Sudan University of Science and Technology

College of Graduate Studies

Evaluation of Renal Volume in Patients with Diabetes Mellitus Using Ultrasonography

تقويم حجم الكلى لدى مرضى السكري بإستخدام التصوير بالموجات فوق الصوتية

Thesis Submitted for Partial Fulfillment for The Requirement Of (M.Sc.)
Degree in Medical Diagnostic Ultrasound

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الآيـة

قــال تــعــالــى:

﴿ فَتَعَالَى اللَّهُ الْمَلِكُ الْحَقُّ ۗ وَلَا تَعْجَلْ بِالْقُرْآنِ مِن قَبْلِ أَن يُقْضَىٰ إِلَيْكَ وَحْيُهُ ۖ وَقُل رَّبِّ

زِدْنِي عِلْمًا ﴾

صدق الله العظيم

سورة طه - الآية (114)

Dedication

This thesis is dedicated to:

The sake of Allah, my creator and my master.

My great teacher and messenger, Mohamad (May Allah bless and grant him), who taught us the purpose of life.

My great parents, whom never stop giving of themselves in countless ways,

My beloved sister Ragda.

My friends whom encourage and support me (Amna and Maha).

All the people in my life who touch my heart.

Acknowledgment

Praise is to Allah, who blessed me with knowledge and enables me to complete this study.

Then, I would like to express my sincere gratitude to mggfdy supervisor prof. Caroline Edward for the continuous support of my study.

Also great thanks to all my teachers who in one way or another shared their knowledge, support and help.

Finally I would like to thanks anyone who gave me any type of support.

Abstract

This cross-sectional study was done in Khartoum State (Omdurman Military Hospital) during the period extended from October 2018 to October 2019 for 50 diabetic patients (26 were males and 24 were females), 5 of them are type1 diabetes mellitus, 45 are type2, their ages ranged between 10-90 years old and there were 25 apparently healthy subjects as control group were assessed.

Diabetes affected many organs; no recent study was done regarding the effect of diabetes on the kidneys.

The aim of this study was to evaluate the renal volume in diabetic patients using ultrasound scan. All patients had been scanned with Mindary DC40 ultrasound machine and Siemens sonoline G50 with curivilinear probe had a frequency from 3-3.5MHZ for measuring renal dimension (length, width and AP diameter), renal volume was calculated using this formula:

$V=0.49\times L\times W\times AP$

A data collection sheet was designed to include general information of patient (age, gender, type of diabetes and duration of disease) and dimension of the kidneys. SPSS was used to analysed the collected data

The study showed that there was significant difference between the kidneys volume of diabetic group and non-diabetic group (P value=0.006, 0.004), also there was strong correlation between age and the volume of the kidneys (p value =0.000,0.000) for the right and left kidney in respectively, there was no significant difference in the renal volume between males and females (p value=0.576,0.935) for right and left kidney respectively. Thus showed the importance of US as useful tool to measure renal volume and detecting changes in diabetic patient. Additional studies with large sample size are recommended to improve statistical information and compare the result.

المستخلص

هذه الدراسة التطبيقية قد اجريت في ولاية الخرطوم في مستشفى السلاح الطبي في فترة امتدت من اكتوبر 2018 وحتى اكتوبر 2019 لعدد خمسون مريض سكري (26 ذكر و24 انثى) 5 منهم من النوع الاول لمرض السكري و45 منهم من النوع الثاني لمرض السكري تتراوح اعمارهم من 10 سنوات وحتى 90 سنة مقارنة مع 25 شخصا اصحاء ظاهريا كمجموعة تحكم. مرض السكري يوثر على عدة اعضاء ولا توجد دراسات حديثه في تاثير مرض السكري على الكلى . والهدف من هذه الدراسة هو تقويم حجم الكلى لدى مرضى السكري باستخدام الموجات فوق الصوتية. وقد تم فحص جميع المرضى باستخدام جهاز مندري DC40, وسيمنس G50 باستخدام بروب منحني ذا تردد 3.5−5ميجاهيرتز لقياس ابعاد الكليتين(الطول ،العرض والبعد الامامي الخلفي) تم قياس حجم الكليتين باستخدام هذه المعادلة:

الحجم=0.49×الطول × العرض× البعد الامامي الخلفي للكلية

تم تصميم ورقة جمع البيانات لتشمل المعلومات العامة للمريض(العمر، الجنس، ونوع مرض السكري ومدة المرض) وابعاد الكليتين. تم تحليل البيانات المجموعة بواسطة برنامج الحزم التحليلي الاحصائي، وقد اظهرت النتائج انه يوجد فرق واضح بين احجام الكليتين لدى الاشخاص السليمين وبين حجم الكليتين لدى مرضى السكري(Pvalue=0.006,0.004). وايضا انه يوجد ارتباط قوي بين حجم الكليتين والتقدم في العمر(Pvalue=0.000,0.000).ولا يوجد فروق معنوية في حجم الكليتين بين الذكور والاناث (Pvalue=0.576,0.935).

وكل ذلك يدل على اهمية الموجات فوق الصوتية باعتبارها اداة مفيدة لقياس حجم الكليتين والكشف عن التغيرات التي تحدث للكليتين خلال الاصابة بمرض السكري ،وتوصي الدراسة انه من الضروري اجراء دراسات اضافية وبحجم عينة اكبر لتحسين المعلومات الاحصائية ومقارنة النتائج.

List of abbreviations

AP	anterior posterior diameter
BMI	body mass index
CEUS	contrast enhanced ultrasound
DM	diabetes mellitus
DN	diabetic nephropathy
IDDM	insulin dependent diabetes mellitus
L	length
MHZ	mega hertz
NHANES	national health and nutrition examination survey
NIDDM	non-insulin dependent diabetes mellitus
SD	standard deviation
US	ultrasound
W	width
WHO	world health organization

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Chapter one
Introduction

Chapter one

Introduction

1-1. Introduction:

Renal ultrasound is a common examination, which has been performed for decade. Using B mode imaging, assessment of renal anatomy is easily performed, and US is often used as image guidance for renal interventions furthermore, novel applications in renal US have been introduced with contrast enhanced ultrasound (CEUS), elastography and fusion imaging. (Wilson,1981). 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 (Rumack, 2005).

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 (Rumack, 2005).

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, further review of the literature shows that renal size varies with age, gender, body mass index, pregnancy and co-morbid conditions. Renal size may be an indicator for the loss of kidney mass and therefore, kidney function. It is valuable in monitoring unilateral kidney disease through comparison with the other, compensatory increased side and for the discrimination between upper and lower urinary tract infections. Renal infections/inflammations, nephrologic disorders, diabetes mellitus and hypertension are the most important co-morbid conditions affecting renal size (Buchholz et al., 2000)

Diabetes mellitus (DM) is a syndrome of impaired carbohydrates, fat and protein metabolism caused by either lack of insulin secretion or decreased sensitivity of the tissue to insulin there are general types of diabetes mellitus. Type 1 diabetes, also called insulin dependent diabetes mellitus (IDDM), is caused by lack of insulin secretion. Type2 diabetes mellitus, also called noninsulin dependent diabetes mellitus (NIDDM), is caused by decreased sensitivity to insulin is called insulin resistance. In both types of diabetes mellitus, metabolism of all food stuffs is altered. Basic effect of insulin lack or insulin resistance on glucose metabolism is to prevent the efficient uptake and utilization of glucose by most cell of the body, except those of the brain. As the result, blood glucose concentration increases, cell utilization of glucose falls increasingly lower, and utilization of fats and protein increase. Also, chronic hyperglycemia of diabetes is associated with long term damage dysfunction and failure of different organs, especially the eyes, kidneys, nerves, heart and blood vessels. About 347 million people worldwide have diabetes. In 2004, an estimated 3.4 million people died from consequence of high fasting blood sugar. Also, the diabetes increases the risk of heart disease and stroke; 50% of people with diabetes die of cardiovascular diseases (primarily heart disease and stroke (Ali et al,.2014).

DM is a group of a metabolic disorders characterized by high blood sugar level over a prolonged period symptoms of high blood sugar include frequent urination, increased thirst and increased hunger. If left untreated, diabetes can cause many complications.

Diabetes is due to either the pancreas not producing enough insulin, or the cells of the body not responding properly to the insulin produced.

Diabetic nephropathy (DN) is kidney disease that is a complication of diabetes; DN is caused by damage to the tiniest blood vessels. When small blood vessels begin damaged, both kidneys begin to leak protein into the urine. As damage to the blood vessels is continue, the kidneys gradually lose their ability to remove waste products from the blood. Renal ultrasonography has become the standard imaging modality in the investigation of the kidneys. Renal size and location can be determined. Ultrasonography can detect nephrolithiasis and hydro nephrosis. Post renal failure can usually be easily differentiated from prerenal or intrarenal acute renal failure; Ultrasonography today is established method for the initial evaluation of the kidneys (Abdalgyoum et al., 2013).

1-2. Problem Statement:

Diabetes mellitus (DM) is becoming a major outbreak in affecting both adult and young people and even children. Diabetes affect many organ, the kidney is our issue, and one complication of diabetes is diabetic nephropathy(DN); therefore, we need early detect to any damage that might happen to kidney. Can U/S evaluate renal volume?? Can ultrasound detect early damage that might happen to kidney??

1-3. objectives of the study:

1-3-1. General objective:

Evaluation of renal volume in diabetic patients using ultrasound.

1-3-2. Specific objectives:

- To measure renal volume in diabetic patients by ultrasound and compare with control group
- To correlate the volume of the kidney with the type of diabetes
- To correlate the volume of kidneys with the duration of diabetes

1-4. Thesis overviews:

This study consists of five chapters:

Chapter one contains introduction and objectives (general and specific), Chapter two deal with literature review anatomy, physiology of the kidney, Chapter three include contains the materials and methods, Chapter four deal with the results presentation and Chapter five contains the discussion, conclusion and recommendations.

