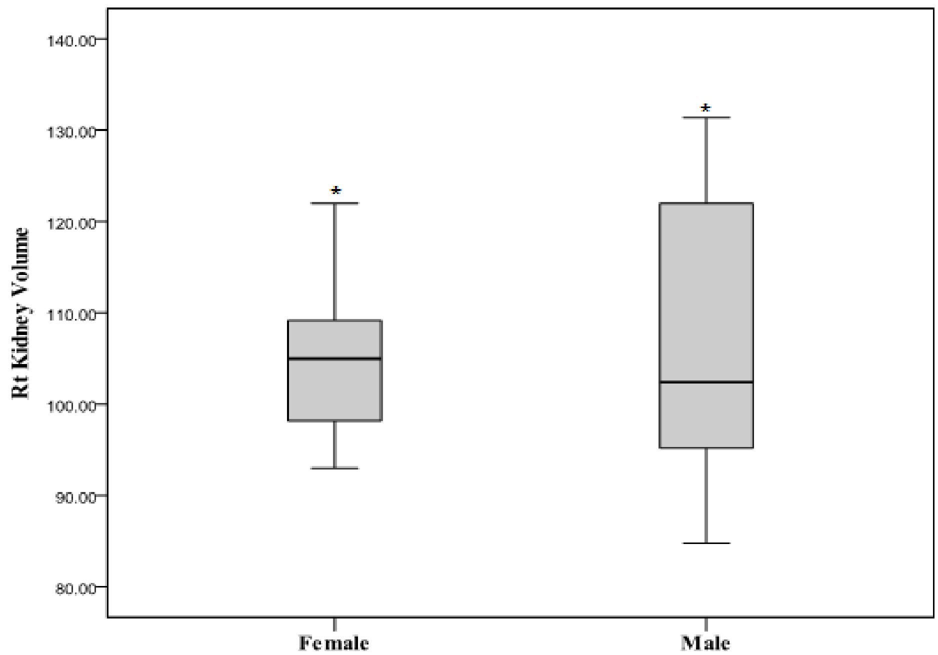
	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	20	60	38.22	12.494
BMI	50	22	30	26.08	2.284
Rt Kidney Volume	50	84.80	131.40	105.9980	11.44227
Lt Kidney Volume	50	88.60	169.00	118.9700	13.96857

Table4-2 shows the length, width & depth of both kidneys.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Rt Kidney Length	50	10.20	11.20	10.5340	.22552
Rt Kidney Width	50	4.00	5.30	4.6280	.34049
Rt Kidney Depth	50	3.90	4.60	4.1760	.18688
Lt Kidney Length	50	10.40	11.80	10.8080	.26174
Lt Kidney Width	50	4.10	5.70	4.8480	.36658
Lt Kidney Depth	50	4.00	5.00	4.3600	.20504

Graph 4- 1 shows the comparison between the right kidney volume in males and females.



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Graph4- 2 shows the comparison between the left kidney volume in males and females

