بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Assessment of Renal Values in Healthy Sudanese Adult Population using Computer Tomography

تقيم قياسات الكلى للسودانيين الاصحاء البالغين باستخدام الاشعه المقطعيه

A thesis submitted for partial Fulfillment for the Requirement of M.Sc Degree in Diagnostic Radiologic technology

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الآيـــــــــــــــــة

قال تعالي

(ربي اشرح لي صدري(25) ويسر لي امري(26) واحلل عقده من(27) لساني يفقهه قولي(28)

صدق الله العظيم

Dedication

To my father

To My mother

*To my sister*s and brothers

To my teachers

To all those who help me in preparation of the study

Acknowledgement

My deep thanks to my supervisor Dr. Ikhlas Abdelaziz for her contact supervision, inexhaustible patience &unlimited help.

My thanks extend to staff of Alribat Hospital. and also EMAM EISMAT whose help me to complete this research.

My thanks to everyone who helped, supported and provided any type of help through this study.

Finally, special thanks to my family and friends who were of helpful during the whole study period.

ABSTRACT

This is descriptive study was conducted in three six during the period from JUNE 2018 to OCTOBER 2018 in Alribat Diagnostic Hospital.

The aims of this study were to evaluate normal renal measurements in Sudanese adults using Computed Tomography and correlated to age and gender and BMI

This study carried out in a sample of 50 patients (25 males and 25 females) who underwent to Computed Tomography examination for different reason.

The main results of this study were that mean and standard deviation of all sample of the tow kidneys, the lengths 10.44 ±0.85,

10.57 ±0.91, widths 4.55±0.6, 4.71 ± 0.66 And the cortex thickness was 0.73±0.21, 0.74 ±0.22 cm for right and left kidneys respectively, also the study showed that the texture of Right, Left kidneys 39.20 ± 5.08, 39.20 ± 6.27Hounsfield unit. also mean and standard deviation of male's kidney lengths 10.47 ±0.87 ,widths 4.58 ± 0.66 And the cortex thickness 0.74 ±0.22 cm and texture 39.30 ± 6.04 Hounsfield unit, The female's kidney length 10.54 ± 0.89 width 4.68 ± 0.65, the cortex thickness 0.72±

0.21 cm and texture 39.10 ± 5.04 Hounsfield unit.

The concluded of this study were that the kidneys measurements decreased with age, and the texture of kidneys increased with age .also the study showed there were no different between males and females kidneys measurements and texture.

The study recommended the future studies should be done with other modalities (magnetic resonance Imaging, positron emission tomography / computed tomography).

ملخص البحث

هذه الدراسه الوصفيه اجريت في خمسه اشهر من يونيو 2018 الي اكتوبر 2018 بمستشفي الرباط الوطني.

هدف هذه الدراسة هو تقيم قياسات الكلي الطبيعية ونسيج الكلي في البالغين وعلاقتها بمعامل الجسم الكتلي في السودانيين البالغين الاصحاء باستخدام التصوير المقطعي وربطها بالعمر والنوع.

اجريت هذه الدراسة علي عينه 50مريض(25 اناث و25ذكور)أخضعوا لفحص بالاشعه المقطعيه لاسباب مختلفه.

كانت اهم نتائج هذه الدراسة ان المتوسط والانحراف المعياري لكل العينات بالنسبة للكليتين ان الطول للكلي(0.9+_10.57_0.85+_10.44) العرض (0.66+_4.71_0.64+_4.55) وسمك القشرة(0.22+_0.74_0.21+_0.73)سم للكليه اليمين و الشمال على التوالي ,وايضا اشارت الدراسة ان نسيج الكلى اليمين والشمال(6.27+_39.20, 5.08+_39.20). و معامل التوهين الخطي و المتوسط والانحراف المعياري بالنسبه لطول الكلى بالنسبة للذكور(0.87+_10.47)والعرض(0.66+_4.58) و سمك القشره(0.22+_0.74) و نسيج الكلى(6.04+_39.30 و طول الكلى بالنسبه للاناث (0.89+_10.54)العرض(0.65+_4.68) سمك القشره (0.72+_0.21)و نسيج الكلى (5.04+_,39.10)

وايضا خلصت الدراسة ان قياسات الكلي تقل مع العمر وان نسيج الكلي يزيد مع العمر.

اظهرت الدراسة انه لا يوجد فرق في قياسات ونسيج الكلي بين الذكور والاناث

توصي الدراسة الدراسات القادمة ان تجري باستخدام الرنين المغنطيسي والانبعاث الاشعاعي بالأشعة المقطعية.

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List of abbreviations

BMI	Body mass index.
Ca+	Calcium ion.
CT	Computer Tomography.
CTU	Computer tomography urography.
HU	Hounsfield Unit.
IV	Intra venous.
IVC	Inferior Vena cava.
KV	Kilo volt.
L3	Third lumbar vertebrae.
LT	Left.
MA	Mill Amber.
ml/sec	Mill/second.
MRI	Magnetic Resonance Imaging.
Na+	Sodium ion.
NaCl	Sodium chloride.
PET	Positron Emission Tomography.
PH	Plasma hydrogen ion.
R2	Liner Correlation Coefficient.
RT	Right.
T12	Thoracic spine number 12.
TBW	Total body water.
UPJ	Uretero Pelvic Junction.

Chapter One

Introduction

Chapter one

Introduction

1-1Introduction to CT:

Computed tomography (CT) of the renal system is a diagnostic imaging test used to help detect normal anatomy and diseases of the kidneys. CT scanning is fast, painless, noninvasive and accurate. Spiral CT provides many advantages in evaluation of the kidneys. Spiral scanning essentially eliminates data misregistration, and allows for visualization of the entire kidney during peak contrast enhancement. The generated dataset is free from motion artifact, which improves multiplanar reconstructions, these factors are importance for the evaluation and characterization of small renal tumors .Increased sensitivity in the detection of subtle asymmetries of the cortical nephrogram is also obtained, which is useful in diagnosing disorders such as renal artery stenosis, renal vein thrombosis, acute pyelonephritis, and renal obstruction .The advantages of spiral scanning in the evaluation of both renal inflammatory diseases and renal masses (hopkinsmedicine.org 2016).

The kidneys are retroperitoneal bean-shaped organs that lie in the paravertebral gutters against the posterior abdominal wall. They lie at an oblique orientation, with the upper poles more medial and posterior than the lower poles. They are located on each side of the spine between T12 and L4 and are embedded in perirenal fat (Lorrie, 2007).

The right kidney is usually slightly lower due to displacement by the liver. Each kidney is composed of an outer cortex and an inner medulla. Each kidney has 7 to 14minor calyces that merge into 2 or 3 major calyces. The major calyces join to form the renal pelvis, which is the largest dilated portion of the collecting system and is continuous with the ureters. The fat-filled cavity surrounding the renal pelvis is called the renal sinus.

Surrounding the kidneys and perirenal fat is another protective layer called the renal fascia. The medial indentation in the kidney is called the hilum; it allows the renal artery and vein and ureters to enter and exit the kidney the primary function of the urinary system is to filter blood, produce and excrete urine, and help maintain normal body physiology (Lorrie, 2007).

Typically, the kidneys are fully developed in the early twenties (about 23 to 25 years of age). There should be very little or no changes to the size of the kidneys, after this age. Kidney disease is an important factor that may affect kidney size. In fact, the size of a kidney and changes in its size can provide indications of renal problems. Polycystic disease and hydronephrosis (a condition where fluids accumulate inside the kidney) can cause distension (enlargement) of the kidneys. Other chronic renal conditions can affect kidney size and cause the kidneys to decrease in size. This is known as atrophy and usually occurs over a period of time (usually years). Chronic Glomerulonephritis and Hypertensive Nephrosclerosis are examples of conditions, which may cause atrophy (Hilaire, 2006-2016).

1-2 Problem of the study:

The variant in normal renal measurements which may be due to ethnic variation and socioeconomic status and regions of zone, also some pathology may reduce or increase in kidneys size and changes in renal measurements .The size of kidney in Sudanese population compared to international index. Also The organ measurement usually affected by body characteristic, this characteristic might lead to wrong diagnosis therefore we need to compare this measurement to the body characteristic and hence we can have our own index.

1-3Objectives:

1-3-1 general objective:

To assessment of renal size and it correlation with body mass index in healtyadult Sudanese by using computed tomography.

1-3-2 specific objectives:

To measure the kidneys size (length, width,).

To evaluate the texture of the normal kidneys.

To compare kidneys measurements and texture with gender.

To correlate kidneys (length, width) and texture with age.

To correlate kidneys (length, width .size) with a body mass index.

1.4 Significant of the study:

This study provides good information about Sudanese kidneys measurement and it used as guide line to proper Sudanese index.

1.5 Overview of study:

Chapter One_ Introduction and objectives of the study.

Chapter two_ Literature review and background studies.

Chapter three_ Materials and Methods.

Chapter four_ The Results.

Chapter five_ Discussion, Conclusion, Recommendations, References and Appendices.

Chapter Two

Literature Review and Back ground

Chapter two
Literature Review and Previous Studies

2-1Anatomy:

The kidneys are retroperitoneal bean-shaped organs that lie in the paravertebral gutters against the posterior abdominal wall. They lie at an oblique orientation, with the upper poles more medial and posterior than the lower poles. They are located on each side of the spine between T12 and L4 and are embedded in perirenal fat; the right kidney is usually slightly lower due to displacement by the liver. Each kidney is composed of an outer cortex and an inner medulla. The renal cortex comprises the outer one third of the renal tissue and has extensions between the renal pyramids of the medulla. The cortex contains the functional subunit of the kidney, the nephron, which consists of the glomerulus and convoluted tubules and is responsible for filtration of urine. (Lorrie, 2007).

The renal medulla consists of segments called renal pyramids that radiate from the renal sinus to the outer surface of the kidney. The striated-appearing pyramids contain the loops of Henle and collecting tubules and function as the beginning of the collecting system. Arising from the apices of the pyramids are the cup-shaped minor calyces. Each kidney has 7 to 14 minor calyces that merge into 2 or 3 major calyces. The major calyces join to form the renal pelvis, which is the largest dilated portion of the collecting system and is continuous with the ureters. The fat-filled cavity surrounding the renal pelvis is called the renal sinus. Surrounding the kidneys and perirenal fat is another protective layer called the renal fascia (Gerota's fascia). The renal fascia functions to anchor the kidneys to surrounding structures in an attempt to prevent bumps and jolts to the body from injuring the kidneys. In addition, the renal fascia acts as a barrier, limiting the spread of infection that may arise from the kidneys. The medial indentation in the kidney is called the hilum; it allows the renal artery and vein and ureters to enter and exit the kidney *(*Lorrie, 2007).

The kidneys can be divided into five segments according to their vascular supply: apical, anterosuperior (upper anterior), anteroinferior (middle inferior), inferior, and posterior the segmental classification helps with surgical planning for partial nephrectomies (Lorrie, 2007).

