Sudan University of Science and Technology

College of Graduate Studies

Measurement of Kidneys Dimensions for Diabetic Patients Using Ultrasonography

قياس ابعاد الكلى لمرضى السكر باستخدام التصوير بالموجات فوق الصوتية

A thesis submitted for partial fulfillment for the requirements of M.Sc. degree in diagnostic medical ultrasonography

By:

Beirut Basher Mohammed Alhilali

Supervisor:

Dr. Salah Ali Fadlulah

2021

الاية

قال تعالي:

((وما أوتيتم من العلم إلا قليلا))

صدق الله العظيم

الاسراء(85)

Dedication

This Research is dedicated to my respective mother and father ..
to Dr bassma fouad who has been my constant source of inspiration To my husband who always supports me .To my family and my friends .who have given me the drive and discipline to tackle any task with enthusiasm and determination. Without their love and support this project would not have be impossible .

Acknowledgement

My acknowledgements and gratefulness firstly to God ,who gave me the gift of the mind and blessed and guided me to a accomplish this thesis.

My gratitude is extended to my supervisor Dr. Salah Ali Fadlulah for his support and his good guidance and help through this thesis.

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

Abstract

Diabetes is common disease in many populations including Sudanese This is a descriptive study done in Alrakha hospital in Omdurman - Sudan during the period from May to November 2018, to measure the kidneys dimensions in Sudanese diabetic patients using ultrasonography .The data of this study were collected by data master sheets include the following parameter (age, gender, weights, type of DM, and duration of DM) and analyzed by SPSS based on descriptive statistics. 80 patients were enrolled in this study, 50 patients had diabetes mellitus .and 30 patient are healthy (control group). The kidneys measurements were taken in two diameters: the longitudinal diameter and the transfer's diameter with patient in supine position.

The study found that 64% of patients had DM for 1-8 years, and 24 % had DM for 9-16 years, and 6% of patients had DM for less than one year, and 6% of patients had DM for exceeding 17-25 years in addition the study found 64% had type 2 DM and 26% had type 1 DM . The study found that the kidney diameter had negative correlation with age which is agreed with other study finding.

The study showed that the ultrasonography as useful tool to measure renal volume and detecting renal changes in diabetic patients.

المستخلص

مرض السكري مرض شائع في العديد من السكان كما هو الحال في السودانيين هذه دراسة وصفية أجريت في مستشفى الرخا بأم درمان - السودان خلال الفترة من مايو إلى نوفمبر 2018 ، لقياس أبعاد الكلى لدى مرضى السكري السودانيين باستخدام الموجات فوق الصوتية ، وتم جمع بيانات هذه الدراسة حسب الأوراق الرئيسية للبيانات ، تتضمن العوامل التالية (العمر والجنس والأوزان ونوع السكري ومدة المرض بالسكرى) والتي تم تحليلها بواسطة SPSS بناءً على الإحصاء الوصفي. تم تسجيل 80 مريضا في هذه الدراسة ، 50 مريضا يعانون من مرض السكري و 30 مريضا بصحة جيدة (مجموعة التحكم). تم أخذ قياسات الكلى بقطرين: القطر الطولي وقطر النقل مع المريض في وضع الاستلقاء .وجدت الدراسة أن 64٪ من المرضى يعانون من مرض السكرى لمدة 1-8 سنوات ، و 24٪ مصابين لمدة 9-16 عامًا ، و 6٪ من المرضى لديهم DM لمدة تقل عن عام واحد ، و 6٪ من المرضى لديهم DM لأكثر من 17 عامًا - 25 سنة بالإضافة إلى ذلك ، وجدت الدراسة أن 64٪ لديهم مرض سكرى النوع التانى و 26٪ لديهم الاول. ووجدت الدراسة أن قطر الكلية له علاقة سلبية مع العمر وهو ما يتفق مع نتائج الدراسة الأخرى .وأوضحت الدراسة أن التصوير بالموجات فوق الصوتية أداة مفيدة لقياس حجم الكلى واكتشاف التغيرات الكلوية لدى مرضى السكري.

Table of contents

List of Tables

List of Figures

List of abbreviations

CCD	**Cortical collection duct**
CL	**Capillary loops**
DM	**Diabetes mellitus**
GBM	**glomerular basement membrane**
IMCD	**Inner medullary collecting duct**
Lt KL	**Left kidney length**
Lt KW	**Left kidney width**
OMCD	**Outer medullary colleting duct**
Rt KL	**Right kidney Length**
Rt KW	**Right Kidney width**
SPSS	**Statistical Package for Social Science**

Chapter One

Introduction

Chapter One

Introduction

1.1 Introduction

Diabetes mellitus (DM) is a heterogeneous group of diseases characterized by chronic elevation of glucose in the blood. It arises because the body is unable to produce enough insulin for its own needs, either because of impaired insulin secretion, impaired insulin action, or both. Diabetes affects some 300 million people world- wide, and is on the increase chronic exposure to high blood glucose is a leading cause of renal failure, visual loss and a range of other types of tissue damage diabetes also predisposes to arterial disease, not least because it is often accompanied by hypertension, lipid disorders and obesity .(G. Andresdottir, et al 2015.)

Diabetes sets the stage for kidney damage. Chronic high blood glucose levels, often in combination with hypertension (high blood pressure), damage the glomeruli and progressively diminish kidney function. (High blood pressure alone is the second-leading cause of kidney failure behind diabetes.) This type of kidney dysfunction is known as diabetic nephropathy. in its earliest stages, it has no symptoms; however, the “silent” damage going on behind the scenes can still pave the way for kidney failure.(G. Andresdottir, et al 2015.) .

Many cases of diabetes and almost all of its unwanted long-term consequences are potentially avoidable, but this will require intervention at asocial as well as at a medical level. end-stage renal failure following diabetic nephropathy is still the leading cause of death among patients with diabetes.(Andresdottir, et al ,2015)

in the early stage of diabetic nephropathy, the arteriolar vasoconstriction increases glomerular pressure causing glomerular hypertension leading to hyper-filtration-induced nephromegaly. (B.A. Perkins,2003)

In the later stage of the disease, however, the progressive damage of the kidney from glomerular sclerosis and tubular ischemia results in the shrinkage of the kidneys and reduction in its functionality. (P. Hovind,2004)

The determination of kidney size is important, because it can help in the detection of renal abnormalities and predict renal function. Renal ultrasound typically assesses kidney size, parenchymal echogenicity, rule out obstruction, as well as measures parenchymal resistive index using Doppler. (P. Gaede, et al 2004) Varying degrees of accuracy of evaluation of renal volume have been obtained using X-rays, magnetic resonance imaging (MRI), computerized tomography, scintigraphy and excretory urography. (A. Solini, et al ,2012) , However, apart from MRI (which is expensive and relatively unavailable), the others are associated with risks of ionizing radiation; hence, these may not be suitable for regular patients' follow-up. The use of contrasts agents with its attendant potential complications count also against the use of these imaging modalities. (L.M. Thorn, et al 2015)

Diabetic kidney disease is a decrease in kidney function that occurs in some people who have diabetes. It means that your kidneys are not doing their job as well as they once did to remove waste products and excess fluid from your body .In patients with Type I (juvenile-onset or insulin-dependent) diabetes, a diagnosis of early kidney disease can be based on the presence of very small amounts of protein in the urine (microalbuminuria). Special methods are needed to measure these small amounts of protein. When the amount of protein in the urine becomes large enough to be

detected by standard tests, the patient is said to have "clinical" diabetic kidney disease.

1-2Problem of the statement :

The ultrasound is one of best modality that used in diagnosis of kidney disease, Diabetic mellitus has severe effect on kidney, which can lead to decrease the kidney size , examination of diabetic mellitus patient kidney earlier it is important in diagnosis and treatment

There is a lack of accuracy in detecting because all patients don't participate in advanced exams and this contributes to the increased prevalence

1-3 importance of the study

Diabetes mellitus is serious disease that could lead to the death of the patient. Add to that the common complication like; renal disease. Diabetes is more dangerous than most people assume, because if not managed correctly, it can wreak havoc on just about every system and organ in the body.

1-4 Objectives:

1-4-1 General objective:

To measure the Renal dimensions in diabetic patients using ultrasonography

1-4-2 Specific objectives

- To study renal measurement in a group of diabetic patients
- To correlate the results and findings with patient age.
- To correlate findings with the type of diabetes (insulin dependent or non-insulin dependent) diabetic mellitus.
- To correlate findings with family history .
- To compare between the normal and diabetic patients to correlate the result .

1-5 Research out line

The study was highlight on evaluation of the effect received by kidney in diabetic patient using ultrasound examination by measuring of the kidney size and evaluation of morphological characteristic of kidney in duration of the diabetes Miletus therefore prediction of the early management of these effect. .

Chapter Two

Literature Review

Chapter Two

Literature Review

2.1: Theoretical background

Firstly we will review the anatomy, physiology, ultrasound technique for kidneys and sonographic features of kidney and secondly the pathological features in this organ in diabetic patient and previous studies.

2.1.1-Anatomy of the kidney:

Kidneys are paired retroperitoneal organs situated in the posterior part of the abdomen on each side of the vertebral column, the upper pole of each kidney lies opposite the twelfth thoracic vertebra, and the lower pole lies opposite the third lumbar vertebra. The right kidneys usually slightly more caudal in position. The weight of each kidney ranges from 125 g to 170 g in the adult male and from 115 g to 155 g in the adult female. The kidney is approximately 11 cm to 12 cm in length, 5.0 cm to 7.5 cm in width, and 2.5 cm to 3.0 cm in thickness. Located on them edial or concave surface of each kidneys slit ,called the hilus (Walter et al., 2004)

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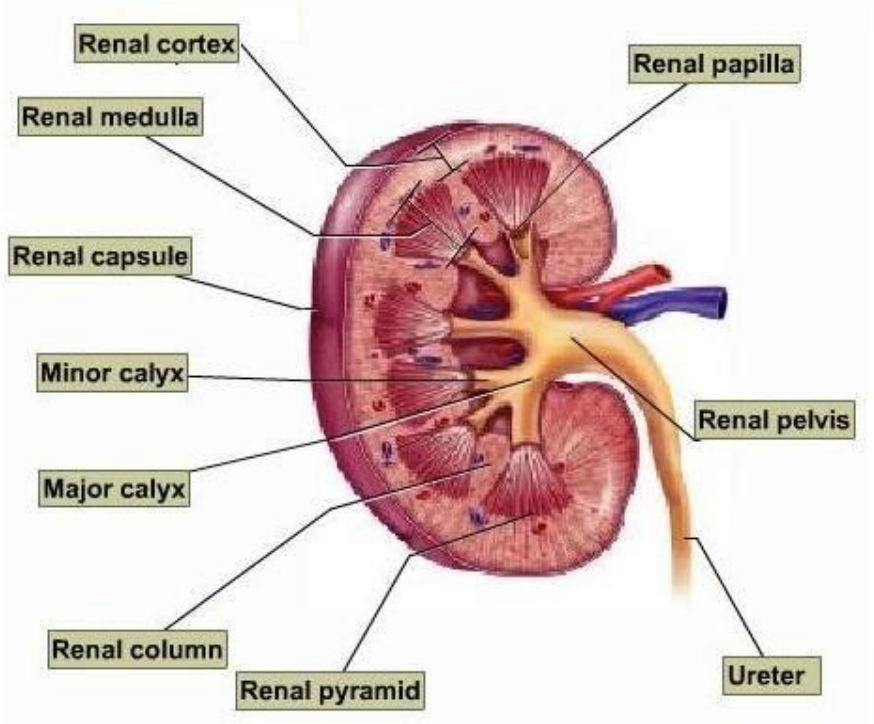