Chapter Two
Literature Review

Chapter Two

Literature Review

2.1. Literature Review:

2.1.1. Anatomy:

2.1.1.1. Kidney:

The kidneys excrete the end products of metabolism and excess water. These actions are essential for the control of concentrations of various substances in the body, maintaining electrolyte and water balance approximately constant in the tissue fluids. The kidneys also have endocrine functions, producing and releasing erythropoietin, which affects red blood cell formation; renin, which influences blood pressure; 1,25-di-hydroxycholecalciferol (the metabolically active form of vitamin D), which is involved in the control of calcium absorption and mineral metabolism; and various other soluble factors with metabolic actions. (Standring et al., 2008)

In the fresh state, the kidneys are reddish-brown. They are situated posteriorly behind the peritoneum on each side of the vertebral column and are surrounded by adipose tissue. Superiorly they are level with the upper border of the 12th thoracic vertebra, inferiorly with the third lumbar vertebra. The right is usually slightly inferior to the left, reflecting its relationship to the liver. The left is a little longer and narrower than the right and lies nearer the median plane (Fig2-1). The long axis of each kidney is directed inferolaterally and the transverse axis posteromedially, which means that the anterior and posterior aspects usually described are in fact anterolateral and posteromedial. An appreciation of this orientation is important in percutaneous and endo urologic renal surgery.

Each kidney is typically 11 cm in length, 6 cm in breadth and 3 cm in anteroposterior dimension. The left kidney may be 1.5 cm longer than the right; it is rare for the right kidney to be more than 1 cm longer than the left.

2.1.1.2 Relations:

The superior poles of both kidneys are thick and round and each is related to its suprarenal gland. The inferior poles are thinner and extend to within 2.5cm of the iliac crests. The lateral borders are convex. The medial borders are convex adjacent to the poles, concave between them and slope superior poles of both kidneys are thick and round and each is related to its suprarenal gland. The inferior poles are thinner and extend to within 2.5cm of the iliac crests. The lateral borders are convex. The medial borders are convex adjacent to the poles, concave between them and slope inferolaterally. In each a deep vertical fissure opens anteromedially as the hilum, which is bounded by anterior and posterior lips and contains the renal vessels and nerves and the renal pelvis. The relative positions of the main hilar structures are the renal vein (anterior), the renal artery (intermediate) and the pelvis of the kidney (posterior). Usually an arterial 1branch from the main renal artery runs over the superior margin of the renal pelvis to enter the hilum on the posterior aspect of the pelvis, and a renal venous tributary often leaves the hilum in the same plane. Above the hilum the medial border is related to the suprarenal gland and below to the origin of the ureter. (Standring et al., 2008)

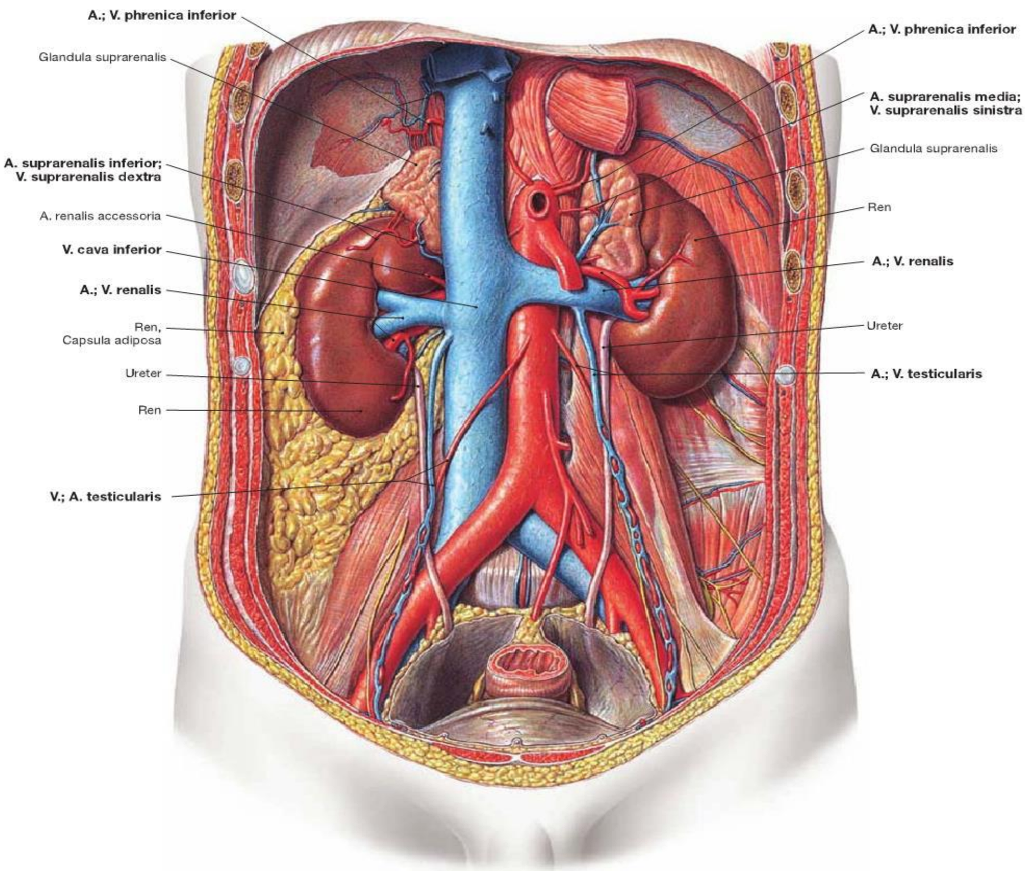

Fig 2-1: Relationships of the kidneys and ureters in the male retroperitoneum (

The kidney itself can be divided into an internal medulla and external cortex. The renal medulla consists of pale, striated, conical renal pyramids, their bases peripheral, their apices converging to the renal sinus. At the renal sinus they project into calyces as papillae. (Standring et al., 2008)

The renal cortex is subcapsular, arching over the bases of the pyramids and extending between them towards the renal sinus as renal columns

(Standring et al., 2008)

2.1.1.3 Renal pelvis and calyces:

The hilum of the kidney leads into a central renal sinus, lined by the renal capsule and almost filled by the renal pelvis and vessels, the remaining space being filled by fat. Dissection into this plane can be challenging but is important in surgery on the renal pelvis, particularly open stone surgery. Within the renal sinus, the collecting tubules of the nephrons of the kidney open onto the summits of the renal papillae to drain into minor calyces, which are funnel-shaped expansions of the upper urinary tract, see fig. (2-2). the renal capsule covers the external surface of the kidney and continues through the hilum to line the sinus and fuse with the adventitial coverings of the minor calyces. (Standring et al.,2008)

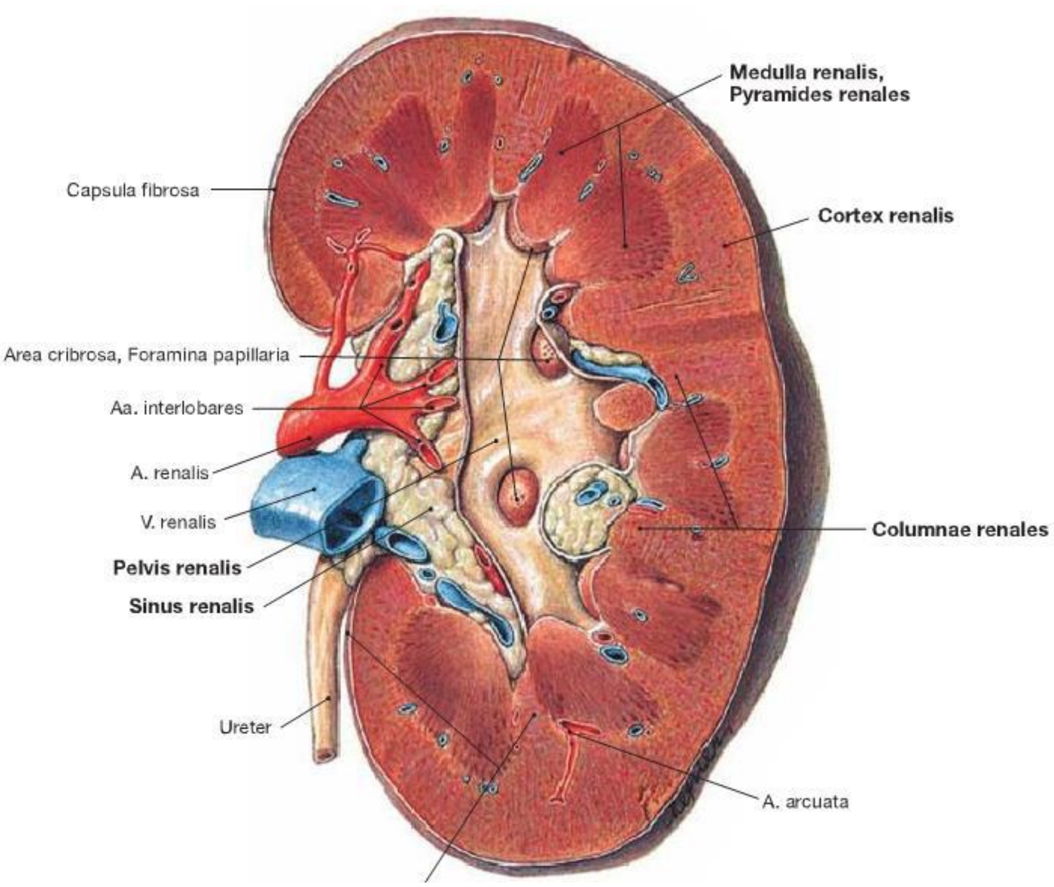

Fig 2.2 Left kidney, oblique vertical hemi section: normal macroscopic appearance of the renal cortex and renal medulla and the major structures at the hilum of the kidney. (Paulsen, F. and Waschke, J.2011).

