بسم الله الرحمن الرحيم

Sudan University of Science and Technology

Collage of Graduate Studies

Characterization of Renal system Function and Morphology in Hypertensive Patients using Renal Scintigraphy and Ultrasonography

توصيف الجهاز البولي في مرضي ارتفاع ضغط الدم باستخدام التصوير القياسي العددي والموجات فوق الصوتيه

Thesis submitted for Fulfillment of Ph.D. Degree Requirement in Nuclear Medicine Technology

By:

Hossam Mustafa Ahmed Gasmalseed

Supervisor:

Prof. Mohamed Elfadil Mohamed Gar-elnabi

Co-Supervisor

Assoc. Prof. Ahmed AL Mustafa Abukonna

2019

Ref: SUST/ CGS/A11

Approval Page

(To be completed after the college council approval)

Name of Candidate: Hossam Mustafa Ahmed Gasmalseed

Thesis title: Characterization of Renal System Function and Morphology in Hypertensive Patients using Renal Scintigraphy and Ultrasonography

Degree Examined for: PhD

Approved by:

1. External Examiner

Name: Dr. Mohamed Ahmed Ali Omer

Signature: .... Date: 11/12/2019

2. Internal Examiner

Name: Prof. Elsafi Ahmed Abdullah

Signature: .... Date: 11/12/2019

3. Supervisor

Name: Prof. MOHAMED ELFADIL MOHAMED

Signature: .... Date: 11/12/2019

بسم الله الرحمن الرحيم

(قَالُواْ سُبْحَانَكَ لاَ عِلْمَ لَنَا إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ)

صدق الله العظيم

سورة البقرة (32)

Dedication

- *First and last extend my thanks to Allah, who help us in the completion of this research alhamdollah (thank Got)*
- *I would like to dedicate to my **parent** There is no doubt in my mind that without this continued support and counsel I could not have completed this process.*
- *A special feeling of gratitude to my small family for words of encouragement and push for tenacity.*
- *To each of us has the right to me. We dedicate this modest work.*
- *I also dedicate this dissertation to my family brother and sister who have supported me throughout the process.*

Acknowledgements

- I would like to thanks the inspirational instruction and guidance of **Dr. Mohamed alfadil Mohamed for** given me a deep appreciation encouragement and love for the beauty and detail of this subject.
- I'm deeply indebted to for his valuable support
- My honest thanks and gratitude to the staff al-ghad **collage - radiology department for** their support, and technical assistance.
- It is a great pleasure, a privilege, an honor, a source of much personal satisfaction **to patient** become part of this project.
- Thanks for their help in analysis of results, I would like to express my gratefulness.

Abstract:

The aim of this research to characterized the renal system function and morphology in adult hypertensive patients with further correlation to age, gender, body mass index, body surface area and duration of hypertension. A total of 75 patients (33 males, 42 females) with essential hypertension were evaluated sonographically in this prospective study and 25 healthy individuals (12 males, 13 females) were also evaluated as control groups. Renal volume was then calculated from the kidney's length, width and anterio-posterior diameter using formula (LxWxAPx0.53). The range of renal volume 46.65 to 105.02 cm^3 for the left kidney and 42.59 to 102.33 cm^3 for the right kidney. In control group, (mean ± SD) volumes of the right and left kidneys in males (80.7 cm3 ± 36 and 75.3 ±33respectively), in females (78.2 cm3 ± 33 and 70.4, ± 29 respectively). The (mean ± SD) kidney length was (9.95 ±2.3cm). It was (9.15 ±1.1cm) on the right side and (9.27 ±1.3 cm) on the left side. The hypertensive kidneys volume slightly in lower limit in compared to control group. The (mean ± SD) kidney width was (4.45 ±1.1cm) and the cortical thickness 1.46 ±0.5 cm, consider with in normal range. Renal volume correlated significantly with BMI in hypertensive patients (r= 0.35 and 0.31 p<0.005 for right and left kidney, respectively), There was no significant correlation between renal volume and duration of hypertension (r=0.9 and 0.8; p>0.005 for left and right kidneys, respectively). In radionuclide Renography, total glomerular filtration rate (GFR) ranged from 130-40 (mean ± SD) 87. 9±17.3 (male 86.8±16.3 female 88.8±18.1), correlated GFR with age decline rate was 0.82 (1.2 ml/min/years) Renal Scintigraphy demonstrated 84% has normal renal function with mild (AORTA- RENAL DELAY), normal cortical and clearance phase 16% had abnormal function (unilateral 93% and bilateral

7%. more affected RT kidney than left). Both kidneys show decrease renal function with age and duration of disease. The association was stronger in person had uncontrollable and long standing hypertensive disease. Also noted the average peak activity decrease when the duration of disease increase.

ملخص الدراسه

الهدف من الدراسه توصيف وظائف وشكل الكلى في المرضى البالغين المصابين بارتفاع ضغط الدم وربطه مع العمر، النوع ،مؤشر كتلة الجسم ، مساحة سطح الجسم ومدة ارتفاع ضغط الدم. تم تقييم مجموعة 75 مريض يعانون من ضغط الدم باستخدام الموجات فوق الصوتيه (33 من الذكور ، 42 إناث) ، و تقييم أيضا 25 من الأفراد الأصحاء لمقارنة النتائج والتغييرات . (12 من الذكور ، 13 إناث) دون ارتفاع ضغط الدم . تم حساب حجم الكلى بقياس طول وعرض وقطر الكلي باستخدام المعادله (LxWxAPx0.53) يتراوح حجم الكلى(بين 46.65 إلى 105.02 سم ^{3}) للكلية اليسرى (42.59 إلى 102.33 سم ^{3}) للكلى اليمنى. في الاصحاء ، الوسط والانحراف المعياري للكليه اليمنى واليسرى عند الذكور (80.7 سم 3 ± 36 و 75.3 ± 33) و عند الإناث (78.2 سم 3 ± 33 و 70.4 ، ± 29). كان الوسط والانحراف المعياري لطول الكلى 9.35 ± 1.3. (9.15 ± 1.1 سم) على الجانب الأيمن و (9.27 ± 1.3سم) على الجانب الأيسر.وتبين ان حجم الكلى في المرضي في الحد الأدنى بالنسبة للمجموعة الضابطة .كان عرض الكلى (متوسط ± 1.1 ± 4.45 سم) وسمك القشرة 1.46 ± 0.5 سم ، يعتبر في المعدل الطبيعي . يرتبط حجم الكلى بشكل كبير مع مؤشر كتلة الجسم في المرضى (ص = 0.35 و 0.31 ص <0.005 للكلية اليمنى واليسرى ، على التوالي) ، لم يكن هناك ارتباط كبير بين حجم الكلى ومدة ضغط الدم (ص = 0.9 و 0.8 ؛ ع > 0.005 ل الكلى الأيسر والأيمن ، على التوالي). في تصوير الطب النووي ، تراوح معدل الترشيح الكبيبي الإجمالي من 130-40 المتوسط والانحراف المعياري (17.3 ± 9 .87ذكور 86.8 ± 16.3 أنثى 88.8 ± 18.1) ، كان معدل الترشيح الكبيبي مرتبط بمعدل انخفاض العمر 0.82 (1.2 مل / دقيقة / سنة) أظهرالتصوير النووي 84٪ من المرضي لديهم وظائف الكلى طبيعية مع تاخير قليل في تدفق الدم للكلي ، 16٪ من المرضي كانت وظائف الكلي غير طبيعية (93٪ من جانب واحد 7 ٪ بالجانبين. واثبتت الدراسه ان الكليه اليمين اكثر تأثيرا من اليسار). كلا الكليتين تظهر انخفاض وظيفة الكلى مع التقدم في العمر و ذيادة مدة المرض. وكان الارتباط أقوى في شخص لديه مرض ضغط الدم لفترة طويله وغيرمسيطرعليه. ولوحظ أيضًا أن متوسط امتصاص الكلي للماده المشعه يتناقص عندما يزيد مدة المرض.

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List of Abbreviations

BP	Blood Pressure
HTN	Hypertension
BMI	Body mass index
BSA	Body surface area
CKD	Chronic kidney disease
WHO	World Health Organization
KDIGO	Kidney Disease Improving Global Outcomes
EGFR	Estimated glomerular filtration rate
GFR	Glomerular filtration rate
RAS	Renal artery stenosis
C/M	Cortical medulla differentiation
CT	Computer tomography
KUB	Kidney ureter Bladder
PKD	Polycystic kidney disease
ACE	Angiotensin Converting Enzyme
RVH	Renovascular hypertension
MAG 3	Mercaptoacetyltriglycine
DTPA	diethylenetriaminepentacetate

Tc-99m	Technetium
TAC	Time-Activity Curve
K/A	Kidney to Arterial
ROI	Region Of Interest
SD	Standard deviation

Chapter One

1.1. Introduction

Hypertension is one of the most common diseases worldwide especially essential hypertension [1], which is a multi-factorial disorder. Bp is the force of blood pushing against blood vessel walls as the heart pumps out blood. The high blood pressure, also called hypertension, is an increase in the amount of force that blood places on blood vessels as it moves through the body [1]. High blood pressure can damage blood vessels in the kidneys, reducing their ability to work properly. When the force of blood flow is high, blood vessels stretch so blood flows more easily. Eventually, this stretching scars and weakens blood vessels throughout the body, including those in the kidneys [1].

The kidney plays a major role in the regulation of blood pressure (BP) and is one of the main organs affected by high BP, makes it important to study the effect it has on the kidneys. Blood pressure is the force of the blood against the walls of blood vessels as heart pumps blood around the body. [2]

Renal scintigraphy and renal ultrasound is effective way to demonstrate renovascular hypertension. Ultrasound is a simple non-invasive method for estimating the kidney size in vivo and has many advantages over other imaging methods. These include use of non-ionizing radiation, little or no patient preparation and no need for medication or injection of contrast media. It is also readily available, cheap and easily reproducible to a large extent [2]. Renal length and volume are important parameters in clinical settings. Where the facility is available, Doppler ultrasound scan of the renal vessels can also be important in the diagnosis of renal artery stenosis and renovascular disease. It is also useful in assessment of intra renal hemodynamics in different pathological conditions such as essential hypertension, acute and chronic renal failure (CRF). Kidney length is the most easily reproducible parameter in assessing kidney size. However, renal volume is a better approximation of size than length because the shape of the kidney varies considerably. It has also been shown that renal volume correlates well with kidney weight. (3)

High BP is a leading cause of chronic renal disease. Over time, high blood pressure can damage blood vessels throughout your body. This can reduce the blood supply to important organs like the kidneys. High blood pressure also damages the tiny filtering units in your kidneys. As a result, the kidneys may stop removing wastes and extra fluid from your blood. The extra fluid in your blood vessels may build up and raise blood pressure even more. (3)

Renal parenchymal hypertension is hypertension occurring with renal parenchymal disorders and is one of the most frequent forms of secondary hypertension. Although hypertension occurs from an early stage in glomerular disorders, it occurs in the terminal stage in renal interstitial disorders. However, hypertension occurs frequently from an early stage in PKD, one of the tubule-interstitial disorders. (3)

As hypertension accelerates the progression of nephropathy, antihypertensive treatment is important for both the prevention of cardiovascular events and the protection of the kidney. In glomerular disorders (glomerulonephritis and diabetic nephropathy), the glomerular capillary pressure generally increases and the urinary protein level remains high (4).

In renal interstitial disorders (pyelonephritis and PKD) and hypertensive nephrosclerosis, the glomerular capillary pressure is generally normal or low, and the urinary protein level is low. The control of blood pressure to <130/80 mm Hg using antihypertensive drugs (of any type) should be attempted. However, if proteinuria increases, a more aggressive blood pressure control using RA system inhibitors would be required, as with glomerular disorders [4].

Our primary aim was to establish a normal range of values for kidney length and volume in hypertensive patient, recognizing individual variations observed. We aimed to evaluate renal volume in patients with essential hypertension and have developed chronic renal disease, and correlate it with age, somatic parameters and duration of hypertension [4].

Normally, the kidneys receive 20% of cardiac output, with renal plasma flow (RPF) averaging 600 mL/min. The kidneys clear the plasma and body of waste products. The clearance, or rate of disappearance, of a substance can be measured as:

Clearance (mL/min) =

$$\frac{\text{Urine concentration (mg/mL)} \times \text{Urine flow (mL/min)}}{\text{Plasma concentration (mg/mL)}}$$

Hypertension occurs in approximately 40% of patients with acute renal failure, its prevalence is higher in vascular and glomerular diseases (73%) than in tubular necrosis (15%). In the latter group, hypertension mainly results from the rapid reduction in glomerular filtration rate and consequently salt and water retention, whereas in the acute nephritic syndrome, hypertension may be present in the absence of a marked decline in glomerular filtration rate. Surprisingly, in rapidly progressive glomerulonephritis, blood pressure is normal or slightly elevated, even in patients with severe renal failure and fluid retention. [4]

1.2 Problem of Study:

High BP can damage blood vessels in the kidneys, reducing their ability to work properly. When the force of blood flow is high, blood vessels stretch so blood flows more easily. Eventually, these stretching scars and weakens blood vessels throughout the body, including those in the kidneys leading to a decrease in kidney size and chronic renal disease. Hypertension caused by renal hypo perfusion, which is usually the result of renal artery stenosis. The stenosis may be unilateral or bilateral and may involve one or more branches of the renal artery.

1.4 Objective of study:

1.4.1 General objective:

Characterization of renal function and morphology in hypertensive patients using Renal Scintigraphy and Ultrasonography.

1.4.2 Specific objective:

-To determine the renal function uses GFR and Renogram.

-To correlate the renal function in hypertension patients with age, gender, GFR, and duration of disease.

-To determine the morphology (shape, size, site, texture of the kidney using scintigraphy and ultrasonography

-To determine cortical thickness and kidney volume in hypertensive patient

-To correlate the duration of disease with renal volume

-To correlate between duration of the disease and renal function parameter

-To correlate between onset of disease and renal size

1.5 Significance of study:

Unilateral or bilateral changes in kidney size or morphology are manifested by many renal pathologies and are important parameters in clinical evaluation and management of patients with kidney diseases. Renal ultrasonography provides a safe, reliable, widely accessible and affordable way of imaging the kidneys. Estimation of renal size by sonography can be performed by measuring renal length, renal volume, cortical volume or thickness. Renal length as well as renal cortical thickness has been closely related to creatinine clearance in patients with chronic kidney disease and hypertensive patient.

1.6 Over view of study:

Chapter one deal with introduction and objective and research problem, chapter tow deal with theoretical background and literature review, chapter three deal Methodology, chapter four deal result, and chapter five deal with discussion, conclusion, recommendation, references and appendix.

Chapter two

Literature Review

2.1. Kidney Anatomy

The kidneys remove excess water, salts, and wastes of protein metabolism from the blood while returning nutrients and chemicals to the blood. They lie retroperitoneal on the posterior abdominal wall, one on each side of the vertebral column at the level of the T12–L3 vertebrae. At the concave medial margin of each kidney is a vertical cleft, the renal hilum.

The renal hilum is the entrance to a space within the kidney, the renal sinus. Structures that serve the kidneys (vessels, nerves, and structures that drain urine from the kidney) enter and exit the renal sinus through the renal hilum. The hilum of the left kidney lies near the Trans pyloric plane, approximately 5 cm from the median plane. The Trans pyloric plane passes through the superior pole of the right kidney, which is approximately 2.5 cm lower than the left pole, probably due to the presence of the liver. Posteriorly, the superior parts of the kidneys lie deep to the 11th and 12th ribs.

The levels of the kidneys change during respiration and with changes in posture. Each kidney moves 2–3 cm in a vertical direction during the movement of the diaphragm that occurs with deep breathing. Because the usual surgical approach to the kidneys is through the posterior abdominal wall, it is helpful to know that the inferior pole of the right kidney is approximately a finger's breadth superior to the iliac crest. During life, the kidneys are reddish brown and measure approximately 10 cm in length, 5 cm in width, and 2.5 cm in thickness. Superiorly, the posterior aspects of the kidneys are associated with the diaphragm, which separates them from the pleural cavities and the 12th pair of ribs. More inferiorly, the posterior surfaces of the kidney are related to the psoas major muscles medially and the quadratus lumborum muscle [3].

The subcostal nerve and vessels and the iliohypogastric and ilio-inguinal nerves descend diagonally across the posterior surfaces of the kidneys. The liver, duodenum, and ascending colon are anterior to the right kidney. This kidney is separated from the liver by the hepatorenal recess. The left kidney is related to the stomach, spleen, pancreas, jejunum, and descending colon. At the hilum, the renal vein is anterior to the renal artery, which is anterior to the renal pelvis. Within the kidney, the renal sinus is occupied by the renal pelvis, calices, vessels, and nerves, and a variable amount of fat. [4]

Each kidney has anterior and posterior surfaces, medial and lateral margins, and superior and inferior poles. However, because of the protrusion of the lumbar vertebral column into the abdominal cavity, the kidneys are obliquely placed, lying at an angle to each other. Consequently, the transverse diameter of the kidneys is foreshortened in anterior views and anteroposterior (AP) radiographs. The lateral margin of each kidney is convex, and the medial margin is concave where the renal sinus and renal pelvis are located. The indented medial margin gives the kidney a somewhat bean-shaped appearance. The renal pelvis is the fl attened, funnel-shaped expansion of the superior end of the ureter. The apex of the renal pelvis is continuous with the ureter. The renal pelvis receives two or three major calices (calyces), each of which divides into two or three minor calices. Each minor calyx is indented by a renal papilla, the apex of the renal pyramid, from which the urine is excreted. In living persons, the renal pelvis and its calices are usually collapsed (empty). The pyramids and their associated cortex form the lobes of the kidney. The lobes are visible on the external surfaces of the kidneys in fetuses, and evidence of the lobes may persist for some time after birth (3)

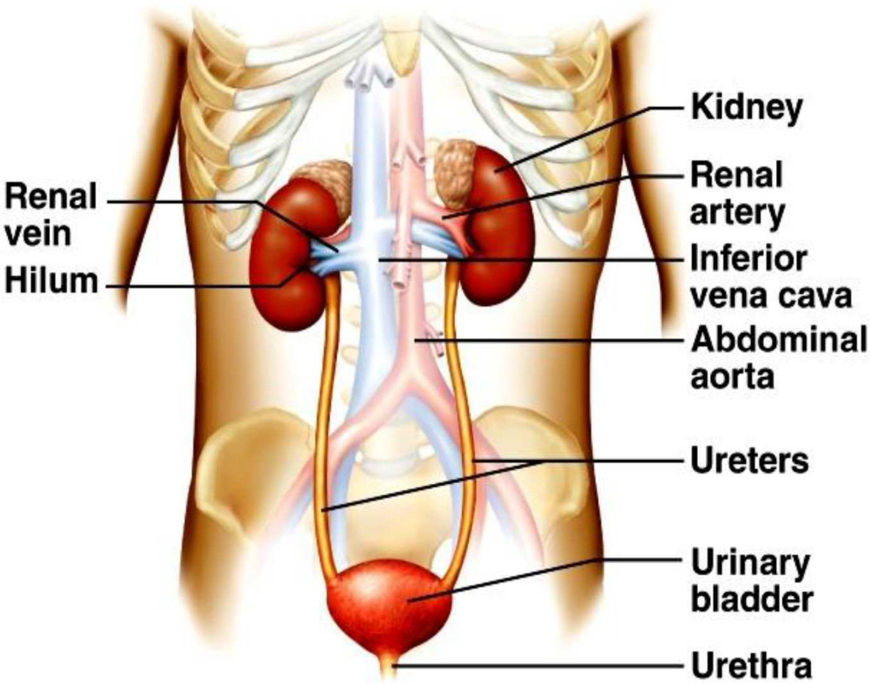

Fig (2-1): Anatomy of the kidneys

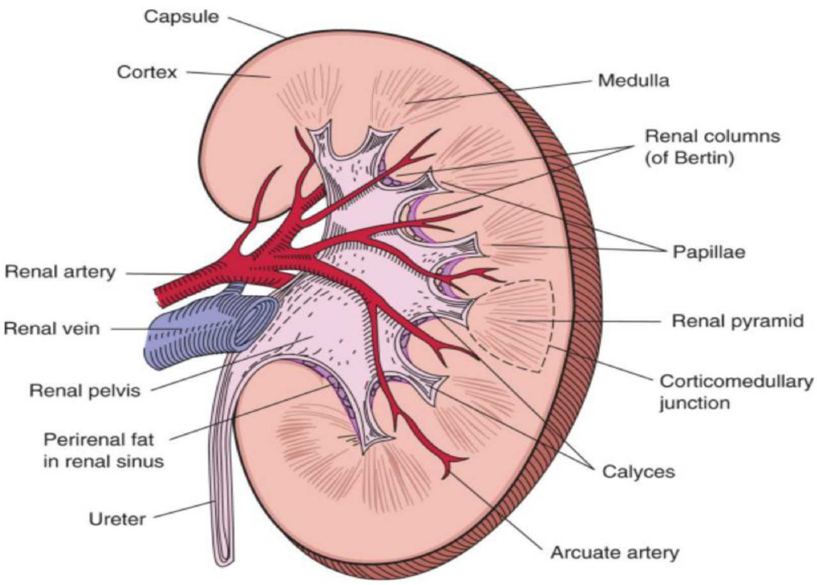

Fig (2.2): Schematic anatomy of a bisected kidney

The renal arteries arise at the level of the IV disc between the L1 and L2 vertebrae. The longer right renal artery passes posterior to the IVC. Typically, each artery divides close to the hilum into five segmental arteries that are end arteries (i.e., they do not anastomose signify cantle with other segmental arteries, so that the area supplied by each segmental artery is an independent, surgically resect able unit or renal segment). Segmental arteries are distributed to the renal segments as follows. The superior (apical) segment is supplied by the superior (apical) segmental artery; the anterosuperior and anteroinferior segments are supplied by the anterosuperior segmental and anteroinferior segmental arteries; and the inferior segment is supplied by the inferior segmental artery. These arteries originate from the anterior branch of the renal artery. The posterior segmental artery, which originates from a continuation of the posterior branch of the renal artery, supplies the posterior segment of the kidney [(3)].

Several renal veins drain each kidney and unite in a variable fashion to form the right and left renal veins. The renal lymphatic vessels follow the renal veins and drain into the right and left lumbar (cava and aortic) lymph nodes. The nerves to the kidneys arise from the renal nerve plexus and consist of sympathetic and parasympathetic fibers. The renal nerve plexus is supplied by fibers from the abdominopelvic (especially the least) splanchnic nerves [(3)].

2.2. Functions of the Urinary System:

One of the major functions of the Urinary system is the process of excretion. Excretion is the process of eliminating, from an organism, the waste products of metabolism and other materials that are of no use. Regulation of plasma ionic composition. Ions such as sodium, potassium, calcium, magnesium, chloride، bicarbonate, and phosphates are regulated by the amount that the kidney excretes. Regulation of plasma osmolarity. The kidneys regulate osmolarity because they have direct control over how many ions and how much water a person excretes Regulation of plasma volume. Your kidneys are so important they even have an effect on your blood pressure. The kidneys control plasma volume by controlling how much water a person excretes. The plasma volume has a direct effect on the total blood volume, which has a direct effect on your blood pressure [4].

Regulation of plasma hydrogen ion concentration (pH). The kidneys partner up with the lungs and they together control the ph. The kidneys have a major role because they control the amount of bicarbonate excreted or held onto. The kidneys help maintain the blood Ph. mainly by excreting hydrogen ions and reabsorbing bicarbonate ions as needed. Removal of metabolic waste products and foreign substances from the plasma. Secretion of Hormones the endocrine system has assistance from the kidneys when releasing hormones. Renin is released by the kidneys. Renin leads to the secretion of aldosterone which is released from the adrenal cortex. Aldosterone promotes the kidneys to reabsorb the sodium (Na^+) ions. The kidneys also secrete erythropoietin when the blood doesn't have the capacity to carry oxygen. Erythropoietin stimulates red blood cell production. The Vitamin D from the skin is also activated with help from the kidneys. Calcium (Ca^+) absorption from the digestive tract is promoted by vitamin D [4].