Figure 2.1 anatomy of the kidney

Through which the renal pelvis, the renal artery and vein, the lymphatic's, and a nerve plexus pass into the sinus of the kidney. The organ is surrounded by a tough fibrous capsule, which is smooth and easily removable under normal conditions. The kidneys receive blood from the renal arteries, left and right, which branch directly from the abdominal aorta. Despite their relatively small size, the kidneys receive approximately 20% of the cardiac output. (Walter et al., 2004) each kidney is supplied normally by a single renal artery, although the presence of one or more accessory renal arteries is not uncommon. The renal artery enters the hilar region and usually divides to form an anterior and a posterior branch. Three segmental or lobar arteries arise from the anterior branch and supply the upper, middle, and lower thirds of the anterior surface of the kidney. the posterior branch supplies more than half of the posterior surface and occasionally gives rise to a small apical

segmental branch. However, the apical segmental or lobar branch arises most commonly from the anterior division. No collateral circulation has been demonstrated between individual segmental or lobar arteries or their subdivisions. Not uncommonly, the kidneys receive aberrant arteries from the superior mesenteric, suprarenal, testicular, or ovarian arteries. True accessory arteries that arise from the abdominal aorta usually supply the lower pole of the kidney.

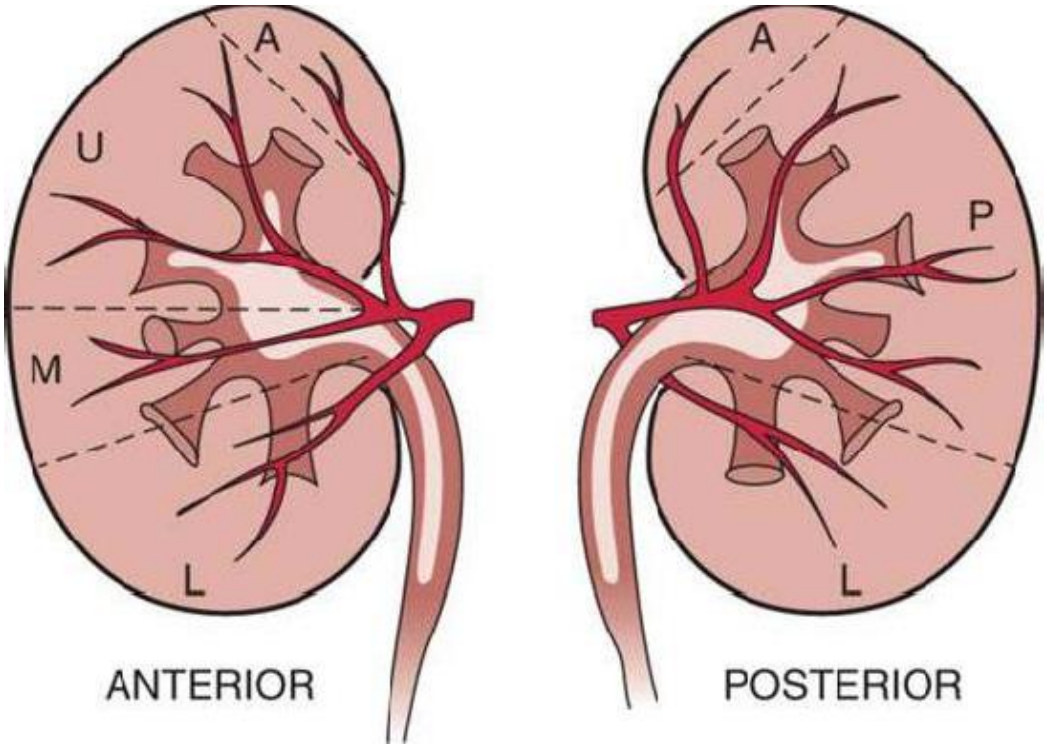


FIGURE 2-2 Diagram of the vascular supply of the kidney.

Two distinct regions can be identified on the cut surface of a bisected kidney: a pale outer region, the cortex, and a darker inner region, the medulla. This is divided into8 to 18 striated conical masses, the renal pyramids. The base of each pyramid is positioned at the corticomedullary boundary, and the apex extends toward the renal pelvis to form a papilla. On the tip of each papilla are 10 to 25 small openings that represent the distal ends of the collecting ducts (of Bellini). These openings form the area

cribrosa, the renal cortex is about 1 cm in thickness, forms a cap over the base of each renal pyramid, and extends downward between the individual pyramids to form the renal columns of Bertin. from the base of the renal pyramid, at the corticomedullary junction, longitudinal elements termed the "medullary rays of Ferrein" extend into the cortex. Despite their name, the medullary raysare actually considered a part of the cortex and are formed by the collecting ducts and the straight segments of the proximal and distal tubules. The renal pelvis is lined by transitional epithelium and represents the expanded portion of the upper urinary tract. In humans, two and sometimes three out pouching, the major calyces, extend outward from the upper dilated end of the renal pelvis. From each of the major calyces, several minor calyces extend toward the papillae of the pyramids and drain the urine formed byeach pyramidal unit. In mammals possessing a unipapillate kidney, the papilla is directly surrounded by the renal pelvis. The ureters originate from the lower portion of the renal pelvis at the ureteropelvic junction, and in humans they descend a distance of approximately 28 cm to 34 cm to open into the fundus of the bladder. The walls of the calyces, pelvis, and ureters contain smooth muscle that contracts rhythmically to propel the urine to the bladder. (www.mdconsult.com)

2-1-1-1 The nephron:

The functional unit of the kidney is the nephron. Each human kidney contains about 0.6 × 10 to 1.4 × 10nephrons, which contrasts with the approximately 30,000 nephrons in each adult kidney. The essential components of the nephron include the renal or Malpighian corpuscle (glomerulus and Bowman's capsule), the proximal tubule, the thin limbs, the distal tubule, and the connecting tubule. The origin of the nephron is the metanephricblastema. although there has not been universal agreement on

the origin of the connecting tubule, it is now generally believed to derive from the metanephricblastema. The collecting duct system, which includes the initial collecting tubule, the cortical collecting duct (CCD) in the medullary ray, the outer medullary collecting duct (OMCD), and the inner medullary collecting duct (IMCD), is not, strictly speaking, considered part of the nephron because embryologicaly it arises from the ureteric bud. However, all of the components of the nephron and the collecting duct system are inter related functionally.

Two main populations of nephrons are recognizable in the kidney: those possessing a short loop of Henle and those with a long loop of Henle. The loop of Henle is composed of the straight portion of the proximal tubule (pars recta), the thin limb segments, and the straight portion of the distal tubule (thick ascending limb, or pars recta). The length of the loop ofHenleis generally related to the position of its parent glomerulus in the cortex. most nephrons originating from superficial and mid cortical locations have short loops of Henle that bend within the inner stripe of the outer medulla close to the inner medulla. A few species, including humans, also possess cortical nephrons with extremely short loops that neverenter the medulla but turn back within the cortex. Nephrons originating from the Juxtamedullary region near the corticomedullary boundary have long loops of Henle with long descending and ascending thin limb segments that enter the inner medulla. many variations exist, however, between the two basic types of nephrons, depending on their relative position in the cortex. The ratio between long and short loops varies among species. Humans and most rodents have a larger number of short-looped than long-loopednephrons.

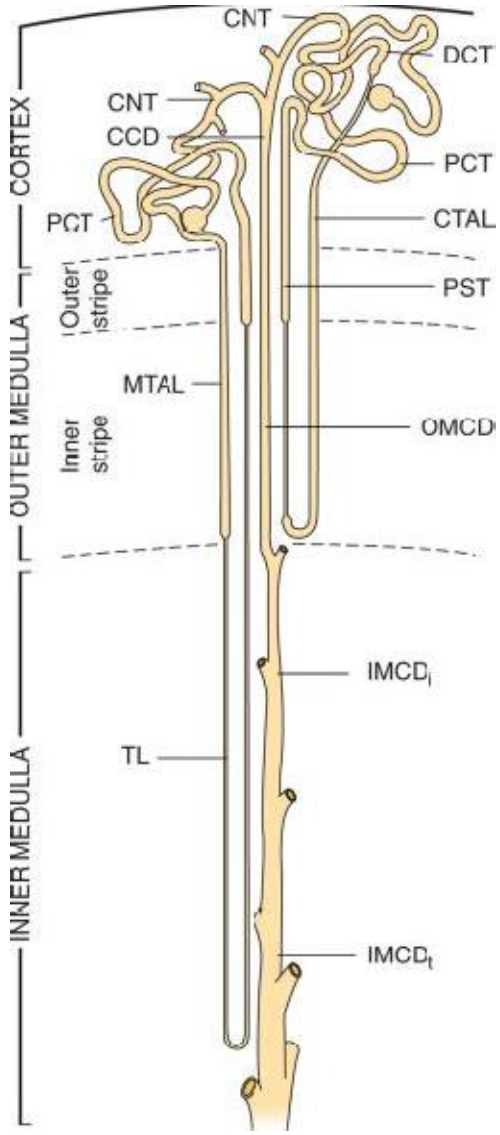


FIGURE 2-3: Diagram illustrating superficial and Juxtamedullary nephron.

On the basis of the segmentation of the renal tubule, the medulla can be divided into an inner and an outer zone, with the outer zone further subdivided into an inner and an outer stripe.The inner medulla contains both descending and ascending thin limbs and large collecting ducts, including the ducts of Bellini. In the inner stripe of the outer medulla, thick ascending limbs are present in addition to descending thin limbs and collecting ducts. The outer stripe of the outer medulla contains the terminal segments of the pars recta of the proximal tubule, the thick ascending limbs (partesrectaeof

the distal tubule), and collecting ducts. The division of the kidney into cortical and medullary zones and the further subdivision of the medulla into inner and outer zones are of considerable importance in relating renal structure totheabilityof an animal to form maximally concentrated urine.(www.mdconsult.com)

Renal Corpuscle (Glomerulus): The renal corpuscle is composed of a capillary network lined bya thin layer of endothelial cells; a central region of mesangial cells with surrounding mesangial matrix material; the visceral epithelial cells and the associated basement membrane; and the parietal layer of Bowman's capsule with its basement membrane, Between the two epithelial layers is a narrow cavity called Bowman's space, or the urinary space. Although the term renal corpuscle is more precise anatomically than the term glomerulus when referring to that portion of the nephron composed of the glomerular tuft and Bowman's capsule, the term glomerulus is employed throughout this chapter because of its common use. The visceral epithelium is continuous with the parietal epithelium at the vascular pole, where the afferent arteriole enters and the efferent arteriole exits the glomerulus. The parietal layer of Bowman's capsule continues into the epithelium of the proximal tubule at the so-called urinary pole.