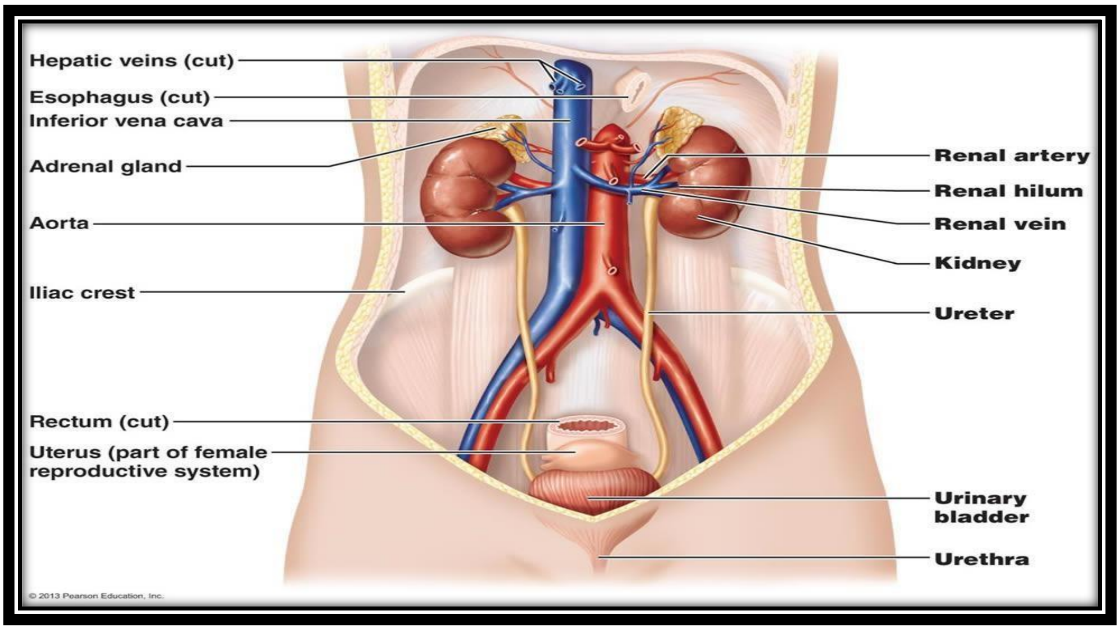

Figure 2.1 Coronal view shows Location and External Anatomy of kidneys**. (classes.midlandstech.edu).**

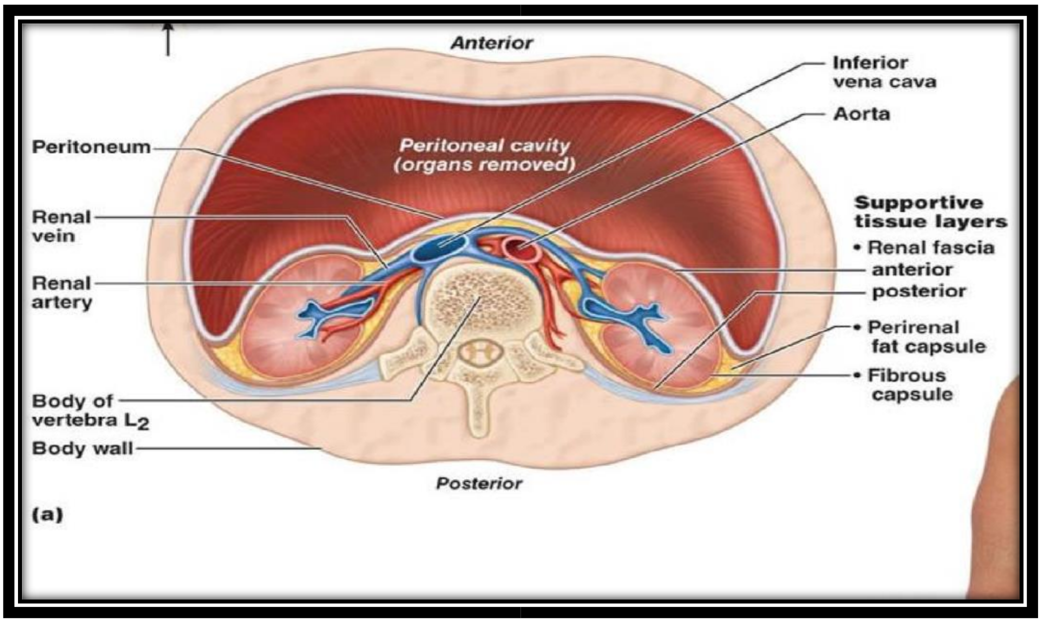

Figure: A

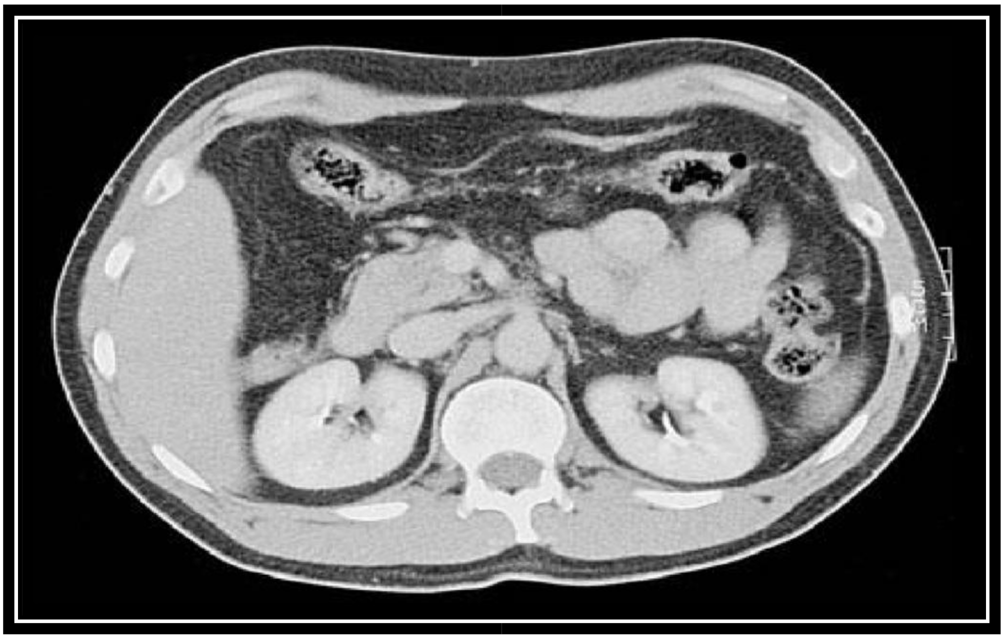

Figure: B

Figure: 2.2: A and B axial view show Location and External Anatomy of kidneys.(classes.midlandstech.edu)

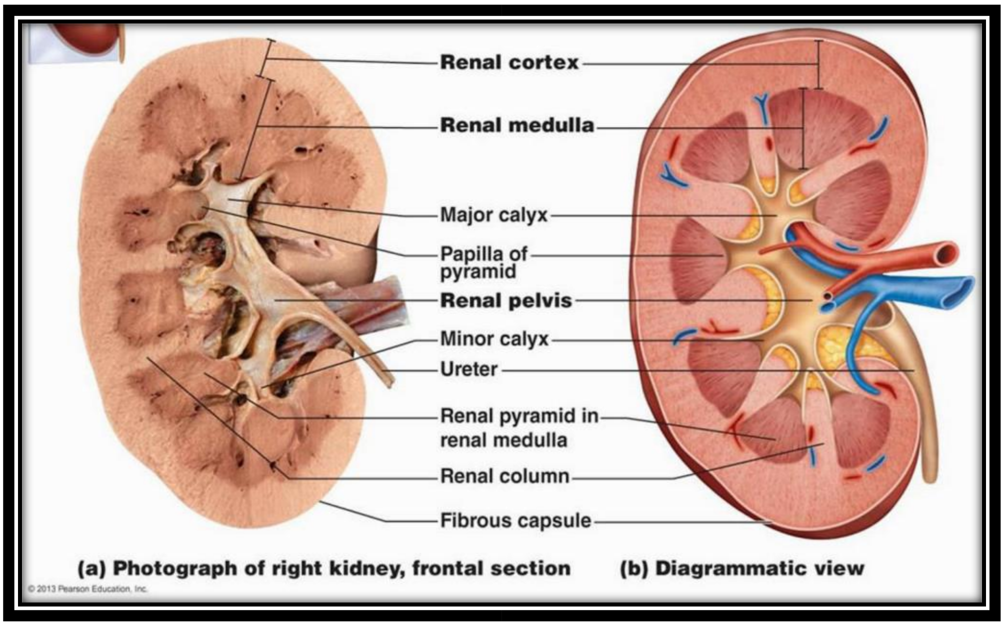

Figure: A

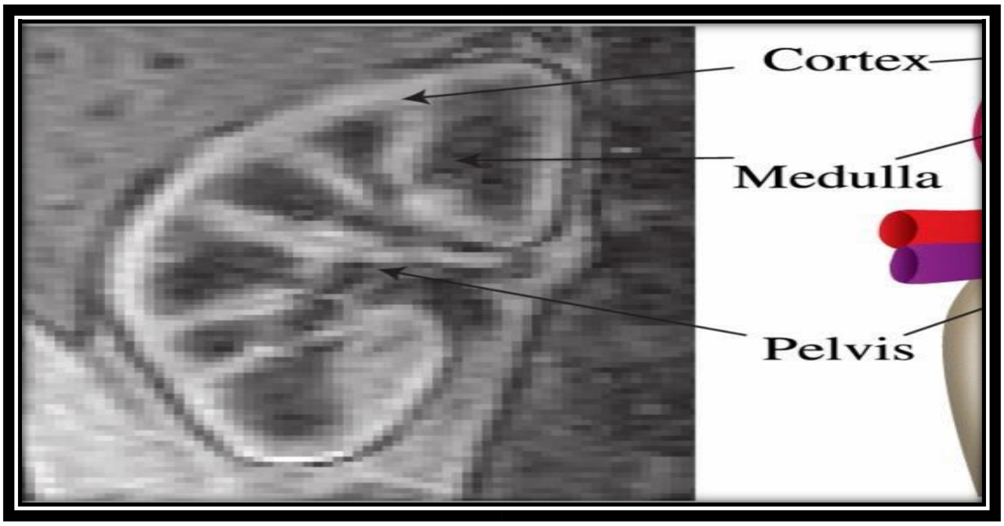

Figure: B

Figure 2-3: A and B show coronal image of internal anatomy of kidney. (classes.midlandstech.edu)

Relations of the right kidney:

Superiorly and Anteriorly: the right suprarenal gland and the liver.

Anteriorly: The second part of the duodenum and the right colic flexure. Posterior :the diaphragm, cost diaphragmatic recess of the pleura, the 12th rib and muscles of the posterior abdominal wall (Butler et al. 2007).

Relations of the left kidney:

Anteriorly: The left suprarenal gland, the spleen, the stomach, the Pancreas, the left colic flexure, and loops of jejunum.

Posteriorly: as for the right kidney (Butler et al.2007).

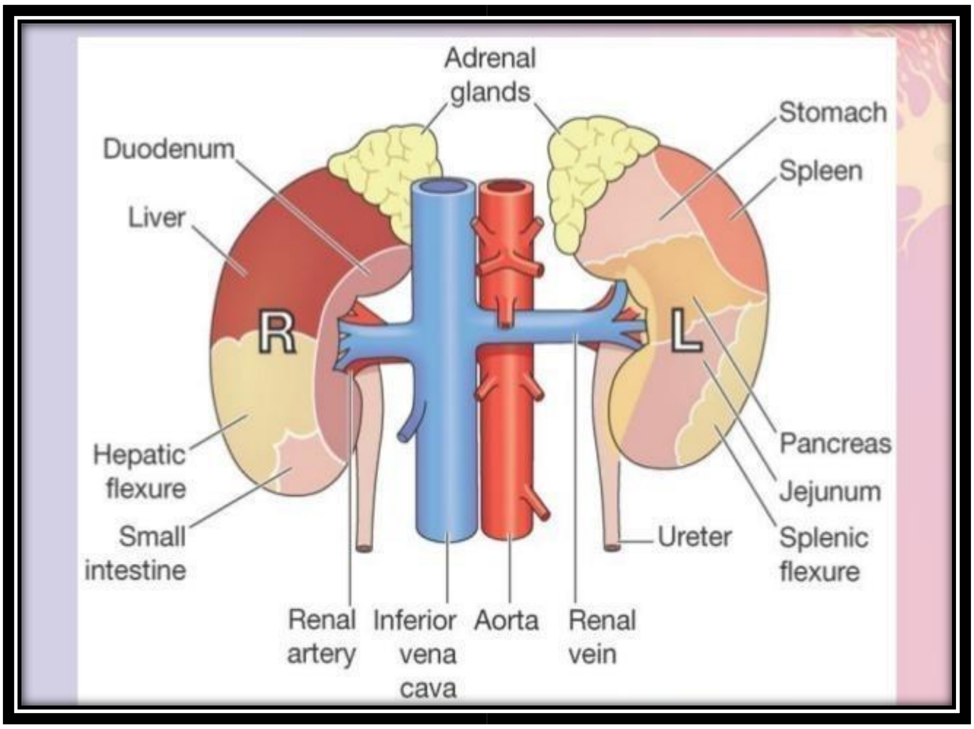

Figure: 2.4 Show anterior view Relations of the kidneys. (www.studyblue.com).