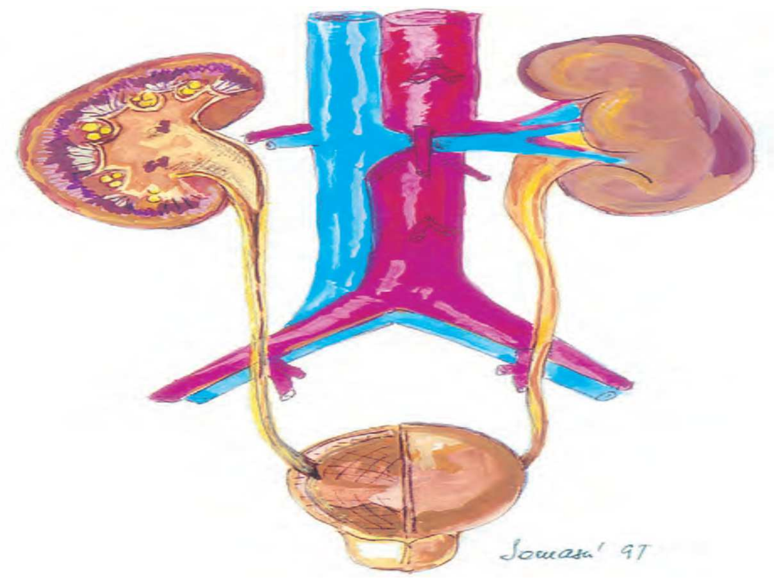

Fig (2-3) Function of renal system

2.3. Hypertension (HTN)

Or high BP, sometimes called arterial hypertension, is a chronic medical condition in which the blood pressure in the arteries is elevated. This equals the maximum and minimum pressure, respectively. There are different definitions of the normal range of BP. Normal BP at rest is within the range of (100–140) mmHg systolic (top reading) and (60–90) mmHg diastolic (bottom reading). High blood pressure is said to be present if it is often at or above (140/90) mmHg [(4)]. Hypertension puts strain on the heart, leading to hypertensive heart disease and coronary artery disease. Hypertensions also major risk factor for stroke, aneurysms of the arteries, peripheral artery disease and chronic kidney disease [(4)].

Hypertension is classified as either primary essential hypertension or secondary hypertension; about 90–95% of cases are categorized as primary hypertension which means high BP with no obvious underlying medical cause. The remaining 5–10% of cases categorized as secondary hypertension is caused by other conditions that affect the kidneys, arteries, heart or endocrine system [5].

Hypertension is rarely accompanied by any symptoms, and its identification is usually through screening, or when seeking healthcare for an unrelated problem. A proportion of people with high blood pressure report headaches (particularly at the back of the head and in the morning), as well as lightheadedness, vertigo, tinnitus (buzzing or hissing in the ears), altered vision or fainting episodes [6]. These symptoms, however, might be related to associated anxiety rather than the high blood pressure itself [7].

On physical examination, hypertension may be suspected on the basis of the presence of hypertensive retinopathy detected by examination of the optic fundus found in the back of the eye using ophthalmoscopy [8] Classically, the severity of the hypertensive retinopathy changes is graded from grade I–IV, although the milder types may be difficult to distinguish from each other [8]. Ophthalmoscopy findings may also give some indication as to how long a person has been hypertensive [6].

Some additional signs and symptoms may suggest secondary hypertension, i.e. hypertension due to an identifiable cause such as kidney diseases or endocrine disease. For example, truncal obesity, glucose intolerance, moon face a hump of fat face behind the neck/shoulder, suggest Cushing's syndrome thyroid disease and acromegaly can also cause hypertension and have characteristic symptoms and signs. An abdominal bruit may be an indicator of renal artery stenosis (a narrowing of the arteries supplying the kidneys), while decreased blood pressure in the lower extremities and/or delayed or absent femoral arterial pulses may indicate aortic coarctation (a narrowing of the aorta shortly after it leaves the heart). Labile or paroxysmal hypertension accompanied by headache, palpitations, pallor, and perspiration should prompt suspicions of pheochromocytoma (9).

The Definition of CKD is defined as kidney damage, as confirmed by kidney biopsy or markers of damage, or glomerular filtration rate (GFR) <60 mL/min/1.73 m^2 for ≥3 months' reviews evaluation for proteinuria, other markers of kidney damage, and estimation of GFR from measurements of serum creatinine and prediction equations (9).

Diagnosis of the type of CKD is important for evaluation and management of hypertension and use of antihypertensive agents. Diagnosis is based on pathology and etiology. Definitive diagnosis is based on biopsy or imaging studies. However, biopsy and invasive imaging procedures are associated with a risk of small, but potentially serious complications. In most patients, well-defined clinical presentations and causal factors provide a sufficient basis to assign a diagnosis of CKD without these procedures (10)

The Hypertension is a common clinical finding in CKD; however, it is not part of the definition of CKD. Illustrates the classification of individuals based on presence or absence of kidney damage, level of GFR, and presence or absence of hypertension. Shaded areas indicate individuals with CKD; unshaded areas indicate individuals without CKD. Because of the age-related rise in blood pressure and decline in GFR, "high blood pressure" and "high blood pressure with decreased GFR" are common in the elderly. Determining whether elderly individuals with hypertension and decreased GFR have CKD requires assessment for markers of kidney damage (for example, measurement of urine protein, urinalysis with urine dipstick or sediment examination, or imaging studies of the kidneys [11].

There is a strong relationship between hypertension and (CKD). Hypertension is an important cause of End-Stage Renal Disease, contributing to the disease itself or, most commonly, contributing to its progression. On the other hand, hypertension is highly prevalent in CKD patients, playing a role in the high cardiovascular morbidity and mortality of this particular population. The relationship between abnormal BP and kidney dysfunction was first established in the 19th century. The prevalence of both, and of the associated burden of cardiovascular morbidity and mortality, has been dramatically increasing. Data from several renal databases identifies systemic hypertension as the second most common cause of ESRD, with diabetes mellitus being the first. Additionally, for any given cause of CKD, the elevation in systemic BP accelerates the rate at which the glomerular filtration rate (GFR) declines. This is particularly true for patients with proteinuria nephropathies [12].

Although the kidney is also involved in essential or primary hypertension, its insufficiency causes high BP, contributing to 2-5 % of all cases of hypertension or half the cases of all forms of secondary hypertension [11]. The pathogenesis of hypertension-related to CKD is complex and multifactorial, mainly in the late stages of the renal disease. In addition to the classical factors, such as increased intravascular volume and excessive activity of the RAS, there are new recognized players such as increased activity of the sympathetic nervous system, endothelial dysfunction and alterations of several humoral and neural factors that promote an increase of the blood pressure. Hypertension is highly prevalent in CKD, being related with the level of renal function, the etiology of the kidney disease and the age of the patient. Patients with vascular disease, diabetes and polycystic kidney disease (PKD) are more prone to be hypertensive. It is also known that as renal function worsens the prevalence of hypertension increases. Therefore, more than 80 % of the patients beginning renal replacement therapy have high BP [13]

The relevance of the RAS, in physiological terms, is based on its capacity to regulate arterial pressure and sodium balance. When the blood pressure or perfusion fall, or the sympathetic activity increases, the juxtaglomerular cells secrete renin, which cleaves angiotensinogen, leading to an increase in angiotensin II levels. This octal peptide is a powerful vasoconstrictor and stimulates the production of aldosterone, which, in turn, increases renal sodium reabsorption, and closes the regulatory feedback loop. However, if the blood volume is normal, the increased activity of the RAS produces an abnormal rise in the BP. Only a small proportion of CKD patients have a measurable increase of the RAS. However, this activity in most of these patients is inappropriately high in the volume expanded milieu of CKD. Furthermore, in CKD, mainly secondary to vascular disease, diabetes or PKD, in areas of renal injury or ischemia there is a greater production of local and intra-renal AII which then exacerbates systemic hypertension [12].

The treatment of hypertension in CKD has three main goals: BP control; delaying the progression of CKD itself; decreasing the risk of cardiovascular complications in this particular population. The role of non-drug therapy is frequently underestimated. However, salt restriction and lifestyle modifications are invaluable to achieve the goals defined above. Drug therapy is fundamental, and at later stages of CKD, double or multiple drug associations are often needed. RAS antagonists should the preferred drugs and their association with diuretics mandatory [12].

The vast majority of patients with secondary hypertension have Reno vascular disease. Renovascular disease is most frequently caused by atherosclerosis (66%), and the majority of the remaining cases largely result from fibromuscular dysplasia. Many different imaging techniques have been used in an effort to detect patients with renovascular hypertension. These include intravenous and intra-arterial digital subtraction angiography, captopril renal scintigraphy, duplex and color Doppler US, and magnetic resonance angiography. Numerous studies and clinical experience in ultrasound laboratories have indicated the utility of Doppler ultrasound as an initial screening examination for renal vascular hypertension. Despite this, use of this method remains controversial. The screening approach may involve detection of abnormal Doppler signals at or just distal to the stenosis or detection of abnormal Doppler signals in the intra renal vasculature. Evaluation of the main renal arteries in their entirety is usually impossible. It is estimated that the main renal arteries are not seen in up to 42% of patients (13).

In addition, approximately 14% to 24% of patients will have accessory renal arteries that are usually not detected sonographically. Therefore, evaluation of the main renal arteries as a screening approach for renal artery stenosis often fails, particularly in difficult-to-scan patients. The second approach is to interrogate the intra renal vasculature, which can be identified in virtually all patients. Normally, there is a steep upstroke in systole with a second small peak in early systole. A tardus-parvus waveform downstream from a stenosis refers to a slowed systolic acceleration with low amplitude of the systolic peak (13).

2.4. Renal Artery Stenosis:

When an arterial lesion causes significant vascular renal artery stenosis (RAS), glomerular perfusion pressure drops, causing the GFR to fall. The kidney responds by releasing the hormone renin from the juxtaglomerular apparatus. Renin converts angiotensinogen made in the liver to angiotensin I. In the lungs, angiotensin I is converted by angiotensin converting enzyme (ACE) to vasoactive angiotensin II, which acts as a powerful vasoconstrictor. This constriction raises blood pressure peripherally and acts on the efferent arterioles of the glomerulus to raise filtration pressure, thus maintaining. *If* renal blood flow remains low, the kidney will become scarred and contracted with time. Renovascular hypertension (RVH) is present, early intervention decreases arteriolar damage and glomerulosclerosis, increasing the chance for cure. The development of ACE inhibition Renography using captopril led to a sensitive, noninvasive functional method for diagnosing RVH. ACE inhibitors work by blocking the conversion of angiotensin I to angiotensin II = this causes the GFR to fall in patients with RVH who rely on the compensatory mechanism to maintain perfusion pressure. Functional changes can be seen on the scintigram.

2.5. Dynamic Renography (Renogram):

Dynamic functional studies are generally acquired in two parts. Renal blood flow is assessed in the first pass of the radiopharmaceutical bolus to the kidney. Then, over the next 25 to 30 minutes, uptake and clearance assess function. Similar protocols can be used for the dynamic functional agent's Tc-99m DTPA and Tc-99m MAG3.Patients should be well hydrated before the study. While blood flow, radiopharmaceutical uptake, or functional calculations (ERPF or GFR) are not altered, excretion and

Washout can be delayed by dehydration, simulating obstruction or poor function. It is important to document all medications the patient has taken that may affect the study, such as diuretics and blood pressure medicines. Any known anatomic anomalies and prior interventions are important factors to consider in positioning and image interpretation.

A supine position is preferred because kidneys are frequently mobile and can move to the anterior pelvis when patients are upright. Patients are placed so that the kidneys are closest to the camera, with the camera posterior for normal native kidneys and anterior for transplants, pelvic kidneys, and horseshoe kidneys.

Image Acquisition After a bolus injection of radiopharmaceutical, the image acquisition begins when activity is about to enter the abdominal aorta. Images are acquired at a rate of 1 to 3 seconds per frame for 60 seconds to assess renal perfusion. Then images are acquired at 60 seconds per frame for 25 to 30 minutes to evaluate parenchymal radiotracer uptake and clearance.

Perfusion Time-Activity Curve The first-pass perfusion TAC shows the blood flow to each kidney compared with arterial flow. A region of interest is drawn around each kidney and the closest major artery (aorta for native kidneys, iliac artery for transplanted kidneys) on the initial 60-second portion of the study. Although absolute flow (milliliters per kilogram per minute) cannot be calculated with the radiotracers discussed, relative flow can be visualized or calculated using the upslope of the perfusion curve. A ratio of the activity compared to the aorta or kidney to arterial (K/A) ratio can help follow changes in perfusion.

Dynamic Renal Function Time-Activity Curve A TAC is generated for the remaining portion of the examination by drawing on the computer a region of interest (ROI) around each kidney. The selection of kidney ROI depends on the information needed. Whole-kidney regions can be used if the collecting system clears promptly. When a whole-kidney ROI is used in a patient with retained activity in the collecting system, clearance will appear delayed on the TAC. In cases of hydronephrosis and obstruction, a 2-pixel-wide peripheral cortical region of interest, excluding the collecting system, can be helpful, although some overlap with calyces is inevitable. Various methods of background correction have been employed using a 2-pixel-wide region of interest. It may be placed beneath the kidneys, around the kidneys, or in a crescent configuration lateral to the region of interest.

Differential Function is a universally performed calculation. This calculation is particularly useful because estimated GFR and serum creatinine may not identify unilateral lesions from the ROI drawn after the blood flow phase and before excretion into collecting system (at the peak nephrogram activity 1 to 3 minutes after injection), the actual counts in each kidney are expressed as a fraction of 100% total function. Normally, the relative contribution for each kidney lies between 45% to 85%.This value does not indicate whether the overall or global renal function is normal or abnormal. A calculation of GFR or ERPF can be done as a separate study to quantify actual function.

Flow Phase Blood flow to the kidneys is normally seen immediately after flow appears in the adjacent artery. In practice, arterial flow can be judged by the first few 2-sec flow frames. It is important to assess the quality of the injection bolus, because delayed renal visualization may be artifactual, as a result of suboptimal injection technique. If the slope of the arterial TAC is not steep or if activity visibly persists in the heart and lungs, the injection may have been given over too long a period. Any asymmetry in tracer activity suggests abnormal perfusion to the side of decreased or delayed activity. A smaller or scarred kidney will have less flow as a result of a decrease in parenchymal tissue volume.

Cortical Function Phase Normal kidneys accumulate radiopharmaceutical in the parenchymal tissues in the first 1 to 3 minutes. The cortex should appear homogeneous. The calyces and renal pelvis are either not seen in this initial phase or appear relatively photopenic. If decreased function is present on one side, the rate of uptake and function are often delayed on that side relative to the better functioning kidney. This produces a “flip-flop” pattern; the poorly functioning side initiallyhas lower uptake, but the cortical activity on later images is higher than on the better functioning side, which has already excreted the radiotracer. Cortical retention, or delayed cortical washout, is a nonspecific finding, occurring in acute and chronic renal failure.

Clearance Phase The calyces and pelvis usually begin filling by 3 minutes. Over the next 10 to 15 minutes, activity in the kidney and collecting system decreases. With good function, most of the radiotracer clears into the bladder by the end of the study. In some healthy subjects, pooling of activity in the dependent calyces can result in focal hot spots that usually clear at least partially over time. Lack of clearance or overlap of pelvocalyceal structures on the cortex suggests hydronephrosis. Because areas with increased activity appear larger, caution must be taken in diagnosing hydronephrosis on scintigraphic studies.

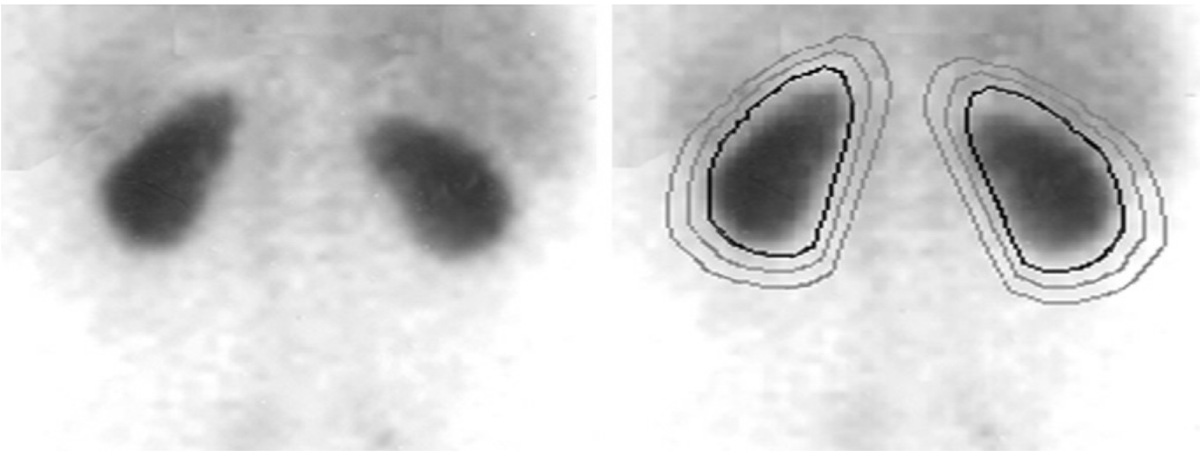

Fig (2.4) Regions of interest (ROI) for time-activity curves. *Left,* an image at 3 minutes with peak cortical activity is chosen for the ROIs. *Right,* Regions of interest are drawn for the kidney (*dark lines*) and for background correction (*gray lines*).

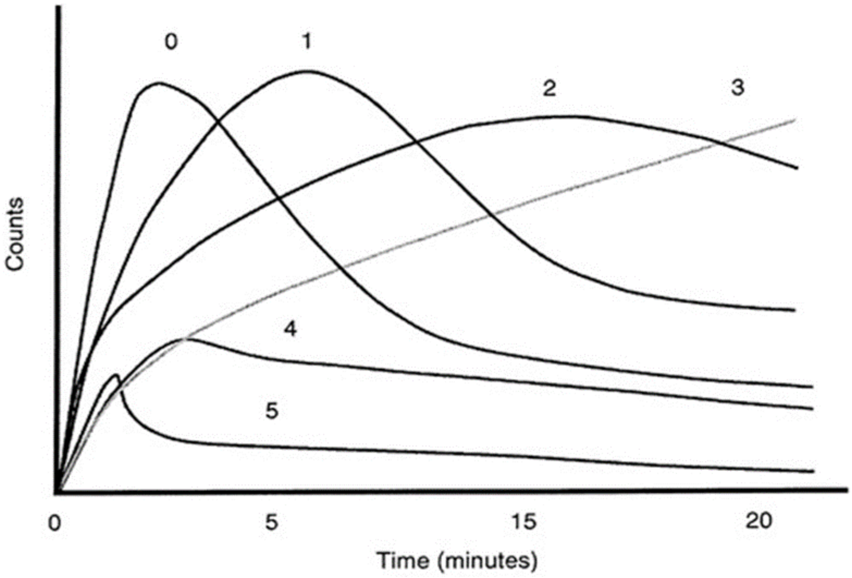

Fig (2.5) **Renogram interpretation** curves 0 normal, 1 = minor abnormalities but with T^{max} greater than 5 minutes and, 20-minute/peak uptake ratio greater than 0, 3. 2 = marked delayed excretion rate with preserved washout phase, 3 = delayed excretion rate without washout phase (accumulation curve), 4 = renal failure pattern with measurable kidney uptake, 5 = renal failure pattern without measurable kidney uptake (blood background-type curve)

2.6: previous study

Adedeji et.al[14] studied the Evaluated of renal volume by US in patients with essential hypertension in Ile-Ife, south western Nigeria, this determine the renal volume in adult patients with essential hypertension and correlate it with age, sex, BMI, BSA and duration of hypertension, a total of 150 patients (75 males, 75females) with essential hypertension and normal renal status were evaluated Sonographically in there prospective study. Fifty healthy individuals (25 males, 25 females) without hypertension were also evaluated as control. Renal volume was then calculated from the kidney's length, width and anterio-posterior diameter using the formula L×W×AP×0.523, the range of renal volume obtained was (51.65–205.02) cm^3, with a mean of 114.06 ± 29.78 cm^3 for the left kidney and (47.37–177.50) cm^3 with a mean of 106.14 ± 25.42 cm^3 for the right kidney. The mean volumes of the right and left kidneys in males (112.98 ± 25.56) cm^3 and (123.11 ± 32.49) cm^3, respectively), were significantly higher than in females (99.31 ± 23.07) cm^3 and (105.01 ± 23.77) cm^3, respectively). Renal volume correlated significantly with BSA and BMI, but decreased with age. The renal volume showed no correlation with duration of hypertension. Renal volume is higher in the left than the right kidney in hypertensive patients of both sexes and female hypertensive patients have smaller kidney size compared to males. The study also shows that volume of both kidneys decreases with age and positive correlation between renal volume, BSA and BMI. However, there is no correlation between the renal size and duration of hypertension.

Päivänsalo and Merikanto [15] studied the Effect of hypertension, diabetes and other cardiovascular risk factors on kidney size in middle-aged adults. The aim of the study was to investigate in a population-based series (1031 subjects, age range 40-60 years), whether the renal size of hypertensive subjects differs from that of control subjects and whether the difference might be due to hypertension itself or risk factors associated with hypertension. The renal measurements were performed by abdominal US. The genders were analyzed separately. Hypertensive men had slightly larger kidneys than controls (70.1+/-8.9 cm2 vs. 67.9+/-8.7 cm2, p <0.008). The difference was, however, mediated mainly through the BMI, whereas hypertension, BP or hypertensive medication did not affect renal size. High serum concentrations of uric acid and creatinine were associated with smaller kidney size (p <0.001 and p <0.05, respectively). Alcohol users had slightly larger kidneys than abstainers, but the difference was not significant. Renal size increased with pack years of smoking. Diabetics had 4.8% larger kidneys (p <0.039), but no difference was observed between the subjects with impaired glucose tolerance and those with normal test results. In multivariate analysis, the most significant factors associated with enlarged kidney size were the fasting blood glucose concentration (p < = 0.0001), smoking (p < or = 0.0001) and atherosclerotic lesions in carotid arteries (p <0.002). The kidneys were also slightly larger in hypertensive women than in control subjects, but the difference was only of borderline significance (p <0.08). Women on hormone replacement therapy had smaller kidneys than other women (p <0.05), but there was no difference in renal measures between premenopausal and postmenopausal women. In multivariate analysis, the most significant factors contributing to large kidney size were blood glucose concentration (p<0.0001) and smoking (p <0.05), while age and serum creatinine concentration were associated with smaller kidney size ($p < 0.0001$ and $p < 0.0001$)[15].

Mujahid [(16)] studied US assessment of renal size and its correlation with BMI in adult many conditions affect the renal size. To evaluate abnormalities in renal size, knowledge of standardised values for normal renal dimensions is essential as it shows variability in the values of normal renal size depending on body size, age and ethnicity. Ultrasound, being an easily available, noninvasive, safe and less expensive modality, is widely used for evaluation of renal dimensions and repeated follow-ups. The objectives of this study were to determine renal size by US in adults without any known renal disease, and to determine the relationship of renal size with BMI. Study was conducted in the Department of Diagnostic Radiology, Shiva International Hospital and PIMS Islamabad. Renal size was assessed by US in 4,035 adult subjects with normal serum creatinine and without any known renal disease, between November 2002 and December 2010. Renal length, width, thickness and volume were obtained and mean renal length and volume were correlated with BMI and other factors like age, side, gender, weight and height of the subjects. The study shows mean renal length on right side was (101.6±8.9) mm, renal width (42.7±7.1) mm, and parenchymal thickness (14.4±2.9) mm. On left side, mean renal length was (102.7±9.2) mm, width (47.6±7.0) mm, and parenchymal thickness (15.1±3.1) mm. Mean renal volume on right was (99.8±37.2) cm3 and on left was (124.4±41.3) cm3. The Left renal size was significantly larger than right in both genders. Relationship of mean renal length was significant when correlated with age, side, gender, height and weight, and BMI. Renal volumes also showed a similar relationship with side, gender, height and weight, and BMI; but with age such a relationship was seen only for left kidney the concluded that the Pakistani population has mean renal size smaller than reference values available in international literature. Renal length and volume have a direct relationship with body mass index. Mean renal size is related to the side, age, gender, height and weight as well [16].

Raman1, Clark [17] studied Is BP related to kidney size and shape. To examine the relationship between BP and the size and shape of the kidneys in healthy volunteers from the community. A cross-sectional community-based study of normal volunteers in Portsmouth City, Hampshire, UK. Subjects numbered 185 (99 female), aged 19–66 years. Blood pressure was higher in men, and in those with higher BMI. Both systolic and diastolic blood pressure were correlated with the derived kidney volume. However, when corrected for age, sex and BMI the relationship was not statistically significant. Blood pressure correlated inversely with the width, length ratio of the left kidney. Concluded that BP was not correlated with kidney size in this group of adults [17].

Adalbert and Manfred [18] studied the renal morphology in essential hypertension a morphological and clinical analysis of 1177 renal biopsies from nonselected patients with essential hypertension yielded the following results. In most cases (5775), kidneys showed only the changes of compensated benign nephrosclerosis, with varying degrees of segmental arteriolar hyalinosis, sometimes associated with ischemic glomerulopathy. The mean serum creatinine concentration was (1.3-0.6 mg %). This value was too high, considering that in an unknown number of these patients with essential hypertension, mild acute renal failure developed with serum creatinine values up to 2.8 mg% as a consequence of BP reduction before the diagnostic biopsy. The area of the juxtaglomerular apparatus as the location for renin production was, as shown by morphometric investigations, equivalent to kidneys in patients with normal BP [(18)].