The average diameter of the glomerulus is approximately 200 mm in the human kidney and 120 mm in the rat kidney. However, glomerular number and size vary significantly with age andgender as well as birth weight. The average glomerular volume has been reported tobe 3 to 7 million mm in humans and 0.6 to 1 million mm in the rat. In the rat, Juxtamedullary glomeruli are larger than glomeruli in the superficial cortex. However, this isnot the case in the human kidney The glomerulus is responsible for the production of an ultra-filtrate of plasma. The filtration barrier between the

blood and the urinary space is composed of a fenestrated endothelium, the peripheral glomerular basement membrane (GBM), and the slit pores between the foot processes of the visceral epithelial cells the mean area of filtration surface per glomerulus has been reported to be 0.203 mm in the human kidney and 0.184mmin the rat kidney. Endothelial Cells The glomerular capillaries are lined by a thin fenestrated endothelium The endothelial cell nucleus usually lies adjacent to the mesangial, away from the urinary space, and the remainder of the cell is irregularly attenuated around the capillary lumen the endothelium is perforated by pores or fenestrae, which in the kidney range from 70 nm to 100 nm in diameter Thin diaphragms have been observed extending across these fenestrae and electron microscopic studies using a modified fixation method reported the presence of filamentous sieve plugs in the fenestrae .The function of these plugs remains to be established and it is not known whether they represent a significant barrier to the passage of macromolecules. Recent studies have confirmed the presence of electron-dense filamentous material in the fenestrae and also demonstrated a thick filamentous surface layer on the endothelial cells. Non fenestrated, ridge-like structures termed cytofolds are found near the cell borders.(www.mdconsult.com)

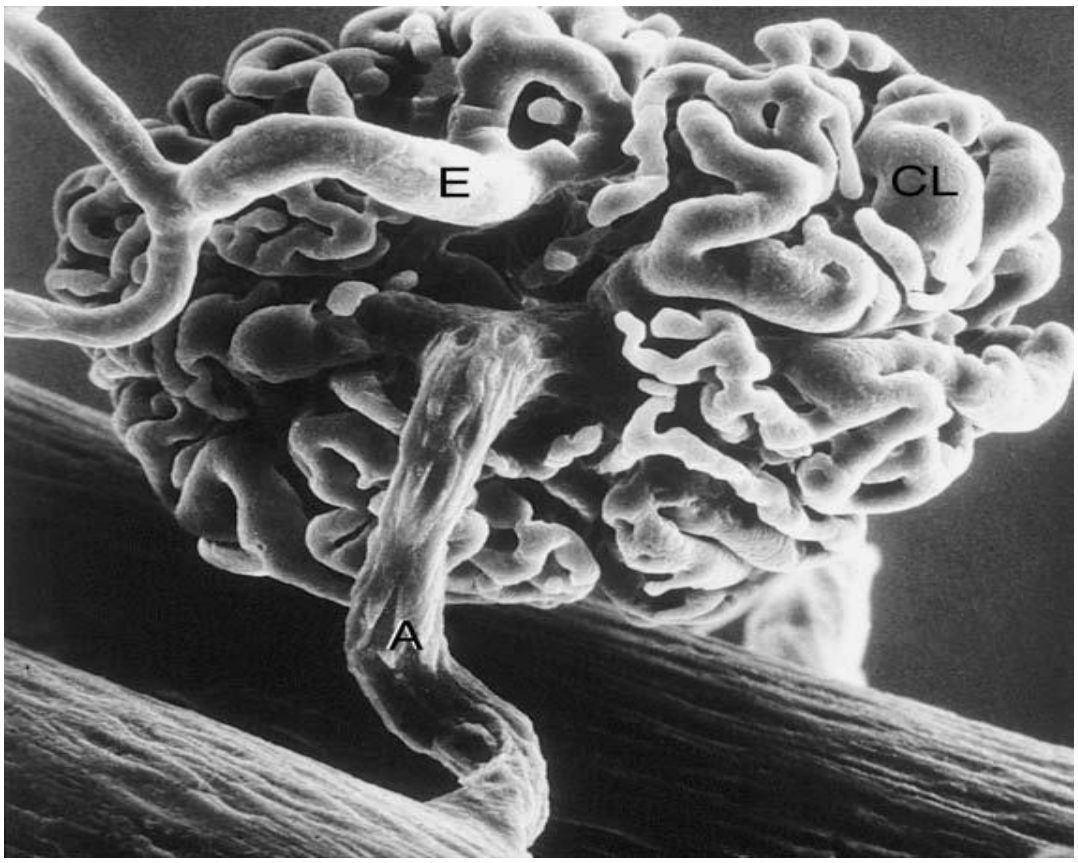


Figure 2-4 Scanning electron micrograph of a cast of a glomerulus with its many capillary Loops (CL) and adjacent renal vessels.

2-1-1-2 Juxtaglomerular Apparatus:

The juxtaglomerular apparatus is located at the vascular pole of the glomerulus, where a portion of the distal nephron comes into contact with its parent glomerulus. It has a vascular and a tubule component. The vascular component is composed of the terminal portion of the afferent arteriole, the initial portion of the efferent arteriole, and the extraglomerular mesangial region. The tubule component is the macula densa, which is that portion of the thick ascending limb that is in contact with the vascular component. The extraglomerular mesangial region, which has also been referred to as the polar cushion (polkissen) or the lacis, is bounded by the cells of the macula

densa, the specialized regions of the afferent and efferent glomerular arterioles, and the mesangial cells of the glomerular tuft (the intraglome-rular mesangial cells). Within the vascular component of the juxtaglomerular apparatus, two distinct cell types can be distinguished: the juxtaglomerular granular cells, also called epithelioid or the myoepithelial cells, and the agranular extraglomerular mesangial cells, which are also refer-red to as the lacis cells or pseudo-meissnerian cells of Goormaghtigh. (www.mdconsult.com)

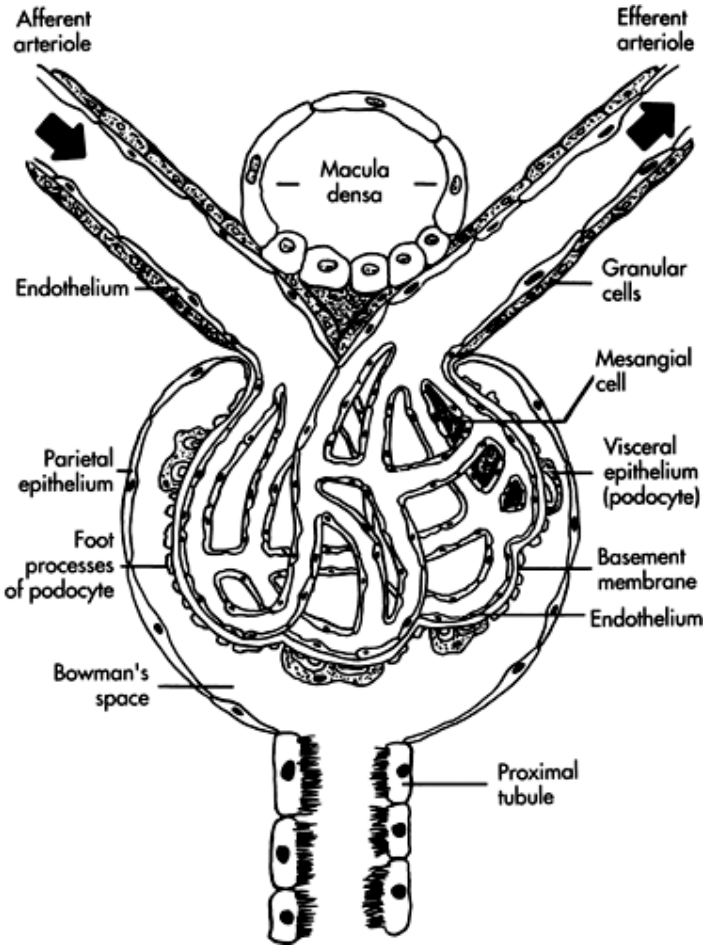


Figure 2-5 : Diagram shows the component of Juxtamedullary apparatus

2-1-2-Physiology:

The kidney participates in whole-body homeostasis, regulating acid-base balance, electrolyte concentrations, extracellular fluid volume, and regulation of blood pressure. The kidney accomplishes these homeostatic functions both independently and in concert with other organs, particularly those of the endocrine system. Various endocrine hormones coordinate these endocrine functions; these include renin, angiotensin II, aldosterone, antidiuretic hormone, and atrial natriuretic peptide, among others. Many of the kidney's functions are accomplished by relatively simple mechanisms of filtration, reabsorption, and secretion, which take place in the nephron. Filtration, which takes place at the renal corpuscle, is the process bywhichcells and large proteins are filtered from the blood to make an ultrafiltrate that eventually becomes urine. The kidney generates 180 liters of filtrate fluid on a day, while reabsorbing a large percentage, allowing for the generation of only approximately 2 liters of urine. Reabsorption is the transport of molecules from this ultrafiltrate and into the blood. Secretion is the reverse process, in which molecules are transported in the opposite direction, from the blood into the urine. (www.Wikipedia-org/wiki/kidney,(2012).

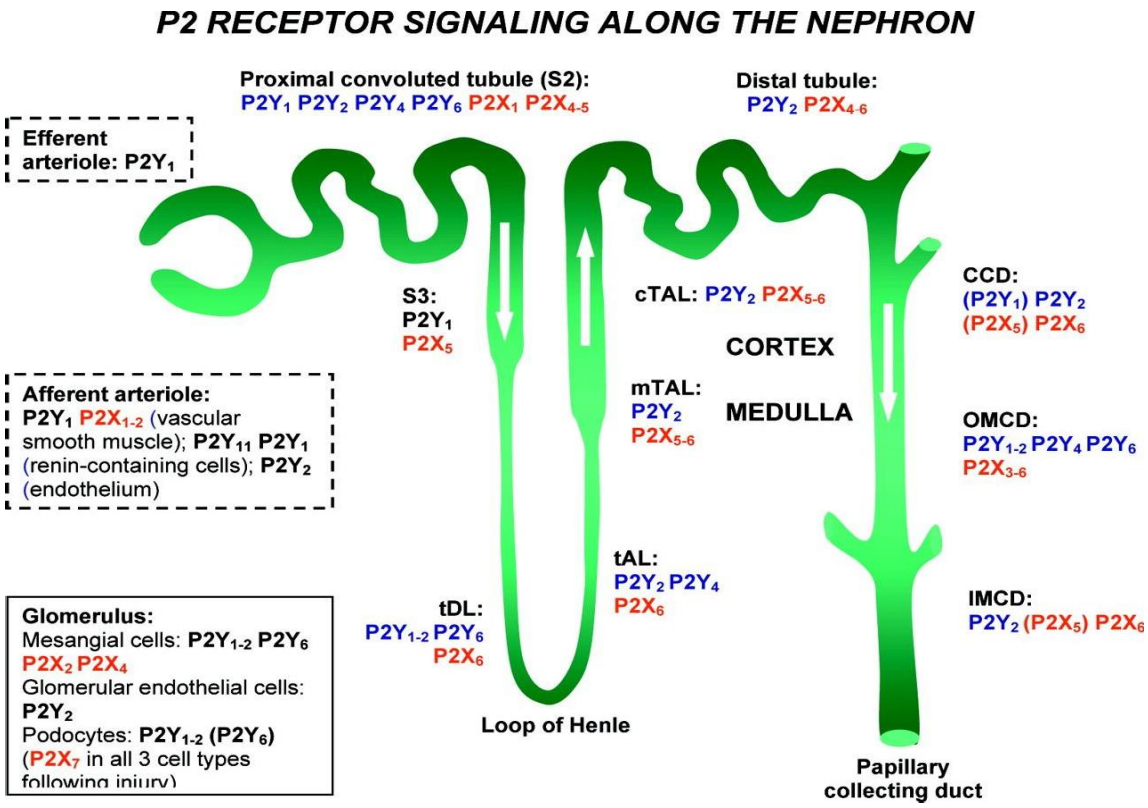


Figure 2-6: diagram shows p2 receptor signaling along the nephron

2-1-3 Ultrasound Technique of kidney:

The examination begins with the patient in the supine position. Scans are performed in the sagittal and transverse planes from the anterior approach using the liver and spleen as acoustic windows. Various maneuvers may enhance demonstration of the kidneys: left lateral decubitus or lateral oblique positions for the right kidney and right lateral decubitus or lateral oblique positions for the left kidney. Coronal longitudinal and transverse scans may also be obtained and are recommended for evaluating the renal pelvis and proximal ureter on hydronephrotic patients.

