بسم الله الرحمن الرحيم

Sudan University for Science & Technology

College of Graduate Studies

Measurement of the Normal Kidney Dimensions in Primary School Age Children using Ultrasonography

قياس ابعاد الكلى الطبيعي لدى الأطفال في اعمار مرحلة الاساس باستخدام الموجات فوق الصوتية

A thesis Submitted For Partial Fulfilment of the Requirements of M.Sc. Degree in Medical Diagnostic Ultrasound

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بسم الله الرحمن الرحيم

الآيـــــــة :

وَمَا تَوْفِيقِي إِلَّا بِاللَّهِ عَلَيْهِ تَوَكَّلْتُ وَإِلَيْهِ أُنِيبُ

سورة هود الآية (88)

Dedication

I dedicate this workTo
All Children in my Beloved Country,
My Family,
My Colleagues
And I would like to thank all pearsons they help me to produce this work
My Supervisor : Dr Afraa Seddig.

Acknowledgment

My acknowledgements and gratefulness at the beginning and at end to Allah who gave us the gift of the mind and for give me the strength and health to do this project work until it done completely.

I would like to express my great thanks and tribute to everyone who support me in my work, especially who helped me in the Alazhari banat and Alabas primary schools for their cooperation to do my study.

Full regard for my supervisor Dr.Afraa Seddig who gave aperfect advices and ideas, in such way he that he motivated me to complete the work in success.

I would also like to give my thanks to Dr. Awadia Greeballa Suliman, also I would like to thanks my husband and my family and special thank to my mother.

Abstract

This study is descriptive study, the aim of this study to determine the renal sizes for healthy Sudanese children, and to correlate this measurement with age and somatic parameters (height weight, and abdomen circumference).

We examined 60 children their age from (6years-16year), including a total of 38 females and 22 males without renal problems,the renal length (CM),width (CM) were measured by zonecare ultrasound machine with high resolution 3.5 frequency carveliner transducer.

The study found that, there is no significant correlation between the kidney measurements and gander, there is significant correlation between the kidney measurement (length, width) and age , In addition, there is significant correlation between the kidney measurement (length, width) and height. There is significant correlation between the kidney measurement (length, width) and weight, and there is significant correlation between the kidney measurement (length, width) and AC.
The research presented normal measurements of kidney in healthy Sudanese children.

ملخص البحث

هذه وصفيه تهدف الى تحديد حجم الكلى عند الأطفال السودانيين الاصحاء وربط هذه المقاسات بالمقاييس العمرية والجسدية (الوزن والطول ومحيط البطن).

قمنا بفحص 60 طالب تتراوح أعمارهم بين 6-16 سنه بما في ذلك 38 اناث و22 ذكور لا يعانون أي مشاكل صحيه مرتبطة بالكلى ،تم قياس مقاسات الكلى بواسطه جهاز موجات صوتي(zoncare) باستخدام تردد 3.5Mhz.

وجدت الدراسة انه لا يوجد أي ارتباط بين مقاسات الكلى والنوع بينما وجدت ان هناك ارتباط بين مقاسات الكلى والعمر كما يوجد ارتباط كبيير بين مقاسات الكلى والطول وكذلك بين قياسات الكلى والوزن يوجد ارتباط كبير وهنالك ارتباط بين مقاسات الكلى ومحيط البطن .

قدم البحث قياسات طبيعية لأطفال سودانيين بمرحلة الأساس اصحاء.

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List of Abbreviations

AC	abdomen circumference
BMI	Body mass index
C/M	Cortiomedullary
CT	Computed tomography
SD	Standered deviation
SPSS	Statistical package for the social science
Cm	centimeter
Kg	kilogram
CKD	chronic kidney diseases

Chapter one
Introduction

Chapter one

1-1Introduction:

Kidney size is an essential parameter for evaluating pediatric renal and genitourinary tract pathologies .(Oswald J, 2004)

Measurement of kidney size is important because many current disorders with enlargement or kidney reduction, which means that renal size and function determined the health status of the kidney . It can be helpful and facilitate the follow up for the treatment of children with chronic pyelonephritis, obstructive uropathy, and chronic glomerulonephritis in early childhood. (Bax L, 2003)

Radiography, computed tomography and radionuclide imaging expose the patients to ionizing radiation while magnetic resonance imaging is expensive and is not readily available, Kidney ultrasound is a noninvasive diagnostic exam that produces images, Renal ultrasonography has become the standard imaging modality in the investigation of kidneys because it offers excellent anatomic detail, requires no special preparation of patients is readily available and does not expose the patient to radiation or contrast agents. Renal size and location can be determined. Solid tumors can be detected and can be distinguished from renal cysts. Ultrasonography can detect nephrolithiasis and hydronephrosis. Dilated ureters can frequently be followed up to the location of the occluding concernment. detection of renal arteries is reliably possible with Color Doppler sonography.(bruyn, 2005)

Renal size can be estimated by measuring renal length, renal volume and cortical volume or thickness. Renal volume is the most accurate measurement of kidney size because it is correlated with the subject's height, weight and total body area; however measurement of renal volume is not a precise method due to high inter-observer variation. Renal length as measured by ultrasonography is a simple, practical and reproducible measurement and widely accepted to monitor renal size and growth A growing kidney in a child is a healthy kidney, whereas a kidney static in size over time may be an early indicator of CKD. A 3.5-5 MHz probe is typically used to scan the kidney. For the right kidney, have the patient lie supine and place the probe in the right lower intercostal space in the midaxillary line. Use the liver as your "acoustic window" and aim the probe slightly posteriorly (toward the kidney). Gently rock the probe (up and down or side to side) to scan the entire

kidney. If needed, you can have the patient inspire or exhale, which allows for subtle movement of the kidney. • Obtain longitudinal (long axis) and transverse (short axis) views. For the left kidney have the patient lie supine or in the right lateral decubitus position. Place the probe in the lower intercostal space on the posterior axillary line. The placement will be more cephalad and posterior than when visualizing the right kidney. Again gently rock the probe to scan the entire kidney. Obtain longitudinal and transverse views.(bruyn, 2005)

In this study we have determined the renal sizes for healthy Sudanese children (7years to 13years), we measured the kidney length, width of kidney for healthy children by using ultrasound, we found Individual variations associated with age and somatic parameters (height and weight, abdomen circumference). The renal length was correlated with somatic parameters like age, weight, height and abdomen circumference Regression equations were derived for kidney length and height, we found: no statistical difference in renal size between sexes .strong correlation was seen between renal size with various somatic parameters, the best correlation was between renal length and body height (coefficient of correlation).

1-2 problem of study:

The measurement of kidney size correlation with age and somatic parameters (height weight, and abdomen circumference).

1 - 3 Objectives:

1-3-1 General objective:

Measurement of the Normal Kidney in Sudanese Primary School Age Using Ultrasonography**.**

1-3-2 specific objectives:

- To measure renal length, width,
- To correlate gender, ages, height, weight , abdomen circumference with the renal measurements.

1-4 Overview of the study:

This study consist of five chapters. Chapter one contains introduction, problem, objectives and overview of the study. Chapter two deal with literature review which include urinary system embryology, anatomy, physiology, appearance of normal and abnormal in ultrasound, investigations which usually done for urinary system and previous

studies. Chapter three contain methodology of the study. Chapter four contains results presentation, chapter five contain discussion, conclusion and recommendations. Finally, there are lists of references and appendices that include ultrasound images.

Chapter tow
Previous study

Chapter Two

2-1Literature Review:

Firstly, we review the Embryology, Anatomy, Physiology, and Pathology, General Investigation Done for Kidney, Renal Sonography and previous studies.

2-1-1 Embryology:

Kidney development, or nephrogenesis, describes the embryologic origins of the kidney.

2-1-1-1 phases:

The development of kidney proceed through a series of successive phases, each marked by development of amore advance kidney: the pronephros ,mesonephric, and metaphors.

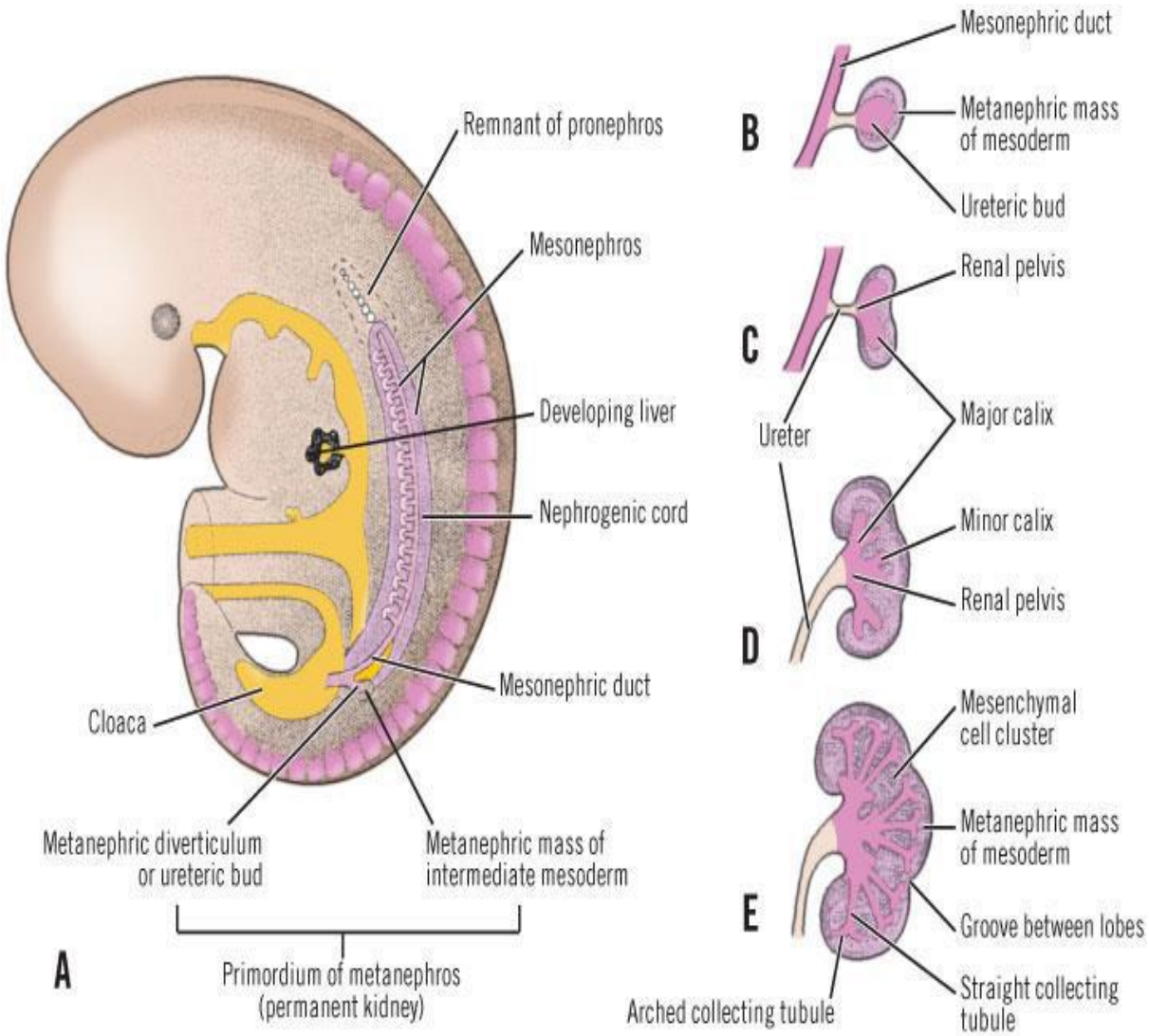
Pronghorns : the pronephros develop in cervical region of the embryo during approximately day 22 of human gestation , the paired pronephros appear to words the cranial end of intermediate mesoderm .In this region epithelial cells arrange themselves in a series of tubules called nephrotoms and join laterally with the pronephric duct this duct fully contained within the embryo and excrete filtered material outside the embryo there for pronephros is non functioning in mammals.(Carlson, 2015)

Mesonephros: the development of pronephric duct proceeds in a cranial – to caudal direction .As it elongates caudally the pronephric duct induces nearby intermediate mesoderm in the thoracolumbar area to become epithelial tubules called mesonephric tubules glum. Each mesonephric tubules receive blood supply from a branch of aorta ending in capillary tuft analougus to glomerulus of the definitive nephron , the mesonephric tubule form a capsule around the capillary tuft allowing filtration of blood.(Carlson, 2015)

Metanephros: during the fifth week of gestation the mesonephric duct develops an out pouching the ureteric bud, near it,s attachment to cloaca . This bud also called metanephrogenic diverticulum , grow posterior and to words the head of the embryo ,the elongated stalk of the ureteric bud ,called the metenephric duct ,later form the ureter , as the cranial end of the bud extends in to intermediate mesoderm , it undergoes series of branching to form the collecting duct system of the kidney . It also forms the major and miner calyces and the renal pelvis . The portion of un differentiated intermediate mesoderm in contact with the tips of the

branching ureteric bud is known as metanephrogenic blastoma.Signal released from ureteric bud induce the differentiation of metanephrogenic plastoma in to renal tubules . As the renal tubule grow , they come in to contact and join with connecting tubules of the collecting duct system, forming a continuous passage for flow from renal tubule to collecting duct.stimultaneously, precursors vascular endothelial cells begin to take their position at the tips of the renal tubules. These cell differentiate in to the cell of the definitive glomerulus .In human all the branches of ureteric bud and the nephrogenic units have been formed by 32 to 36 weeks of gestation . However ,these structures are not yet mature , and will continue to mature after birth . once matured human have anestimated one million nephrons (approximately 500,000 per kidney) . (Carlson, 2015)

Migration: after including the metanephric mesenchyme the lower portion s of the nephric duct will migrate caudally (down ward) and connect with the bladder, there by forming the ureters . The ureter will carry urine from the kidneys to the bladder for excretion from the fetus in to amniotic sac . As the fetus develops , the torso elongates and the kidneys rotate and migrates up ward with in the abdomen which couse the length ureters to increase . (Carlson, 2015)



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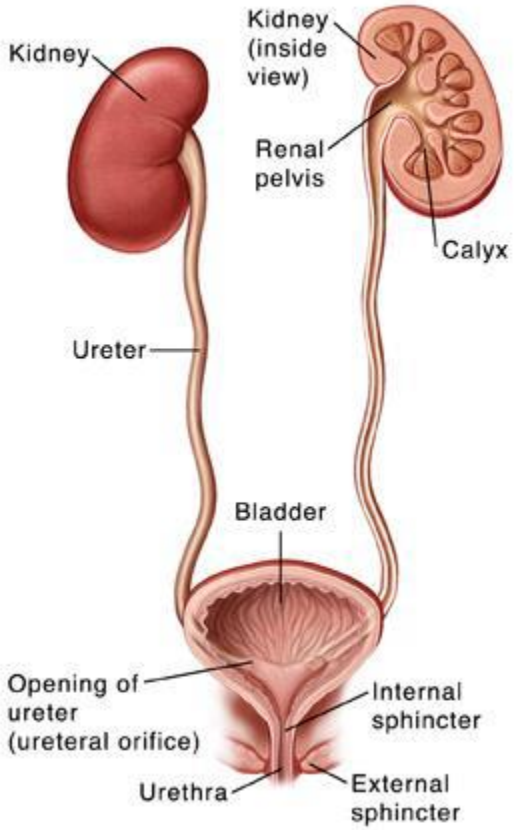
FEG2-1emperiology of urinary system(Carlson, 2015)

2-1-2Anatomy:

The urinary (¯ ur′i-n ¯ ar- ¯ e) system consists of two kidneys, two ureters, the urinary bladder, and the urethra.



FEG.2-2 the Urinary System(Carlson, 2015)

2-1-2-1 Kidneys:

The kidneys are bean-shaped organs, each about the size of a tightly clenched fist. They lie on the posterior abdominal wall behind the peritoneum to either side of the vertebral column.(Marieb, 2011)

Structures that are behind the peritoneum are said to be retroperitoneal (reʹtr ¯ o-perʹi-t ¯ o-n ¯ eʹ˜al). A connective tissue renal capsule surrounds each kidney. Around the renal capsule is a thick layer of fat called the renal fat pad, which protects the kidney from mechanical shock . On the medial side of each kidney is the hilum (h ¯ ıʹl˜um, a small amount), where the renal artery and nerves enter and where the renal Vein and ureter exit the kidney. The hilum opens into a cavity called the renal sinus, which is filled with fat and other connective tissues.(Marieb, 2011)

The kidney is divided into an outer cortex and an inner medulla, which surrounds the renal sinus. The bases of several cone-shaped renal pyramids are located at the boundary between the cortex and the medulla, and the tips of the renal pyramids project toward the center of the kidney.

A funnelshaped structure called a calyx (k ¯ a′liks, cup of a flower) surrounds the tip of each renal pyramid. The calyces from all the renal pyramids join together to form a larger funnel called the renal pelvis, which is located in the renal sinus. The renal pelvis then narrows to form a small tube, the ureter (¯ u-r ¯ e′ter or ¯ u′re-ter), which exits the kidney and connects to the urinary bladder. Urine passes from the tips of the renal pyramids into the calyces. From the calyces, urine collects in the renal pelvis and exits the kidney through the ureter.(Marieb, 2011)

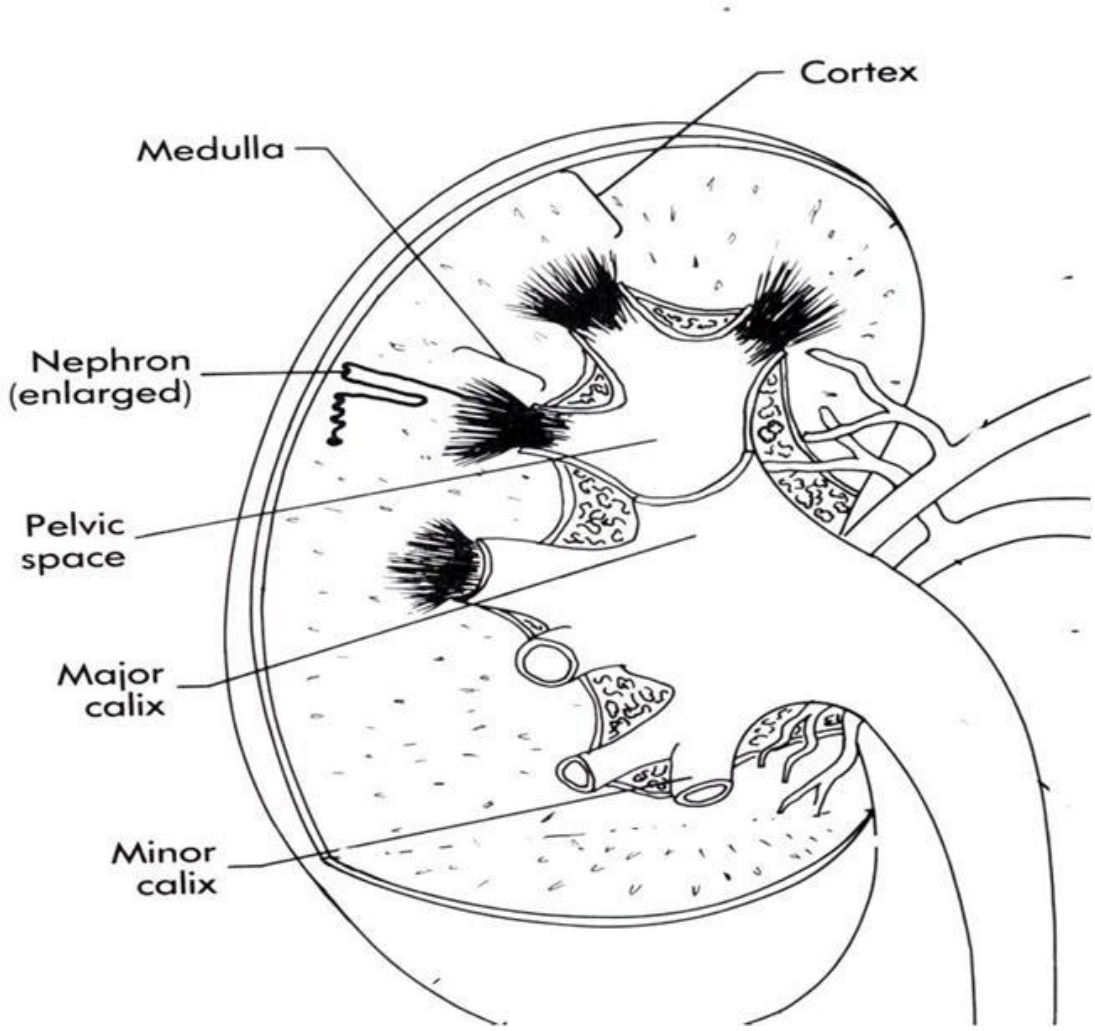
The functional unit of the kidney is the nephron (nef′ron), and there are approximately 1.3 million of them in each kidney. Each nephron consists of an enlarged ending called a renal corpuscle, a proximal tubule, a loop of Henle, or nephronic loop, and a distal tubule. (Marieb, 2011)

