Sudan University of Science and Technology

College of Graduate Studies

Evaluation of Renal Changes in Diabetic Patients Using Ultrasonography

تقويم التغيرات الكلوية لمرضى السكري باستخدام الموجات فوق الصوتية

A thesis Submitted for Partial Fulfillment of the Requirements of MSc Degree in Medical Diagnostic Ultrasound

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الآية الكريمة

﴿يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ والله بماتعملون خبير﴾

صدق الله العظيم

(سورة المجادلة 11)

Dedication

This thesis is dedicated:

To my Family ...my wife and lovely kids Hanin& Amoury…..

To my Teachers & Colleagues …..

To my Friends *…*

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My gratitude goes to Almighty God for His favour and may His name be glorified.

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Abstract

Kidneys may be exposed to many pathological conditions due to Diabetes mellitus which is a common multi-systemic disease with serious effects on the urinary system and was considered the main causes of chronic renal failure in worldwide . This disease may lead to some renal changes in morphology and function, The aim of this study was to evaluate the renal changes in diabetic patient using ultrasound scan . This cross-sectional –case control study was done in Khartoum and north kurdofan States from the period of June 2018 to January 2019 , for 50 diabetic patients (29 males and 21 females) , 4 of them are type 1 diabetic mellitus, and 46 are type 2 , their age ranged between 20 - 90 years old and there was 30 apparently healthy subjects as a control group were assessed. Pregnant women , patient with renal congenital anomalies , renal tract obstruction , malignant tumor and renal failure were excluded ,all patients had been scanned with ultrasound for measuring renal dimensions , renal volume was also been calculated and echogenicity was evaluated , a data collection sheet was designed to include general information of the patients. The study showed that as the duration of diabetes increase the length and volume decreased but the echogenicity increased , Furthermore, it revealed the that increase in duration of diabetes has direct impact on kidney texture . These findings could be utilized as assessment of the diabetes severity and its impact on renal system . also study showed the left side is more affected than the right side . It was also observed that the renal volumes were higher in the diabetics compared to the nondiabetic thus showed the important of ultrasound as a useful tool to measure renal volume and detecting renal changes in diabetic patient. additional studies with large sample size are recommended to improve statistical information and compare the results.

ملخص البحث

تتعرض الكلى الي حالات مرضية متعددة بسبب مرض السكري الذى يعتبر من اكثر الامراض تاثيرا علي الجهاز البولي ، ويعتبر مرض السكر من الاسباب الرئيسية التى تؤدي للاصابة بالفشل الكلوي المزمن في العالم . هذا المرض قد يحدث بعض التغيرات فى شكل ووظيفة الكلية , هدف هذه الدراسة هو تقويم التغيرات التى تحدث للكلي لدى مرضى السكري باستخدام الموجات فوق الصوتية . وقد اجريت هذه الدراسة التطبيقية في ولايتى الخرطوم وشمال كردفان فى الفترة من يونيو 2018 و حتي يناير 2019 لعدد خمسون مريض سكري (29 ذكر و 21 انثي) 4 منهم من النوع الاول لمرض السكري و 46 منهم من النوع الثاني لمرض السكري تتراوح أعمارهم من 20 وحتي 90 سنة مقا رنة مع 30 ثلاثون شخصا اصحاء ظاهريا كمجموعة سيطرة وقد استبعدت النساء الحوامل ومرضى التشوهات الخلقية للكلى , انسداد مجري الكلي , الاورام الخبيثة و الفشل الكلوي . وقد تم فحص جميع المرضى بالموجات فوق الصوتية لقياس ابعاد الكلى تم حساب حجم الكلى أيضا وكذلك تم تقويم الصدى الراجع , تم تصميم ورقة جمع البيانات لتشمل المعلومات العامة للمريض . و قد اظهرت النتائج ان طول فترة المرض يقلل من طول وحجم الكلى ولكن كمية الصدى الراجع تزيد. بالاضافة لذلك وجد ان زيادة طول فترة الاصابة بمرض السكري له تاثير مباشر في شكل الكلى. ويمكن استخدام هذه النتايج لتقيم حدة مرض السكري وتاثيره علي النظام الكلوي . ايضا وجد ان الكلية اليسرى اكثر تأثرا بالمرض من الكلية اليمنى . بالاضافة الى ذلك هذه الدراسة اظهرت عدم وجود فروق معنوية في لمختلف قياسات الكلى بين مجموعة مرضى السكرى ومجموعة السييطرة ولوحظ كذلك زيادة معنوية فى حجم الكلى عند المصابين مقارنة بمجموعة السيطرة مما يبرهن عن أهمية الموجات الصوتية باعتبارها أداة مفيدة لقياس حجم الكلى والكشف عن التغيرات التى تحدث للكلى خلال الاصابة بمرض السكرى . وتوصى الدراسة انه من الضروري أجراء دراسات إضافية وبحجم عينة أكبر لتحسين المعلومات الاحصائية ومقارنة نتائج الدراسة .

List of abbreviations

AKD	Acute kidney disease
ANOVA	Analysis Of Variance
AP	Antroposterior
BMI	Body mass index
CEUS	Contrast-enhanced ultrasound
CKD	Chronic kidney disease
CMD	Cortico-medullary differentiation
CT	Computed tomography
DGC	Deapth gain compensation
DN	Diabetic nephropathy
GFR	glomerular filtration rate
IVP	Intravenous pyelogram
IVC	Inferior vena cava
KUB	Kidney, ureter and urinary bladder
LTK	Left kidney
MHz	Mega hertz
NKF	National Kidney Foundation
PCS	Pelvi-calceal system
RTK	Right kidney
SMA	Superior mesenteric artery
SPSS	Statistical Package for Social Science
TGC	Time gain compensation
T2DM	Type-2 Diabetes Mellitus
US	Ultrasound
NCS	nutcracker syndrome
NHANES	National Health and Nutrition Examination Survey
WHO	World health organization
3D	Three dimensional

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CHAPTER ONE

1.1 Introduction

The Kidney affected by many disease which leads to changing in its function and morphology, diabetes is one of them. Diabetes is common lifelong health, it is a condition where the amount of glucose in blood is too high because the body cannot use it properly, diabetes affected most body organs like eye (blurred vision) blood vessels (atherosclerosis), With diabetes small blood vessels of the kidney injured so kidney cannot clean the blood properly, Morphologic changes in diabetic nephropathy affect all 4 renal compartments: glomeruli, tubules, interstitium, and vessels.(Saeed., 2016).

Diabetes may leads to a kidney disease which cause damage to capillaries in the kidney glomeruli, it characterized by nephritic syndrome and diffuses scarring of the glomeruli, it is due to longstanding diabetes mellitus, effect 40% of type 1and type 2 diabetic Pt, this stage has been refer to overt nephropathy, proteinuria, or macroalbuminura. Is most common cause of end stage kidney disease which may require hemodialysis or kidney transplantation, it is associated with increased risk of death in general particular from cardiovascular disease.(Mohamed., 2016).

During early course diabetic nephropathy has no symptoms, symptoms can take 5 to 10 years to appear after kidney damage begins, the cause of diabetic nephropathy is not well understood hyperglycemia, increased blood pressure level and genetic predisposition are the main risk factors for development diabetic nephropathy.(Edwards et al., 2008)

Diabetic nephropathy is the leading cause of renal failure in the United States. It is defined by proteinuria > 500 mg in 24 hours in the setting of diabetes, but this is preceded by lower degrees of proteinuria, or “microalbuminuria(Donaghue et al., 2007).

The pathological changes to the kidney include increased glomerular basement membrane thickness, microaneurysm formation , mesangial nodule formation and other changes.(Kimmelsteil-Wilson bodies), The underlying mechanism of injury may also involve some or

all of the same mechanisms as diabetic retinopathy.(Donaghue et al., 2007).

Screening for microalbuminuria should be performed yearly, starting 5 years after diagnosis in type 1 diabetes or earlier in the presence of puberty or poor metabolic control. In patients with type 2 diabetes, screening should be performed at diagnosis and yearly. (Gross et al., 2005),

Screening for diabetic nephropathy or microalbuminuria may be accomplished by either a 24-hour urine collection or a spot urine measurement of microalbumin. Measurement of the microalbumin-to-creatinine ratio may help account for concentration or dilution of urine, and spot measurements are more convenient for patients than 24-hour urine collections. It is important to note that falsely elevated urine protein levels may be produced by conditions such as urinary tract infections, exercise, and hematuria.(Donaghue et al., 2007)

Diagnosis is usually based on measurement of high levels of albumin in the urine or evidence of reduced kidney function, to test kidney function the person estimated glomerular filtration rate measured from blood sample.(Levey et al., 1999)

Assessment of renal function is often required in radiological diagnosis, mainly for assessment of renal insufficiency, renovascular disease, metabolic disorders and renal transplant. Several non invasive test of renal function have been developed, this includes measurement of serum creatinine level(Brosnahan et al., 2010).

Many diabetic patient developing renal diseases so the function and morphology of the kidney will change.

This study provided evaluation of renal morphology of diabetic patients by using ultrasound imaging.

1.2 Problem of the study:

The diabetes affected on many body organs. Especially the kidney and cause changes lead to renal failure. So the questions to be answered are:-

a- Can ultrasound able to detect changes occurs in the kidneys in diabetic patient

b- To which extent does the diabetes mellitus affect the kidney size , volume and echotexture.

1.3 Objectives of the study:

1.3.1General objective:

The main objective of this study is to evaluate renal changes in diabetic patients mainly size and volume using ultrasonography.

1.3.2 Specific objectives:

To measure the kidneys size (length, width, thickness) and shape in normal and diabetic patient population by ultrasound.

To compare renal size of normal population with the renal size of diabetic patient.

To correlate the age , gender and duration of disease with renal change.

To evaluate corticomedullary differentiation in diabetic patients.

To evaluate renal echogenicity and texture in diabetic patients.

To define which kidney is more affected and if there is different between right kidney and left kidney in diabetic patients .

1.4 Importance of the study:

This study will provide us to detect that if the diabetic disease change in renal function and morphology and use these finding information for nephropathy diagnosis, it will also show the importance of volume measurement in routine evaluation and monitoring of kidney

diseases in diabetic patients, the study will improve gray scale ultrasound parameters as a first step in detecting the causes of renal change in diabetic patients.

1.5 Overview of the study:

This study consisted of five chapters. Chapter one is deal with introduction , problems of study, objective of the study, Importance of the study and overview of the study. Chapter two is Literature review this include (anatomy , physiology , pathology , pathophysiology of the kidney, pathology of diabetic mellitus, Investigation of the kidneys, normal sonographic features of kidney and previous studies). Chapter three is material and methods. Chapter four is results and data analysis Chapter five is discussion, conclusions and recommendations.

CHAPTER TWO

2.1 Anatomy, physiology and pathology of the Kidney

2.1.1 Kidney Anatomy

2.1.1.1 Location and Description

The kidneys have a bean-shaped structure; they are located in the retroperitoneum, one on each side of the spinal column. Ribs extend forward and downward over the kidneys, covering the upper third of each organ. The longitudinal axes of the kidneys converge toward the spinal column at an acute angle when viewed from behind and from the side. Their transverse axes form an approximately 45° angle with the sagittal plane the right kidney. The right kidney lies posteriorly in an angle between the spinal column, musculature, and right lobe of the liver. The right hepatic lobe extends laterally to the lower third of the kidney. The kidney is covered anteriorly by the right lobe, and its lower half in particular is covered by the right colic flexure and duodenum. (Berthold Block., 2011).

The left kidney lies posteriorly in an angle between the spinal column, musculature, and spleen. The spleen extends laterally to about the middle of the left kidney. The lower half of the kidney is covered by the descending colon and left flexure. The left flexure passes around the anterior surface of the kidney and is in contact with it. The stomach overlies the front of the upper pole. The left kidney usually lies 1 to 2 cm higher than the right kidney. The kidneys are mobile and will move depending on body position. In the supine position, the superior pole of the left kidney is at the level of the 12th thoracic vertebra, and the inferior pole is at the level of the third lumbar vertebra. The kidneys move readily with respiration; on deep inspiration, both kidneys move downward approximately 1 inch. In the adult, each kidney measures

approximately 9 to 12 cm long, 5 cm wide and 2.5 cm thick and weights 120 to 170 grams. (Rumack, et al.,2011)

2.1.1.2 Covering

The kidneys have the following coverings:

∗ **Fibrous capsule**; this surround the kidney and closely applied to its outer surface.

∗ **Perirenal fat**; it covers the fibrous capsule.

∗ **Renal fascia**; this is a condensation of connective tissue that lies outside the Perirenal fat.

∗ **Pararenal fat**; lie external to renal fascia and is often in the large quantity renal fat, perirenal fat. It supports the kidney and hold it in position. (Richart.S.Snell, 2005)

2.1.1.3 kidney Structure

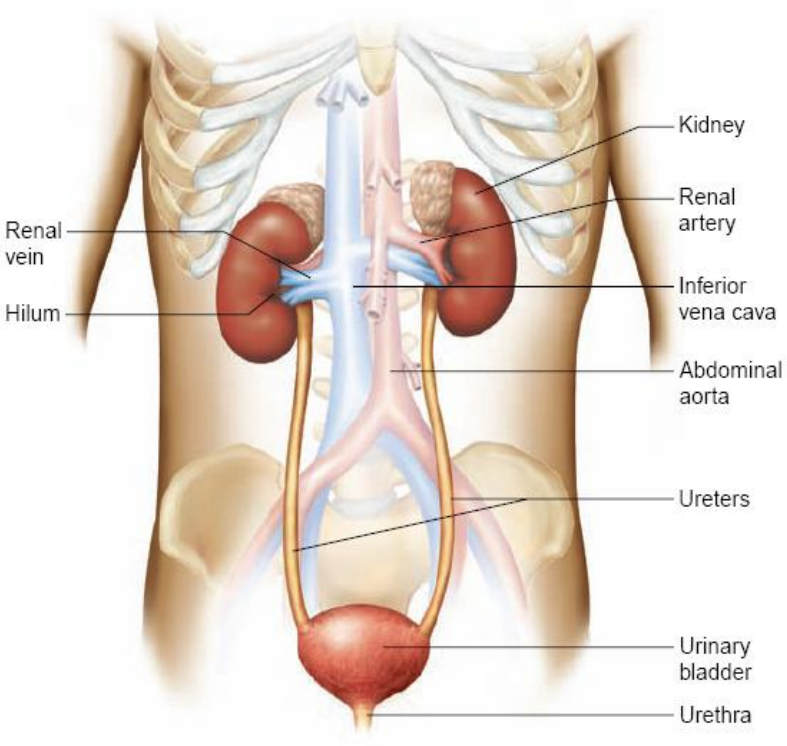
Each kidney has a dark brown outer cortex and a light brown medulla. The medulla is composed of about 10 conical structures known as renal pyramids; each having its base facing towards the cortex and its apex is . The renal papilla projecting medially, the cortex extends into the medulla between adjacent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

2.1.1.4 Relationships

Anterior to the right kidney are the right adrenal gland, liver, Morison's pouch, second part of the duodenum, and right colic flexure. Anterior to the left kidney are the left adrenal gland, spleen, stomach, pancreas, left colic flexure, and coils of jejunum. Posterior to the right kidney are the diaphragm, costodiaphragmatic recess of the pleura,

twelfth rib, psoas muscle, quadrates lumborum, and transverses abdominis muscles. The subcostal (T12), iliohypogastric, and ilioinguinal (L1) nerves run downward and laterally. Posterior to the left kidney are the diaphragm, costodiaphragmatic recess of the pleura, eleventh and twelve ribs, psoas muscle, quadrates lumborum, and transverses abdominis muscles. The same nerves are seen near the left kidney as in the right. (Sandra L. et al, 2012).

The kidneys are bean-shaped organs that are reddish brown in color. Tough, fibrous capsules cover them. The kidneys are retroperitoneal in position, which means that they lie behind the peritoneal cavity. They lie on either side of the vertebral column at about the level of the lumbar vertebrae. The medial depression of a kidney is called a renal sinus. The entrance of the sinus is called the hilum and contains the renal artery, renal vein, and ureter. The ureter is a tube that carries urine out of a kidney to the urinary bladder. Inside the kidney, the ureter expands as the renal pelvis. The renal pelvis divides into small tubes inside the kidney called calyces. The outermost layer of the kidney is called the renal cortex, and the middle portion is called the renal medulla. The renal medulla is divided into triangular shaped areas called renal pyramids. The renal cortex covers the pyramids and also dips down between the pyramids. The portion of the cortex between pyramids is called a renal column (Figure 2-2.) .(Kathryn A et al.,2008)

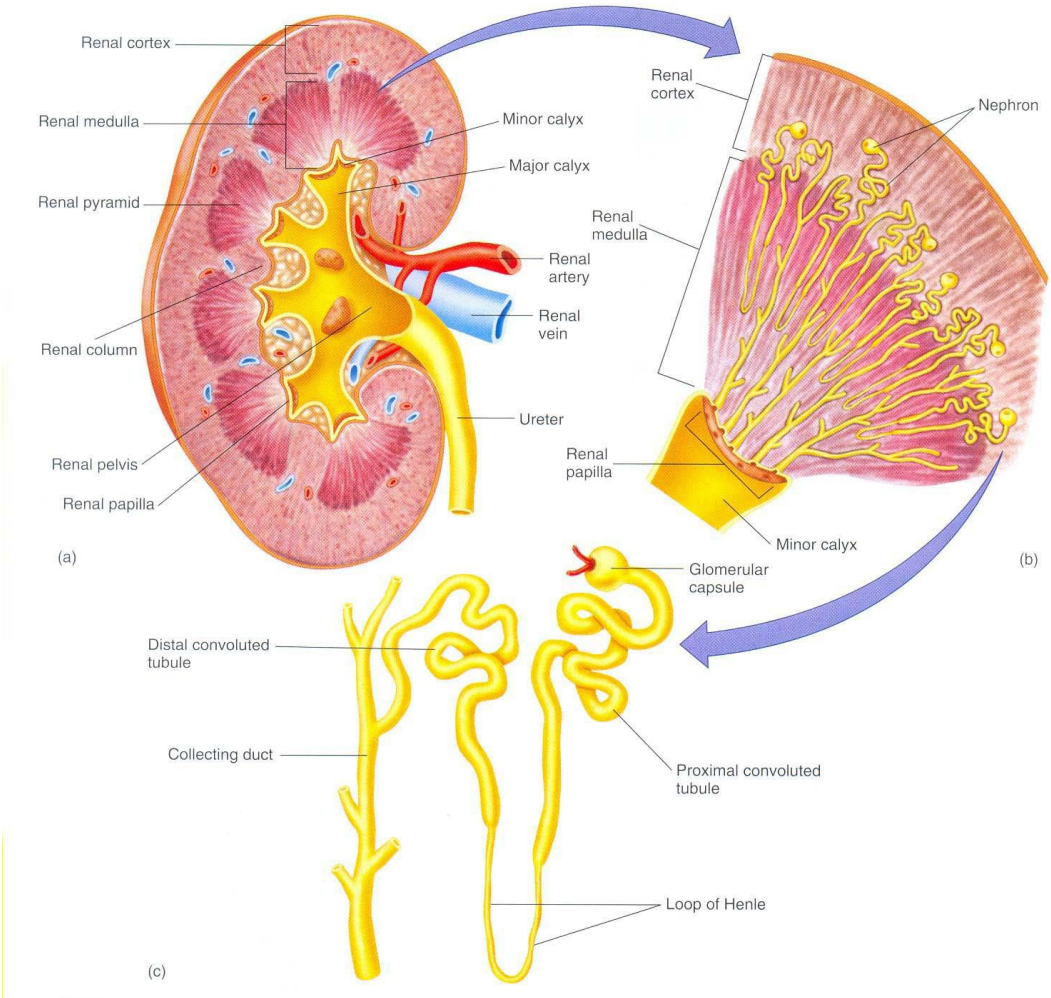


Figure(2.1) Organs of the urinary system.(Kathryn A et al.,2008).

2.1.1.5 macroscopic structure of the kidney:

The kidneys are paired organ lying at the posterior wall of the abdominal cavity just above the waistline, at about the level of the 12th rib. Each kidney is roughly bear shaped and is about the size of fist. Although most abdominal organs are enclosed within the peritoneum, a clear membrane that lines the abdominal cavity, the kidneys are located between the peritoneum and the walls of the abdominal cavity. Each kidney weights only (115-170 gram) (less than half a pound), their combined weights is less than 1% of the body weight of an average adult . Despite their small fraction of body weight, the kidneys received about 20% of the cardiac output under normal resting conditions. This rich blood supply is critical to the kidneys function not only because it provides them with oxygen and nutrients, but also because it enables the

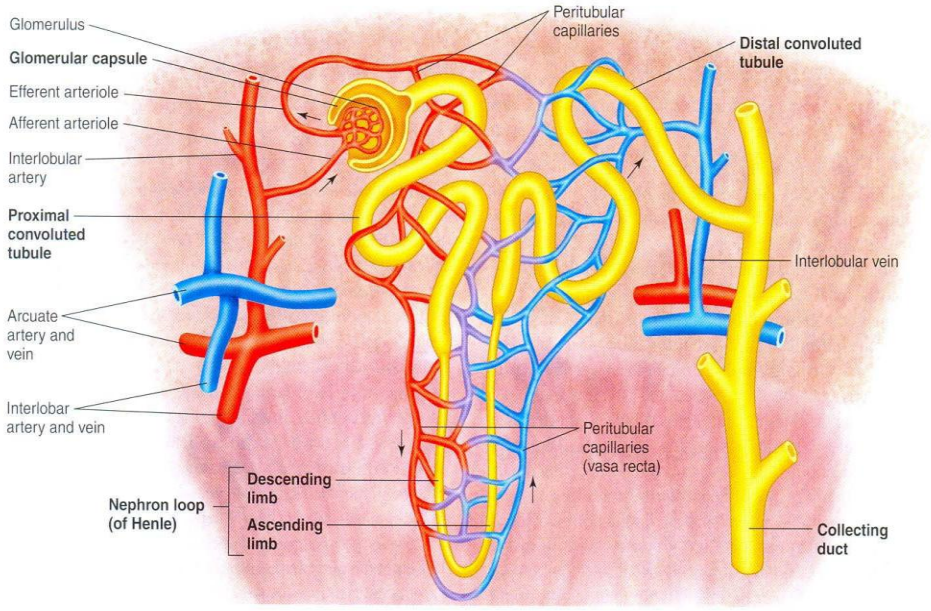
kidney to remove or to clear unneeded solutes and water from the body at a rapid rate and eliminates them as urine. The kidneys receive their blood supply from the renal arteries which branch off the aorta and enter each kidney at a region called the renal hilus. The blood returns to the general circulation via the renal veins, which runs parallel to the renal arteries and drain into the inferior vena cava (Figure 2.4) (William J,2005)



Figure(2.2): Macroscopic structure of the kidney(Stuart,2006)

The nephron is the functional unit of the kidney responsible for the formation of urine. Each kidney contains more than a million nephrons. A nephron consists of glomerular capsule, proximal convoluted tubules, descending limb of the loop of Henle, ascending loop of Henle and distal convoluted tubules. The glomerular capsule surrounds the glomerulus and they are both located in the cortex of the kidney(Stauart,2006).