2.1.2. Physiology:

2.1.2.1. Functions of the kidney (Formation of urine):

The kidneys form urine which passes through the ureters to the bladder for storage prior to excretion. The composition of urine reflects the activities of the nephrons in the maintenance of homeostasis. Waste products of protein metabolism are excreted, electrolyte balance is maintained and the pH (acid-base balance) is maintained by the excretion of hydrogen ions. There are three processes involved in the formation of urine:

• Simple filtration • selective reabsorption • secretion. (Waugh & Grant. 2004)

2.1.2.2. Simple filtration:

Filtration takes place through the semipermeable walls of the glomerulus and glomerular capsule. Water and a large number of small molecules pass through, although some are reabsorbed later. Blood cells, plasma proteins and other large molecules are unable to filter through and remain in the capillaries.

2.1.2.3. Auto regulation of filtration:

Renal blood flow is protected by a mechanism called auto regulation whereby renal blood flow is maintained at a constant pressure across a wide range of systolic blood pressures (from 80 to 200mmHg). Auto regulation operates independently of nervous control; i.e. if the nerve supply to the renal blood vessels is interrupted, auto regulation continues to operate. It is therefore a property inherent in renal blood vessels; it may be stimulated by changes in blood pressure in the renal arteries or by fluctuating levels of certain metabolites, e.g. prostaglandins. (Waugh & Grant. 2004)

2.1.2.4. Selective reabsorption:

Selective reabsorption is the process by which the com position and volume of the glomerular filtrate are altered during its passage through the convoluted tubules, the medullary loop and the collecting tubule. The general purpose of this process is to reabsorb into the blood those filtrate constituents needed by the body to maintain fluid and electrolyte balance and the pH of the blood. (Waugh & Grant. 2004).

2.1.2.5. Secretion:

Filtration occurs as the blood flows through the glomerulus. Substances not required and foreign materials, e.g. drugs including penicillin and aspirin, may not be cleared from the blood by filtration because of the short time it remains in the glomerulus. Such substances are cleared by secretion into the convoluted tubules and excreted from the body in the urine. Tubular secretion of hydrogen (H^+) ions is important in maintaining homeostasis of blood pH.

2.1.2.6. Composition of urine:

Water 96%, Urea 2%, Uric acid, Creatinine, Ammonia, Sodium, Potassium 2%Chlorides, Phosphates, Sulphates, Oxalates.

2.1.2.7 Water balance and urine output:

Water is taken into the body through the alimentary tract and a small amount (called 'metabolic water') is formed by the metabolic processes. Water is excreted in saturated expired air, as a constituent of the faeces, through the skin as sweat and as the main constituent of urine. The amount lost in expired air and in the faeces is fairly constant and the amount of sweat produced is associated with the maintenance of normal body temperature. (Waugh & Grant. 2004).

2.1.3Sonographic appearance:

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 thin linear structure. 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 sinuses not visible, but it creates a hetero echoic appearance with the interposed fat and vessels. The parenchyma is more hypoechoic and homogenous and is divided into the outermost cortex and innermost and slightly less echogenic medullary pyramids Between the pyramids are the cortical infoldings, called columns of Bertin as in fig (2-3). (Emamian et al.,1993).

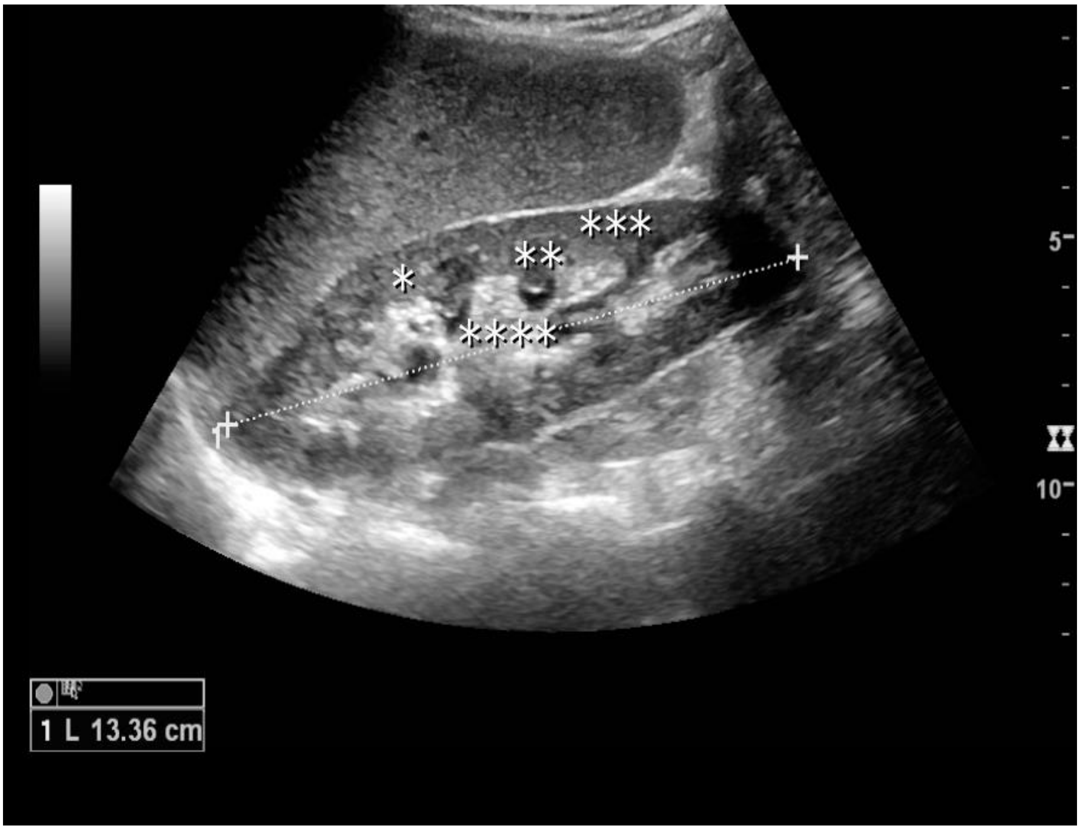

Figure (2-3). Normal adult kidney. Measurement of kidney length on the US image is illustrated by ‘+’ and a dashed line. * Column of Bertin; ** pyramid; *** cortex; **** sinus.

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 as in fig (2-4) (Rumack ,2005).

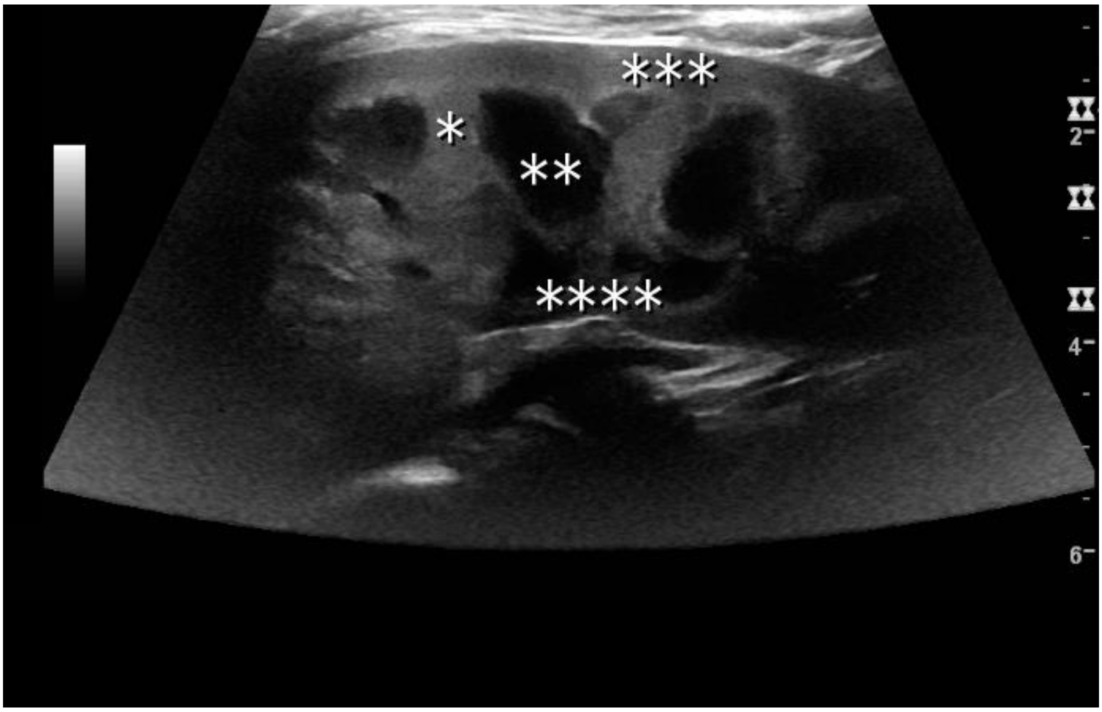

Fig 2-4 Normal pediatric kidney. * Column of Bertin; ** pyramid; *** cortex; **** sinus.

2.2 Previous studies:

- Study conducted by Mohammed Ali Omer etal (2014) tilted as “ultrasnographic characteristics of diabetes impacts in kidneys morphology” the study involved 150 diabetic males to assess the impact of diabetes in kidney morphology and it is distributed in Sudan, the collected data were patient age, height, weight, kidney size, ultrasound finding of involved kidneys and duration of diabetes and residence region. The analyzed data show that the diabetes has been as endemic disease in central Sudan (Khartoum and Jazeera) representing 55% and in the west of Sudan representing 38% the BMI of diabetic patients has been significantly (R2 =0.6) decreasing following aging. The kidney size increases significantly as R2 = 0.75 and 0.6 for left and right kidney respectively. their correlation is fitted in the following equations: Y= 3.95x+27.26 and Y=2.41x+35.12for the left and right kidney respectively. The impact of duration was a reduction in size significantly asR2=0.61and 0.55with a correlation fitted in the following equation: Y=-2.22x+139.9 and Y=-1.51x+96.59 for the left and right kidney respectively. The mean kidney length was (14.5cm) and the renal cortex in the range of 2-2.3cm, the kidneys size were so enlarged as 92.4±11.7 and 121±17.1 for the right and left kidney respectively. While in late case of diabetes the kidney is more echogenic atrophied size with loss of corticomedullary differentiation.