The highest frequency transducer permitting adequate penetration is used. This is usually in the 3 to 5 MHz range. A phased array sector probe with its small footprint permits subcostal and intercostal scanning.

2-1-4 Normal Sonographic Appearances of Kidney:

The kidney is an ellipsoid structure when demonstrated in its long axis as (figure 2-7) which demonstrate right kidney. The capsule is an echogenic white boundary separating the kidney from adjacent structures anteriorly and the musculature posteriorly, the renal cortex is homogeneous, fine textured and poorly echogenic, the cortex is equal to, or less echogenic than the normal liver, the medulla consists of pyramids which are anechoic structures with their bases adjacent to the renal cortex and their apices directed towards the renal sinus, the renal sinus is the most echogenic portion of the adult kidney. This echogenic areais called the central echo complex. In thenon hydrated state the renal pelvis is collapsed. (Gilani S.A , 2003)

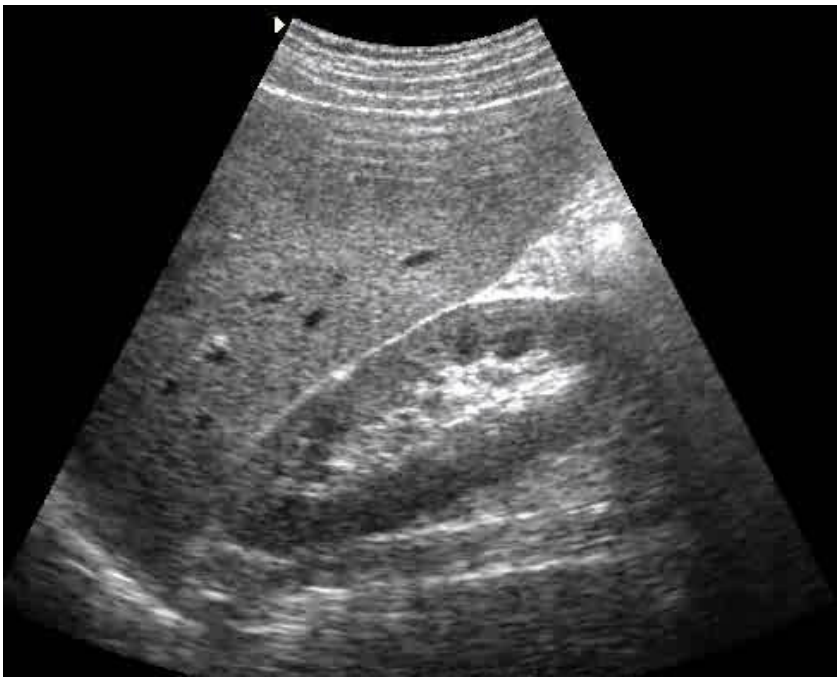


Figure 2-7 Sonographic appearance of normal right kidney.

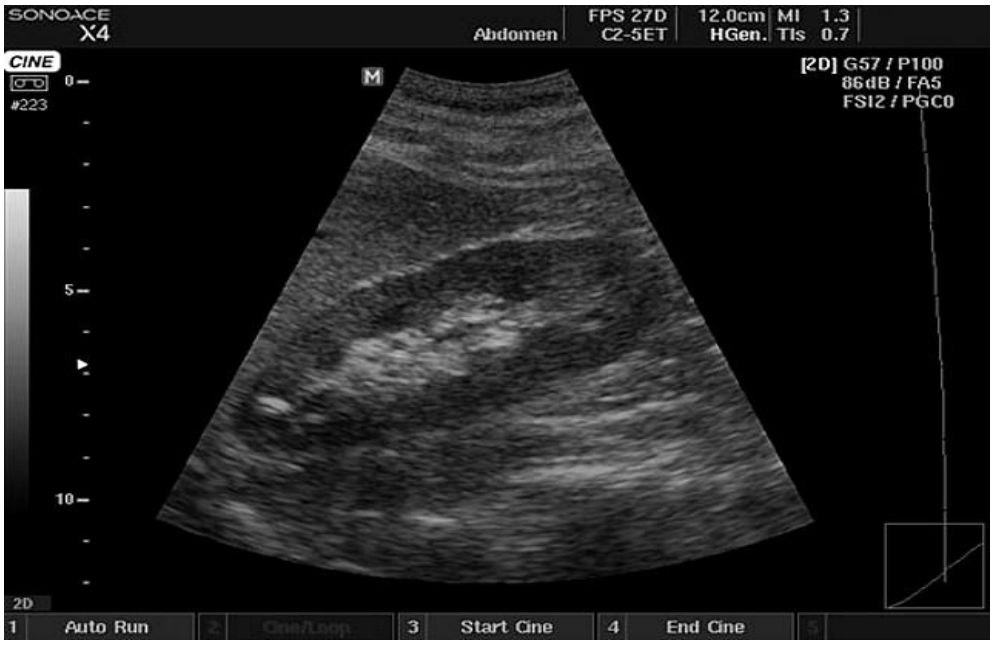


Figure 2-8 Sonographic appearance of normal left kidney.

2-1-5 Normal Renal Measurements:

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.

The normal renal length in females ranges from 9.5 to 12.1 cm and in males from 10.1 to 12.6 cm. Therefore, the normal adult kidney should measure 9-13 cm in length, 2.5 to 3.5 cm3,4in 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 abnormalin 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 (Gilani S.A , 2003).

2-1-5-1 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 echogenicityincreases.
3. The overall size decreases gradually but is only apparent in theelderly.

2-1-6-Diabetic nephropathy:

Diabetic nephropathy (*nephropatiadiabetica*), also known as Kimmelstiel-Wilson syndrome, or nodular diabetic glomerulosclerosis and intercapillary glomerulonephritis, is a progressive kidney disease caused by angiopathy of capillaries in the kidney glomeruli. It ischaracterized by nephrotic syndrome and diffuse glomerulosclerosis. It is due to longstanding diabetes mellitus, and is a prime indication for dialysis in many Western countries.(Berkman, James; *et al*. 1973).

The syndrome can be seen in patients with chronic diabetes (usually less than 15 years after onset) after about 5 years in type 1 diabetes. Clinical nephropathy secondary to glomerular disease usually manifests 15–25 years after diagnosis of diabetes and affects 25-35% of patients under the age of 30 years. It is theleadingcause of premature death in young diabetic patients.(between 50 and 70 years old) The disease is progressive and may cause death two or three years after the initial lesions, and is more frequent in men. Diabetic nephropathy is the most common cause ofchronic kidney failure and end-stage kidney disease in the United States. People with both type 1 and type 2 diabetes are at risk. The riskis higher if blood- glucose

levels are poorly controlled. Furthermore, once nephropathy develops, the greatest rate of progression is seen in patients with poor control of their blood pressure. Also people with high cholesterol level in their blood have much more risk than others. . (www.Wikipedia-org/wiki/diabetic-nephropathy).

2-1-6-1 Cause:

The word diabetes means "passing through", referring to the polyuria (abnormal increase ofurine production), a symptom historically present in those affected by the disease. When the level of blood glucose rises beyond the kidney's capacity to reabsorb glucose from the renal ultrafiltrate, glucose remains diluted in the fluid, raising its osmotic pressure and causing more water to be carried out, thus, increasing the excreted urine volume. The increased volume dilutes the sodium chloride in the urine, signaling the macula dense to release more renin, causing vasoconstriction, a survival mechanism to retain water by passing less blood through the kidneys. Because the kidney is nurtured exclusively by the blood it filtrates, the vasoconstriction also reduces the nutrients supplied to it, causing infarct of its tissues and reduction of renal function. (Www.Wikipedia-org/wiki/diabetic-nephropathy).

2-1-6-2-Pathophysiology:

The earliest detectable change in the course of diabetic nephropathy is a thickening in the glomerulus. At this stage, the kidney may leak more serum albumin (plasma protein) than normal in the urine (albuminuria), and this can be detected by sensitive medical tests for albumin. This stage is called “microalbuminuria”. As diabetic nephropathy progresses, increasing numbers of glomeruli are destroyed by progressive nodular glomerulosclerosis. Consequently, urine albumin increases to the point that

it may be detected by ordinary urinalysis techniques. At this stage, a kidney biopsy generally clearly shows diabetic nephropathy (Kimmelstiel . P, et al 1936).

2-1-6-3-Signs and symptoms:

Kidney failure provoked by glomerulosclerosis leads to fluid filtration deficits and other disorders of kidney function. There is an increase in blood pressure (hypertension) and fluid retention in the body plus a reduced plasma oncotic pressure causes edema. Other complications may be arteriosclerosis of the renal artery andproteinuria.

Throughout its early course, diabetic nephropathy has no symptoms. They develop in late stages and may be a result of excretion of high amounts of protein in the urine or dueto renal failure . edema: swelling, usually around the eyes in the mornings; later, general body swelling may result, such as swelling of the legs , foamy appearance or excessive frothing of the urine (caused by theproteinuria),unintentional weight gain (from fluid accumulation) , anorexia (poor appetite),nausea and vomiting , malaise (general ill feeling) , fatigue., headache and generalize ditching.

The first laboratory abnormality is a positive microalbuminuria test. Most often, the diagnosis is suspected when a routine urinalysis of a person with diabetes shows too much protein in the urine (proteinuria). The urinalysis may also show glucose in the urine, especially if blood glucose is poorly controlled. Serum creatinine and BUN may increase as kidney damage progresses.

A kidney biopsy confirms the diagnosis, although it is not always necessary if the case is straightforward, with a documented progression of proteinuria over time and presence of diabetic retinopathy on examination of the retina of the eyes.