The capsule contains an inner visceral layer of epithelium around the glomerular capillaries and an outer parietal layer. The space between these two layers is continuous with the lumen of the tubules and receives the glomerular filtrate, and then it passes into the lumen of the proximal convoluted tubules. The walls of the proximal convoluted tubules consist of the single layer of cuboid cells containing millions of microvilli; these microvilli increase the surface area of reabsorption. Salts, water and other molecules needed by the body are transported from the lumen, though the tubular cells and into the surrounding peritubular capillaries. Fluid passes from the proximal convoluted tubules to the loop of Henle. This fluid is carried into the medulla in the descending limb of the loop of Henle and return to the cortex in the ascending limb of the loop of Henle. Back in the cortex, the tubule becomes coiled and is called distal convoluted tubules. The distal convoluted tubule is shorten than the proximal convoluted tubules and relatively has few microvilli. The distal convoluted tubules terminates as it empties into a collecting duct. The collecting duct receives fluid from the distal convoluted tubules of several nephrons. Fluid is then drained by the collecting duct from the cortex to the medulla as the collecting duct passes through the renal pyramids. This fluid now called urine passes into the major calyx. Urine is then funneled through the renal pelvis and out of the kidney in the ureter.(Figure2.4) (Stauart,2006)

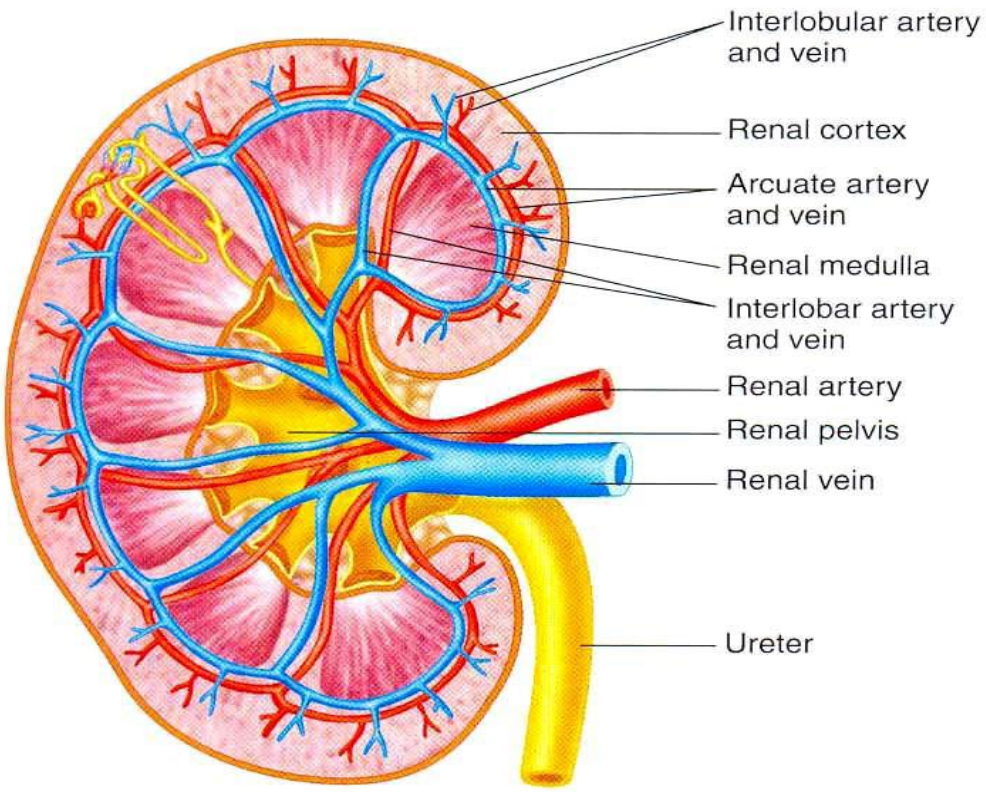


Figure(2.3): microscopic structure of the kidney (Stuart,2006)

2.1.1.6 kidney blood vessels:

The kidneys are supplied by oxygenated blood through renal arteries. Renal artery arises from the abdominal aorta immediately below the superior mesenteric artery (SMA) and then it directed across the crus of diaphragm and form right angle to the aorta. There maybe one or more renal arteries supply each kidney. When the renal artery enters the kidney it located above the renal vein. It has a radius of approximately 0.25cm at the root. The measured mean diameter can differ depending on the image method used, for example the diameter was found to be (5.04 ± 0.7) using ultrasound, but (5.68±1.19) using angiography . Due to the position of aorta, the inferior vena cava (IVC) and the kidney in the body, the right renal artery is normally longer than the left renal artery. The right passes behind the (IVC), the right renal vein, the head of pancreas and the descending part of the duodenum. The left renal artery is somewhat higher than the right; it lies behind the left renal vein, the body of pancreas and the splenic vein, and is crossing by the inferior mesenteric vein.(Elaine N,2003)

Arterial blood inters the kidney through renal artery, which divided into interlobar artery that passes between pyramids through the renal columns. Arcuate arteries branch from the interlobar arteries at the boundary of the cortex and medulla. A number of interlobular arteries radiate from the arcuate arteries into the cortex and subdivided into numerous afferent arterioles which are microscopic. The afferent arterioles deliver blood into glomeruli capillary networks that produce a blood filtrate that enter the urinary tubules. The blood remaining in the glomerulus leaves through an efferent arteriole, which deliver the blood into another capillary network- the peritubular capillaries surroundings the renal tubules.(Elaine N,2003).



Figure(2.4): Renal blood vessels (Gerhard,1985)

2.1.1.6.1 Renal Artery

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

2.1.1.6.2 Renal Vein

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

2.1.1.6.3 Lymphatic Vessels of the Kidney

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

2.1.1.6.4 Innervations of the kidney

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

2.1.1.7 Normal kidney size:

The development or increase in the size of the kidney stops at the age of 25 or 26. when the kidney stop to increase in size, the average length usually reach 12cm while the width is approximately 6cm. The mean thickness of kidney is around 3cm. With these dimensions, any decrease in the kidney size in abnormal. However the size of the kidney can still grow after maturation. This can happen if one of the kidneys was removed. The remaining kidney increases to compensate the functions of the other kidney (Gerhard,1985) .

The normal size of the kidney in the human is fist size. There are same factors that can affect the abnormal growth in size. One of the factors is the development of a cyst in the kidney. When cyst starts to develop, the kidney can grow as high as a football. Another factor that affects the size of the kidney is gender. The kidneys of females are smaller than males and the left kidney is larger than the right kidney, regardless of gender. A decrease in the size of the kidney can be caused by decrease level of blood supply. Aside from gender, age, and race, the kidney size can also be affected by the presence of some diseases. Example of these diseases are; renal dysplasia, renal agenesis, lupus nephritis, and renal parenchymal diseases. In addition to these, acquired diseases like diabetic nephropathy, Glomerulonephritis , interstitial nephritis, renal cell carcinoma and Willims tumors also have effects on the dimensions of the kidney.(WilliamJ,2005).

2.1.1.8 Normal kidney volume:

Renal length and volume are important indicator of the presence or progression of disease. They are also important clinical parameters in the evaluation and follow up of kidney transplant recipients, patients with hypertension and renal insufficiency related to renal artery stenosis, patient with recurrent urinary infection and younger patient with

vesicoureteric reflux. Because therapeutic decisions frequently are based on the result of these dimensions, accurate and reproducible methods for assessing renal length and volume are of increasing importance. In additions, an understanding of reference values of normal renal metrics is critical to assess alteration from these values. (Nicholson,2000)

A number of imaging methods are used for calculating the renal volume. Tomographic imaging method, such as x-ray computed tomography(CT) and magnetic resonance imaging (MRI) can acquire three dimensional data to estimate the volume of kidney. In the case of (CT) the need of ionizing radiation and potentially nephrotoxic contrast media limits its place as a routine non invasive imaging method for measuring kidney volumes. Conversely, MRI has the benefits of acquiring true tomographic data a long any orientation, without the constraints of ionizing radiation and nophrotoxic contrast burden. Although MRI has those previous benefits it is expensive and not available. Ultrasound is not invasive, simple and reliable method used to measure the volume of kidney in two dimensional. (Mario M,2002)

2.1.2 Kidney physiology:

2.1.2.1 Glomerular filtration:

The glomerular capillaries have large pores in their walls, and the layers of Bowman's capsule in contact with the glomerulus have filtrations slits. Water together with dissolved solutes (except proteins), can thus pass from the blood plasma to the inside of the capsule and the nephron tubules. The volume of this filtrate produced by both kidneys per minute is called the glomerular filtration rate (GFR). The (GFR) averages 115mil per minute in women and 125 mil per minute in men. This is equivalent to 180 liter per day (about 45 gallons). Most of the filtrate water must obviously be returned immediately to the vascular system (Born,2005) .

2.1.2.2 Regulation of GFR:

Vasoconstriction or dilation of afferent arterioles affects the rate of blood flow to the glomerulus, and thus affects the GFR. Changes in the diameter of afferent arteriole result from both extrinsic regulatory mechanism produced by sympathetic nervous innervation and intrinsic regulatory mechanism produced by the kidneys. The later is called renal auto regulations mechanism (ElaineN,2003) .

2.1.2.3 Renal auto regulations:

Is the ability of the kidney to maintain a relatively constant (GFR) in the face of fluctuating blood pressures. This is achieved through the effect of locally produced chemicals on the afferent arterioles. When systemic arterial pressure falls towards a mean of 70mm/11g, the afferent arterioles dilate, and when the pressure rises, the efferent arterioles constrict. Blood flow to the glomeruli and GFR can thus remain relatively constant within the auto regulatory range of blood pressure values (Stauart,2006) .

2.1.2.4 Juxtaglomerular apparatus:

The Juxtaglomerular apparatus is the region in each nephron when the afferent arteriole comes into contact with the last portion of the thick ascending limb of the loop. Under the microscope, the afferent arteriole and tube in this small region have a different appearance than in the other region. The cells in this region secrete the enzyme rennin into the blood. This enzyme catalyzes the conventions of angiotensinogen (a protein) into angiotensin I. Angiotensin I will be converted to angiotensin II by angiotensin converting enzyme (ACE). This convention occurs as the blood passes through the capillaries of the lung (Richart.S.Snell,2004).

2.1.2.5 Regulation of blood pressure by the kidneys:

The regulation of the blood by kidneys is done by a system called rennin-angiotensin aldesterone system. When the blood flow is reduced in the renal artery, juxtaglomerular apparatus start to secrete the enzyme rennin into the blood. Condition of salt deprivation, low blood volume, and low pressure in summary cause increased production of angiotensin II in the blood. Angiotensin II exerts numerous effects that produce a rise in blood pressure. This rise in pressure is partly due to vasoconstriction and partly to increase in blood volume. Vasoconstriction of arterioles and small muscular arteries is produced directly by the effect of angiotensin II on the small muscles of these vessels. The increased blood volume is an indirect effect of angiotensin II. Angiotensin II promotes a rise in blood volume by means of two ways or mechanism. The thirst centres in the hypothalamus are stimulated by angiotensin II, and thus more water is ingested, and secretion of aldesterone from the adrenal cortex, isstimulated by angiotensinII, and higher aldesterone secretions causes more salt and water to be retained by the kidneys, so blood volume will be increased (Figure 2.5) .

The rennin angiotensin-aldesterone system can also work in the opposite direction: high salt intake, leading to high blood volume and pressure normally inhibits rennin secretion, with less angiotensin II formation and less aldesterone secretion, less salt is retained by the kidney and more is excreted in the urine. Unfortunately, many people with chronically high blood pressure may have normal or even elevated levels of rennin secretion (WilliamJ,2005).

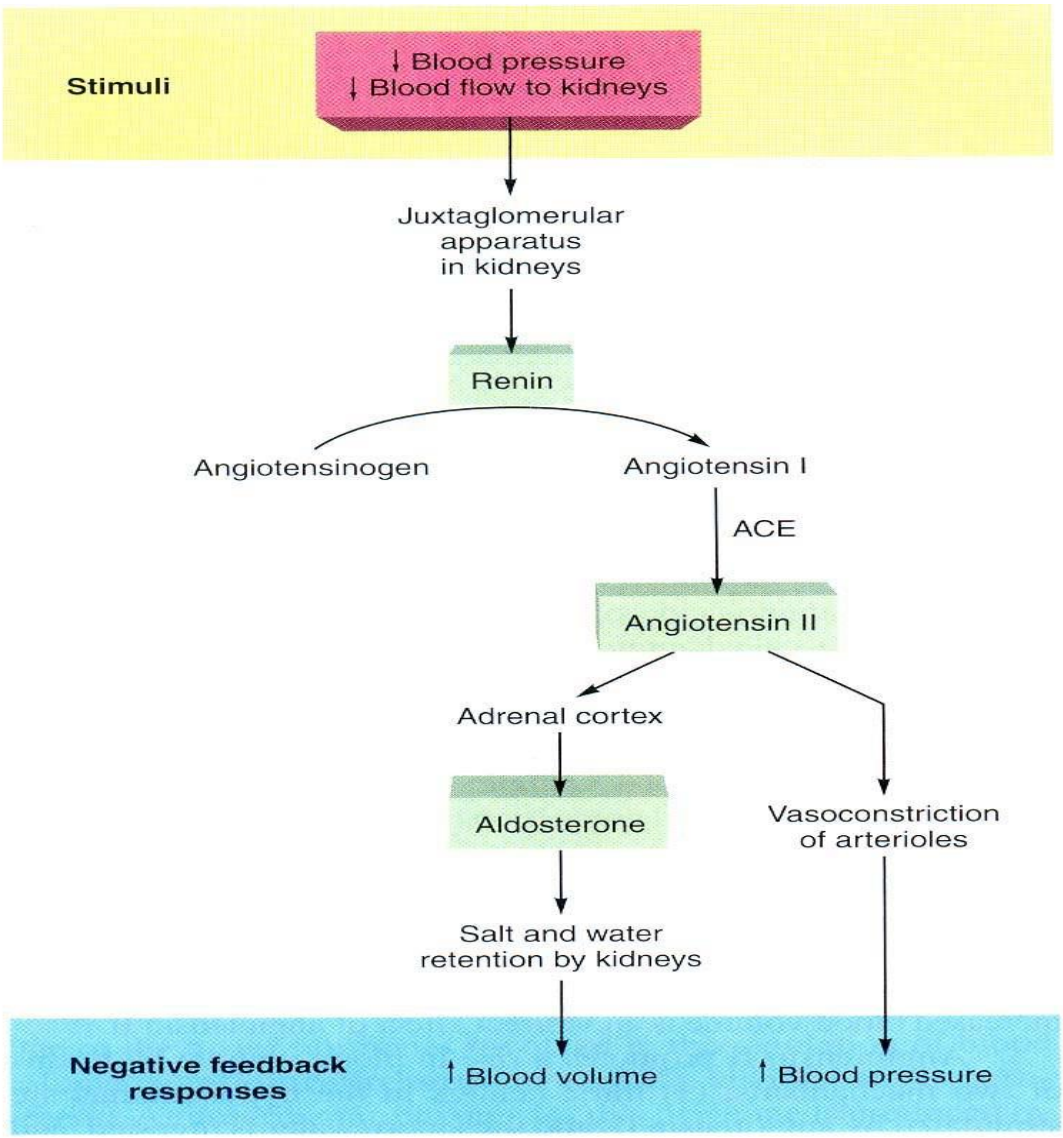


Figure (2.5): Renal-Angiotensin-Aldesterone system(William,2005)

2.1.3 Kidney Pathology:

2.1.3.1 Normal Variants:

In the first trimester, the developing kidneys ascend in the fetal abdomen. If the progress is hampered, this can result:

2.1.3.1.1 Dromedary Humps:

are prominent focal bulges on the lateral border of the left kidney. They are normal variants of the renal contour, caused by the splenic impression onto the Superolateral left kidney Dromedary humps

are important because they may mimic a renal mass, and as such is considered a renal pseudotumour(Devin Dean, 2005).

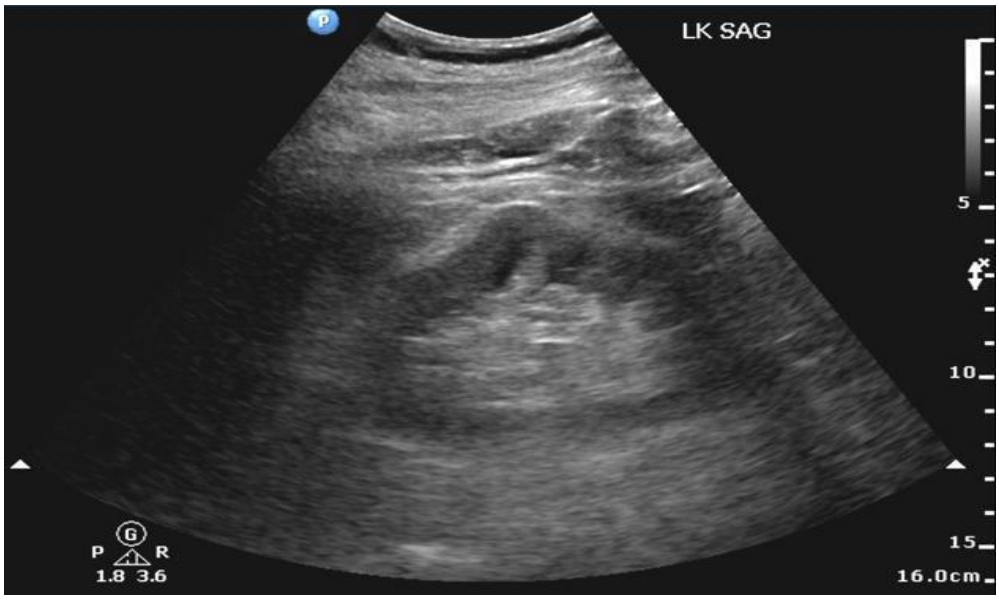


Figure (2.6) show Sagital US image Dromedary humps (Devin Dean, 2005).

2.1.3.1.2 Extra Renal Pelvis:

refers to the presence of the renal pelvis outside the confines of the renal hilum. It is a normal variant that in ~10% of population. The renal pelvis is formed by all the major calyces. An extarenal pelvis usually appears dilated giving a false indication of an obstructive pathology. Subsequent investigation with CT, usually clarifies the false interpretation on ultrasound (Devin Dean, 2005).

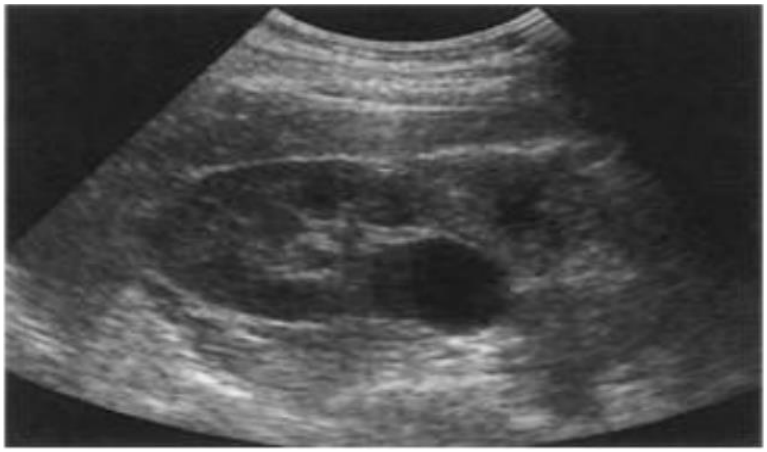


Figure (2.7) show Sagital US image Extra Renal Pelvis (Devin Dean, 2005).

2.1.3.1.3 Junctional parenchymal defects:

in renal imaging are a normal variant. It results from incomplete embryonic fusion of renunculi. sonographic appearance : It can be seen as an triangular echogenic cortical defect, frequently seen in upper lobe parenchyma. The defect is the extension of sinus fat into the cortex, usually at the border of the upper pole and interlobar region of the kidney (Devin Dean, 2005).