- Ala Mohammed, etal (2014) as in ultrasonography patterns for diabetic nephropathy according to the body shape, ultrasonographic of kidneys were performed on 205 patients with known DM, concerning on kidneys echogenicity corticomedullary differentiation and right and left kidneys length. The effect of age, gender, onset, renal parenchymal disease and pyelonephritis was statistically analyzed. it is found that there were association between patient shape, renal failure and renal parenchymal disease (p=0.000, 0.429 and 0.068) respectively relation was statistically significant since p=o.oo5, the study proved that diabetic patients were subject to multiple changes in kidneys that can be diagnosed by ultrasound.
- Another study done by Mohammed Edris Amer tilted as “evaluation of renal changes in diabetic patients using ultrasonography” study involved 50 diabetic patients and 75 participants as control group measurements included length, width, volume, corticomedullary differentiation, the effect of age, gender and onset. Was statistically analyzed the results showed that as the duration of diabetes increase the length and volume decreased but the echogenicity increased, furthermore it revealed that increase in duration of diabetes has direct impact on kidney texture.
- Renal duplex sonographic evaluation of type2 diabetic patients study was done in 88 diabetic patients and 73 non-diabetic control participants, the

renal volume and resistive index (RI) of segmental arteries were assessed by duplex sonography, both renal volume and RI values in diabetic patients were significantly higher compared to the controls(mean volume±SD:diabetic patients,197±47.6ML;controls,162.5±35.2ML;P<.0001;RI:diabetic patients,0.70±0.05;controls,0.59±0.06;P<.0001).(Mancini M. et al.,2013).

Chapter Three

Material and Methods

Chapter Three
Materials and Methods

3.1. Materials:

3.1.1. Type of study

Cross section case control study deals with the evaluation of the kidney in diabetic patients.

3.1.2. Study duration:

The study has been done from October 2018 to October 2019.

3.1.3. machine:

In this study, the ultrasound machines that have been used were high resolution real time (Mindray DC40 ultrasound machine), in ER Military Hospital. Siemens sonoline G50 which contain curvilinear probe have a frequency from 3.5 to 5 MHZ in ultrasound department in the Military Hospital.

3.1.4Ultrasound gel:

Ultrasound gel was applied to the transducer to prevent any attenuation or artifact and thermal paper printer was used. a data collection sheet was used to collect the data and to number the patients.

Scanning technique for the kidney: The patient lies supine. The kidneys are examined in longitudinal and transverse scan planes with the transducer placed in the flanks. May use contralateral with care giver support, posterolateral imaging.

Prone (if gases preclude visualization).

.

3.2 Methods:

3.2.1. Sampling and sample technique:

50 Sudanese males and females were selected all were had different types of diabetes, their ages from 10-90 years.

3.2.2. Inclusion criteria:

All Sudanese diabetic patients aging from10-90years, 25 participants act as control group.

3.2.3. Exclusion criteria:

Pregnant women, patients with renal congenital anomalies, renal obstruction, malignant tumor and renal failure

3.2.4. Data collection:

Data were collected from ultrasound examinations of abdominal and pelvic scans using data collection sheet that include all variables of study such as patient age, gender, right and left kidney volume (kidney length, width and AP diameter), corticomedullary differentiation, duration of the diabetes and type of the diabetes.

3.2.5 Data analysis:

The data were analyzed by SPSS.

3.2.6 Data presentation:

The data were presented by tables and figures.

3.2.7 Ethical considerations:

- The procedures of the scanning with ultrasound were explained to the patient and the purpose of incorporating their data in the study, verbal consent was acquired.
- Permission from the hospital and the department were granted.

- Data were collected from different patient with maintain privacy and confidentiality.

3.2.8 Interpretation:

I obtained renal volume in my study by measuring renal length on the longitudinal scan plane and then width and AP diameter on transverse scan plane and then used the formula below:

$V=0.49 \times L \times W \times AP$

Chapter four
Results

Chapter four

Results

4-1. Results:

About 50 cases having diabetes to evaluate kidney volume and about 25 case control. The results of this study are presented into tables and figures below.

Table (4-1) Distribution of study group according to the age.

Age	Case		Control	
	Frequency	Percent	Frequency	Percent
Less than 20	**1**	**2.0**	1	4
21-40	**9**	**18.0**	9	40
41-60	**16**	**32.0**	10	20
>61	**24**	**48.0**	5	10
Total	**50**	**100.0**	25	

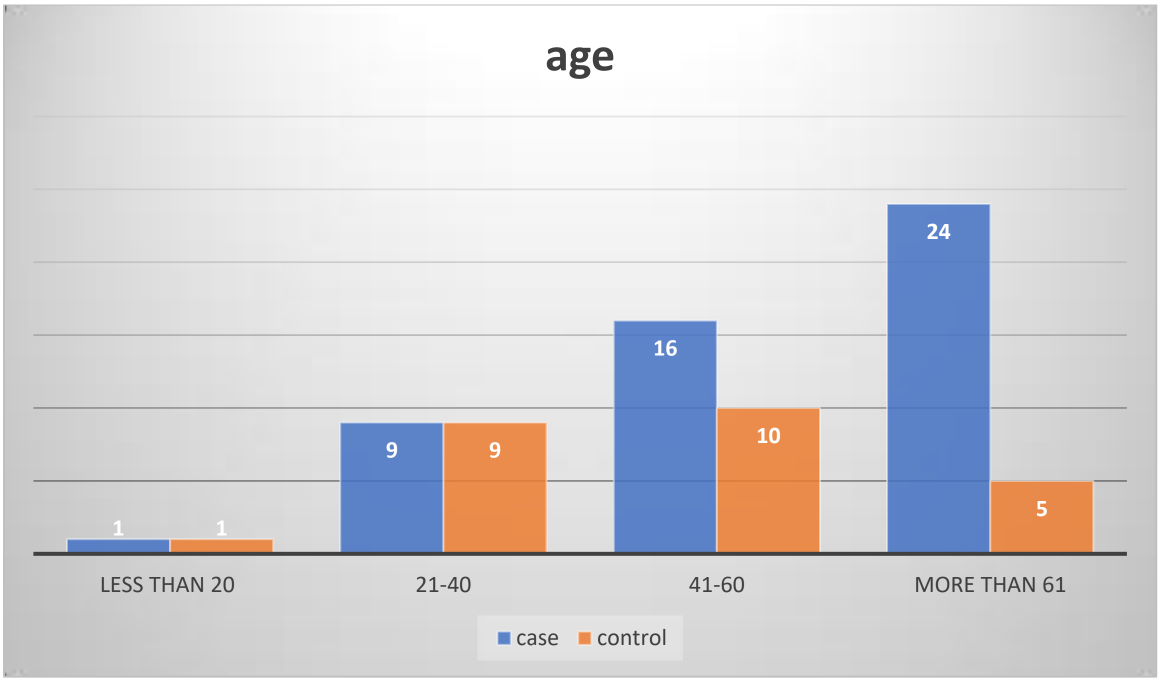

Figure (4-1) Distribution of study group according to the age.

Table (4-2) Distribution of study group according to the gender.

Gender	Case		Control	
	Frequency	Percent	Frequency	Percent
Male	26	52	11	44
Female	24	48	14	56
Total	50	100.0	25	

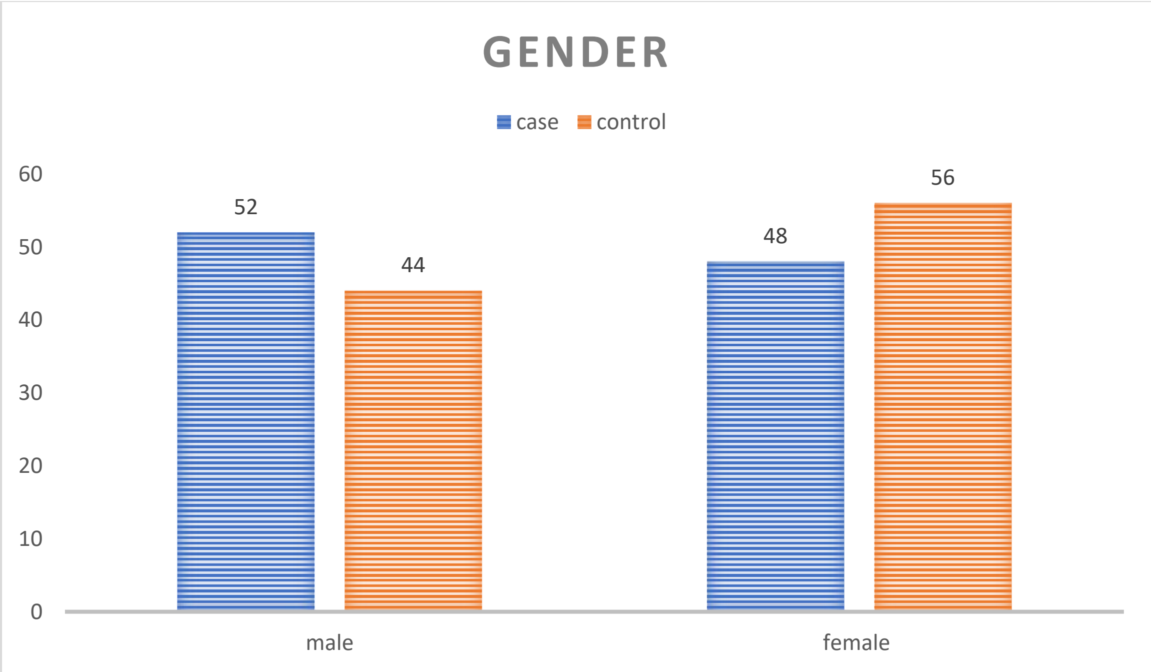

Figure (4-2) Distribution of study group according to the gender

Table (4-3) Distribution of study group according to the duration (50).