Mustafa J.Musa[19] (2017) studied Sonographic measurement of renal size in normal populations, the purpose of this study was to investigate the normal sonographic measurement of the kidney in people. Length, width and thickness were measured in stratified random group of 125 volunteers with different age and sex. Their age ranges from 20 to 60 years old. Renal volumes were calculated and correlate with age, height, weight, body mass index and sex. Median renal lengths were 10.7 cm on the left side and 9.76 cm on the right side. These measurements were found to be lower than the length in low altitude. Median renal volumes were 106.08 cm on the left side and 94.25 cm on the right side. Renal size decreases with increased age because of parenchyma reduction, but it was increased with increasing body mass index. Renal length correlates with body height. Renal volume was larger in males than in females. The median cortical size was found 1.8 cm on both sides.

Chapter Three

Material and Method

3.1 Study design:

Nonintervention – A prospective study

3.2 Study area and duration:

This study was done in Radiation and Isotope Center of Khartoum in the period from 1.7.2017 up to 1.8.2019

3.3 Study sample:

A total of 200 adult patients with essential hypertension was examined using Renogram and sonographically after informed consent was obtained. The sample size was based on an estimated prevalence of hypertension. The patients were selected using a gender- random sampling technique. A control group of 25 healthy individuals without hypertension were also sonographically examined to compare kidney volume.

3.4 Inclusion criteria:

Patient with different age group included.

All patients suffer long standing hypertension and have request NM and ultrasound scan

3.5. Exclusion criteria:

Patient known renal failure

All pregnant women.

All women who had given birth in the last 12 months.

All Patients with congenital anomalies such as a horse shoe-shaped or ectopic kidney.

3.6. Method of data collection:

The patients' age, gender and duration of well obtain before examination. The height (in meters) and weight (in kilograms) of the patients well measure. The BMI and BSA well calculate using the formula weight/height^2 and weight$^{0.425}$×height$^{0.725}$×71.84, respectively. BP well measure using a sphygmomanometer. Real-time grey scale ultrasound examination well performs.

3.7. Method of data analyzes:

Data processing and statistical analysis were carried out using Microsoft Excel and Statistical Software Package for Social Sciences (SPSS).

3.8. Equipment:

3.8.1. Protocol Summary for Dynamic Renal Scintigraphy (Gamma camera):

PATIENT PREPARATION Hydration: Begin 1 hour before examination give fluids over 30 minutes' drink about 300-500 mL water.

RADIOPHARMACEUTICAL Tc-99m MAG3 5-10 mCi (185-370 MBq) *INSTRUMENTATION*

Gamma camera: Large field of view

Collimator: Low energy, high resolution, parallel hole

Photo peak: 15%-20% window centered over 140 keV

POSITIONING

Routine renal: Supine, camera posterior

COMPUTER ACQUISITION

Blood flow: 1- to 2-second frames for 60 seconds

Dynamic: 30-second frames for 25-30 minutes

Pre void image: 500k count

PROCESSING

Draw region of interest around kidneys.

Draw background area next to each kidney.

Generate time-activity curves for flow and dynamic phases.

Generate differential function calculation.

3.8.2. Weight measurement:

The weight was measured using Detector's world-renowned eye-level mechanical weigh beam physician scales feature a heavy-duty solid stable 10.5 x 14.5 inch (27 x 37 cm) platform, a dual-reading die-cast weigh beam which may be read from either side of the scale. -manufactured long-lasting, durable steel construction with an electrostatic powder paint finish for optimum quality. Capacity may be increased by using an optional counter weight. Scale is 59 inch (150 cm) high. Height rod, wheels and handpost features available.

Fig (3.1): weight and high count scale

3.8.3. Ultrasound Machine:

Evaluation of renal volume in patients with essential hypertension was done at the Department of ultrasound clinic and Real-time grey scale ultrasound examination was performed with The Fukuda Denshi FF sonic UF-4100 is a portable, multipurpose system with black and white imaging and a hardwired probe. This compact desktop design can be used in a variety of different clinical settings and applications using the 3.5–5 MHz curvilinear probe.

Fig (3.2): Ultrasound machine Fukuda Denshi FF sonic UF-4100

Sonography was performed on the patients with a full urinary bladder and in supine position. Acoustic gel was applied to the skin (to obliterate the air interface between the probe and skin). The kidney was clearly identified as having a brightly echogenic renal capsule with a central (sinus) echogenicity. The superior and inferior poles were clearly identified and marked in the longitudinal scan of the kidney, the renal length was taken as the longest distance between the poles using an electronic caliper. The antero-posterior diameter was also measured on longitudinal scan, and the maximum distance between the anterior and posterior walls at the mid-third of the kidney was taken as AP diameter. The renal width was measured on transverse scan, and the maximum transverse diameter was taken at the hilum as the renal width. The unit of measurement was centimeter (cm). Kidney volume was calculated using the formula: $L \times W \times AP \times 0.523$.

3.10 Sonographic Technique of Renal System

The ability to visualize organs of the genitourinary tract by ultrasound depends on the patient's body habitus, operator experience, and scanner platform. The patient should fast a minimum of 6 hours before the examination to limit bowel gas. High-frequency probes should be used for patients with a favorable body habitus. Harmonic imaging is often useful for difficult to scan patients (e.g. obese patients); additional recent software advances, including compound imaging and speckle reduction, may increase lesion conspicuity and decrease artifacts. The kidneys should be assessed in the transverse and coronal plane. Optimal patient positioning varies; supine and lateral decubitus positions often suffice, although oblique and occasionally prone positioning may be necessary (e.g., obese patients). Usually, a combination of subcostal and intercostal approaches is required to evaluate the kidneys fully; the upper pole of the left kidney may be particularly difficult to image without a combination of approaches [13].

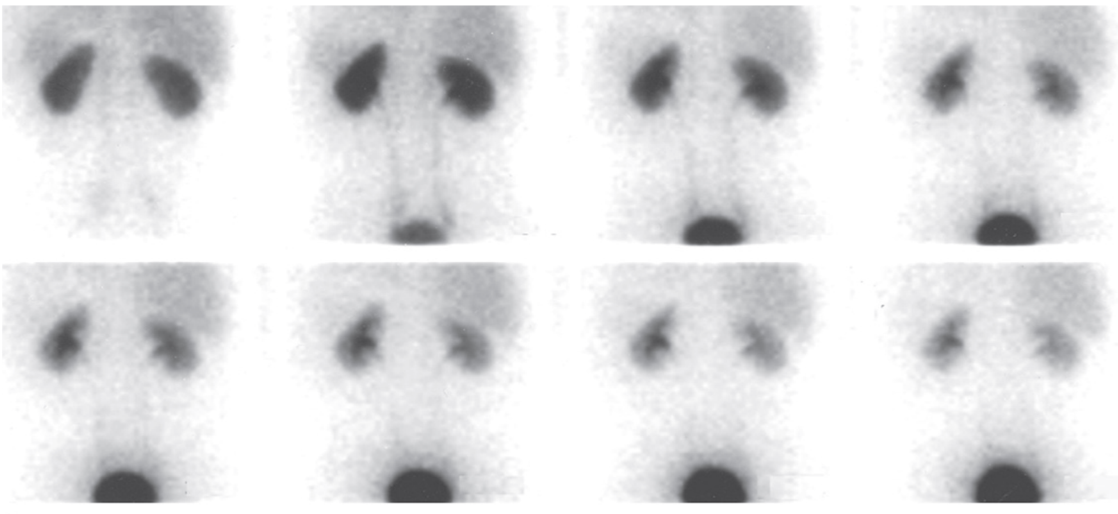

Fig 3.3 Normal Tc-99m MAG3. Normal dynamic functional images with prompt symmetric radiotracer uptake and rapid clearance over the study.

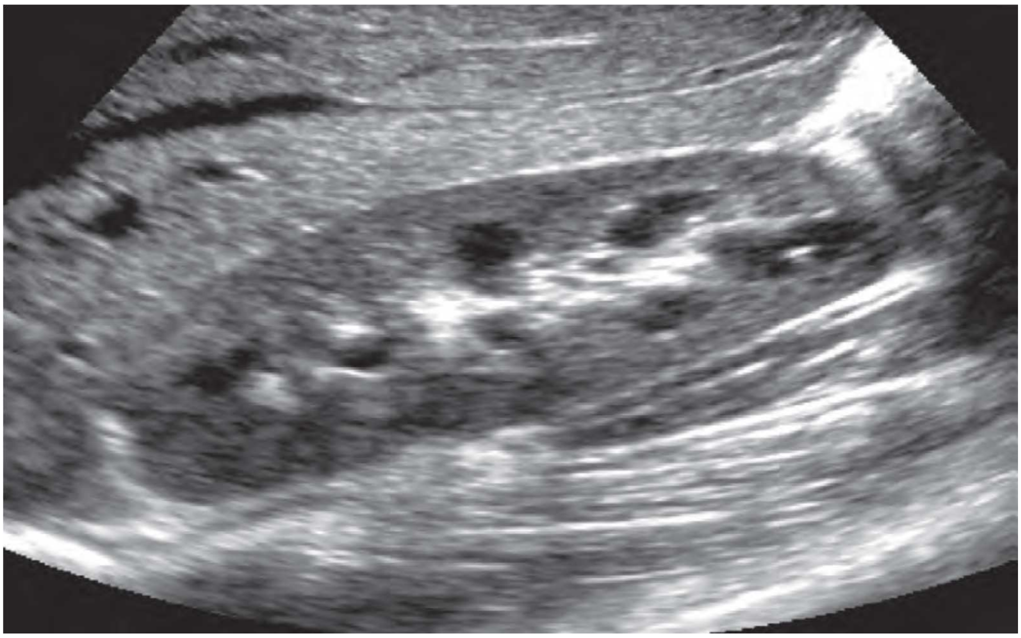

Fig (3.4): Sagittal sonogram shows normal renal anatomy with clear corticomedullary differentiation.

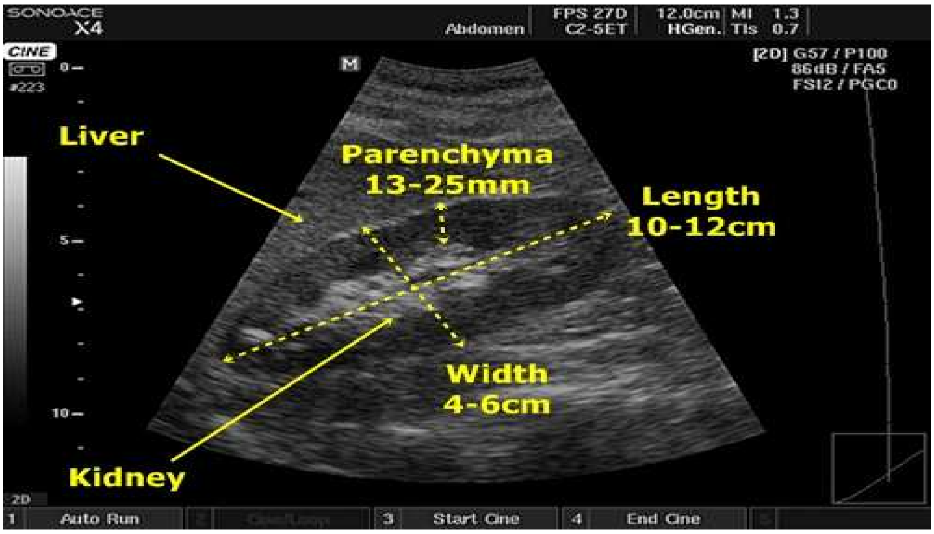

Figure (3.5): Sagittal sonograms shows normal measurement adult Rt kidney.

Chapter four

Result

Section one renal morphology by ultrasound

This study is conducted on a 75 hypertensive patient 33(44%) male, 42 (56%) female, control groups 12 (48%) male, 13 (52%) female was examined using US. Shows the disease among the female more than male 56% and 44% respectively shown in table (4.1) and fig (4.1).

Table (4.1): The Gender of hypertension and control group

Gender	Frequency	Percentage	Control	Percentage
Male	33	44%	12	48%
Female	42	56%	13	52%

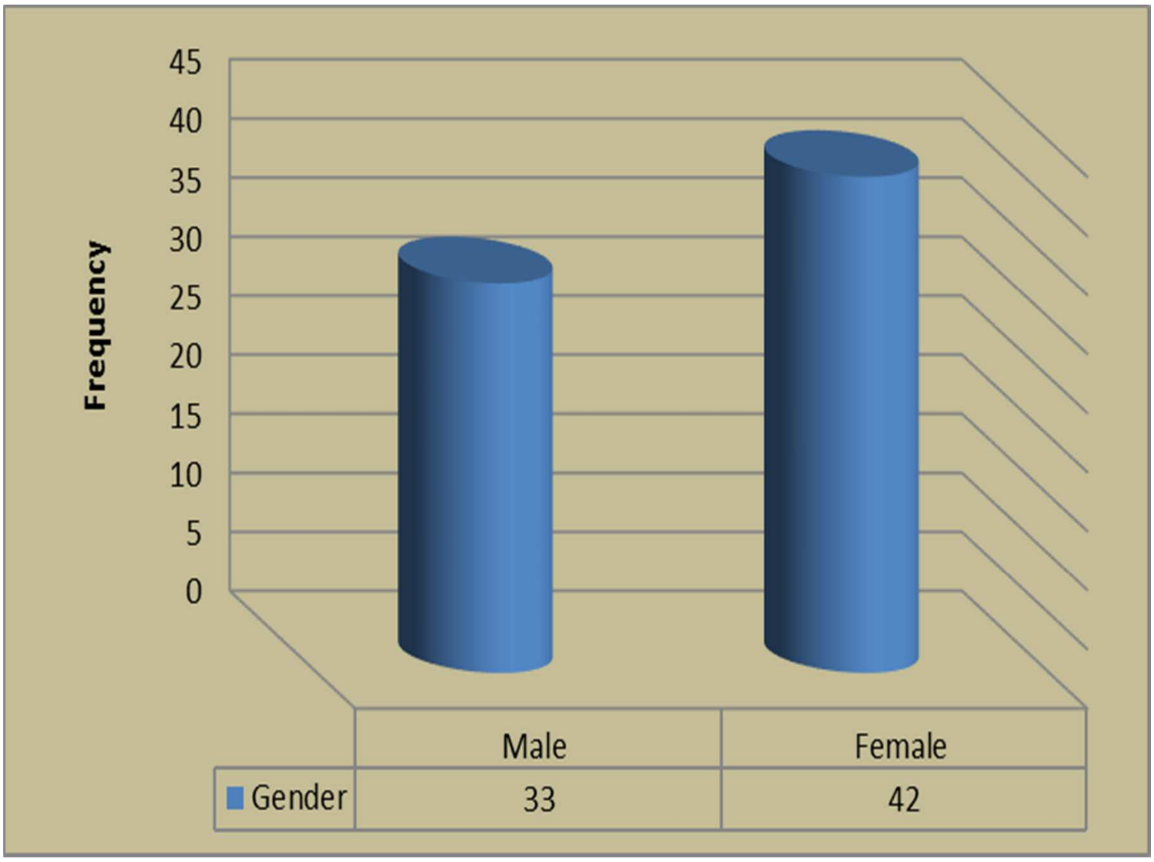

Fig (4.1): Represents the gender of hypertensive patient

The age of patient's understudy was distributed into groups, 1 (1.3%) between 21-30 yrs., followed by 3 (4%) between 31-40 yrs., 12 (16%) between 41-50 yrs., 18(24%) between 51-60 yrs., and the majority 41(54%) were above 60 yrs. The age range was 21–79 years, with a mean of 64.6 years. The ages of the control group of12 males and 13 females ranged from 21to 70 years, with a mean of 44.1 years. As shown in table (4.2) and fig (4.2).

Table (4.2): the age of hypertension and control group:

Age	Frequency	Percentage	Control	Percentage
<21	0	0%	0	0%
21-30	1	1.3%	7	28%
31-40	3	4%	6	24%
41-50	12	16%	9	36%
51-60	18	24%	2	8%
>60	41	54.6%	1	4%

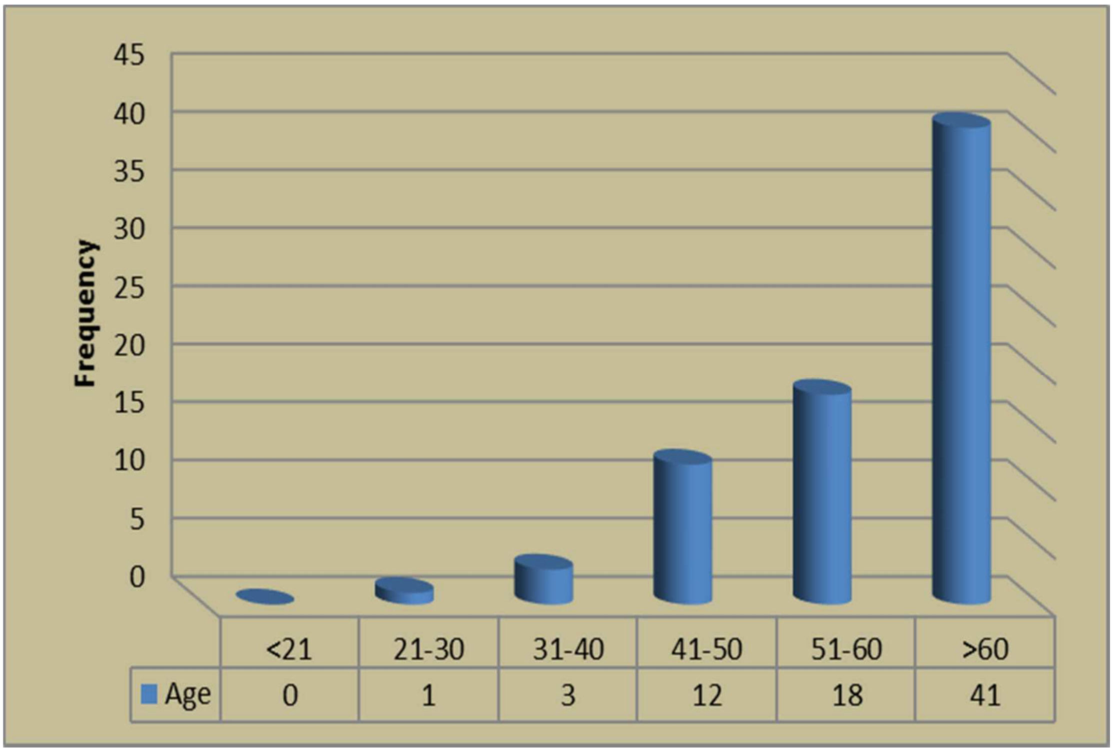

Fig (4.2): represent the common age affected by hypertensive patient.

Among this patient under the study 51(68%) residence in Khartoum followed Aljazeera 10(13%), Alshamalia 9(12%) and 5 (7%) from Kurdfan. Table (4.3) and fig (4.3)

Table (4.3) the Residence of hypertensive patients:

Residence	Frequency	Percentage
Khartoum	51	68%
Aljazeera	10	13%
Alshamalia	9	12%
Kurdfan	5	7%

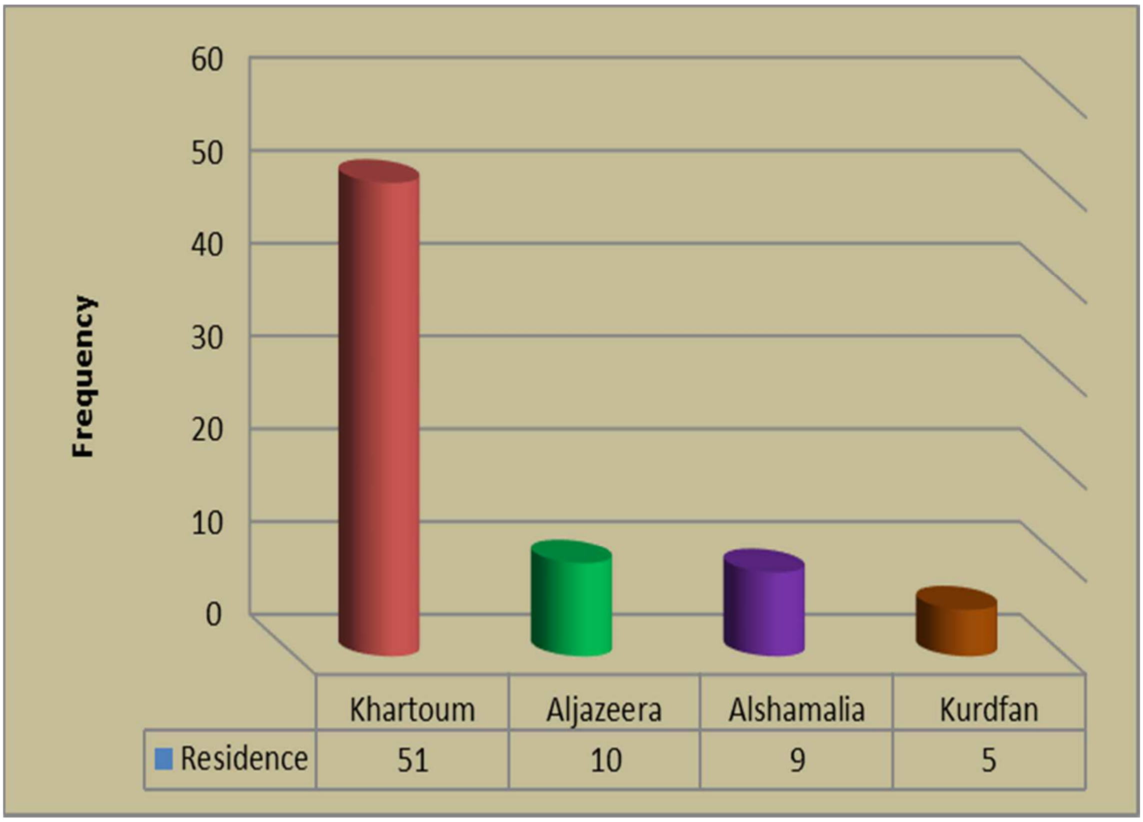

Fig (4.3) the Residence of hypertensive patients:

According to patient occupations, 30(40%) of them were housewives, 5(6.6%) teacher, 3(4%) lawyer, 3(4%) engineer, 7(9.3) driver, manager 5(6.6), accountant 6(8%) and 16(21.4%) other occupation not mentioned as shows in table (4.4) and fig (4.4).

Table (4.4): the occupation of hypertensive patient:

Occupation	Frequency	Percentage
Housewife	30	40%
Teacher	5	6.6%
Lawyer	3	4%
Engineer	3	4%
Driver	7	9.3%
Soldier	3	6.6%
Accouter	6	8%
Other occupation	13	21.4%

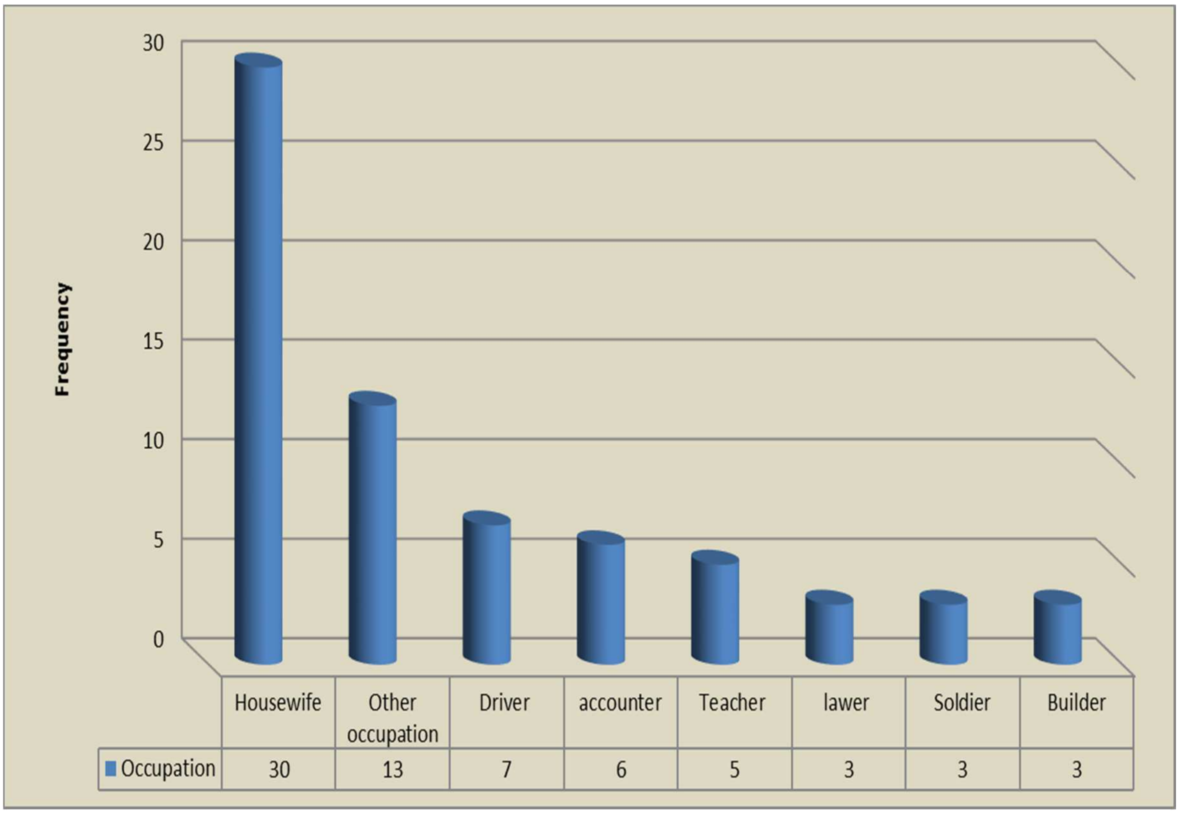

Fig (4.4): The occupation of hypertensive patient

The duration of hypertension ranged between 4 months and 40 years with a mean of 7 years. Less than half of the patients 33 (44%) have hypertension for more than six years, 15 (20.3%) have had it for 1–5 years, and 5 (6.6%) had it for less than one year and 22 (29.4) have hypertensive more than ten years.