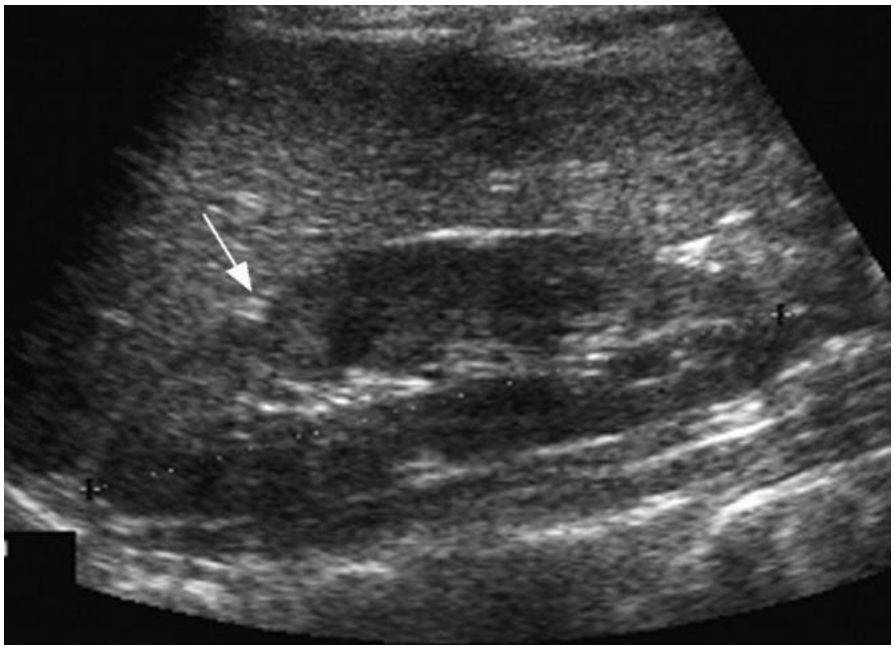


Figure (2.8) show Sagital image Junctional Parenchymal Defects (Devin Dean, 2005).

2.1.3.1.4 Duplex kidney:

appears as two central echo complexes with intervening renal parenchyma. Hydronephrosis at one pole is suggestive of a duplex kidney. although hydronephrosis can occur at either pole, it is more common in the upper one. Occasionally, two distinct collecting systems and ureters can be observed on ultrasonographic images (Devin Dean, 2005).

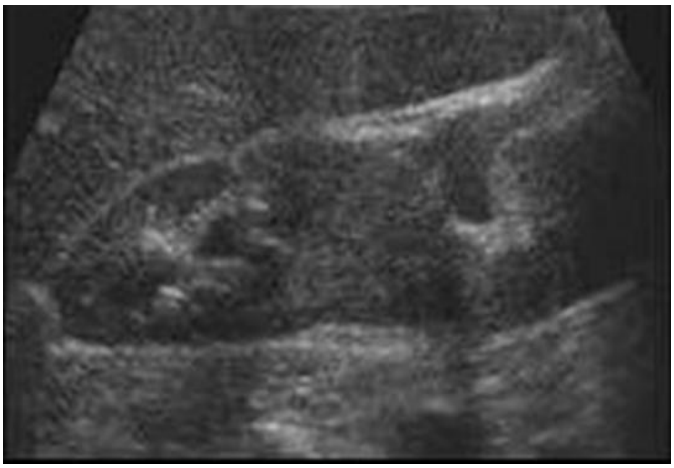


Figure (2.9)Sagital image Duplex kidneys(Devin Dean, 2005).

2.1.3.1.5 Congenital Fusion (Horseshoe Kidney):

Horseshoe kidney is the most common renal fusion anomaly, with a prevalence of approximately 1:400 births and a male predominance. The lower poles of the kidneys fuse and this fused area is called the isthmus. The hilum of each kidney looks forwards and the ureters always pass in front of the connecting in ultrasound, the isthmus can be seen anterior to the aorta and IVC; the low position and abnormal renal alignment will be seen (Devin Dean, 2005).

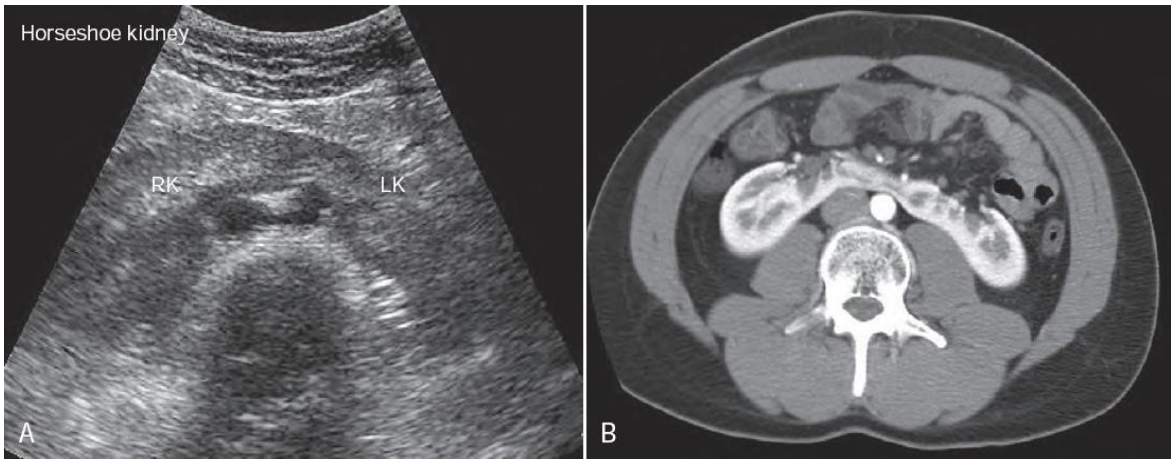


figure (2.10) Horseshoe kidney. **A,** Transverse sonogram shows the isthmus crossing anterior to the retroperitoneal great vessels, with the renal parenchyma of each limb of the horseshoe draping over the spine. **B**, Confirmatory contrast-enhanced CT examination. (Rumack, et al.,2011).

2.1.3.1.6 Hypertrophied column of Bertin

The septum of Bertin is an invagination of renal cortex down to the renal sinus. It occurs at the junctions of original fetal lobulations and is present in duplex systems (see above), 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,(Jane A,2004).

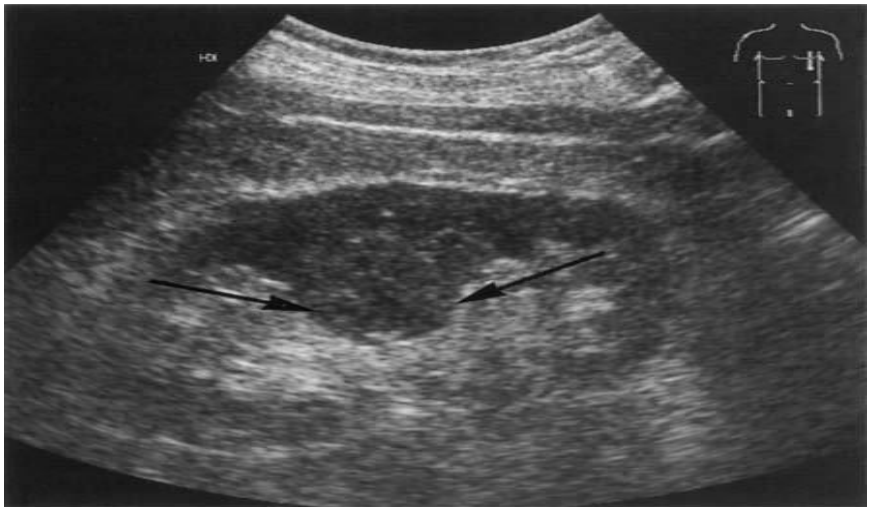


figure (2.11) Hypertrophied column of Bertin (**arrows**). (Jane A,2004)

2.1.3.1.7 Fetal Lobulation

Fetal lobulation is developmental variation that is usually present in children up to 5 years old, and may be persistent in up to 51% of adults. The surfaces of the kidneys are generally indented in between the calyces, giving the kidneys a slightly lobulated appearance. (Ansert, et al, 2012).

2.1.3.1.8 Sinus Lipomatosis

Sinus lipomatosis is a condition characterized by deposition of a moderate amount of fat in the renal sinus with parenchymal atrophy. In sinus lipomatosis, the abundant fibrous tissue may cause enlargement of the sinus region with increased echogenicity and regression toward the

center of the parenchymal. Occasionally, a fatty mass is localized in only one area; this is called lipomatosis circum scripta. (Ansert, et al, 2012)

2.1.3.2 Kidney Stone

Urinary calculi most commonly form in the kidney. They are asymptomatic until they lodge in the ureter and cause partial obstruction, resulting in extreme pain that radiates from the area of the kidney to the groin. The cause of kidney stones is varied and often reflects an underlying metabolic abnormality, such as hypercalcemia, resulting from hyper parathyroidism or any cause of increased calcium excretion in the urine. (Mosby et al., 2005).

Urinary stasis and infection are also important factors in promoting stone formation. More than 80% of symptomatic renal stones contain enough calcium to be radiopaque and detectable on plain abdominal radiographs completely radiolucent calculi content no. Calcium and are composed of a variety of substances that are in excessive concentration in the urine. Excretory urography is used to detect these otherwise invisible nonopaque stone, which appear as filling defects in the contrast-filled collecting system.(Mosby et al., 2005).

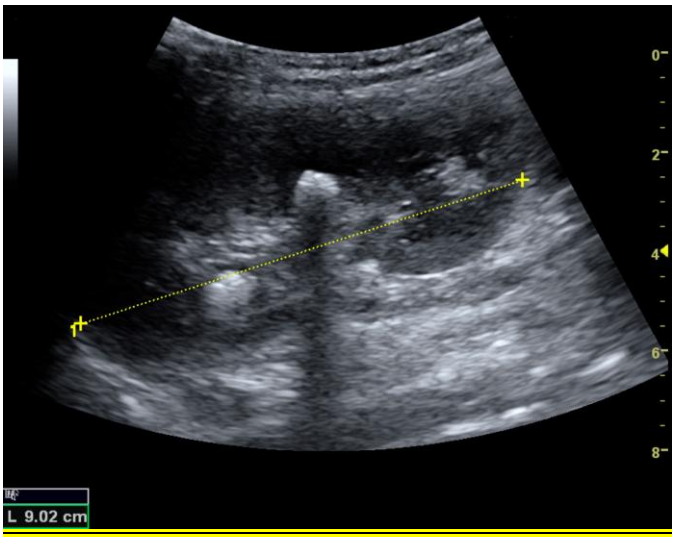


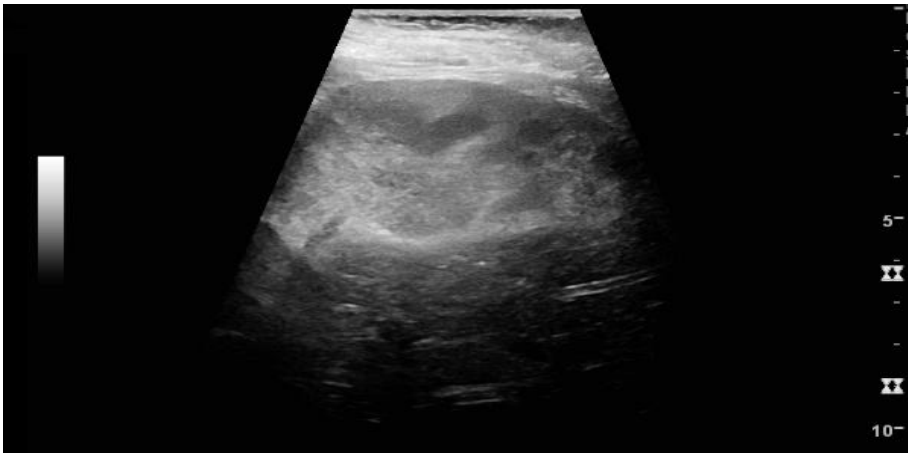
Figure (2.12). Centrally-located stone with posterior shadowing , No hydronephrosis is present . Measurement of kidney length on the US image is illustrated by '+' and a dashed line. (Osman, 2016)

2.1.3.3 Renal Failure

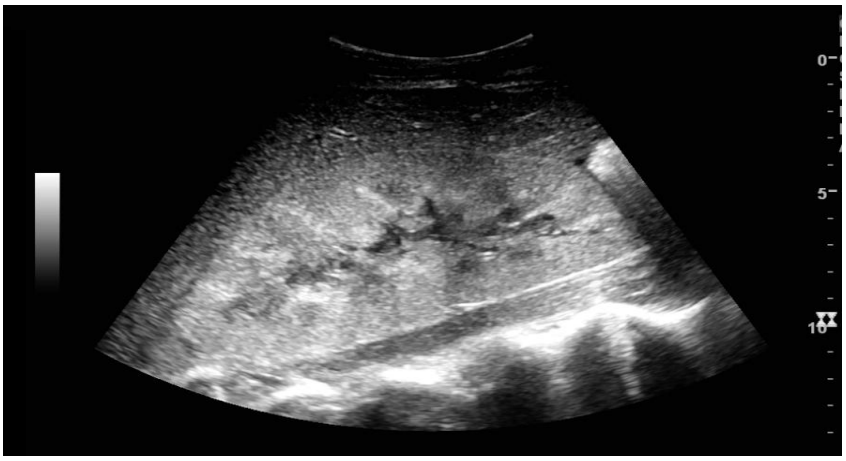
2.1.3.3.1 Acute Renal Failure

Acute renal failure refers to a rapid deterioration in kidney function that is sufficient to result in the accumulation of nitrogen-containing wastes in the blood and a characteristic odor of ammonia on the breath. In prerenal failure, There is decreased blood flow to the kidneys cause by low blood volume (e.g. hemorrhage, dehydration, surgical, shook), cardiac failure, or obstruction of both renal arteries (Mosby et al., 2005).

The acute changes in the kidney are often examined with US as the first-line modality, where CT and magnetic resonance imaging (MRI) are used for the follow-up examinations and when US fails to demonstrate abnormalities . In evaluation of the acute changes in the kidney, the echogenicity of the renal structures, the delineation of the kidney, the renal vascularity, kidney size and focal abnormalities are observed (Figures 2.18 and 2.19). (Osman, 2016).



Figure(2.13). Acute pyelonephritis with increased cortical echogenicity and blurred delineation of the upper pole. (Osman, 2016).



Figure(2.14) . Postoperative renal failure with increased cortical echogenicity and kidney size. Biopsy showed acute tubular necrosis(Osman, 2016).

2.1.3.3.2Chronic Renal Failure

Like acute renal failure, chronic kidney dysfunction may reflect prerenal, postrenal, or intrinsic kidney disease. Therefore underlying causes of chronic renal failure include bilateral renal artery stenosis, bilateral ureteral obstruction, and intrinsic disorders such as chronic glomerulonephritis, pyelonephritis, and familial cystic diseases. (Mosby et al., 2005).

2.1.3.3.3 What Causes Kidney Disease?

As mentioned previously, there are two types of kidney disease:

1) Acute Kidney Failure, and

2) Chronic Kidney Disease (which can lead to Chronic Kidney Failure).

Each has its own causes. (Empowered et al., 2009)

2.1.3.3.3.1Causes of Kidney Disease

2.1.3.3.3.2Chronic Kidney Disease

US is useful for diagnostic and prognostic purposes in chronic kidney disease. Whether the underlying pathologic change is glomerular sclerosis, tubular atrophy, interstitial fibrosis or inflammation, the result is often increased echogenicity of the cortex. The echogenicity of the kidney should be related to the echogenicity of either the liver or the spleen (Figures 2.20) (Baumgarten and Gehr, 2011) . Moreover,

decreased renal size and cortical thinning are also often seen and especially when disease progresses (Figures 2.21). However, kidney size correlates to height, and short persons tend to have small kidneys; thus, kidney size as the only parameter is not reliable (Baumgarten and Gehr, 2011).

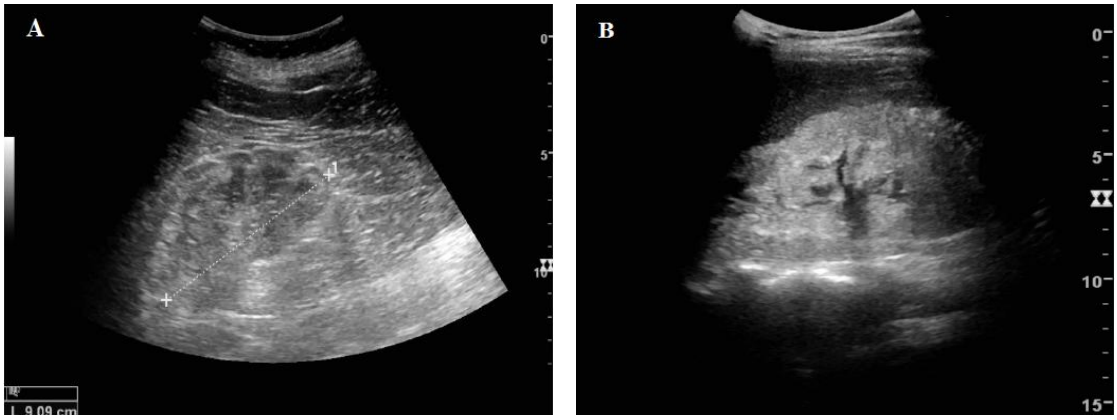


Figure (2.5) A-Chronic renal disease caused by glomerulonephritis with increased echogenicity and reduced cortical thickness. Measurement of kidney length on the US image is illustrated by '+' and a dashed line. **B-** Nephrotic syndrome. Hyperechoic kidney without demarcation of cortex and medulla. (Osman, 2016)

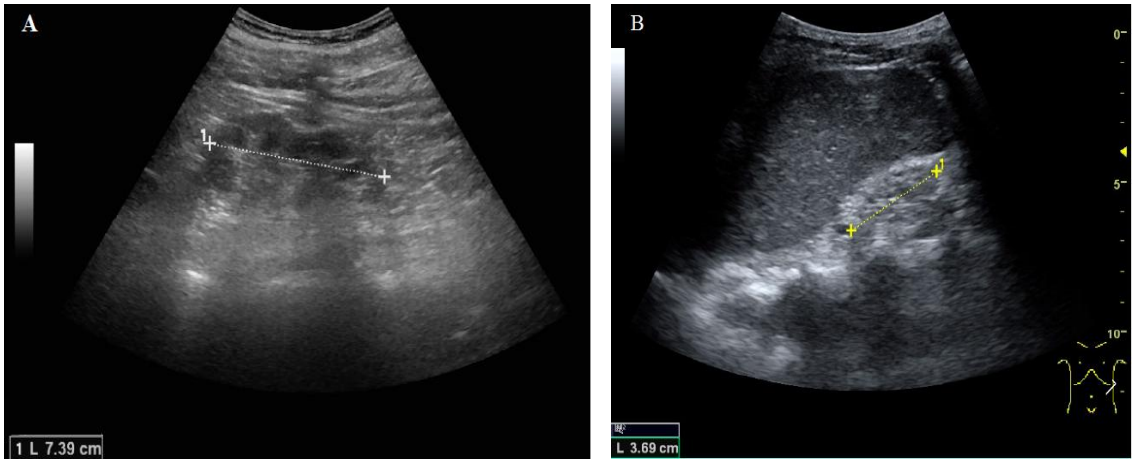


Figure 2.16. A-Chronic pyelonephritis with reduced kidney size and focal cortical thinning. Measurement of kidney length on the US image is illustrated by '+' and a dashed line. **B-** End-stage chronic kidney disease with increased echogenicity, homogenous architecture without visible differentiation between parenchyma and renal sinus and reduced kidney size. Measurement of kidney length on the US image is illustrated by '+' and a dashed line. (Osman, 2016)

Chronic kidney disease (CKD) is one of the common causes of renal failure. It involves a progressive loss over the course of months in the structure and function of the kidneys, with or without a decreased glomerular filtration rate (GFR). CKD can be diagnosed by its pathological abnormalities, changes in the levels of kidney function markers in the blood or urine, or by imaging investigations(Gareeballah et al., 2017).

Ultrasound is the ideal imaging modality in CKD because of its non-invasiveness, and because it provides easy accessibility and visualization of the kidneys. Ultrasonography is the first, and, in most cases, the only imaging investigation required in the work up of chronic renal failure. Observation of a small kidney with a thin, echogenic cortex or parenchyma indicates irreversible damage. The best screening modality to evaluate renal insufficiency in patients is sonography. As ultrasonographic findings like echogenicity, longitudinal length, parenchymal, and cortical thickness represent irreversible changes, ultrasonography is a better imaging modality when it comes to ascertaining the progression of the disease(Gareeballah et al., 2017).

The serum creatinine level is an endogenous serum marker that is commonly used to estimate GFR, and accordingly, the stage of CKD. The aim of our study is to correlate renal echogenicity with serum creatinine levels and to investigate the significance of renal echogenicity in identifying the progression of CKD, as well as use sonographic imaging in grading CKD.(Gareeballah et al., 2017).

2.2 Diabetes

2.2.1 there are three types of diabetes:

2.2.1.1 Type 1 diabetes

Type 1 Diabetes the body does not produce insulin. Some people may refer to this type as insulin-dependent diabetes, juvenile diabetes, or early-onset diabetes. People usually develop type 1 diabetes before their 40th year, often in early adulthood or teenage years. Type 1 diabetes is nowhere near as common as type 2 diabetes. Approximately 10% of all diabetes cases are type 1. Patients with type 1 diabetes will need to take insulin injections for the rest of their life. They must also ensure proper blood-glucose levels by carrying out regular blood tests and following a special diet. Patients with type 1 are treated with regular insulin injections, as well as a special diet and exercise. (Markus 2015).

2.2.1.2 Type 2 diabetes

The body does not produce enough insulin for proper function, or the cells in the body do not react to insulin (insulin resistance). Approximately 90% of all cases of diabetes worldwide are type 2. Some people may be able to control their type 2diabetes symptoms by losing weight, following a healthy diet, doing plenty of exercise, and monitoring their blood glucose levels. However, type 2 diabetes is typically a progressive disease - it gradually gets worse - and the patient will probably end up have to take insulin, usually in tablet form. Patients with Type 2 diabetes are usually treated with tablets, exercise and a special diet, but sometimes insulin injections are also required. (Markus 2015).