Duration		Frequency	Percent
Valid	Less than 5	14	28.0
	5-10	25	50.0
	11-15	9	18.0
	>15	2	4.0
	Total	50	100.0

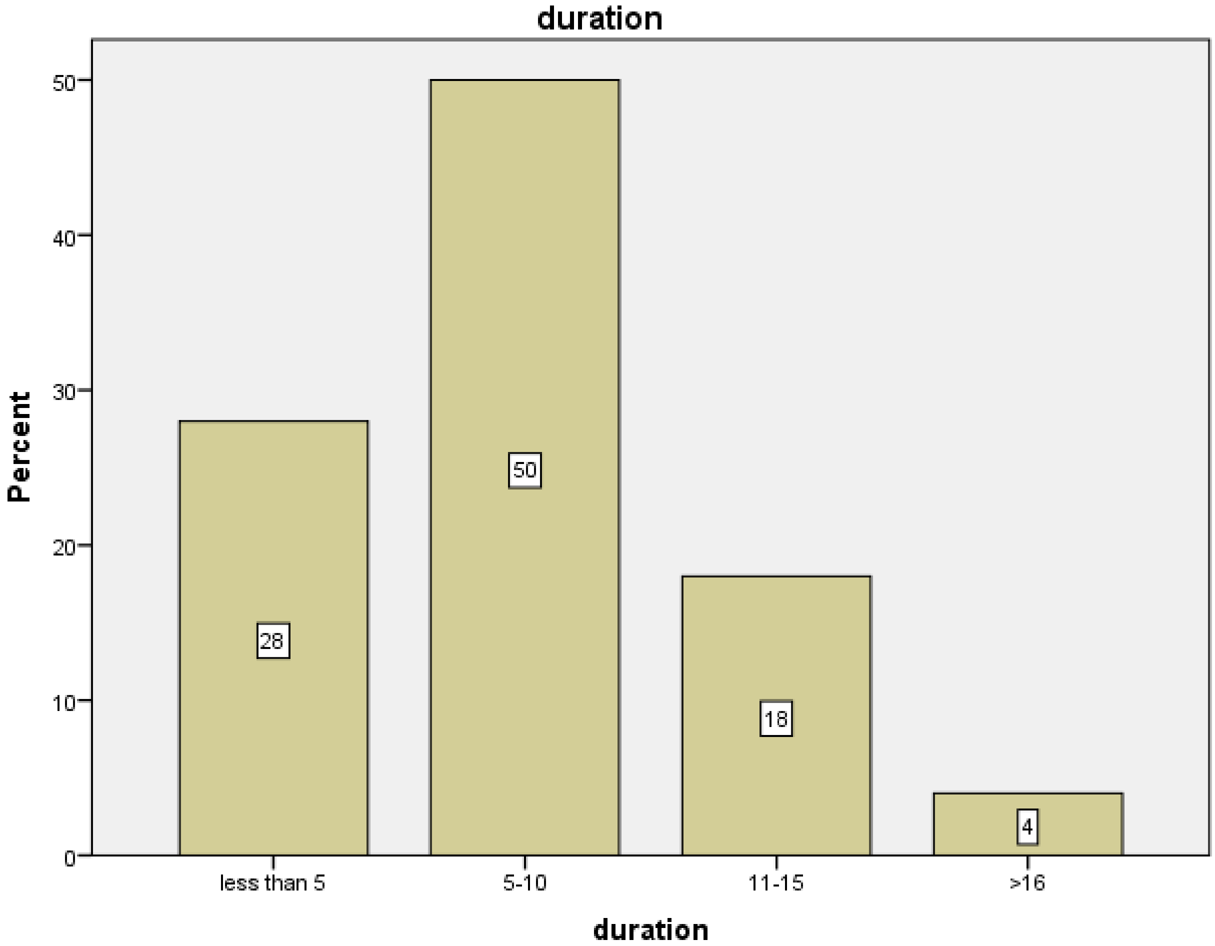

Figure (4-3) Distribution of study group according to the duration

Table (4-4) Distribution of study group according to diabetic types (50).

Diabetic types		**Frequency**	**Percent**
Valid	Type one	5	10.0
	Type two	45	90.0
	Total	50	100.0

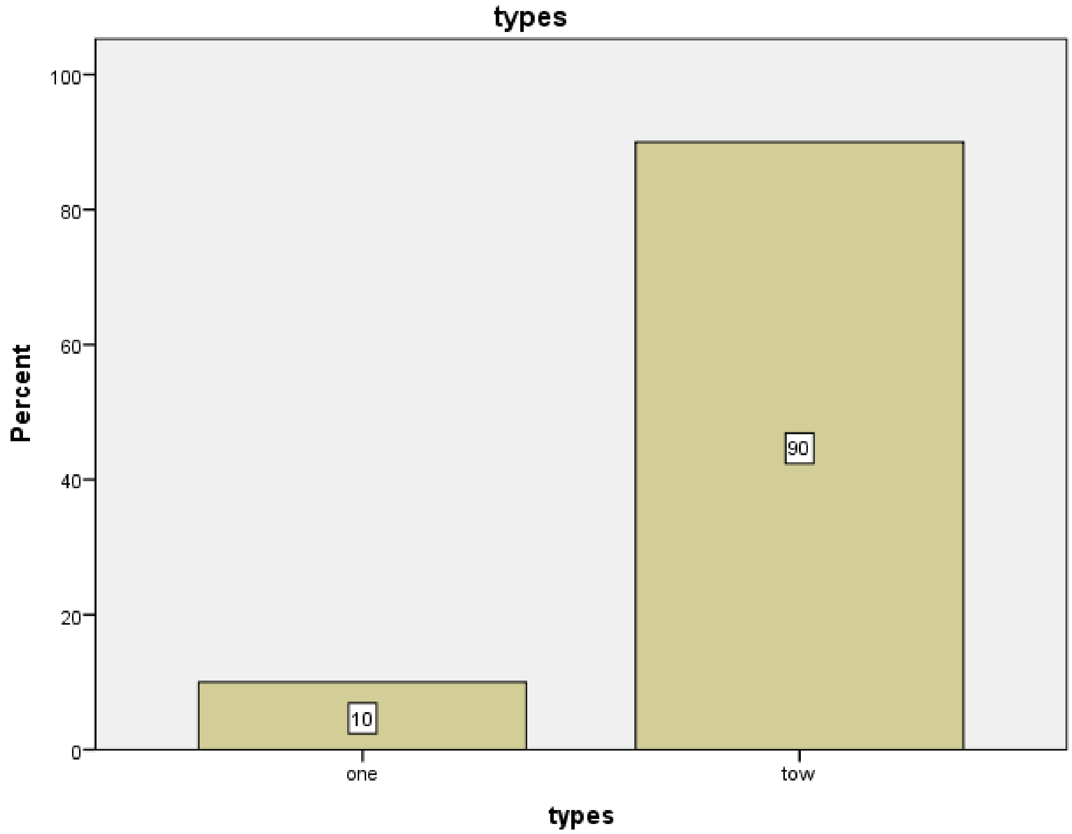

Figure (4-4) Distribution of study group according to diabetic types (50).

Table (4-5) Descriptive statistics of study group according to kidney volume.

		N	Minimum	Maximum	Mean	Std. Deviation
Case (diabetic)	Right-kidney volume	50	39.85	196.78	91.7344	29.63793
	Left-kidney volume	50	35.26	175.96	97.4178	30.86264
Control (non-diabetic)	Right-kidney volume	25	89.57	150.33	113.1460	18.71089
	Left-kidney volume	25	101.04	154.37	122.8112	16.19309

Table (4-6) Descriptive statistics of kidney volume for case and control groups.

		Mean	Std. Deviation	Std. Error Mean
Case	Right-kidney volume	92.9808	28.82376	5.76475
Control	Right-kidney volume	113.1460	18.71089	3.74218
Case	Left-kidney volume	101.9976	27.74670	5.54934
Control	Left-kidney volume	122.8112	16.19309	3.23862

Table (4-7) Correlation between kidney volume of case and control group.

Paired Samples Test									
		Paired Differences					T	Df	Sig.
		Mean	Std.	Std. Error	95% Confidence Interval of the Difference				
					Lower	Upper			
Case/ control	Right-kidney volume - Right-kidney volume	-20.16	33.27	6.65	-33.97	-6.42	-3.0	24	**0.006***

Case/ control	Left-kidney volume - Left-kidney volume	-20.81	32.58	6.517	-34.26	-7.36	-3.19	24	**0.004***

Table (4-8) Correlation between age and kidney volume.