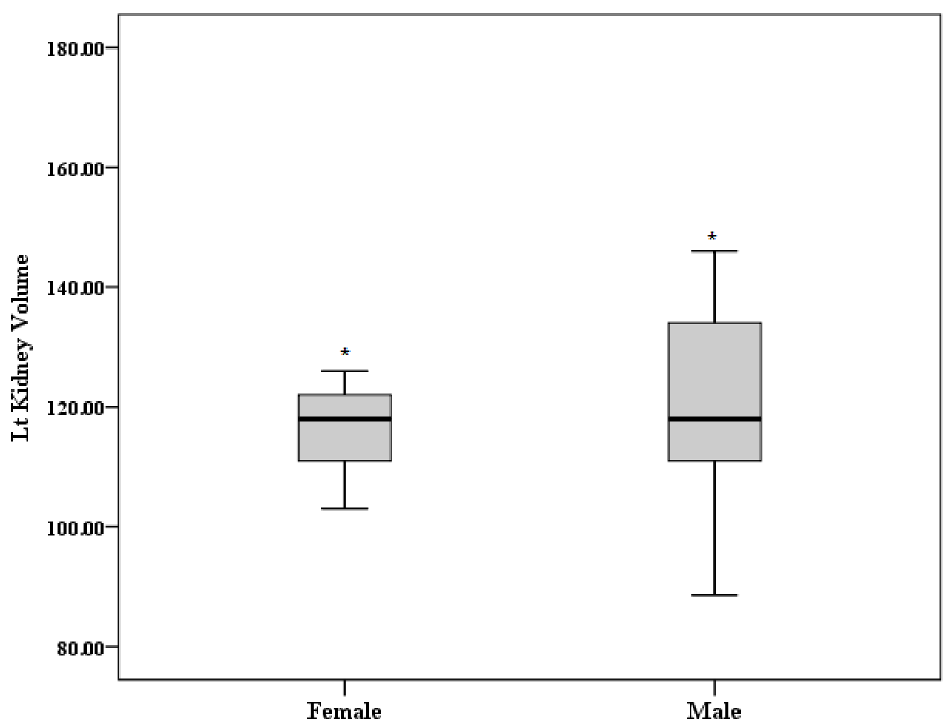


Table 4- 3 shows the correlation between the BMI and the kidneys volume.

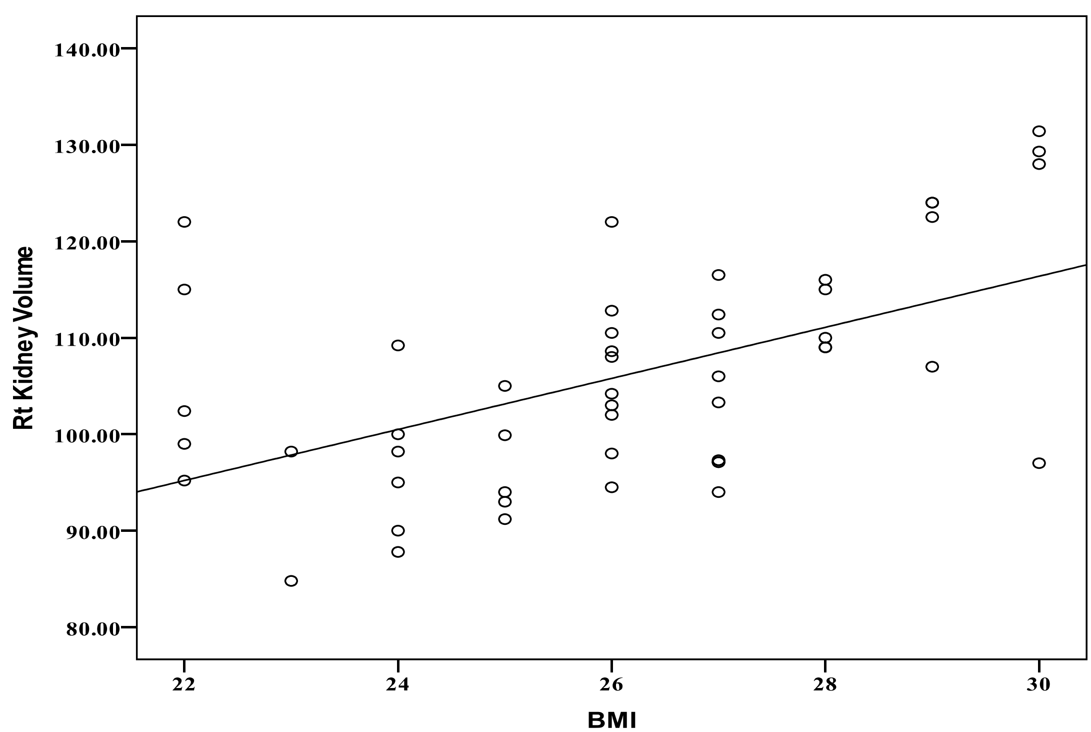
Correlations

		BMI	Rt Kidney Volume	Lt Kidney Volume
BMI	Pearson Correlation	1	.528**	.518**
	Sig. (2-tailed)		.000	.000
	N	50	50	50
Rt Kidney Volume	Pearson Correlation	.528**	1	.909**
	Sig. (2-tailed)	.000		.000
	N	50	50	50
Lt Kidney Volume	Pearson Correlation	.518**	.909**	1
	Sig. (2-tailed)	.000	.000	
	N	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		BMI	Rt Kidney Volume	Lt Kidney Volume
BMI	Pearson Correlation	1	.528**	.518**
	Sig. (2-tailed)		.000	.000
	N	50	50	50
Rt Kidney Volume	Pearson Correlation	.528**	1	.909**
	Sig. (2-tailed)	.000		.000
	N	50	50	50
Lt Kidney Volume	Pearson Correlation	.518**	.909**	1
	Sig. (2-tailed)	.000	.000	
	N	50	50	50