Blood supply of the kidneys:

Renal arteries, veins and lymphatic drainage: The right and left renal arteries arise from the abdominal aorta, at approximately the level of the superior margin of L2, immediately caudal to the origin of the superior mesenteric artery, there is usually a single artery supplying each kidney, although there are many anatomical variants, with up to four renal arteries supplying each kidney. The renal artery divides in the renal hilum into three branches. Two branches run anteriorly, supplying the anterior upper pole and entire lower pole, and one runs posterior supplying the posterior upper pole and mid pole. Five or six veins arise within the kidney and join to form the renal vein, which runs anterior to the artery within the renal pelvis . The right renal vein has a short course, running directly into the IVC. The left renal vein runs anterior to the abdominal aorta and then drains into the IVC. Occasionally, the left renal vein runs posterior to the aorta, known as a retro-aortic renal vein. The left renal vein receives tributaries from the left inferior phrenic vein, the left gonadal and the left adrenal vein (Butler et al. 2007).

The lymphatic drainage of the kidneys follows the renal arteries to nodes situated at the origin of the renal arteries in the Para-aortic region (Butler et al. 2007).

Nerve supply:

The sympathetic nerves supplying the kidney arise in the renal sympathetic

Plexus and run along the renal vessels. Afferent fibers, including pain fibers, travel with the sympathetic fibers through the splanchnic nerves and join the dorsal roots of the 11th and 12th thoracic and the 1st and 2nd lumbar levels (Butler et al. 2007).

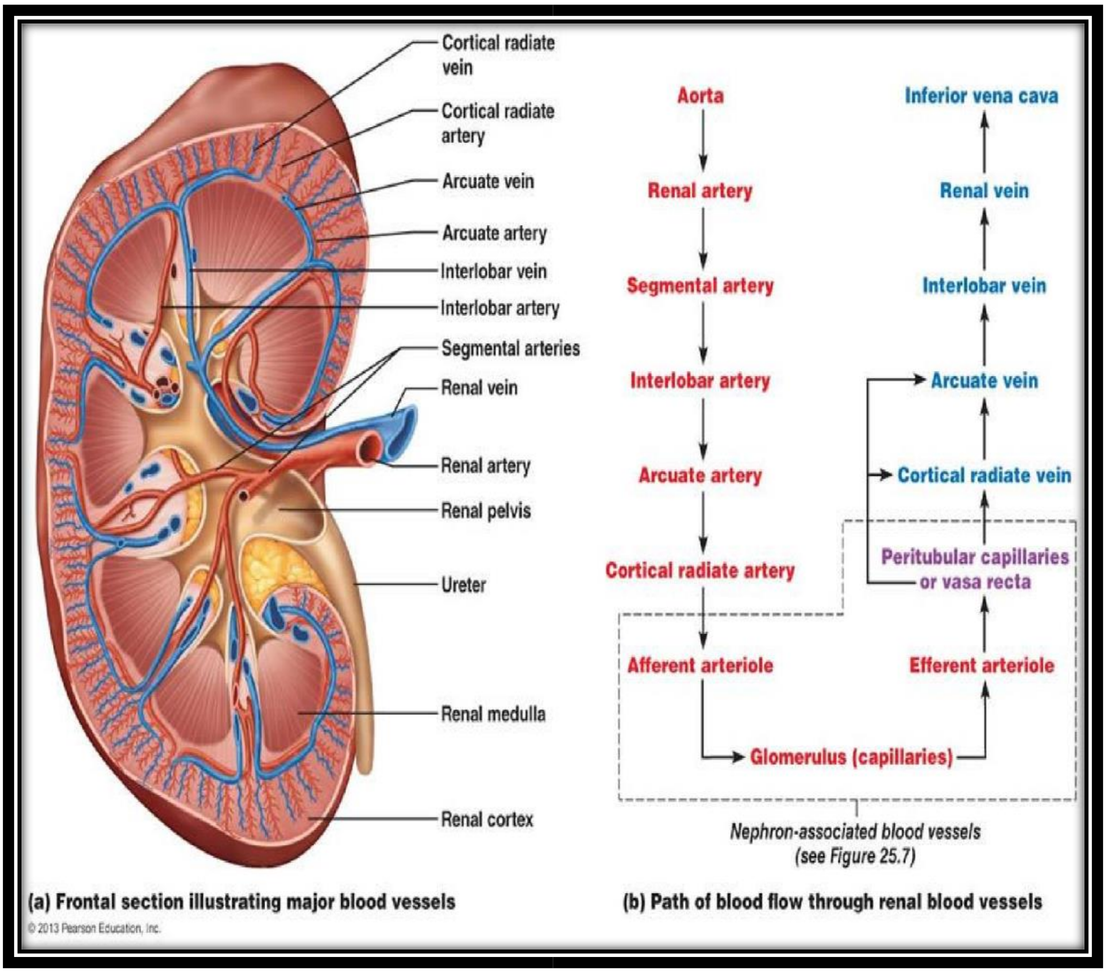

Figure: 2.5 Blood Supply of Kidney. (classes.midlandstech.edu).

2.2 Physiology:

The primary function of the kidneys is to maintain a stable internal environment (homeostasis) for optimal cell and tissue metabolism. They do this by separating urea, mineral salts, toxins, and other waste products from the blood. They also do the job of conserving water, salts, and electrolytes. At least one kidney must function properly for life to be maintained. (Wiki/Human Physiology 2016).

Important roles of the kidneys are: **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. Salt (NaCl) will cause osmosis to happen; the diffusion of water into the blood **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 Phmainly by excreting hydrogen ions and reabsorbing bicarbonate ions as needed **Removal of metabolic waste products and foreign substances from the plasma**. One of the most important things the kidneys excrete is nitrogenous waste. As the liver breaks down amino acids it also releases ammonia. The liver then quickly combines that ammonia with carbon dioxide, creating urea which is the primary nitrogenous end product of metabolism in humans. The liver turns the ammonia into urea because it is much less toxic. We can also excrete some ammonia, creatinine and uric acid. **The creatinine** comes from the metabolic breakdown of creatine phosphate (a high-energy phosphate in muscles). **Uric acid** comes from the breakdown of nucleotides. Uric acid is insoluble and too much uric acid in the blood will build up and form crystals that can collect in the joints and cause gout. **Secretion of Hormones** The endocrine system has assistance from the kidney's 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. (wiki/Human_Physiology2016)

2.3 Pathology:

Kidney stones:

Kidney stone (renal calculus or nephrolith) is formed by combination of a high level of calcium with oxalate, phosphate, urea, uric acid, and cystine. Crystals and subsequently stones are formed in the urine and collected in calyces of the kidney or in the ureter the kidney stone varies in size from a grain of sand to the size of a golf ball and produces severe colicky pain while traveling down through the ureter from the kidney to the bladder. Common signs of kidney stones include nausea and vomiting, urinary frequency and urgency, and pain during urination (Chung et al.2012).

Polycystic kidney disease:

Is a genetic disorder characterized by numerous cysts filled with fluid in the kidney; the cysts can slowly replace much of normal kidney tissues, reducing kidney function and leading to kidney failure. It is caused by a failure of the collecting tubules to join a calyx, which causes dilations of the loops of Henle, resulting in progressive renal dysfunction. This kidney disease has symptoms of high blood pressure, pain in the back and side, headaches, and blood in the urine. It may be treated by hemodialysis or peritoneal dialysis and kidney transplantation (Chung et al. 2012).

Hydronephrosis:

Is a fluid-filled enlargement of the renal pelvis and calyces as a result of obstruction of the ureter. It is due to an obstruction of urine flow by kidney stones in the ureter, by compression on the ureter by abnormal blood vessels, or by the developing fetus at the pelvic brim. It has symptoms of nausea and vomiting, urinary tract infection, fever, dysuria (painful or difficult urination), urinary frequency, and urinary urgency (Chung et al. 2012).

Pelvic kidney:

Is an ectopic kidney that occurs when kidneys fail to ascend and thus remain in the pelvis. Two pelvic kidneys may fuse to form a solid lobed organ because of fusion of the renal anlagen, called a cake (rosette) kidney (Chung et al. 2012).

Horseshoe kidney develops: As a result of fusion of the lower poles of two kidneys and may obstruct the urinary tract by its impingement on the ureters (Chung et al. 2012).

2-4 CT scanners:

Are complex, with many different components involved in the process of creating an image. Adding to the complexity, different CT manufacturers often modify the design of various components. From a broad perspective, all makes and models of CT scanners are similar in that they consist of a scanning gantry, x-ray generator, computer system, operator's console, and physician's viewing console. Although hard-copy filming has largely been replaced by workstation viewing and electronic archiving, most CT systems still include a laser printer for transferring CT images to film (Lois, 2011).

The three major components of a CT imaging system are the operating console, the computer, and the gantry. Each of these major components has several subsystems.

Computed tomography imaging systems can be equipped with two or three consoles. One console is used by the CT radiologic technologist to operate the imaging system. Another console may be available for a technologist to post process images to annotate patient data on the image (e.g., hospital identification, name, patient number, age, gender) and to provide identification for each image (e.g., number, technique, couch position),This second monitor also allows the operator to view the resulting image before transferring it to the physician's viewing console. A third console may be available for the physician to view the images and manipulate image contrast, size, and general visual appearance. This is in addition to several remote imaging stations (Lois, 2011).

The computer is a unique subsystem of the CT imaging system. Depending on the image format, as many as 250,000 equations must be solved simultaneously; thus, a large computing capacity is required. Many CT imaging systems use an array processor instead of a microprocessor for image reconstruction. The array processor does many calculations simultaneously and hence is significantly faster than the microprocessor(Lois, 2011).

The gantry includes the x-ray tube, the detector array, the highvoltage generator, the patient support couch, and the mechanical support for each. These subsystems receive electronic commands from the operating console and transmit data to the computer for image production and post processing tasks (Lois, 2011).

X-ray tubes produce the x-ray photons that create the CT image. Their design is a modification of a standard rotating anode tube, such as the type used in angiography. Tungsten, with an atomic number of 74, is often used for the anode target material because it produces a higherintensity x-ray beam. CT tubes often contain more than one size of focal spot; 0.5 and 1.0 mm are common sizes. Early CT scanners used recoiling system cables to rotate the gantry frame. Current systems use electromechanical devices called slip rings. Slip rings use a brush like. Apparatus to provide continuous electrical power and electronic communication across a rotating surface. They permit the gantry frame to rotate continuously, eliminating the need to straighten twisted system cables. (Lois, 2011).

As the x-ray beam passes through the patient it is attenuated to some degree. To create an x-ray image we must collect information regarding the degree to which each anatomic structure attenuated the beam. In CT, detectors used to collect the information. The detector array comprises detector elements situated in an arc or a ring, each of which measures the intensity of transmitted x-ray radiation along a beam projected from the x-ray source to that particular detector element. Detectors can be made from different substances, each with their own advantages and disadvantages(Lois, 2011).

All new scanners possess detectors of the solid-state crystal variety. Detectors made from xenon gas have been manufactured but have largely become obsolete as their design prevents them from use in MDCT systems (Lois, 2011).