Table (4.5): Duration of disease:

Duration	Frequency	Percentage
<1	5	6.6%
1-5	15	20%
6-10	33	44%
>10	22	29.4%

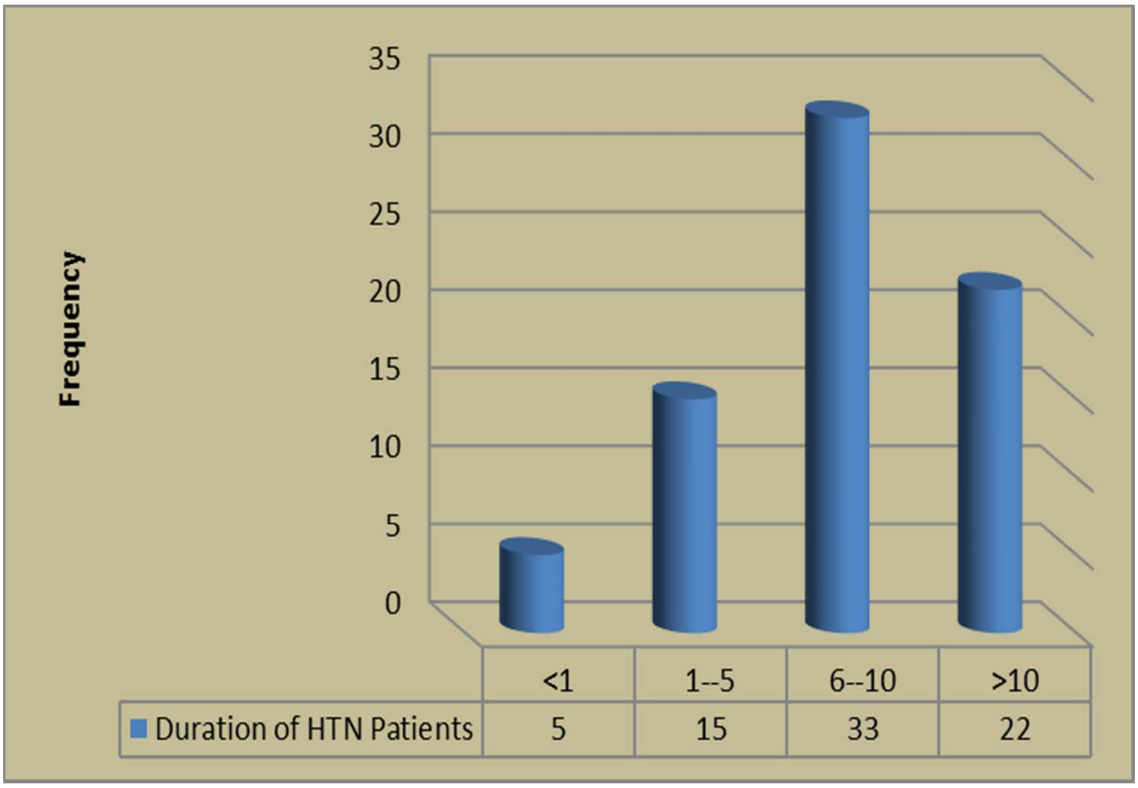

Fig (4.4): Duration of hypertension disease:

Most renal echogenicity among patient have normal echogenicity same echogenicity control group for both kidneys only 4% among patient have decrease echogenicity. Table (4.6) and fig (4.6).

Table (4.5): Represent echogenicity of both kidneys:

Echogenicity	Rt kidney (F)	Percentage	Lt kidney(f)	Percentage
Normal	72	96%	72	96%
Increase	0	0%	0	0%
Decrease	3	4%	3	4%

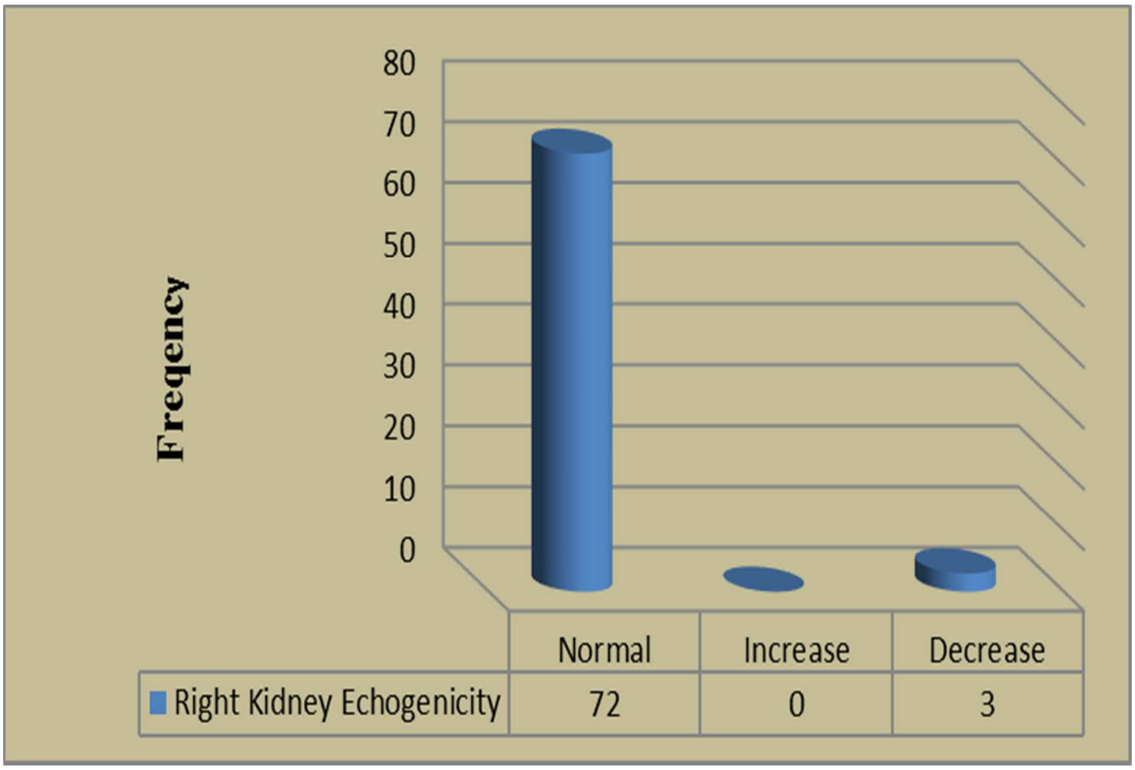

Fig (4.5) Represent echogenicity of RT kidney

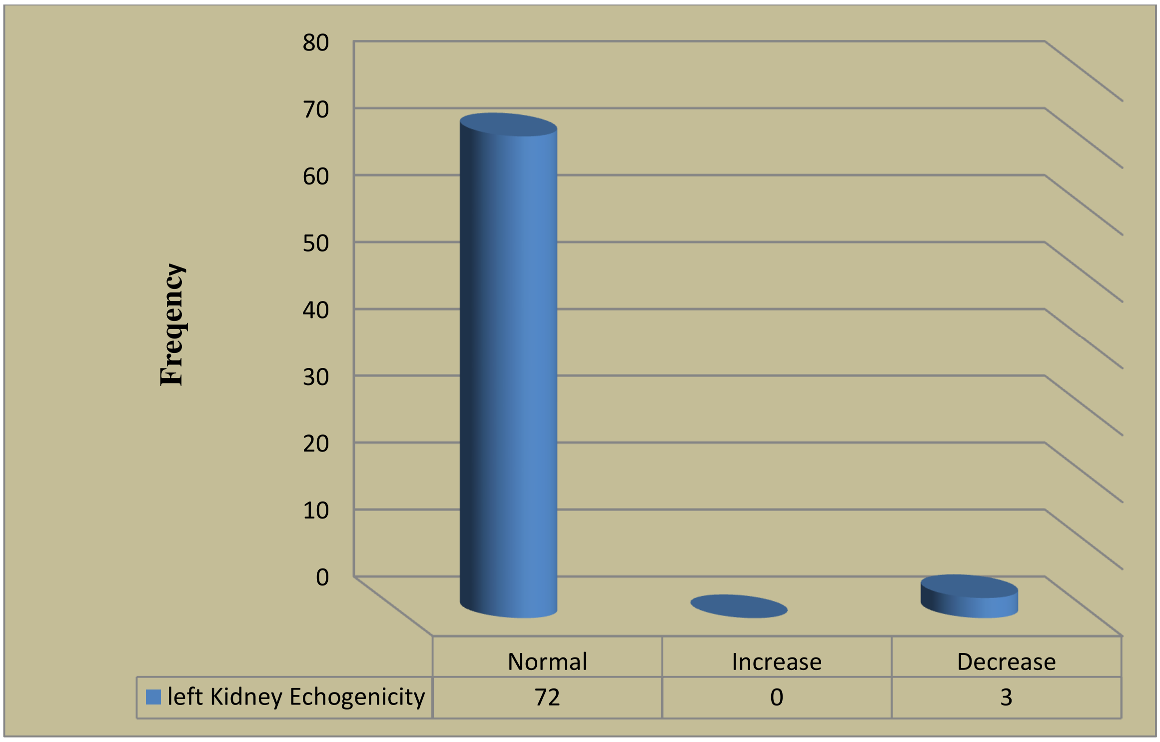

Fig (4.6): Represent echogenicity of LT kidney.

Most of the hypertensive patient had normal cortical thickness 72(96%) same as that of control group for both kidneys. only 3 (4%) had thin cortical thickness. Table (4.7) and fig (4.7).

Table (4.7) Represent cortical thickness of both kidneys:

Cortical thickness	Rt kidney(f)	Percentage	Lt kidney (f)	Percentage
Normal	72	96%	72	96%
Thin	3	4%	3	4%
Thick	0	0%	0	0%

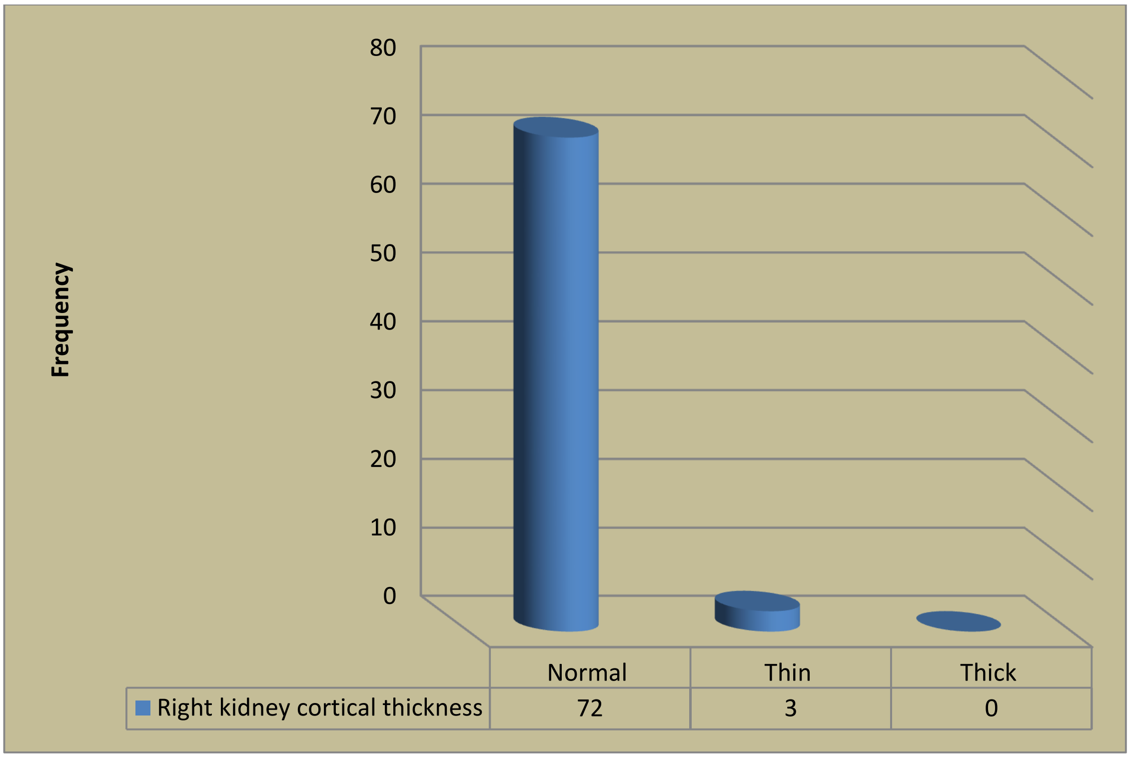

Fig (4.7) Represent cortical thickness of RT kidneys:

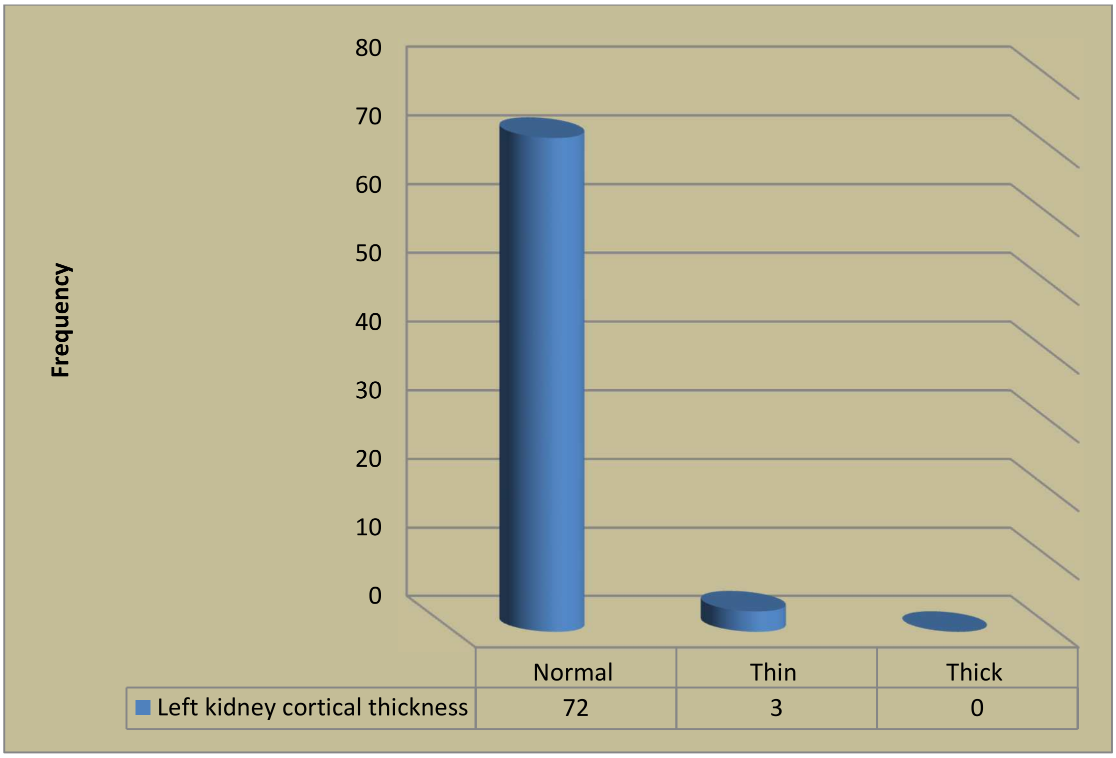

Figure 4.8 Represent cortical thickness of Lt Kidneys:

Regarding the common disease associated of hypertensive patient, 39 of patient (52%) had suffered only hypertension, 18(24) with diabetics, 14(19%) with renal cyst and only 4(5%) with cardiac diseases. Table (4.8) and fig (4.9).

Table (4.8): common diseases associated with hypertension in study:

Disease	Frequency	Percentage
Hypertension only	39	52%
Diabetics	18	24%
Renal cyst	14	19%
Cardiac disease	4	5%

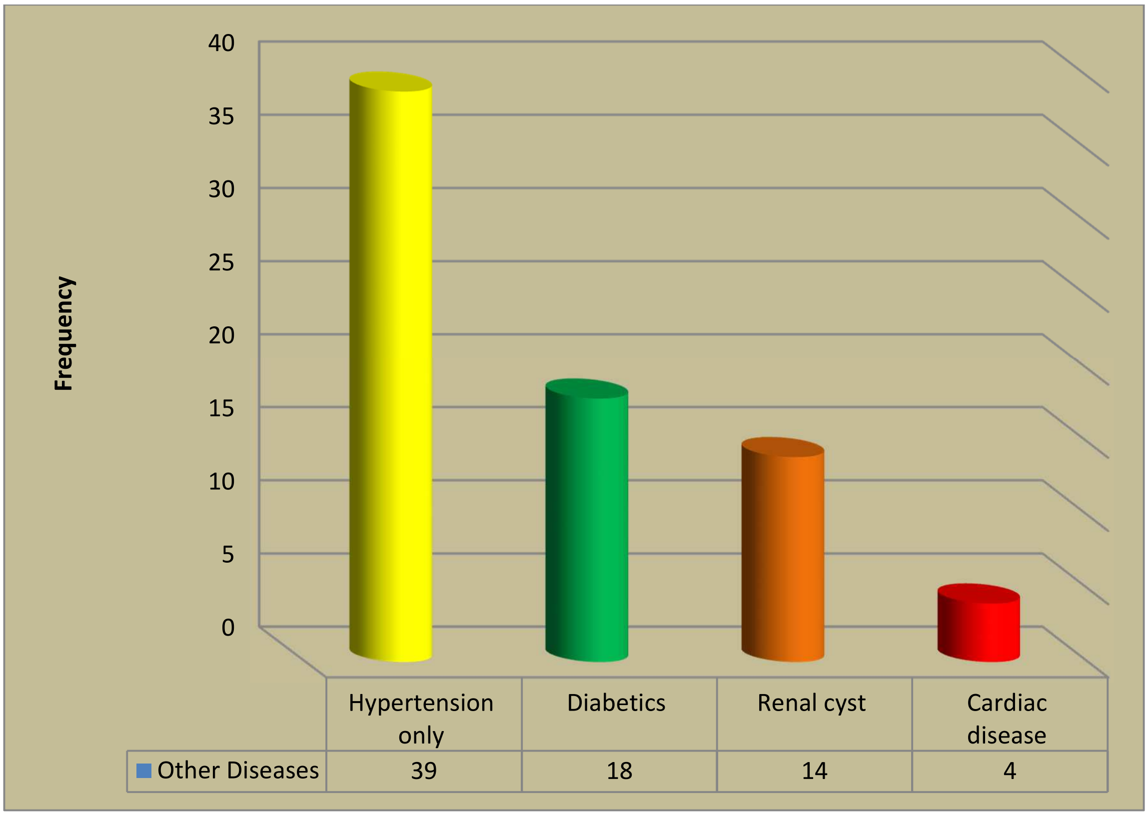

Fig (4.9): Common disease associated with hypertension:

-Among patient we also show that there is considerable reduction in renal volume as age advances for both kidneys.

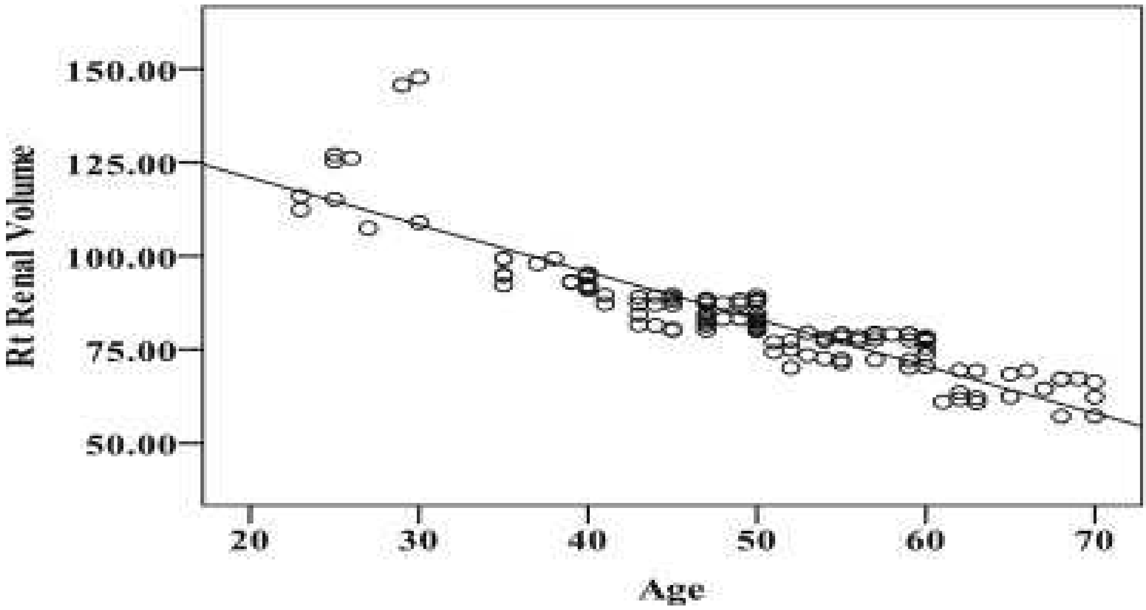

Fig (4.10) correlation RT kidney volume with age in hypertension patient shows reduction in renal volume as age increase.

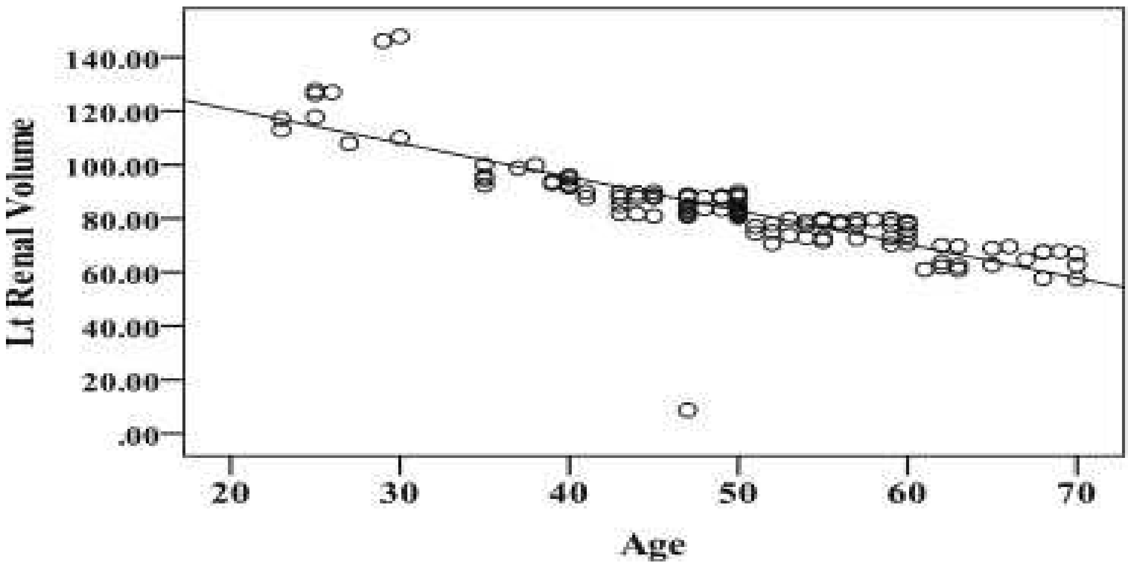

Fig (4.11) correlation LT kidney volume with age in hypertensive patient shows reduction in renal volume as age increase.