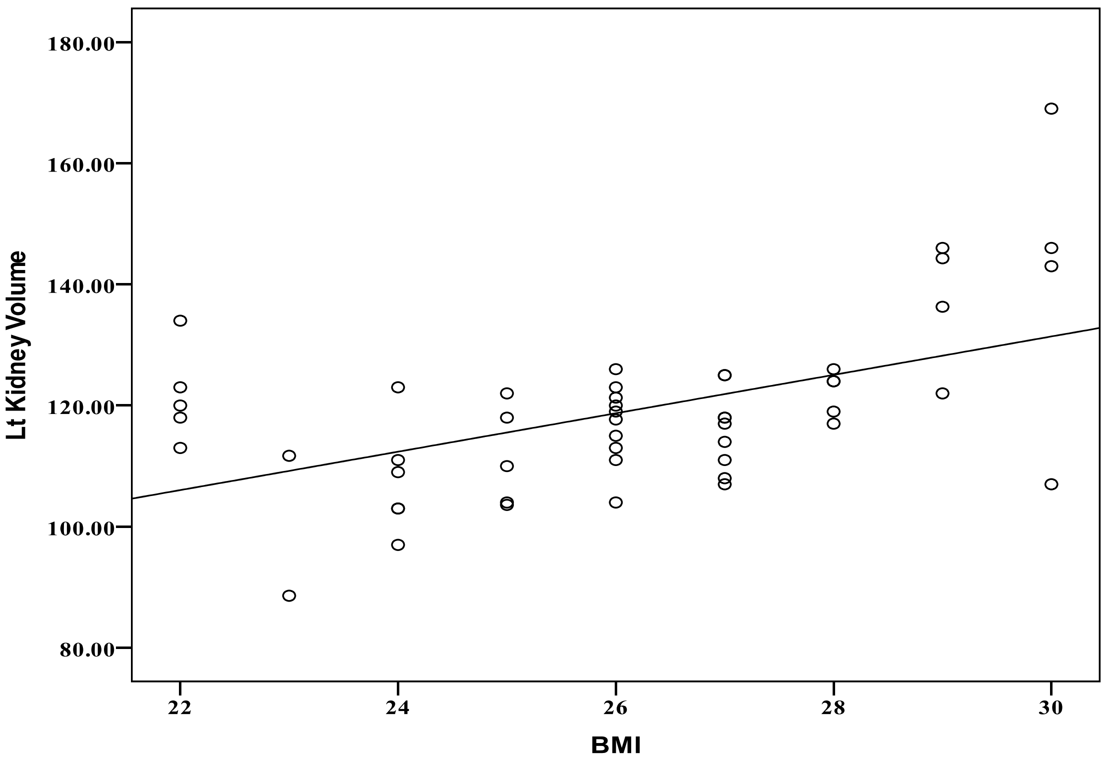


Table (4-4) shows the relation between the age and the kidney volume.

Correlations

		Age	Rt Kidney Volume	Lt Kidney Volume
Age	Pearson Correlation	1	-.624**	-.612**
	Sig. (2-tailed)		.000	.000
	N	50	50	50
Rt Kidney Volume	Pearson Correlation	-.624**	1	.909**
	Sig. (2-tailed)	.000		.000
	N	50	50	50
Lt Kidney Volume	Pearson Correlation	-.612**	.909**	1
	Sig. (2-tailed)	.000	.000	
	N	50	50	50

Correlations

		Age	Rt Kidney Volume	Lt Kidney Volume
Age	Pearson Correlation	1	-.624**	-.612**
	Sig. (2-tailed)		.000	.000
	N	50	50	50
Rt Kidney Volume	Pearson Correlation	-.624**	1	.909**
	Sig. (2-tailed)	.000		.000
	N	50	50	50
Lt Kidney Volume	Pearson Correlation	-.612**	.909**	1
	Sig. (2-tailed)	.000	.000	
	N	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

Chapter five

Discussion ,Conclusion & recommendation

Discussion :-

The normal size of the a kidney is variable and is affected by age, gender, BMI, as well as the side .the size provides a rough indication of the renal function. the minimal size of a fully functional kidney is 9cm in length ,most studies have looked at kidney length .Ultrasonic kidney length measurement (bi-polar measurement)is the most common used and most practical measurement in clinical practice and is correlated to renal function.

Normal renal length varies from100mm and 124mm in length depend on ethnic background side and sex.