High-frequency generators are currently used in CT. They are small enough so that they can be located within the gantry. Generators produce high voltage and transmit it to the x-ray tube. CT generators produce high kV (generally 120–140 kV) to increase the intensity of the beam, which will increase the penetrating ability of the x-ray beam and thereby reduce patient dose. In addition, a higher kV setting will help to reduce the heat load on the x-ray tube by allowing a lower MA setting. Reducing the heat load on the x-ray tube will extend the life of the tube (Lois, 2011).

The patient lies on the table (or couch, as it is referred to by some Manufacturers and is moved within the gantry for scanning. The process of moving the table by a specified measure is most commonly called incrimination, but is also referred to as feed, step, or index. Helical CT table incrimination is quantified in millimeters per second because the table continues to move throughout the scan. The degree to which a table can move horizontally is called the scan able range, and will determine the extent a patient can be scanned without repositioning. The specifications of tables vary, but all have certain weight restrictions (Lois, 2011).

On most scanners, it is possible to place the patient either head first or feet first, supine or prone. Patient position within the gantry depends on the examination being performed(Lois, 2011).

2.5 Previous studies:

The study was done by (Krairittichai U et al 2011) by ultrasound The average lengths of left and right kidney were 10.24 +/- 0.70 and 10.09 +/- 0.68 cm, respectively. Male kidney was bigger than the female kidney. Kidney length slightly increased until the age of 50 and become smaller at the age of 60 or more. Kidney length showed no correlation with age, body weight, body mass index and body surface area.

Another study was done by (Abdullah et al 2014) by MRI .The study showed that the kidneys length measured for normal Sudanese subjects were 10.08±0.46, 10.67±0.47and the volumes were 101.6±12.98, 104.0±12.99 for right and left kidneys respectively, and it differed from other population. There were significant differences between males and females measurements and the correlation was significant between kidneys length and volume with BMI, TBW and subjects height.

The study was done by (Maaji et al 2015) by ultrasound the mean kidney length was 11.3 ± 8.8 and 11.6 ± 9.8 for right and left kidney, respectively. The mean height and weight was 1.67 ± 0.85 and 70.9 ± 11.2, respectively. The mean kidney width was 4.4 ± 0.71 and 5.2 ± 5.26 for right and left kidney respectively. The mean renal thickness was (4.7±0.67, 4.5±0.68) or right and left kidney respectively.

Another study was done by The (Rathore et al 2016) by computer tomography mean length, width, thickness and volume of the left kidney were 11.02 ± 1.13 cm, 5.21 ± 0.75 cm, 4.65 ± 0.84 cm and 138.22 ± 29.81 mL, respectively, and those for the right kidney were 10.86 ± 1.12 cm, 5.13 ± 0.77 cm, 4.73 ± 0.95 cm and 137.54 ± 34.48 ML, respectively.

Another study was done by the (Hameed A, Khan MI) by ultrasoundMean renal length on right side was 101.6 +/- 8.9 mm, renal width 42.7 +/- 7.1 mm,. On left side, mean renal length was 102.7 +/- 9.2 mm, width 47.6 +/- 7.0) mm, and. Mean renal volume on right was 99.8 +/- 37.2 cm3 and on left was 124.4 +/- 41.3 cm3. Left renal size was significantly larger than right in both genders.

Chapter Three

Materials and Methods

Chapter Three

Materials and Methods

3.1 Materials:

3.1.1 Study sample:

This was descriptive study and the data collected and interpreted by radiologist.

3.1.7 Equipments:

In the present study, CT machinewere used.
study, CT machinewere used.

ALRIBAT HOSPITAL NEUROSOFT CT SCAN MACHIN 16 SCLICE

3.2 Methods:

3.2.1 Technique used:

The patient should be fasting at least 8 hours prior to exam.

The patient position is in supine (feet first), with arms over head on CT table.

The scout from diaphragmatic dome to the symphsis pubis.

The slice thickness is used: 4-5 mm through the kidney.

Breathe hold: suspended expiration.

Land mark: xiphoid tip.

I contrast: 2-4 ml/sec, 100-150 ml.

Scout: AP, Pre contrast scans.

3.2.2 Image interpretation:

All CT image were studied for the study group sample to measure the RT_LT Kidneys and evaluated the texture of kidneys and Statistical analyses were performed using excel software programmed and using the SPSS software.

3.2.3Method of kidneys Measurement:

- **Length measurement:**

On the coronal image from upper pole to lower pole (longest area), were measured in nephrogram phase.

- **Width measurement:**

On the coronal image from middle to lateral area (widest area), Three measurements were taken in nephrogram phase (First at upper pole, 2 at middle pole&3 at lower pole).

- **Cortical thickness measurement:**

On the coronal image from renal capsule to the base of renal pyramids is measured in nephrogram phase.

3.2.4 Method Of Body Mass Index Measurement

Body mass index

T is body mass divided by the square of the body height,

Height by cm

Weight by k

Chapter four

Results

Chapter Four Results

The following tables and figures represent data obtained from randomly selected sample of patients (25males and 25females) and age range between (20_75) years that underwent CT for other indications without evidence of renal diseases.

Table 4.1: Show Study group gender distribution:

Gender	Frequency	Percentage
Male	25	50%
Female	25	50%
Total	50	100%

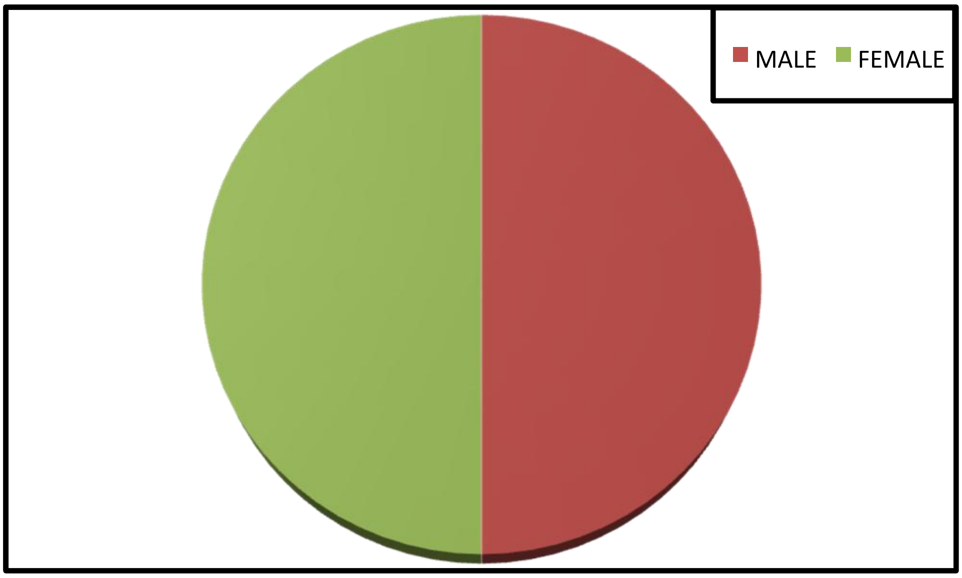

Figure 4.1: Show Study group gender distribution

Table 4.2: Study group Age distribution of Males:

	Males	
Age classes	**Frequency**	**Percentage %**
20_30	5	20
31_40	7	28
41_50	6	24
51_60	2	8
61_70	4	16
71_80	1	4
Total	25	100%

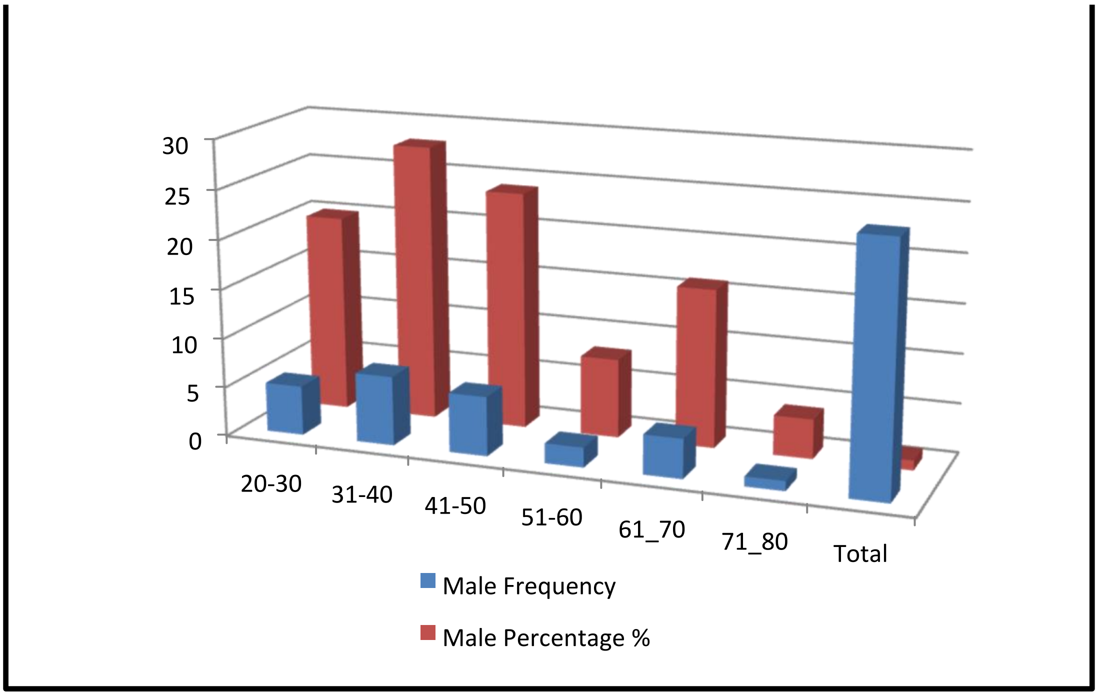

Figure 4.2: Show age group distribution of males

Table 4.3: Show Study group Age distribution of females:

	Females	
Age classes	**Frequency**	**Percentage %**
20_30	6	24
31_40	4	16
41_50	7	28
51_60	3	12
61_70	4	16
71_80	1	4
Total	25	100%

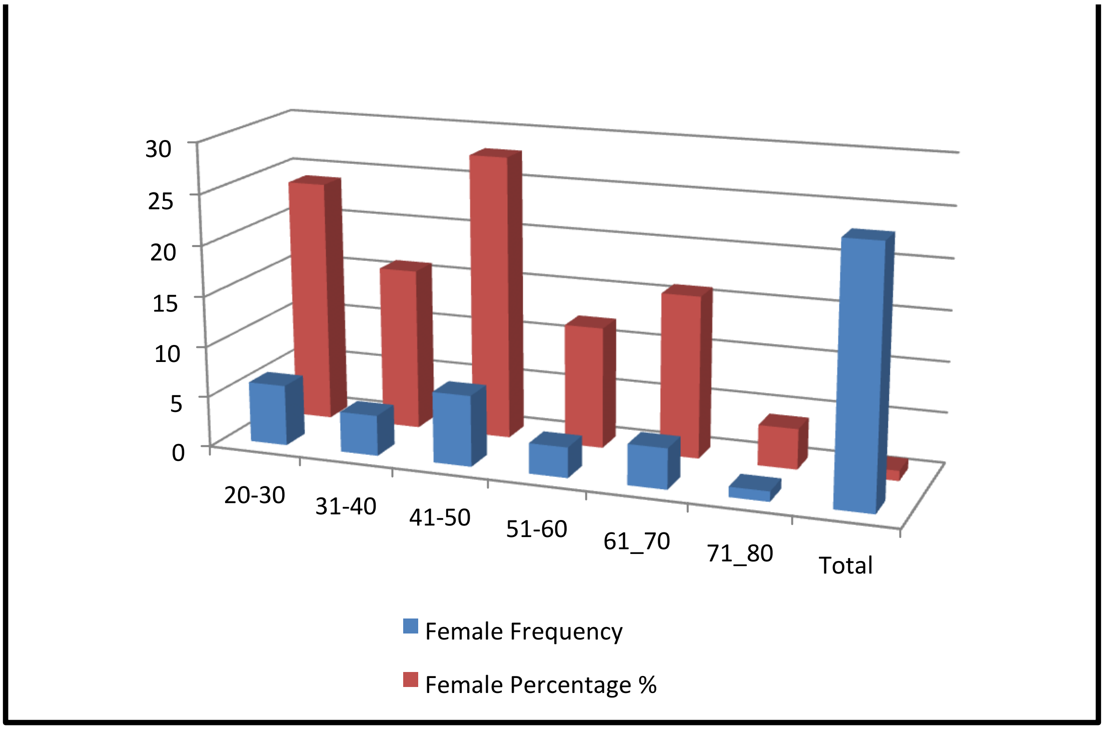

Figure 4.3: Show age group distribution of females

Table 4.4: Descriptive statistics of the Age (Total Sample)