2.2.1.3 Gestational diabetes

This type affects females during pregnancy. Some women have very high levels of glucose in their blood, and their bodies are unable to produce enough insulin to transport all of the glucose into their cells,

resulting in progressively rising levels of glucose. Diagnosis of gestational diabetes is made during pregnancy. The majority of gestational diabetes patients can control their diabetes with exercise and diet. Between 10% and 20% of them will need to take some kind of blood-glucose controlling medications. Undiagnosed or uncontrolled gestational diabetes can raise the risk of complications during childbirth. The baby may be bigger than he/she should be. (Markus 2015).

diabetes is the number one cause of kidney disease, present in a staggering 43.8% of all cases! This is something that needs urgent attention, and scarily the number of people developing diabetes each year is only growing... enormously. The way diabetes causes kidney disease is threefold. (Empowered et al., 2009)

Damaged Blood Vessels – High sugar levels within the blood of diabetics causes the tiny blood vessels within the kidneys to become narrow and clogged, essentially cutting off the blood supply to the kidneys and causing death of tissue. (Empowered et al., 2009).

Damaged Nerve Supply - In this instance, high blood sugar levels cause the nerve supply to (but not limited to) the bladder to become weakened and incommunicative with the rest of the body. Therefore, as the kidneys begin to excrete urine and the urine begins to accumulate within the bladder, the nervous system's messenger system gets confused – it does not tell the brain that the bladder is full. This creates a back-up of pressure in the bladder, which in turn places added stress on the kidneys. (Empowered et al., 2009)

Urinary Tract - High blood sugar causes an increased likelihood of urinary tract infections, as sugar is the favorite food of bacteria. Urine with a high concentration of sugar in it becomes a breeding ground for infections. This can later develop into infections to the kidneys. (Empowered et al., 2009).

2.2.2 Diabetic Nephropathy

Diabetic nephropathy (or diabetic kidney disease) is a progressive kidney disease caused by damage to the capillaries in the kidneys' glomeruli It is characterized by nephritic syndrome and diffuse scarring of the glomeruli, It is due to longstanding diabetes mellitus, and is a prime reason for dialysis in many developed countries. It is classified as a small blood vessel complication of diabetes. (Blackwell et al.,1991).

During its early course, diabetic nephropathy often has no symptoms. Symptoms can take 5 to 10 years to appear after the kidney damage begins. These late symptoms include severe tiredness, headaches, a general feeling of illness, nausea, vomiting, lack of appetite, itchy skin, and leg swelling. (Blackwell et al.,1991).

Urinary tract infections are said to be more common in patients with diabetes but the evidence is inconclusive. Certain organisms, e.g. coagulase positive staphylococci ,occur more frequently and, if associated with acute pyelonephritis, may result in acute papillary necrosis.(Blackwell et al.,1991).

Diabetic glomruloslerosis this condition is usually associated with other diabetic microangiopathies, including retinopathy and neuropathy. Insulin dependent diabetics are at a special risk, and present with proteinuria, nephritic syndrome or renal failure. (Blackwell et al., 1991).

Renal failure is the cause of death in 10% of all diabetics and up to 50% of cases of the insulin-dependent (type I) diabetes mellitus (p. 236). There is damage to large and small blood vessels in many parts of the body.(Blackwell et al., 2011).

2.2.2.1The effects include

Progressive glomerulosclerosis followed by atrophy of the tubules Acute pyelonephritis with papillary necrosis. Atheroma of the

renal arteries and their branches, leading to renal ischemia and hypertension (Ch. 5) Nephrotic syndrome.(Elsevier et al., 2004).

Diabetes is the most common cause of chronic renal failure. Characterized By proteinuria, glomerular lesions that are associated with eventual capillary collapse glomruloslerosis, and loss of GFR. Hyperglycemia and insulin deficiency play a major role in diabetic nephropathy at least in the development of "nephron hypertension" and hyperfiltration. In many instances the patient begins with an above normal GFR. (Kaplan et al.,2014).

The first sign of renal disease is microalbuminuria. AS GFR decreases the proteinuria increases. Diabetic nephropathy (DN) is renal manifestation of diabetes mellitus; it is glomerulosclerosis caused by lesions of the arterioles and glomeruli and associated with pyelonephritis and necrosis of the renal papillae. Diabetic nephropathy ,or diabetic glomerulosclerosis, is a very important complication of adult- onset diabetes mellitus and the most (Kaplan et al., 2014).

Important complication leading to death in juvenile-onset diabetes .The changes are related to the duration of the diabetes state. All insulin dependent diabetic patients can expect to develop DN. Once proteinuria occurs, the renal changes invariably progress. Patients with diabetic nephropathy have increased morbidity and mortality. (Mosby et al., 2005).

Although the survival of diabetic patients treated with dialysis or transplantation has improved somewhat in recent years, the outcomes are not nearly as good as in nondiabetic patients. Diabetic patients have particular problems with atherosclerosis ,coronary artery disease, peripheral vascular disease, retinopathy, and neurologic deficits. The likelihood of their successful rehabilitation is limited but has increased in recent years. (Mosby et al., 2005).

Diabetes mellitus is a disease characterized by a high blood sugar and a concomitant excretion of glucose in the urine. It usually caused by an insufficient insulin secretion by the pancreas. The insulin deficiency may be due to an initial defect in the beta cells, or it may be the result of an overstimulation, followed by exhaustion of the beta cells. In addition, abnormally high blood sugar levels maintained for a long period of time may exhaust the beta cell diabetes.(Fleur et al., 2001).

2.3 Radiological investigation:

2.3. 1 Plain x-ray for kidney, ureter and urinary bladder (KUB):

KUB x-ray is a plain AP supine radiograph of the abdomen to assess the organs and structure of the urinary and or gastrointestinal system, the indication of KUB x-ray to determine the shape and position of the kidneys and bladder also to detect obvious abnormalities of the urinary system such as kidney stones (Lumin, 2015).

2.3. 2 Intravenous Urography (Intravenous Pyelography or Excretory Urography):

Intravenous pyelogram (IVP) is x-ray exam that uses an injection of contrast material to evaluate your kidneys, ureter and bladder and help diagnose blood in the urine or pain in your side or lower back (Gerst and Hricak, 2008).

2.3.3 Computerized Tomography:

Computerized tomography scans use a combination of x-rays and computer technology to create three dimensional (3D) images, CT scans can show stones in the urinary tract ,obstructions ,infections, cysts, tumors, and traumatic injuries . (Holt et al., 2014).

2.3.4 Magnetic resonance imaging (MRI):

Is a test that takes pictures of the body's internal organs and soft tissues without using x-rays.MRI machines use radio waves and magnets to produce detailed pictures .MRI my include the injection of contrast medium.MRI used to diagnosis large number of disease such as tumor, cystic lesion ,obstruction and infections.(Holt et al., 2014).

2.3.5 Nuclear Medicine: Nuclear medicine studies of the kidneys involve administration of an I.V. radionuclide which is filtered through the kidneys at a specific rate and concentration. A series of films document the effectiveness of renal perfusion and function. The disadvantages of nuclear medicine studies are they rely on function and demonstrate only gross anatomy (Devin Dean, 2005).

2.3.6 Ultrasound:

2.3. 6.1 Renal Ultrasound Protocol:

2.3. 6.1.1 Examination Technique

The ultrasonic renal exam does not require any preparation of the patient and is usually performed with the patient in the supine position. The kidneys are examined in longitudinal and transverse scan planes with the transducer placed in the flanks. When insonation of the kidney is obscured by intestinal air, the supine scan position is combined with the lateral decubitus position with the transducer moved dorsally. Preferably, the exam is initiated in the longitudinal scan plane, parallel to the long diameter of the kidney, as the kidney is easier to distinguish (Baumgarten and Gehr, 2011)

In the adult patient, a curved array transducer with center frequencies of 3–6 MHz is used, while the pediatric patient should be examined with a linear array transducer with higher center frequencies. Artifacts of the lowest ribs always shadow the upper poles of the kidneys. However, the whole kidney can be examined during either

normal respiration or breath hold, as the kidney will follow the diaphragm and change position accordingly (Baumgarten and Gehr, 2011).

Choice of transducer: For adults, use a3.5MHz transducer. For children and thin adults, use a 5.0 MHz transducer. Setting the correct gain: Start by placing the transducer over the right upper abdomen. Angle the beam as necessary and adjust the gain to obtain the best image of the renal parenchyma.

Scanning technique: The right kidney can be seen best with the patient supine, using the liver as an acoustic window. Scanning is always done in deep suspended inspiration: ask the patient to take a deep breath and hold the breath in. Do not forget to tell the patient to relax and breathe normally again .Start with a longitudinal scan over the right upper abdomen and then follow with a transverse scan. Next, rotate the patient to the left lateral decubitus position, to visualize the right kidney in this coronal view (P. E. S. Palmer ,1995).

2.3. 6.1.2 Normal sonographic features of kidney:

2.3. 6.1.2.1 Findings in the Normal Kidney

In the longitudinal scan plane, the kidney has the characteristic oval bean-shape. The right kidney is often found more caudally and is slimmer than the left kidney, which may have a so-called dromedary hump due to its proximity to the spleen .The kidney is surrounded by a capsule separating the kidney from the echogenic perirenal fat, which is seen as a thin linear structure (Emamian et al., 1994)

The kidney is divided into parenchyma and renal sinus. The renal sinus is hyperechoic and is composed of calyces, the renal pelvis, fat and the major intrarenal vessels. In the normal kidney, the urinary collecting system in the renal sinus is not visible, but it creates a heteroechoic appearance with the interposed fat and vessels. The parenchyma is more

hypoechoic and homogenous and is divided into the outermost cortex and the innermost and slightly less echogenic medullary pyramids (Emamian et al., 1994).

2.3. 6.1.2.2 Parenchymal thickness

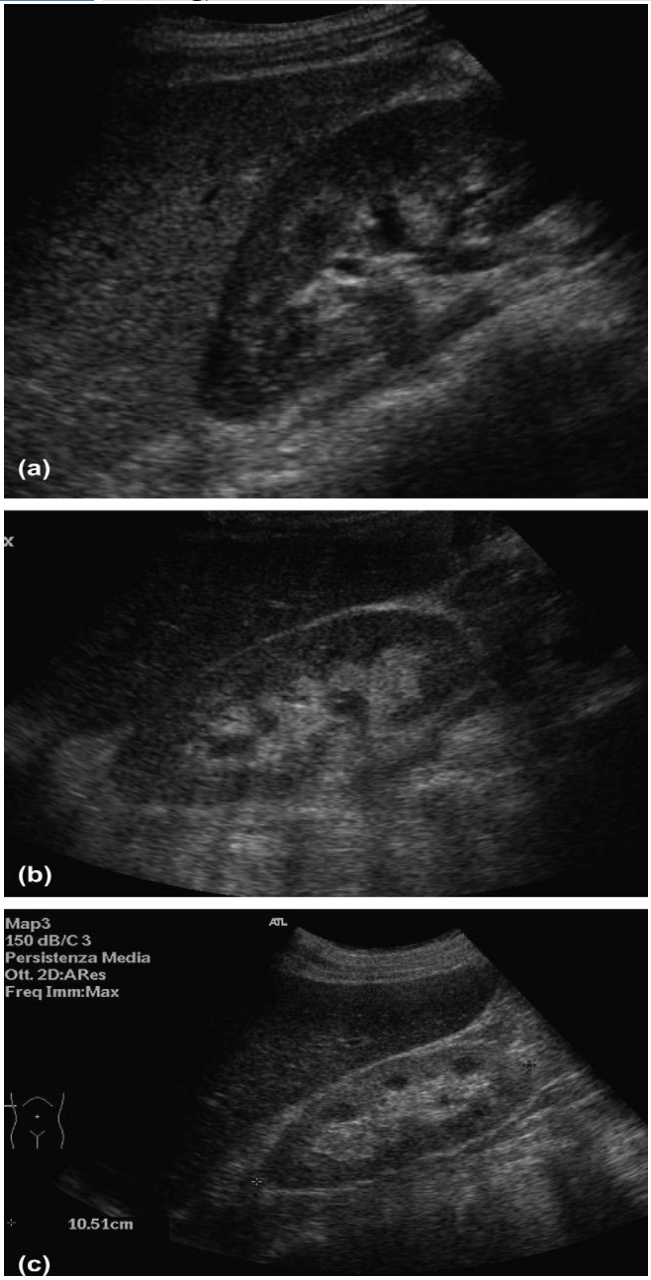
Parenchymal thickness is a US parameter used in the functional evaluation of the kidney, and a thickness ranging from 15 to 20 mm is considered normal. There are no established guidelines concerning the scanning plane and where measurement should be performed, i.e. if the thickness of the whole parenchyma should be evaluated or only the cortical parenchyma. Parenchymal thickness correlates with the longitudinal diameter of the kidney but not with prognosis and histopathology .(Roger SD, et al.,1994).

2.3. 6.1.2.3 Parenchymal echogenicity

Parenchymal echogenicity is the most frequently used marker for evaluating the presence of nephropathy. It is evaluated by comparing the echogenicity of the renal cortex, medulla and pelvic sinus with that of the adjacent liver and spleen (assuming that the liver and spleen present normal echogenicity). Echogenicity is divided into four different grades from 0 to III (Table 1, Fig. 2.22) (Barozzi .L .,etal1999)

However, the grading of parenchymal echogenicity does not differentiate between different histopathological conditions, and a normal renal echogenicity does not exclude that the patient's kidney is damaged. In the evaluation of renal pathologies, sensitivity and specificity of echogenicity in grades I and II are 62% and 58%, respectively, whereas sensitivity and specificity of echogenicity in grade III are 20% and 96%, respectively . Parenchymal echogenicity varies also with the patient's age (it is increased in newborn babies due to elevated cellularity and in elderly patients due to fibrosis). (Platt JF. ,etal 1988).

Table 2.1	Classification of parenchymal echogenicity (Hricak et al., 1982)
Grade 0:	echogenicity poorer than that of the liver parenchyma (normal finding)
Grade I:	echogenicity identical to that of the liver parenchyma (normal finding)
Grade II:	echogenicity more intense than that of the liver parenchyma (pathological finding)
Grade III:	echogenicity identical to that of the renal sinus (pathological finding)



Figure(2.17) Kidney**:(a)** parenchyma appears hypoechoic when compared to the liver parenchyma; **(b)** parenchyma appears isoechoic when compared to the liver parenchyma;**(c)** parenchyma appears hyperechoic when compared to the liver parenchyma.

Between the pyramids are the cortical infoldings, called columns of Bertin (Figure **2.24)**. In the pediatric patient, it is easier to differentiate the hypoechoic medullar pyramids from the more echogenic peripheral zone of the cortex in the parenchyma rim, as well as the columns of Bertin (Figure 2.24) (Alshaya et al., 2017).

The length of the adult kidney is normally 10–12 cm, and the right kidney is often slightly longer than the left kidney (Van Der Velde et al., 2011). The adult kidney size is variable due to the correlation with body height and age)Van Der Velde et al., 2011(; however, normograms for pediatric kidney size are available (Rosenfield and Siegel, 1981). Cortical thickness should be estimated from the base of the pyramid and is generally 7–10 mm. If the pyramids are difficult to differentiate, the parenchymal thickness can be measured instead and should be 15–20 mm (Figure 2.26) .The echogenicity of the cortex decreases with age and is less echogenic than or equal to the liver and spleen at the same depth in individuals older than six months (Van Der Velde et al., 2011)In neonates and children up to six months of age, the cortex is more echogenic than the liver and spleen when compared at the same depth (Osman, 2016).

Renal cortical echogenicity was compared and graded with the echogenicity of the liver and renal medulla, where:

Grade 0: Normal echogenicity less than that of the liver, with maintained corticomedullary definition

Grade 1: Echogenicity the same as that of the liver, with maintained corticomedullary definition

Grade 2: Echogenicity greater than that of the liver, with maintained corticomedullary definition

Grade 3: Echogenicity greater than that of the liver, with poorly maintained corticomedullary definition

Grade 4: Echogenicity greater than that of the liver, with a loss of corticomedullary definition (Gareeballah et al., 2017)

The detection of diabetes could be carried out by different methods, such as creatinine level in blood and sugar level, in addition to ultrasound as non invasive tool. In the assessment of diabetes impact on kidney's morphology using ultrasound. showed that there was abnormal renal echogenicity with nephropathy Grade 1 which was so greater than Grade 2 that showed decreased renal size among diabetic patients as highlighted in Figure 1 (Jastaniah, et al 2013)

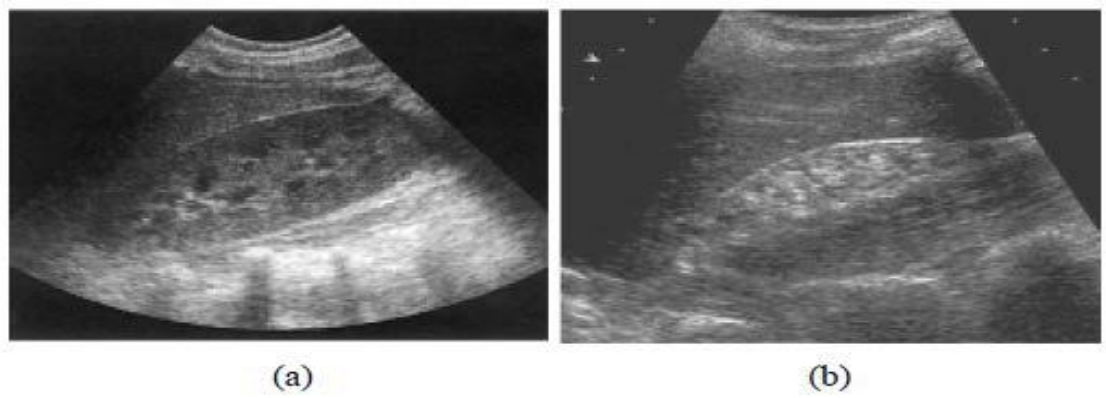
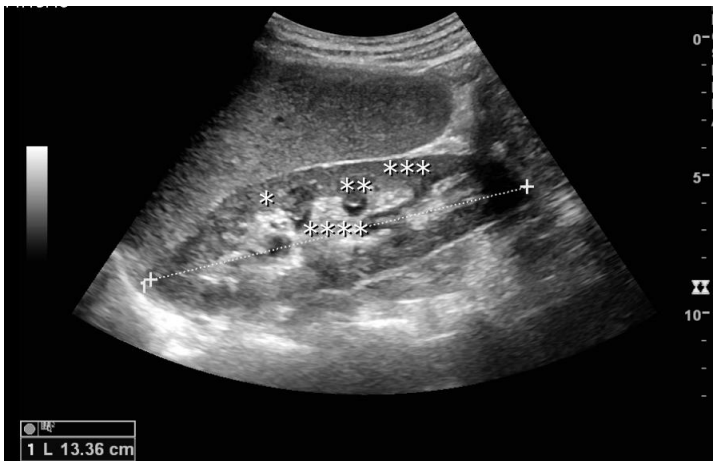
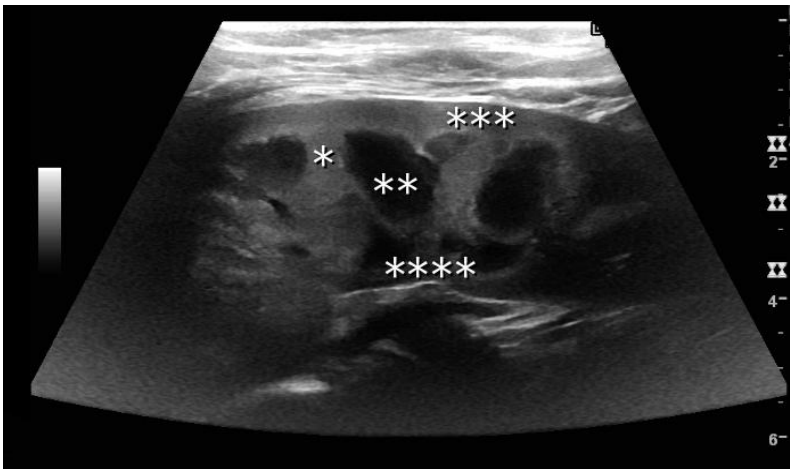


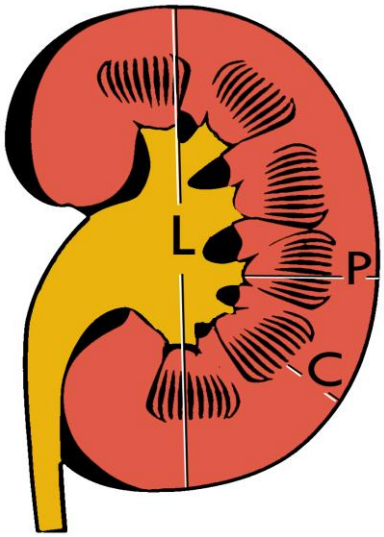
Figure (2.18). The abnormal renal parenchymal echogenicity: (a) Grade 1 nephropathy high echogenicity; (b) Grade 3 nephropathy (also notice the small renal size in (a) due to chronic nephropathy) (Jastaniah . S. D ,et al;2013).



Figure(2.19). Normal adult kidney. Measurement of kidney length on the US image is illustrated by '+' and a dashed line. * Column of Bertin; ** pyramid; *** cortex; **** sinus. (Osman, 2016).



Figure(2.20) Normal pediatric kidney. * Column of Bertin; ** pyramid; *** cortex; **** sinus. (Osman, 2016).



Figure(2.21). Measures of the kidney. L = length. P = parenchymal thickness. C = cortical thickness. (Osman, 2016).

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 comparatively 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. 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. (jane Bates ,2004).

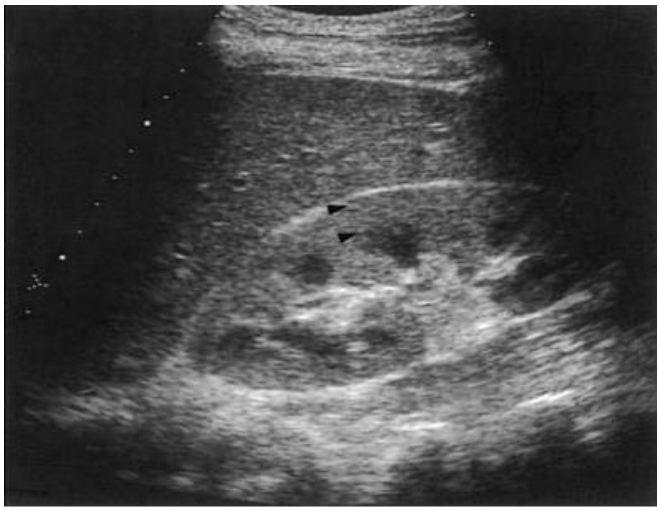


Figure (2.22) Right normal kidney (jane Bates, 2004).