Fluid enters the renal corpuscle and then flows into the proximal tubule. From there, it flows into the loop of Henle. Each loop of Henle has a descending limb, which extends toward the renal sinus, and an ascending limb, which extends back toward the cortex. The fluid flows through the ascending limb of the loop of Henle to the distal tubule. The distal tubule empties into a collecting duct, which carries the fluid from the cortex, through the medulla, and empties its contents into a calyx. Many distal tubules empty into each collecting duct.(Marieb, 2011)

The renal corpuscle and both convoluted tubules are in the renal cortex (see figure 18.4). The collecting duct and loop of Henle enter the medulla. Approximately 15% of the nephrons have loops of Henle that extend deeply into the medulla of the kidney. The other nephrons (85%) have loops of Henle that do not extend deeply into the medulla. The renal corpuscle of the nephron consists of Bowman’s capsule and the glomerulus.(Marieb, 2011)

The wall of Bowman’s capsule is indented to form adouble-walled chamber. The indentation is occupied by a tuft of capillaries called the glomerulus (gl ¯ o-m ¯ ar_ ¯ u-l˘us), which resembles a ball of yarn. The cavity of Bowman’s capsule opens into the proximal tubule, which carries fluid away from the capsule. The inner wall of Bowman’s capsule surrounds the glomerulus and consists of specialized cells called podocytes (pod′ ¯ o-s ¯ ıts).(Marieb, 2011)

The glomerular capillaries have pores in their walls, and the podocytes have cell processes with gaps between them. The endothelium of the glomerular capillaries, the podocytes, and the basement membrane between them form a filtration membrane. In the first step of urine formation, fluid called filtrate is filtered from the glomerular capillaries into Bowman's capsule through the filtration membrane.(Marieb, 2011)
A large part of the descending limb has very thin walls made up of simple squamous epithelium. The remainder of the nephron and collecting duct are made up of simple cuboidal epithelium. The cells of the proximal tubules, ascending limb of Henle's loops, distal tubules, and collecting ducts have microvilli and many mitochondria. The proximal tubule, ascending limb of Henle's loop, and the collecting duct actively transport molecules and ions across the wall of the nephron, where as the descending limb of Henle's loop is very permeable to water and solutes.(Marieb, 2011)



FEG2-3 kidney anatomy(Carlson, 2015)

2-1-2-1-1Arteries and Veins:

The renal arteries branch off the abdominal aorta and enter the kidneys (figure 18.6). They give rise to several interlobar arteries, which pass between the renal pyramids. The interlobar arteries give rise to the arcuate arteries, which arch between the cortex and medulla. Interlobular arteries branch off the arcuate arteries to project into the cortex. The afferent arterioles arise from branches of the interlobular arteries and extend to the glomerular capillaries. Efferent arterioles extend from the glomerular capillaries to the peritubular capillaries, which surround the proximal and distal tubules and the loops of Henle.(Marieb, 2011)

The vasa recta (v ¯ a′s˘a rek′t˘a) are specialized portions of the peritubular capillaries which extend deep into the medulla of the kidney. Blood from the peritubular capillaries, including the vasa recta, enters the interlobular veins. The veins of the kidney run parallel to the arteries and have similar names.(Marieb, 2011)

A specialized structure called the juxtaglomerular (j ˘uks′-t˘a-gl˘o-mer′ ¯ u-l˘ar) apparatus is formed where the distal tubule projects between the afferent arteriole and the efferent arteriole next to Bowman's capsule. The specialized walls of the distal tubule and afferent arteriole form the juxtaglomerular apparatus.(Marieb, 2011)

2-1-2-2 Ureters, Urinary Bladder, and Urethra:

2-1-2-2-1 Ureters:

The ureters are small tubes that carry urine from the renalpelvis of the kidney to the posterior inferior portion of the urinary bladder.(Marieb, 2011)

2-1-2-2-2The urinary bladder:

The urinary bladder is a hollow muscular container that lies in the pelvic cavity just posterior to the pubic symphysis. It functions to store urine, and its size depends on the quantity of urine present. The urinary bladder can hold from a few milliliters to a maximum of about 1000 milliliters (mL) of urine. When the urinary bladder reaches a volume of a few hundred milliliters, a reflex is activated, which causes the smooth muscle of the urinary bladder to contract, and most of the urine flows out of the urinary bladder through the urethra.(Marieb, 2011)

2-1-2-2-3The urethra:

The urethra is a tube that exits the urinary bladder inferiorly and anteriorly. The triangle-shaped portion of the urinary bladder located between the opening of the ureters andthe opening of the urethra is called the trigone (tr ¯ ı′g ¯ on). The urethra carries urine from the urinary bladder to the outside of the body. The ureters and the urinary bladder are lined with transitional epithelium, which is specialized to stretch . As the volume of the urinary bladder increases, the epithelial cells change from columnar to flat epithelial cells, and the number of epithelial cell layers decreases. As the volume of the urinary bladder decreases, transitional epithelial cells assume their columnar shape and form a greater number of cell layers. The walls of the ureter and urinary bladder are composed of layers of smooth muscle. Regular waves of smooth muscle contractions produce the force that causes urine to flow from the kidneys through the ureters to the urinary bladder. Contractions of smooth muscle in the urinary bladder force urine to flow from the bladder through the urethra. At the junction of the urinary bladder and urethra, the smooth muscle of the bladder wall forms the internal urinary sphincter. No well-defined internal urinary sphincter is found in females. Elastic fibers at the junction of the urinary bladder and urethra keep urine from passing through the urethra until the urinary bladder pressure increases. The internal urinary sphincter of males is under involuntary control. Contraction of the internal urinary sphincter during ejaculation prevents semen from entering the urinary bladder and keeps urine from flowing through the urethra. The external urinary sphincter is formed of skeletal muscle that surrounds the urethra as the urethra extends through the pelvic floor. The external urinary sphincter is under involuntary and voluntary control. It controls the flow of urine through the urethra. In the male, the urethra extends to the end of the penis, where it opens to the outside. The female urethra is muchshorter (approximately 4 cm) than the male urethra (approximately 20 cm) and opens into the vestibule anterior to the vaginal opening.(Marieb, 2011)

ammonia is a by-product. Ammonia, which is toxic to humans, is converted into urea by the liver. Urea forms part of the filtrate and, although some of it is reabsorbed, much of it is eliminated in the urine. Tubular secretion is the transport of substances, usually waste products, into the filtrate. Urine produced by the nephrons therefore consists of the substances that are filtered and secreted from the peritubular capillaries

into the nephron, minus those substances that are reabsorbed.(Marieb, 2011)

2-1-3 physiology:

2-1-3-1 Functions of the Urinary System:

The major functions of the urinary system are performed by the kidneys, and the kidneys play the following essential roles in controlling the composition and volume of body fluids:

1. *Excretion.* The kidneys are the major excretory organs of the body. They remove waste products, many of which are toxic, from the blood. Most waste products are metabolic by-products of cells and substances absorbed from the intestine. The skin, liver, lungs, and intestines eliminate some of these waste products, but they cannot compensate if the kidneys fail to function.
2. *Blood volume control.* The kidneys play an essential role in controlling blood volume by regulating the volume of urine produced.
3. *Ion concentration regulation.* The kidneys help regulate the concentration of the major ions in the body fluids.
4. *pH regulation.* The kidneys help regulate the pH of the body fluids. Buffers in the blood and the respiratory system also play important roles in the regulation of pH.
5. *Red blood cell concentration.* The kidneys participate in the regulation of *red blood cell* production and, therefore, in controlling the concentration of *red blood cells* in the blood.
6. *Vitamin D synthesis.* The kidneys, along with the skin and the liver, participate in the synthesis of vitamin D.(Marieb, 2011)

2-1-3-2Urine Production:

Urine is mostly water and contains organic waste products such as urea, uric acid, and creatinine (kr ¯ e˝a-t ¯ en), as well as excess ions, such as sodium, potassium, chloride, bicarbonate, and hydrogen. The three processes critical to the formation of urine are filtration, reabsorption, and secretion.(Marieb, 2011)

Filtration is the movement of water, ions, and small moleculesthrough the filtration membrane of the renal corpuscle.The portion of the plasma entering the nephron is called the filtrate. Tubular reabsorption is the movement of substances from the filtrate back into the blood of the

peritubular capillaries. Certain molecules and ions are reabsorbed by processes such as active transport. Water is reabsorbed by osmosis. In general, the useful substances that enter the filtrate are reabsorbed, and metabolic waste products remain in the filtrate and are eliminated. For example, when proteins are metabolizedammonia is a by-product. Ammonia, which is toxic to humans, is converted into urea by the liver. Urea forms part of the filtrate and, although some of it is reabsorbed, much of it is eliminated in the urine. Tubular secretion is the transport of substances, usually waste products, into the filtrate. Urine produced by the nephrons therefore consists of the substances that are filtered and secreted from the peritubular capillaries into the nephron, minus those substances that are reabsorbed.(Marieb, 2011)

Urine formation results from the following three processes:

1. Filtration: Filtration is the movement of materials across the filtration membrane into the lumen of Bowman's capsule to form filtrate.

2. Reabsorption: Solutes are reabsorbed across the wall of the nephron by transport processes,

such as active transport and cotransport.

3. Secretion

Water is reabsorbed across the wall of the nephron by osmosis.

Solutes are secreted across the wall of the nephron into the filtrate.(Marieb, 2011)

2-1-3-2-1Filtration:

An average of 21% of the blood pumped by the heart each minute flows through the kidneys. Of the total volume of blood plasma that flows through the glomerular capillaries, about 19% passes through the filtration membrane into Bowman’s capsule to become filtrate. In all of the nephrons of both kidneys, about 180 liters (L) of filtrate is produced each day, but only about 1% or less of the filtrate becomes urine because most of the filtrate is reabsorbed.(Marieb, 2011)

The filtration membrane allows some substances, but not others, to pass from the blood into Bowman’s capsule. Water and solutes of small size readily pass through the openings of the filtration membrane, but blood cells and proteins, which are too large to pass through the filtration membrane, do not enter Bowman’s capsule. Albumin, a blood protein with a diameter slightly less than the openings in the filtration membrane, enters the filtrate in very small amounts. Negative charges on the albumin

proteins are repelled by the negative charges of the filtration membrane. Consequently, the filtrate contains no cells and only a small amount of protein. The formation of filtrate depends on the pressure difference between the glomerular capillaries and Bowman's capsule, called the filtration pressure. It forces fluid from the glomerular capillaries through the filtration membrane into Bowman's capsule. (Marieb, 2011)

Under most conditions, the filtration pressure remains within a narrow range of values. However, when the filtration pressure increases, both the filtrate and urine volumes increase. When the filtration pressure decreases, the filtrate volume and the urine volume decrease.(Marieb, 2011)

The filtration pressure is influenced by the blood pressure in the glomerular capillary, the blood protein concentration, and the pressure in Bowman's capsule. The blood pressure is normally higher in the glomerular capillaries than it is in most capillaries. The filtration pressure increases if the blood pressure in the glomerular capillaries increases further. The filtration pressure decreases if the blood pressure in the glomerular capillary decreases.(Marieb, 2011)

The concentration of proteins in the blood opposes the effect of blood pressure on the filtration pressure because of osmosis . An increase in blood protein concentration reduces the filtration pressure, and a decrease in blood protein concentration increases the filtration pressure. The pressure in Bowman's capsule also opposes the effect of blood pressure on the filtration pressure. For example, an increase in the pressure in Bowman's capsule reduces the filtration pressure.(Marieb, 2011)

The blood pressure within the glomerular capillaries is fairly constant because the afferent arterioles either dilate or constrict to regulate the blood pressure in the glomerular capillaries. Also, the concentration of blood proteins and the pressure inside Bowman's capsule are fairly constant. As a consequence, the filtration pressure and the rate of filtrate formation are maintained within a narrow range of values most of the time.(Marieb, 2011)

The filtration pressure does change dramatically under some conditions. Strong sympathetic stimulation in response to periods of excitement, rigorous physical activity, or emergency conditions cause renal blood vessels to undergo vasoconstriction. The blood pressure in the glomerular capillaries decreases, causing the filtration pressure to decrease. The rate

of filtrate and urine formation can be reduced to nearly zero.(Marieb, 2011)

Decreases in the concentration of plasma proteins, caused by conditions such as inflammation of the liver, increase the filtration pressure. The increased filtration pressure causes the filtrate and urine volume to increase.(Marieb, 2011)

2-1-3-2-2Reabsorption:

As the filtrate flows from Bowman's capsule through the proximal tubule, loop of Henle, distal tubule, and collecting duct, many of the solutes in the filtrate are reabsorbed. About 99% of the original filtrate volume is reabsorbed and enters the peritubular capillaries. The reabsorbed filtrate flows through the renal veins to enter the general circulation. Only 1% of the original filtrate volume becomes urine . Because excess ions and metabolic waste products are not readily reabsorbed, the small volume of urine produced contains a high concentration of metabolic waste products.(Marieb, 2011)

The proximal tubule is the primary site for the reabsorption of solutes and water. The cuboidal cells of the proximal tubule have numerous microvilli and mitochrondria, and they are well adapted to transport molecules and ions across the wall of the nephron by active transport and secondary active transport. Substances transported from the proximal tubule include proteins; amino acids; glucose; and fructose molecules; as well as sodium, potassium, calcium, bicarbonate, and chloride ions. The proximal tubule is permeable to water. As solute molecules are transported out of the proximal tubule to the peritubular capillaries, water moves by osmosis in the same direction. Consequently, 65% of the filtrate volume is reabsorbed from the proximal tubule .

The descending limb of the loop of Henle functions to further concentrate the filtrate. The renal medulla contains very concentrated interstitial fluid that has large amounts of sodium chloride and urea. The wall of the descending limb is permeable to water and moderately permeable to solutes. As the filtrate passes through the descending limb of the loop of Henle into the medulla of the kidney, water moves out of the nephron by osmosis, and some solutes move into the nephron by diffusion. By the time the filtrate has passed through the descending limb, another 15% of the filtrate volume has been reabsorbed, and the filtrate is as concentrated

as the interstitial fluid of the medulla. The reabsorbed filtrate enters the vasa recta.(Marieb, 2011)

The ascending limb of the loop of Henle functions to dilute the filtrate by removing solutes. The cuboidal epithelial cells of the ascending limb actively transport sodium ions out of the nephron, and the negatively charged chloride ions are transported by secondary active transport. The ascending limb is not permeable to water, however. As a result, sodium and chloride ions, but little water, are removed from the filtrate. Because of the efficient removal of sodium and chloride ions, the highly concentrated filtrate that enters the ascending limb of Henle's loop is converted to a dilute solution by the time it reaches the distal tubule . As the filtrate enters the distal tubule, it is more dilute than the interstitial fluid of the renal cortex. Also, because of the volume of filtrate reabsorbed in the proximal tubule and the descending limb of Henle's loop, only about 20% of the original filtrate volume remains. The solutes transported from the ascending limb of the loop of Henle enter the interstitial fluid of the medulla and help keep the concentration of solutes in the medulla high. Excess solutes enter the vasa recta.(Marieb, 2011)

The cuboidal cells of the distal tubule and collecting duct function to remove water and additional solutes. Solutes such as sodium and chloride ions are actively reabsorbed, and 19% of the original filtrate volume is reabsorbed by osmosis, leaving about 1% of the original filtrate as urine. The reabsorbed water and solutes from the distal tubule enter the peritubular capillaries and enter the vasa recta from the collecting ducts. The reabsorption of water and solutes from the distal tubule and collecting duct is controlled by hormones, which have a great influence on urine concentration and volume (see under Regulation of Urine Concentration and Volume, which follows).(Marieb, 2011)

The wall of the descending limb of the loop of Henle is permeable to water, and to a lesser extent to solutes. The interstitial fluid and the vasa recta in the medulla of the kidney have a high solute concentration. Solutes diffuse slowly into the descending limb of the loop of Henle, and water moves quickly by osmosis out of the descending limb of the loop of Henle into the interstitial fluid. An additional 15% of the filtrate volume is reabsorbed from the descending limb of the loop of Henle. The vasa recta carry the excess water away from the medulla.(Marieb, 2011)

Sodium, potassium, and chloride ions are transported by active transport and secondary active transport out of the ascending limb of the loop of Henle. The wall of the ascending limb of the loop of Henle is not permeable to water. The filtrate is more dilute than the interstitial fluid by the time it exits the ascending limb and enters the distal tubule.(Marieb, 2011)

In summary, most of the useful solutes that pass through the filtration membrane into Bowman's capsule are reabsorbed in the proximal tubule. Filtrate volume is reduced by 65% in the proximal tubule and by 15% in the descending limb of the loop of Henle. In the ascending limb of the loop of Henle, sodium chloride, but little water, is removed from the filtrate. Consequently, the filtrate becomes dilute. In the distal tubule and the collecting duct, additional sodium chloride is removed, water moves out by osmosis, and the filtrate volume is reduced by another 19%, leaving 1% of the original filtrate volume as urine.(Marieb, 2011)

2-1-3-2-3Secretion:

Some substances, including by-products of metabolism thatbecome toxic in high concentrations and drugs or molecules not normally produced by the body, are secreted into the nephron from the peritubular capillaries. As with tubular reabsorption, tubular secretion can be either active or passive. For example, ammonia diffuses into the lumen of the nephron, whereas hydrogen ions, potassium ions, creatinine, histamine, and penicillin are actively transported into the nephron.(Marieb, 2011)

Hydrogen ions are actively transported into the proximal tubule. The epithelial cells actively transport large quantities of hydrogen ions across the wall of the nephron into the filtrate. The secretion of hydrogen ions plays an important role in the regulation of the body fluid pH.(Marieb, 2011)

In the proximal tubule, potassium ions are reabsorbed. In the distal tubule and collecting duct, potassium ions are secreted.(Marieb, 2011)

2-1-4Regulation of Urine Concentration and Volume:

Given a solution in a container, such as a pan on a stove, it is possible to decrease the concentration of the solution by adding water to it. It is also possible to increase the concentration of the solution by boiling the water in the pan, thus removing water from the solution by evaporation. Similarly, the kidneys function to maintain the concentration of the body fluids by increasing water reabsorption from the filtrate when the body

fluid concentration increases and by reducing water reabsorption from the filtrate when the body fluid concentration decreases. The volume and composition of urine therefore changes, depending on conditions in the body. If body fluid concentration increases above normal levels, the kidneys produce a smaller than normal amount of concentrated urine. This eliminates solutes and conserves water, both of which help to lower the body fluid concentration back to normal. On the other hand, if the body fluid concentration decreases, the kidneys produce a large volume of dilute urine. As a result, water is lost, solutes are conserved, and the body fluid concentration increases.(Marieb, 2011)