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age	50	20.	75.	44.84	14.89742

Table 4.5 Descriptive Statistics Mean Standard deviation of Right Kidney Measurements for the total sample:

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Length	50	8.60	12.00	10.4460	.85576
Width	50	3.50	5.90	4.5520	.64404
Cortex thickness	50	.27	1.67	.8002	.30186
Texture	50	30.00	55.00	39.200	5. 53652

Table 4.6 Descriptive Statistics Mean Standard deviation of LT Kidney Measurements for the total sample:

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Length	50	8.70	12.00	10.5700	.91879
Width	50	3.70	6.00	4.7120	.66995
Cortex thickness	50	.35	1.75	.7558	.24367
texture	50	31.00	59.00	39.2000	5.65685

Table 4.7 Descriptive Statistics Mean, Standard deviation of the variables for (25) Males:

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age	50	20.00	75.00	44.8400	14.89742
Length	50	8.70	12.00	10.4720	.87902
Width	50	3.60	6.00	4.5840	.66712
Cortex thickness	50	.27	1.75	.8556	.30503
Texture	50	30.00	59.00	39.3000	6.04773

Table 4.8 Descriptive Statistics Mean, Standard deviation of the variables for (25) females:

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age	50	21.00	75.00	44.8400	15.16893
Length	50	8.60	12.00	10.5440	.89947
Width	50	3.50	6.00	4.6800	.65341
Cortex thickness	50	.37	1.26	.7004	.21487
Texture	50	30.00	49.00	39.1000	5. 04773

Table 4.9 Correlation between age and right kidney texture:

Correlations			
		Age	**texture**
age	Pearson Correlation	1	.732**
	Sig. (2-tailed)		.000
	N	50	50
****. Correlation is significant at the 0.01 level (2-tailed).**			

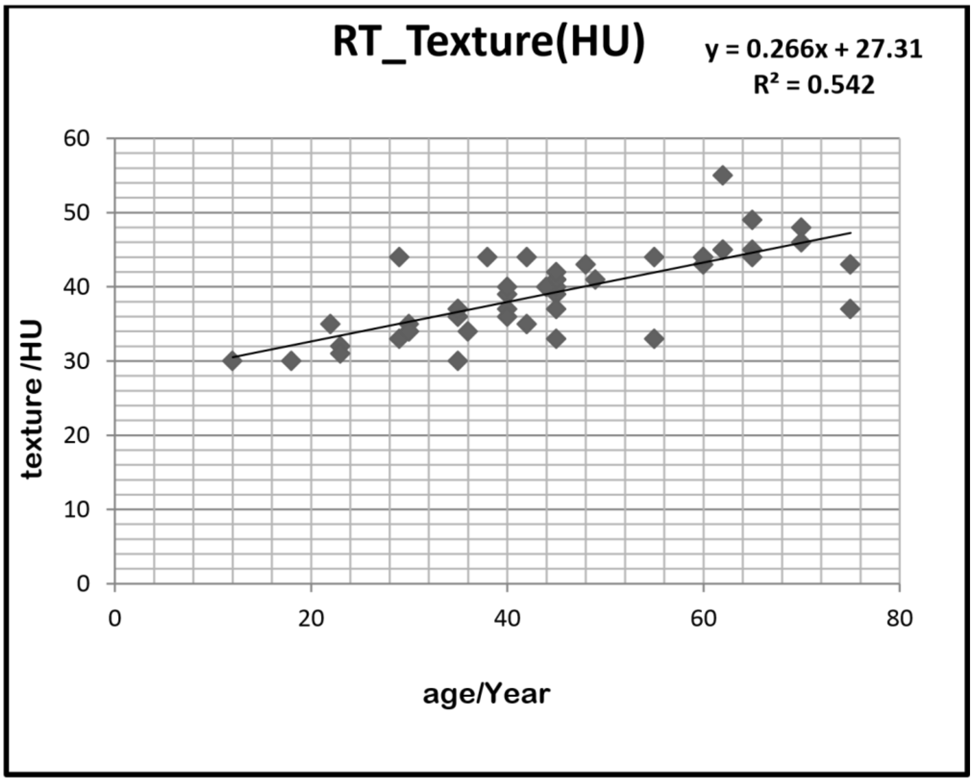

Figure 4.4: Scatter plot diagram shows a linear relation relationship between the age and the texture of RT kidney and the correlation is significant at P value 0.01, as the age increase the renal texture is also increased by factor of 0.266 starting from 27.3

Table 4.10 Correlation between age and right kidney lengths:

Correlations			
		age	length
age	Pearson Correlation	1	-.871**
	Sig. (2-tailed)		.000
	N	50	50
****. Correlation is significant at the 0.01 level (2-tailed).**			

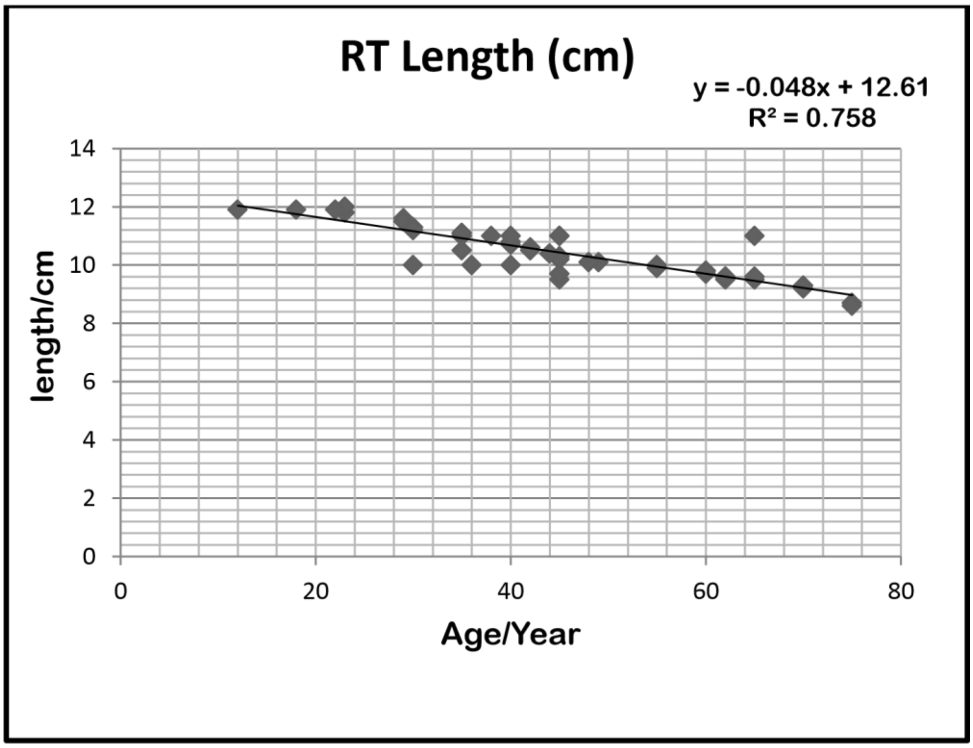

Figure 4.5: Scatter plot diagram shows a linear relation between the age and the length of RT kidney and the correlation is significant at p value 0.01, as the age increase the renal length is decreased by factor of -0.048 starting from 12.6.

Table 4.11 Correation between age and right kidenywidth :

Correlations			
		age	**width**
age	Pearson Correlation	1	-.862**
	Sig. (2-tailed)		.000
	N	50	50
****. Correlation is significant at the 0.01 level (2-tailed).**			

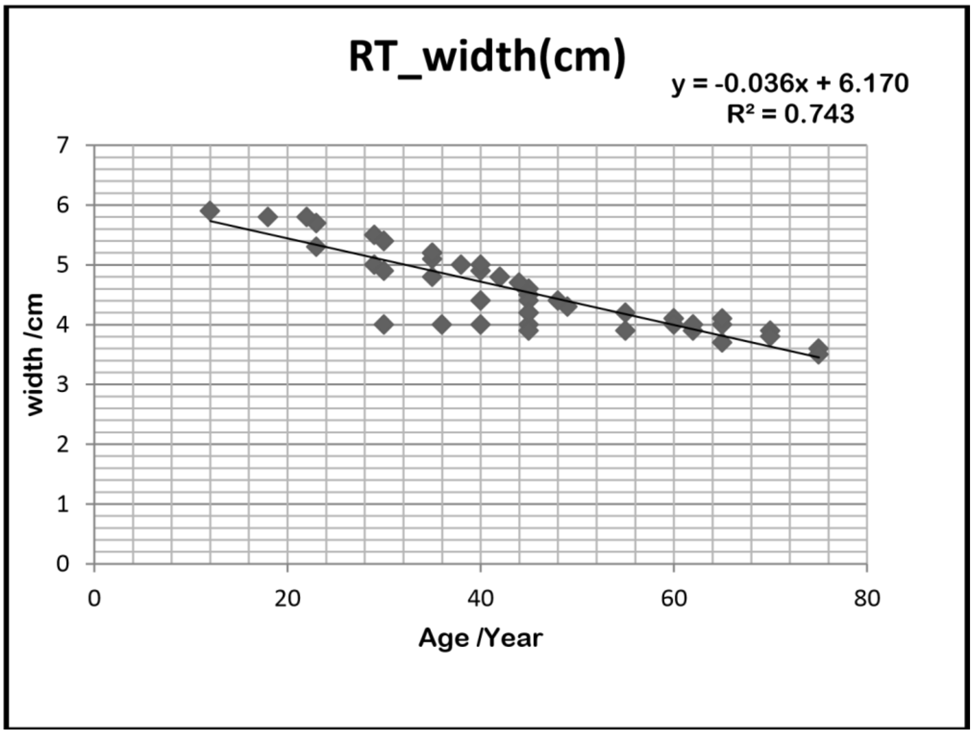

Figure 4.6: Scatter plot diagram shows a linear relation between the age and the width of RT kidney and the correlation is significant at p value 0.01 as the age increased the renal width is decreased by factor of -0.036 starting from 6.17.