In this study the mean length is 106mm near to the Pakistani study which is 104 mm, which shows the asians background, but far from the African measurements may be because of the body nature.(JPSA Journal of Pakistan medical association)

In this study the kidney volume is significantly larger in males than in females of the same BMI , there is a marked but not significant difference of kidney length, between the right and the left one, this is may because of the hepatic mass which does not allow compareable vertical growth of the right kidney to that which is attained by the left one, so except the the length the other dimentions are found to be of much value in showing the difference between the left and the right kidney as well as the volume.

The age is an important factor in this study which shows an icrease in the kidney volme up to the 3rd decade then remain stable through the middle age then decline, in table four it shows a negative correlation between the age and volume .

Conclusion:-

Mean renal volume in emirates population are found to be within the normal limits compared with the nearby countries ,but it is less than in the reference value available in literature from American and the Europian population.

Left kidney is significantly larger than the right and larger renal volume are seen bilaterally in male as compare to females. A direct relationship between BMI and renal volume is seen in emirates population , a negative relation is seen between age and the kidneys volume .

Recommendation :-

While performing ultrasound ,dependability of renal size on age, gender and BMI has to be considered by the radiologist or sonologist so as to differentiate between a pathological and normal volume small or large kidney.

I recommend to use three- dimentioned sonography with the matrix array transducer which is found to have a capability to play a critical role in many clinical application , as a part of its capability , the described technique.

The American institute of ultrasound medicine had published a study in june18, 2008 , in which they found that the use of the three dimentioned sonography with the matrix array transducer is significantly reduce renal volume measurement errors and thus to offer a reliable means of measuring renal volume.

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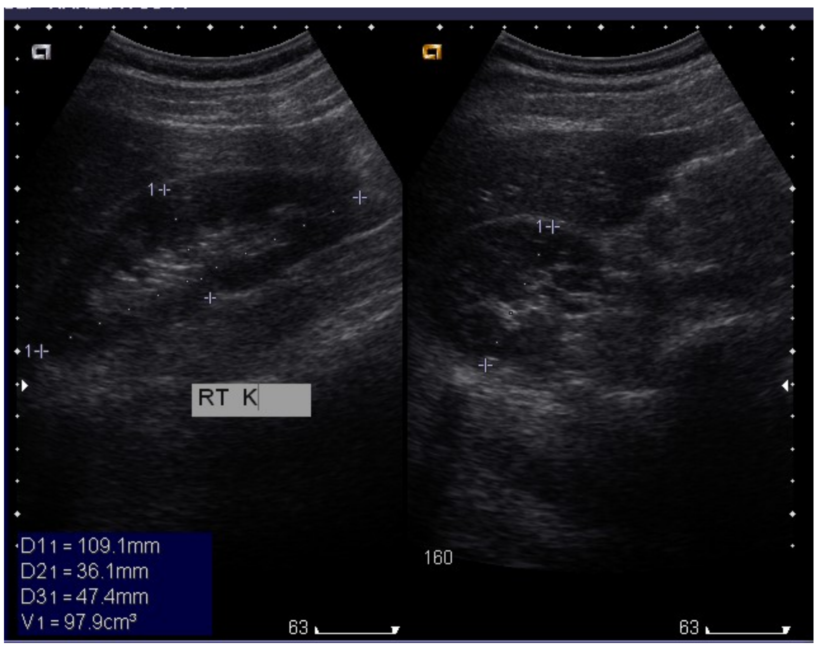
Appendices