Urine production also maintains blood volume and therefore blood pressure. An increase in blood volume can increase blood pressure, and a decrease in blood volume can decrease blood pressure. When blood volume increases above normal, the kidneys produce a large amount of dilute urine. The loss of water in the urine lowers blood volume.(Marieb, 2011)

Conversely, if blood volume decreases below normal, the kidneys produce smaller than normal amounts of concentrated urine to conserve water and maintain blood volume.(Marieb, 2011)

2-1-5Hormonal Mechanisms:

2-1-5-1Antidiuretic Hormone:

Antidiuretic (an′t ¯ e-d ¯ ı- ¯ u-ret′ik) hormone (ADH), secreted by the posterior pituitary gland, passes through the circulatory system to the kidneys. ADH regulates the amount of water re- absorbed by the distal tubules and collecting ducts. When ADH levels increase, the permeability to water of the distal tubules and collecting ducts increases, and more water is reabsorbed from the filtrate. Consequently, an increase in ADH results in the production of a small volume of concentrated urine. On the other hand, when ADH levels decrease, the distal tubules and collecting ducts become less permeable to water. As a result, less water is reabsorbed, and a large volume of dilute urine is produced.(Marieb, 2011)

The release of ADH from the posterior pituitary is regulated by the hypothalamus. Certain cells of the hypothalamus are sensitive to changes in the solute concentration of the interstitial fluid within the hypothalamus. An increased solute concentration of the blood and interstitial fluid results in action potentials being sent along the axons of the ADHsecreting neurons of the hypothalamus to the posterior pituitary,

causing ADH to be released from the ends of the axons . A reduced solute concentration in the blood and interstitial fluid within the hypothalamus causes inhibition of ADH release.(Marieb, 2011)

Baroreceptors that monitor blood pressure also influence ADH secretion. Increased blood pressure causes a decrease in ADH secretion, and decreased blood pressure increases ADH secretion.(Marieb, 2011)

Renin is released from the kidney. The resultant increase in aldosteronecauses an increase in sodium reabsorption from thenephron. Water follows the sodium ions. Thus, the volume of water lost in the form of urine declines. This method of conserving water helps prevent a further decline in blood pressure.(Marieb, 2011)

2-1-5-2Renin-Angiotensin-Aldosterone:

Renin (r ¯ e′nin or ren′in) and angiotensin (an′j ¯ e- ¯ o-ten′sin) help regulate aldosterone (al-dos′ter- ¯ on) secretion. Renin is secreted by cells of the juxtaglomerular apparati in the kidneys.(Marieb, 2011)

Renin is an enzyme that acts on a protein produced by the liver called angiotensinogen (an′j ¯ e- ¯ o-ten-sin′ ¯ o-jen). Amino acids are removed from angiotensinogen, leaving angiotensin I. Angiotensin I is rapidly converted to a smaller peptide called angiotensin II by angiotensin-converting enzyme. Angiotensin II acts on the adrenal cortex, causing it to secrete aldosterone.(Marieb, 2011)

Aldosterone increases the rate of active transport of sodium ions in the distal tubule and collecting duct. In the absence of aldosterone, large amounts of sodium ions remain in the nephron and become part of the urine. A high sodium ion concentration in the filtrate causes water to remain in the nephron and increases urine volume. When the rate of active transport of sodium ions is slow, urine volume therefore, increases, and the urine contains a high concentrations of sodium. Because chloride ions are attracted by thepositive charge on the sodium ions, chloride ions follow thesodium ions.(Marieb, 2011)

When blood pressure suddenly decreases or when the concentration of sodium ions in the blood becomes too low, renin is released from the kidney. The resultant increase in aldosterone causes an increase in sodium reabsorption from the nephron. Water follows the sodium ions. Thus the volume of water lost in the form of urine declines. This method

of conserving water helps prevent a further decline in blood pressure.(Marieb, 2011)

2-1-5-3Atrial Natriuretic Hormone:

Atrial natriuretic (n ¯ a′tr ¯ e- ¯ u-ret′ik) hormone (ANH) is secreted from cardiac muscle cells in the right atrium of the heart when blood pressure in the right atrium increases. Atrial natriuretic hormone acts on the kidney to decrease sodium ion reabsorption Sodium ions and water therefore remain in the nephron to become urine. The increased loss of sodium ions and water as urine reduces the blood volume and the blood pressure.(Marieb, 2011)

2-1-6Effect of Sympathetic Innervation on Kidney:

Function:

Sympathetic neurons with norepinephrine as their neurotransmitter substance innervate the blood vessels of the kidney. Sympathetic stimulation constricts the arteries, causing a decrease in renal blood flow and filtrate formation. Intense sympathetic stimulation causes the rate of filtrate formation to decrease to only a few milliliters per minute. Consequently only a small volume of urine is produce.(Marieb, 2011)

Decreases in blood pressure, such as during shock, are detected by baroreceptors and the result is to increase sympathetic stimulation of renal blood arteries. Other conditions such as intense physical activity or trauma increase sympathetic stimulation of renal blood arteries and decrease urine production to very low levels. Increased blood pressure is detected by barorectors and decreases sympathetic stimulation of renal blood arteries. Urine volume increases in response to a decrease in sympathetic stimulation of renal arteries.(Marieb, 2011)

2-1-7 investigations of urinary system:

Investigation that done for urinary system include lab investigation and radiographic examination and sonogram.

2-1-7-1LABORATORY TESTS:

Both urine and blood tests are used to evaluate renal function. A urinalysis for renal function includes, but is not limited to, an evaluation of the urine for bacteria (bacteruria), pus (pyuria), blood (hematuria), and protein (proteinuria) . Blood tests may be used to analyze levels of blood urea nitrogen (BUN), creatinine, and lactate dehydrogenase (LDH) . BUN measures the amount of urea nitrogen, a byproduct of protein metabolism

that occurs within the liver and is excreted by the kidneys. Creatinine, also excreted by the kidneys, measures the amount of creatinine phosphate found in the skeletal muscles. An elevation in either BUN or creatinine indicates some form of renal disease. LDH is an additional enzyme found within the blood that may be used to monitor renal function and other abnormalities, including some forms of cancer. LDH is found in nearly all tissues of the body. LDH elevates as a result of cell death. Therefore, an elevation in LDH is not a specific indicator for renal disease.(Penny, 2011)

2-1-7-2-Radiographic examination:

2-1-7-2-1Kidney,ureter bladder x-ray (KUB):

This type of x-ray may done to check the organs of urinary system. Is the first diagnostic procedure used ot check the urinary system.(Penny, 2011)

2-1-7-2-2Intravenous urography:

x-ray visualization of urinary tract with injection of contast substances , used for diagnosing diseases f upper urinary system .(Penny, 2011)

2-1-7-2-3computed tomography :

CT scan may include the injection of contrast medium .CT scan is expensive and have radiation hazard.(Penny, 2011)

2-1-7-3SONOGRAPHY OF THE KIDNEYS:

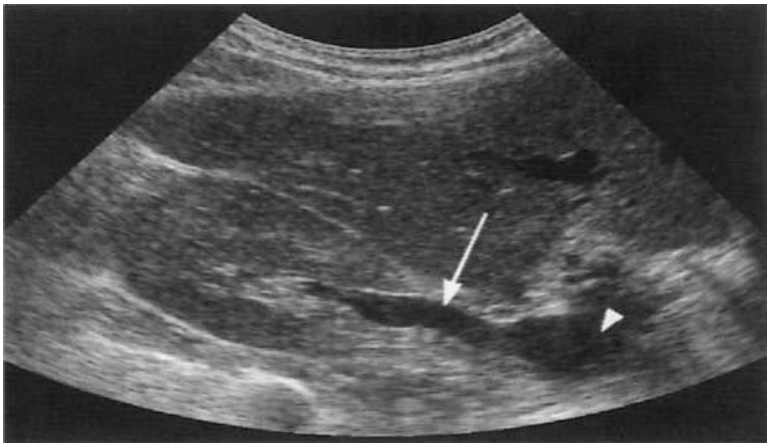
The sonographic appearance of the kidneys differs with age, and multiple variants may be noted with sonography. Neonatal and pediatric kidneys may appear lobulated, have prominent renal pyramids, and/or have subtle sonographic distinctions between the renal cortex and renal sinus. Normal adult kidneys are elliptical in shape in the longitudinal plane and rounded in the transverse plane. They typically measure approximately 8–13 cm in length, 2–3 cm in the anteroposterior dimension, and 4–5 cm in width.(Bates, 2004)

The renal sinus is central in the kidney and has an echogenic appearance. The renal cortex appears as medium-to-low level echoes surrounding the central sinus. The normal cortex should be more hypoechoic than, or isoechoic to, the liver or spleen. It should measure more than 1 cm in thickness from the outer margin of the renal pyramids to the outer margin of the kidney. Increased echogenicity of the renal cortex suggests intrinsic renal disease. Within the cortex, the triangular shaped medullary pyramids may be noted separated by the columns of Bertin. Occasionally,

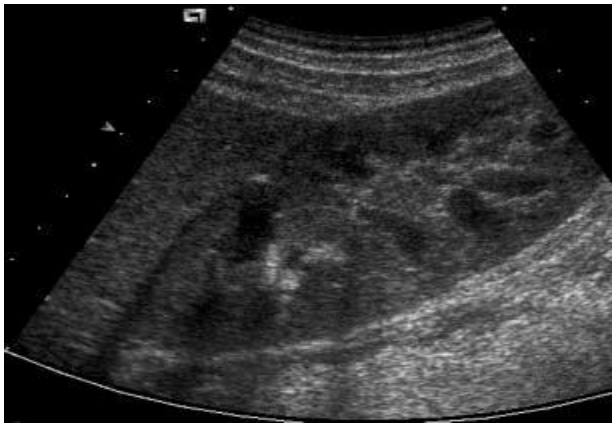
the renal capsule may be observed in some cases. It appears as a highly reflective hyperechoic line surrounding the kidney.(Bates, 2004)

2-1-7-3-1Ultrasound technique:

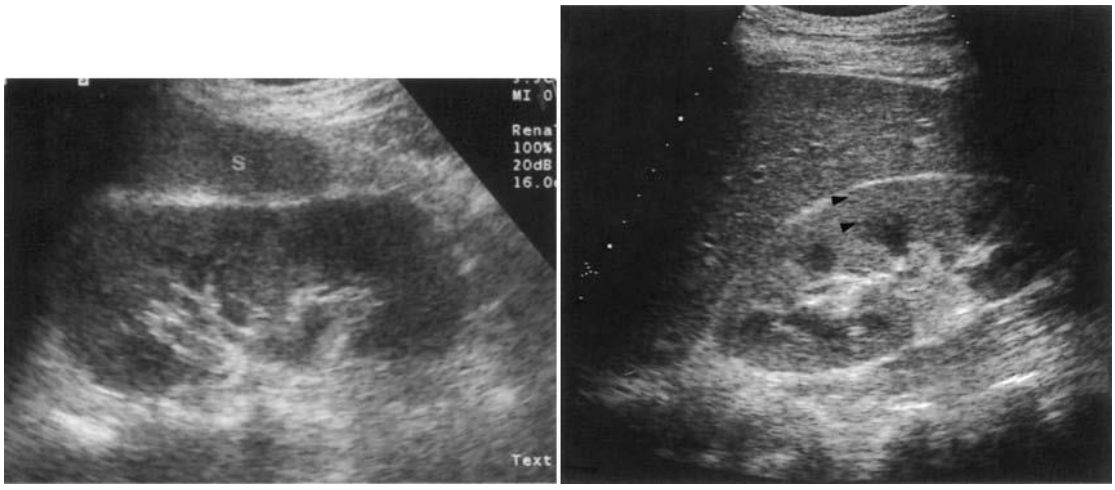
The right kidney is readily demonstrated through the right lobe of the liver. Generally, a subcostal approach displays the (more anterior) lower pole to best effect, while an intercostal approach is best for demonstrating the upper pole. The left kidney is not usually demonstrable sagittally because it lies posterior to the stomach and splenic flexure. The spleen can be used as an acoustic window to the upper pole by scanning coronally, from the patient's left side, with the patient supine or decubitus (left side raised), but, unless the spleen is enlarged, the lower pole must usually be imaged from the left side posteriorly. Coronal sections of both kidneys are particularly useful as they display the renal pelvicalyceal system (PCS) and its relationship to the renal hilum. This section demonstrates the main blood vessels and ureter (if dilated).(Bates, 2004)



FEG2-4TS through the hilum of the RK, demonstrating the renal vein (arrow) draining into the inferior vena cava (IVC) (arrowhead).(Bates, 2004)



FEG2-5Sagittal section through the normal right kidney (RK), using the liver as an acoustic window. The central echoes from the renal sinus are hyperechoic due to the fat content. The hypoechoic, triangular, medullary pyramids are demonstrated in a regular arrangement around the sinus. The cortex is of similar echogenicity to the liver.(Bates, 2004)



FEG2-6Left image showLeft kidney (LK) in coronal section. The renal hilum is seen furthest from the transducer (s = spleen). (Compare this with the *sagittal* section of the RK in which cortex is seen all the way around the pelvicalyceal system.) Right image show The renal cortex lies between the capsule and the lateral margin of the medullary pyramid (arrowheads).(Bates, 2004)

As with any other organ, the kidneys must be examined in both longitudinal and transverse (axial) planes. This usually requires a combination of subcostal and intercostal scanning with anterior, posterior and lateral approaches. The operator must be flexible in approach to obtain the necessary results.(Bates, 2004)

The bladder should be filled and examined to complete the renal tract scan. An excessively full bladder may cause mild dilatation of the PCS, which will return to normal following micturition.(Bates, 2004)

2-1-7-3-2Normal ultrasound appearances of the kidneys:

The cortex of the normal kidney is slightly hypoechoic when compared to the adjacent liver parenchyma, although this is age-dependent. In young people it may be of similar echogenicity and in the elderly it is not unusual for it to be compara-tively hyperechoic and thin. The medullary pyramids are seen as regularly spaced, echo-poor triangular structures between the cortex and the renal sinus. The tiny reflective structures often seen at the margins of the pyramids are echoes from the arcuate arteries which branch around the pyramids.(Bates, 2004)

The renal sinus containing the PCS is hyperechoic due to sinus fat which surrounds the vessels. The main artery and vein can be readily demonstrated at the renal hilum and should not be confused with a mild degree of PCS dilatation. Colour Doppler can help differentiate.(Bates, 2004)

The kidney develops in the fetus from a number of lobes, which fuse. Occasionally the traces of these lobes can be seen on the surface of the kidney, forming *fetal lobulation* ; these may persist into adulthood.(Bates, 2004)

2-1-7-3-3Normal ultrasound appearances of the lower renal tract:

When the bladder is distended with urine, the walls are thin, regular and hyperechoic. The walls may appear thickened or trabeculated if the bladder is insufficiently distended, making it impossible to exclude a bladder lesion.(Bates, 2004)

The ureteric orifices can be demonstrated in a transverse section at the bladder base. Ureteric jets can easily be demonstrated with colour Doppler at this point and normally occur between 1.5 and 12.4 times per minute (a mean of 5.4 jets perminute) from each side.(Bates, 2004)

It is useful to examine the pelvis for other masses, e.g. related to the uterus or ovaries, which could exert pressure on the ureters causing proximal dilatation.(Bates, 2004)

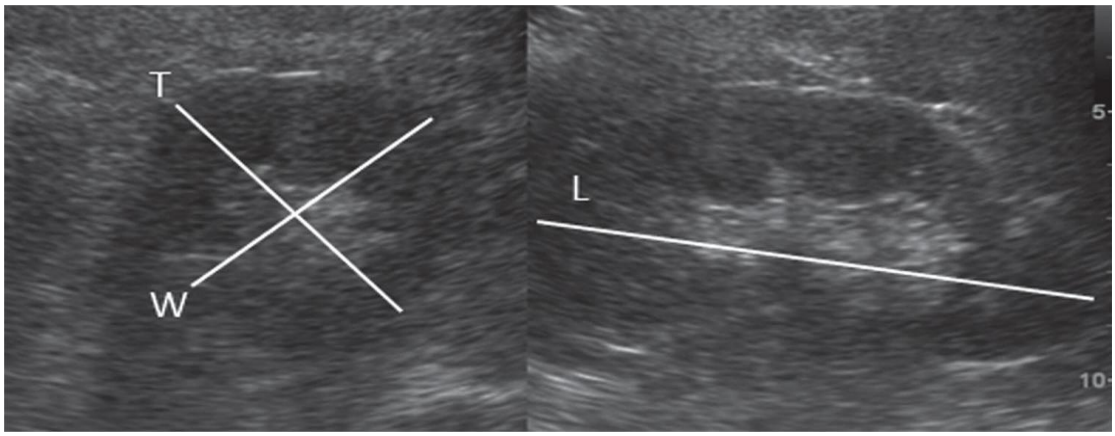
The prostate is demonstrated transabdominally by angling caudally through the full bladder. The investigation of choice for the prostate is transrectal ultrasound; however an approximate idea of its size can be gained from transabdominal scanning. When prostatic hypertrophy is suspected, it is useful to perform a postmicturition bladder volume measurement to determine the residual volume of urine.(Bates, 2004)

2-1-7-3-4Measurements:

The normal adult kidney measures between 9 and 12 cm in length. A renal length outside the normal range may be an indication of a pathological process and measurements should therefore form part of the protocol of renal scanning. The maximum renal length can often only be obtained from a section which includes rib shadowing. A subcostal section, which foreshortens the kidney, often underestimates the length and it is more accurate to measure a coronal or posterior longitudinal section.

The cortical thickness of the kidney is generally taken as the distance between the capsule and the margin of the medullary pyramid. This varies between individuals and within individual kidneys and tends to decrease with age.(Bates, 2004)

The bladder volume can be estimated for most purposes by taking the product of three perpendicular measurements and multiplying by 0.56:(Bates, 2004)



FEG2-7Basic Renal Dimensions L: length, W ; Width ,Thickness(Bates, 2004)

2-1-8Normal variants:

2-1-8-1Duplex kidneys:

These occur in a spectrum of degrees, from two separate organs with separate collecting systems and duplex ureters, to a mild degree of separation of the PCS at the renal hilum. The latter is more difficult to recognize on ultrasound, but the two moieties of the PCS are separated by a zone of normal renal cortex which invaginates the kidney, a *hypertrophied column of Bertin* . If duplex ureters are present (a difficult diagnosis to make on ultrasound unless dilatation is present) then a ureterocoele related to the upper moiety should be sought at or adjacent to

the bladder. This may cause dilatation of the affected moiety. The main renal artery and vein may also be duplicated, which can occasionally be identified using colour or power Doppler.(Bates, 2004)

2-1-8-2Ectopic kidneys:

The kidney normally ascends from the pelvis into the renal fossa during its course of development. During this 'migration' it rotates inwards so that the renal hilum faces medially. A failure of this mechanism causes the kidney to fall short of its normal position, remaining in the pelvis, that is, a pelvic kidney. Usually it lies on the correct side, however occasionally it can cross to the other side, lying inferior to its normally placed partner—*crossed renal ectopia*. Frequently it may fuse with the lower pole of the other kidney, *crossed fused renal ectopia*, resulting in what appears to be a very long, unilateral organ.(Bates, 2004)

2-1-8-3Horseshoe kidneys:

In the horseshoe kidney, the kidneys lie one on each side of the abdomen but their lower poles are fused by a connecting band of renal tissue, or *isthmus*, which lies anterior to the aorta and IVC. The kidneys tend to be rotated and lie with their lower poles medially. It may be difficult to visualize the isthmus due to bowel gas anterior to it but a horseshoe kidney should always be suspected when the operator is unable to identify the lower poles of the kidneys confidently.(Bates, 2004)

When the isthmus can be seen, it is important not to confuse it with other abdominal masses, such as lymphadenopathy. CT is occasionally performed because of this but normally clarifies the findings.(Bates, 2004)

2-1-8-4Extrarenal pelvis:

Not infrequently, the renal pelvis projects outside the kidney, medial to the renal sinus. This is best seen in a transverse section through the renal hilum. It is frequently 'baggy', containing anechoic urine, which is prominently demonstrated on the ultrasound scan.