Table 4.12 Correlation between age and Left kidney texture:

Correlations			
		age	**texture**
age	Pearson Correlation	1	.719**
	Sig. (2-tailed)		.000
	N	50	50
****. Correlation is significant at the 0.01 level (2-tailed).**			

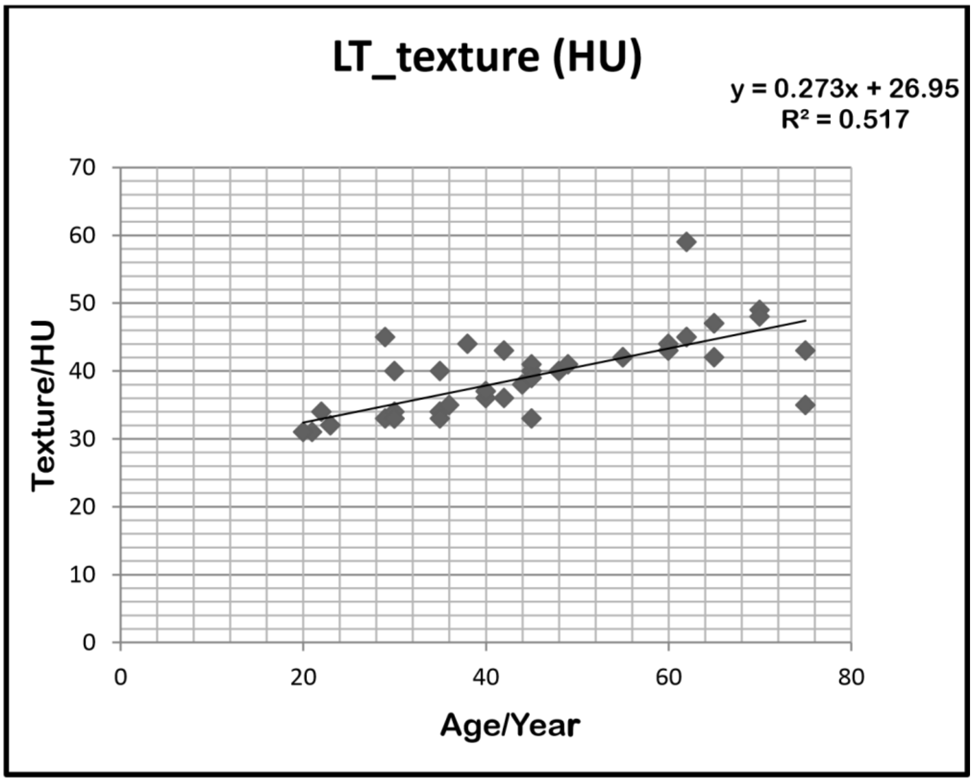

Figure 4.7: Scatter plot diagram shows a linear relation between the age and the texture of LT kidney and the correlation is significant at p value

0.01 as the age increased the renal texture is also increased by factor of 0.273 starting from 26.95

Table 4.13 Correlation between age and left kidney length:

Correlations			
		age	**length**
age	Pearson Correlation	1	-.900**
	Sig. (2-tailed)		.000
	N	50	50
****. Correlation is significant at the 0.01 level (2-tailed).**			

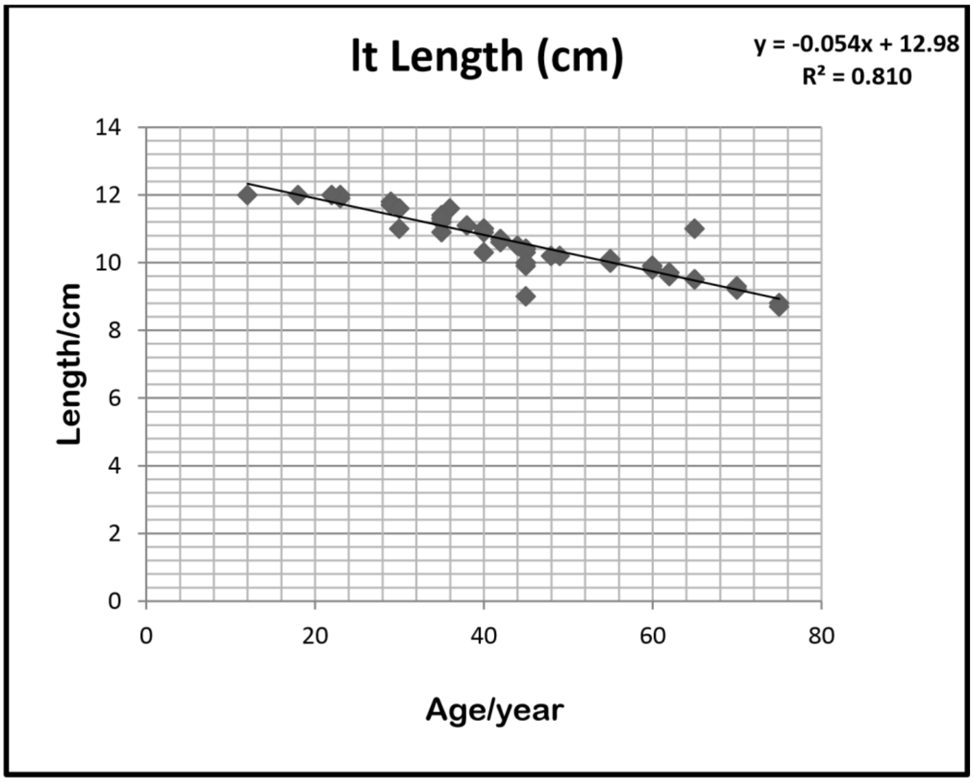

Figure 4.8: Scatter plot diagram shows a linear relation between the age and the length of RT kidney and the correlation is significant at P value 0.01, as the age increased the renal length is decreased by factor of -0.054 staring from 12.98

Table 4.14 Correlation between age and left kidney width:

Correlations			
		age	**width**
age	Pearson Correlation	1	-.884**
	Sig. (2-tailed)		.000
	N	50	50
****. Correlation is significant at the 0.01 level (2-tailed).**			

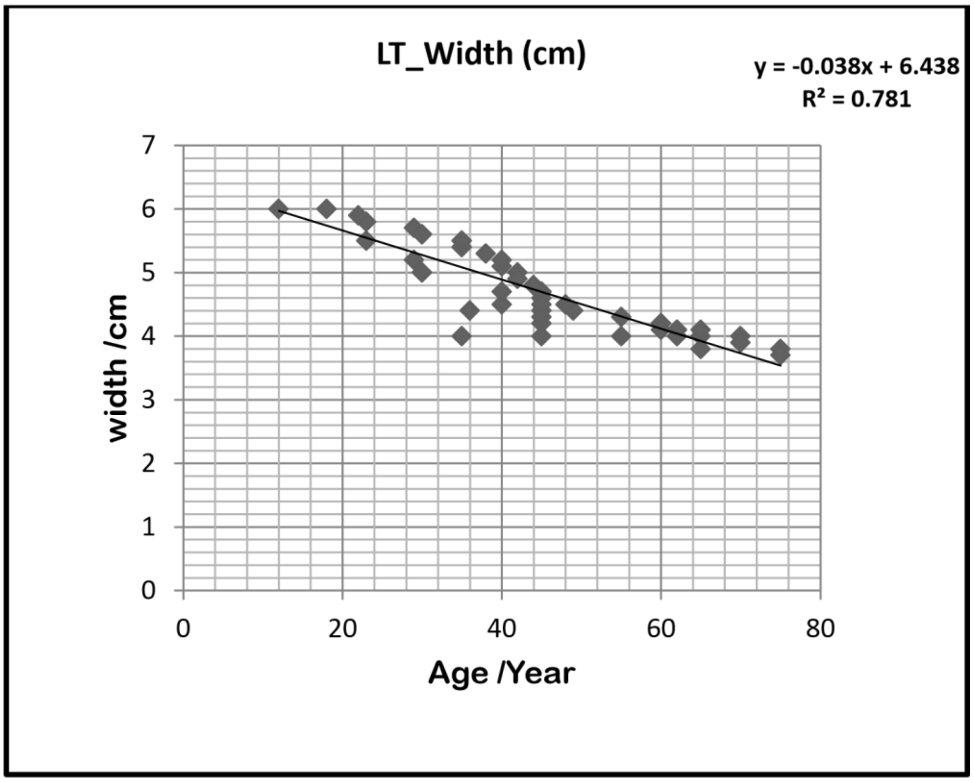

Figure 4.9: Scatter plot diagram shows a linear relation between the age and the width of LT kidney, and the relation show and the correlation is significant at p value 0.01, as the age increased the renal width is decreased by factor of -0.038 starting from 6.438

TABLE 4 .15 Descriptive Statistics Mean of BMI AND CORREATION WITH RENAL SIZE Measurements for the total sample

		Main
Weight		66.36
Height		166.90
BMI		23.84
RT KIDNEY MEAURE	**WIDTH**	14.26
	LENGTH	9.25
	SIZE	42.52
LT KIDNEY MEASURE	**WIDTH**	6.43
	LENGTH	10.04
	SIZE	48.64
	Total	**50**

Table 4.16 Correlation between BMI and RT kidney width:

		BMI	WIDTH
BMI	Pearson Correlation	1	-.032
	Sig. (2-tailed)		.827
	N	50	50
WIDTH	Pearson Correlation	-.032	1
	Sig. (2-tailed)	.827	
	N	50	50

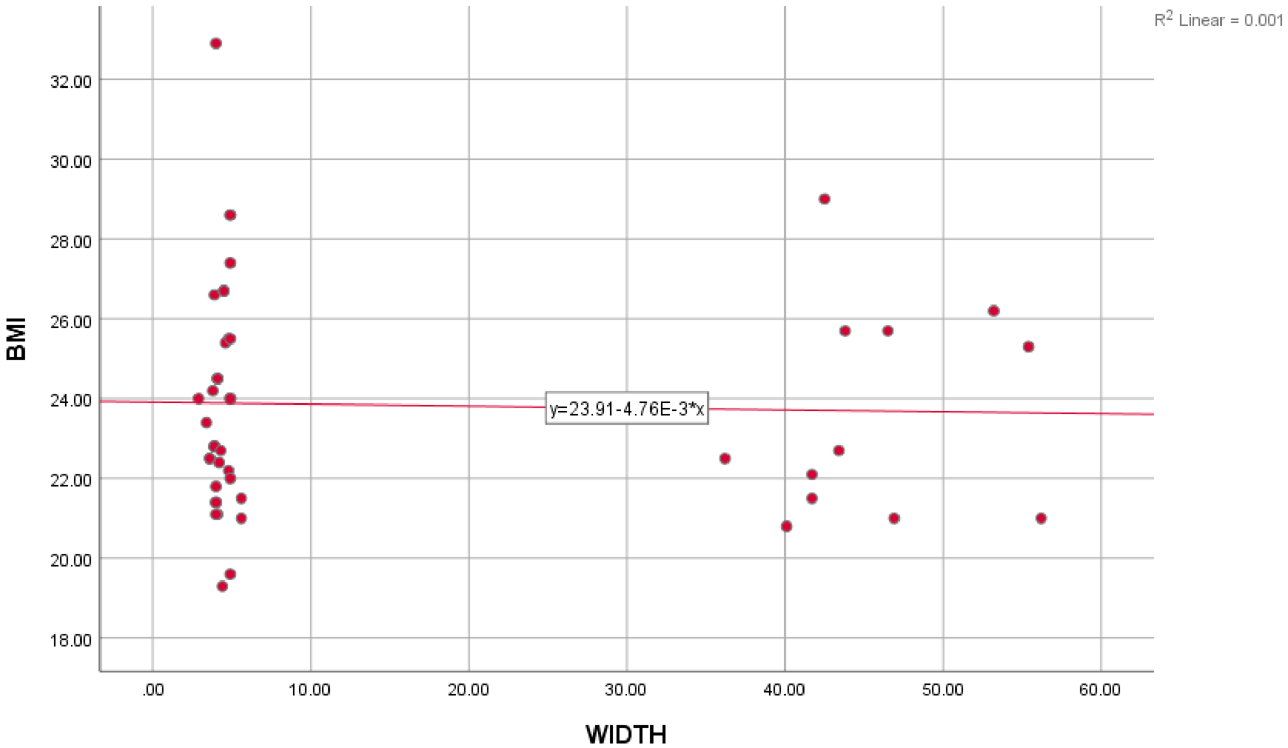

Figure 4.10: Scatter plot diagram shows a linear relation between the RT kidney width and the BMI and the correlation is significant at p value 0.032 as the width increased

R value = .827
P value = -.032

Table 4.17 Correlation between BMI and RT kidney length

Correlations

		BMI	LENGTH
BMI	Pearson Correlation	1	.082
	Sig. (2-tailed)		.571
	N	50	50
LENGTH	Pearson Correlation	.082	1
	Sig. (2-tailed)	.571	
	N	50	50