Age	N	Right kidney volume		Left kidney volume	
		Mean	**Std.**	**Mean**	**Std.**
Less than 20	1	39.85	.	35.2600	.
21-40	9	111.46	19.39	122.3822	19.94
41-60	16	108.98	32.7	113.5244	29.66
>61	24	74.995	16.56	79.9083	20.11
Total	50	91.73	29.63	97.4178	30.86
P value		**0.000***		**0.000***	

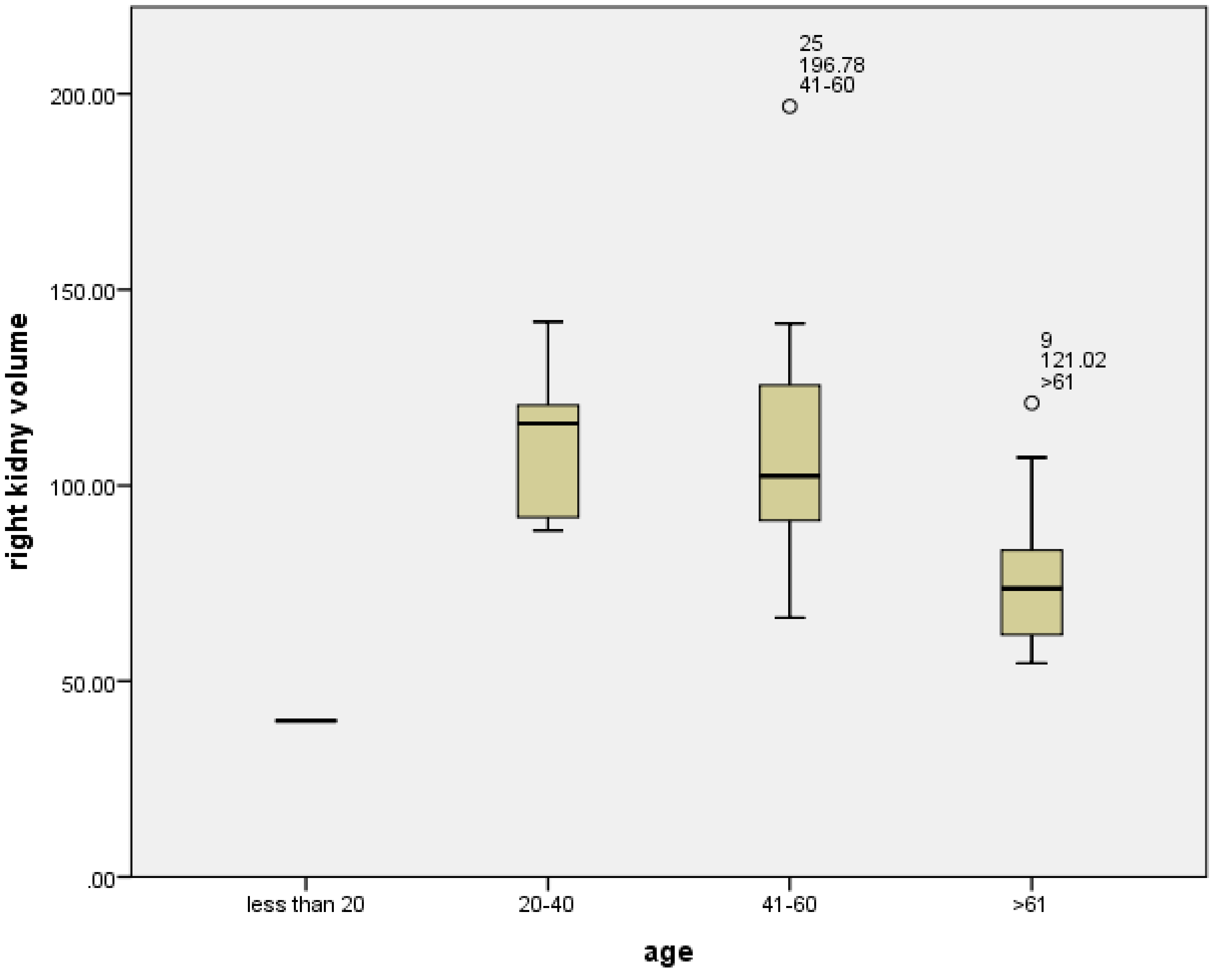

Figure (4-5) Correlation between age and Right-kidney volume.

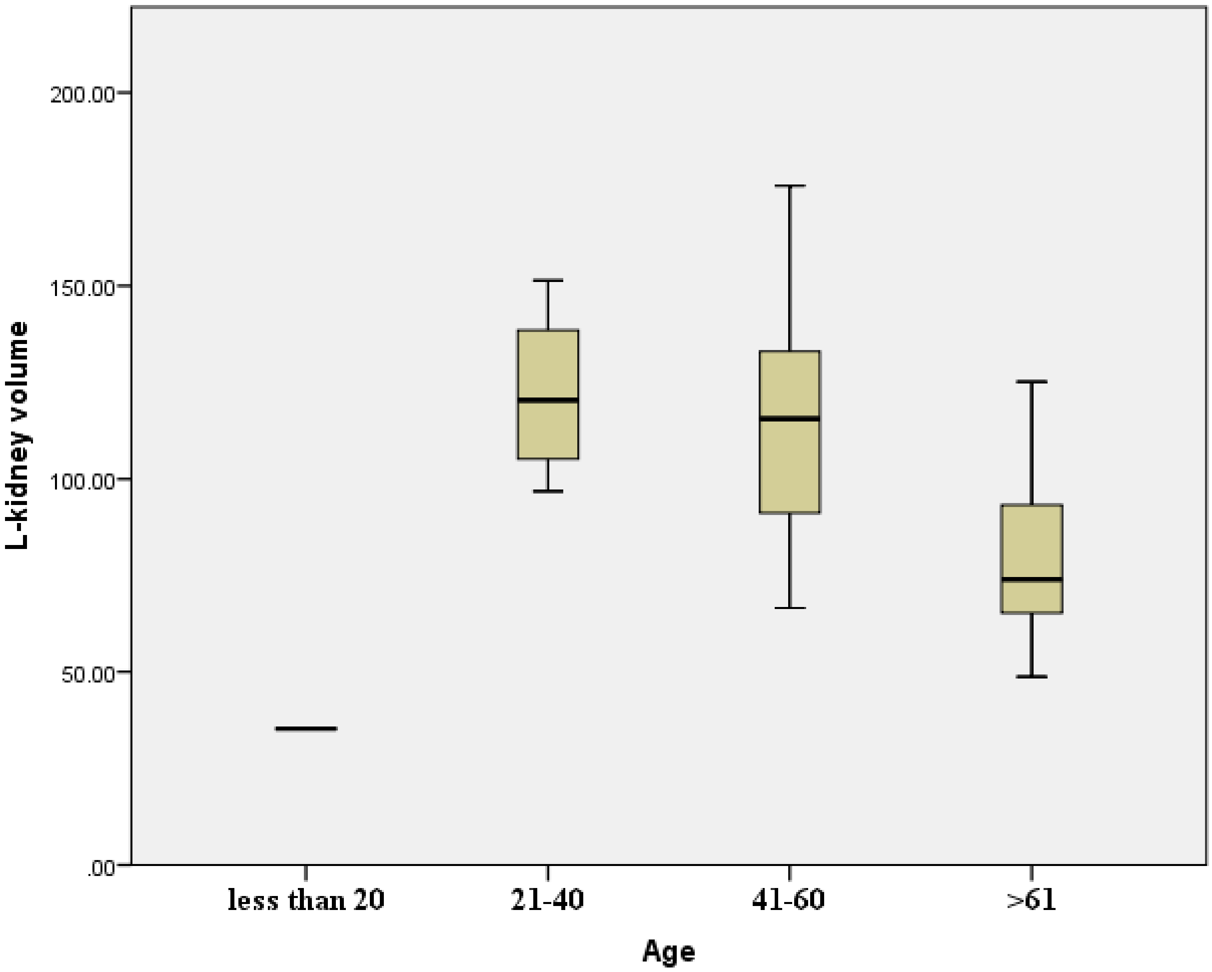

Figure (4-6) Correlation between age and Left-kidney volume.

Table (4-9) Correlation between gender and kidney volume.

Gender	N	Right kidney volume		Left kidney volume	
		Mean	Std.	Mean	Std.
Male	26	94.013	34.313.	97.803	6.205.
Female	24	89.261	24.068	96.999	6.260
P value		0.576		0.935	

Table (4-10) Correlation between duration and kidney volume.

Duration		N	Mean	Std.	Minimum	Maximum	P-value
Right-kidney volume	Less than 5 years	14	87.5079	35.65050	39.85	141.83	0.858
	5-10	25	95.4484	30.70610	59.18	196.78	
	11-15	9	88.3478	19.94257	57.06	121.02	
	>16	2	90.1350	2.41123	88.43	91.84	
	Total	50	91.7344	29.63793	39.85	196.78	
Left-kidney volume	Less than 5 years	14	91.8179	38.92080	35.26	151.38	0.811
	5-10	25	101.3232	28.64324	65.87	175.96	
	11-15	9	94.2544	28.10022	59.82	138.62	
	>16	2	102.0350	4.40528	98.92	105.15	
	Total	50	97.4178	30.86264	35.26	175.96	