2.3.6.2 Normal renal measurements in adult:

Adult "The size of the kidneys is affected by age, sex (greater in men than in women), and body size; furthermore, the left kidney is slightly larger than the right in most individuals."2 The normal renal length in females ranges from 9.5 to 12.1 cm and in males from 10.1 to 12.6 cm.2 Therefore, the normal adult kidney should measure 9-13 cm in length,1 2.5 to 3.5 cm3,4 in thickness and 4 to 5 cm in width3,4.These are good average measurements for exam purposes. Body habitus and age should be considered since a single measurement could misrepresent the patient's condition. A 10 cm long kidney is a normal renal length; however, it is likely to be abnormal in a 20 year old male who is 6 feet tall and weighs 200 pounds. Parenchymal thickness is 11-18 mm in the male and 11-16 mm in the female. Renal volume is a more sensitive indicator of size. In certain clinical settings such as renal transplant recipients, it may be necessary to obtain a renal volume on the kidney. (Makusidi et al., 2014).

Renal volume: is estimated volume of kidney it will be calculated by formula; R v = L x w x d x 0.523 (RV :renal volume – l : length – W : width D : depth) .Or it calculated automatically by computer of the us machine .Cortical thickness: referred to distant between capsule and medullary pyramids .Cortical thickness is varies between individual kidneys, and tend to decrease by age .Parenchyma thickness (PT): defined as combined thickness of the cortex and medulla measured at the upper and lower poles and averaged it's from 11 - 18 mm in the male and 11- 16 in female. Medullary pyramid thickness: measurement of the dimension of the pyramids usually used for pediatrics (Devin Dean, 2005).

Ultrasonographic measurement of the length, width an depth of a kidney. Kidney volume is calculated using the ellipsoid formula as Length x Width x Depth x 0.523. (Leung et al., 2007)

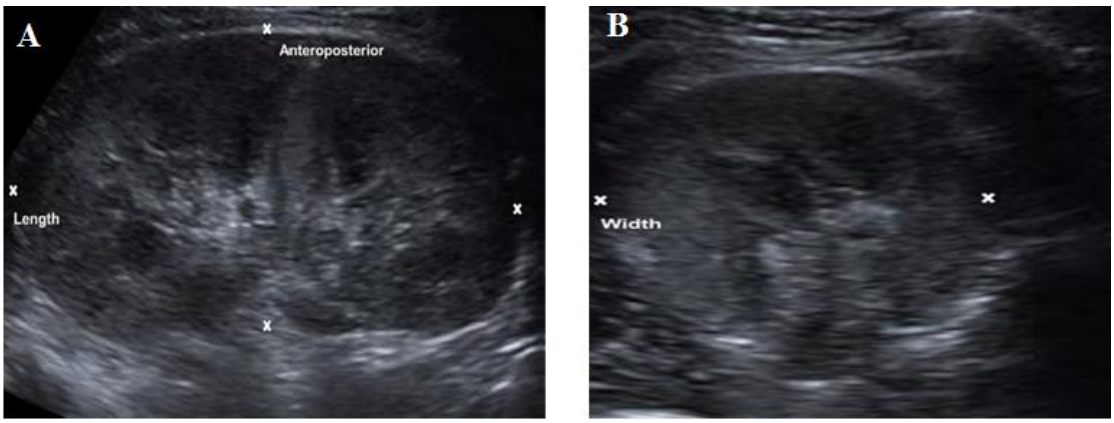


Figure (2.23)A sagittal image with two measurements obtained in the longitudinal and anteroposterior directions. The width is measured from a transverse image obtained through the renal hilum. (Leung et al., 2007)

2.3.6.3 Age Related Changes in the Adult:

1. "The thickness of the renal parenchyma decreases at about 10% per decade after age 20 years.

2. There is a loss of contrast between the cortex and pyramids as "the normal aging process increases cortical and pyramidal echogenicity, but

the effect is more obvious in the pyramids, which gradually fade from view as their echogenicity increases.

3. The overall size decreases gradually but is only apparent in the elderly. (Makusidi et al., 2014).

"Measurements of median renal volume in adults range from **134 to 150 ml.** Again with men larger than women and the left kidney larger than the right."2 There is correlation between the renal volume and weight of the patient. (Makusidi et al., 2014).

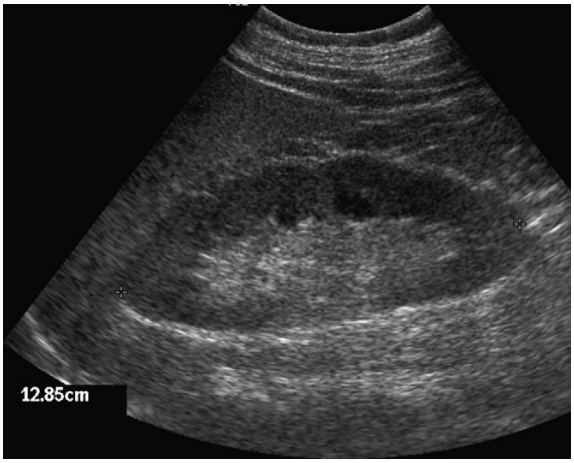


Figure (2.24) Kidney: maximum length in a 195 cm tall patient weighing 98 kg.(F. Fiorini, L. Barozzi).

2.3.6.4 Renal measurements in pediatric

The kidneys of newborns are about 4.5 cm long, almost 2 inches, and weigh just less than an ounce. Kidneys of adults are about 12 cm long, nearly 5 inches, and weight about 5 cm. The growth of kidneys correlates more with a child's growth in height rather than age, and the normal length of the kidneys can be estimated using a simple mathematical formula based on your child's height. The kidneys grow rapidly in the first year of life, from 4.5 cm to 6.5 cm, and then gradually into adulthood, only about 0.3 cm, an eighth of an inch, per year on average(Devin Dean, 2005).

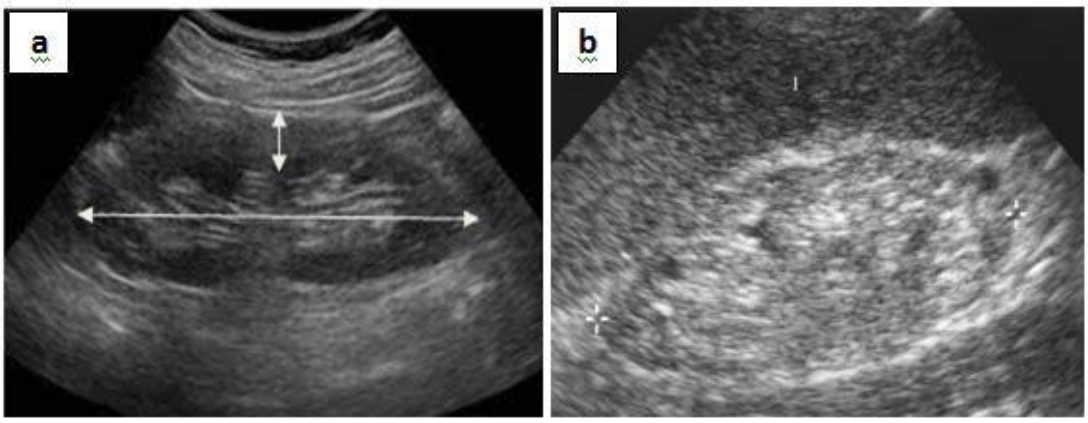


Figure (2.25) The sonographic appearance of diabetes impact in renal morphology: **(a)** cortex enlargement and atrophied medulla and the renal enlargement greater than 14.5cm; **(b)** late case in which the kidney is more echogenic with loss of corticomedullary differentiation, the patient requiring dialysis or kidney transplantation. (F. Fiorini, L. Barozzi).

2.4 Previous studies:

renal ultrasound is typically obtained to measure the renal size , volume and echogenicity. Renal enlargement may be seen early in diabetes due to hyper filtration, while in late stages the kidneys diminish in size from glomerulosclerosis. In addition, renal cortical hyperechogenicity is seen suggesting deteriorated renal function. Ultrasound is also used to exclude non diabetes-related renal disorders, e.g. renal stones, masses or hydronephrosis. (Jastaniah.S.D ,et al 2013).

Renal length and volume measurements are clinically relevant, serving as surrogates for renal functional reserve, and are used frequently as the basis for making clinical decisions. Serial measurements can also provide information regarding disease progression or stability. A number of reports have described ultrasonography measurement of renal length and volume in the healthy Western population (Allan, P .,et al 2001).

The kidney size of a patient is a valuable diagnostic parameter in urological and nephrologic practice, while the leading anatomy text

describes the adult kidney as 12 cm long, 6 cm wide and 3 cm deep (Standring, S .,et al 2008).

Intensive studies in the field of renal change in diabetic Patient shows that the renal size varies with age, gender, body mass index, pregnancy and concomitant conditions. Renal size may be an indicator for the state kidney and therefore, kidney function or physiology , as well as renal echogenicity also affect according to the duration and types DM of the disease , While the current study was used the renal volume measurement as indicator for the state kidney , and these Previous studies have reached conclusions can be summarized as follows.

Ultrasonographic Characteristics of Diabetes Impacts in Kidneys' Morphology this study assumed that The ultrasound scanning has been the best choice for abdominal diagnosis and diseases assessment. It reveals that the diabetes has direct impact on kidney morphology in view of renal volume enlargement and cortical thickening in early stage, then atrophied and echogenic in late stage. Also there is a significant correlation between kidney size and the BMI in a linear form as R2 = 0.8 and 0.6 for left and right kidney respectively as well as the kidney size versus duration with R2 = 0.6 and 0.5 for left and right kidney respectively . Such finding could be utilized successfully to assess the diabetes severity and stage as well as to determine the treatment model. (M. A. Ali Omer .,et al 2014).

Ultrasonographic Renal Size in Individuals with Known Diabetes Mellitus , this study assumed that the renal changes in diabetic patients are detectable by conventional ultrasound only in very advanced stages of the disease. Pathologic resistive indices, however, may be detected in the earlier stages. Even later in life, combined lifestyle factors are associated with a markedly lower incidence of new-onset diabetes mellitus. Intensive therapy effectively delays the onset and slows the

progression of diabetic retinopathy, nephropathy, and neuropathy in patients with IDDM. Diabetes is the most prevalent diseases in the world WHO expects that the number of infected will increase from 200 million to 2.5 million by 2010, despite the seriousness of this disease and rapidly spread it ranks seventh in the list of causes of death and is responsible for one third of cases leading to renal failure and cardiovascular disease are known to most people with diabetes die from heart attacks.(John et al., 2018).

Ultrasonographic Characteristics of Diabetes Impacts in Kidneys' Morphology this study assumed that the ultrasound scanning has been the best choice for abdominal diagnosis and diseases assessment. It reveals that the diabetes has direct impact on kidney morphology in view of renal volume enlargement and cortical thickening in early stage, then atrophied and echogenic in late stage. Also there is a significant correlation between kidney size and the BMI in a linear form as R2 = 0.8 and 0.6 for left and right kidney respectively as well as the kidney size versus duration with R2 = 0.6 and 0.5 for left and right kidney respectively. Such finding could be utilized successfully to assess the diabetes severity and stage as well as to determine the treatment model.(Omer et al., 2014).

The role Of Ultrasound And Doppler In Diabetic Renal Disease-Correlative Study With Biochemical Parameters this study assumed that the Renal length and parenchymal thickness showed a progressive decrease with progression of diabetic renal disease. All patients in the preclinical and incipient nephropathy subgroups showed normal echogenicity. 40 % and 47.37 % of the patients in overt nephropathy. Renal length and parenchymal thickness showed no correlation with serum creatinine and urine protein. A progressive increase in resistive index values was noted with progression of diabetic nephropathy.

Resistive index values showed a positive correlation with blood urea nitrogen and serum creatinine, but this correlation was not found to be statistically significant. In conclusion, renal length, parenchymal thickness and echogenicity are reliable indicators of the disease severity in diabetic renal disease. The positive correlation of intrarenal resistive index with most of the biochemical parameters.(Harish, 2006).

Diabetic Nephropathy: Ultrasound, Color Doppler and Biochemical Correlation- A 2 Year Study, this study assumed that the All patients in preclinical and incipient subgroup; more than half of the patients with renal failure were found to have normal renal parenchymal echogenicity. Around one third and 18.2% of patients had grade I and grade II cortical echogenicity changes in renal failure subgroup respectively. Most of the patients in preclinical group had normal RI value while patient belonging to other 3 subgroups had raised RI value (>0.7) with highest values in Renal failure subgroup. Renal sonomorphological changes were noted in few patients and only in advanced stages of diabetic nephropathy but Resistive indices values were increased in most of the patients belonging to subgroups 2,3 and 4 and even in patients having normal sonomorphological features. Resistive indices values showed positive correlation with serum creatinine and blood urea nitrogen values suggesting complementary role of Doppler ultrasound in Diabetic nephropathy.(Shaw, 2016).

nephropathy comparison of conventional and duplex Doppler ultrasonographic findings , this study assumed that the In asymptomatic diabetic nephropathy, renal length and parenchymal thickness were significantly increased compared to that of controls, reflecting hyperfiltration- induced nephromegaly . Differences between controls and patients with clinically manifest nephropathy were insignificant; only in advanced renal disease were both values significantly decreased.

Cortical hyperechogenicity was noted only in very advanced disease. Resistive indices correlated well with renal function, and pathologic values (i. e. 20.70) were observed in 15% in the asymptomatic group and in 87% in the group with advanced nephropathy. Renal changes in diabetic patients are detectable by conventional ultrasound only in very advanced stages of the disease. Pathologic resistive indices, however, may be detected in the earlier stages. Resistive indices correlate with serum creatinine levels and creatinine clearance rates. However, it remains unclear as to whether a diagnostic or prognostic benefit can be expected as compared to standard laboratory examinations. .(Soldo et al., 1997).

Sonographic Findings in Renal Parenchymal Diseases at Sudanese, The study revealed that the echogenicity of renal parenchyma and cortex increased in all types of renal parenchymal diseases. The Cortico medullary differentiation was mainly disturbed in acute parenchymal disease (69.04%), loss in chronic end-stage parenchymal disease (85%); and there was significant difference (p-value = 0.0001). The Ultrasound provided useful and accurate diagnosis of renal parenchymal diseases. In this study, renal parenchymal diseases had been classified into acute, chronic and end-stage renal parenchymal diseases. The ultrasound plays a great role in evaluation of renal parenchymal diseases. It is capable to differentiate renal parenchymal diseases and this enables their follow-up and facilitates the choice of appropriate medication and treatment. (Gareeballah et al., 2015).

Sonographic assessment of kidneys and associated abdominal findings in patients with renal parenchymal diseases .The study revealed that echogenicity of the renal cortex was increased in 93.69% of the cases. This increased echogenicity was mainly attributed to inflammatory infiltrates, fibrosis and proteinaceouscasts. This finding

agrees with (Jagdeesh et al) who reported that echogenicity is a useful sonographic parameter to assess renal parenchymal diseases. Ultrasound is an essential imaging method to assess kidneys and complications in renal parenchymal diseases. Small hyperechoic kidneys with thin cortices were the most common findings in renal parenchymal diseases while irregularity of renal surface is less frequent. diabetic Pleural effusion, ascites and liver cirrhosis were the most common systematic findings complicated of renal parenchymal diseases. Sonographic assessment of kidneys in parenchymal diseases might be helpful in treatment and prevention of renal failure and other severe complications. (Gareeballah et al., 2017).

Evaluation of Type of Nephropathy in Patients of Type-2 Diabetes Mellitus, this study assumed that the nephropathy occurs at a much earlier age in T2DM patients in India and the duration of diabetes resulting in nephropathy is less as compared to the western population. The typically described high triglyceride and low HDLc in Indian diabetics were not found in our study. We conclude that nephropathy in patients of T2DM mellitus is of two distinctive pattern of glomerular pathology i.e. DGS and NGS. There was little difference between clinical and biochemical parameters in the DGS and NGS groups with respect to age, hypertension, BMI, duration of diabetes, dyslipidemia and glycemic control as reflected by HbA1c levels. Also noteworthy in the findings of this study was the fact that glomerular lesions other than those associated with diabetes were found in only three (3) patients. Hence, coexisting non diabetic renal disease may be associated with diabetic nephropathy in only a few patients with T2DM. Studies evaluating renal Parenchymal changes in T2DM are limited. Larger studies undertaking Histopathological evaluation of T2DM with

Nephropathy will throw more light on NDRD & DN.(Nayak et al., 2017).

Evaluation of Renal Disorders in Type 2 Diabetic Patients Using Ultrasonography , this study assumed that the renal Ultrasound for patients with type 2 DM has a great role in diagnosing and grading diabetic nephropathy, selecting cases with non-diabetic nephropathy for renal biopsy, and detecting associated renal abnormalities not related to DM e.g. renal cysts and stones which allow to study the relation between them. Due to the high prevalence of DM in Saudi Arabia and the national efforts to reduce the incidence and complications of this epidemic, we recommend future expanding study of the underlying possible genetic relation between DM and renal cysts and also the relation between renal stones and type 2 DM. Renal US for type 2 DM has a great role in diagnosing and grading diabetic nephropathy, selecting cases with non-diabetic nephropathy for renal biopsy, and detecting associated renal abnormalities. Due to the high prevalence of DM in Saudi Arabia, we recommend future expanding study of the underlying possible genetic relation between DM and renal cysts and also the relation between renal stones and type 2 DM.(Jastaniah et al., 2013).

Comparative sonographic assessment of renal dimensions and clinico-biochemical parameters among diabetic and nondiabetic adults in Benin City, Nigeria, this study assumed that the right and average renal volumes were higher in the diabetics than that in the non-diabetics. The left renal volume, although higher in diabetics, was, however, not statistically significant (P=0.219). The renal volumes (right, left, and average) showed positive correlation with height, weight, and body mass index for the group of adults with diabetes and the nondiabetic groups. The renal volumes also correlated negatively with a duration of diabetes at significant statistical levels (r=−0.453, P=0.012; r=−0.424, P=0.020;

r= −0.404, P=0.027 for right, left, and average kidney volumes, respectively). Renal changes in diabetics that affect its dimensions are demonstrable sonographically. Hence, ultrasound plays some role in monitoring diabetics. This study has shown that renal volume is increased in participants with diabetes compared with participants with diabetes. Assessment of renal volume should be part of routine evaluation of all patients with diabetes at first diagnosis as well as follow-up evaluation of these patients. This may help in the early detection of any renal disorder in these patients. (John et al., 2018).

CHAPTER THREE

Materials and Method

3.1. Materials:

3-1-1.Ultrasound Machine:

This study was performed using different standard B-mode grayscale ultrasound scanners available at the areas of study such as (SIUI Apogee 3800 Omni Ultrasound Machine) , (Fukuda diagnostic US Imaging equipment UF -4100- Fukuda Denshi ,Tokyo , Japan), (Toshiba Aplio XG SSA-790A Ultrasound System, Japan) . All of these scanners drive convex probes produce a frequency of 3.5 - 5.00 MHz; also they were connected with printing facility .

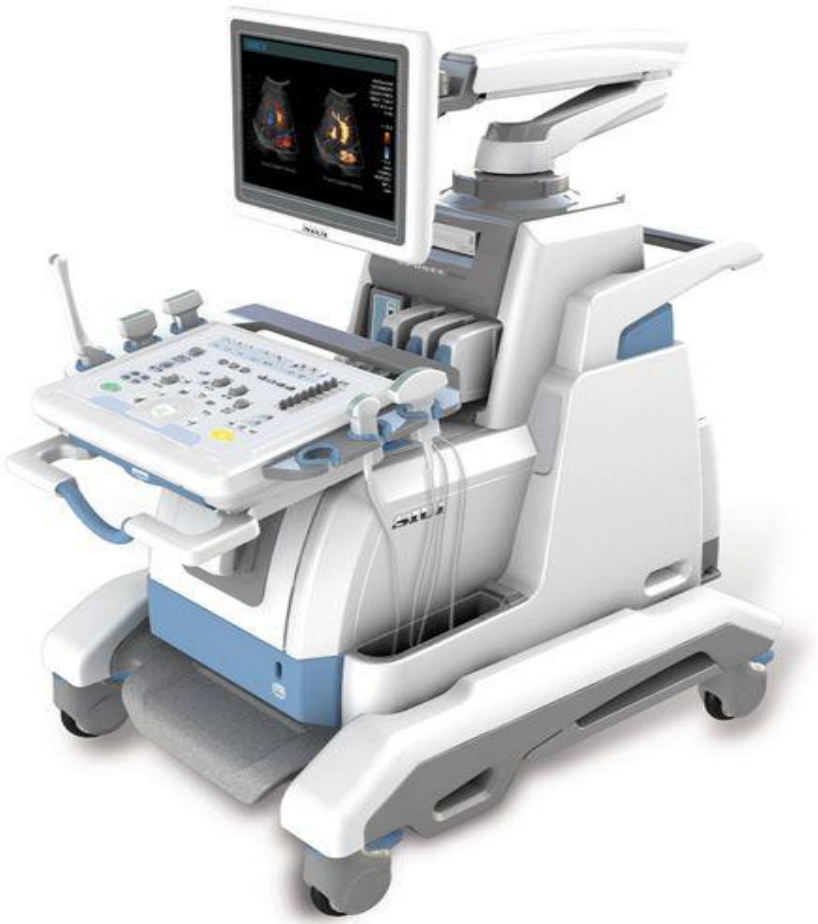


Figure (3.1) SIUI Apogee 3800 Omni Ultrasound Machine

3.1.2 Study designs and population

The study was a cross-sectional - prospective design. The study was conducted in Khartoum and north kurdofan States from the period of June 2018 to January 2019, patients were selected according to the positive evidence of diabetes among the out flow of the patients and another group of healthy patients they are came for routine abdominal ultrasound examination they are used as a control group and gray scale ultrasound procedure was done for them.