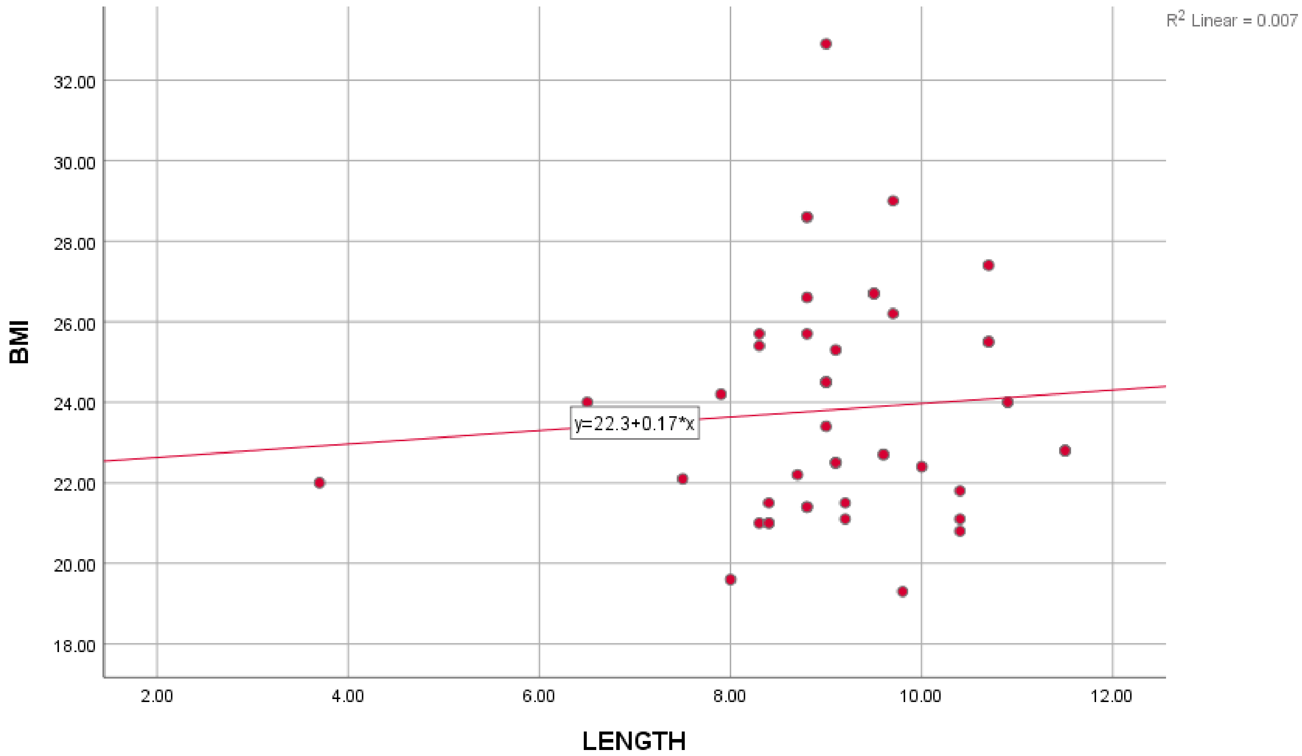

Figure 4.11: Scatter plot diagram shows a linear relation between the RT kidney length and the BMI and the correlation is significant at p value 0.032 as the width increased

Table 4.18 Correlation between BMI and RT kidney size

Correlations

		BMI	SIZE
BMI	Pearson Correlation	1	-.135
	Sig. (2-tailed)		.349
	N	50	50
SIZE	Pearson Correlation	-.135	1
	Sig. (2-tailed)	.349	
	N	50	50

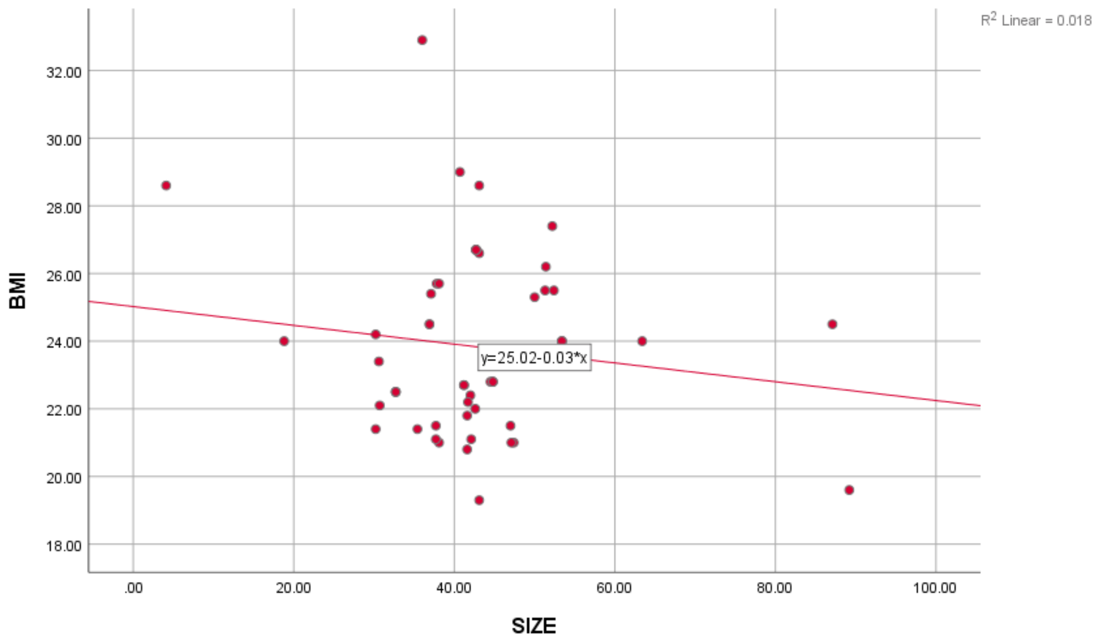

Figure 4.12: Scatter plot diagram shows a linear relation between the RT kidney size and the BMI and the correlation is significant at p value 0.032 as the width increased

Table 4.18 Correlation between BMI and LT kidney width

Correlations

		BMI	WIDTH1
BMI	Pearson Correlation	1	.067
	Sig. (2-tailed)		.644
	N	50	50
WIDTH1	Pearson Correlation	.067	1
	Sig. (2-tailed)	.644	
	N	50	50

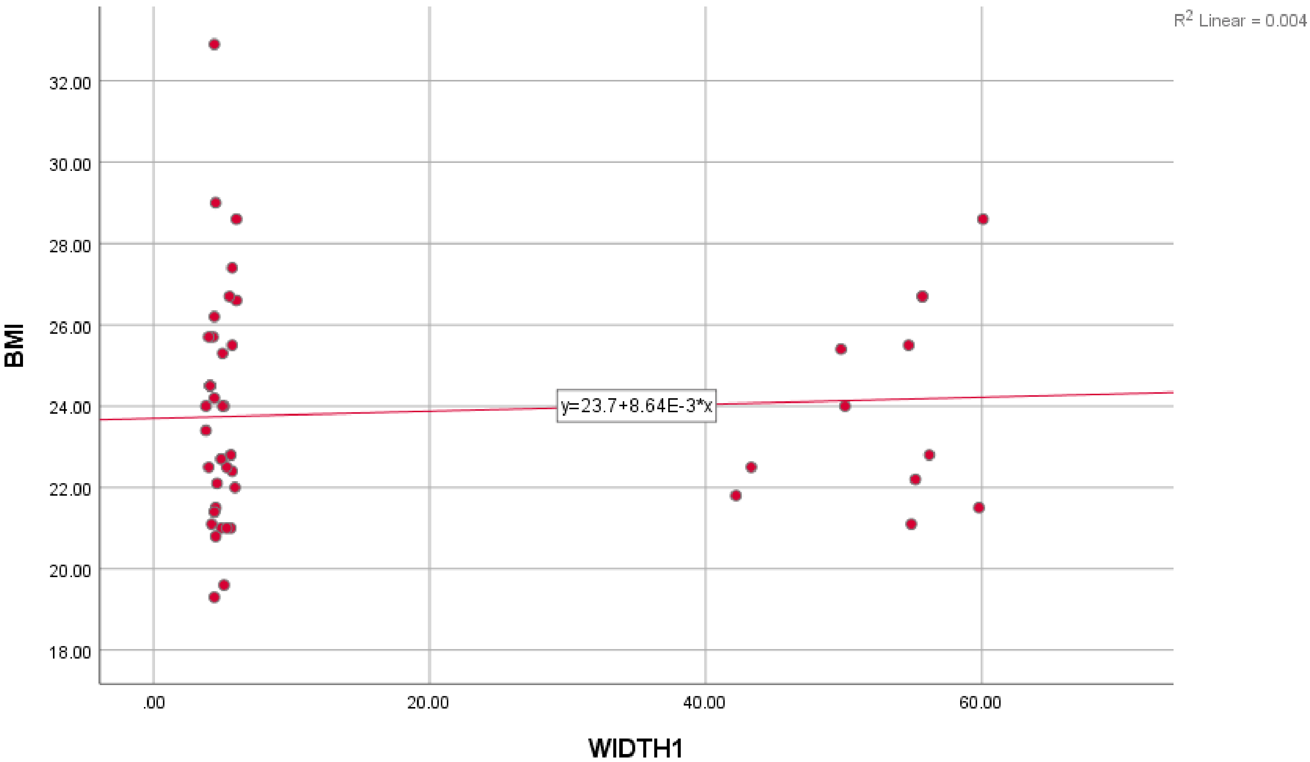

Figure 4.12: Scatter plot diagram shows a linear relation between the LT kidney width and the BMI and the correlation is significant at p value 0.032 as the width increased

Table 4.19 Correlation between BMI and LT kidney length

Correlations

		BMI	LENGTH1
BMI	Pearson Correlation	1	-.042
	Sig. (2-tailed)		.771
	N	50	50
LENGTH1	Pearson Correlation	-.042	1
	Sig. (2-tailed)	.771	
	N	50	50

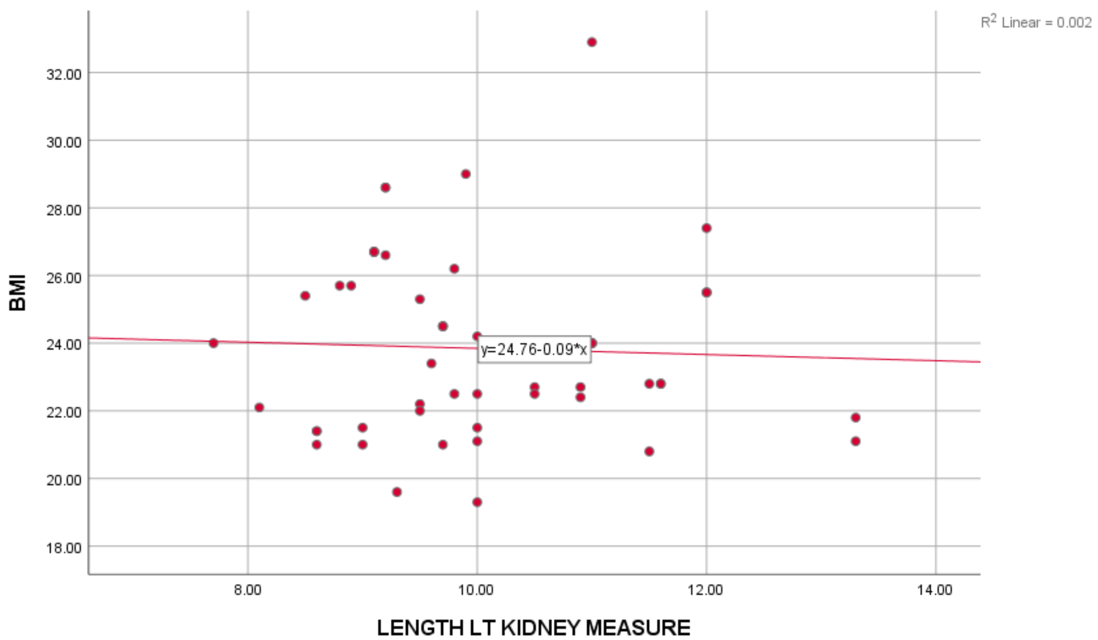

Figure 4.13: Scatter plot diagram shows a linear relation between the ltLTkidney lengh and the BMI and the correlation is significant at p value