The importance of recognizing the extrarenal pelvis lies in not confusing it with dilatation of the PCS, or with a parapelvic cyst or collection.(Bates, 2004)

2-1-8-5Hypertrophied column of Bertin:

The septum of Bertin is an invagination of renal cortex down to the renal sinus. It occurs at thejunctions of original fetal lobulations and is present in duplex systems , dividing the two moieties. Particularly prominent,

hypertrophied columns of Bertin may mimic a renal tumour. It is usually possible to distinguish between the two as the column of Bertin does not affect the renal outline and has the same acoustic characteristics as the adjacent cortex.(Bates, 2004)

2-1-8-6Renal humps:

These are areas of renal cortex, which form a bulge in the renal outline. Like the hypertrophied column of Bertin, a hump may mimic a renal mass. Careful scanning can usually solve the dilemma as the cortex remains constant in thickness. The most usual manifestation is the *splenic hump* on the left kidney, which is a flattening of the upper pole with a lateral prominence just below the margin of the spleen. Humps are basically a variation in the shape of the kidney rather than an area of hypertrophied tissue.(Bates, 2004)

2-1-9 KIDNEY PATHOLOGY:

2-1-9-1Renal Failure:

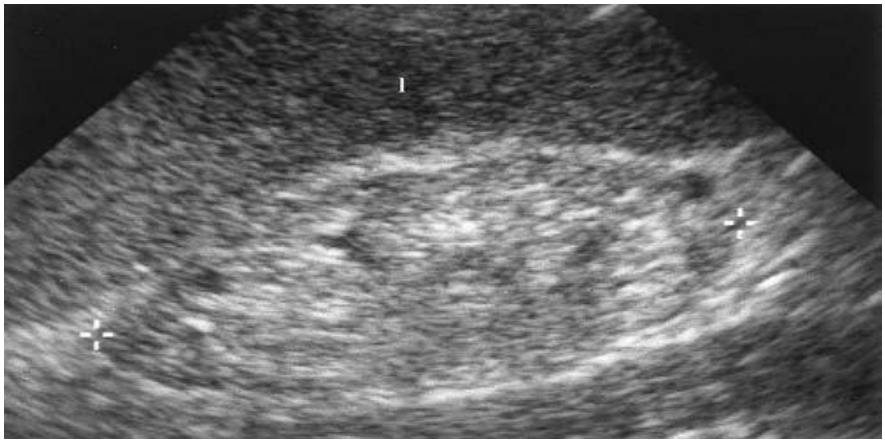
2-1-9-1-1Acute Renal Failure:

A sudden decrease in renal function is termed acute renal failure (ARF). The most common cause of ARF is acute tubular necrosis.With acute tubular necrosis; the kidney suffers from ischemic damage and subsequent cell destruction. Other causes of ARF include renal artery stenosis, renal infection, urinary tract obstruction, poly-cystic kidney disease, and metabolic disorders. Clinical findings of ARF include elevated BUN, elevated creatinine, oliguria, hypertension, leukocytosis, hematuria, edema, and hypovolemia. Sonographically, the kidneys may appear normal or the cortex may appear hyperechoic.(Penny, 2011)

2-1-9-1-2Chronic Renal Failure:

The gradual decrease in renal function over time is referred to as chronic renal failure (CRF). The most common cause of CRF is diabetes mellitus. Other causes of CRF include, but are not limited to, glomerulonephritis, chronic pyelonephritis, metabolic disorders, chronic urinary tract obstruction, and tuberculosis. CRF leads to end-stage renal disease. Clinical findings include diabetes, malaise, elevated BUN, elevated creatinine, fatigue, hypertension, and hyperkalemia. Patients are typically placed on dialysis or a donor kidney may be needed. Sonographically, the kidneys will appear
small, echogenic, and may contain cysts.(Penny, 2011)

There is also typically loss of normal corticomedullary differentiation(Penny, 2011).

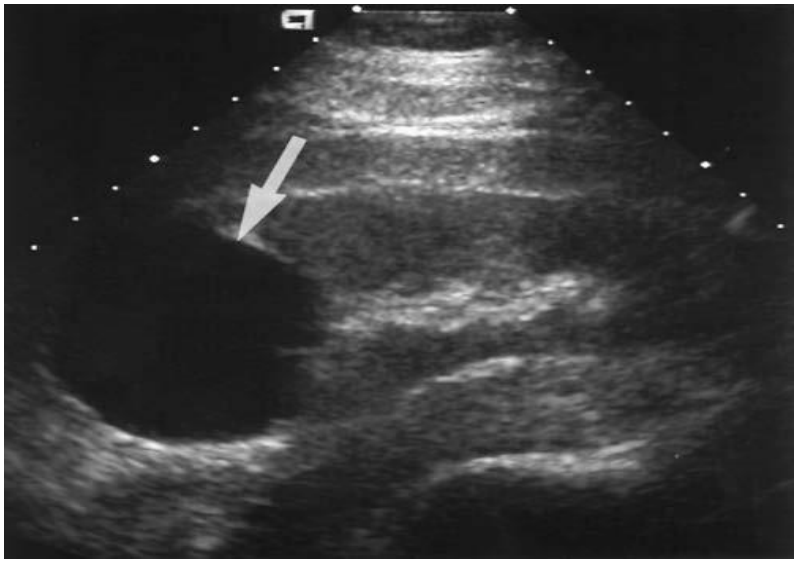


FEG2-9Chronic renal failure. The kidney (between calipers) is significantly more echogenic than the adjacent liver parenchyma (*l*). The kidney is small, and there is also loss of the normal corticomedullary differentiation. (Bates, 2004)

2-1-9-2Renal Cystic Disease:

2-1-9-2-1Simple Renal Cyst:

The simple cyst is the most common renal mass. A simple renal cyst should appear sonographically as an anechoic mass that is spherical, has smooth walls, posterior acoustic enhancement, and no internal echoes. An anechoic mass that does not specifically meet all of these criteria is not considered a simple renal cyst. Although larger cysts may cause some pain as they compress adjacent renal tissue, they are typically asymptomatic and clinically insignificant. Renal cysts can be peripelvic, parapelvic, cortical, or exophytic in location. A parapelvic cyst is one that originates in the renal parenchyma and protrudes into the renal sinus. They may be difficult to differentiate from a dilated renal pelvis. Peripelvic cysts are renal cysts that originate in the renal sinus. They may appear similar to pelvicaliceal dilations. Small cortical cysts are located within the cortex and may be difficult to differentiate from prominent renal pyramids, especially if they are solitary. Renal cysts that appear to be projecting out away from the kidney may be termed exophytic.(Bates, 2004)



FEG2-10Simple renal cyst. Anechoic internal fluid, sharp interface with the renal parenchyma, thin wall, and posterior enhancement are features of this simple renal cyst (*arrow*).(Bates, 2004)

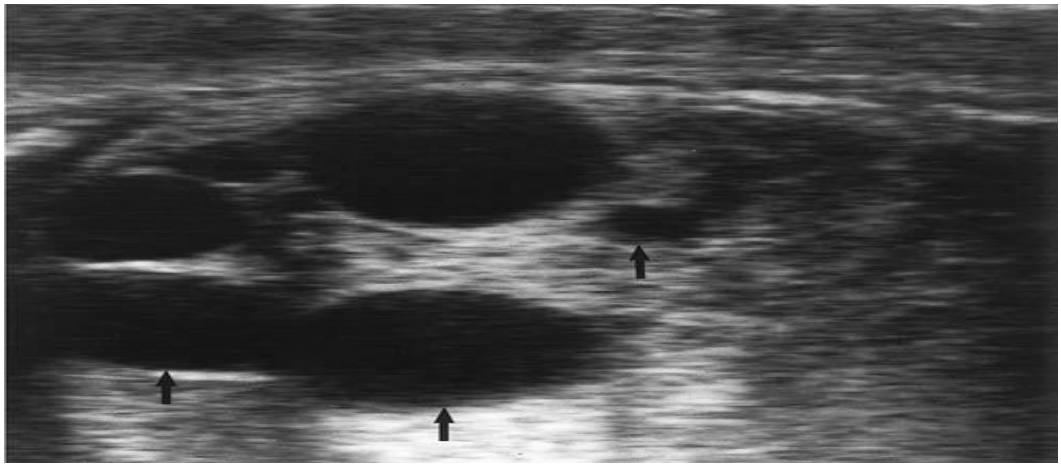
2-1-9-2-2Complex Renal Cysts:

A cyst that does not meet all of the characteristics of a simple cyst will fall into the complex cyst category. It is important to note that renal cell carcinoma (RCC) may manifest as a multicystic mass. Therefore, when a cyst has characteristics that include a septation, internal debris, mural nodules, papillary projection, or irregular borders, it becomes more worrisome for malignancy and is often followed up with further imaging or surgical intervention. A wide range of sonographic findings may be noted with complex renal cysts.(Bates, 2004)

2-1-9-2-3Autosomal Dominant Polycystic Kidney Disease:

Autosomal dominant polycystic kidney disease (ADPKD) may also be referred to as adult polycystic kidney disease (APKD). ADPKD can lie dormant for many years, often not manifesting in clinical symptoms until the person is in the third to fourth decade of life. Clinical symptoms include hypertension and decreasing renal function. Also, the patient may suffer from a urinary tract infection, renal calculi, flank pain, hematuria, and have a palpable mass in the abdomen.(Bates, 2004)

With ADPKD, the patient will develop numerous cortical renal cysts of varying sizes . Cysts may also be found in other organs including the pancreas, liver, and spleen. In fact, ADPKD has a 40% association with polycystic liver disease. Sonographically, the kidneys will appear enlarged and contain numerous renal cysts, with possible cysts identified in the pancreas, liver, and/or spleen.(Bates, 2004)



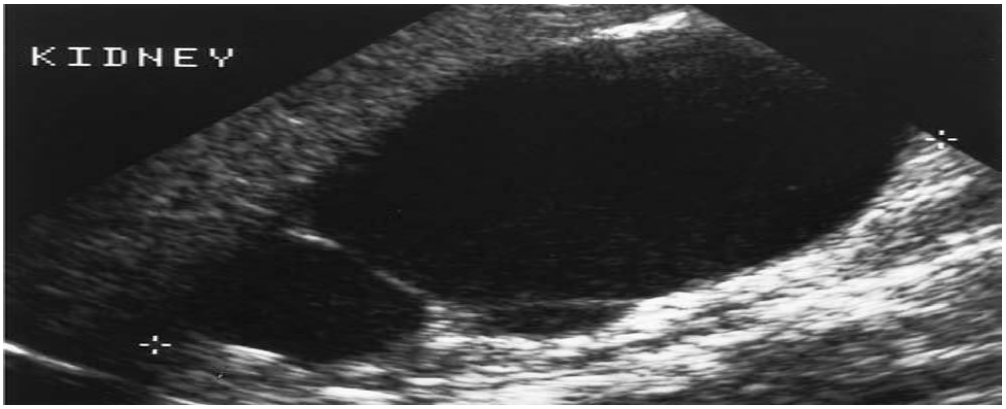
FEG2-11Autosomal dominant polycystic kidney disease. Advanced renal cystic disease results in the parenchyma being replaced by numerous noncommunicating cysts of varying sizes (*arrows*).(Bates, 2004)

2-1-9-2-4Autosomal Recessive Polycystic Kidney Disease:

Autosomal recessive polycystic kidney disease (ARPKD) may also be referred to as autosomal recessive polycystic renal disease and infantile polycystic kidney disease. ARPKD is characterized by dilation of the renal collecting tubules. This disorder is often recognized in the fetus and can be confirmed with a postnatal sonographic examination. If perinatal death does not occur, patients often die secondary to complication of renal failure and hepatic disease. The typical sonographic findings of a newborn affected by ARPKD are bilateral, enlarged, echogenic kidneys, with a loss of corticomedullary differentiation.(Bates, 2004)

2-1-9-2-5Multicystic Dysplastic Kidney Disease:

Multicystic dysplastic kidney disease (MCDK) may also be referred to as multicystic dysplastic renal disease and multicystic renal dysplasia. MCDK is thought to be caused by an early, first trimester obstruction of the ureter. There is typically no normal functioning renal tissue present in the kidney affected by MCDK. Therefore, if this condition is bilateral, it is fatal. Clinically, MCDK may be asymptomatic and incidentally identified in the adult patient. The sonographic finding of MCDK is the identification of several, smooth-walled, noncommunicating cysts of varying sizes in the area of the renal fossa, which completely replaces all renal parenchyma . Also, as a result of the nonfunctioning MCDK kidney, the contralateral kidney will take over the function of the abnormal kidney and undergo compensatory hypertrophy.(Bates, 2004)

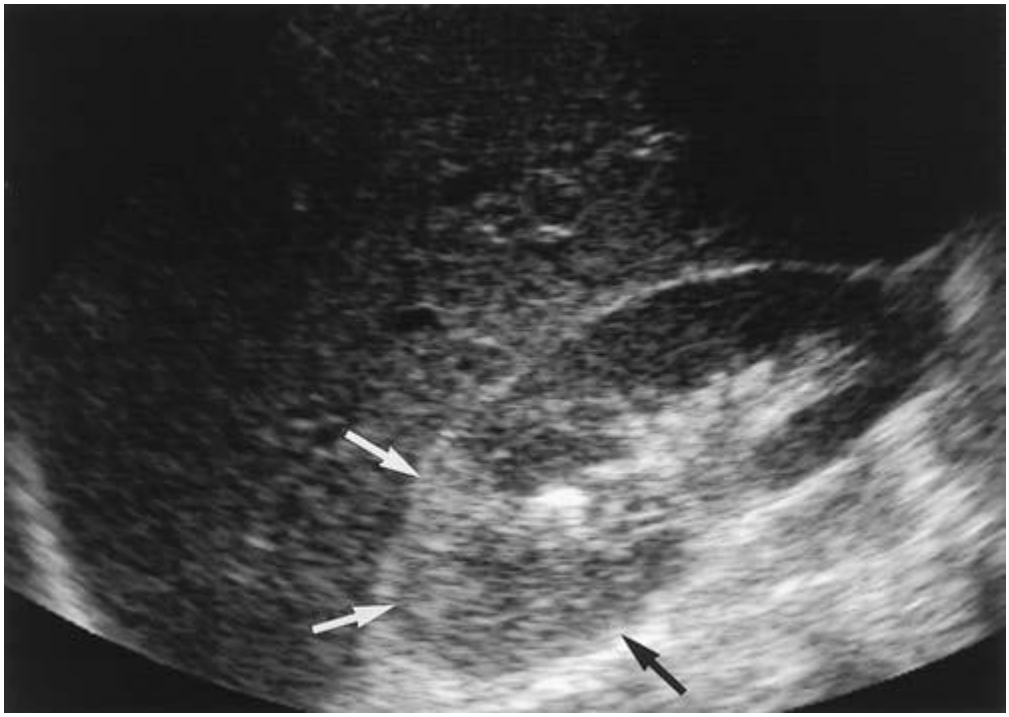


FEG2-12Multicystic dysplastic kidney. The parenchyma of this multicystic dysplastic kidney has been completely replaced by large cysts.(Penny, 2011)

2-1-9-3Renal Infection:

2-1-9-3-1Acute Pyelonephritis:

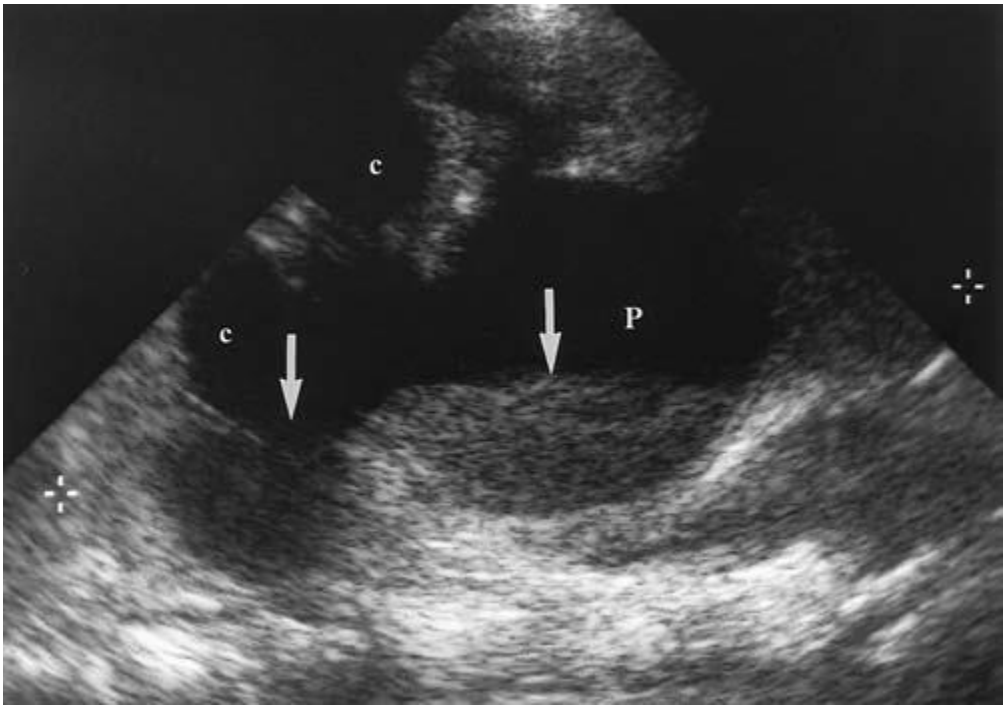
Acute pyelonephritis is an inflammation of the kidney or kidneys. Bacteria can spread to the kidney through the bloodstream or, more commonly, from the lower urinary tract. This type of infection is referred to as an ascending infection. The infection begins in the bladder and refluxes up through the ureters and into the kidney. It is most commonly encountered in women and is treated by antibiotics. Clinically, patients present with flank pain, bacteriuria, pyuria, dysuria, urinary frequency, and leukocytosis. A patient with acute pyelonephritis may not have any sonographically identifiable abnormalities. However, some findings consistent with acute pyelonephritis include renal enlargement, focal areas of altered echotexture, and compression of the renal sinus . Complications of acute pyelonephritis include the development of a renal abscess, pyonephrosis, xanthogranulomatous pyelonephritis, emphysematous pyelonephritis, and chronic pyelonephritis.(Penny, 2011)



FEG2-13Acute pyelonephritis. Acute renal infection with interstitial hemorrhage produces hyperechoic focal swelling in the upper pole of this kidney (*arrows*).(Penny, 2011)

2-1-9-3-2Pyonephrosis:

Pyonephrosis describes the condition of having pus, also referred to as purulent material, within the collecting system of the kidney. The accumulation of pus is most likely caused by some obstructive process or infection that leads to urinary stasis, as seen in many cases of pyelonephritis. The patient will likely present with pyuria, bacteruria, fever, flank pain, and leukocytosis. Sonographically, hydronephrosis will be evident. Within the dilated collecting system, thick pus or debris will appear as dependent layering, low-level echoes.(Penny, 2011)



FEG2-14Pyonephrosis. Pus (*arrows*) is noted within the dilated calices (*c*) and renal pelvis (*P*) in this kidney (between calipers).(Penny, 2011)

2-1-9-3-3Renal or Perinephric Abscess:

A renal abscess can occur in regions of the kidney affected by pyelonephritis or be located adjacent to the kidney. A perinephric abscess is a collection of purulent material that has leaked through the capsule into the tissue surrounding the kidney. Patients with a renal abscess present with signs of a urinary tract infection including high fever, flank pain, and leukocytosis. An abscess on sonography may appear anechoic, hypoechoic, or complex, depending on its contents. Gas development within the abscess produces dirty shadowing or reverberation artifac.(Bates, 2004)