-Among patient we also show that there is considerable increase in renal volume as BMI increase. (Linear relation)

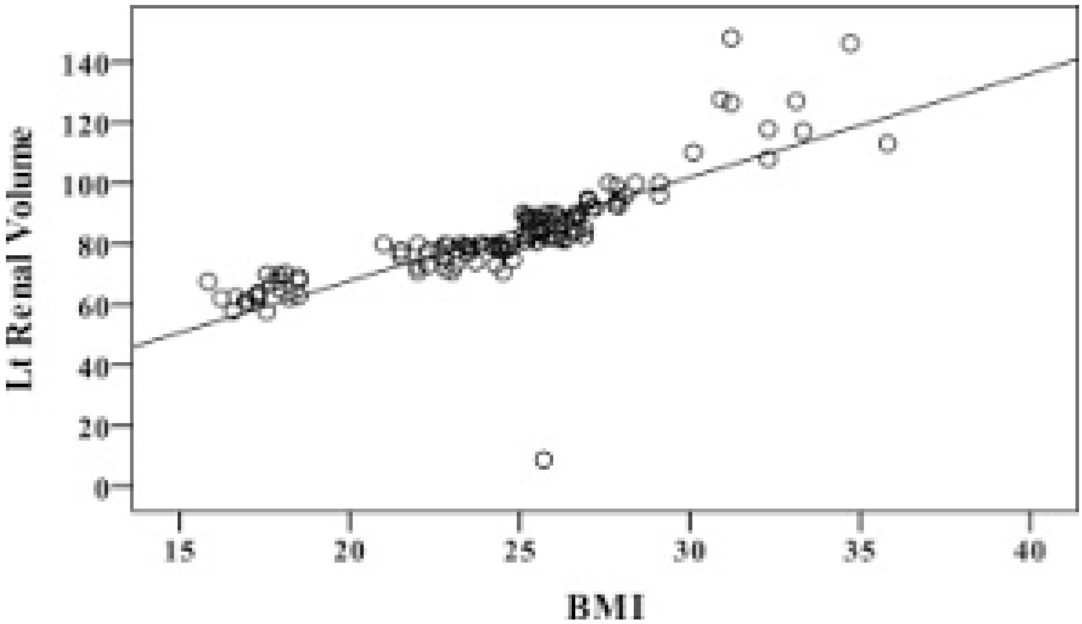

Fig (4.12) correlation LT kidney volume with BMI in hypertensive patient shows increase renal volume as BMI increase.

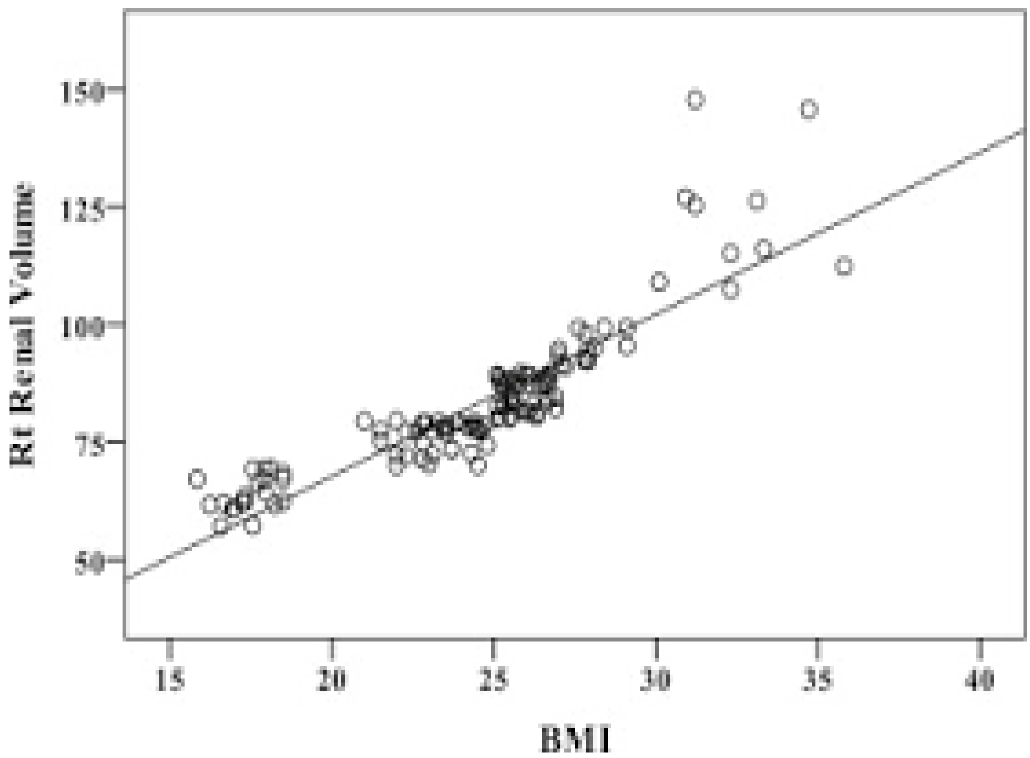

Fig 4.13 correlation RT kidney volume with BMI in hypertensive patient shows increase renal volume as BMI increase.

Section two:

Renal scintigraphy (Renal function)

Table (4-9) represents gender of hypertensive patient (mean and SD) related to GFR, function, and(peak time peak activity from injection)

Gender		N	Mean	Std. Deviation
GFR	Male	42	86.810	16.3129
	Female	58	88.810	18.1306
Function RT kidney	Male	42	53.143	12.9588
	Female	58	56.534	15.7271
Function LT kidney	Male	42	56.976	13.0561
	Female	58	61.534	13.3813
RT kidney peak time	Male	42	2.7900	0.51620
	Female	58	2.8812	0.57404
LT kidney peak time	Male	42	2.9921	0.46527
	Female	58	3.0519	0.49106
Peak activity	Male	42	3.4769	0.58249
	Female	58	3.3112	0.61994

Table (4.10) Comparison of renal function using Renogram for hypertensive patient:

	Frequency	Percentage
Normal Function	84	84%
Abnormal function	16	16%
Rt kidney	11	68%
Lt kidney	4	25%
Bilateral	1	7%

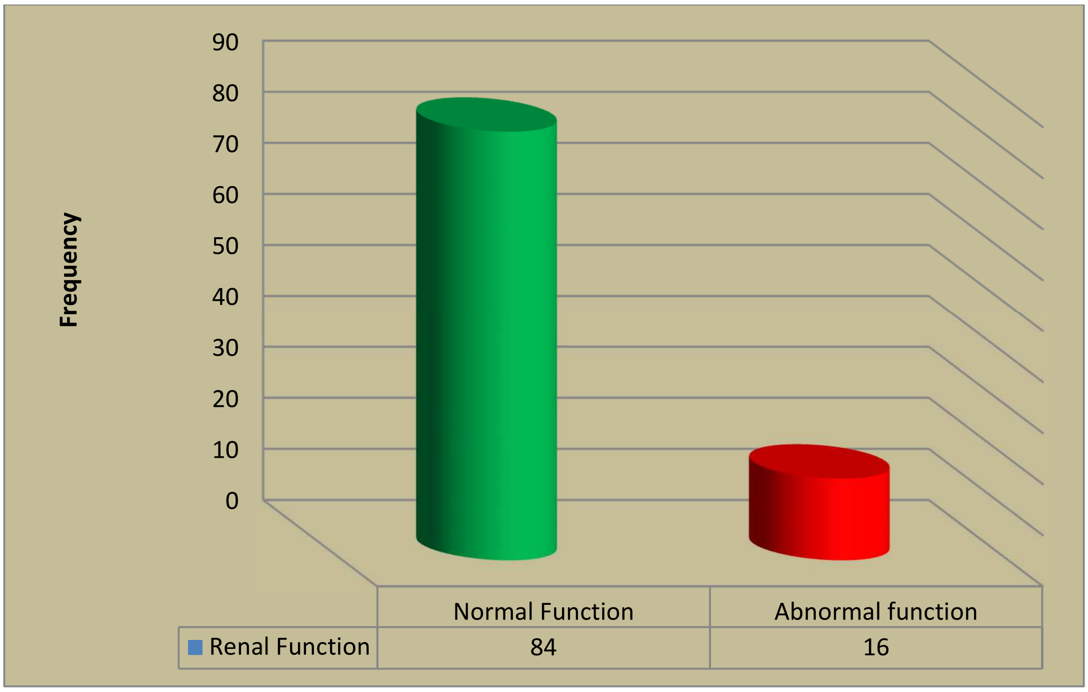

Fig (4.14) renal function using Renogram for hypertensive patient

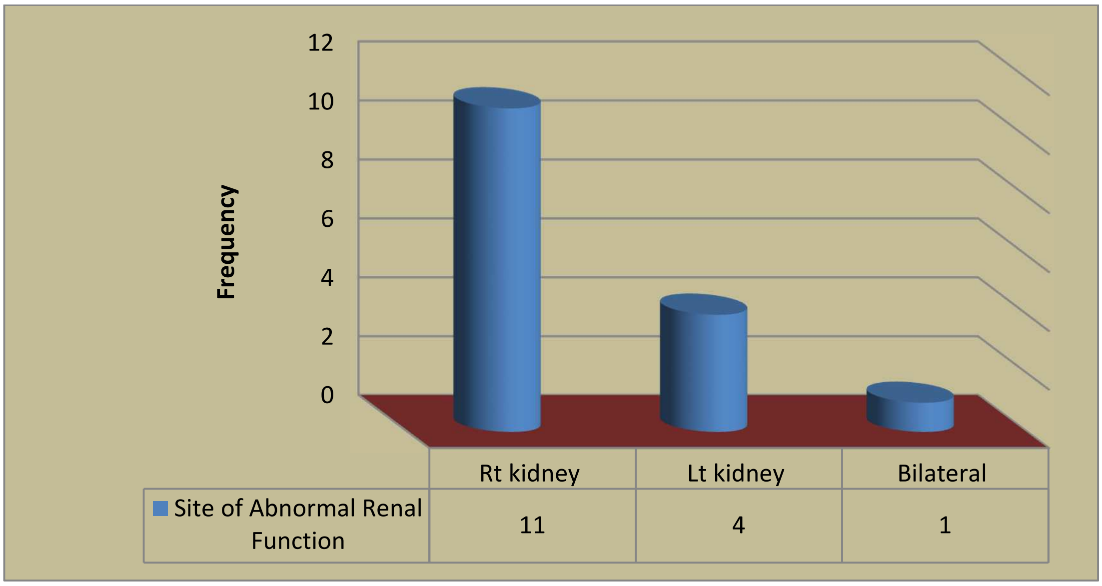

Fig (4.15) Site of abnormal renal function using Renogram for hypertensive patient

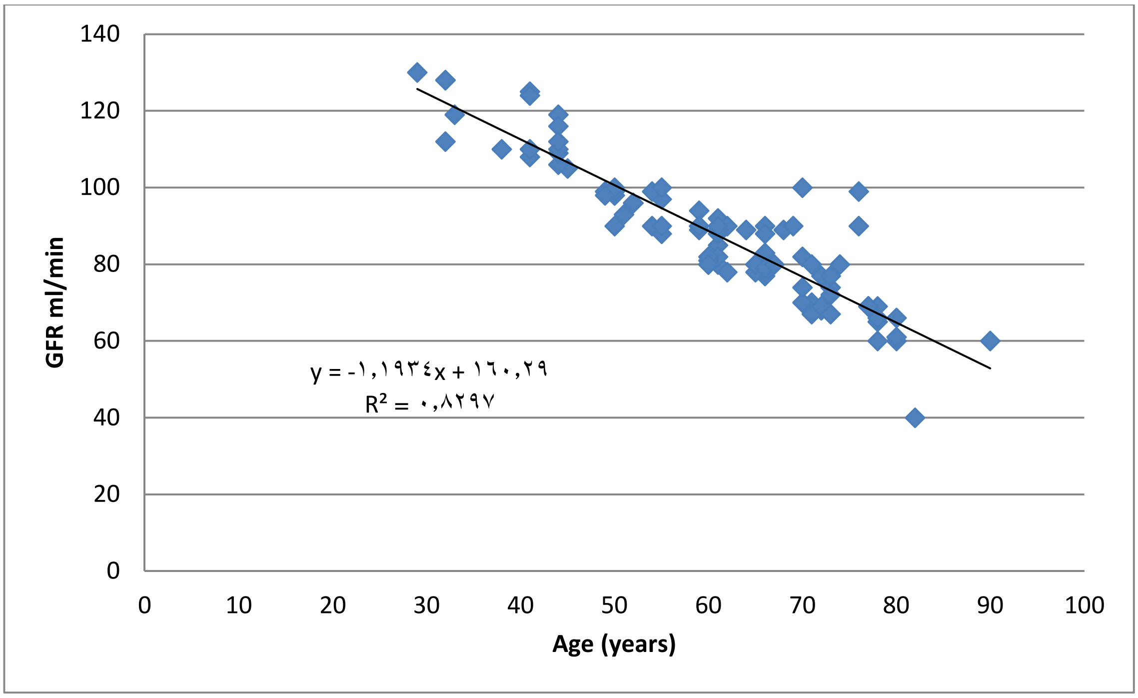

Fig (4.16) correlation GFR with age shows linear decrease glomerular filtration rate with age decline rate was 0.82 (1.2 ml/min/years)

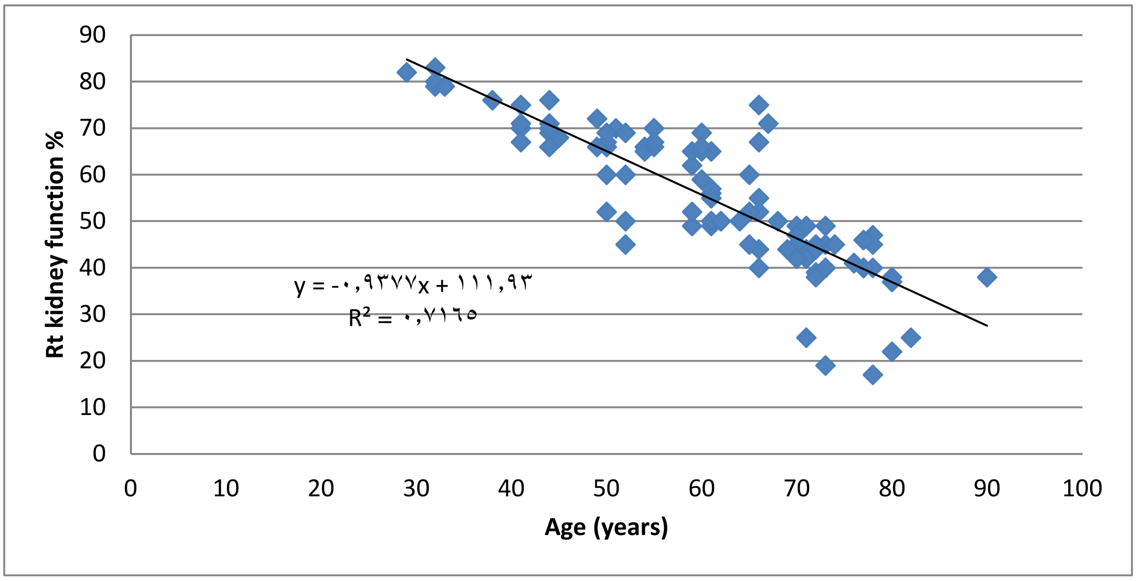

Fig fig. (4.17) correlation RT kidney with age of hypertensive patient shows linear decrease function with age.

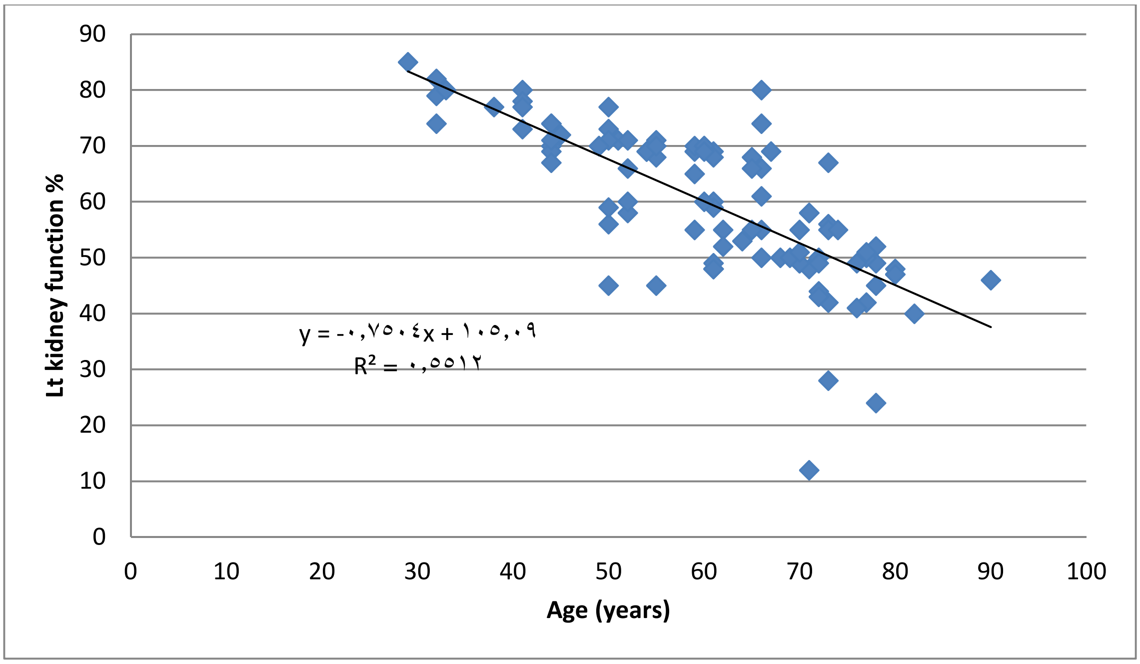

Fig (4.18) correlation LT kidney with age of hypertensive patient shows linear decrease function with age.

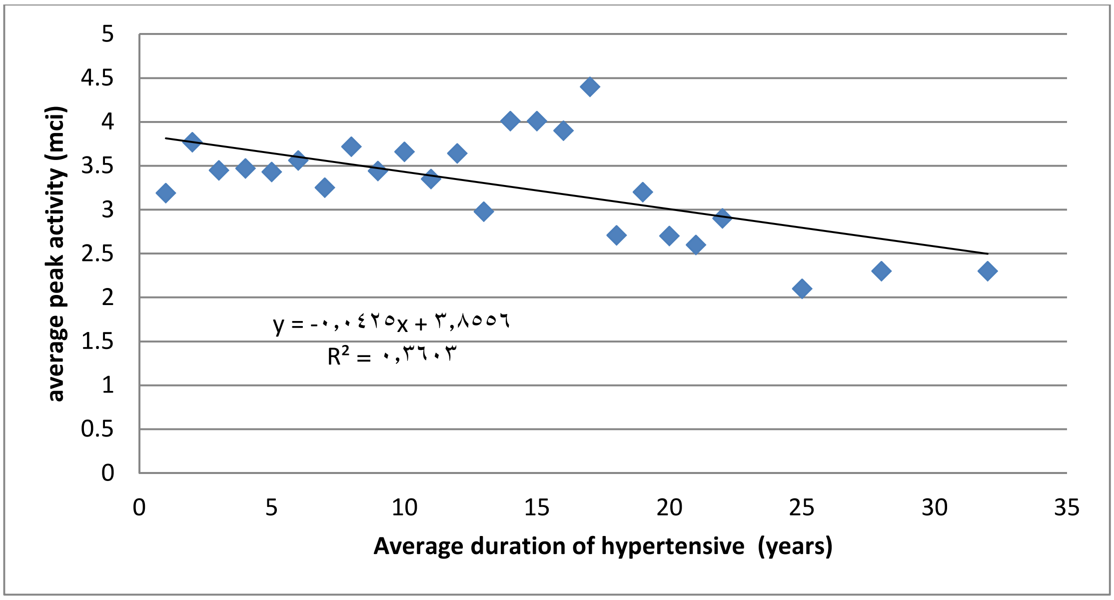

Fig (4.19) correlation of duration of hypertension and average activity (increase the duration decrease the average peak activity for both kidneys)

Chapter five

5.1 Discussion

SCINTAGRAPHY The renal function status was evaluated by Renogram. All patients underwent a dynamic renal radioisotope using 99mTc-MAC3 to quantify renal functions and estimate the GFR using single injection**.**

In this study Age was found to be important factor for hypertension, ranging between 29 and 90 years most of the patients were in the age groups more than 55 years. Similar finding where reported by other studies [(19, 20)] also where advancing age was positively related to hypertension (because when increasing age, the aorta and arteries wall will be stiffened, decrease renal blood flow and reduction in nephrons number.) [(19, 20, 21)]

The percentage of patient’s gender was 42% males and 58% female, similarly various study came out with higher percentage of hypertension in women than men [(20, 21)]

In this study total glomerular filtration rate (GFR) ranged from 130-40 (mean ±SD) 87.9±17.3 (male 86.8±16.3 female 88.8±18.1) female had higher GFR than male (shows table 1), correlated GFR with age decline rate was 0.82 (1.2 ml/min/years) (shows fig 2) agreement with other study [(21, 22)]

Among those patient’s understudy using renal scintigraphy for diagnosing renal hypertension 84% has normal renal function with mild (AORTA- RENAL DELAY), normal cortical and clearance phase 16% had abnormal function (unilateral 93% and bilateral 7% more affected Rt kidney than left shows table 2). Significant renal artery stenosis (60% to 75%) decreases afferent arteriolar blood pressure, which stimulates renin secretion by the juxtaglomerular apparatus. Renin elicits the production of angiotensin I, which is acted on by ACE to yield angiotensin II.

Angiotensin II induces vasoconstriction of the efferent arterioles, which restores glomerular filtration pressure and rate. ACE inhibitors, such as captopril, prevent the production of angiotensin II, so that in patients with renal artery stenosis and compensated renal function, pre glomerular filtration pressures are no longer maintained. This results in a significant sudden decrease in glomerular filtration.

Among this study strong correlation of duration of hypertension and average activity when increase the duration of disease decrease the average peak activity absorbed by both kidneys. Previous study has not reported.

Ultrasound A total of 75 patients (33 males and 42 females) were examined. The age was ranged (21–79) years, with a mean of 64.6 years. The age of the control group of 12 males and 13 females ranged from 21 to 70 years, with a mean of 44.1 years. Among the hypertensive patients, 41 (54.6 %) were above 60 years.

The duration of hypertension ranged between 4 months and 40 years with a mean of 7 years. Less than half of the patients 33 (44%) have had hypertension for more than six years, 15 (20.3%) for 1–5 years, 5(6.6%) for less than one year and 22 (29.4) more than ten years.

Among patient the residence 51(68%) from Khartoum followed Aljazeera 10(13%), Alshamalia 9(12%) and 5 (7%) from Kurdfan.

The patient occupation most hypertensive women have housewife 30 (40%) and most male occupation driver and manager 7(9.3%) and 5(7%) respectively.

The mean kidney length was 9.35 cm. Mean kidney lengths were 9.15 cm on the right side and 9.27 cm on the left side. The mean kidney width was 4.45cm, cortical thickness 1.46 cm making the estimated average kidney size and volume.

In the hypertensive group, kidney volume ranged from 46.65 to 105.02 cm^3 for the left kidney and 42.59 to 102.33 cm^3 for the right kidney. In this group, mean volumes of the right and left kidneys in males (80.7 cm^3 and 75.3, respectively) in females (78.2 cm^3 and 70.4, respectively). In the control group, the range of renal volume was 60.51–108.9 cm^3 for the left kidney and 59.5–105.01 cm^3 for the right kidney. The mean renal volumes we observed were. Within the range from those reported volumes in other studies (15, 16, 17)

This study found that the left kidney is larger than the right kidney, and both kidneys are larger in males than in females. Coincide with reported in other studies. (15, 16, 17.18)

Also the present study shows that there is considerable reduction in renal size as age advances. With agree with other studies. (15)

The duration of hypertension in the patients was calculated from the time of hypertension was first diagnosed in the hospital in a patient. It is very difficult to determine the actual duration because of the insidious on-set of the disease, which means that it can go undetected for a long time. Therefore, was no significant correlation between renal size and duration of hypertension?