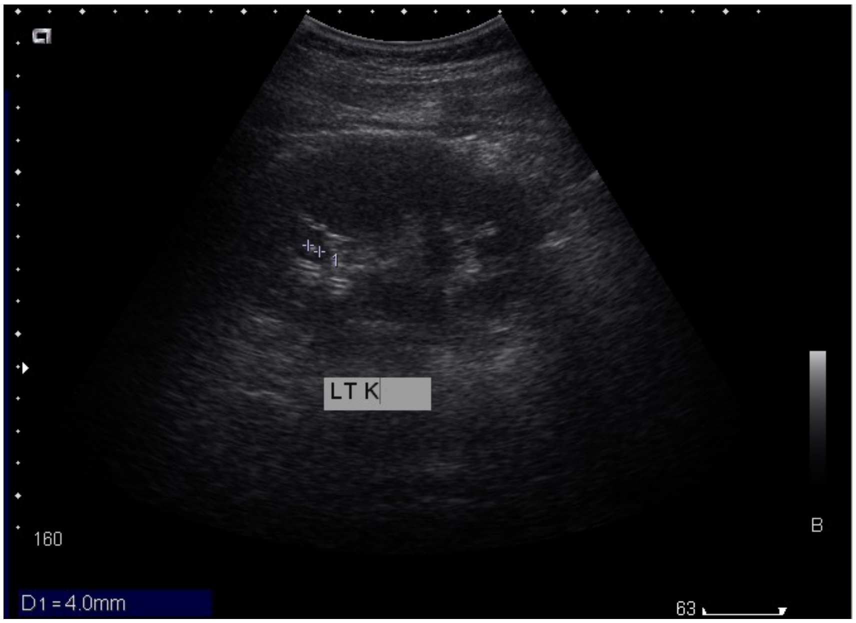
Appendix 1

No	Sex	age	L	W	BMI	RKL	RKW	RKD	RK V	LKL	LK W	LKD	LK V
1	F	60	160	70	27	10.4	4.5	4	97.3	10.8	4.5	4.4	111
2	F	20	164	67	25	10.4	4.4	4.2	99.9	10.8	4.3	4.9	118
3	F	25	165	72	26	10.7	5.1	4.3	122	11.1	5.3	4.5	126
4	F	30	169	78	27	10.6	5.1	4	112.4	11	5.2	4.2	125
5	F	47	165	66	24	10.7	4.4	4.1	100	10.9	4.7	4.2	111
6	F	27	170	75	25	11.2	4.3	4.2	105	10.9	5	4.3	122
7	F	21	167	77	28	10.8	4.8	4.3	116	11	5	4.4	126
8	F	48	165	73	27	10.2	5	3.9	103.3	10.4	5.1	4.3	118
9	F	56	167	80	27	10,6	4.3	4.1	97.1	10.8	4.6	4.2	108
10	F	27	165	80	29	10.9	4.4	4.3	107	11.1	4.9	4.3	122
11	F	35	160	74	26	10.4	4.7	4.1	104.2	10.8	4.8	4.4	119
12	F	42	166	66	24	10.5	4.5	4	98.2	10.7	4.4	4.2	103
13	F	55	156	63	26	10.6	4.4	3.9	94.5	10.8	4.5	4.1	104
14	F	58	159	76	30	10.8	4.3	4	97	10.9	4.4	4.3	107
15	F	25	164	66	24	10.5	5	4	109.2	10.6	5.1	4.4	123
16	F	37	153	67	25	10.5	4.3	4	94	10.7	4.6	4.3	110
17	F	28	161	70	27	10.6	4,5	4.3	106	10.7	4.7	4.5	117
18	F	34	156	65	27	10.3	4.8	4.3	110.5	10.5	4.9	4.4	118
19	F	31	154	71	28	10.6	4.5	4.4	109	10.7	4.8	4.4	117
20	F	44	157	66	26	10.4	4.9	4.1	108.6	10.5	5	4.5	123
21	F	46	160	67	26	10.5	4.4	4.3	103	10.7	4.7	4.4	115
22	F	55	158	62	25	10.4	4.2	4.1	93	10.6	4.5	4.2	104
23	F	36	154	62	26	10.2	5	4	108	10.7	4.8	4.5	120
24	F	36	163	75	28	10.6	5	4	110	10.8	5.2	4.1	119
25	F	29	171	81	28	10.6	5.1	4.1	115	10.7	5.3	4.2	124