0.032 as the width increased

Table 4.19 Correlation between BMI and RT kidney size

Correlations

		BMI	SIZE1
BMI	Pearson Correlation	1	.147
	Sig. (2-tailed)		.308
	N	50	50
SIZE 1	Pearson Correlation	.147	1
	Sig. (2-tailed)	.308	
	N	50	50

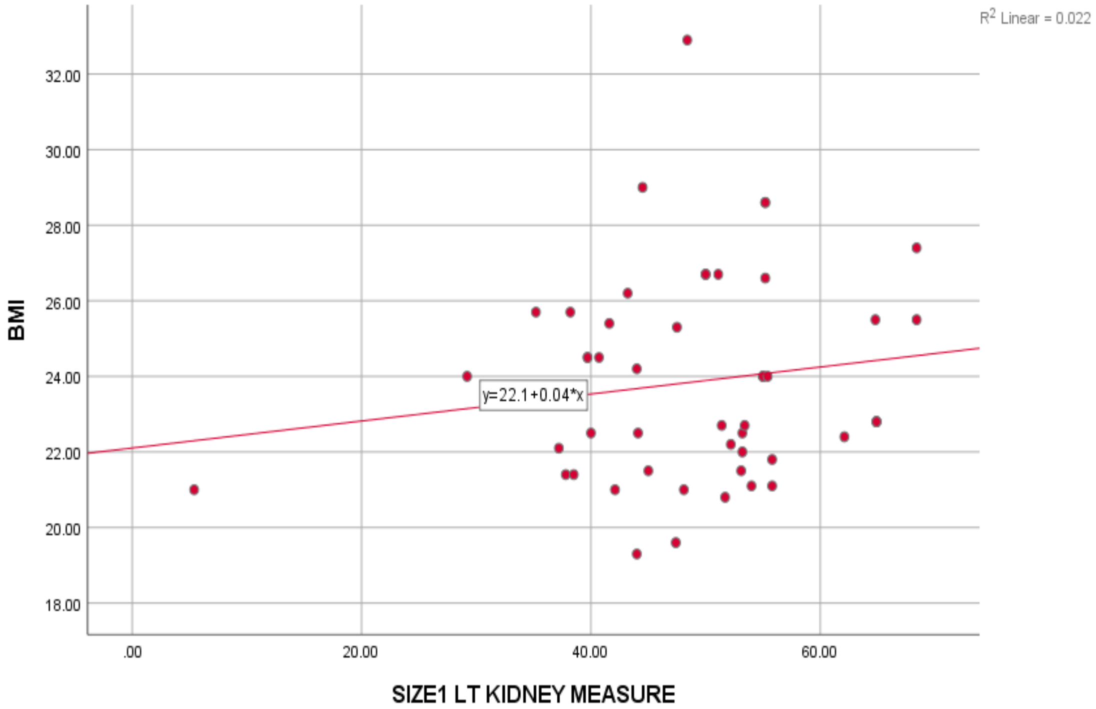

Figure 4.14: Scatter plot diagram shows a linear relation between the LT kidney size and the BMI and the correlation is significant at p value 0.032 as the width increased

Chapter five

Discussion, Conclusion and Recommendations

Chapter five

Discussion, Conclusion and Recommendations

5.1 Discussion:

The aims of this study were to measure the kidneys size and evaluated the texture for Sudanese adult using CT.

The study showed mean and STD of total samples of the right kidney length measurements were 10.44 ±0.85,width 4.55±0.64, cortical thickness 0.80 ±0.30 cm, texture39.2±, 5.53 HU. And the LT kidney length measurements were 10.57±0.91,width 4.71 ± 0.66, cortical thickness 0.76 ±0.24 cm, texture 39.2±5.65HU, in tables [4.5and 4.6].

These measurements compare to study done by (Maajiet al 2015) found mean of RT,LT Kidneys length was 11.3 ± 8.8 ,11.6 ± 9.8 cm ,which was decrease than this study by 0,86 , 1.03cm , and RT,LT Kidneys width was 4.4 ± 0.71 and 5.2 ± 5.26 cm ,the RT which was increase than this study by 0.15 cm , and the LT was decrease than this study by 0.49cm .

The study showed mean and STD of The males' kidney length 10.47 ±0.87, width4.58 ± 0.66 and the cortex thickness 0.86 ±0.30 cm, texture 39.30 ±6.04 HU. And the females' kidney length10.54± 0.89, width4.68± 0.65, the cortex thickness 0.70± 0.21and texture 39.10±5.04 in tables [4.7 and 4.8].

This study showed there was no difference between males and females measurements.

The correlation between the age and the texture of Kidneys, the study showed that there was significant correlation at (P_value 0.01) .and the texture of RT and LT kidney increased by factor of 0.266 _0.273 with age as in figure [4.4_4.7].

The correlation between the age and the length Diameter of RT, LT kidney, the study showed that there was significant correlation at

(P_value 0.01).and the length of RT, LT Kidneys decreased by factor of -0.048 _-0.054 with age as in figure [4.5_4.8].

The correlation between the age and the width Diameter of RT, LT kidneys, the study showed that there was correlation at (P_value

0.01).And the width of RT, LT Kidney decrease by factor of -0.036 _-0.038 with age as in figure [4.5_4.8].

5.2 Conclusion:

The mean and STD for measurement of the right kidney length measurements were 10.44 ±0.85,width 4.55±0.64, cortical thickness 0.80 ±0.30 cm, texture 39.2±, 5.53 HU. And the LT kidney length measurements were 10.57±0.91, width 4.71 ± 0.66, cortical thickness 0.76 ±0.24 cm, and texture 39.2±5.65HU.

The study showed that no difference between males and females subject in the kidneys measurements and kidneys texture.

The study showed that the texture of renal increased with age.

The study showed that the RT, LT Kidney measurements (length, width) decreased with age and this indicate that the size of kidneys decreased with age.

5.3 Recommendations:

For further assessment another study should be done using large sample of patient for more accurate results.

Future studies should be done with several body characteristic in correlation with kidneys measurements.

Future studies should be done with laboratory investigation in correlation with kidneys measurements.

Futures studies should be done with other modalities (MRI, PET/ CT).

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Appendices

Appendix 1

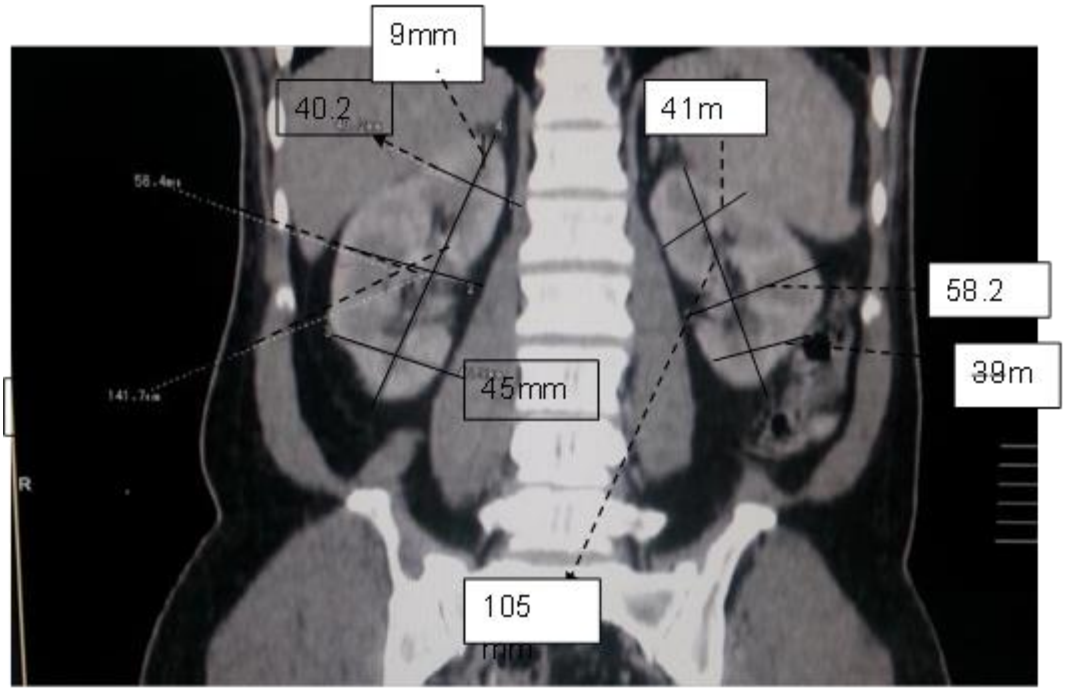

Image 1: coronal CT image for female (27years) show site measurements

of RT Kidney length, width and cortical thickness diameters.

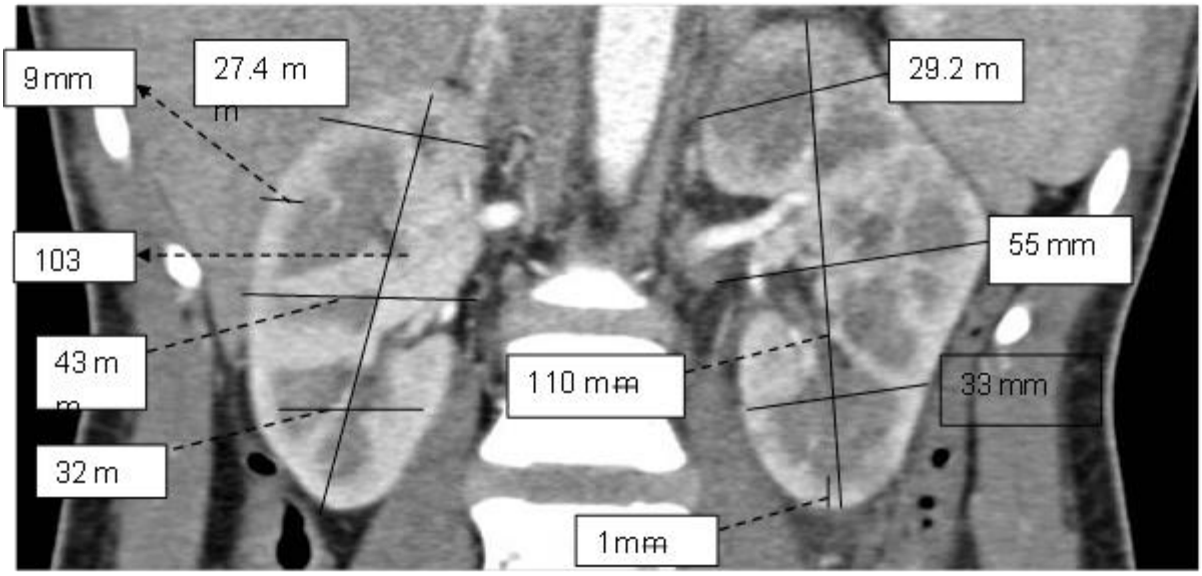

Image 2: coronal CT image for Male (33 years) show site measurements

of RT, LT Kidney length, width and cortex thickness diameter.

Appendix 2

Data collection sheet

PT Data					RT Kidney data				LT Kidney Data			
N	GENDER	ADE	WIDTH	LENGHT	LENGHT	Width cm	Cortex thickness cm	Texture HU	Length cm	Width cm	Cortex thickness cm	Texture HU