2-1-6-4 Treatment:

The goals of treatment are to slow the progression of kidney damage and control related complications. The main treatment, once proteinuria is established, is ACE inhibitor drugs, which usually reduces proteinuria levels and slows the progression of diabetic nephropathy .Blood-glucose levels should be closely monitored and controlled. This may slow the progression of the disorder, especially in the very early ("microalbuminuria") stages. Medications to manage diabetes include oral hypoglycemic agents and insulin injections. As kidney failure progresses, less insulin is excreted, so lesser doses may be needed to control glucose levels .Diet may be modified to help control blood-sugar levels. Modification of protein intake can affect hemodynamic and non-hemodynamicinjury.

High blood pressure should be aggressively treated with antihypertensive medications, in order to reduce the risks of kidney, eye, and blood vessel damage in the body. It is also very important to control lipid levels, maintain a healthy weight, and engage in regular physical activity .Dialysis may benecessary once end-stage renal disease develops. At this stage, a kidney transplantation must be considered. Another option for type 1 diabetes patients is a combined kidney-pancreas transplant. C-peptide, a by-product of insulin production, may provide new hope for patients suffering from diabetic nephropathy (Wahren J, al. 2007).

2-1-6-5-Prognosis:

Diabetic nephropathy continues to get gradually worse. Complications of chronic kidney failure are more likely to occur earlier, and progress more rapidly, when it is caused by diabetes than other causes. Even after initiation of dialysis or after transplantation, people with diabetes tend to do worse than those without diabetes.

2-1-6-6Complications:

Possible complications include: hypoglycemia (from decreased excretion of insulin) (insulin isn’t secreted by the kidneys) (decreased excretion of insulin would cause hyperglycemia) , rapidly progressing chronic kidney failure , end-stage kidney disease , hyperkalemia , severe hypertension , complications of hemodialysis , complications of kidney transplant , coexistence of other diabetes complications , peritonitis (if peritoneal dialysis used) and increase infections.

2-2-Previous studies :

1. **Evaluation of Diabetic nephropathy Using Ultrasound, by: Gadi Osman TalbAllaShikeshMohmed ; 2010 in Sudanese patients :**

Advances in medical diagnostic technology induced accurate diagnostic values for most of diseases especially abdominal ones. The purpose of the study was to highlight the role of ultrasound in evaluation of early diabetic nephropthy. This study showed that the most common cause of kidney failure, is diabetic nephropthy which begins silent before patients have symptoms, and so early discovery may slow down kidney damage. In this study normal ultrasound procedure was performed for all patients, the size of kidneys was measured., the echogencity of right kidney was compared with the liver echogencity , while the echogencity of the left kidney was compared with spleen echogencity in both male and female. The study was done for 100 diabetc patients (male and female) all of them have dibetic type 1 or type 2 for more than five years. Their age ranging (40-70 years). The control groups were 50 healthy people with similar age ranging (40-70years). Patients with renal congenital anomalies , urinary tract obstruction, hydronephrosis, malignant tumor, renal failure and HIV were excluded The main findings of this study, is that diabetic nephropathy induced by type 1 diabetes mellitus has high frequency in female than male. Diabetic nephropathy change induced by type 2 diabetes mellitus has high frequency in patients with poor blood sugar level control. This result is similar like others study findings.

2. Characterization of the diabetic kidneys by ultrasound, by: Somia Mohammed Salih; 2013 Sudanese patients :

In fact diabetes is the most common cause of kidney failure. The purpose of study is characterization of diabetic patient kidney by using ultrasound. The study were done for 50 diabetic patient (30male and20 female) all of them have diabetes mellitus (18 type I and 32 type II) for more than thre e years their ages over 20years were included, and the patient with renal congenital anomalies ,renal tract obstruction, malignant tumor and renal failure wear excluded . In this study ultrasound was perform for all patient by measured the size of kidneys and evaluated the echogencity of right kidney compared with the liver echogencity ,while the echogencity of the left kidney was compared with spleen echogencity and the corticomiddlry ratio was measured also .the ultrasound scan done by using TA carve liner prop 3.5MHz. the value of the study characterized their is decrease in kidney volume cumbering with normal range and increase in C/M ratio and no significant different in the echogencity

3. Ultrasonographic Characteristics of Diabetes Impacts in Kidneys Morphology in Sudanese patients , OMER, M. A. A., ELJACK, A. H., GAR-ALNABI, M. E., MAHMOUD, M. Z., ELSEID, M. & EDAM, G. A. 2014. .

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 .

4. Evaluation of Renal Disorders in Type 2 Diabetic Patients Using Ultrasonography , JASTANIAH, S. D., ALSAYED, N. M., AWAD, I. A., FIDA, H. R. & ELNIEL, H. H. 2013.

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 .

Chapter Three

Materials and Methods

Chapter Three
Materials and Methods

3-1 Materials:

3-1-1 Study sample:

Analytical descriptive study was carried out of (50) patients 20 adult male and 30 adult female in. different ages. , and (30) of normal Sudanese peoples , whose undergone abdominal ultrasound , the study takes place in Khartoum state with permission from Alrakha Hospital . The study was conducted in November 2019.The data were analyzed using data sheet and simple frequency tables, following information about patients was taken : age, gender, height, weight ,duration of the diabetes, type of diabetes kidneys .length and width .

3.1.2 Methods of data collection

Data were collected from text book , web sides , data sheets .

3.1.3 Methods of data analysis

SPSS program was used for data analysis as well as ratio

3-1-4 Ultrasound machine characteristics:

.Probe: curve linear array C 3-5 MHz.

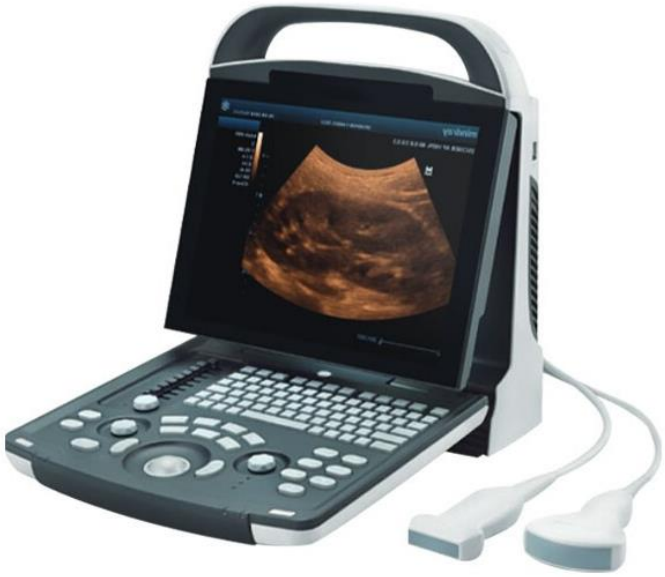


Fig (3.1): Ultrasound machine

3-2 Methods:

The patient should be fasting for 4-6 hours before the exam .

3-2-1 Methods of scanning :

The examination begins with the patient in the supine position. Scans are performed in the sagittal and transverse planes from the anterior approach using the liver and spleen as acoustic window. Various maneuvers may enhance demonstration of the kidneys: left lateral decubitus or lateral oblique positions for the right kidney and right lateral decubitus or lateral oblique position for the left kidney. Coronal longitudinal and transverse scans may also be obtained and recommended for evaluating the renalpelvis and proximal ureter.

The highest frequency transducer permitting adequate penetration is used(5MHz).A curvilinear array probe used for scanning in subcostal and intercostal area.

3-2-2 Methods of measurement:

Kidneys length, width were calculated in longitudinal scan. The kidney length was measured from the end of upper pole to the end of lower pole and the width from superior border to inferior border. The unite of measurements used was metric.

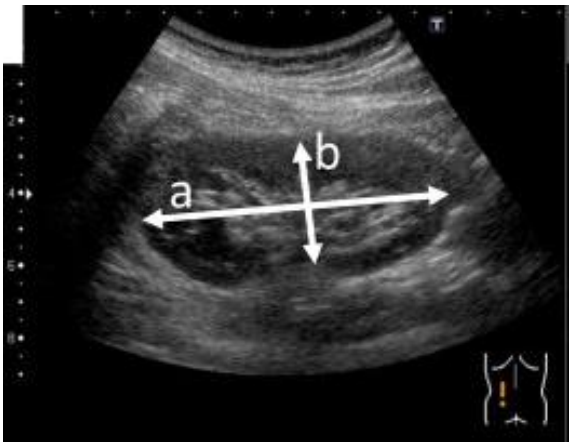


Fig (3.2): Measurement of normal Kidneys length (a), width (b)

Chapter four

Results

Chapter four

Results

Table (4.1): Distribution Participants with respect to age:

Age	Percent
32-41 years	18.0
42-51 years	32.0
52-61 years	36.0
62-70 years	14.0
Total	**100.0**

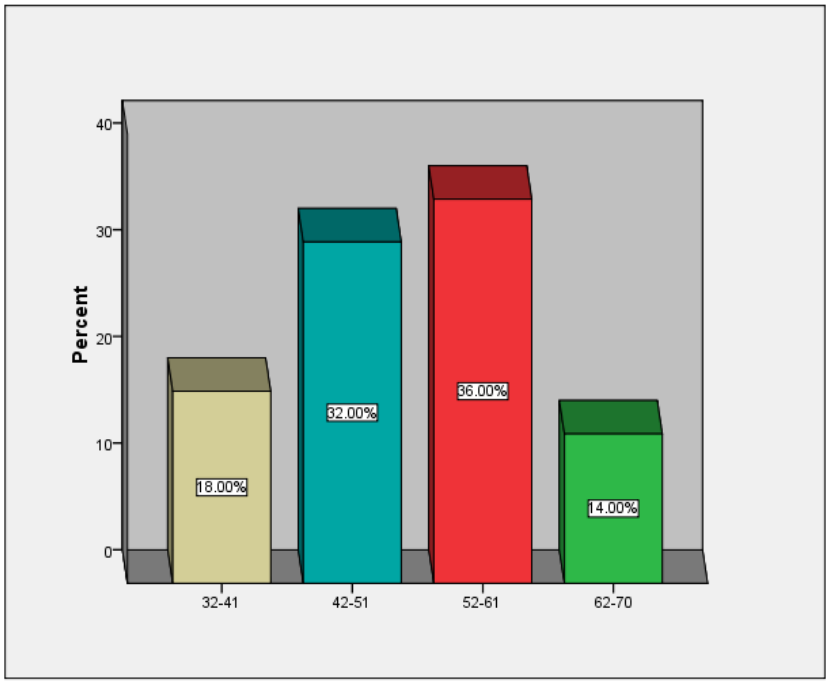


Figure (4.1) Distribution participants with respect to age

Table (4.2): Distribution participants with respect to gender:

Gender	Frequency	Percent
Male	20	40.0
Female	30	60.0
Total	**50**	**100.0**

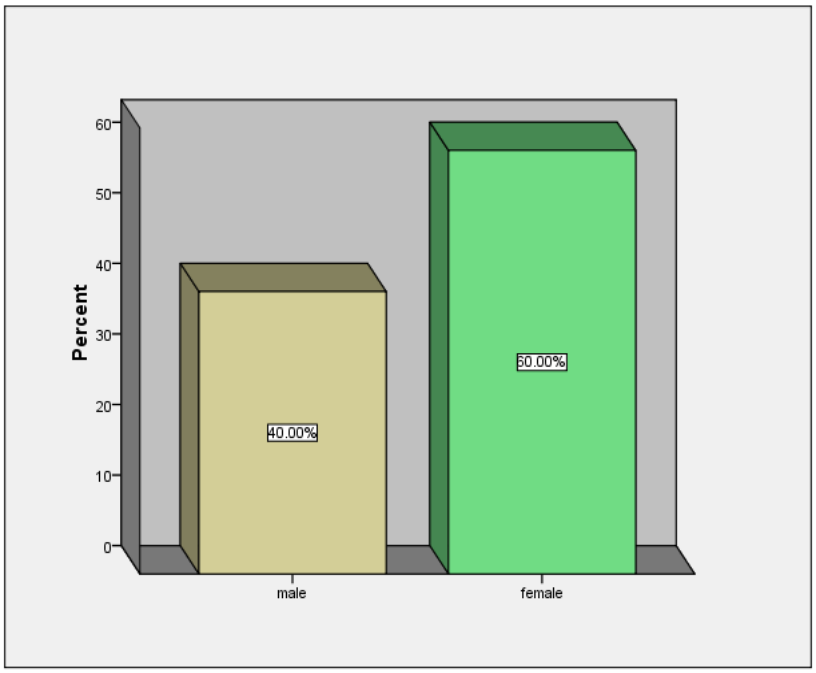


Figure 4.2: Distribution of participants according to gender

Table (4.3) Distribution of participants according to duration of the diabetic

Duration	Frequency	Percent
less than 1 years	3	6.0
1-8 years	32	64.0
9-16 years	12	24.0
17-25 years	3	6.0
Total	**50**	**100.0**

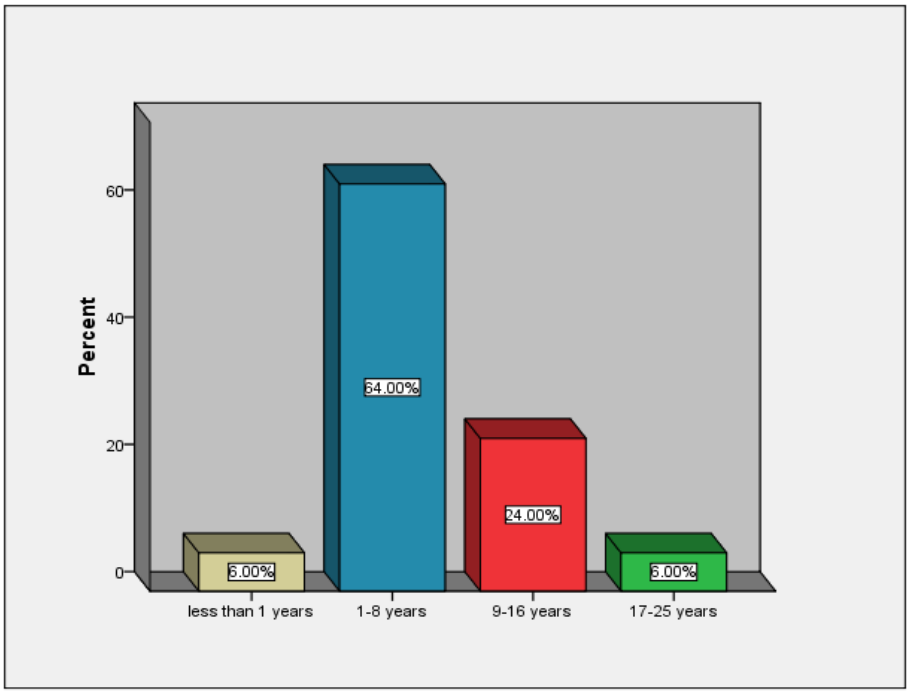


Figure (4.3) Distribution of participants according to duration of DM

Table (4.2):Participants distribution with respect to type of DM:

Type	Frequency	Percent
1	13	26.0
2	37	74.0
Total	**50**	**100.0**

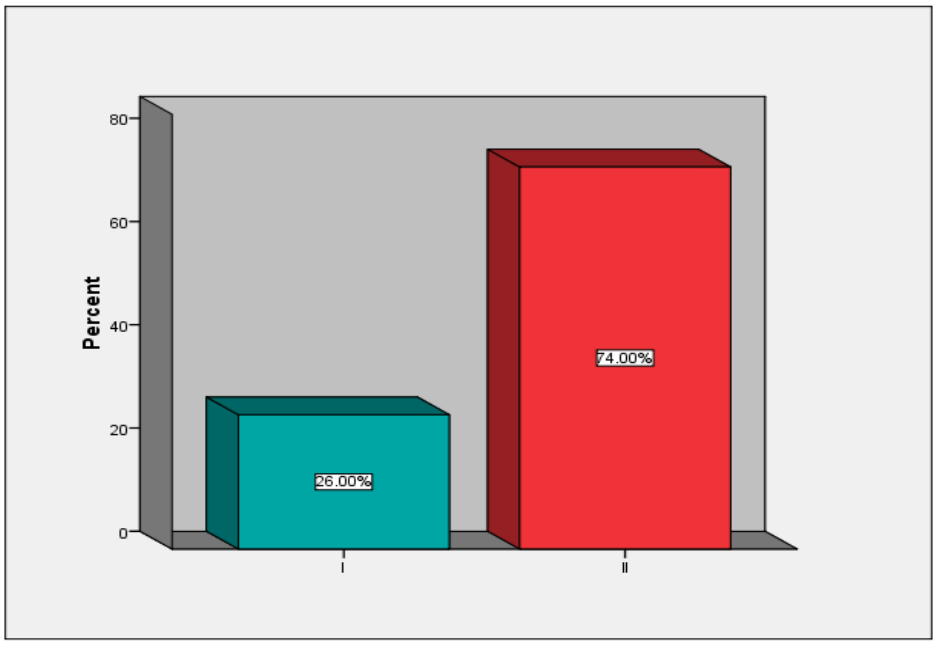


Figure (4.4) Participants distribution with respect to type of DM

Table (4.5) Descriptive statistic age, height, weight, BMI and measurement of kidneys

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	32	70	51.14	10.045
BMI	50	19.59	44.08	27.4574	4.64210
RTK Length	50	7.2	11.3	9.338	1.0178
RTK width	50	3.1	6.0	4.318	0.5627
LTK length	50	7.3	12.0	9.524	1.0362
LTK width	50	3.2	6.2	4.426	0.6688

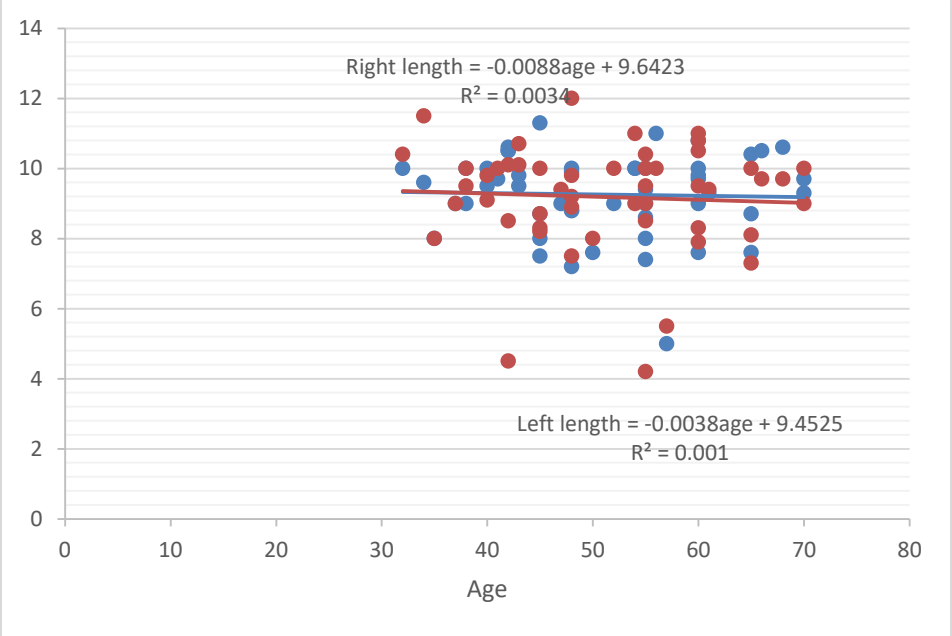


Figure (4.5) Scatterplot shows relation between age and measurements (length)

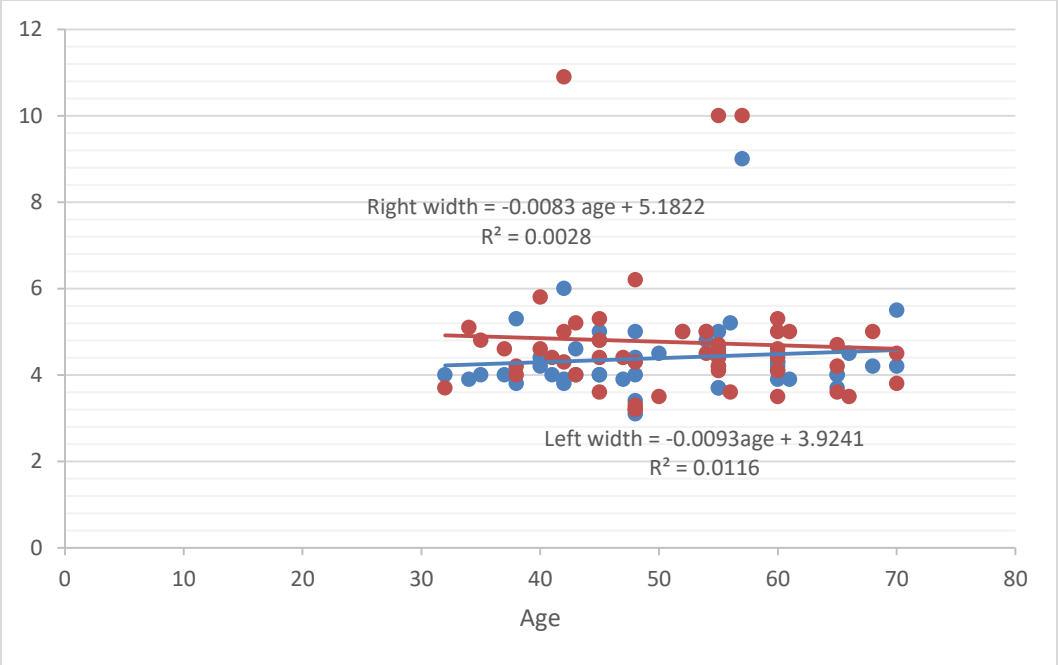


Figure (4.6) scatterplot shows relation between age and measurements (width)