2-1-9-4Urinary Tract Obstruction and Stones:

2-1-9-4-1Determining the Level of Urinary Tract Obstruction:

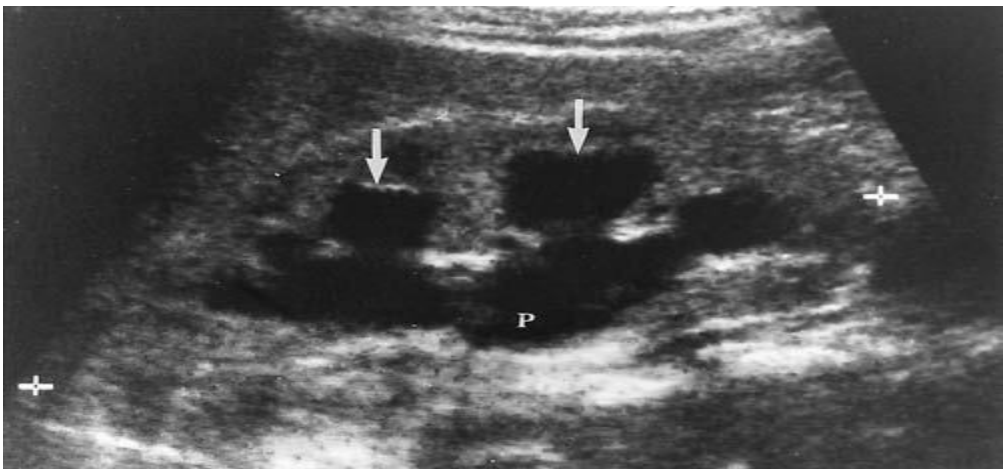
To determine the level of urinary tract obstruction, one must have a fundamental understanding of the normal flow of urine from the kidneys to the external orifice of the urethra. Essentially, urine is created within the kidneys, travels down the ureters, collects in the bladder, and exits the urethra. Dilation of the urinary tract occurs proximal to the level of obstruction. Therefore, if there is distention of the ureter and dilation of the renal collecting system with a normal urinary bladder, the level of obstruction must be proximal to the urinary bladder, either within the

ureter or at the level of the ureterovesicular junction. This is a simple concept and functional for both clinical practice and the registry examinations.(Penny, 2011)

2-1-9-4-2Hydronephrosis and Renal Obstruction:

Hydronephrosis is a general term that is defined as the dilation of the renal collecting system secondary to the obstruction of normal urine flow. Accordingly, hydronephrosis is dilation of the calices, infundibula, and renal pelvis. Hydronephrosis may also be referred to as pyelocaliectasis, and described more specifically according to which part of the kidney is dilated. It may also be described as mild, moderate, and severe or marked. Mild hydronephrosis is noted as distension of the renal pelvis, whereas moderate hydronephrosis is described as further progression of distension into the calices and medullary pyramids. Marked hydronephrosis extends into the cortex and causes severe thinning of the parenchyma.(Penny, 2011)

Irregularities that lead to renal obstruction that are located inside of the urinary tract are called intrinsic causes of hydronephrosis, and abnormalities that are located outside of the urinary tract that lead to renal obstruction are referred to as extrinsic causes of hydronephrosis. Sonographically, hydronephrosis will appear as anechoic fluid filling all or part of the renal collecting system.(Penny, 2011)

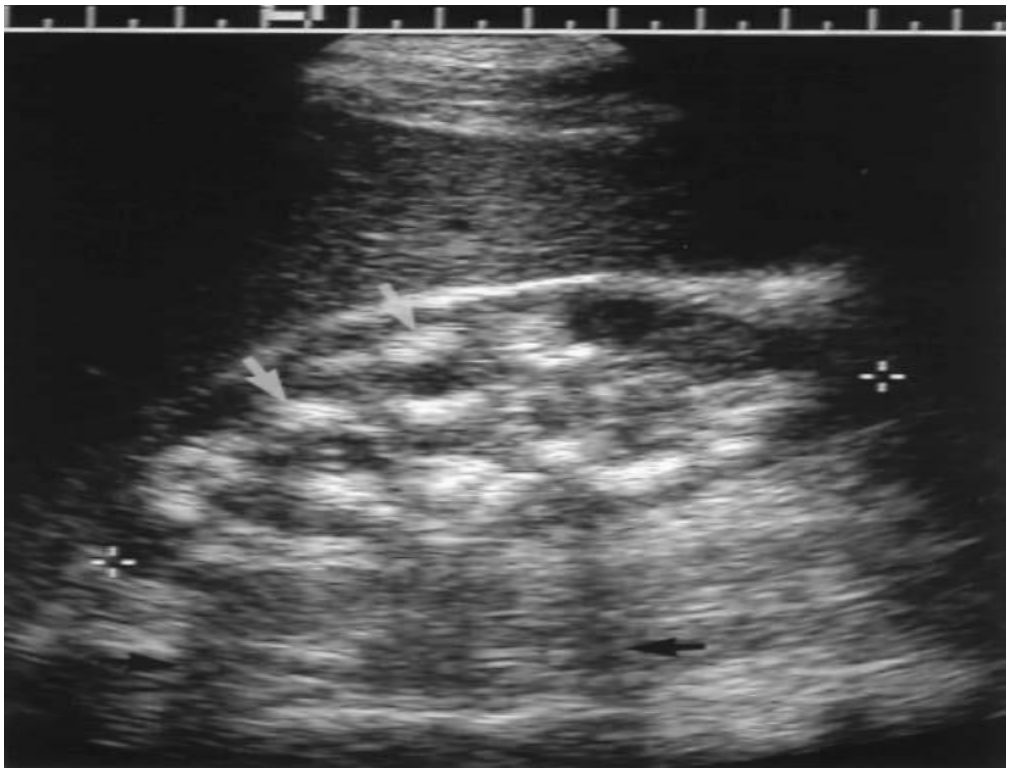


FEG2-15Moderate hydronephrosis. Urine filled dilated renal pelvis (*P*) and calices (*arrows*) are sonographic findings consistent with moderate hydronephrosis.(Penny, 2011)

2-1-9-5Nephrocalcinosis and Medullary Sponge Kidney:

Nephrocalcinosis is an accumulation of calcium within the renal parenchyma. There are two forms of nephrocalcinosis defined by their

location: medullary nephrocalcinosis and cortical nephrocalcinosis. Though medullary nephrocalcinosis may be caused by hypercalcemia associated with hyperparathyroidism, the most common cause of medullary nephrocalcinosis is a congenital defect known as medullary sponge kidney. Medullary sponge kidney is the accumulation of calcium within abnormally dilated collecting ducts located within the medulla. Clinically, patients with medullary sponge kidney may be asymptomatic or can have signs of infection and a history of urinary calculi. Medullary sponge kidney appears sonographically as highly echogenic renal pyramids that may shadow. Nephrocalcinosis that occurs within the cortex is termed cortical nephrocalcinosis. It may be caused by hyperparathyroidism, AIDS, or found in association with some malignancies. Sonographically, cortical nephrocalcinosis appears as small calculi within the cortex.(Penny, 2011)



FEG2-16Medullary nephrocalcinosis. Echogenic renal pyramids (*white arrows*) that may produce shadowing (*black arrows*) are sonographic findings consistent with medullary nephrocalcinosis.(Penny, 2011)

2-1-9-6Benign Masses of the Kidney:

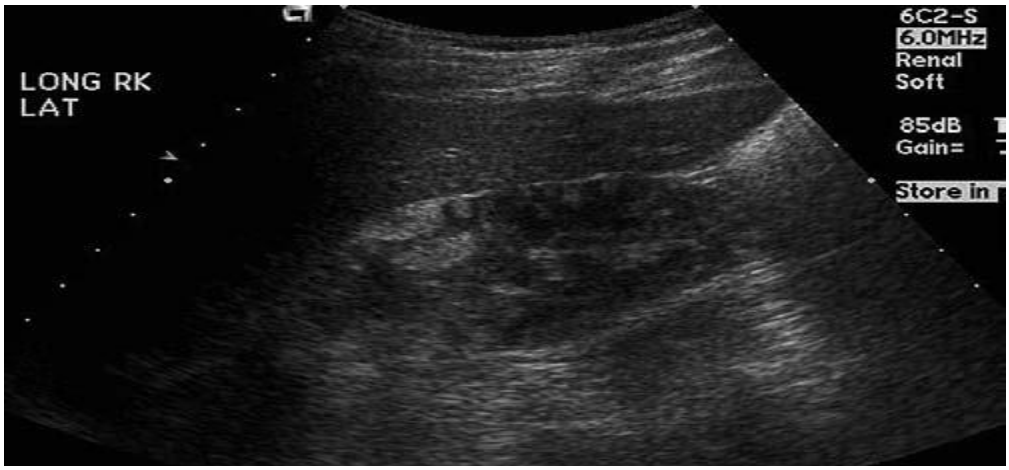
2-1-9-6-1Renal Adenoma:

A renal cell adenoma is a benign mass that appears sonographically similar to its malignant counterpart, the RCC. Clinically, patients are

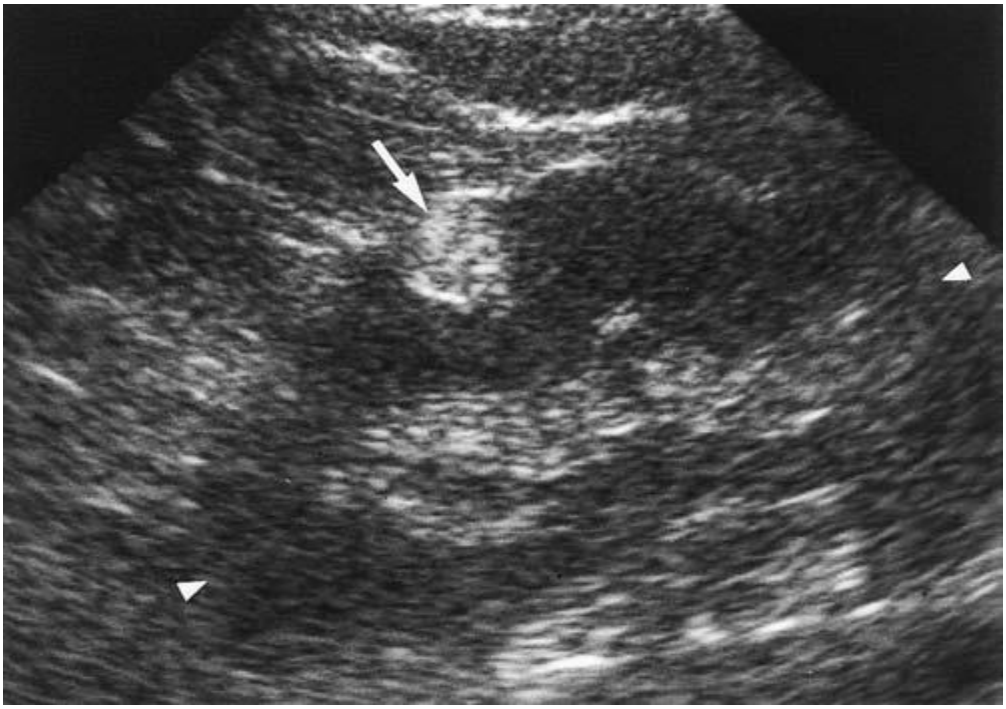
most often asymptomatic, although larger tumors may lead to hematuria. Sonographically, a renal cell adenoma appears as a vascular hyperechoic mass with areas of internal calcifications that may produce acoustic shadowing. They typically measure less than 1 cm. Surgical excision or biopsy is often warranted to differentiate the renal adenoma from RCC.(Penny, 2011)

2-1-9-6-2Angiomyolipoma:

The angiomyolipoma is a common benign renal tumor that consists of a network of blood vessels, muscle, and fat. It may also be referred to as a renal hamartoma. These masses are frequently incidentally encountered and are unilateral and asymptomatic in the general population. However, patients with tuberous sclerosis have a tendency to have multiple and bilateral angiomyolipomas . If symptoms do occur, they will be secondary to hemorrhage within the mass. These symptoms include hematuria, pain, and/or hypertension. Classically, the sonographic appearance of an angiomyolipoma is a solid, echogenic mass. However, depending on the composition of the mass, the sonographic appearance may vary. Angiomyolipomas, in 20% to 30% of the cases, will shadow secondary to its high fat component. Because RCC rarely shadows, the acoustic shadowing seen posterior to a hyperechoic mass is helpful, but not always indicative of an angiomyolipoma.(Penny, 2011)



FEG2-17Multiple angiomyolipomas. This patient with tuberous sclerosis had multiple small echogenic masses distributed throughout the kidneys. These were proven to be angiomyolipomas.(Penny, 2011)



FEG2-18Angiomyolipoma. A small echogenic mass (*arrow*) is noted within the renal parenchyma. This is highly characteristic sonographic findings of an angiomyolipoma.(Penny, 2011)

2-1-9-6-3Renal Lipoma:

A lipoma is a benign fatty tumor. The renal lipoma is most often found in women and they are typically asymptomatic. Sonographically, a renal lipoma will appear as well-circumscribed hyperechoic mass that typically measures less than 5 mm in diameter.(Penny, 2011)

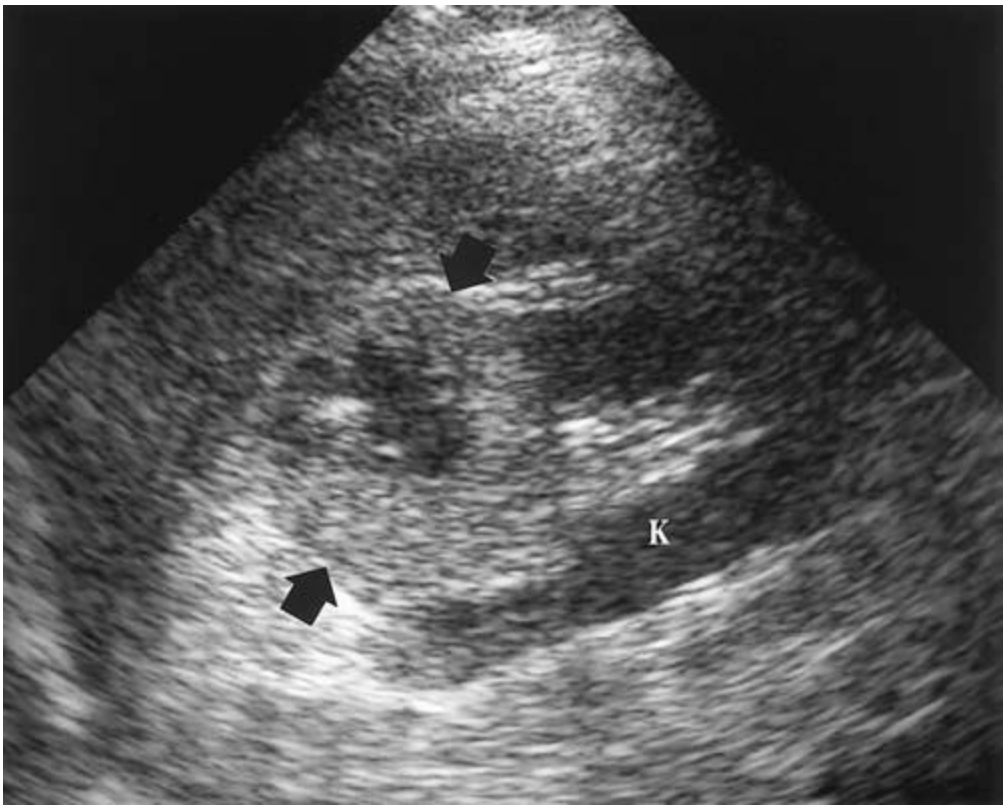
2-1-9-7Malignant Renal Masses:

2-1-9-7-1Renal Cell Carcinoma:

Renal cell carcinoma (RCC) may also be referred to as a hypernephroma or adenocarcinoma of the kidney. It is a primary form of renal cancer. Smoking, hypertension, obesity, and tuberous sclerosis increased risk for developing RCC. Also, there seems to be a strong association between RCC and von Hippel–Lindau disease. Patients who have acquired renal cystic disease from long-term dialysis are especially susceptible to develop RCC.(Penny, 2011)

Unfortunately, frequently symptoms manifest late in the disease when the tumor is moderately large. Patients may present with flank pain, a palpable mass, and gross hematuria. They may also suffer from unexplained weight loss and anorexia. The tumor can spread into the renal vein and inferior vena cava. The sonographic findings of RCC vary . Although, often the tumor is either hypoechoic or isoechoic to normal

renal tissue.The ipsilateral renal vein and IVC should be analyzed closely for tumor invasion.(Penny, 2011)



FEG2-19Renal cell carcinoma. This malignant tumor (*between fat arrows*) extends from the upper pole of the kidney (*K*) and contains some areas of hemorrhage and calcification.(Penny, 2011)

2-1-9-7-2Transitional Cell Carcinoma of the Kidney:

Transitional cell carcinoma (TCC) of the kidney is a malignant tumor that is most often found in the area of the renal pelvis. TCC may also be found within the ureter and urinary bladder (see TCC of the urinary bladder inthis chapter). TCC can cause focal dilation of the calices and small lesions can be difficult to identify with sonography. Larger masses most often appear as hypoechoic or isoechoic masses within the renal sinus. Patients may present with hematuria and pain secondary to renal obstruction.(Penny, 2011)

2-1-9-7-3Metastases to the Kidney and Other Malignancies:

Metastases to the kidneys are most often from the lungs or breast, with prostate, pancreas, and melanoma occurring less frequently. RCC can also metastasize from the contralateral kidney. These tumors appear as solid masses that are often hypoechoic or hyperechoic. Lymphoma and leukemia of the kidney will appear sonographically similar. Both can

either result in a focal, hypoechoic masses or be seen as bilateral, renal enlargement with a decrease in overall renal echogenicity. Patients who have a history of primary malignancy should be thoroughly evaluated for renal metastasis. Clinical findings may include hematuria, fever, and weight loss.(Penny, 2011)

2-1-9-8Pediatric Kidney Pathology:

2-1-9-8-1Congenital Hydronephrosis:

Congenital hydronephrosis can occur as a result of several conditions,The most common cause of congenital hydronephrosis in infants and children is a ureteropelvic junction obstruction. Vesicoureteral reflux (VUR) may also be the cause of congenital hydronephrosis. VUR is the backward flow of urine from the urinary bladder into the ureter, and possibly all the way back into the kidney. This is. It is graded on its severity. Other causes of congenital hydronephrosis include posterior urethral valves and prune belly syndrome. Posterior urethral valves are folds of excessive urethral tissue found exclusively in males. Posteriorurethral valves cause dilation of the bladder, both ureters, and both renal collecting systems. Prune belly syndrome is typically caused by megacystis, a massively dilated urinary bladder. This syndrome is mostly seen in male fetuses and is the result of a urethral abnormality, which in turn leads to a bladder outlet obstruction. Prune belly describes the result of the abdominal wall musculature being stretched by the extremely enlarged urinary bladder. Enlargement of the bladder, ureter, and the renal collecting system will occur. The triad of absent abdominal musculature, undescended testis, and urinary tract abnormalities is consistent with the diagnosis of prune belly syndrome.(Bates, 2004)