The Renal volume as already proven is the most precise measurement of renal size and tends to show the highest correlation with height, weight and BSA. Our results are in accordance with this statement because we observed there was significant correlation between renal volume and BSA, particularly with the left kidney. Significant correlation was also demonstrated between the renal volume and BMI. However, the right renal volume correlates better with BMI, as reported in other studies [15].

The present study found that BSA has better correlation with renal volume than BMI. The mean BSA in males was significantly larger than in females, which may also explain the higher mean renal volume observed in males.

5.2 Conclusion

Renal US scan is a simple non-invasive method for estimating the kidney size in vivo and has many advantages over other imaging methods. The kidney plays a major role in the regulation of (BP) and is one of the main organs affected by high BP. Unilateral or bilateral changes in kidney size and/or morphology are manifested by much renal pathology and are important parameters in clinical evaluation and management of patients with kidney diseases. Estimation of renal size by US scan be performed by measuring renal length, renal volume, cortical volume or thickness.

As renal volume is the most precise measurement of renal size, this study established values of renal volume in patients with essential hypertension in our study. This study has shown that renal size decreases with age in hypertensive adults, and that renal size on the left is larger than on the right. Also female hypertensive patients have smaller kidneys than males.

No significant difference was seen in the mean renal volume between the hypertensive and the control group in this study. The renal volume shows significant positive correlation with BSA and BMI. Moreover, renal size and duration of hypertension do not seem to be significantly correlated.

Radionuclide techniques in the present study were confirmed as the appropriate to assess renal functions. This study revealed that isotopic Renogram is sensitive, readily available and non-invasive and is more reliable for the evaluation of renal functional status.

5.3 Recommendation

Measurement of the renal volume is the most accurate compared provided by the renal length.

Use renal Doppler ultrasound for evaluation the renal artery and vein in combination to accurate measure of renal volume.

To recognize anatomical deviations in individuals with renal diseases, it is important to have a set of standard sonographic measurements for appropriate comparison.

Must be Correlation of renal length and volume with BMI and also with age, gender, height and weight of the subjects.

5.4 References

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5.5 appendix

Appendix (1)

Data collection sheet

NO ☐☐☐

Gender
Male ☐ Female ☐

Age
less than 21 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ More than 60 ☐

Residence ☐ occupation ☐

Patient height ☐ Patient weight ☐
BMI ☐ BSA ☐

Duration of disease
less than 1 ☐ 1-5 ☐ 5-10 ☐ More than 10 ☐

ultrasound finding:
RTKidney
Length ☐ dth ☐ ickness ☐ lume ☐

RT kidney:
Cortical echogenicity: normal ☐ increase ☐ decrease ☐
Cortical thickness: normal ☐ thin ☐ thick ☐
C/M differs: will ☐ demarcate ☐ poor ☐ loss ☐
Finding: ....

Lt Kidney
Length ☐ Width ☐ thickness ☐ volume ☐

lT kidney:
Cortical echogenicity: normal ☐ increase ☐ decrease ☐
Cortical thickness: normal ☐ thin ☐ thick ☐
C/M differs: will ☐ demarcate ☐ poor ☐ loss ☐
Finding: ....

Other disease...
Treatment:
Regular ☐ **No Regular** ☐
Notes:
....
....

Appendix 2

Master table Renogram (1 Male 2 Female)

Gender	Age (years)	Duration (years)	GFR	Function RT	Function LT	RT peak time	LT peak time	Peak activity
1	66	7	90	55	74	2.4	2.89	3.2
1	70	9	82	49	55	2	2.6	3.5
2	45	4	105	68	72	2.69	2.78	3.01
2	55	11	97	70	68	2.4	2.89	3.03
2	68	13	89	50	50	1.9	2.4	4.01
2	73	17	77	40	42	2.69	2.78	4.4
1	50	7	98	52	56	2.4	2.89	3.03
1	52	3	96	60	58	2	2.6	4.01
2	41	2	108	70	73	2.69	2.78	4.4
2	44	4	106	69	70	2.4	2.89	3.2
1	61	7	92	49	48	1.9	2.4	3.5
1	71	8	80	44	48	2.69	2.78	3.01
2	59	6	94	62	65	1.9	2.4	3.03
1	66	9	88	67	66	2.69	2.78	4.01
2	51	4	93	70	71	2.4	2.89	4.01
2	64	10	89	50	53	2	2.6	3.03
2	62	7	90	50	55	2.69	2.78	4.01
2	73	8	74	45	56	2.4	2.89	4.01
1	50	4	99	60	59	1.9	2.4	4.4
1	52	3	96	69	60	2.69	2.78	3.2
2	49	5	99	72	70	2.69	2.78	3.5
2	44	2	119	76	74	2.4	2.89	3.01
2	61	11	89	56	69	3.04	3.68	3.03
2	71	13	70	25	58	4.09	3.01	2.4
1	59	9	90	49	69	2.69	2.78	3.5
1	66	12	77	44	55	2.4	2.89	3.01
2	32	1	128	79	82	3.04	3.68	3.03
2	80	20	60	22	47	4.78	3.04	2.2
1	78	25	60	47	24	2.69	2.78	2.1
1	72	16	77	45	50	2.4	2.89	3.9
2	61	8	85	65	68	3.04	3.68	3.4
1	73	13	72	19	67	4.5	2.8	2.3
2	50	5	98	66	45	3.04	3.68	3.2
2	52	8	96	45	66	4.78	3.04	3.5
2	41	3	125	75	80	2.69	2.78	3.01
2	44	5	116	71	69	2.4	2.89	3.03
1	61	7	89	50	48	3.04	3.68	4.01
2	71	14	69	49	58	2.5	2.8	4.01
2	59	6	89	52	55	2.69	2.78	3.03
2	66	10	78	40	61	2.4	2.89	3.8
2	32	2	112	80	74	1.9	2.02	3.6
1	80	22	61	38	48	3.56	3.2	3.7
1	78	19	65	45	52	2.9	2.99	3.2
2	72	18	68	39	44	2.6	2.74	2.4
2	61	7	88	55	60	2.87	2.98	3.2
1	73	11	77	40	55	3.56	3.2	3.5
1	50	4	99	66	77	2.9	2.99	3.01
2	52	9	96	50	71	2.6	2.74	3.03
1	41	2	110	71	78	2.87	2.98	4.01

1	44	2	109	66	74	3.56	3.2	4.01
2	61	9	80	50	49	2.9	2.99	3.03
2	71	11	67	42	12	2.6	4.74	2
2	59	6	90	65	70	2.87	2.98	3.4
2	66	7	83	52	50	3.56	3.2	3.3
1	32	1	128	83	79	2.9	2.99	3.5
1	80	21	66	37	47	2.6	2.74	2.6
2	78	28	69	17	49	2.87	2.98	2.3
2	72	7	69	38	43	3.56	3.2	2.2
1	61	6	82	57	60	2.9	2.99	3.4
1	60	6	81	69	70	2.6	2.74	3.7
2	50	10	100	67	73	2.87	2.98	3.9
1	70	10	70	47	49	2.56	3.2	4.09
1	77	12	69	40	42	2.9	2.99	4.04
1	76	11	99	41	41	2.6	4.74	2.5
2	54	5	90	66	69	3.56	3.2	3.2
1	65	5	80	52	55	2.9	2.99	3.5
2	78	18	66	40	45	2.6	2.74	3.01
2	72	11	69	44	49	2.87	2.98	3.03
2	61	8	89	55	59	3.56	3.2	4.01
2	60	11	82	65	60	2.9	2.99	4.4
1	50	7	90	69	71	2.6	2.74	3.03
1	70	12	74	45	49	2.87	2.98	4.01
2	77	17	69	40	50	3.56	3.2	4.4
2	76	13	90	41	49	2.9	2.99	3.2
1	54	7	99	65	69	2.6	4.74	3.3
2	65	9	78	60	68	3.56	3.2	3.02
2	82	22	40	25	40	2.9	2.99	2.1
1	90	32	60	38	46	2.6	2.74	2.3
2	77	20	69	46	51	2.87	2.98	3.2
2	60	10	80	66	70	3.56	3.2	3.5
2	55	4	88	70	71	2.9	2.99	3.01
2	49	4	98	66	70	2.6	2.74	3.03
1	44	3	110	70	71	2.87	2.98	4.01
1	55	8	100	66	45	3.56	3.2	4.4
2	65	7	80	45	66	2.9	2.99	3.03
2	66	9	79	75	80	2.6	4.74	4.01
1	67	6	80	71	69	2.1	2.4	4.4
1	61	5	90	50	48	3.56	3.2	3.2
2	29	1	130	82	85	2.9	2.99	3.2
1	74	12	80	45	55	2.6	2.74	3.5
2	33	3	119	79	80	2.87	2.98	3.01
2	38	1	110	76	77	3.56	3.2	3.03
2	62	6	78	50	52	2.9	2.99	4.01
2	60	4	80	59	69	2.6	2.74	4.4
1	69	11	90	44	50	2.87	2.98	3.03
1	73	15	67	49	28	3.56	3.2	4.01
2	55	5	90	67	70	2.9	2.99	4.4
2	44	4	112	70	67	2.6	4.74	3.2
1	41	2	124	67	77	2.89	2.9	3.6
1	29	11	100	42	51	2.8	2.99	3.8
	60.19							

Appendix 3

Independent Samples Test

	t-test for Equality of Means	
	t	Sig. (2-tailed)
GFR	-.568	.571
Function RT	-1.144	.255
Function LT	-1.698	.093
RT peak time	-.818	.416
LT peak time	-.614	.541
Peak activity	1.353	.179

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	166.778	4.355		38.292	.000
	Ageyears	-1.214	.054	-.926	-22.394	.000
	Gender	-3.321	1.446	-.095	-2.297	.024

a. Dependent Variable: GFR

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	111.932	3.695		30.292	.000
	Ageyears	-.938	.060	-.846	-15.736	.000

a. Dependent Variable: FunctionRT

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	105.092	4.242		24.775	.000
	Ageyears	-.750	.068	-.742	-10.970	.000

a. Dependent Variable: FunctionLT

Appendix 4

Sudan University of Science and Technology
Collage of Graduate Studies

Data collection sheet

NO 0 5 0

Gender
Male [✓] Female [ ]

Age
less than 21 [ ] 21-30 [ ] 31-40 [ ] 41-50 [ ] 51-60 [ ] More than 60 [✓]

Residence [ ] occupation [driver]

Patient height [178] Patient weight [80]
BMI [26] BSA [1.2]

Duration of disease
less than 1 ☐ 1-5 ☐ 5-10 ☐ More than 10 [✓]

ultrasound finding:
RTKidney
Length [8] dth [3.5] ickness [4] lume [55]

RT kidney:
Cortical echogenicity: normal [ ] increase [✓] decrease [ ]
Cortical thickness: normal [ ] thin [ ] thick [ ]
C/M differs: will [ ] demarcate [ ] poor [ ] loss [ ]
Finding: ....no..........

Lt Kidney
Length [8.2] Width [4] thickness [2.3] volume [37.7]

IT kidney:
Cortical echogenicity: normal [ ] increase [✓] decrease [✓]
Cortical thickness: normal [ ] thin [✓] thick [ ]
C/M differs: will [ ] demarcate [✓] poor [ ] loss [ ]
Finding: ....no..........

Other disease..........dia betes..........
Treatment:
Regular [ ] **No Regular** [ ]
Notes:
..........dia betes..........
....

Appendix 5

Sudan University of Science and Technology
Collage of Graduate Studies

Data collection sheet

NO 070

Gender
Male ☑ Female ☐

Age
less than 21 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☑ More than 60 ☐

Residence: Khartoum occupation: driver

Patient height: 175 Patient weight: 79
BMI: 25.8 BSA: 1.96

Duration of disease
less than 1 ☐ 1-5 ☐ 5-10 ☑ More than 10 ☐

ultrasound finding:
RTKidney
Length 10.5 Width 4.7 thickness 4 volume 98.6

RT kidney:
Cortical echogenicity: normal ☑ increase ☐ decrease ☐
Cortical thickness: normal ☑ thin ☐ thick ☐
C/M differs: will ☐ demarcate ☐ poor ☐ loss ☐
Finding: ....Normal........

Lt Kidney
Length 10.4 Width 4.8 thickness 4.2 volume 104

lT kidney:
Cortical echogenicity: normal ☑ increase ☐ decrease ☐
Cortical thickness: normal ☑ thin ☐ thick ☐
C/M differs: will ☐ demarcate ☐ poor ☐ loss ☐
Finding: ....Normal........

Other disease..
Treatment:
Regular ☑ **No Regular** ☐
Notes:
.... nb ....
....

Appendix 6

Sudan University of Science and Technology
Collage of Graduate Studies

Data collection sheet

NO 004

Gender
Male [ ]   Female [✓]

Age
less than 21 [ ] 21-30 [ ] 31-40 [ ] 41-50 [ ] 51-60 [✓] More than 60 [ ]

Residence: Al Shamali   occupation: House wife

Patient height: 155   Patient weight: 76
BMI: 23.4   BSA: 1.66

Duration of disease
less than 1 [ ] 1-5 [ ] 5-10 [✓] More than 10 [ ]

ultrasound finding:
RTKidney
Length 9 dth 4 ckness 2 lume 36

RT kidney:
Cortical echogenicity: normal [ ] increase [ ] decrease [✓]
Cortical thickness: normal [ ] thin [ ] thick [ ]
C/M differs: will [ ] demarcate [ ] poor [ ] loss [ ]
Finding: ....RD..........

Lt Kidney
Length 9.1 Width 3.9 thickness 2.5 volume 39

lT kidney:
Cortical echogenicity: normal [ ] increase [ ] decrease [ ]
Cortical thickness: normal [ ] thin [ ] thick [ ]
C/M differs: will [ ] demarcate [✓] poor [ ] loss [ ]
Finding: ....RD..........

Other disease..........
Treatment:
Regular [ ]   **No Regular** [✓]
Notes:
....
....

Appendix 7

Sudan University of Science and Technology
Collage of Graduate Studies

Data collection sheet

NO 0 1 2

Gender
Male ☐ Female ☑

Age
less than 21 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☑ 51-60 ☐ More than 60 ☐

Residence: Khartoum occupation: House wife

Patient height: 160 Patient weight: 70
BMI: 23 BSA: 1.7

Duration of disease
less than 1 ☐ 1-5 ☑ 5-10 ☐ More than 10 ☐

ultrasound finding:
RTKidney
Length 10.9 dth 4.9 ckness 4.C lume 112

RT kidney:
Cortical echogenicity: normal ☑ increase ☐ decrease ☐
Cortical thickness: normal ☑ thin ☐ thick ☐
C/M differs: will ☑ demarcate ☐ poor ☐ loss ☐
Finding: ....nb............

Lt Kidney
Length 10.9 Width 4.8 thickness 4.5 volume 115

lT kidney:
Cortical echogenicity: normal ☑ increase ☐ decrease ☐
Cortical thickness: normal ☑ thin ☐ thick ☐
C/M differs: will ☑ demarcate ☐ poor ☐ loss ☐
Finding: ....N............

Other disease............cyst............
Treatment:
Regular ☑ **No Regular** ☐
Notes:
............No............
....

Appendix 8

Sudan University of Science and Technology
College of Graduate Studies

Data collection sheet

NO 035

Gender
Male ☐ Female ☑

Age
less than 21 ☐ 21-30 ☐ 31-40 ☑ 41-50 ☐ 51-60 ☐ More than 60 ☐

Residence: Khartoum occupation: Teacher

Patient height: 144 Patient weight: 60
BMI: 21 BSA: 1.2

Duration of disease
less than 1 ☐ 1-5 ☑ 5-10 ☐ More than 10 ☐

ultrasound finding:
RTKidney
Length 10.9 dth 4.5 ckness 4 lume 98.1

RT kidney:
Cortical echogenicity: normal ☑ increase ☐ decrease ☐
Cortical thickness: normal ☑ thin ☐ thick ☐
C/M differs: will ☑ demarcate ☐ poor ☐ loss ☐
Finding: ....

Lt Kidney
Length 11.2 Width 4.5 thickness 3.9 volume 98.2

IT kidney:
Cortical echogenicity: normal ☑ increase ☐ decrease ☐
Cortical thickness: normal ☑ thin ☐ thick ☐
C/M differs: will ☑ demarcate ☐ poor ☐ loss ☐
Finding: ....n/a...

Other disease...
Treatment:
Regular ☑ **No Regular** ☐
Notes:
..............................n/a...
....

Appendix 9

Imaging

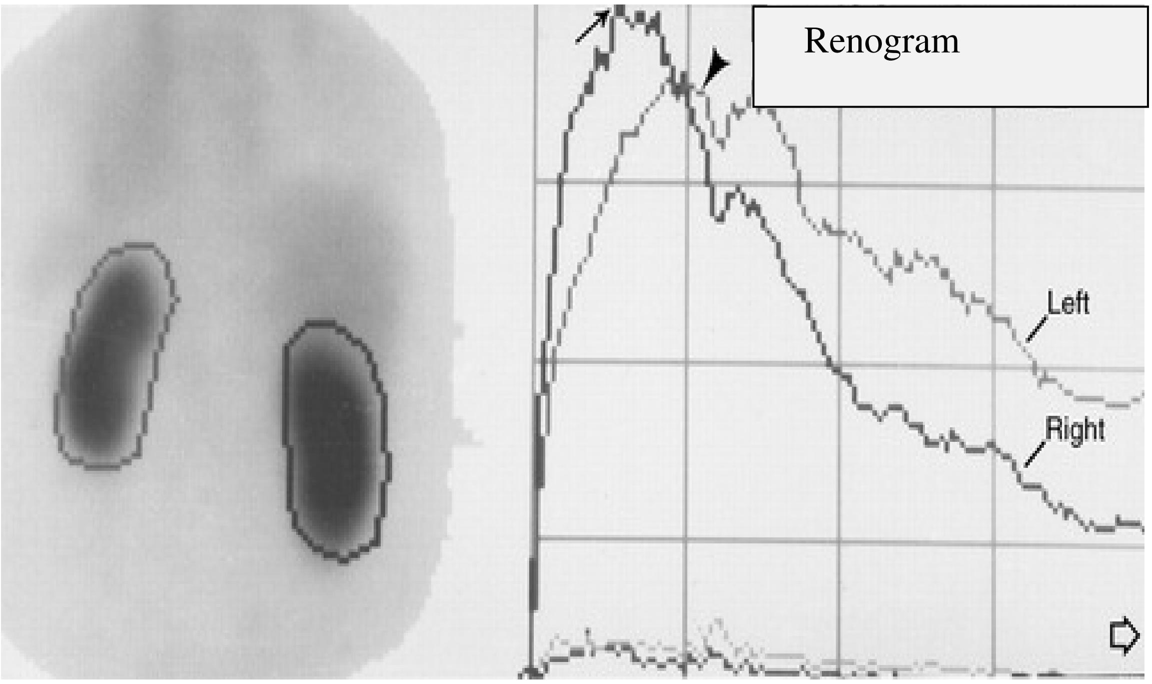

Fig 5.1 Hypertensive patient in a 60-year-old patient. Scintigraphy (posterior view) obtained with Tc-99m MAG_3 shows, decreased amplitude and delayed peaking of the left renal curve relative to the right renal curve.

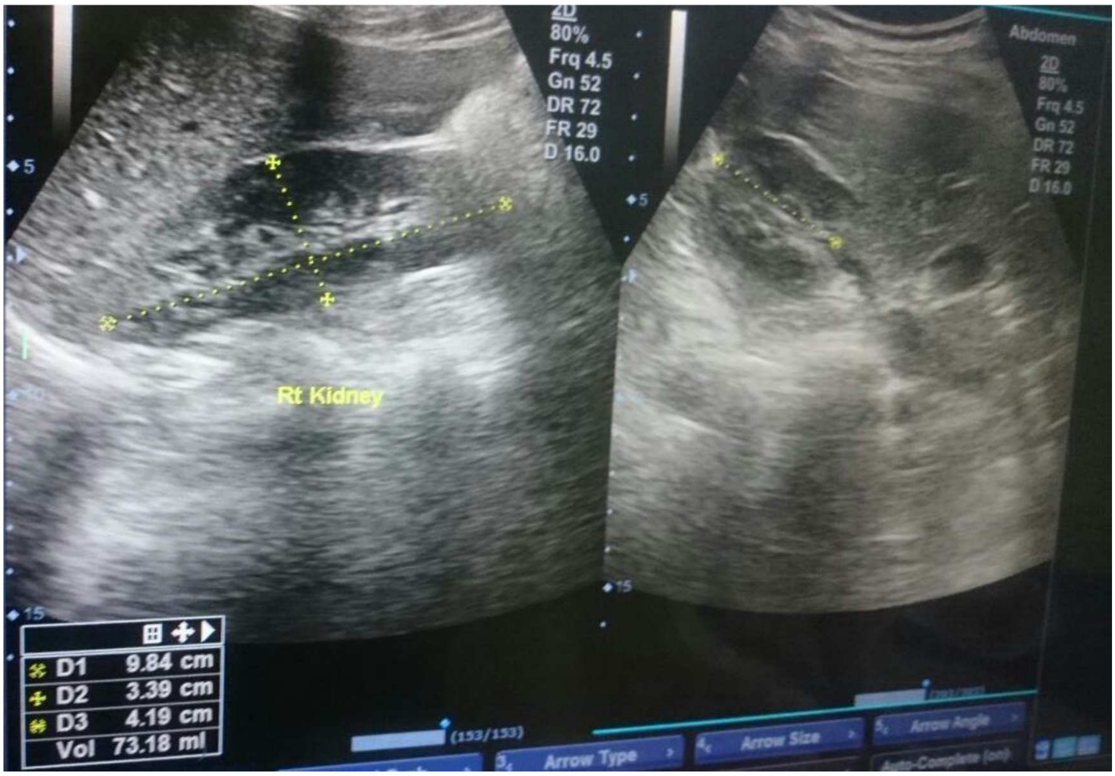

Fig (5.2): Male – 57 years, RT kidney measure 9.84 Length, 4.19 Width, 3.39 thickness, with renal Volume 73.18cc

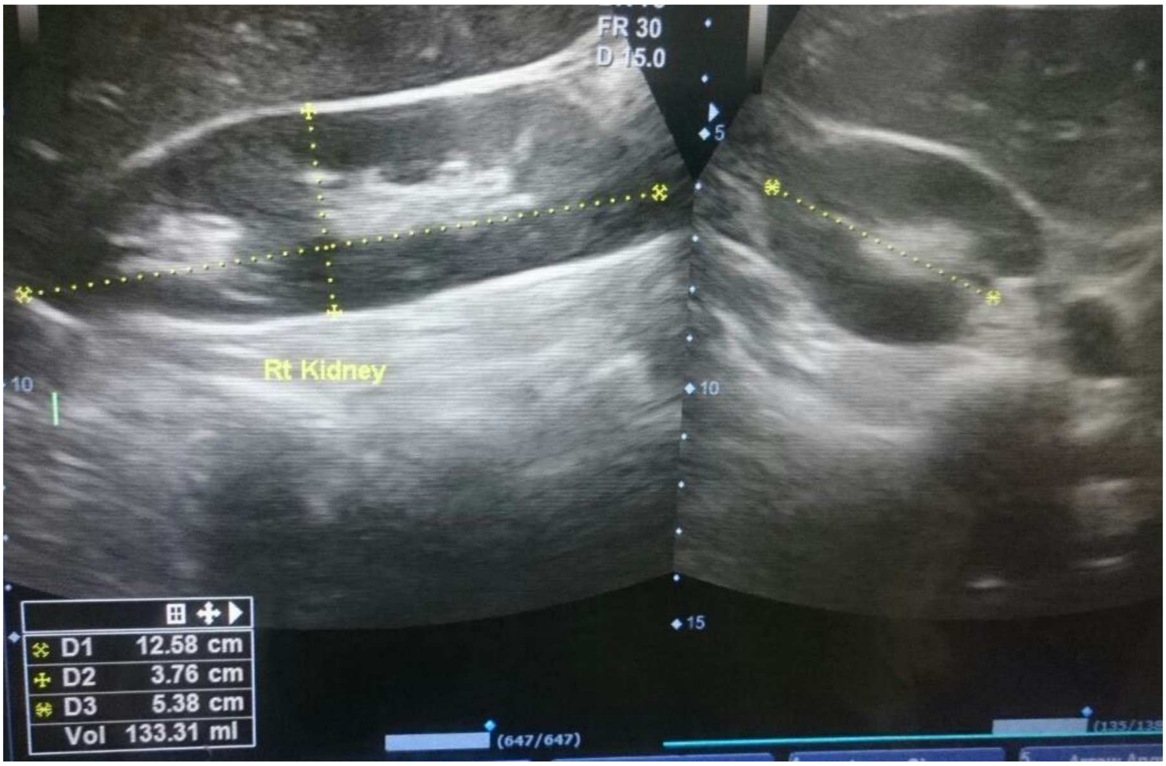

Fig (5-3): Male –42 years the RT kidney measurement was 12.58 Length, 5.38 width, 3.76 D, Volume 133.31cc