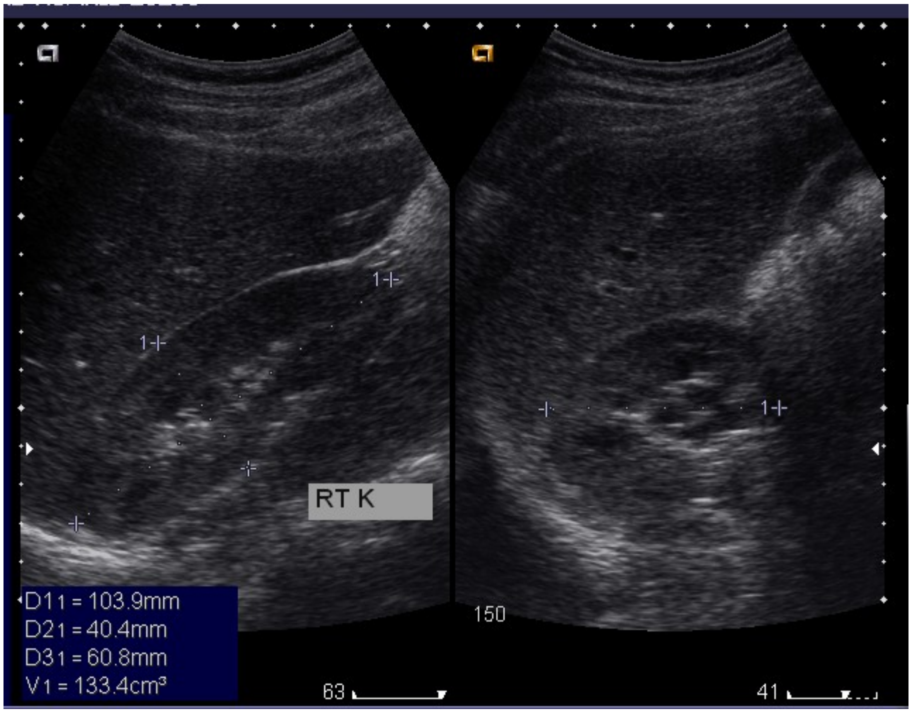
No	Sex	Age	L	W	BMI	RK L	RK W	RK D	RK V	LKL	LK W	LK D	LK V
1	M	60	165	70	25	10.2	4.3	4	91.2	10.8	4.5	4.1	103.6
2	M	20	164	60	22	10.4	4.4	4	95.2	10.8	4.3	4.9	118
3	M	25	180	75	22	10.7	5.1	4.3	122	11.1	5.3	4.5	134
4	M	30	178	80	30	10.8	5.1	4.5	128	11	5.2	4.2	146
5	M	47	165	66	24	10.3	4.1	4.1	90	10.8	4.4	4 .4	109
6	M	27	187	71	22	10.7	4.4	4.2	102.4	10.8	4.7	4.3	113
7	M	31	167	78	29	10.8	4.8	4.6	124.	11	5,6	4,5	146
8	M	28	180	98	30	10.8	5	4,6	129.3	11.3	5.7	5	169
9	M	56	185	93	27	10,6	4.3	4.1	97.1	10.8	4.5	4.3	107
10	M	20	165	60	22	10.3	4.4	4,2	99	10.5	4.8	4.6	120
11	M	35	182	93	29	11.2	4.7	4.6	124.	11.8	5.6	4.2	144.3
12	M	42	167	66	23	10.5	4.5	4	98.2	10.7	4.9	4.1	111.7
13	M	55	172	76	26	10.6	4.5	4.1	102	10.8	4.6	4.3	111
14	M	58	169	77	27	10.5	4.2	4.1	94	10.7	4.9	4.2	114
15	M	25	170	65	22	10.5	4.9	4,3	115	10.8	5.1	4.3	123.
16	M	37	173	89	29	10.5	5.1	4.4	122.5	11.2	5.2	4.5	136.3
17	M	28	178	90	30	10.6	5.3	4.5	131.4	11.3	5.3	4.6	143
18	M	34	166	70	26	10.3	4.8	4.3	110.5	10.5	4.9	4.4	117.7
19	M	31	174	83	28	10.4	5	4	109	11.1	5	4.3	124
20	M	44	171	76	26	10,4	4.4	4.1	98	10.8	4,6	4.4	113
21	M	46	167	65	24	10.4	4.3	4.1	95	10.5	4.6	4.1	103
22	M	55	166	65	24	10.3	4.1	4	87.8	10.4	4.3	4.2	97
23	M	60	175	70	23	10.2	4	4	84.8	10.4	4.1	4	88.6
24	M	36	178	84	27	10.4	4.9	4.4	116.5	10.7	5	4.5	125
25	M	29	177	82	26	10.3	4.9	4.3	112.8	10.6	5	4.4	121.3