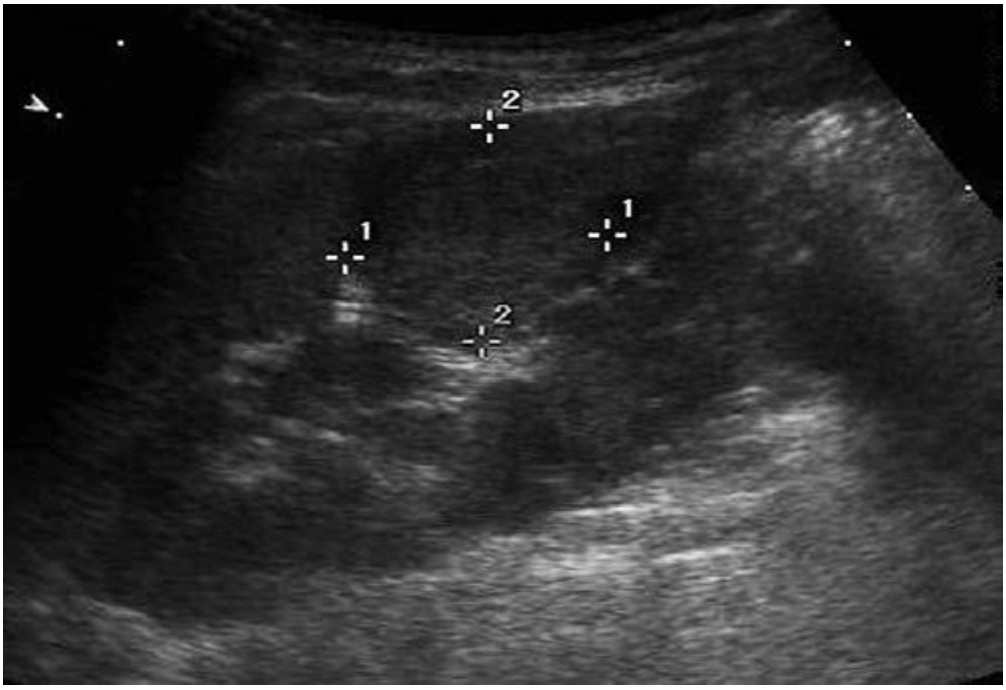
2-1-9-8-2Pediatric Vesicoureteral Reflux:

VUR is common in pediatric patients, especially young girls. VUR is the retrograde flow of urine from the bladder to the ureter. It is most commonly caused by an incompetent at the ureterovesicular junction.3 Urine that travels from the bladder, up the ureter, and into the kidney can become stagnant and lead to the development of bacteria, resulting in a urinary tract infection. Sonography is not highly sensitive for detecting VUR. Often, patients with minimal reflux have normal sonographic findings. However, long-standing and severe reflux can cause obvious enlargement of the ureter and dilation of the renal collecting system. A voiding cystourethrogram (VCUG) or a nuclear cystogram can be

performed to provide a more definitive diagnosis of this condition. Treatment of mild VUR is typically antibiotics, whereas severe forms may require surgical intervention.(Bates, 2004)

2-1-9-8-3Pediatric Wilms Tumor:

A Wilms tumor may also be referred to as a nephroblastoma. The Wilms tumor is the most common solid malignant pediatric abdominal mass. It is typically discovered before the age of 5, with a mean age of 3. These tumors can grow reasonably large before discovery and can invade the renal vein and inferior vena cava. Nephroblastomas tend to spread to the liver and lungs. Clinically, these patients present with a palpable abdominal mass, abdominal pain, hematuria, fever, and hypertension.13 Also, pediatric patients with Beckwith–Wiedemann syndrome have a tendency of developing Wilms tumors. Sonographically, a Wilms tumor appears as a large, solid, mostly echogenic mass that may contain anechoic or hypoechoic regions. Tumor invasion of the renal vein and inferior cava should be evaluated. Also, a thorough evaluation of the abdominal organs for metastasis is necessary.(Bates, 2004)



FEG2-20Wilms tumor. Longitudinal image of the kidney revealed an isoechoic mass (*between calipers*). It was proven to be a nephroblastoma (*Wilm tumor*).(Penny, 2011)

2-1-9-8-4Urachal Anomalies:

The urachus is a remnant of embryonic development. It is a tubular structure that extends from umbilicus to the apex of the bladder. During fetal life, the urachus normally closes. Failure of the urachus to close can result in a urachal anomaly. These include patent urachus, urachal cyst, or urachal sinus. A patent urachus will appear as an anechoic tube that extends from the umbilicus to the apex of the urinary bladder. (Penny, 2011)

Literature reviwo

Anjali S Otiv, et al(India,*)* they study about Sonographic Measurement of Renal Size in Normal Indian Children Cross-sectional observational study carried in Pediatric teaching hospital, Mumbai, Participants was 1000 normal Indian children aged 1 month – 12 years)**,** Sonographic assessment of renal size (length, width and thickness) was performed using Philips real time mechanical sector scanner of 3.5-5 MHz frequency with electronic caliper. The mean renal dimensions and volume were calculated for each age group with ± 2SD. the renal length and calculated renal volume were correlated with somatic parameters like age, weight, height and body surface are, regression equations were derived for each pair of dependent and independent variables the results was no statistical difference was found in renal size between sexes and between right and left kidney. A strong correlation was seen between renal size with various somatic parameters, the best correlation was between renal size length and body height (coefficient of correlation=0.9). (Anjali S. Otiv, 2012)

Kim et al (Korea), they did study about length and volume of morphologically normal kidneys in Korean children : Ultrasound measurement and estimation using body size , the study carried in severance children hospital ,younse , Seoul the aim of study to evaluate the relationship between anthropometric measurements and renal length and volume in Korean children who have morphologically normal kidney and create simple equation to estimate renal size using the anthropometric measurements .they examed 794 Korean children under 18 years of age (394 boys and 400 girl) without renal problem ,the maximum renal length (L) (cm) ,Anteroposterior diameter (D) (cm) and width (w) (cm) of each kidney measured. Kidney volume was calculated as 0.523 X L X D X W (CM3) ,height (cm) , weight (kg) and body mass index (m2/kg) were collected through medical record review .linear regression analysis used to create simple equation to estimate renal length and volume with those anthropometric indices that were mostly correlated withthe ultrasound measured size Renal length showed the strongest significant correlation with patient height, renal volume showed strongest significant correlation with patient weight, the following equations were developed to describe these relations with estimated 95% range of renal length : Renal length = 2.383 + 0.045 x height (=+ 1.135) and = 2.374 + 0.047 X height (-+

1.173) for the right and left kidney respectively .scatter plots between height and renal length and between weight and renal volume have been established from Korean children and simple equation them have been developed . (Jun-Hwee Kim, 2013)

Younus et al (Pakistan) they did a study of Sonographic Measurement of Normal Renal Size and Correlation with Somatic Variables in Subset of Karachi Pediatric Population. a six months crossectional hospital based assessment of kidney size (length and width) was evaluated with ultrasound the mean renal dimensions with standard deviation were estimated for every group of age ,the renal length and width were determinded and correspond with different somatic variables , descriptive statistics with regression analysis was done . the normal length and width and it,s ranges was obtained. Right kidney length moderately and significantly correlated with height and age respectively .how ever moderately insignificant with BMI , left kidney moderately and significantly correlated with height and weight negative insignificant with age and moderately weak insignificant relationship with BMI.**(younus, 2015)**

Rosan et al (Jordon) , the a study carried in Tertiary hospital ,the kidney of 331 children (156 males and 175 females) age between newborns and 14 years of age who had disease un related to urinary tract, all the examined kidneys were normal in size and shape and position the length of kidney were correlated with age , weight and height and was compared to previous international study .they found there was no significant statically difference between the length of right kidney and the left kidney ,and no difference between girls and boys , the was good correlation between the length of the kidneys and the somatic parameters of the patients .also there was agreement between the kidney length in this study those from previous Studies. (Liqa A Rousan, 2015)

C.U. Eze etal (Nigeria), they did study about Sonographic Assessment of Normal Renal Parenchymal and Medullary pyramid thicknesses among Children in Enugu, this was a cross sectional study, the subjects were 512 children aged 1-17 years scanned with ultrasound equipment with 3.5 MHz and 5 MHz curvilinear transducers. the RPT was measured perpendicularly to the long axis of the kidney from the medullary papilla to the renal capsule and MPT was measured from the apex to the base of the medullary pyramid on the same plane. the age and somatometric

parameters of the subjects were recorded ,the results: mean±SD of RPT and MPT for the right kidney were 12.62±1.67 mm and 7.10±0.92 mm and the left kidney were 12.81±1.7 and 7.23±0.94 mm respectively. there was a significant difference between the right and left RPT and MPT ($p<0.05$). The right and left RPT correlated strongly with age,body surface area (BSA), height, and weight but moderately with body mass index (BMI). A moderate positive correlation was observed between MPT and age, BSA, height, and weight. however, a weak correlation was observed between MPT and BMI.Conclusion:Normograms of RPT and MPT in relation to age could be usefulfor grading hydronephrosis inchildren. (C.U. Eze a, 2016)

M Oh in 2016(Korea). they did study about t evaluate Sonographic measurements for Kidney Length in Normal Korean Children Kidney length is the most useful parameter for clinical measurement of kidney size, and is useful to distinguish acute kidney injury from chronic kidney disease. In this prospective observational study of 437 normal children aged between 0 and < 13 years, kidney length was measured using sonography. There were good correlations between kidney length and somatic values, including age, weight, height, and body surface area. The rapid growth of height during the first 2 years of life was intimately associated with a similar increase in kidney length, suggesting that height should be considered an important factor correlating with kidney length. Based on our findings, the following regression equation for the reference values of bilateral kidney length for Korean children was obtained: kidney length of the right kidney (cm) = 0.051 × height (cm) + 2.102; kidney length of the left kidney (cm) = 0.051 × height (cm) + 2.280. This equation may aid in the diagnosis of various kidney disorders**.(Oh, 2016)**

Chapter three
Materials and method

Chapter three
3-Materials and method

3-1Materials:

3-1-1data of study:

The data of this study was collected from healthy children at primary schools of Khartoum state. Renal sonographic examinations were done for 60 children their age from (6years-16year) to estimate normal sonographic measurements of renal size according to specific age, height and weight. This is a Cross-Sectional, descriptive Study where the samples selected randomly. The study was conducted on February 2019 to September 2019 in Khartoum (Sudan) at Alazhari School and alabaas primary school. All healthy males and females Sudanese children with normal kidney position, shape and echo texture from 6 to 16 years old. Any abnormal kidney position, shape and echo texture, children affected with stone, UTI, benign renal conditions, traumatic spleen or any other kidney pathology were excluded.

3-1-2machins:

1. The sonographic examination was performed with high-resolution real time scanners with a 3.5-5MHz convex transducer. (zonecare).
2. Coupling agent (gel).
3. Weighting scale: to measure weight of children,
4. Standiometer: is standing height to measure height children.
5. metter: to measure the abdomen circumference.

3-2mathode:

3-2-1Technique:

First age ,height , weight and abdomen circumference were recorded at the time of scan. All patients in prone position, scanning are performed in the sagittal and transverse planes from posterior approach. Various maneuvers done to enhance demonstration of the kidneys. Coronal longitudinal and transverse scan also obtained for evaluating the renal pelvis and proximal ureter .length of kidney measured from sagittal view was the maximum long axis. Width measured from transverse view.

3.2.2 Data collection:

The data was collected using data collecting sheet design especially for the study, which includes the following variables:

Child’s weight, age, gender, height, abdomen circumference, renal, length, width.

3.3 Method of data analysis:

The data was analyzed using SPSS.

3.4 Ethical consideration:

The verbal permission was taken from the administrator of each school before the beginning of data collection. The children came to scan by themselves, Where verbal consent was taken in case of agreement.

Chapter four
Result

Chapter four
Results

Table (4.1) frequency distribution of age

Age	Frequency	Percent	Valid Percent	Cumulative Percent
6-9 years	24	40.0	40.0	40.0
10-13 years	24	40.0	40.0	80.0
14-16 years	12	20.0	20.0	100.0
Total	60	100.0	100.0	

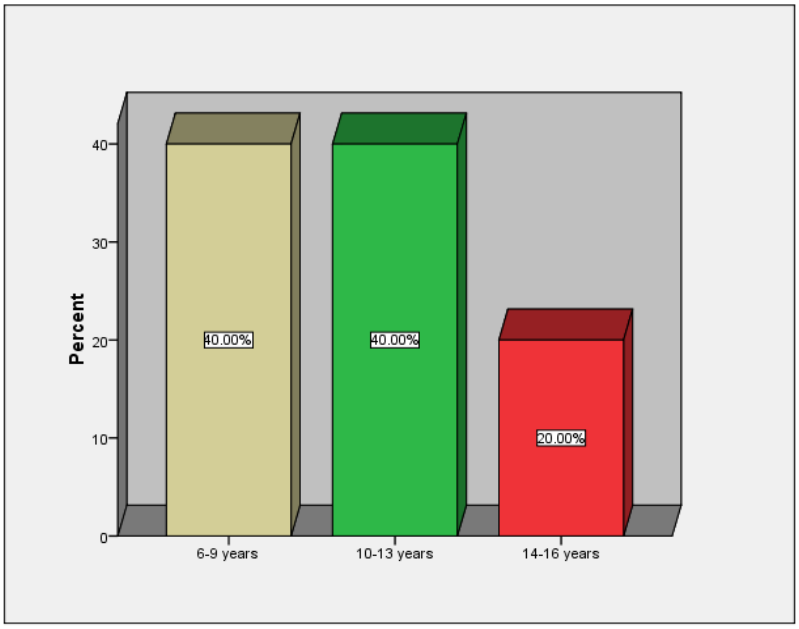


Figure (4.1) frequency distribution of age

Table (4.2) frequency distribution of gender

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	38	63.3	63.3	63.3
Male	22	36.7	36.7	100.0
Total	60	100.0	100.0	

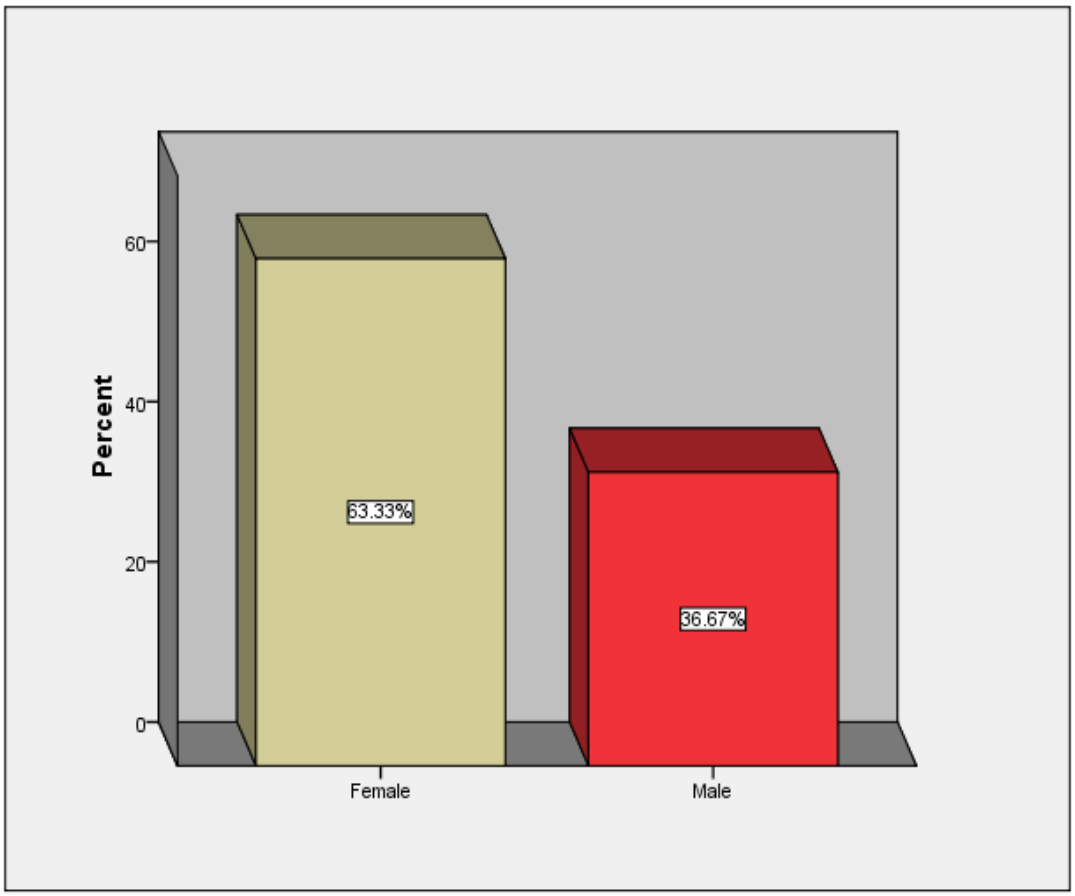


Figure (4.2) frequency distribution of gender

Table (4.3) descriptive statistic for age, height, weight, AC and kidneys measurement (minimum, maximum, mean ± Std. Deviation).

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age	60	6	16	10.78	2.706
Height	60	117	170	141.33	15.676
Weight	60	12	72	32.58	13.222
BMI	60	7.44	30.26	15.7407	3.96683
AC	60	48	84	60.58	8.310
RTK length	60	6.1	10.3	8.268	.8777
RTK width	60	2.2	3.8	3.133	.3662
LTK length	60	7.2	10.3	8.903	.8503
LTK width	60	2.5	4.5	3.582	.4316
Valid N (listwise)	60				

Table (4.4) compare means kidneys measurement and age

Age\ years		RTK length	RTK width	LTK length	LTK width
6-9 years	Mean	7.708	2.946	8.300	3.350
	Std. Deviation	.6685	.3599	.5657	.4253
	Minimum	6.1	2.2	7.2	2.5
	Maximum	8.8	3.7	9.3	4.3
10-13 years	Mean	8.450	3.200	9.112	3.658
	Std. Deviation	.8361	.3464	.8136	.3658
	Minimum	6.4	2.6	7.5	3.2
	Maximum	9.8	3.8	10.3	4.5
14-16 years	Mean	9.025	3.375	9.692	3.892
	Std. Deviation	.5956	.2179	.5071	.3260
	Minimum	8.2	2.9	8.5	3.3
	Maximum	10.3	3.8	10.3	4.4
Total	Mean	8.268	3.133	8.903	3.582
	Std. Deviation	.8777	.3662	.8503	.4316
	Minimum	6.1	2.2	7.2	2.5
	Maximum	10.3	3.8	10.3	4.5
P value		0.000	0.001	0.000	0.000

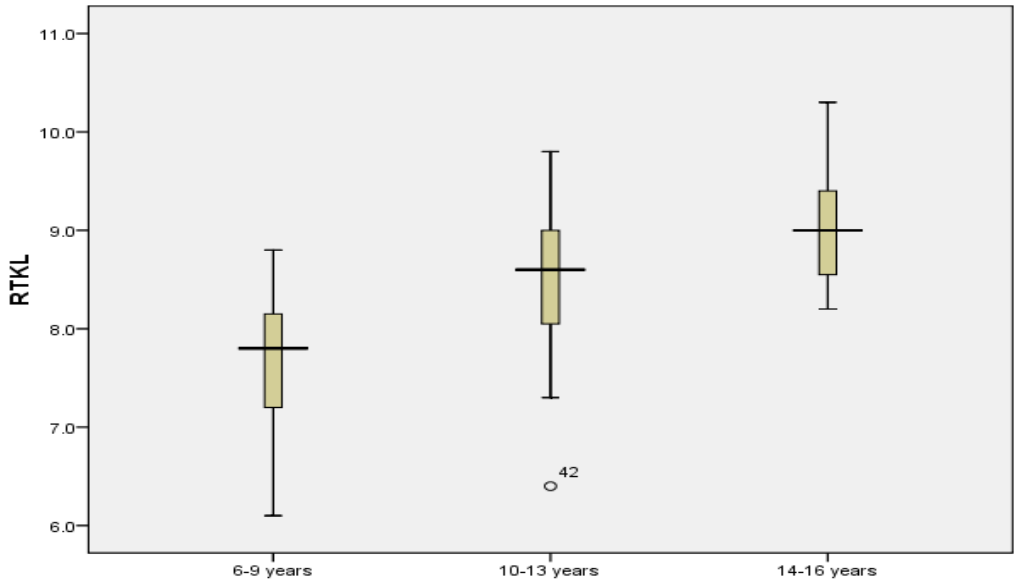


Figure (4.3) plot box shows mean kidney length in different age group (RT)