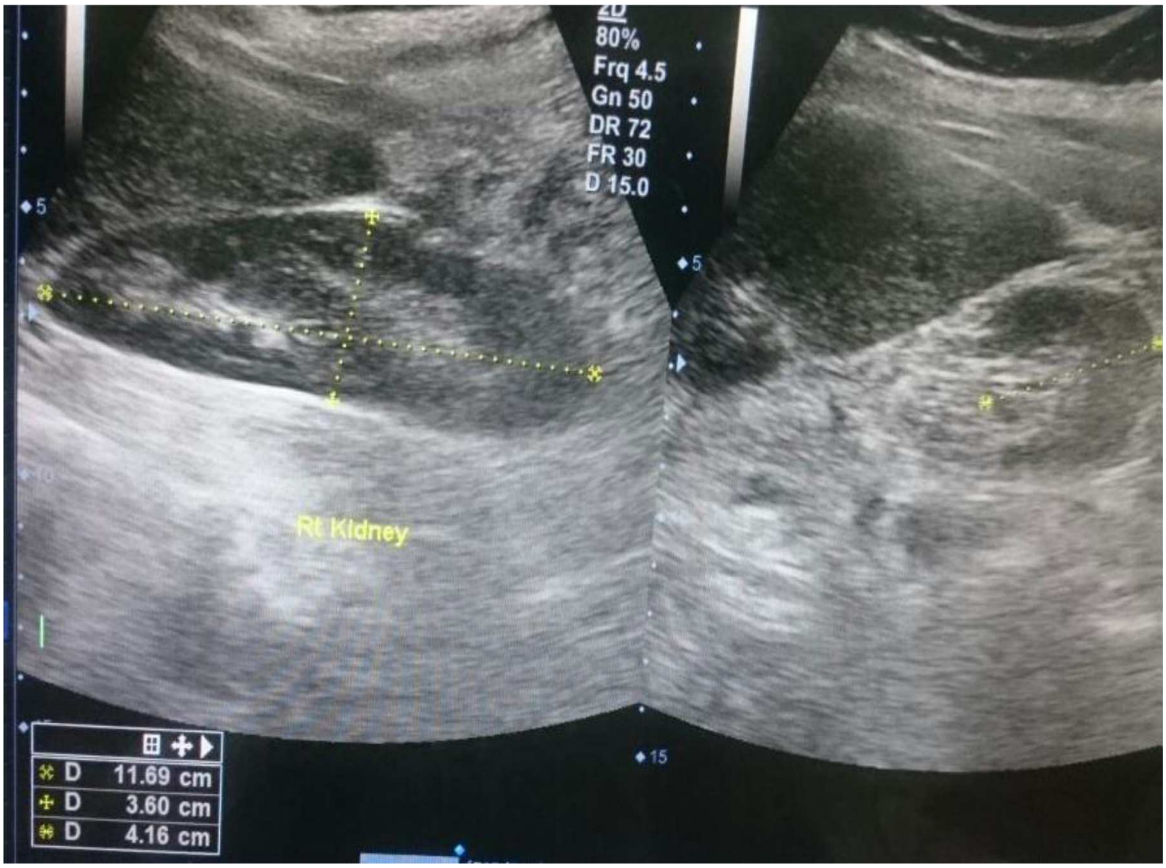

Fig (5.4): Male –49years RT kidney measured 11.69 in length, 4.16 in Width, 3.60 thickness, renal Volume 91c**c**

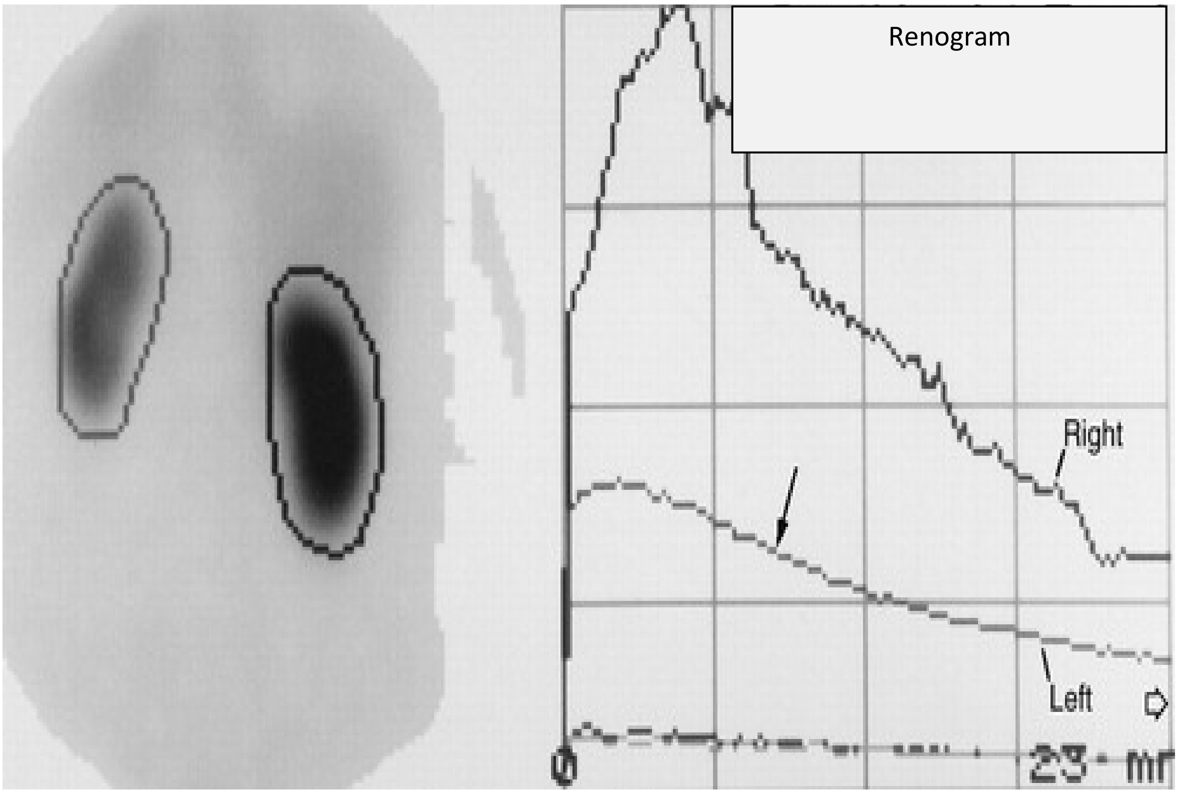

Fig 5.5. Scintigraphy (posterior view) obtained after administration of Tc-99m MAG_3 shows of left kidney abnormal curve suggesting - renovascular disease.

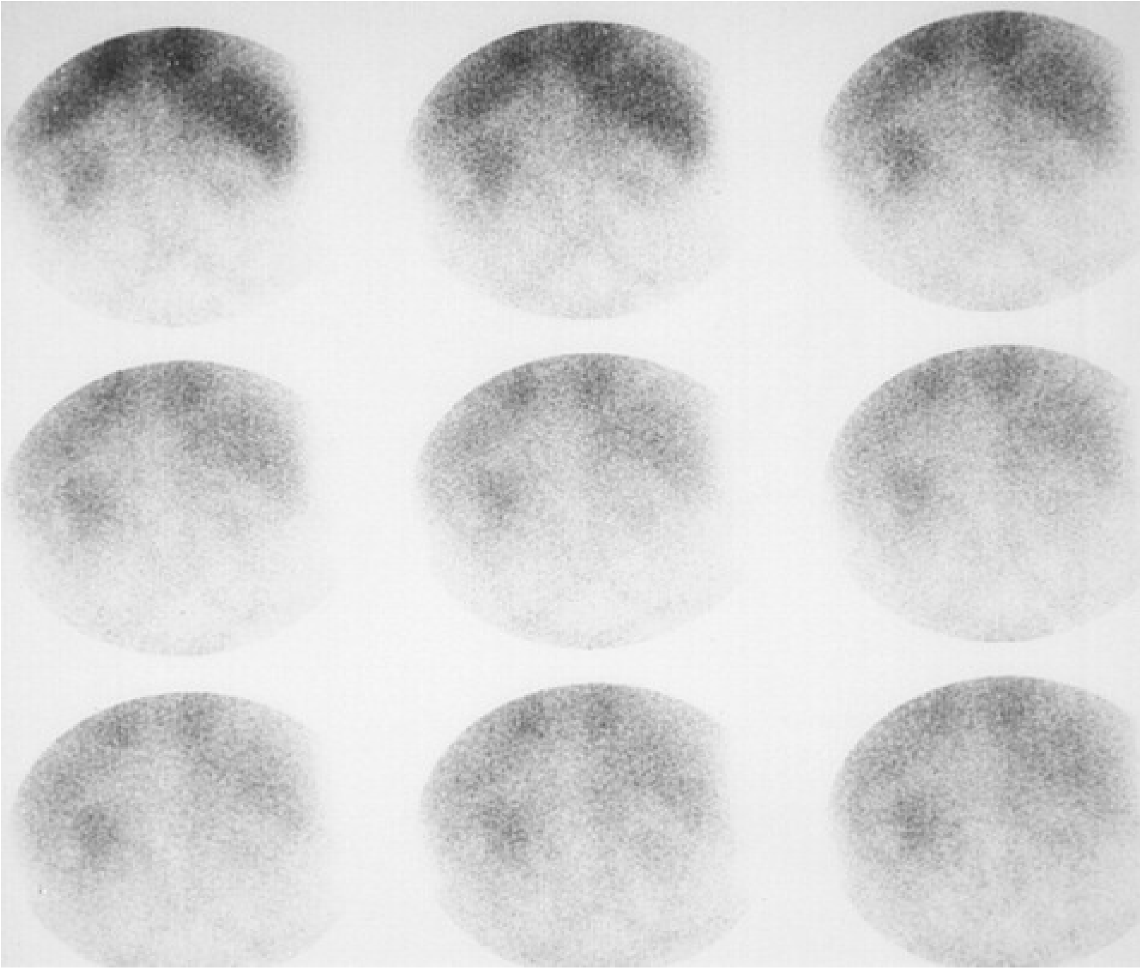

Fig 5.6 scintigraphy results in a 70-year-old patient with renal insufficiency

EUROPEAN ACADEMIC RESEARCH
Vol. VII, Issue 5/ August 2019

ISSN 2286-4822
www.euacademic.org

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

Characterization of Renal Function and Morphology in Hypertensive Patients Using Renal scintigraphy

HOSSAM GASMALSEED
College of Medical Radiological Sciences
Sudan University of Science and Technology, Khartoum, Sudan
Al-Ghad International College of Applied Medical Science
Medical Imaging Technology Department, Dammam, KSA
MOHAMED E. M. GARALNABI
College of Medical Radiological Sciences
Sudan University of Science and Technology, Khartoum, Sudan
OTHILA ABDALAZIZ
College of Medical Radiological Sciences
Sudan University of Science and Technology, Khartoum, Sudan
ADIL A. MANSOUR
Al-Ghad International College of Applied Medical Science
Medical Imaging Technology Department, Dammam, KSA
MOHAMED HASANEEN
Al-Ghad International College of Applied Medical Science
Medical Imaging Technology Department, Dammam, KSA

Abstract

Aim: *The aim of study to evaluate renal function in hypertension patients using renogram and correlate it with age, gender, GFR, and duration of disease.*

Methods: *We studied 100 hypertension patients (42Males,58 Females) mean age 60.6 years, Renal scintigraphy was done to all with 99mTc-MAG3, Renal scintigraphy (anterior and posterior images) was obtained within 20 seconds after administration of 185-370MBq (5-10mCi depended patient weight) of 99mTc-MAG3 and results were evaluated quantitatively and qualitatively calculating both kidneys function.*

Results: *In case of radionuclide renography, total glomerular filtration rate (GFR) ranged from 130-40 (mean ± SD) 87. 9±17.3(male*

86.8±16.3 female 88.8±18.1), correlated GFR with age decline rate was 0.82 (1.2 ml/min/years) Renal Scintigraphy demonstrated 84% Has normal renal function with mild (AORTA- RENAL DELAY), normal cortical and clearance phase 16% had abnormal function (unilateral 93% and bilateral 7% more affected RT kidney than left). both kidneys show decrease renal function with age and duration of disease. The association was stronger in person had uncontrollable and long standing hypertensive disease. Also noted the average peak activity decrease when the duration of disease increase.

Conclusions: *Studies with 99mTc-MAG3 present high specificity and are useful in patients with high probability for renovascular hypertension, identifying high number of patients with significant renal artery stenosis.*

Keywords: Renal Function, Hypertensive Patients

INTRODUCTION

The kidneys are responsible for regulating water and electrolyte balance, excreting waste, secreting hormones (renin, erythropoietin), and activating vitamin D. Renal parenchymal disease and renovascular abnormalities are the most common causes of secondary hypertension.

Renovascular hypertension (RVH) pertains to the causal relationship between a renal artery stenosis (RAS) and its clinical consequences, namely, hypertension or renal failure. Among the population of hypertensive patients, approximately 1-10%[(1).] Have true (RVH) However. Among patients with a significant RAS, only two-thirds show improvement of hypertension after revascularization and 27%–80% show improvement or stabilization of renal function. When left untreated, atheromatous RAS tends to worsen, leading to renal artery thrombosis [(2).]

The kidneys receive 20% of cardiac output, with renal plasma flow (RPF) averaging 600 mL/min. The kidneys clear the plasma and body of waste products. The clearance, or rate of disappearance, of a substance can be measured as:

$$\text{Clearance (mL/min)} = \frac{\text{Urine concentration (mg/mL)} \times \text{Urine flow (mL/min)}}{\text{Plasma concentration (mg/mL)}}$$

Hypertension occurs in approximately 40% of patients with acute renal failure, its prevalence is higher in vascular and glomerular diseases (73%) than in tubular necrosis (15%). In the latter group, hypertension mainly results from the rapid reduction in glomerular filtration rate and consequently salt and water retention, whereas in the acute nephritic syndrome, hypertension may be present in the absence of a marked decline in glomerular filtration rate. Surprisingly, in rapidly progressive glomerulonephritis, blood pressure is normal or slightly elevated, even in patients with severe renal failure and fluid retention. (3)

Radiopharmaceutical used in this study Tc-^{99m} MAG3 because is protein-bound and not filtered, it is exclusively cleared from the kidney by tubular secretion. It has a much higher first-pass extraction than a glomerular filtration agent such as Tc-99m diethylenetriaminepentacetic acid (DTPA). The normal time to peak activity is 3 to 5 minutes, with a time to half peak (T½) of 6 to 10 minutes. Clearance is bi-exponential, and in patients with normal renal function, 90% of the dose is cleared in 3 hours.

Material and Methods:

This study was carried out in Kingdom of Saudi Arabia during the period from April 2018 up to April 2019. A total of 100 adult patients with essential hypertension examined with renal scintigraphy (Tc-^{99m} MAG3).

Functional imaging of the kidneys may be divided into assessment of blood flow, parenchyma, and excretion. Normally, both kidneys can easily be imaged on a standard- or large-field-of-view gamma camera with a parallel-hole collimator. Image information is usually collected in digital dynamic mode or on an interfaced computer and reformatted in temporal sequences that reflect both initial renal perfusion and subsequent function.

To compare our normal value with those of other authors. Studies with similar patient preparation were selected. Our patient will hydrated, seated, and the kidney was localized after preliminary isotope injection. All studies were made using 1½-in.NAL (TI) crystal and 36-deg collimation using dual detector system Gamma camera.

A renogram is simply a time-activity curve that provides a graphic representation of the uptake and excretion of a radiopharmaceutical by the kidneys. Information is displayed from the time of injection to about 20 to 30 minutes after injection.

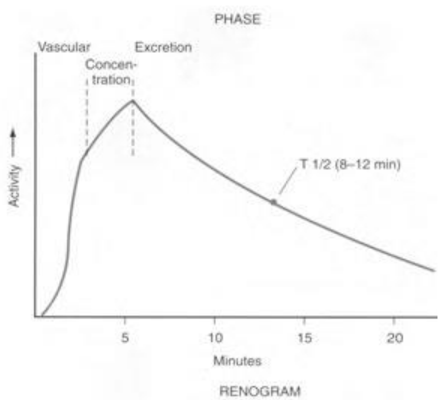

Fig 1: Normal renogram curves demonstrates the conceptual portions of the time-activity curve within the kidney.

COMPUTER ACQUISITION

Blood flow: 1- to 2-second frames for 60 seconds.

Dynamic: 30-second frames for 25-30 minutes.

Pre void image: 500k count.

PROCESSING

Draw region of interest around kidneys.

Draw background area next to each kidney.

Generate time-activity curves for flow and dynamic phases.

Generate differential function calculation.

Inclusion criteria:

- Patient with different age group included.
- All patients suffered from longstanding hypertension and have request renal scintigraphy.

Exclusion criteria:

- Patient Known Renal failure.
- All pregnant women.
- All women who had given birth in the last 12 months.

- All Patients with congenital anomalies such as a horse shoe-shaped or ectopic kidney.

Result:

Table (1) represents gender of hypertensive patient (mean and SD) related to GFR, function, and(peak time peak activity from injection)

Gender		N	Mean	Std. Deviation
GFR	Male	42	86.810	16.3129
	Female	58	88.810	18.1306
Function RT kidney	Male	42	53.143	12.9588
	Female	58	56.534	15.7271
Function LT kidney	Male	42	56.976	13.0561
	Female	58	61.534	13.3813
RT kidney peak time	Male	42	2.7900	0.51620
	Female	58	2.8812	0.57404
LT kidney peak time	Male	42	2.9921	0.46527
	Female	58	3.0519	0.49106
Peak activity	Male	42	3.4769	0.58249
	Female	58	3.3112	0.61994

Table (2) Comparison of renal function using renogram for hypertensive patient:

	Frequency	Percentage
Normal Function	84	84%
Abnormal function	16	16%
Rt kidney	11	68%
Lt kidney	4	25%
Bilateral	1	7%

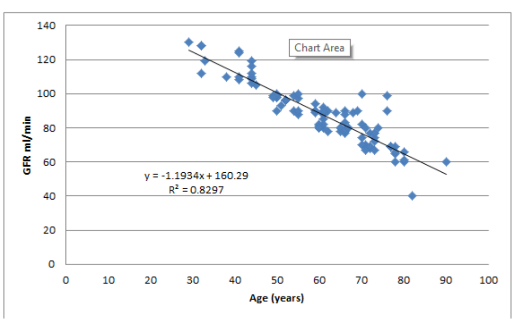

Fig (2) correlation GFR with age shows linear decrease glomerular filtration rate with age decline rate was 0.82 (1.2 ml/min/years)

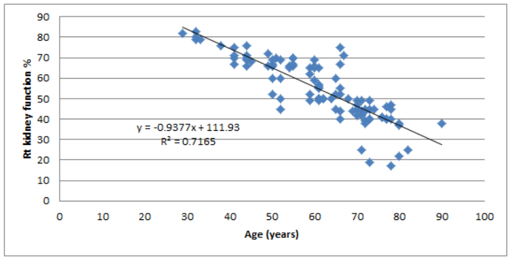

Fig (3) correlation RT kidney with age of hypertensive patient shows linear decrease function with age.

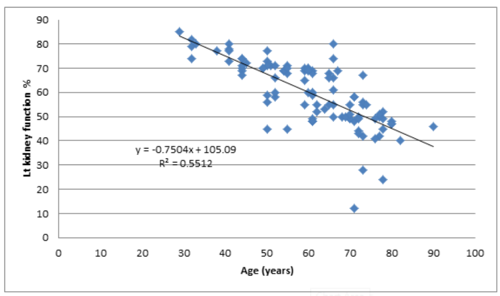

Fig (4) correlation LT kidney with age of hypertensive patient shows linear decrease function with age.

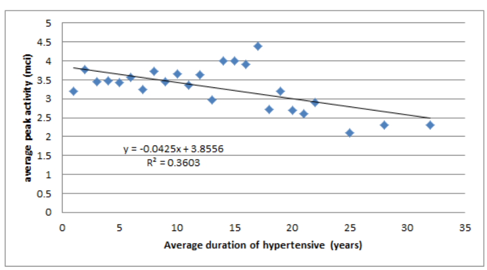

Fig (5) correlation of duration of hypertension and average activity (increase the duration decrease the average peak activity for both kidneys)

Discussion:

The renal function status was evaluated by renogram. All patients underwent a dynamic renal radioisotope using 99mTc-MAC3 to quantify renal functions and estimate the GFR using single injection**.**

In this study Age was found to be important factor for hypertension, ranging between 29 and 90 years most of the patients were in the age groups more than 55 years. Similar finding where reported by other studies. [2,3] also where advancing age was positively related to hypertension (because when increasing age, the aorta and arteries wall will be stiffened, decrease renal blood flow and reduction in nephrons number.) (2,3,4)

The percentage of patient's gender was 42% males and 58% female, similarly various study came out with higher percentage of hypertension in women than men (3,4)

In this study total glomerular filtration rate (GFR) ranged from 130-40 (mean ±SD) 87.9±17.3(male 86.8±16.3 female 88.8±18.1) female had higher GFR than male (shows table 1), correlated GFR with age decline rate was 0.82 (1.2 ml/min/years) **(**shows fig 2) agreement with other study (4,5)

Among those patient's understudy using renal scintigraphy for diagnosis renal hypertension 84% Has normal renal function with mild (AORTA- RENAL DELAY), normal cortical and clearance phase 16% had abnormal function (unilateral 93% and bilateral 7% more affected RT kidney than left shows table 2). Significant renal artery stenosis (60% to 75%) decreases afferent arteriolar blood pressure, which stimulates renin secretion by the juxtaglomerular apparatus. Renin elicits the production of angiotensin I, which is acted on by ACE to yield angiotensin II. Angiotensin II induces vasoconstriction of the efferent arterioles, which restores glomerular filtration pressure and rate. ACE inhibitors, such as captopril, prevent the production of angiotensin II, so that in patients with renal artery stenosis and compensated renal function, pre glomerular filtration pressures are no longer maintained. This results in a significant sudden decrease in glomerular filtration.

Among this study strong correlation of duration of hypertension and average activity when increase the duration of disease decrease the average peak activity absorbed by both kidneys. previous study has not reported.

CONCLUSION:

Radionuclide techniques in the present study were confirmed as the appropriate to assess renal functions. This study revealed that isotopic renogram is sensitive, readily available and non-invasive and is more reliable for the evaluation of renal functional status.

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Characterization of Renal Function and Morphology in Hypertensive Patients Using Renal Ultrasonography

Hossam Gasmalseed [1] Mohamed E. M. Garalnabi[1], Adil A. Mansour [2], MohamedHasaneen [2]
[1]College of Medical Radiological Sciences, Sudan University of Science and Technology, Khartoum, Sudan
[2]Al-Ghad International College of Applied Medical Science, Medical Imaging Technology Department, Dammam, KSA

Abstract:

The aim of research to evaluate renal morphology in adult patients with essential hypertension

A total of 75 patients (33 males, 42 females) with essential hypertension were evaluated sonographically in this prospective study and 25 healthy individuals (12 males, 13 females) without hypertension were also evaluated as control groups. Renal volume was then calculated from the kidney's length, width and anterio-posterior diameter using formula (LxWxAPx0.53) .The range of renal volume 46.65 to 105.02 cm^3 for the left kidney and 42.59 to 102.33 cm^3 for the right kidney. In control group, (mean ± SD) volumes of the right and left kidneys in males (80.7 cm^3 ± 36 and 75.3 ±33respectively), in females (78.2 cm^3 ± 33 and 70.4, ± 29 respectively). The (mean ± SD) kidney length was (9.35 ±1.3cm). It was (9.15 ±1.1cm) on the right side and (9.27 ±1.3 cm) on the left side. The hypertensive kidneys volume slightly in lower limit in relation to control group. The (mean ± SD) kidney width was (4.45 ±1.1cm) and the cortical thickness 1.46 ±0.5 cm, consider with in normal range.

Renal volume correlated significantly with BMI in hypertensive patients (r = 0.35 and 0.31 $p<0.005$ for right and left kidney, respectively), There was no significant correlation between renal volume and duration of hypertension (r = 0.9 and 0.8; $p >0.005$ for left and right kidneys, respectively).