3.1.3 Population of the study:

The study population was composed of group of different patients , they are a 50 of Sudanese diabetic patients and a 30 of normal Sudanese peoples , Their ages from 20 up to 90 years with different gender underwent ultrasound examination of the abdomen at Khartoum and north kurdofan states, The aim of selecting this sample was to assess the distribution of diabetes in Sudanese male and the impact of diabetes in renal morphology during the period from june 2018 to January 2019.

3.1.4. Inclusion criteria

*Patients who were confirmed cases of adult diabetics mellitus who were aged between 20 and 90 years.

*In contrast , inclusion criteria for the controls were peoples their age between 20 and 90 years with no history of diabetes mellitus, kidney diseases, malignant, systemic or chronic diseases that might affect renal volume , shape or other study variables.

3.1.5. Exclusions criteria

*DM pt with ectopic kidneys /other congenital anomalies of the kidneys.

* urinary tract obstruction due to calculi or mass ,which can effect in the kidney volume , shape or other study variables.

* diabetic patient with end-stage renal failure.

* diabetic patient with history of hypertension

*Non diabetes-related renal disorders, e.g. renal stones, masses or hydronephrosis.

3.2 Methods:

Subject gender , age, height , weight, kidneys measurements , ultrasound findings of involved kidneys, duration of diabetes and treatment status recorded in data collection sheet.

3.2.1 Scanning technique:

The patients were investigated by using different standard B-mode grayscale ultrasound scanners as mentioned before with two probes curvilinear probe 3.5 - 5 MHz for obese , normal and thin patients consequently. The Proper machine setting was adjusted , a manual method of adjusting the image parameters such as the focusing , depth , overall gain and depth/ time gain compensation (DGC / TGC) was adjusted to optimally visualize each kidney., The patient was positioned in supine, oblique and even prone to demonstrate the kidneys in their entire size and shape. A coupling agent gel was used to ensure good acoustic contact between the transducer and the skin , then the right and left kidneys were scanned in variable sections such as coronal, longitudinal, transverse, and oblique planes from the anterior approach using the liver and spleen as acoustic windows with measurements of the renal length, thickness and width performed. The renal length was measured from upper margin of upper pole to lower point of lower pole. The corticomedullary was evaluated though out the longitudinal plane . then with consultant radiologists to confirm the findings and diagnosis following the international scan guidelines and protocols. Longitudinal, transverse and coronal sections were taken through the kidneys. Low tissue harmonic imaging was applied to visualize the liver, spleen and kidney in order to assess the echogenicity.

3.2 .1.1 Method of evaluation the volume:

The kidney volume was obtained using the prolate ellipsoid formula (inbuilt in the ultrasound machine software) V = (L ×W ×D × 0.523) (Bushberg JT et al., 2002). Also we used a traditional , measured three dimension length , width and anteroposterior diameter in long and short axes then calculated by formula above so : **V** = kidney volume , **L** = maximum long axis length , **W** = the width measurements taken at the hilum **, D** = Antroposterior(**AP)** measurement measured through the hilum.

3.2.1.2 Method of evaluation the Echogenecity:

Evaluation the echogenicity of right renal cortex and parenchyma was compared with liver echogenicity, while the echogenicity of the left renal cortex and parenchyma was compared with spleen When there was inter observer variation, consensus was sought.

3.2.2 Data collection:

The data was collected by master data sheets using the variables Subject age, height, gender, weight and BMI . Diabetes type Duration and treatment status was recorded in clinical data sheet. Measurement of kidneys was performed by obtaining sagittal planes for measuring the (length) and transverse planes for (width and thickness or depth). Evaluation of the volume by measuring the three dimensions, length, width and depth(AP diameter) in long and short axes then calculated by formula : **V = L x W x AP x 0.523**. Evaluation of C/M differentiation was done by well or ill differences between the cortex and medulla, and evaluation of echogenicity of the RT kidney by comparing with the liver echogenicity, while LT kidney by comparing it with spleen.

3.2.3 Data analysis:

Data obtained were entered into a Microsoft office Excel database and Statistically analyzed using the Statistical Package for the

Social Sciences of windows version 20.0 (SPSS Inc., Chicago, IL, USA) software. Continuous variables were expressed as the mean and standard deviation . Descriptive statistics Percentage were used to describe the data . Data were presented as mean ± SD in a form of comparison tables , Statistical test of significance was conducted using Pearson correlation analysis, chi-square test for categorical data, Student t-test, and analysis of variation where applicable. At 95% confidence interval (CI), two-tailed P-values less than or equal to 0.05 was considered statistically significant.

3.2.4 Ethical considerations:

Special ethical consideration , verbal consent approval will obtain from each participating patient prior to his / her inclusion into the study. Clarification of the nature and purpose of the study will be done with each patient, the sonographer emphasized participation is absolutely voluntary and confidential. Anonymity, privacy, safety and confidentiality was absolutely assured throughout the whole study and the right to withdraw. Justice and human dignity was considered by teaching the selected participant equally when offering them an opportunity to participate in the research. Permission for conducting the study was approved by the local Ethics Committee of faculty of Medical radiological sciences and informed consent was signed by all the subjects examined.

CHAPTER FOUR

Results:

Table (4.1) frequency distribution of gender in diabetic group

Gender	Frequency	Percent%
Male	29	58.0%
Female	21	42.0%
Total	50	100.0%

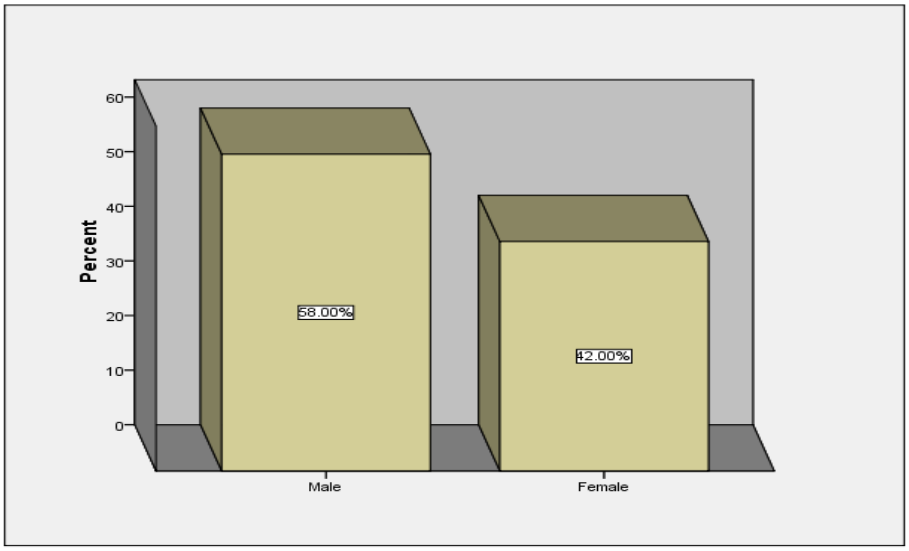


Figure (4.1) frequency distribution of gender in diabetic group

Table (4.2) frequency distribution of gender in control group (none DM)

Gender	Frequency	Percent%
Male	17	56.7%
Female	13	43.3%
Total	30	100.0%

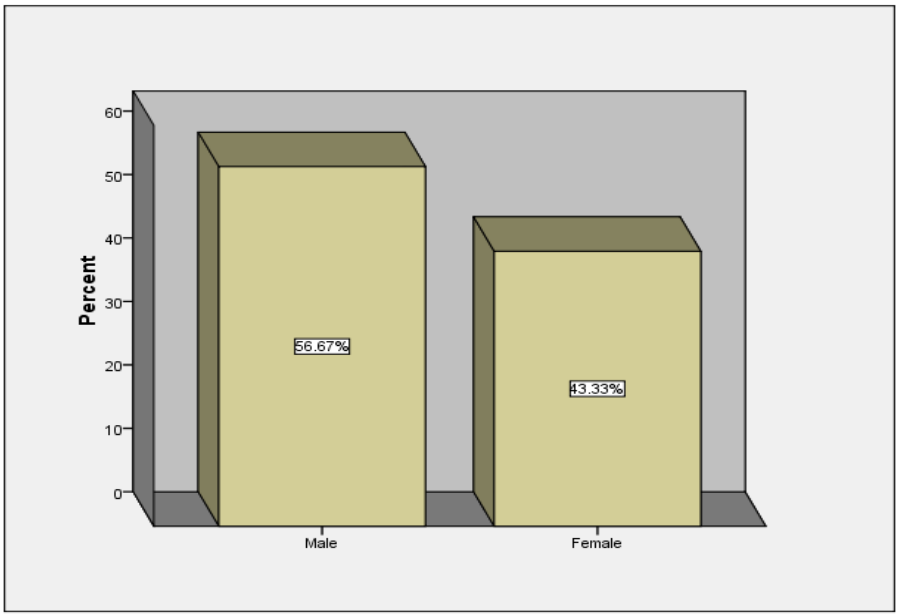


Figure (4.2) frequency distribution of gender in control group (none DM)

Table (4.3) frequency distribution of age

Age/years	Frequency	Percent%
20 - 34	1	2.0%
35 - 49	12	24.0%
50 - 64	24	48.0%
65 -7 9	10	20.0%
80 - 92	3	6.0%
Total	50	100.0%

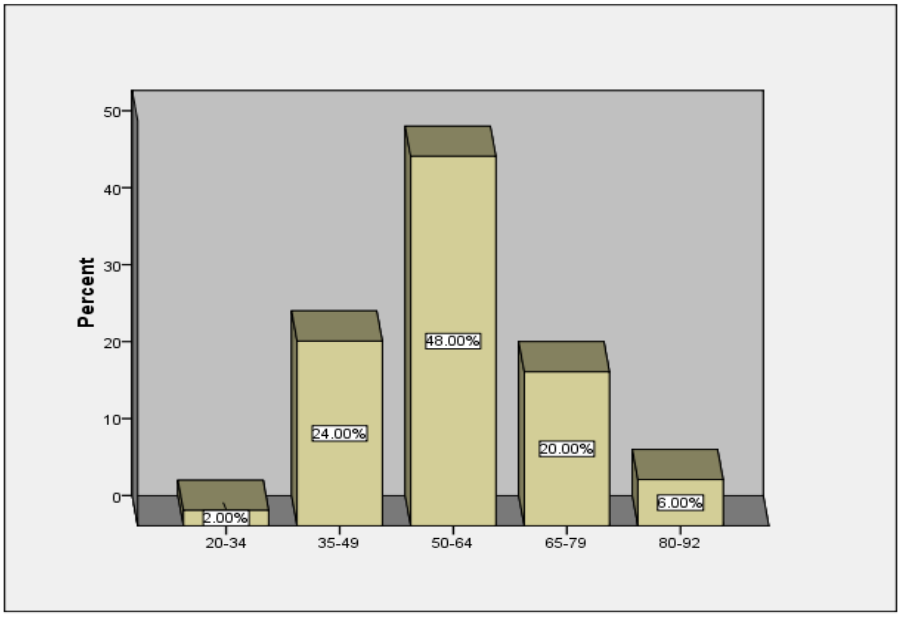


Figure (4.3) frequency distribution of age

Table (4.4) frequency distribution of duration /years

Duration /years	Frequency	Percent%
1 - 10 years	29	58.0%
11 - 20 years	17	34.0%
21 - 30 years	3	6.0%
> 30 years	1	2.0%
Total	50	100.0%

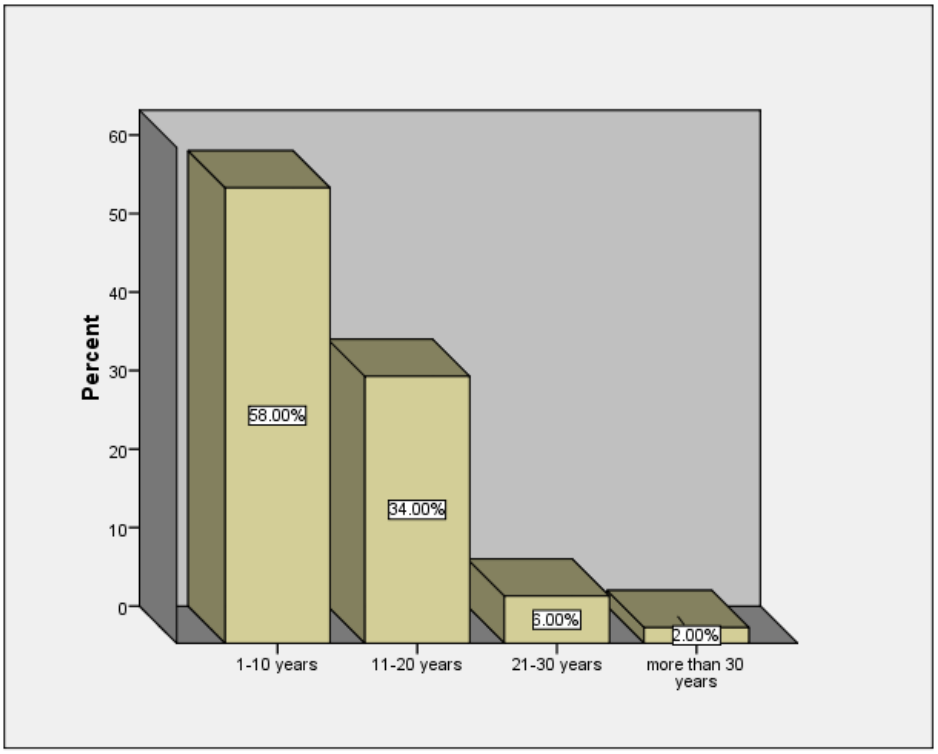


Figure (4.4) frequency distribution of duration /years

Table (4.5) descriptive statistic age, height, weight, BMI, duration and kidney measurements in diabetic group

Descriptive	N	Minimum	Maximum	Mean	Std. Deviation
Age / years	50	20	92	57.26	13.52
Height / cm	50	150	192	168.22	8.36
Weight / kg	50	55	100	69.48	11.43
BMI / (kg\cm^2)	50	19.7	32.3	24.42	3.32
Duration / years	50	1.0	33.0	10.43	7.46
Right kidney length	50	7.5	14.4	9.955	1.39
Right kidney width	50	2.8	6.3	4.333	.86
Right kidney thickness	50	2.9	5.4	4.02	.69
Right kidney volume	50	37.0	183.0	93.8	38.59
Left t kidney length	50	7.6	14.5	10.3	1.31
Left kidney width	50	3.0	6.3	4.70	.84
Left kidney thickness	50	3.0	5.6	4.3	.79
Left kidney volume	50	42.0	215.0	111.9	41.00

Table (4.6) descriptive statistic age, weight, height, BMI and kidney measurements in control group (none DM)

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
Age / years	30	20	60	37.20	12.23
Height / cm	30	150	176	164.93	6.64
Weight / kg	30	55	80	66.80	7.05
BMI / (kg\cm^2)	30	21	31	24.55	2.08
Right kidney length	30	8.9	11.5	10.08	.74
Right kidney width	30	3.5	5.7	4.86	.507
Right kidney thickness	30	3.4	5.2	4.14	.435
Right kidney volume	30	75.0	148.0	98.6	17.24
Left t kidney length	30	8.9	11.8	10.25	.86
Left kidney width	30	4.3	9.1	5.18	.81
Left kidney thickness	30	3.0	5.0	4.39	.53
Left kidney volume	30	57.0	138.3	109.23	20.46

Table (4.7) frequency distribution of echogenicity for the Right kidney

Right kidney echogenicity	Frequency	Percent%
Hyperechoic	13	26.0%
Hypoechoic	10	20.0%
Isoechoic	27	54.0%
Total	50	100.0%

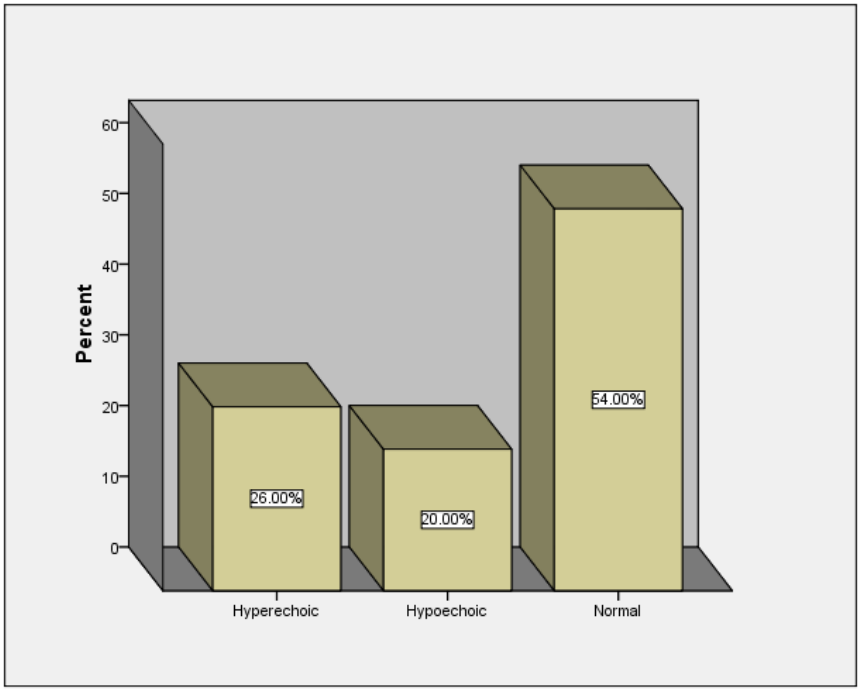


Figure (4.5) frequency distribution of echogenicity for the Right kidney

Table (4.8) frequency distribution of echogenicity for the Left kidney

Left kidney echogenicity	Frequency	Percent%
Hyperechoic	11	22.0%
Hypoechoic	12	24.0%
Isoechoic	27	54.0%
Total	50	100.0%

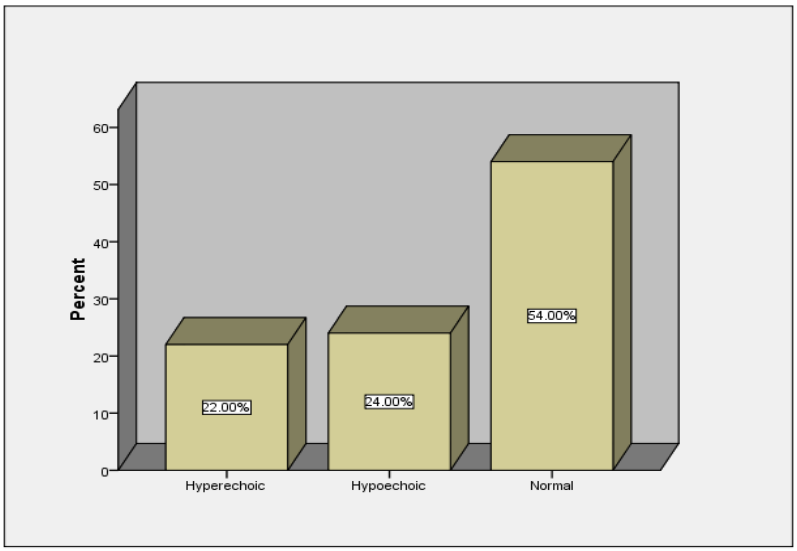


Figure (4.6) frequency distribution of echogenicity for the Left kidney

Table (4.9) frequency distribution of Cortico-medullary differentiation (CMD) for the Right kidney (RTK)

Right kidney CMD	Frequency	Percent%
Well defined	27	54.0%
Ill defined	23	46.0%
Total	50	100.0%

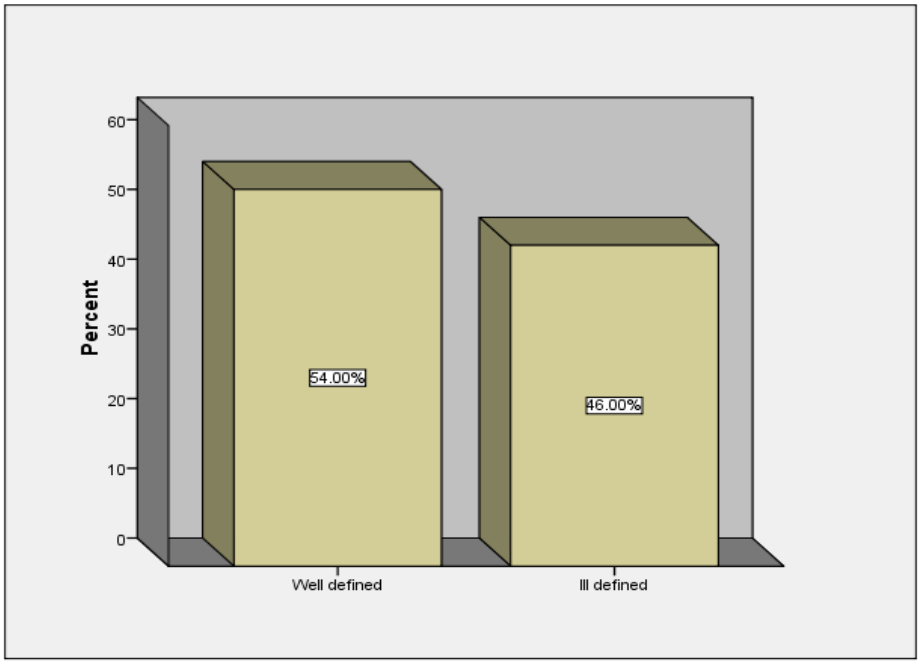


Figure (4.7) frequency distribution of Cortico-medullary differentiation (CMD) for the Right kidney (RTK)

Table (4.10) frequency distribution of Cortico-medullary differentiation (CMD) for the Left kidney (LTK)

Left kidney CMD	Frequency	Percent%
Well defined	29	58.0%
Ill defined	21	42.0%
Total	50	100.0%