Table (4.5) a. Compare means kidneys measurement in different gender

Kidneys measurements	Gender	N	Mean	Std. Deviation	Std. Error Mean
RTK length	Male	22	8.541	.7670	.1635
	Female	38	8.111	.9082	.1473
RTK width	Male	22	3.223	.3221	.0687
	Female	38	3.082	.3840	.0623
LTK length	Male	22	9.227	.7863	.1676
	Female	38	8.716	.8388	.1361
LTK width	Male	22	3.727	.3857	.0822
	Female	38	3.497	.4390	.0712

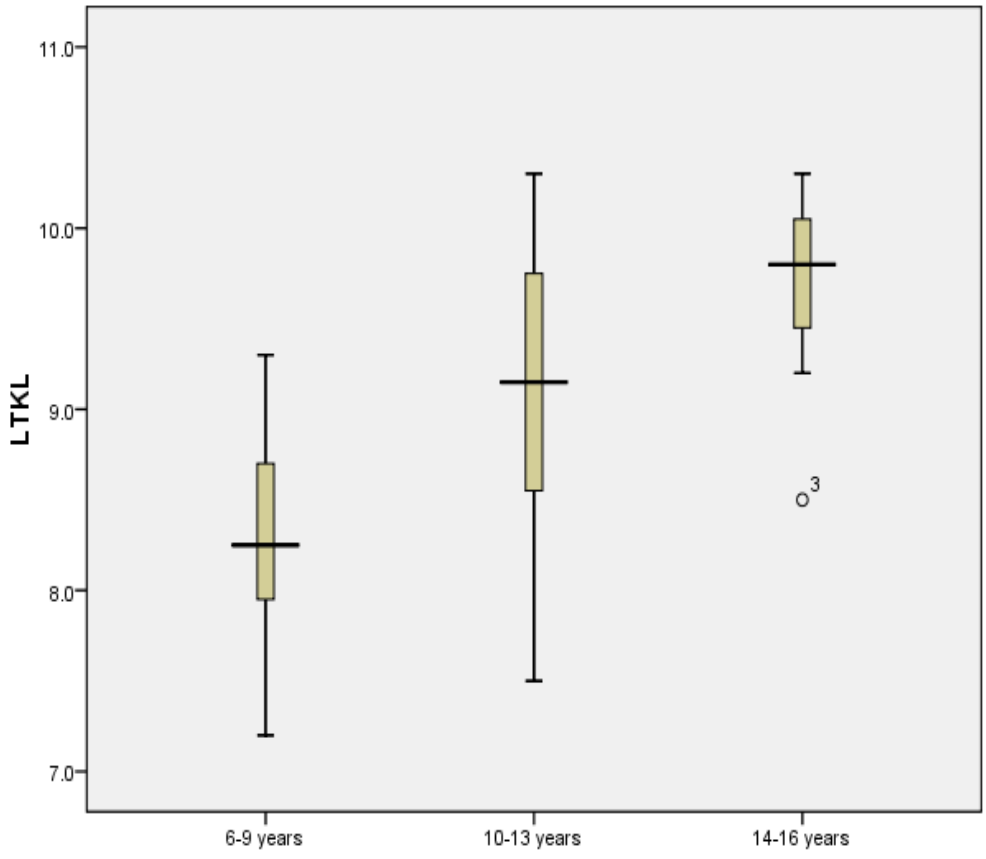


Figure (4.4) plot box shows mean kidney length in different age group (LT)

Table (4.5) b. independent sample t-test for compare means kidneys measurement in different gender

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
RTK length	1.869	58	.067	.4304	.2303	-.0307-	.8914
	1.955	50.168	.056	.4304	.2201	-.0117-	.8724
RTK width	1.452	58	.152	.1411	.0972	-.0534-	.3357
	1.522	50.412	.134	.1411	.0927	-.0450-	.3273
LTK length	2.328	58	.023	.5115	.2197	.0717	.9513
	2.369	46.363	.022	.5115	.2159	.0770	.9460
LTK width	2.041	58	.046	.2299	.1126	.0044	.4554
	2.114	48.749	.040	.2299	.1088	.0113	.4485

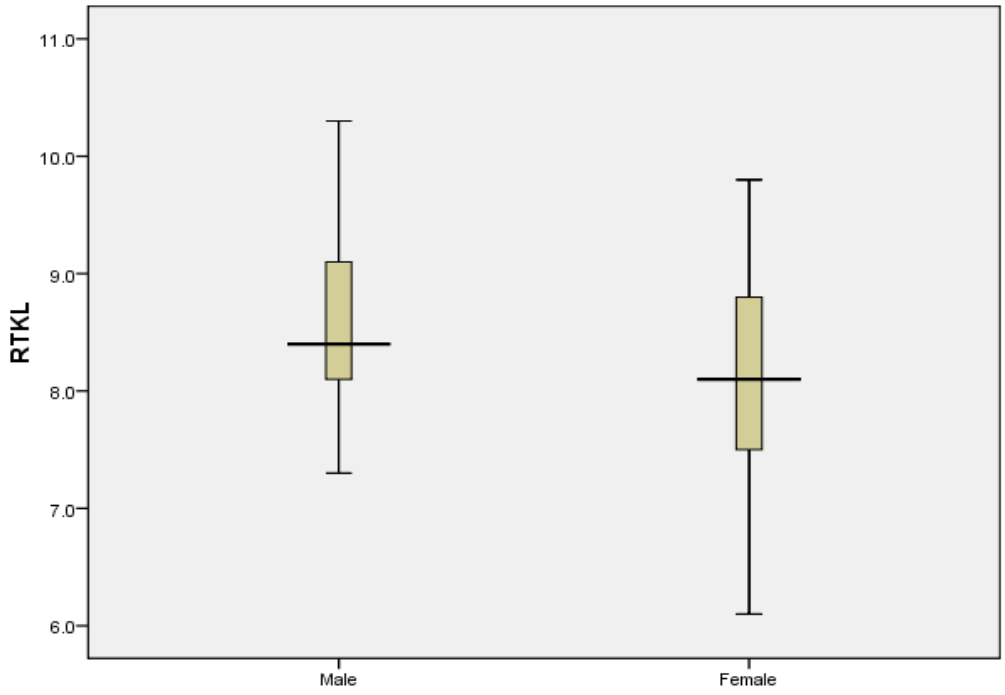


Figure (4.5) plot box shows mean kidney length in different gender (RT)

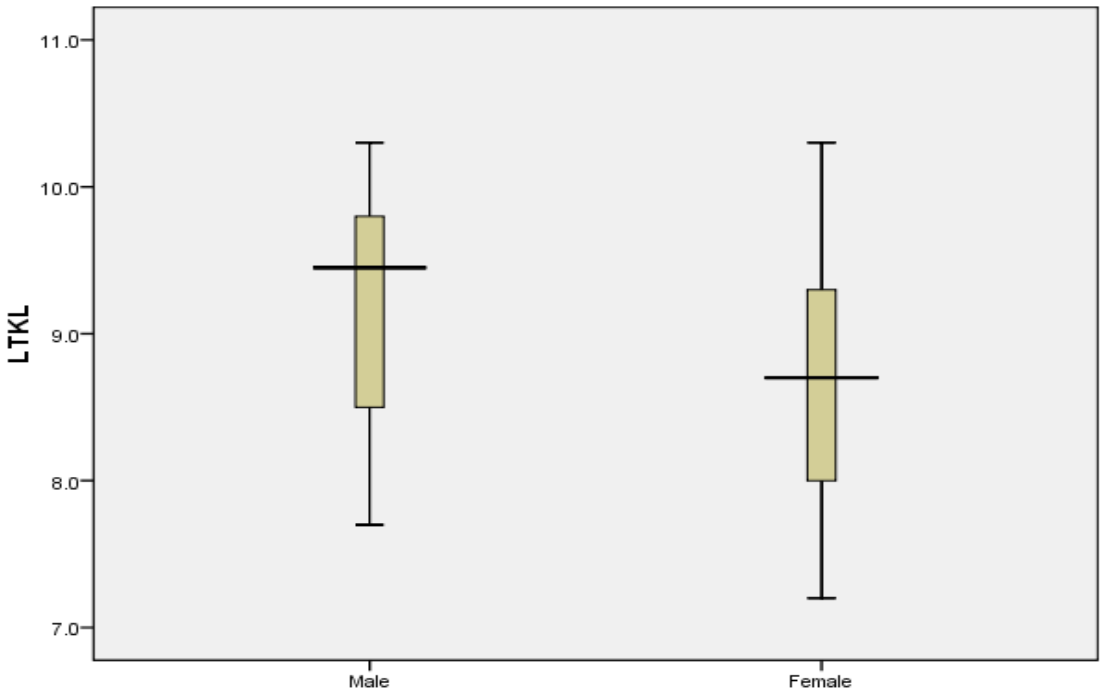


Figure (4.6) plot box shows mean kidney length in different gender (LT)

Table (4.6) Correlation between age, height, weight, BMI, AC and kidneys measurement

		age	height	weight	BMI	AC
RTK length	Pearson Correlation	.574**	.622**	.571**	.374**	.548**
	Sig. (2-tailed)	.000	.000	.000	.003	.000
	N	60	60	60	60	60
RTK width	Pearson Correlation	.495**	.556**	.581**	.453**	.584**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	60	60	60	60	60
LTK length	Pearson Correlation	.589**	.629**	.642**	.484**	.590**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	60	60	60	60	60
LTK width	Pearson Correlation	.477**	.547**	.595**	.495**	.572**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	60	60	60	60	60
**. Correlation is significant at the 0.01 level (2-tailed).						

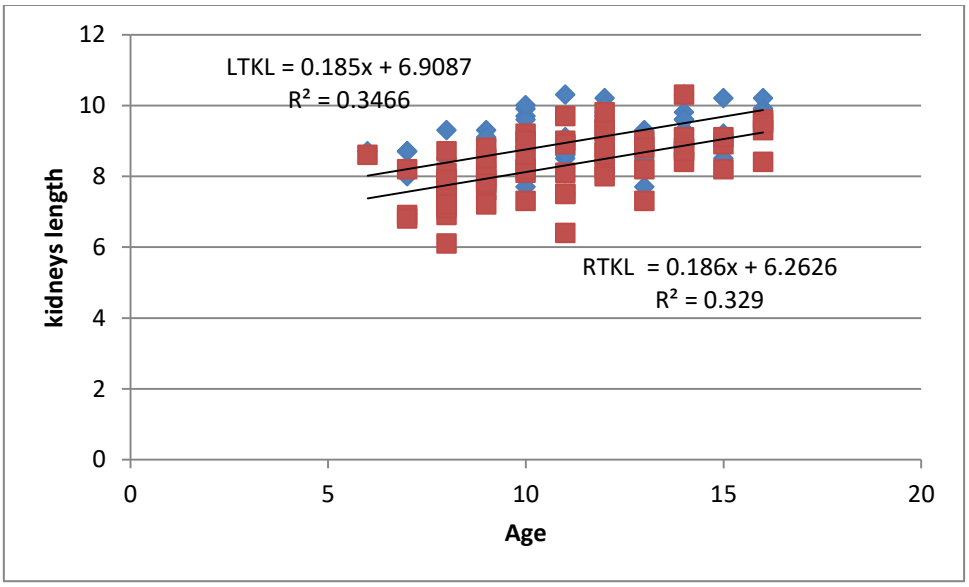


Figure (4.7) scatter plot shows linear relationship between kidneys length and age (R^2= 0.34, 0.32 for left and right respectively)

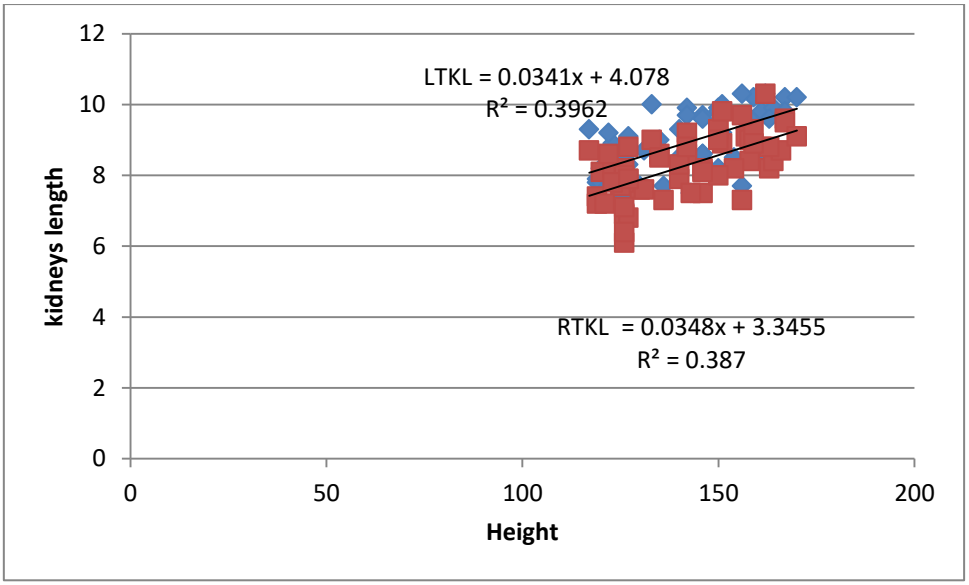


Figure (4.8) scatter plot shows linear relationship between kidneys length and height of pediatrics (R^2= 0.39, 0.38 for left and right respectively)

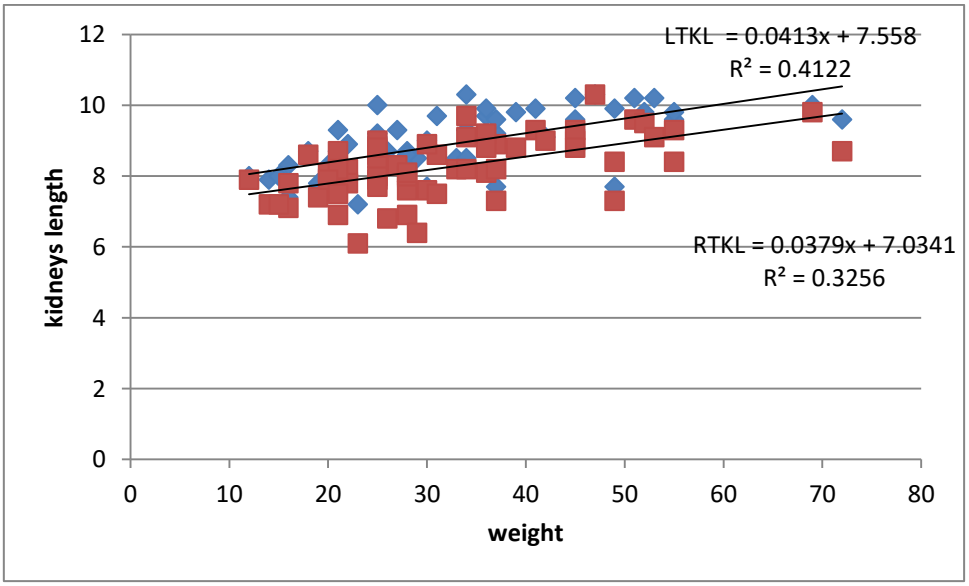


Figure (4.9) scatter plot shows linear relationship between kidneys length and weight of pediatrics (R^2= 0.41, 0.32 for left and right respectively)

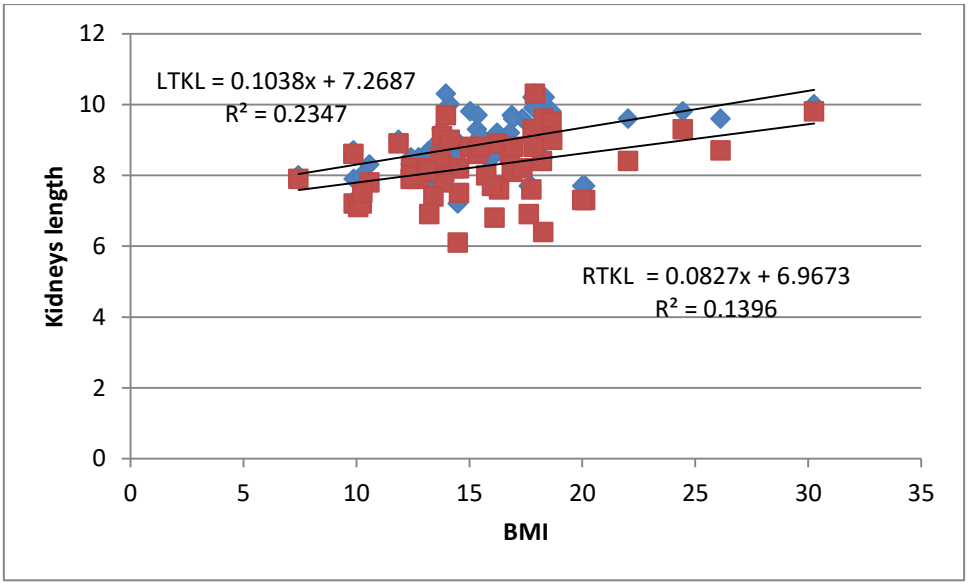


Figure (4.10) scatter plot shows linear relationship between kidneys length and BMI of pediatrics (R^2= 0.234, 0.139 for left and right respectively)

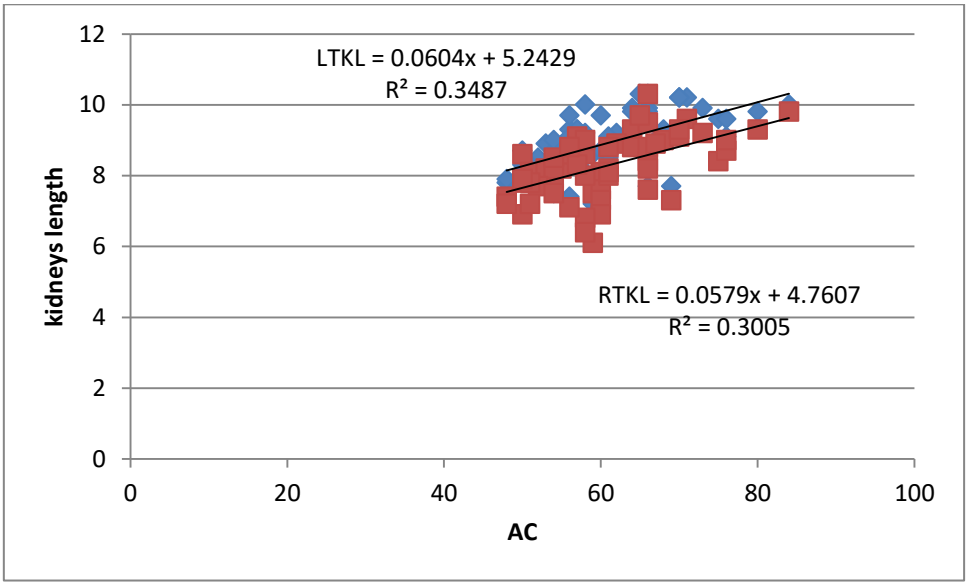


Figure (4.11) scatter plot shows linear relationship between kidneys length and AC of pediatrics (R^2= 0. 348, 0.30 for left and right respectively)

Chapter five
Discussion

Chapter Five
Discussion
Conclusion
Recommendation

5-1 Discussion:

Ultrasound is the modality of choice to assess kidney size and morphology. It,s lacks ionizing radiation, can be performed bedside and in real time, is well tolerated by the patient and parents, and the measurements are reproducible . (Geelhoed JJ, 2009)

In the present study, renal dimensions (length , width , and breadth) was assessed in sagittal view, transverse view with normal children with prone position. The prime rationale was to evaluate the maximum renal dimensions in both planes. Sonography seems to be an optimal technique for estimating the renal parameters in children. this study was performed which evaluates the relationship between renal size and anthropometric indices.