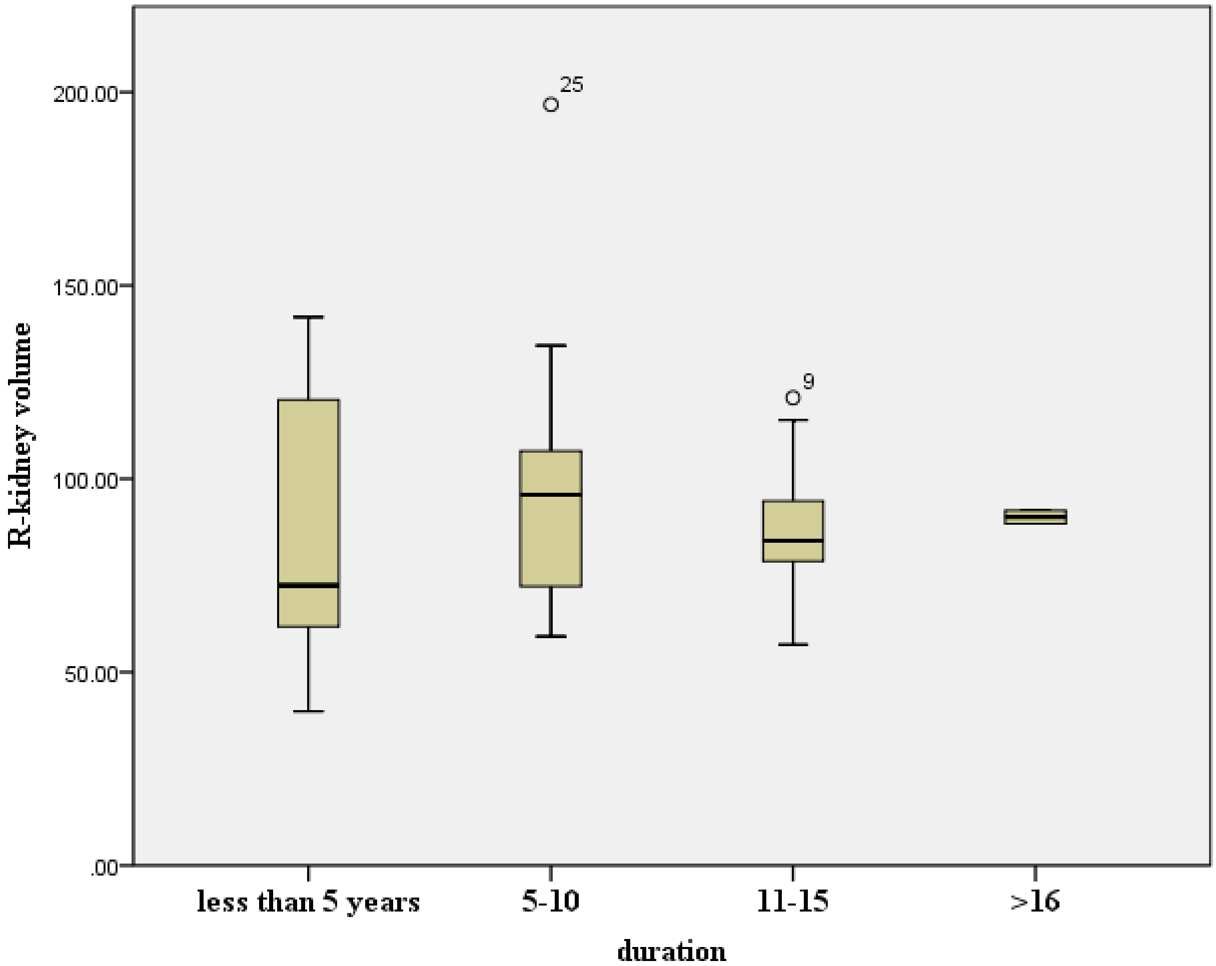

Figure (4-7) Correlation between duration and right-kidney volume.

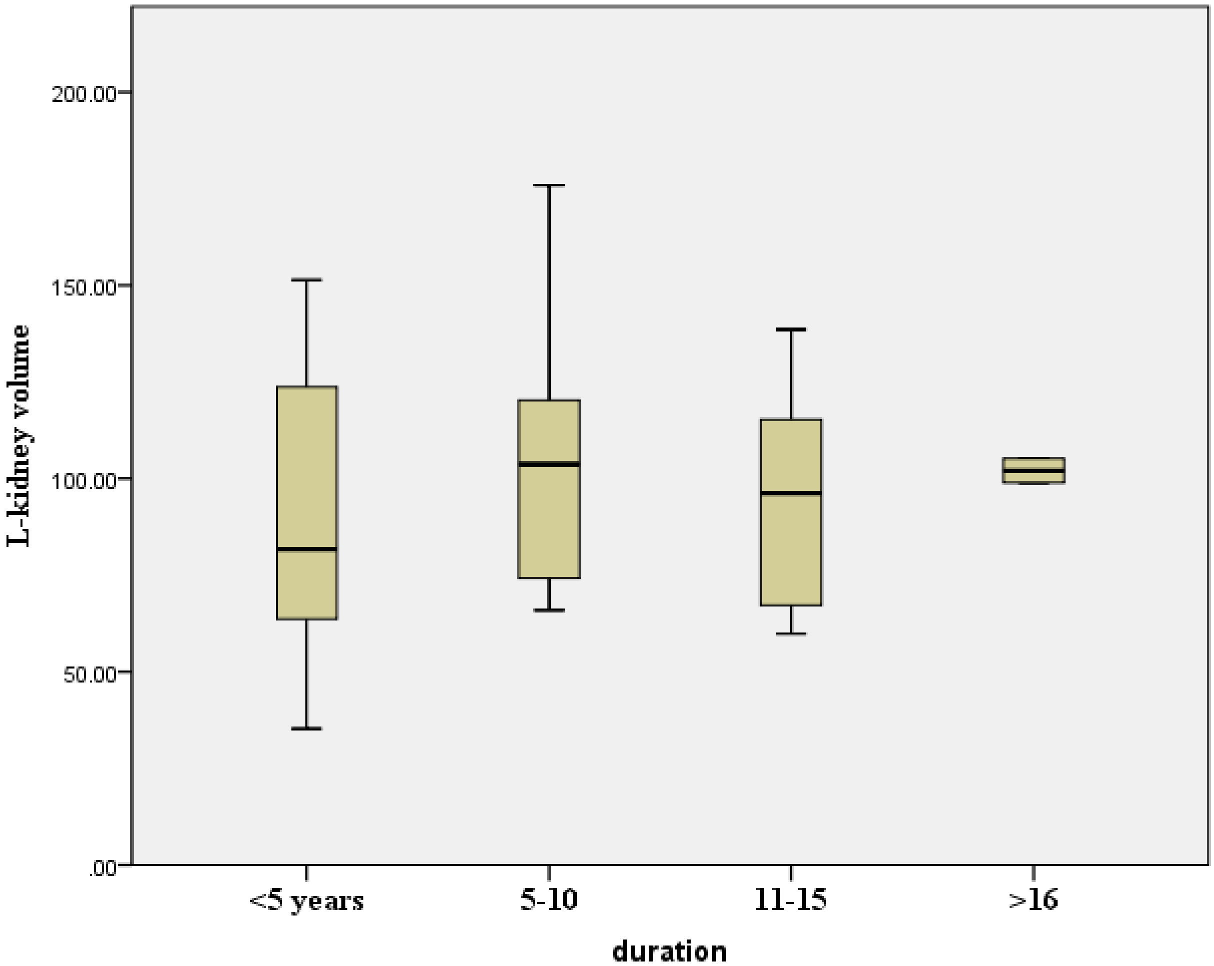

Figure (4-8) Correlation between duration and Left-kidney volume.

Table (4-11) Correlation between diabetic type and kidney volume.

	Types	N	Mean	Std. Deviation	P-value
Right-kidney volume	Type one	5	104.4140	57.25852	0.318
	Type two	45	90.3256	25.68808	
Left-kidney volume	Type one	5	110.7620	52.18612	0.313
	Type two	45	95.9351	28.11899	

Chapter five

Discussion, conclusion, and recommendations

Chapter Five

Discussion, conclusion, and recommendations

5-1 Discussion:

This study was across-sectional prospective design has been conducted to evaluate the effect of diabetes in the kidney volume using ultrasonography. And it was done for 50 diabetic patients 52% male, female 48 % in age between 10-85 years old.

This chapter describes results of standard B-mode gray scale ultrasound of 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 (age, gender, duration of diabetes and type of diabetes).

The results of this study showed that a total of 50 diabetic patients, 26 males (52%) and 24 females (48%) were examined (table4-2) and (figure4-2). their ages range was10to90 years,so diabetes can affect both male and female in near percentages according to this study, this was explained by (National Health and Nutrition examination survey (NHANES)) in 2004 study estimated that 26 million people in United State have CKD (64.4% male and 35.6 female). A total of 25 healthy non-diabetic described as a control group, 11 males (44%) and 14 females (56%) (table4-2) and (figure4-2).

The highest frequency of affected age which representing (48%) was found more than 67 years old and the lowest frequency (1%) was found less than 20 years old in diabetic patient (table4-1) and (figure4-1) this result agreed with(Mohammed,2018).

With regard to duration of having diabetes mellitus disease in both types was range between 1and20 years. Most of patients acquired the disease for a duration of (5-10) years and representing 25(50%).14 cases (28%) have had less than 5years,9 cases (18%) have had it for (11-15) years and only two patients (2%) had it for more than 15 years (table4-3) (figure4-3) agree with (Mohammed, 2018).

Regarding type of diabetes, the majority of patients had type two diabetes, which representing (90%) (45 cases of all number of participants (table4-4) and (figure4-4)) and only 10% (5 cases) had type one DM, this result agrees with (Mohammad, 2018).

Regarding (table4-8) and (figure4-5,4-6) renal volume in diabetic group were correlated with subject′s age (p value=0.000,0.000) for right and left kidney, this result agreed with (Mohammad Ali Omer et al.,2014).

A correlation was made to study the relation between kidney volume of diabetic and non-diabetic group and there was significant correlation as (p value=0.006,0.004) for right and left kidney. agrees with (Mohammed Ali Omer et al., 2014).

5-2 Conclusion:

Diabetic patients were subject to multiple changes in kidneys that can be diagnosed by ultrasound this supports the use of ultrasound in diabetic treatment units.

The results confirmed that there was significant difference between kidney volume of diabetic and nondiabetic group.

Also, the study showed that there was significant correlation between age and the kidney volume.

5-3 Recommendations:

- Further studies, the corticomedullary distance should be tested and doppler for diabetic patients.
- Regular using of ultrasound as follow up for diabetic patients to prevent complication of DM on kidneys.

