

*Sudan University of Science and Technology*

*College of Graduate Studies*

*Characterization of Renal Lesions Using CT  
Imaging*

**توصيف الآفات الكلوية باستخدام التصوير المقطعي**

A Thesis submitted for partial fulfillment for the requirements of  
Msc degree in Diagnostic Radiological Technology

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# الآية

قَالَ تَعَالَى:

أَعُوذُ بِاللَّهِ مِنَ الشَّيْطَانِ الرَّجِيمِ

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ ① الْحَمْدُ لِلَّهِ رَبِّ الْعَالَمِينَ ②  
الرَّحْمَنِ الرَّحِيمِ ③ مَلِكِ يَوْمِ الدِّينِ ④ إِيَّاكَ نَعْبُدُ وَإِيَّاكَ  
نَسْتَعِينُ ⑤ اهْدِنَا الصِّرَاطَ الْمُسْتَقِيمَ ⑥ صِرَاطَ الَّذِينَ أَنْعَمْتَ  
عَلَيْهِمْ غَيْرِ الْمَغْضُوبِ عَلَيْهِمْ وَلَا الضَّالِّينَ ⑦ ﴿

الفاتحة: (١ - ٧)

## ***Dedication***

To

My Parents , Brothers , sisters and wife .

My teachers , colleagues and students .

&

For all those who search for the knowledge .

With my love ...

## ***Acknowledgments***

*Grateful acknowledgment is made to my teacher , supervisor , Dr. Mohamed Mohamed Omar Yousef , who farsighted and generous help has assisted greatly in the develobment of this project .*

*I want to thank my teacher Dr. Ahmed ALmoustafa Abukona for his help and advice .*

*A much appreciation and gratitude giving to any one put ahand and helped in making of this humble effort .*

## **Abstract**

The study an evaluated study, aimed to characterize Renal Lesions using CT.

The study was done in may 2016 at Alribat Hospital , Alamal Hospitel and Abdoon Sidahmed medical center .

Date was collected from patients referred to the CT scan department . They were (50) patients from different ages , male and female having different renal lesions .

The population divided in to four age groups below 20 , between 20 -40 year , 40-60 year and more than 60 year .

The researcher found that :-

1- The most effected group between 20 - 40 year forming about 40% .

2- The renal lesions most common in male 28 = 56% than female 22 = 44% .

3- most common lesions to be found cyst , stones , tumours 58% , 30% 12% respectively .

4- most effected side cortex , both upper and lower poll , medulla 45% , 40% 15% respectively .

## الخلاصة

هذه الدراسة دراسة وصفية تهدف الي تقييم دور الاشعة المقطعية وصف تمييز تصنيف امراض اورام الكلى هذه الدرلسة اجریت في الفترة من يناير الي ابريل 2016 ملادية وتمت هذه الدراسة في المستشفيات التالية:

تم اختيار العينات بواسطة استبيان حيث صنفتم الي اربع مجموعات حسب الاعداد  
مجموعة اقل من 20 سنة, مجموعة من 20 الي 40 سنة, مجموعة من 40 الي 60 سنة  
ومجموعة اكثر من 60 سنة و تتضمن هذه العينات الجنسين الذكور والاناث  
وجدت الدراسة انه تم تشخيص جميع الحالات باستخدام الاشعة المقطعية اكثر فئة  
عمرية متأثرة هي من 20 الي 40 سنة 58% منهم ذكر بعدد 17 حالة, 42% اناث  
بعدد 12 حالة واكثر الاورام شيوعا التي اكتشفت هي التكيسات في الكلى

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# CHAPTER ONE

## 1.1 Introduction

The increasing indication for abdominal CT, MRI, and US has led to increased incidental detection of small solid renal masses.

With this increase in the number of smaller tumors discovered, there has been concomitant increase in the rate of benign and malignant lesions encountered. When a solid renal mass is encountered, the first step is to exclude angiomyolipoma by identifying region of fat within the mass with unenhanced CT [1, 2].

If no fat is detected on CT scans, numerous causes are possible, but the main one is the presence of a malignant lesion, such as renal cell carcinoma (RCC) (clear cell, papillary, and chromophobe subtypes), metastasis, or lymphoma, or of a benign lesion, such as oncocytoma, angiomyolipoma with minimal fat, granuloma, or an inflammatory lesion.

Contrary to past trends whereby all enhancing solid renal masses were treated as RCC and proof of malignancy was obtained after nephrectomy [3], biopsy of renal tumors is now largely used in the evaluation of small renal tumors and has been found safe, accurate, and cost-effective [4\_5]. Biopsy also is recommended as an aid in differentiating benign from malignant tumors [6].