Introduction:

Hypertension is one of the most common diseases worldwide especially essential hypertension' which is a multi-factorial disorder. Bp is the force of blood pushing against blood vessel walls as the heart pumps out blood. The high blood pressure, also called hypertension, is an increase in the amount of force that blood places on blood vessels as it moves through the body. High blood pressure can damage blood vessels in the kidneys, reducing their ability to work properly. [(1)]

The kidney plays a major role in the regulation of blood pressure (BP) and is one of the main organs affected by high BP, makes it important to study the effect on the renal morphology using ultrasound.[(2)]

Renal ultrasound scan is a simple non-invasive method for estimating the kidney size. Renal length and volume, cortical thickness C/M differentiation.

The main objective of this study to evaluate the renal morphology (renal size and shape) on long standing hypertension using ultrasound**.** And find correlation between onset of disease and renal volume.

Material and Methods:

This study was carried out in Khartoum state during the period from January up to December 2018. A total of 75 adult patients with essential hypertension and 25 control group attending the outpatient clinic were examined sonographically after informed consent was obtained. The ultrasound system used Fukuda denshi UF-850XTD. Using the 3.5–5 MHz curvilinear probe. The patients' age, gender and duration of disease obtain before ultrasound examination. The height (in meters) and weight (in kilograms) of the patients are measure. The BMI and BSA well calculate using the formula $weight/height^2$ and $weight^{0.425} \times height^{0.725} \times 71.84$, respectively. A systematic abdominal sonographic examination was performed on all patients. The examination was performed the length, width and thickness were measured using US. Kidney volume well calculate using the formula length x thickness x width x 0.523 were obtained.

Inclusion criteria:

- Patient with different age group included
- All patients suffered from longstanding hypertension and have request ultrasound scan

Exclusion criteria:

- All pregnant women.
- All women who had given birth in the last 12 months.
- All Patients with congenital anomalies such as a horse shoe-shaped or ectopic kidney.

Result:

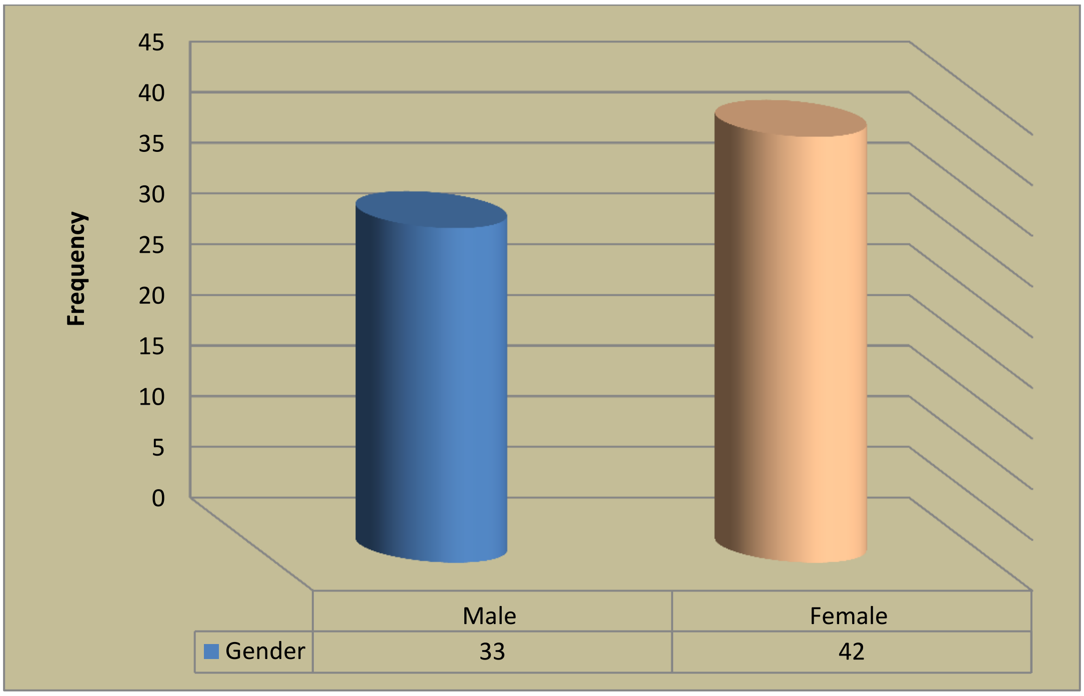

Fig (1): Represents the gender of hypertensive patient

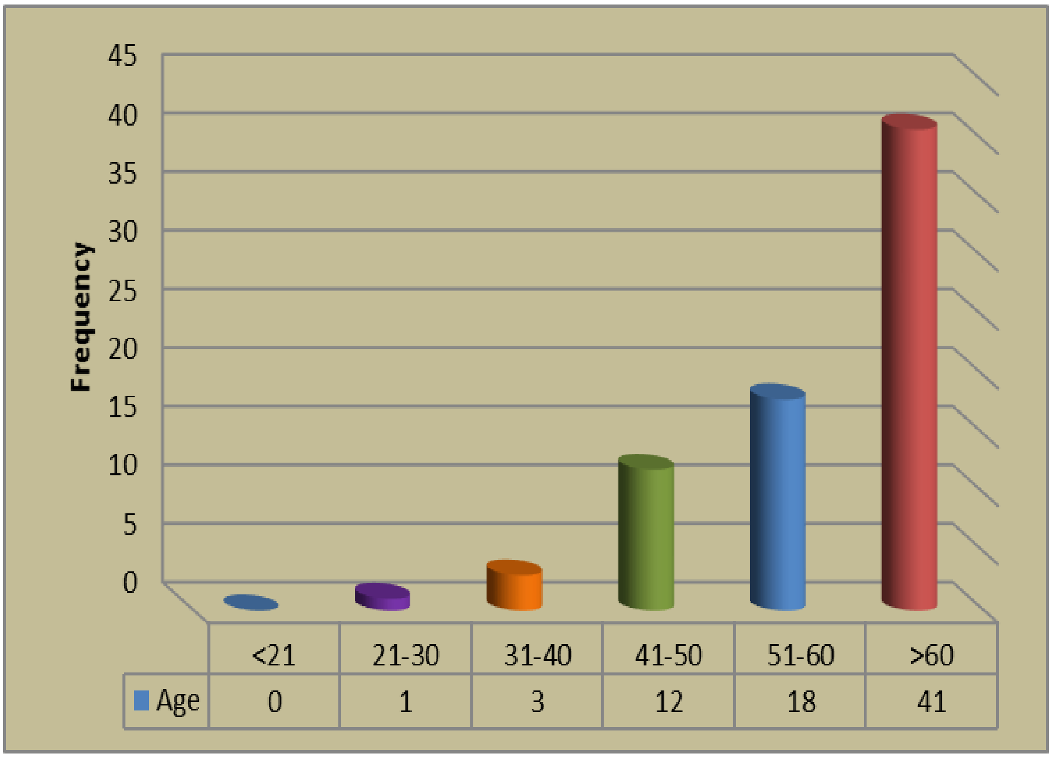

Fig (2): Represent the common age affected by hypertension.

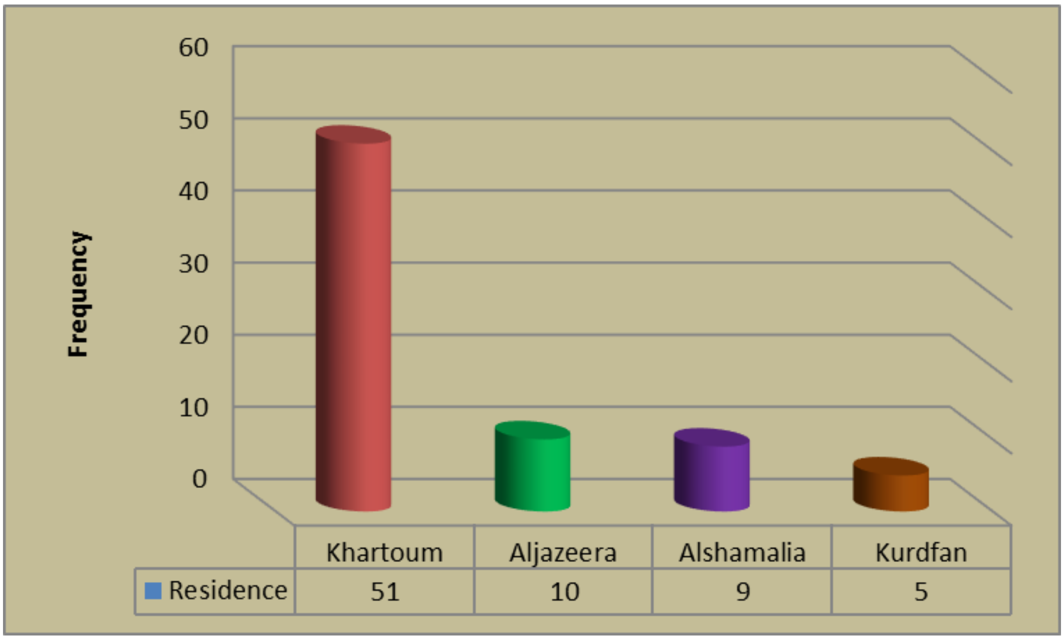

Fig (3): Residence of hypertensive patients.

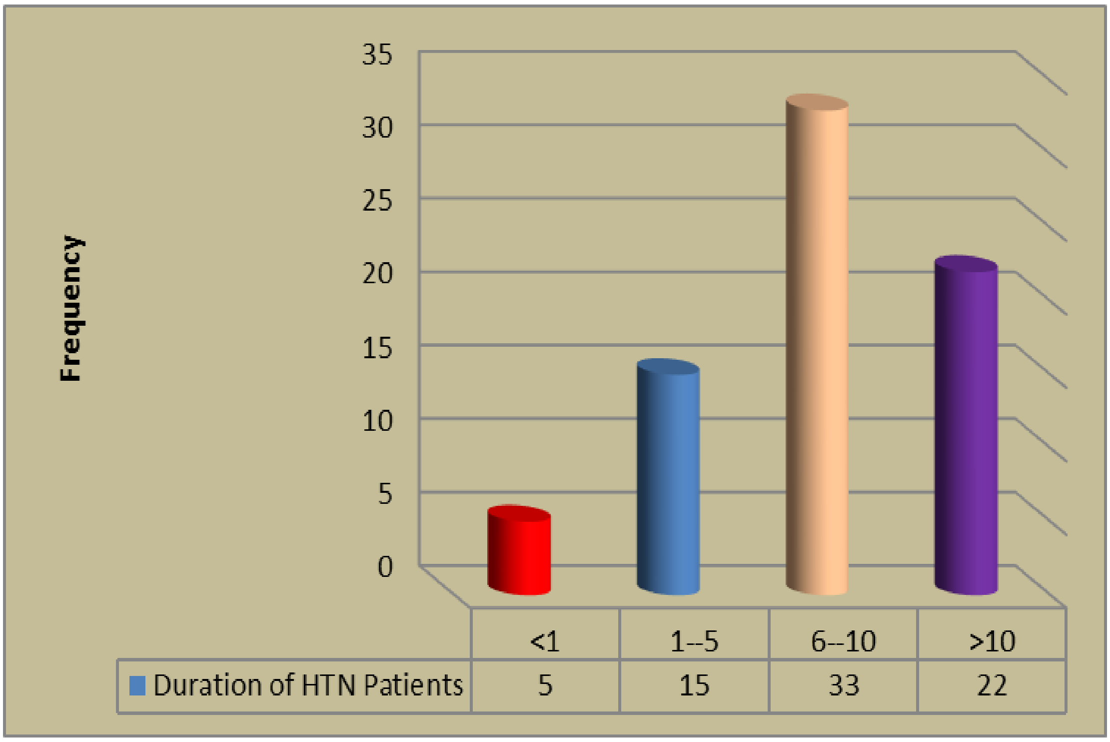

Fig (4) Represent the duration of hypertensive disease

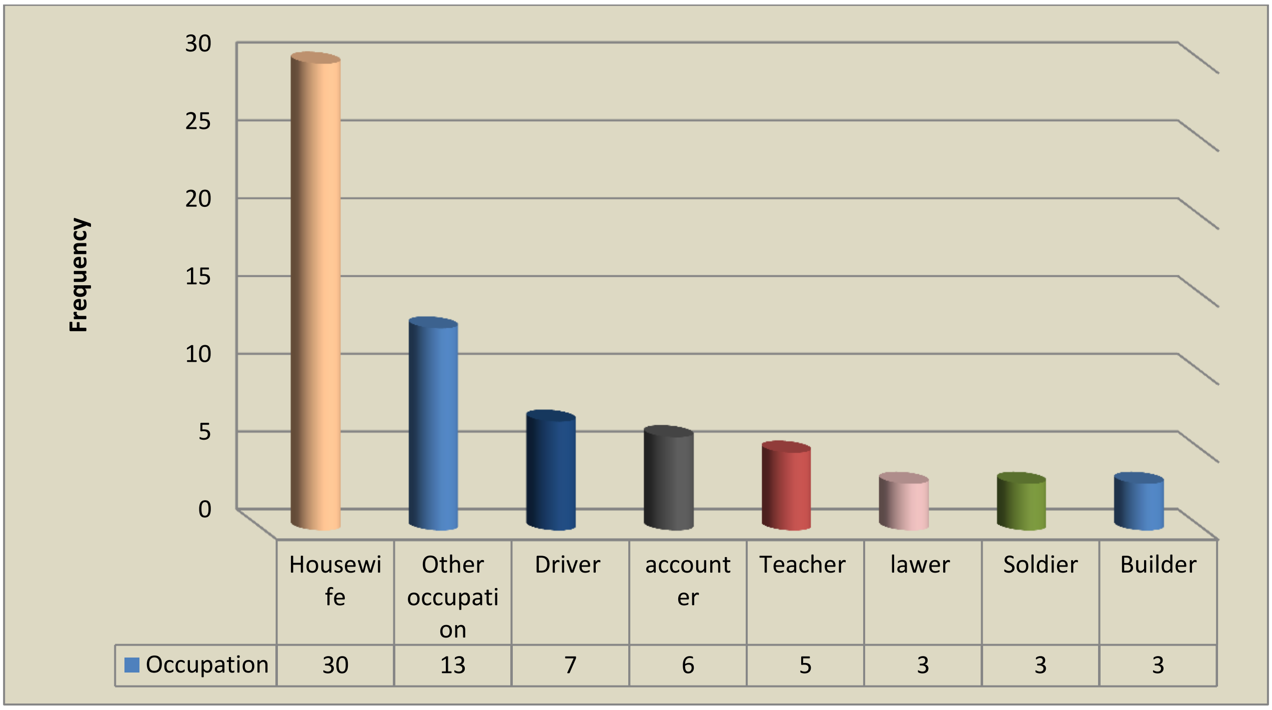

Fig (4): The occupation of hypertensive patients.

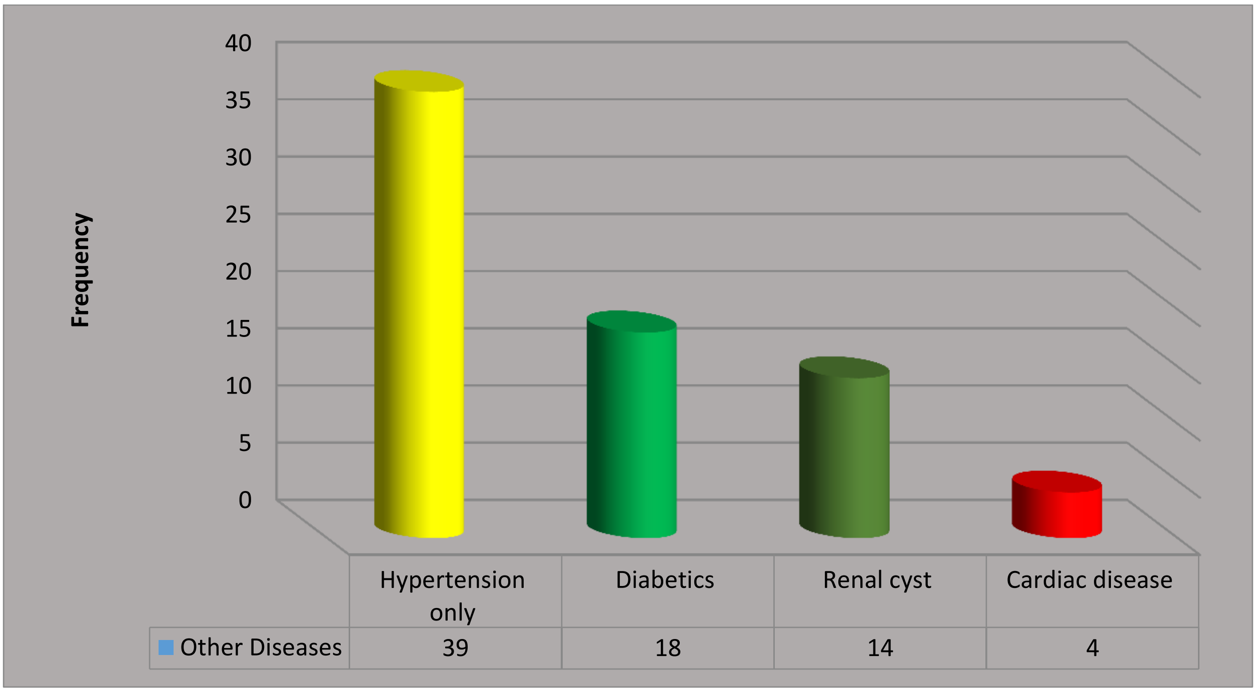

Fig (5): Common disease associated with hypertension.

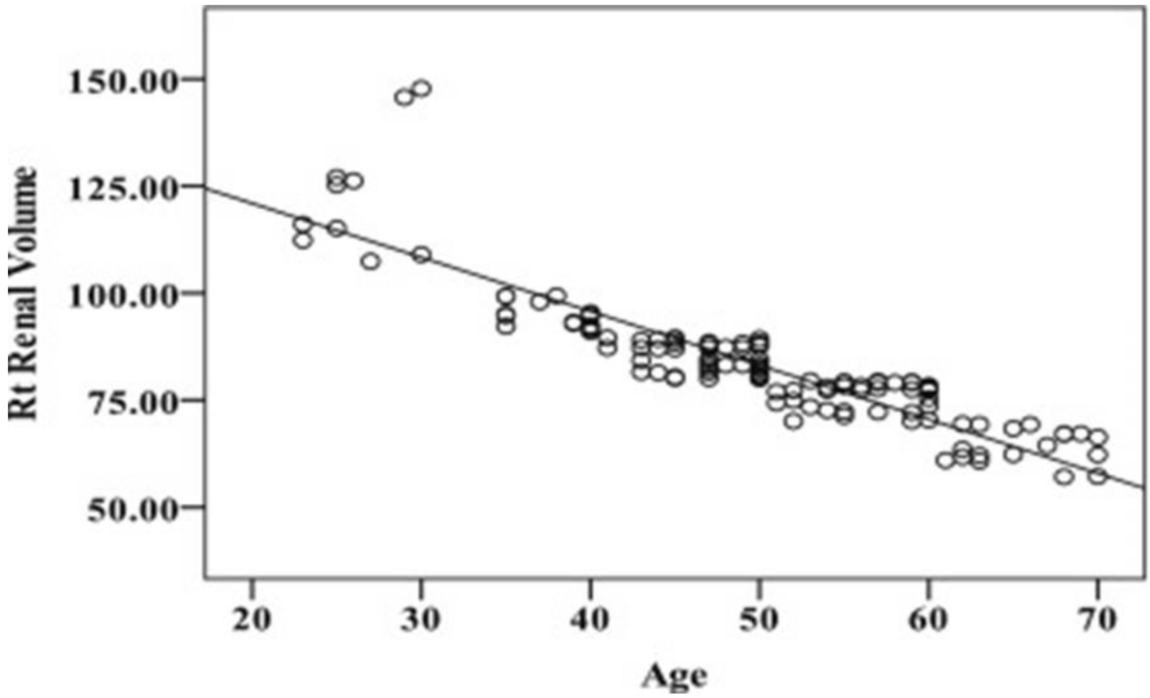

Fig (6): Showing decrease in renal volume as age increases in hypertensive patients.

Also among the patients it was observed that considerable increasing in renal volume as BMI increased (linear relation).

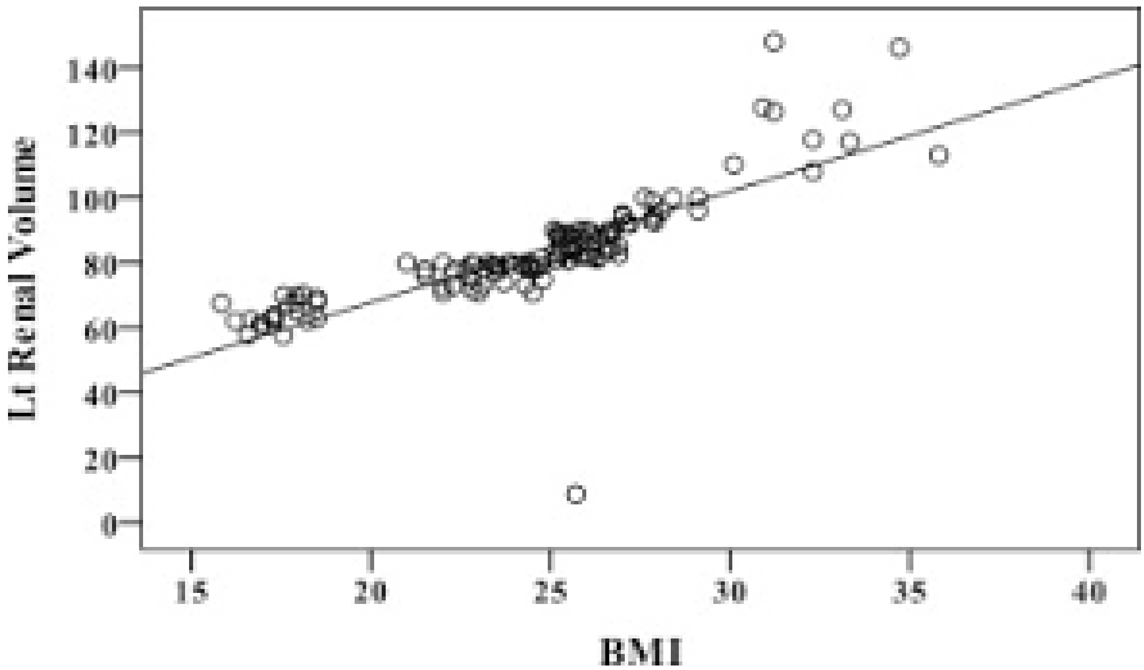

Fig (7): Showing increase in renal volume as BMI increases in hypertensive patients.

Discussion:

A total of 75 participant's hypertensive patient (33 male's and42 females) were examined shows fig (1).

The age range was 21–89years, with a mean of 64.6 years. The ages of the control group 12 males and 13 females ranged from 21 to 70 years, with a mean of 40.1 years. Among the hypertensive patients, 41 (54.6%) were above 60 years fig (2) these result in the present study agree with those reported in the other studies. [2, 3, 4]

Among those patients understudy, 51 (68%) resided in Khartoum followed by Aljazeera 10 (13%), Alshamalia 9 (12%) and 5 (7%) from Kurdfan. fig (3)

According to the patient occupations, 30 (40%) of them were housewives, 5 (6.6%) teachers, 3 (4%) lawyers, 3 (4%) engineers, 7 (9.3) drivers, managers 5(6.6), accountants 6(8%) and 16(21.4%) other occupations, (not mentioned) as shown in fig (4)

In the hypertensive group, the kidney volume ranged from 46.65 to 105.02 cm^3 for the left kidney and 42.59 to 102.33 cm^3 for the right one. In this group, the mean volumes of the right and left kidneys in males (80.7 and 75.3 cm^3, respectively) in females (78.2 and 70.4 cm^3, respectively). In the control group, the range of renal volume was 60.51–108.9 cm^3 for the left kidney and 59.5–105.01 cm^3 for the right one. These result in the present study agree with those reported in the other studies. [, 2, 3&4]

Renal volume as already proven is the most precise measurement of renal size and tends to show the highest correlation with height, weight and BSA (12). Our results are in accordance with this statement because we observed significant correlation between renal volume and BSA, particularly with the left kidney. Significant correlation was also demonstrated between renal volume and BMI. However, right renal volume correlates better with BMI, as reported in other studies (12).

The duration of hypertension in our patients was calculated from the time hypertension was first diagnosed in the hospital in a patient. There was no significant correlation between renal size and duration of hypertension

Conclusion:

Renal Measurement use renal volume is the most accurate compared to renal length measurement in hypertensive patient.in this study showing increase in renal volume as BMI increases. And correlate renal volume with age increases age decrease renal volume in hypertensive patients. No significant difference was seen in the mean renal volume between the hypertensive and the control group in this study.

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