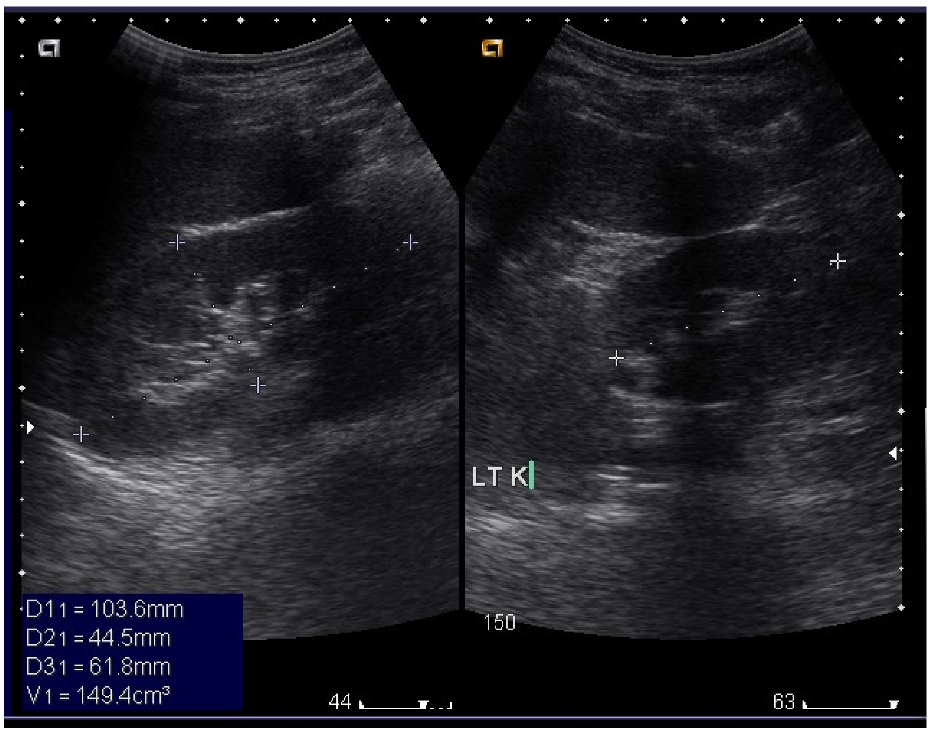
Female -58 years 10.9cm l, 4.7w, 3.6d Volume97.9cc



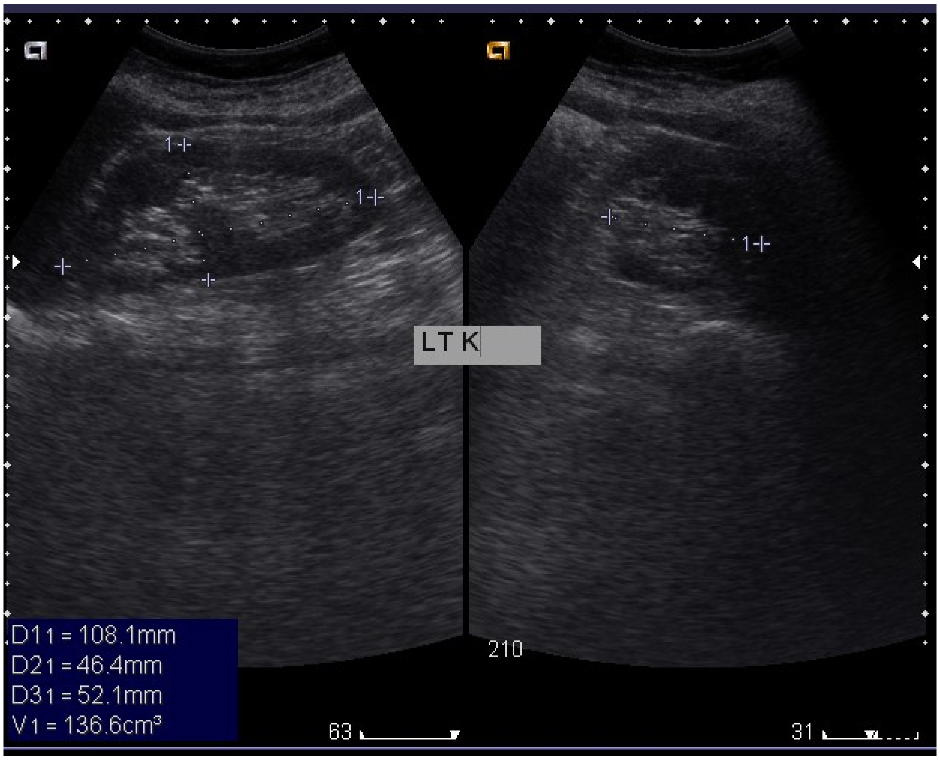
Male - 35years 11.8cm l,5.6cm w.4.2cm d Volume144.3cc