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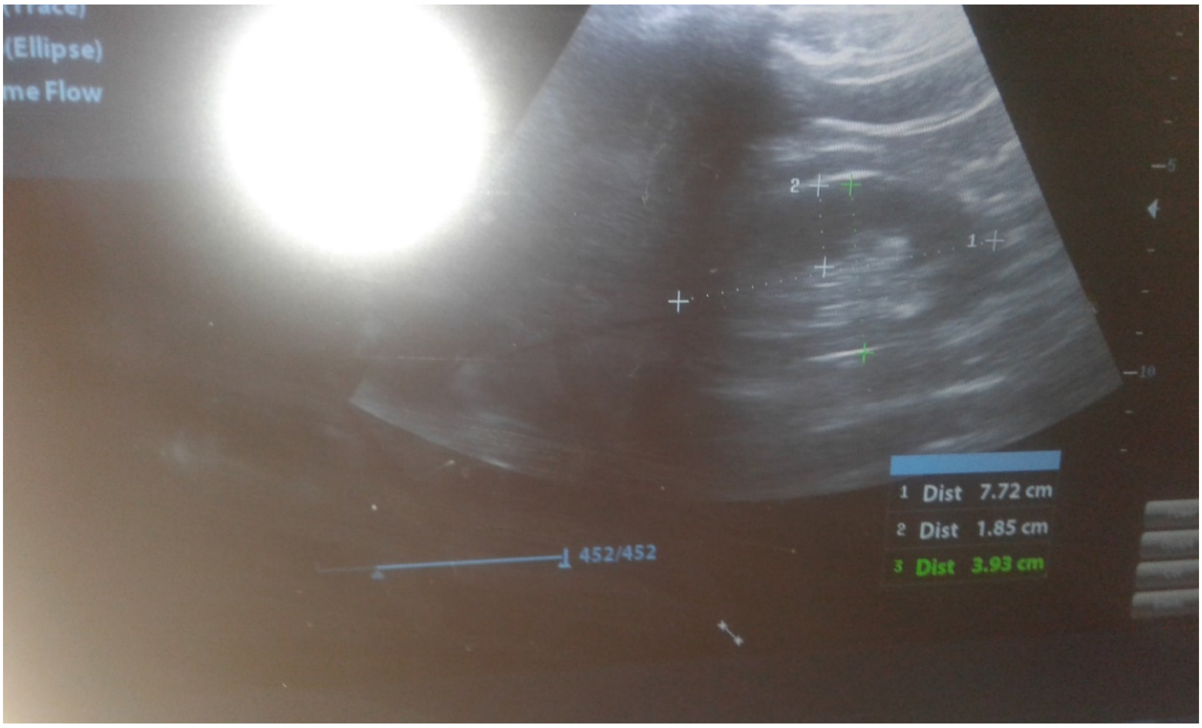
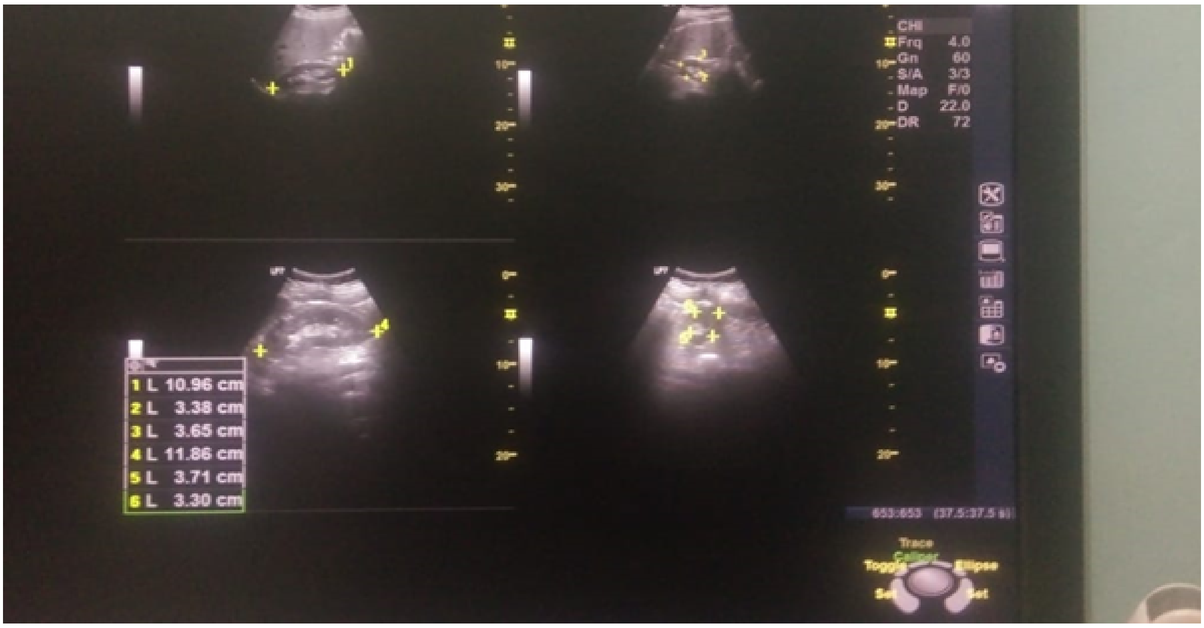
Appendices

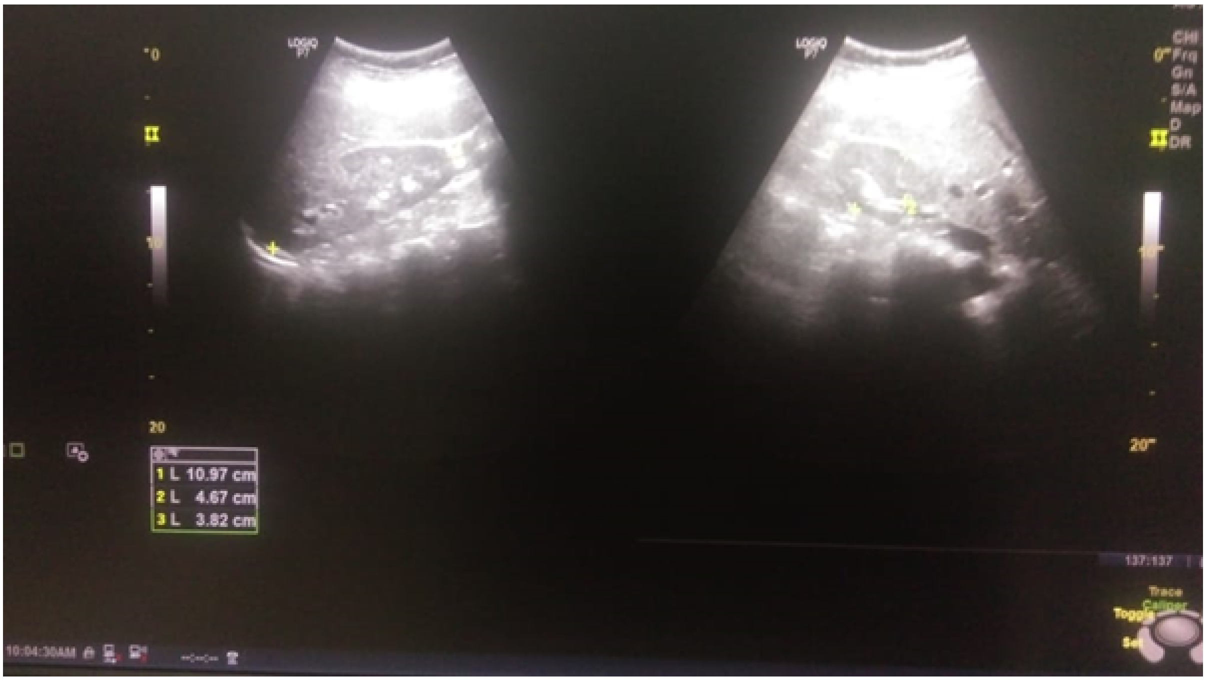
Appendix (1) study images**:**



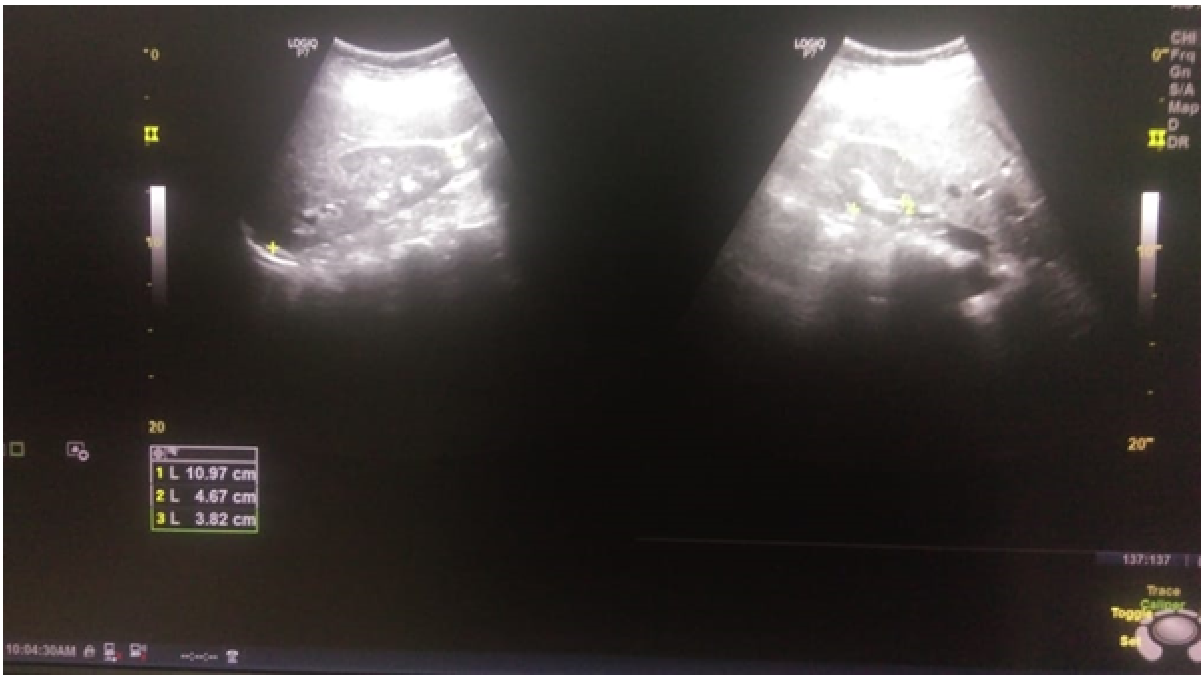
U/S image for 75 years old male diabetic patient.



Renal U/S image for 41 years old diabetic female patient.



Renal U/S image for 55 years old male diabetic patient.



Renal U/S image for 48 years old diabetic female patient.

Appendix (2) Data collection sheet**:**

Sudan University of science And Technology

College Of Graduate Study

Diagnostic Ultrasound

Batch (19)

Data sheet

No	Age	Gender	Kidney volume (length width , AP)				CM differentiation (good , poor)	Duration of diabetes	Type of diabetes
			L	W	AP	VOL			