In children, the growth of organs is dependent on the growth of the child's body, and thus, the organ growth can be correlated with somatic parameters, such as: height, weight, and body surface area in addition to age (Jun-Hwee Kim, 2013).

This study aimed to determine the renal dimensions in Sudanese children between 6-16 years old, data were collected from 60 students, and various methods are defined for the evaluation of renal size in the literature.

However, sonography is a simple, practical, low-cost and accurate method. In the evaluation of renal dimensions, different techniques have been reported.

Thirty eight students were females (63.3%), while twenty tow (36.7%) students were males, however when measurement taken there is obvious difference between female and male.

Data were arranged into three groups according to the age (6-9 yrs old), (10-13 yrs old), (14-16 yrs old) which contain 24, 24 and 12 recruits respectively.

descriptive statistic for age(include minimum, maximum, mean ± Std. Deviation) are 6,16,10.78±2.706, and for the height 117,170,141.33±15.676,and for the weight 12,72,32.58±13.222, and for the abdomen circumference 48,84,60.58±8.310,and for the RT kidney length are 6.1,10.3,8.268±.8777,nd for the RT kidney width are

2.2,3.8,3.133±.3662,and for LT kidney length 7.2,10.3,8.903±.8503, and for the LT kidney width are 2.5,4.5,3.582±.4316 respectively .

Also in this study compare means kidneys measurement and age, in age group 6-9 the RT kidney length (the minimum, maximum, mean ± Std. Deviation) are 6.1,8.8,7.708±.6685, and in age group 10-13 are 6.4,9.8,8.450±.8361, in age group 14-16 are 8.2,10.3,9.025±.5959,and the total 6.1,10.3,8.268±.8777(p value 0.000). RT kidney width in age group 6-9 are 2.2, 3.7, 2.946±.3599, n age group 10-13 are 2.6, 3.8, 3.200±.3464, in age group 14-16 are 2.9, 3.8, 3.375±.2179, and the total are 2.2, 3.8, 3.133±.3662 (p value 0.001).

The LT kidney length in age group 6-9 are 7.2,9.3,8.300±.5657,in age group 10-13 7.5,10.3,9.112±.8136, in age group 14-16 are 8.5,10.3,9.692±.5071,nd the total are 7.2,10.3,8.903±.8503(p value 0.000). LT kidney width in age group 6-9 are 2.5,4.3,3.350±.4253. in age group 10-13 are 3.2,4.5,3.658±.3658, in age group 14-16 are 3.3,4.4,3.892±.3260, and the total are 2.5,4.5,3.582±.4316 (p value 0.000).

The study found that, there is no significant correlation between the kidney measurements and gander (p value .056), more than .05.

Moreover, there is significant correlation between the kidney measurement (length, width) and age (p value .00).

In addition, there is significant correlation between the kidney measurement (length, width) and height (p value 0.00).

In addition, there is significant correlation between the kidney measurement (length, width) and weight (p value .00).

Moreover, there is significant correlation between the kidney measurement (length, width) and AC (p value .00).

5-2limitation to this study:

Is attributed to the fact that two sonographers of different levels of experience (1-5 years) performed,the sonographic measurements contributing to inter-observer bias. In addition to the small sample size from only alsayeda Khadija medical center that might not be entirely representative of the whole Sudanese pediatric.

5-3 Conclusion:

Determination of pathologic changes in size of kidney necessitates knowing the normal range of dimensions for this organ in healthy

neonates, infants, and children. Presented data are applicable in daily routine sonography.

In conclusion, of this study, there is significant difference in the kidney length and width between Rt and Lt kidney in Sudanese children, but there is no significant difference in the kidney length and width among boys and girls.

There were significant correlation between kidney measurements (length, width) and age weight , height ,abd.cer.

5-4 Recommendation :

Height seems to be the most important factor associated with organ growth in growing children. Further studies to evaluate adequate organ growth should be carried out.

Renal sonographic measurement for pediatric can be performed as a bedside investigation by the even more important are serial measurements of renal length over time.Agrowing kidney in a child is a healthy kidney, whereas a kidney static in size over time may be an early indicator of Chronic Kidney Disease.

Further Work up:

Since this study was limited because of small sample size so the further workup is to take large sample.

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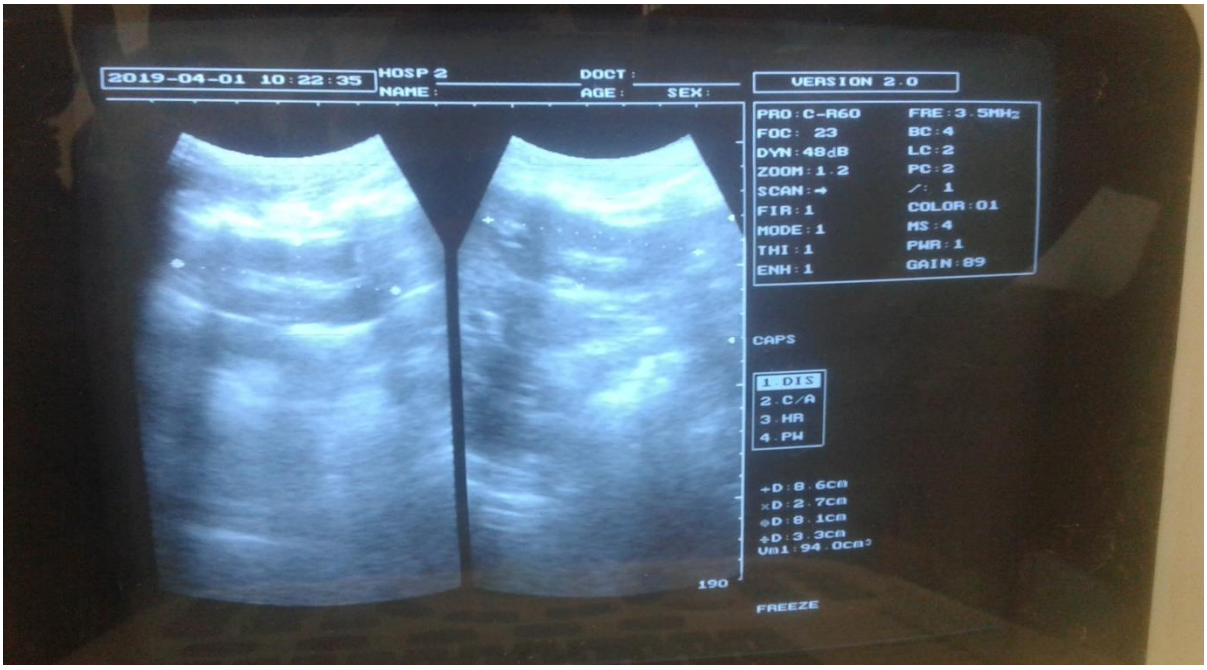
Appendices

Appendex I

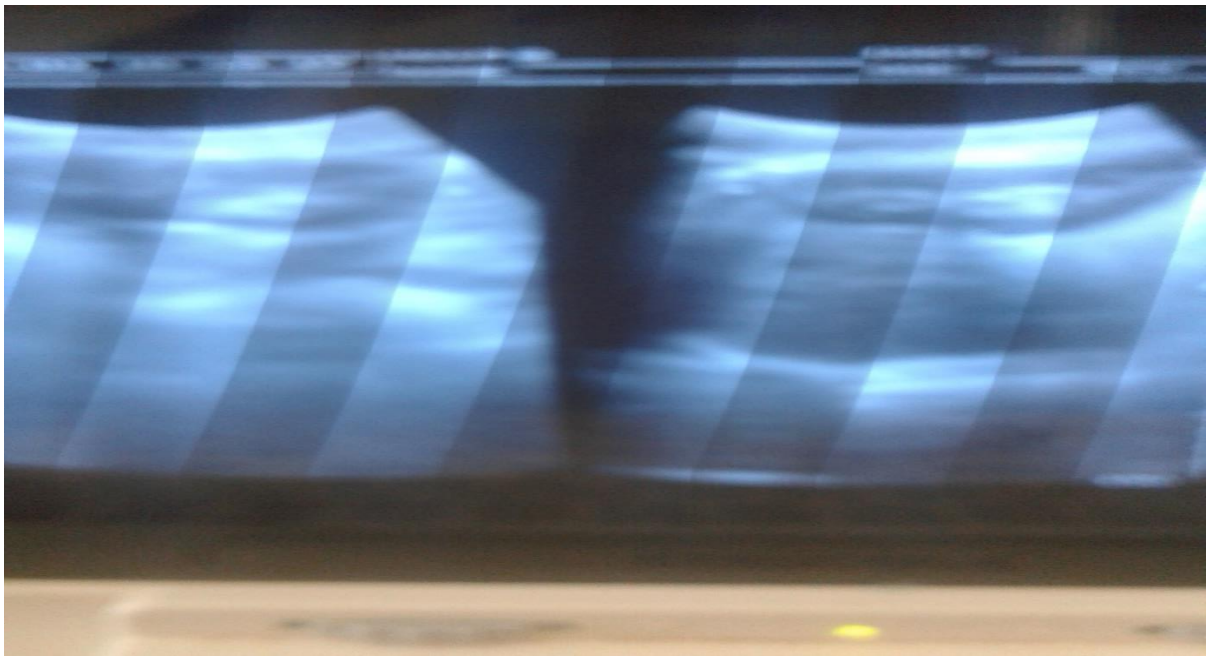
Data collection Sheet

NO	Gander	Age	Wight	Height	Abdomen Circumference	RT Kidney		LT Kidney	
						length	width	length	width

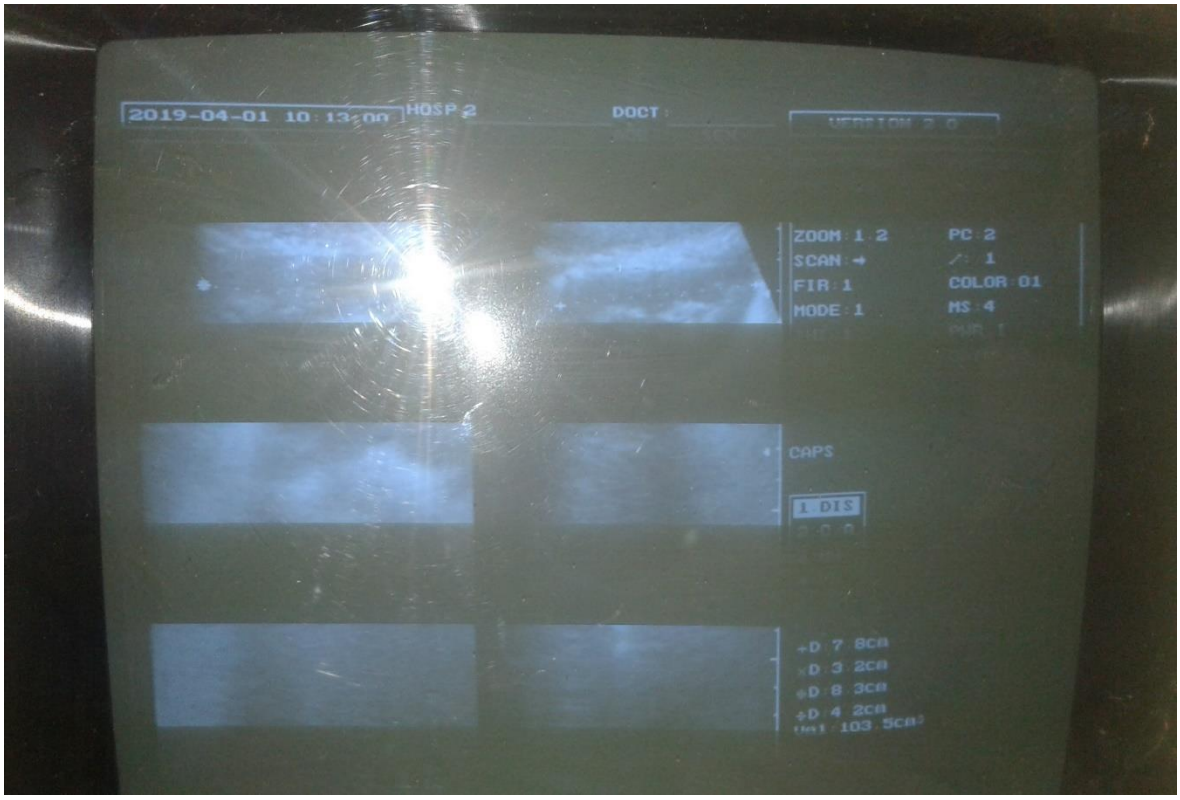
Appendix II
Images of Normal children Kidneys



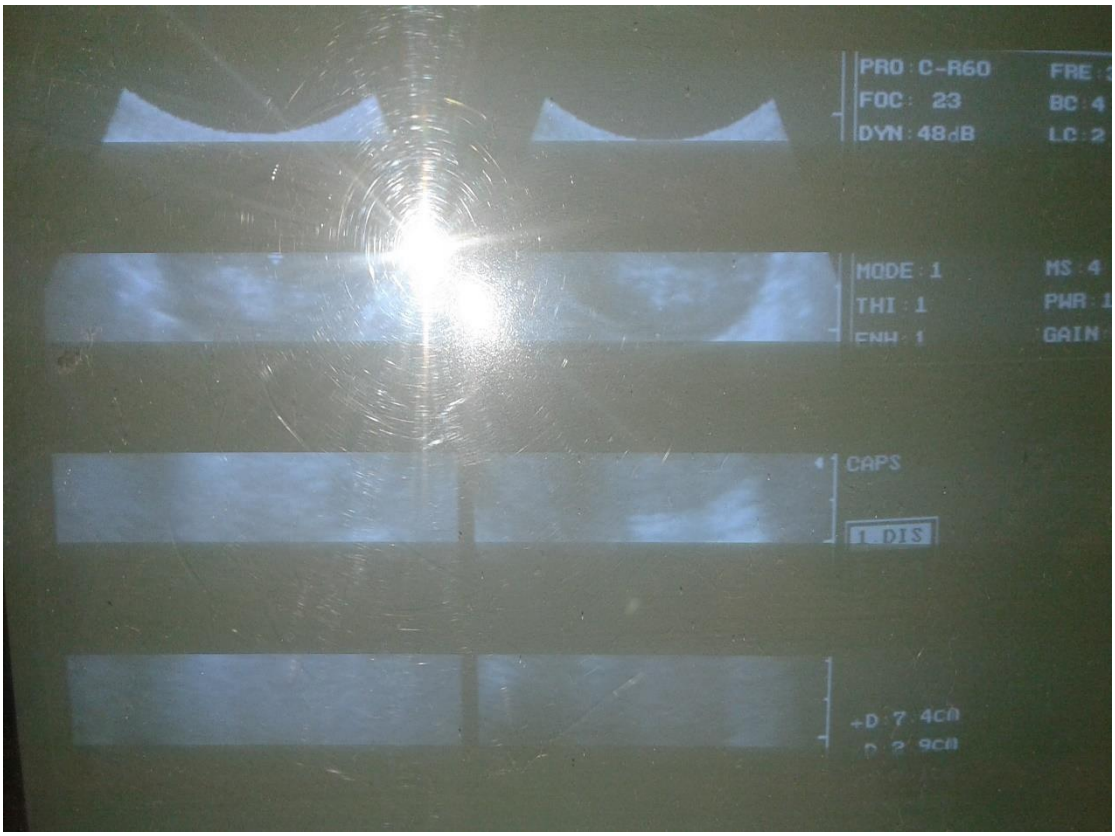
Normal RT and LT KIDNEY MESURMENT IN 14 YEARS



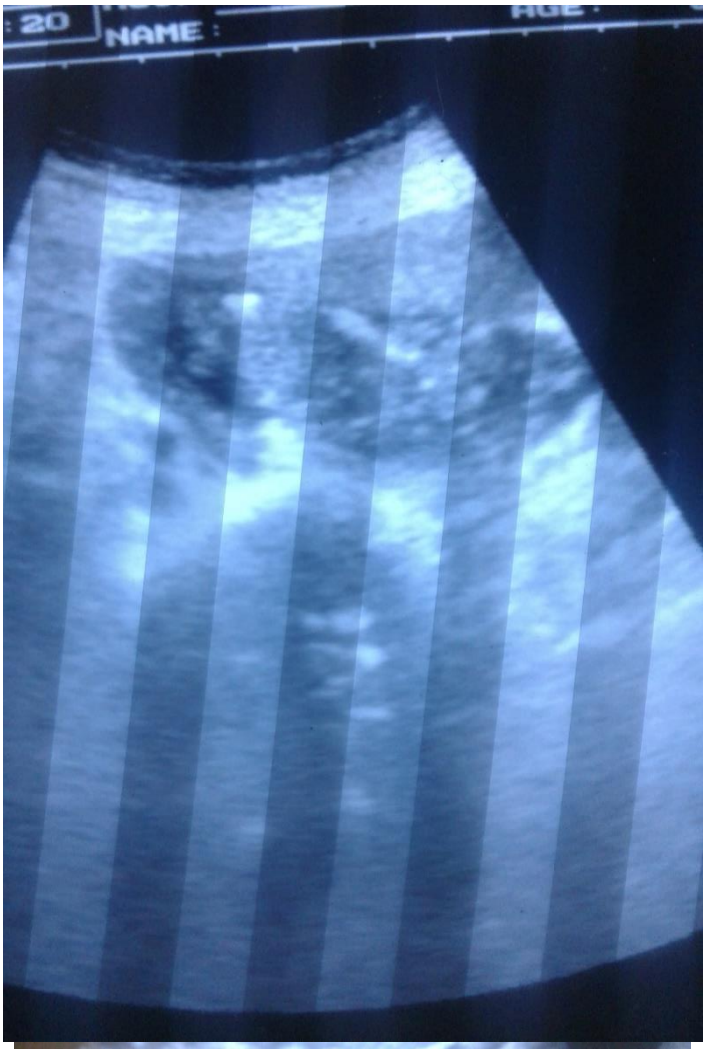
Normal RT and LT KIDNEY MESURMENT IN 16 YEARS

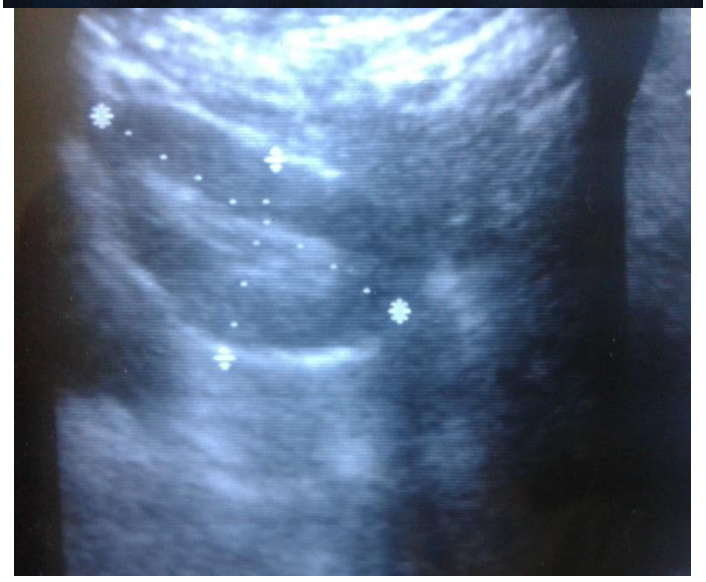


Normal RT and LT KIDNEY MESURMENT IN 13 YEARS



Normal RT and LT KIDNEY MESURMENT IN 14 YEARS





Normal RT and LT KIDNEY