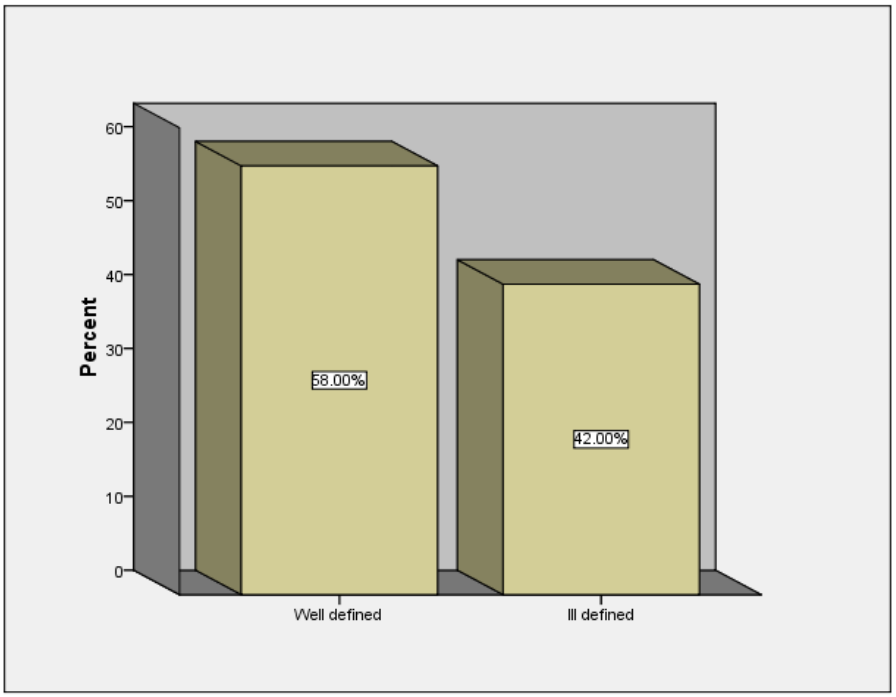


Figure (4.8) frequency distribution of Cortico-medullary differentiation (CMD) for the Left kidney (LTK)

Table (4.11) frequency distribution of treatment

Treatment	Frequency	Percent%
control	22	44.0%
Uncontrol	28	56.0%
Total	50	100.0%

Table (4.12) frequency distribution of DM-type

DM-Type	Frequency	Percent%
Type 1	4	8.0%
Type II	46	92.0%
Total	50	100.0%

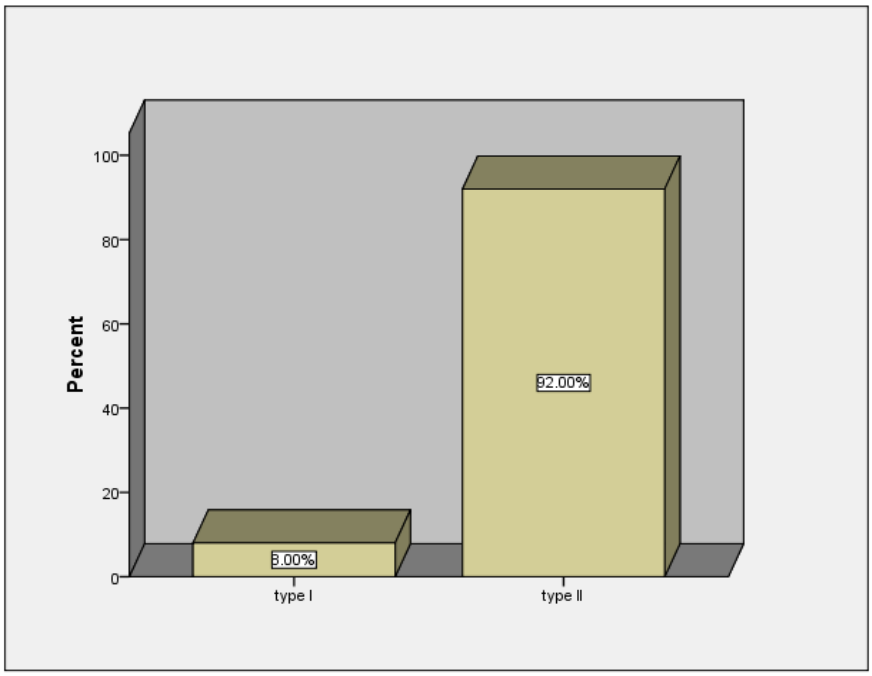


Figure (4.9) frequency distribution of DM- type

Table (4.13) frequency distribution of diagnosis

Diagnosis	Frequency	Percentage%
Acute kidney disease	17	34.0%
Chronic kidney disease	10	20.0%
CRD &stone	1	2.0%
Normal	10	20.0%
Renal cyst	10	20.0%
Stones	2	4.0%
Total	50	100.0%

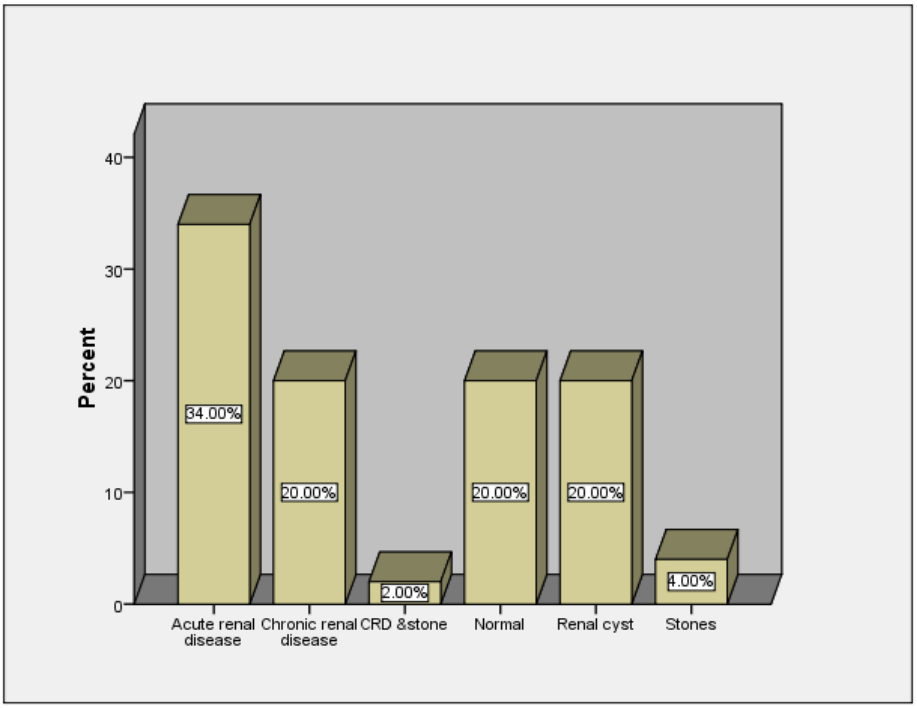


Figure (4.10) frequency distribution of diagnosis

Table (4.14) frequency distribution of side

Side	Frequency	Percent%
Right	9	18.0%
Left	10	20.0%
Both	21	42.0%
Intact	10	20.0%
Total	50	100.0%

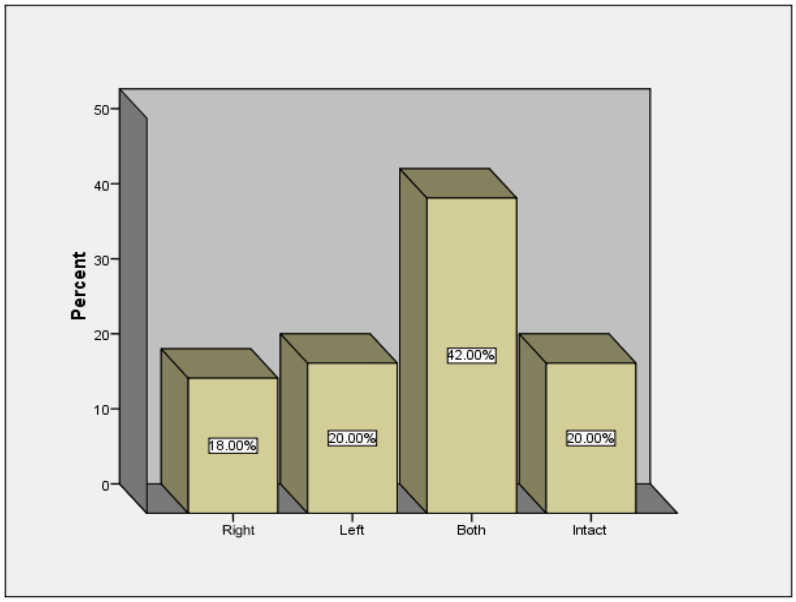


Figure (4.11) frequency distribution of side

Table (4.15) cross tabulation diagnosis and gender

Diagnosis	gender		Total
	Male	Female	
Acute renal disease	10	7	17
CRD &stone	0	1	1
Chronic renal disease	6	4	10
Normal	4	6	10
Renal cyst	7	3	10
Stones	2	0	2
Total	29	21	50
P= 0.444			

Table (4.16) cross tabulation diagnosis and age

Diagnosis	age					Total
	20-34	35-49	50-64	65-79	80-92	
Acute renal disease	0	4	8	5	0	17
CRD &stone	0	0	0	1	0	1
Chronic renal disease	0	4	6	0	0	10
Normal	0	3	5	2	0	10
Renal cyst	1	0	5	2	2	10
Stones	0	1	0	0	1	2
Total	1	12	24	10	3	50
P =0.097						

Table (4.17) cross tabulation diagnosis and duration

Diagnosis	Duration				Total
	1-10 years	11-20 years	21-30 years	> 30 years	
Acute renal disease	12	5	0	0	17
CRD &stone	0	1	0	0	1
Chronic renal disease	5	5	0	0	10
Normal	7	1	1	1	10
Renal cyst	4	5	1	0	10
Stones	1	0	1	0	2
Total	29	17	3	1	50
P =0.175					

Table (4.18) cross tabulation diagnosis and type of DM

Diagnosis	type		Total
	Type I	Type II	
Acute renal disease	0	17	17
CRD &stone	0	1	1
Chronic renal disease	1	9	10
Normal	1	9	10
Renal cyst	1	9	10
Stones	1	1	2
	4	46	50
P = 0.259			

Tables (4.19) compare mean duration and measurements

Duration		**RTKL**	**RTKW**	**RTKTH**	**RTKV**	**LTKL**	**LKW**	**LTKTH**	**LTKV**
1-10 years	Mean	9.80	4.27	4.01	90.36	10.14	4.64	4.247	107.76
	Std. Deviation	1.16	0.89	0.66	37.38	1.08	0.85	0.71	39.86
11-20 years	Mean	10.30	4.29	4.19	101.53	10.60	4.724	4.55	122.65
	Std. Deviation	1.80	0.82	0.77	44.03	1.64	.9087	0.89	45.63
21-30 years	Mean	9.77	5.10	3.27	86.00	10.13	5.200	3.60	98.33
	Std. Deviation	0.80	0.89	0.15	24.43	1.62	.4583	0.87	23.44
> 30 years	Mean	9.10	4.70	3.80	85.00	9.20	4.600	4.10	90.00
Total	Mean	9.95	4.33	4.02	93.79	10.28	4.702	4.31	111.90
	Std. Deviation	1.39	0.86	0.70	38.58	1.31	0.84	0.79	41.01
P-value		0.629	0.442	0.203	0.791	0.569	0.757	0.243	0.569

Tables (4. 20) compare mean diagnosis and measurements

diagnosis		RTKL	RTKW	RTKTH	RTKV	LTKL	LTKW	LTKTH	LTKV
AKD	Mean	10.44	4.4	4.48	109.35	10.52	4.906	4.82	131.71
	Std. Deviation	0.98	0.78	0.67	34.38	0.73	0.77	0.59	33.78
CKD &stone	Mean	8.20	3.50	3.90	59.00	10.00	4.800	5.20	131.00
CKD	Mean	8.49	3.5	3.59	55.90	8.79	3.74	3.94	68.900
	Std. Deviation	0.77	0.56	0.547	18.27	0.87	0.63	0.89	29.77
Normal	Mean	10.07	4.64	3.97	97.85	10.46	4.75	3.98	103.39
	Std. Deviation	0.77	0.81	0.71	30.22	0.85	0.68	0.79	30.97
Renal cyst	Mean	10.59	4.57	3.78	99.50	11.22	5.14	4.14	127.20
	Std. Deviation	1.86	0.82	0.49	42.47	1.73	0.69	0.61	42.96
Stones	Mean	10.30	5.55	3.75	119.50	10.30	5.35	3.90	115.00
	Std. Deviation	1.98	1.06	0.92	71.42	1.69	0.07	0.99	48.08
Total	Mean	9.95	4.33	4.02	93.79	10.28	4.70	4.31	111.89
	Std. Deviation	1.39	0.86	0.69	38.58	1.31	0.84	0.79	41.01
P-value		0.001	0.003	0.016	0.006	0.001	0.001	0.015	0.001

P <0.05 for thickness and <0.01 for others

Table (4.21) correlation between measurements & body characteristic in diabetic group

		RT KIDNEY	VOLUME	LT KIDNEY	VOLUME
height	Pearson Correlation	-.007-	.171	.089	.160
	Sig. (2-tailed)	.961	.236	.537	.268
	N	50	50	50	50
weight	Pearson Correlation	.382**	.508**	.524**	.602**
	Sig. (2-tailed)	.006	.000	.000	.000
	N	50	50	50	50
BMI	Pearson Correlation	.460**	.492**	.564**	.592**
	Sig. (2-tailed)	.001	.000	.000	.000
	N	50	50	50	50
AGE	Pearson Correlation	-.008-	.075	.084	.137
	Sig. (2-tailed)	.958	.604	.564	.342
	N	50	50	50	50
duration	Pearson Correlation	-.007-	-.034-	.017	-.035-
	Sig. (2-tailed)	.964	.817	.905	.809
	N	50	50	50	50
	**. Correlation is significant at the 0.01 level (2-tailed).				
	*. Correlation is significant at the 0.05 level (2-tailed).				

Table (4.22) correlation between measurements and body characteristic in control group (none DM)

		RT KIDNEY	VOLUME	LT KIDNEY	VOLUME
height	Pearson Correlation	.393*	.470**	.804**	.670**
	Sig. (2-tailed)	.031	.009	.000	.000
	N	30	30	30	30
weight	Pearson Correlation	.315	.197	.580**	.428*
	Sig. (2-tailed)	.090	.297	.001	.018
	N	30	30	30	30
BMI	Pearson Correlation	-.008-	-.192-	-.046-	-.071-
	Sig. (2-tailed)	.966	.309	.808	.710
	N	30	30	30	30
AGE	Pearson Correlation	-.366*	-.274-	-.810**	-.555**
	Sig. (2-tailed)	.047	.142	.000	.001
	N	30	30	30	30
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

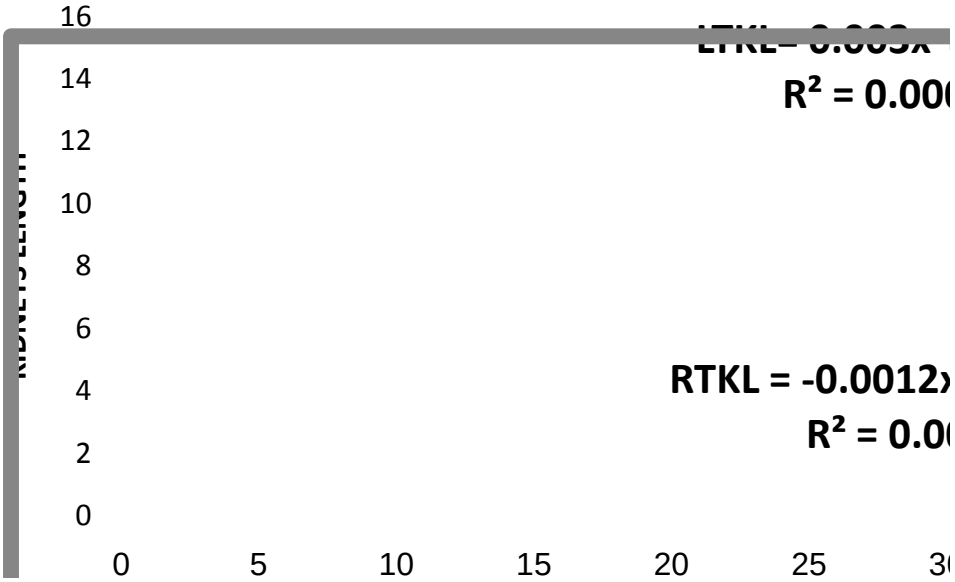


Figure (4.12) scatter plot shows relationship between Kidney length and duration of DM

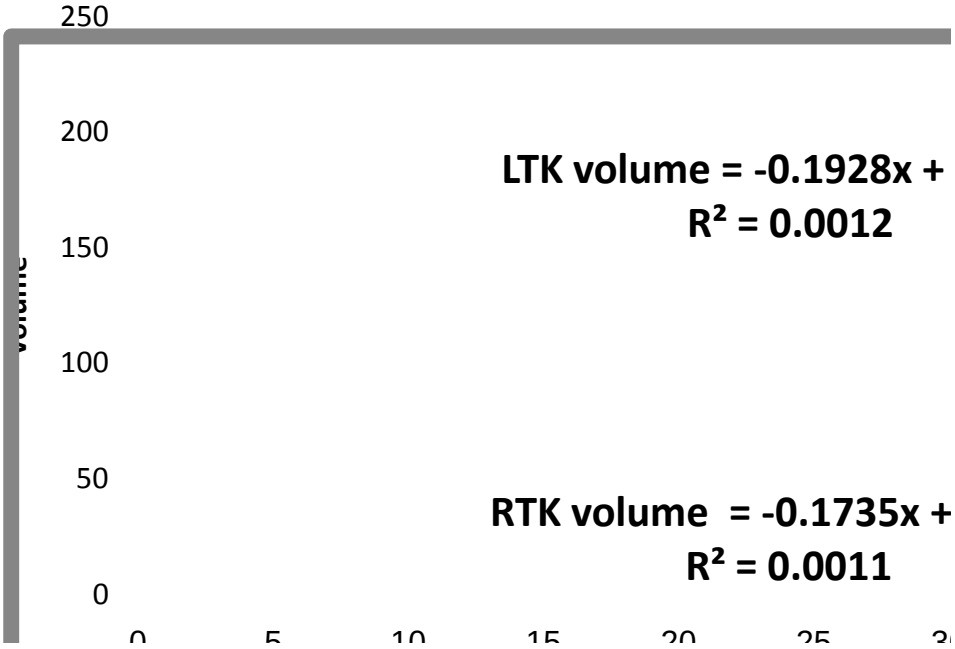


Figure (4.13) scatter plot shows relationship between Kidney volume and duration of DM

Table (4.23) a .compare mean measurements in DM and control group

Group Statistics						
variables		N	Mean	Std. Deviation	Std. Error Mean	p-value
RTK length	DM	50	9.95	1.386	.196	0.602
	None DM(control group)	30	10.08	.740	.135	
RTK volume	DM	50	93.79	38.590	5.457	0.445
	None DM(control group)	30	98.63	17.241	3.148	
LTK length	DM	50	10.28	1.311	.185	0.896
	None DM(control group)	30	10.25	.865	.158	
LTK volume	DM	50	111.90	41.005	5.799	0.700
	None DM(control group)	30	109.23	20.460	3.736	

Table (4.23) b. t-test for compare mean measurements in DM versus control

	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	-.455-	78	.651	-.125-	.274	-.671-	.421
	-.524-	77.18	.602	-.125-	.238	-.599-	.349
RTK volume	-.648-	78	.519	-4.842-	7.469	-19.712-	10.028
	-.769-	73.32	.445	-4.842-	6.300	-17.397-	7.713
LT K length	.132	78	.896	.035	.269	-.500-	.571
	.145	77.21	.885	.035	.243	-.449-	.520
LTK volume	.332	78	.741	2.670	8.040	-13.336-	18.676
	.387	75.99	.700	2.670	6.898	-11.069-	16.409

CHAPTER FIVE

Discussion ,Conclusion and Recommendation

5.1 Discussion

This study was a cross-sectional- prospective design , has been conducted to evaluate the effects of diabetes mellitus of type I and II on kidneys in Khartoum State (police hospital) and north kurdofan State (advance diagnostic center) in U/S department to assess renal change mainly size and volume by using ultrasonography in order to obtain the change in function and morphology of the kidney in diabetic patients. and its was done for 50 diabetic patients 58% male (29 of 50) , female 42% (21 of 50) in age between 20-92 years old.

This chapter describes results of standard B-mode grayscale ultrasound for kidneys of diabetic patients. Ultrasound examination was performed for both kidneys and volume was calculated in order to measure renal changes for diabetic patients. The results were tabulated in forms of figures and tables depending on different variables used in the study.

This chapter was divided in to two sections include general information including gender, age and body mass index and gray scale ultrasound results including kidney measurements.

The results of this study showed that atotal of 50 diabetic patients, 29 males (58%) and 21 females (42%) were examined (Table4.1) and (figure 4.1). Their age range was 20 to 92 years with a mean of 57.26±13.527 years (Table 4.5), so diabetes can affect both male and female in near percentage according to this study, this was explained by (National Health and Nutrition Examination Survey (NHANES) in 2004 study estimated that 26 million people in the United States have CKD (64.4 % male and 35.6 female). A total of 30 healthy none diabetic described as a control group, 17 males (56.7%) and 13

females (43.3%) (Table4.2) and (figure 4.2) were also examined by using gray scale ultrasonography. The age of this group range from 20 to 60 years, with a mean of 37.20±12.282 years (Table4.6).

The highest frequency of affected age which representing (48%) was found in (50 - 64) years group and the lowest frequency (2%) was found in 20 to 34 years group in diabetic patients (Table4.3) and (figure 4.3) , This result agreed with (Hassan, 2016).