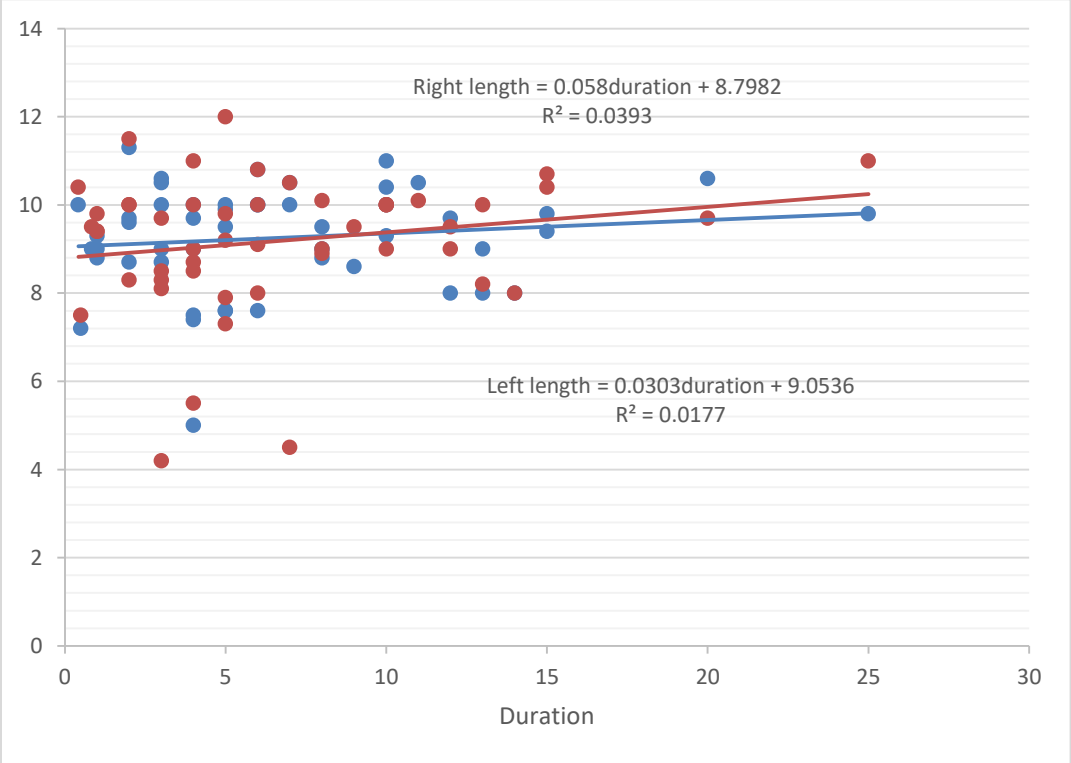


Figure (4.7) Scatterplot shows relation between duration and measurements (length)

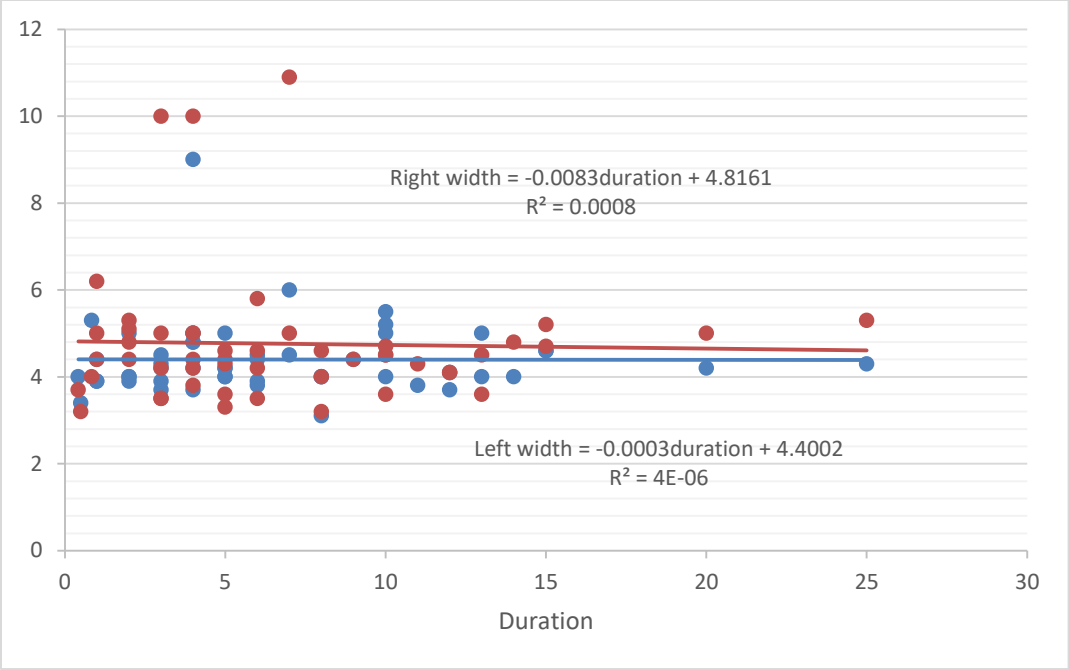


Figure (4.8) Scatterplot shows relation between duration and kidney width

Table (4.6) Compare mean measurement according to type of diabetes

Type of Diabetes		RTKL	RTKW	LTKL	LTKW
I	Mean	9.800	4.331	9.854	4.577
	N	13	13	13	13
	Std. Deviation	0.6557	0.4750	0.4841	0.7395
II	Mean	9.176	4.314	9.408	4.373
	N	37	37	37	37
	Std. Deviation	1.0782	0.5964	1.1533	0.6445
P values		0.056	0.925	0.185	0.39

Table (4.7) Compares mean measurement according to age:

Age		RTKL	RTKW	LTKL	LTKW
32-41	Mean	9.422	4.178	9.700	4.578
	N	9	9	9	9
	Std. Deviation	0.6610	0.4549	0.9811	0.6220
42-51	Mean	9.231	4.275	9.394	4.325
	N	16	16	16	16
	Std. Deviation	1.2333	0.7038	1.2113	0.8505
52-61	Mean	9.311	4.433	9.711	4.533
	N	18	18	18	18
	Std. Deviation	0.9869	0.4814	0.9061	0.5423
62-70	Mean	9.543	4.300	9.114	4.186
	N	7	7	7	7
	Std. Deviation	1.1058	0.5831	1.0479	0.5757
P values		0.917	0.714	0.546	0.546

Table (4.8) Correlation of renal measurements with duration, age, weight, height and BMI

		Age	Height (cm)	Weight (kg)	duration	BMI
RTKL	Correlation	0.009	0.161	0.240	0.167	0.170
	Sig. (2-tailed)	0.949	0.264	0.093	0.248	0.239
RTKW	Correlation	0.081	0.339*	0.125	0.109	-0.020
	Sig. (2-tailed)	0.577	0.016	0.387	0.453	0.891
LTKL	Correlation	-0.105	0.196	0.278	0.173	0.189
	Sig. (2-tailed)	0.469	0.174	0.051	0.231	0.188
LTKW	Correlation	-0.094	0.026	0.238	0.226	0.217
	Sig. (2-tailed)	0.514	0.857	0.096	0.115	0.130
*. Correlation is significant at the 0.05 level (2-tailed).						

Table (4.9) Participants distribution in control group with respect to gender:

Gender	Frequency	Percent
Female	16	53.3
Male	14	46.7
Total	**30**	**100.0**

Table (4.10) age, height and kidneys measurements (Length and Width) in control group

Descriptive	N	Minimum	Maximum	Mean	Std. Deviation
Age	30	35	72	51.90	9.852
Height	30	153	177	165.73	6.659
Weight	30	52	82	62.87	6.689
Rt KL	30	8.0	11.0	9.747	.6553
Rt KW	30	3.0	4.9	3.680	.5301
Lt KL	30	8.3	11.6	10.207	.6721
Lt KW	30	3.1	5.1	3.953	.4732

Table (4.11) Mean kidney measurements (Length and Width) with respect to presence of DM:

		N	Mean	Std. Deviation
Rt K L	DM	50	9.338	1.0178
	None DM	30	9.747	0.6553
Rt KW	DM	50	4.318	0.5627
	None DM	30	3.680	0.5301
Lt K L	DM	50	9.524	1.0362
	None DM	30	10.207	0.6721
Lt K W	DM	50	4.426	0.6688
	None DM	30	3.953	0.4732

Table (12) t-test for equality of mean kidney measurements (Length and Width) for diabetics and non-diabetics:

	t-test for Equality of Means				
Measure	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Rt K L	-2.183	77.549	0.032	-0.4087	0.1872
Rt K W	5.016	78	0.000	0.6380	0.1272
Lt KL	-3.221	78	0.002	-0.6827	0.2120
Lt KW	3.391	78	0.001	0.4727	0.1394

Chapter Five

Discussion, conclusion and recommendations

Chapter Five

Discussion, conclusion and recommendations

5.1 Discussions:

Table (4.1) and figure (4.1) show that (36%) of participants were (52-61) years old, since (32%) of them were 42-51 years, while (18%) of them were 32-41 years old, whereas (14%) were 62-70 years old. Therefore, most of the participants were 42-61 years old.Table (4.2) and figure (4.2) show that most (60%) of participants are females, while (40%) of them are males.

Table (4.3) and figure (4.3) show that most (64%) of participants were present with DM for 1-8 years, since (24%) of them for 9-16 years, while (6%) of them were presented for less than a year or 17-25 years.Table (4.4) and figure (4.4) show that most (74%) of participants complained the type 2 DM, while (26%) of them complained the type 1 DM.

Table (4.5) shows that total of (50) were selected aged (32-70 year within average 51.14±10.045), (which presented (19.59-44.08 with 27.46±4.64 mean of MBI), (7.2-11.3 with 9.34±1.02 mean of right kidney length), (3.1-6 with 4.32±0.56 mean of right kidney width), (7.3-12 with 9.52±1.04 mean of left kidney length), and (3.2-6.2 with 4.43±0.67 mean of left kidney width).

Figure (4.5) shows that the kidney length extremely slight decreases as age increases, since right kidney length decreases 0.0088 mm per year, representing only (0.3%) of its total variation, while left kidney length decreases 0.0038 mm per year, representing only (0.1%) of its total variation.

Figure (4.6) shows that the kidney width extremely slight decreases as age increases, since right kidney width decreases 0.0083 mm per year, representing only (0.28%) of its total variation, while left kidney width

decreases 0.0093 mm per year, representing only (1.16%) of its total variation.

Figure (4.7) shows that the kidney width slightly increases as DM duration increases, since right kidney length increases 0.058 mm per year with DM, representing only (3.93%) of its total variation, while left kidney length increases 0.0303 mm per year with DM, representing only (1.77%) of its total variation.

Figure (4.8) shows that the kidney width too extreme slightly decreases as DM duration increases, since right kidney width decreases 0.0083 mm per year with DM, representing only (0.08%) of its total variation, while left kidney width decreases 0.0003 mm per year with DM, representing only (0.0004%) of its total variation.

Table (4.6) provides useful descriptive statistics for the two types of diabetes that we compared, including the mean and standard deviation, since (P-values) for all measurements were greater than the level of significance of 0.05, then, kidney measures don't dependent on DM type.

Table (4.7) provides useful descriptive statistics for the age groups that we compared including the mean and standard deviation, since (P-values) for all measurements were greater than the level of significance of 0.05, then, kidney measures don't dependent on age.