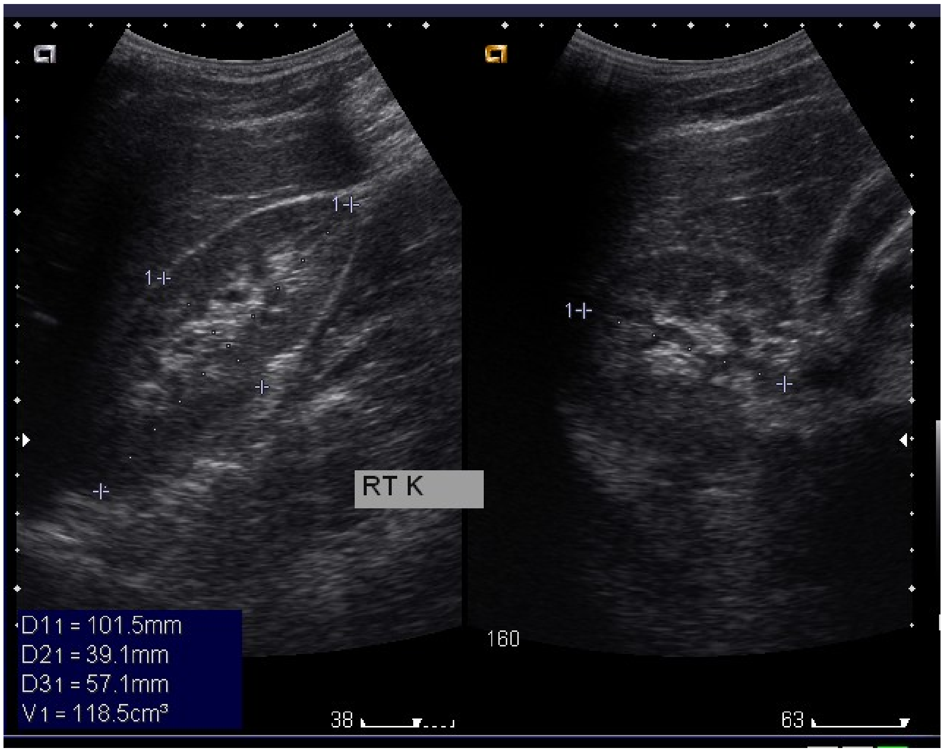
Male-28years-10.3cml ,6cm w ,4cm -d ,volume133cc



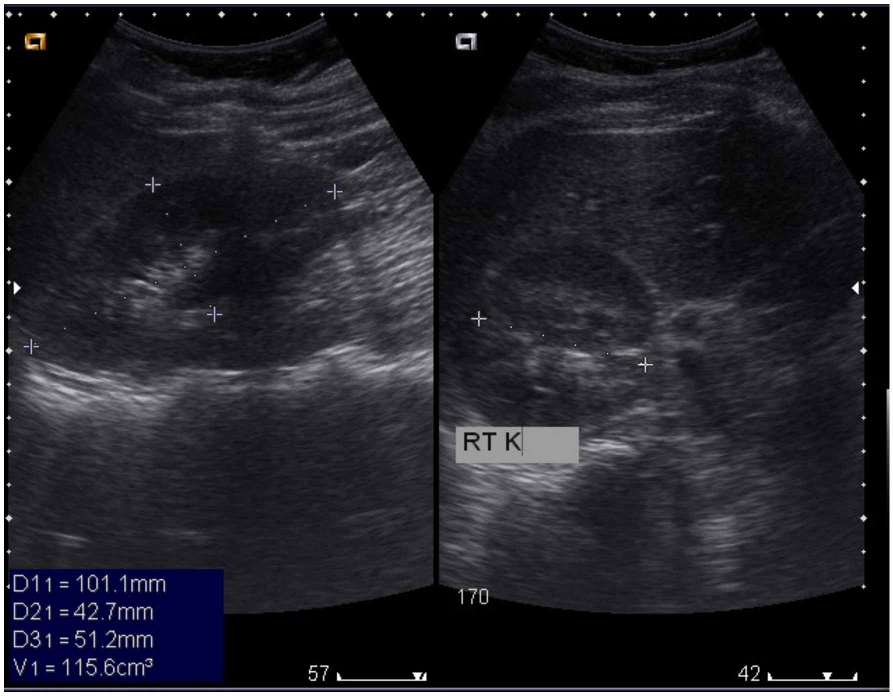
Male 31 10.3cml-6.1 w-4.4d volume 149cc



Female 21 years 10.8cm l 5.2cm w 4.6cm d –volume136cc



Male 36years 10.1cm-l,5.7cm –w ,3.9cm d - volume118.5



Female 21years ,10.1cml 5.1cm w , 4.2cm d.volume115.6cc