With regard to duration of having Diabetes mellitus disease in both types was range between 1year and 33 years. most of patients acquired the disease for a duration of (1 - 10) years and representing 29/50 (58%) , 17 cases (34%) have had it for 11- 20 years, 3 cases (6%) have had it for(21- 30) years and only one patient (2%) had it for more than 30 years (Table4.4) and (figure 4.4).

Regarding the result of gray scale ultrasound, the mean kidney length, width and thickness in diabetic group for the right kidney were 9.955±1.3862 cm, 4.333±0.8647 cm and 4.020±0.6975 cm respectively. And the mean length, width and thickness for the left kidney were 10.281±1.3105cm, 4.702±0.8389cm and 4.309±0.7974cm respectively (Table4.5) . In control group, the mean length , width and thickness for the right kidney were 10.079±0.7401 cm, 4.862±0.5085 and 4.140±0.4347cm respectively while for the left kidney were 10.246±0.8649 cm, 5.183±0.8091 cm and 4.385±0.5285 cm respectively (Table4.6). The right kidney length, and volume were lower in participants with diabetes than those in the controls, but this statistically has no significant difference **(P =0.602)** and **(P =0.445)** respectively(Table4.23).

In this study , right renal length showed a decrease in mean size of the stage of diabetic renal disease progressed (mean right renal length of 9.95±1.386cm comparing to mean length of right renal of the control

group which was 10.08±0.740 cm, but this decrease was not found to be statistically significant (P=0.602) , the left renal length showed a decrease in mean size as the stage of diabetic renal disease progressed (mean left renal length of 10.28±1.311cm comparing to mean length of left renal of the control group which was 10.25±0.87 cm in control group, but this decrease was again not found to be statistically significant (P=0.896) . So the mean length of both right and left kidneys in control group was higher than that in diabetic group which are (10.08±0.740 cm , 10.25±0.865 cm) and (9.95±1.386cm , 10.28±1.311cm) respectively. (Table 4.23-a).

Regarding the study of renal parenchymal echogenicity during the renal ultrasound examination was evaluated and the result was 26% (13 case) had a Hyperechoic appearance, 20% (10 case) had a hypoechoic appearance and 54% from these cases was isoechoic for the right kidney (table 4.7 and figure 4.5). while 22% (11 case) had a hyperechoic appearance, 24% (12 case) had a hypoechoic appearance and 54% from these cases was isoechoic (normal) for the left kidney (table4.8 and figure 4.6) This result agreed with (Jastaniah et al. 2013), he aims to study the role of US in the assessment and differentiation of kidney diseases in patients with type 2 DM., study included 400 type 2 diabetic patients ranging in age from 13 - 93 years (having mean± SD 58.86 ±12.98) (Jastaniah et al., 2013).

The Cortico-medullary differentiation was also recorded by gray scale U/S for both kidneys in diabetic group , a 27cases (54.00%) were found to have well defined Cortico-medullary differentiation and 23 cases (46.00%) have ill defined corticomedullary differentiation in the right kidney (table 4.9 and figure 4.7) and 29 cases (58.00%) were found to have well defined corticomedullary differentiation and only 21

cases (42.00%) have ill defined corticomedullary differentiation in the left kidney (table 4.10 and figure 4.8).

Regarding type of diabetes, the majority of patients had type II diabetes, which representing 92% (46 cases) of all the number of participants (table4.12 and figure4.9), and only 8% (4 cases) had type 1DM. , This result agreed with (Hassan, 2016).

Regarding (table 4.14 and figure 4.11) the frequency distribution of side, the most common affected were both side which representing 42% (21cases) , right side representing 18% (9 cases) , left side representing 20% (10 cases) and 20% (10 cases) were found to be intact. Regarding this we found that the left side is more affected than the right side.

Table 4.16 summarizes the distribution of the study population by final diagnosis and age. In general, most of the renal changes were observed amongst elder people, This result agreed with (Alshaya et al., 2017).

With regard to the diagnosis and type of Diabetes , 4/50 (8%) were found with type I and bout 46/50 (92%) were found with Type II (table 4.18) This result agreed with (Alshaya et al., 2017) , and the most of the changes found were acute kidney disease (34%) then chronic kidney disease and renal cyst which were (20%) and chronic kidney disease with stone and renal stones were rarely found while the other cases were found without renal change, but these renal changes associated with different types of Diabetes was not statistically significant (**P = 0.259**).

Regarding (table 4.21) , renal measurements in diabetic group were correlated with the subject's height, weight and body mass index using the Pearson's correlation. The strongest correlation with right and left renal volume is the weight and body mass index (BMI), the

correlation coefficient was 0.508 and 0.602 ($P < 0.01$) for weight and was 0.492 and 0.592 ($P < 0.01$) for BMI (Table 4.21) ,This result agreed with.(Maaji et al., 2015).

In the nondiabetic group (Table 4.22), statistically significant negative correlation was found between age and renal volumes. This could probably be due to the fact that aging processes generally causes reduction in the size of the organs and the extent of the negative correlation is less marked in the diabetic group because of the effect of diabetes on the kidneys (nephromegaly). This finding is similar to the findings of (John et al., 2018) .

A correlation was made to study the relation between Kidney length and duration of DM using scatter plot which showed that the length of right and left kidney in cm was not significantly difference with duration of diabetes y = 0.003x+10.25 (R2=0.0003) for left kidney where the R2 =0.000 , y = 0.0012x+9.9567 for the right kidney (figure 4.12).

Also correlation was made to study the relation between Kidney volume and duration of DM using scatter plot which showed that the volume of left and right kidney in cm3 have a good correlation in inverse relation with duration of diabetes which decrease by 0.1928 cm3 for every one year increment of this duration y = - 0.1928x+113.91 (R2=0.0012). And decreased by 0.174 for right kidney where the R2=0.0011, y = - 0.174x+95.60 (figure 4.13). This finding agree with the study done by (Couchoud and Villar, 2013).

In our study regarding to (Table 4.23-a) in both diabetic and control group the mean renal length of the left kidney was found to be greater than that of the right kidney , but this was not statistically significant (P=0.896) and (P=0.602) respectively, The difference in size may be because the left kidney has more space to grow than the right

kidney .The presence of the liver on the right may have more impact on renal growth when compared to the spleen on the left. Furthermore, the left renal artery is shorter and straighter than the right; the increased blood flow in the left renal artery may result in relatively increased in volume. (Maaji et al., 2015).

It was also observed that the renal volumes (right, left, and average) were higher in the diabetics compared to the nondiabetic, but this was statistically not significant (P=0.700) and (P=0.445) (Table 4.23-a) this finding is similar to the findings that were reported in other studies. The increase in renal volumes in diabetics in this study is probably due to the pathophysiology of diabetic nephropathy (the arteriolar vasoconstriction increases glomerular pressure causing glomerular hypertension leading to hyper-filtration induced nephromegaly).(John et al., 2018).

We used significance t-test to test the difference in means between these two mean of right and left kidneys concerning the length and volume in diabetic and control groups and the results tell us that there was no significant difference because the values in the "Sig. (2-tailed)" Colum see (Table 4.23-b) were more than 0.05 ($P > 0.05$). So, we can conclude that This study showed there was no significant difference between these two mean groups right and left kidney concerning the length and volume $p > 0.05$.

5.2 Conclusion:

This study has been done in U/S department at Khartoum State (police hospital) and north kurdofan State (advance diagnostic center) for 50 patients who diagnoses as diabetics for more than 1 years their age ranging in 20– 90 years.

The main objective of this study was to assess renal change mainly size , volume and echogenicity by using ultrasonography in order to obtain the change in function and morphology of the kidney in diabetic patients .

-This study conclude that diabetes can affect both gender, according to this no significant difference between male and female gender regarding the presence of associated renal changes (males were slightly more affected than females) .

-The right kidney length, and volume were decreased in participants of the stage of diabetic renal disease progressed than those in the controls, but this statistically has no significant difference (P =0.602) and (P =0.445) respectively.

- we found that the left side is more affected than the right side.

-In the nondiabetic group negative correlation was found between age and renal volumes . This could probably be due to the fact that aging processes generally causes reduction in the size of the organs and the extent of the negative correlation is less marked in the diabetic group because of the effect of diabetes on the kidneys (nephromegaly).

- It was also observed that the renal volumes (right, left, and average) were higher in the diabetics compared to the nondiabetic

- It was also observed that there was no statistically significance of the renal changes among different age groups was found (p value = 0.097 .

A renal ultrasound is typically obtained to measure the renal size and echogenicity. Renal enlargement may be seen early in diabetes due to hyper filtration, while in late stages, the kidneys diminish in size from glomerulosclerosis. In addition, renal cortical hyperechogenicity is seen suggesting deteriorated renal function.

The study found that the kidney in diabetic patients may affected and there was decreased in length , decreased in Cortico-medullary differentiation and increased in echogenecity in most of cases. The study revealed that renal volume inversely related to the duration of diabetes mellitus, these finding provide a basis for using of conventional renal ultrasound among diabetic patients in evaluation of renal morphology in order to predict diabetes complication progression and in exclusion of obstruction and other complications that diabetic patients might have.

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5.3 Recommendations:

After the enumeration of the results that related to the following thesis, there are some ideas which could help further in the field of research and better to be recommended as follow:

☞ renal Ultrasound for patients with DM has a great role in diagnosing and evaluation of different renal changes . It is might be helpful in treatment and prevention of renal failure and other severe complications.

☞ When performing ultrasound, dependability of renal size on age, gender and body mass index has to be considered by the operator so as to differentiate between a pathological and a normal size small or large kidney.

☞ Regular ultrasound scanning for kidneys is recommended for diabetic patients to avoid rapid atherosclerotic changes resulted from DM complications.

☞This study needs further studies with large sample size because Some of the limitations in our study are the smaller sample size, so that the sample size must be large enough which may explain more precise assessment of DM renal changes by measuring the volume which is useful and accurate better for evaluation and comparison between the kidneys.

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APPENDICES

Appendix (A) US images

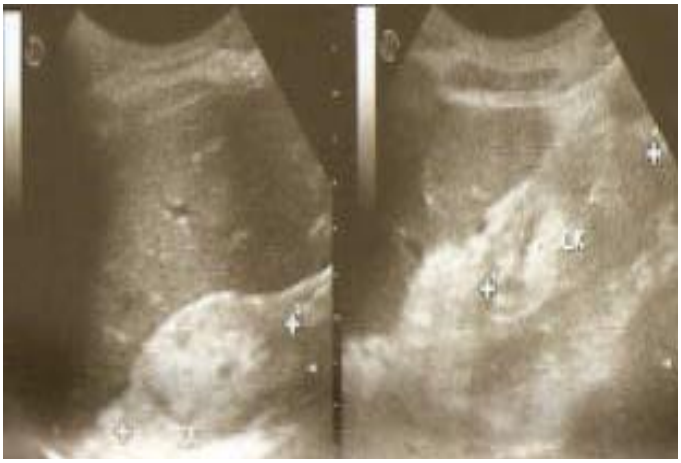

Image (1) . Small hyperechoic kidney with loss of cortico-medullary differentiation in patient with chronic renal failure.

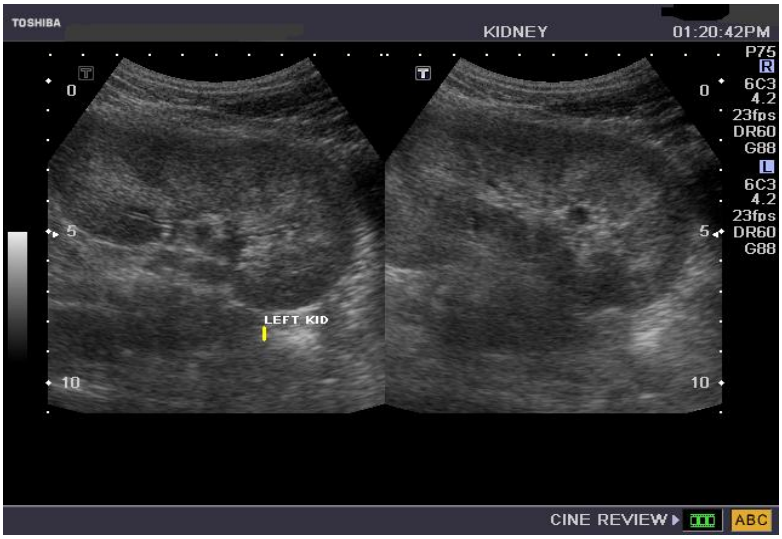

Image (2) . 56 yrs old male DM patient 12 yrs enlarge hypoechoic kidney with loss of cortico-medullary in patient with acute renal failure.

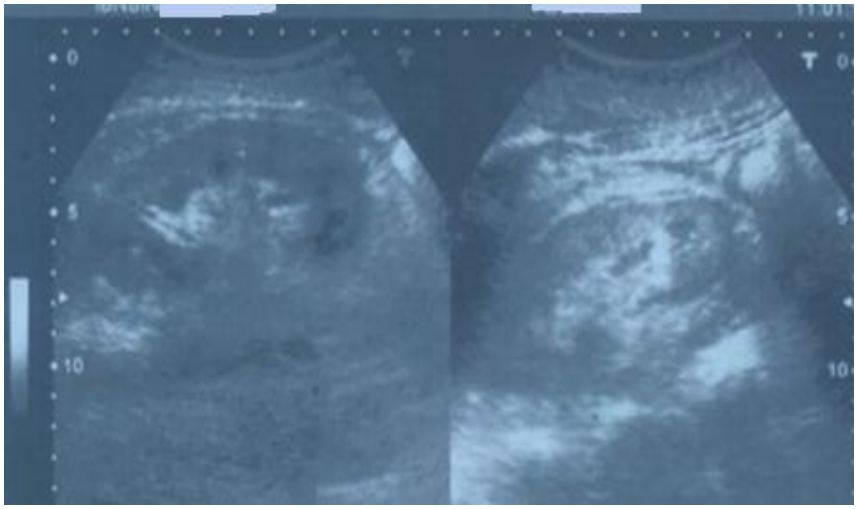

Image (3) . The image Shows enlarged hypoechoic kidney in acute renal parenchymal disease in a patient with DM.

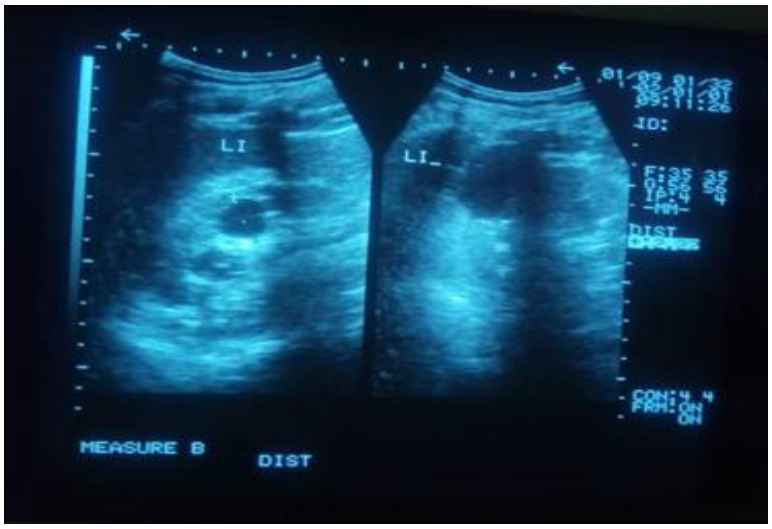

Image (4) . This was 57 yrs old Female obese & DM with 4 yrs of duration she was known and take drugs = finding on Rt kidney (multiple simple cyst the largest one on lower pole measure (2.22*2.22)cm & CMD showed poorly appearance

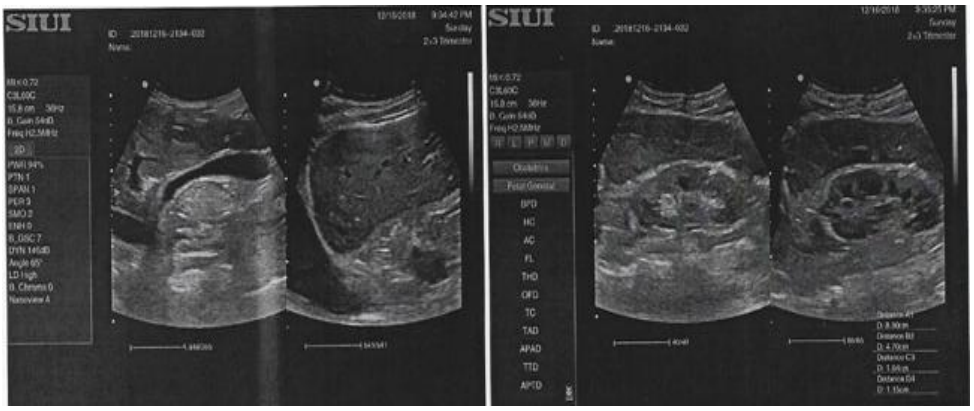

Image (5.a)

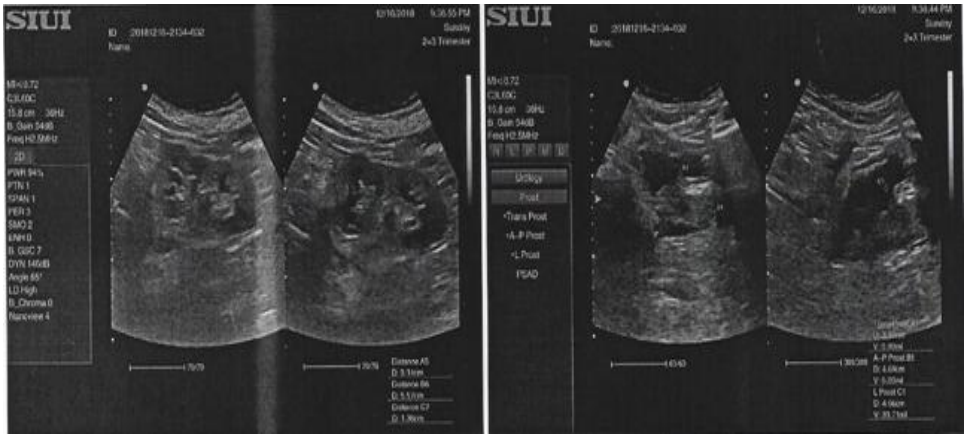

Image (5.b) . This was 60yrs old male DM with 6 yrs of duration finding (both kidney are slightly small in size with good CMD and increase echogenicity features of chronic parenchyma renal CKD

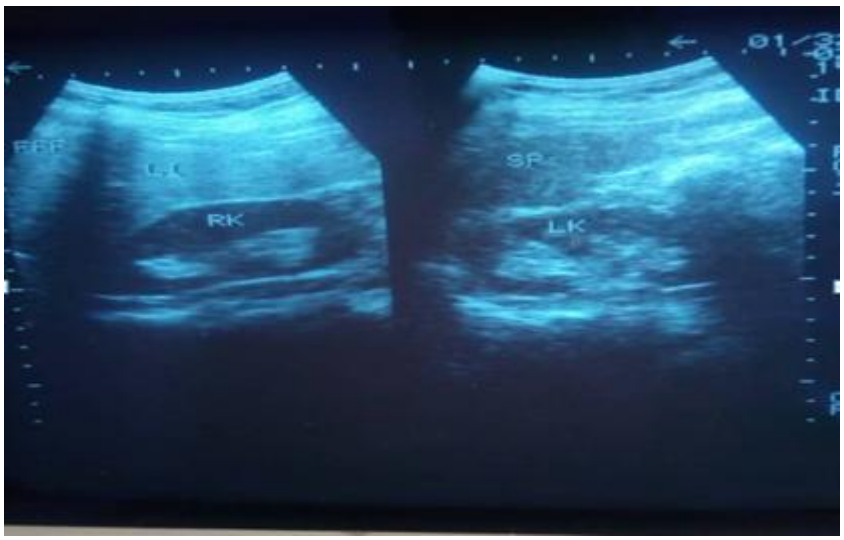

Image (6) . Obese Female about 60 yrs with DM duration (3 - 4) yrs controlled the demographic finding just slightly crystal deposit that greater on left one

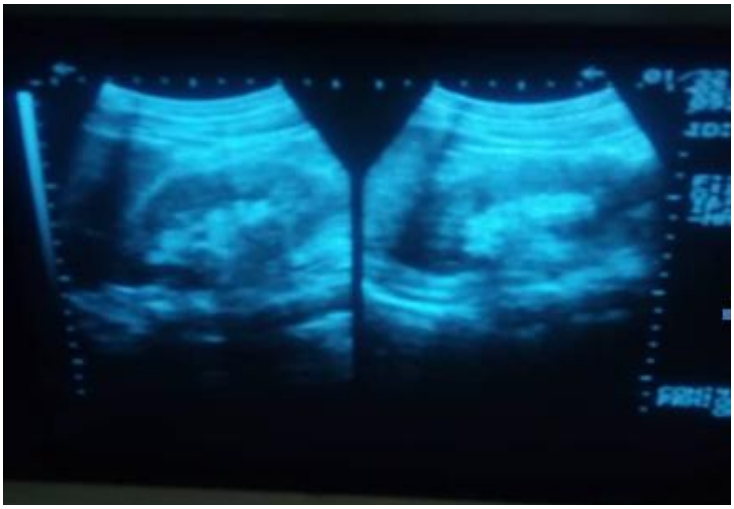

Image (7) . Male pt 73 y old &DM 3 yrs normal weight, controlled >>>>sonogram finding slightly poor CMD both sizes are normal no stones or cyst

Appendix(B)

Data collecting sheet

NO	PATIENT						RT-KIDNEY				C/M-DIFFEREN-TIATION	ECHOGENCITY	LT-KIDNEY				C/M-DIFFEREN-TIATION	ECHOGENCITY	DURATION	FINDING		
	H	W	BMI	GENDER	AGE	TREATMENT STATUS	L	W	D	V	WELL / ILL	HYPO/HYPER/ ISO	L	W	D	V	WELL / ILL	HYPO/HYPER/ ISO		DM TYPE	DIAGNOSIS	SIDE
1				M																		LT
2				F																		RT
3				M																		LT