Table (4.8) shows that there is insignificant correlations between kidney measures and person's age, weight, height, BMI and the duration with DM, since (P-values) for all correlation coefficients were greater than the level of significance of 0.05, except for correlation coefficients between right kidney width and person's height (Sig. (2-tailed) = 0.016), which indicates a medium positive (0.339) correlation between right kidney width and person's height.

Table (4.10) shows that total of (30) nondiabetics were selected for controlling, aged in (35-72 with average 51.9±9.852 years) with mean 165.73±6.66 mm height and 62.87±6.69 kg weight, which presented (8-11 with 9.75±0.66 mean of right kidney length), (3-4.9 with 3.68±0.53 mean of right kidney width), (8.3-11.6 with 10.21±0.67 mean of left kidney length), and (3.1-5.1 with 3.95±047 mean of left kidney width).

Table (4.11) provides useful descriptive statistics for the two groups that we compared, including the mean and standard deviation.

T-test results will tell us if the mean kidney measures for the two groups were statistically different (significantly different) or they were relatively the same.

We can see that the means kidney measurements for diabetics and non-diabetics are statistically, significantly different because all values of P-values in "Sig. (2-tailed) are less than 0.05. Looking at the Distributions of two groups table (4.11) above, we can conclude that there were statistically significant differences in kidney measurements mean between diabetics and non-diabetics, there for kidney length increases with diabetes while its width decreases with diabetes

This result is similar like other study findings .

5-2 Conclusion

The study concluded that the diabetes mellitus is affecting on the renal size with respect the age, DM duration , and the type of DM .

The most exact variable is the renal size measurement which agree with previous study but there is minimal difference in size with duration of DM .

The result of this study regarding the length of kidneys in diabetics to non-diabetics.

The ultrasound scanning can characterize kidneys to detects any diabetes nephropathy changes to avoid the complication .

5.3 Recommendations

- U/S should be used as routine checkup, follow up to help treatment and control of diabetic nephropathy.
- U/S imaging should always be made for patients with DM to detect the complications in order to avoid renal failure.
- Researcher should be encouraged to conduct advanced research about diabetes and its complication and how to be avoided.
- More advanced U/S machines should be used in order to have more accurate investigation.
- Future studies are highly recommended using larger samples to have reliably results.

References:

G. Andresdottir, M.L. Jensen, B. Carstensen, et al *.Improved prognosis of diabetic nephropathy in type 1 diabetes* Kidney Int, 87 (2015), pp. 417-426

B.A. Perkins, L.H. Ficociello, K.H. Silva, et al. *Regression of microalbuminuria in type 1 diabetes* N Engl J Med, 348 (2003), pp. 2285-2293

P. Hovind, L. Tarnow, P. Rossing, et al. *Predictors for the development of microalbuminuria and macroalbuminuria in patients with type 1 diabetes: inception cohort study* Br Med J, 328 (2004), p. 1105

P. Gaede, L. Tarnow, P. Vedel, et *al. Remission to normoalbuminuria during multifactorial treatment preserves kidney function in patients with type 2 diabetes and microalbuminuria Nephrol Dial Transplant*, 19 (2004), pp. 2784

A. Solini, G. Penno, E. Bonora, et al *.Diverging association of reduced glomerular filtration rate and albuminuria with coronary and noncoronary events in patients with type 2 diabetes: the renal insufficiency and cardiovascular events (RIACE) Italian multicenter studyDiabetes Care*, 35 (2012), pp. 143-149

L.M. Thorn, D. Gordin, V. Harjutsalo, et al. *The presence and consequence of nonalbuminuric chronic kidney disease in patients with type 1 diabetesDiabetes Care*, 38 (2015), pp. 2128-2133

Balens ytanatomy (Superficial anatomy of the trunk). AncaDragomir, Mats Hjortberg and Godfried M. Romans. Section for human anatomy at the Department of medical biology, Uppsala university , Sweden.

Berkman, James; Rifkin, Harold (1973)."Unilateral nodular diabetic glomerulosclerosis (Kimmelstiel-Wilson): Report of a case". *Metabolism*

(Elsevier Inc.) 22 (5): 715–722. Doi:10.1016/0026- 0495(73)90243-6. PMID4704716.

Bruce M. Carlson (2004). Human Embryology and Developmental Biology(3rd edition ed.). Saint Louis: Mosby. ISBN0-323-03649-X.

Cotran, RS S.; Kumar, Vinay; Fausto, Nelson; Robbins, Stanley L.; Abbas, AbulK. (2005). *Robbinsand Cotran pathologic basis of disease*. St. Louis, MO: Elsevier Saunders. ISBN0-7216-0187-1.

Diabetes Mellitus and Angiotensin Converting EnzymeInhibitors

Gilani S.A (2003). Abdominal Ultrasound. Guidelines and protocol for medical diagnostic US, Burrwin institute of US, moduletwo.

Glodny B, UnterholznerV, Taferner B, *et al*. (2009). "Normal kidney size and its influencing factors - a 64-slice MDCT study of 1.040asymptomatic patients". *BMC Urology*9: 19. doi:10.1186/1471.

http// www. Kidney .niddk..nih .gov/kudiseas/pubs/index.asppage from National Kidney and Urologic Diseases Information Clearinghouse, NIH Publication No. 08-3925 September2008.

http://www. Kidney .net.nz/view article/64297

http://www.biomedcentral.com/1471-2490/9/19

http://www.diabetesbluecircle.org/

http://www.diabetesbluecircle.org/ view article/74317

http://www.indexedvisuals.com/scripts/ivstock/pic.asp?id=118-100

http://www.medicalnewstoday.com/articles/139028.php

http://www.medscape.com/viewarticle/590644

Http; //en.Wikipedia-org/wiki/kidney,(2012).

Kimmelstiel P, Wilson C. *Benign and malignant hypertension and nephrosclerosis. A clinical and pathological study.*Am J Pathol1936;12:45-

OMER, M. A. A., ELJACK, A. H., GAR-ALNABI, M. E., MAHMOUD, M. Z.,

ELSEID, M. & EDAM, G. A. 2014. Ultrasonographic Characteristics of Diabetes

Impacts in Kidneys‟ Morphology. *Open Journal of Radiology*, 4**,** 301

Jastaniah, S.D., Alsayed, N.M., Awad, I.A., Fida, H.R. and Elniel, H.H. 2013.

Evauation of Renal Disorders in Type 2 Diabetic Patients Using Ultrsonography.

Open Journal of Medical Imaging, **3**, 165-170.

Radermacher J (2003) Ultrasonography of the kidney and the renal vessels Part I Normal findings, inherited and renoparenchymatous diseases

The ONTARGET Investigators; Yusuf, S; Teo, KK; Pogue, J; Dyal, L; Copland, I; Schumacher, H; Dagenais, G et al. (2008). "Telmisartan, Ramipril, or Both in Patients at High Risk for Vascular Events". *New England Journal of Medicine* 358 (15): 1547–59. doi:10.1056/NEJMoa0801317. PMID18378520.

Wahren J, Ekberg K, Jörnvall H (2007). "C-peptide is a bioactive peptide". *Diabetologia*50 (3): 503–9. doi:10.1007/s00125-006-0559.

Walter F., PhD. Boron (2004). *Medical Physiology: A Cellular AndMolecular Approach*. Elsevier/Saunders.ISBN1-4160-2328-3.

World Health Organization. Diabetes Mellitus: Report of a WHO Study Group. Geneva: WHO, 1985. Technical Report Series727.

Appendices

Appendix 1

Sudan university of science and technology

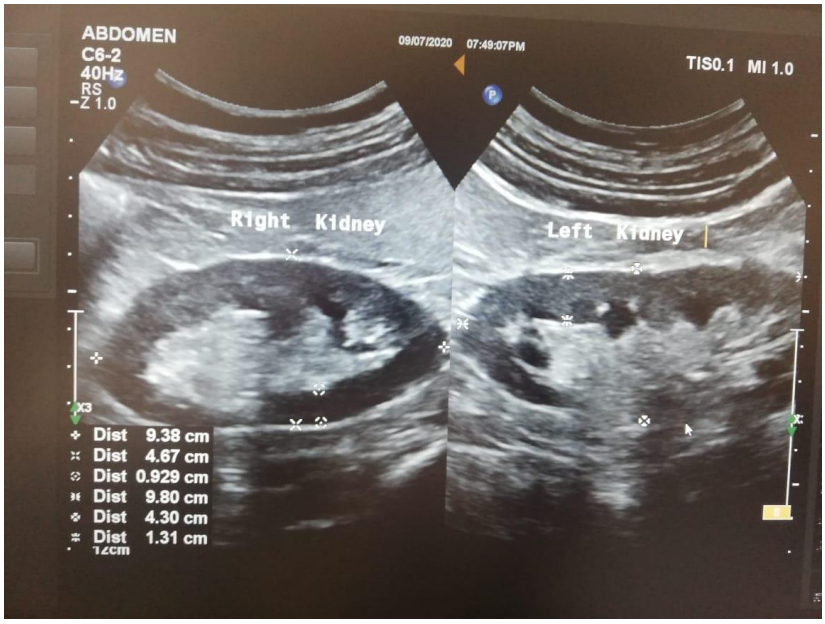
college of graduate studies

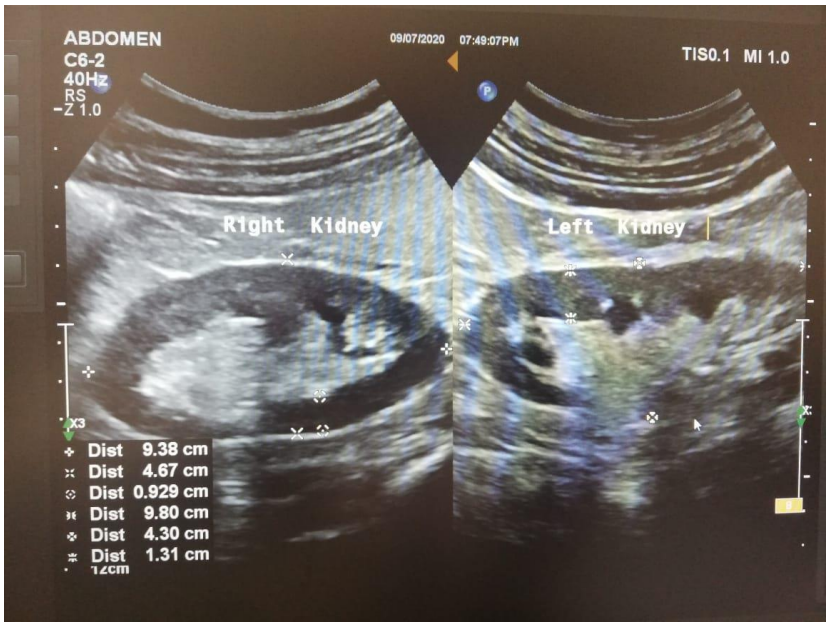
Data collecting sheet

Age	Gender	Height	Weight	Type of DM	Duration	Rt kidney measurement	Lt kidney Measurement

Appendix 2

Ultrasound Image





Ultrasound image for right and left kidney measurement Length , width and thickness .