A major reason for deciding on renal tumor biopsy is that imaging alone is often insufficient for differentiating the benign versus malignant nature of solid renal tumors without fat [4].

However, studies have shown that some imaging features and the degree of enhancement on CT imaging are helpful in differentiating renal cortical

tumor subtype, despite overlap [7], and that some CT finding can be used to characterize benign tumors.

Segmental enhancement inversion in the corticomedullary and excretory phases has been found to be a characteristic enhancement pattern of oncocytoma [8], and homogeneous and prolong enhancement or a sufficient percentage of voxels and pixels with negative attenuation at histogram analysis has been found useful for characterizing angiomyolipoma without visible fat at CT.

## **1.2 Research problem.**

There are increasing in the rate effecting of the renal lesion wide spread the world, especially in Sudan.

And most of this cause is hereditary and with availability and develop of CT we can diagnosis early and have proper treatment.

The Computer Tomography has ability to make diagnosis more simply and easy, and can be the first procedure in renal disease.

There are interface in renal diseases in the textures and shapes, whether it's malignant or benign, as routinely to differentiate between them done biopsy which is invasive way, therefore this study aim to find radiology or CT features which can reduce invasive biopsy procedure.

### **1.3 Objectives**

#### **1.3.1 General objective.**

To characterize the renal lesion using CT

#### **1.3.2 specific objective.**

- 1-To calcify the renal diseases (cystic and solid)
- 2-To measure size, site and CT number for each case
- 3-To correlate CT finding with pt age, gender, clinical finding and clinical history.

## **CHAPTER TWO**

### **2-1Anatomy of the Kidneys**

#### **2-1-Location**

The kidneys are a pair of organs found along the posterior muscular wall of the abdominal cavity. The left kidney is located slightly more superior than the right kidney due to the larger size of the liver on the right side of the body. Unlike the other abdominal organs, the kidneys lie behind the peritoneum that lines the abdominal cavity and are thus considered to be retroperitoneal organs. The ribs and muscles of the back protect the kidneys from external damage. Adipose tissue known as perirenal fat surrounds the kidneys and acts as protective padding.

#### **2-1-2Structure**

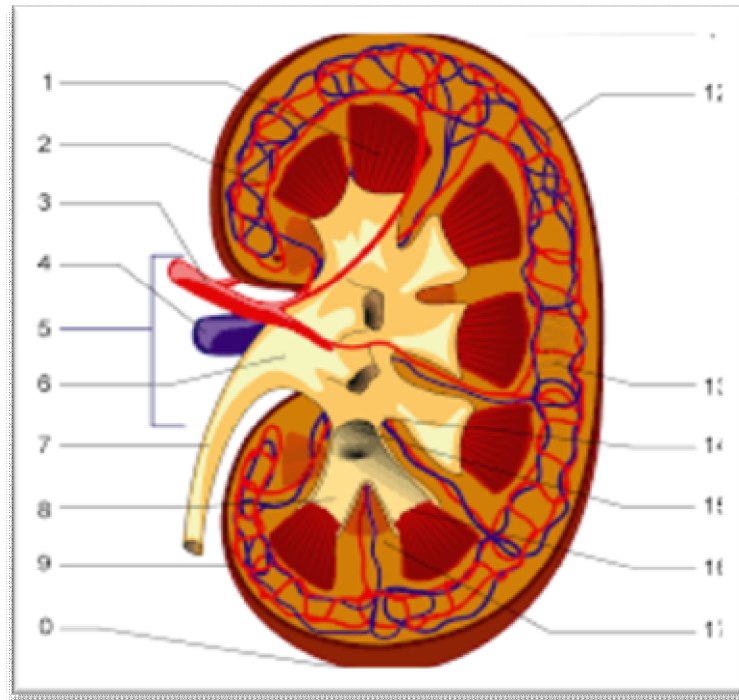
The kidneys are bean-shaped with the convex side of each organ located laterally and the concave side medial. The indentation on the concave side of the kidney, known as the renal hilus, provides a space for the renal artery, renal vein, and ureter to enter the kidney.

A thin layer of fibrous connective tissue forms the renal capsule surrounding each kidney. The renal capsule provides a stiff outer shell to maintain the shape of the soft inner tissues.

Deep to the renal capsule is the soft, dense, vascular renal cortex. Seven cone-shaped renal pyramids form the renal medulla deep to the renal cortex. The renal pyramids are aligned with their bases facing outward toward the renal cortex and their apexes point inward toward the center of the kidney.

Each apex connects to a minor calyx, a small hollow tube that collects urine. The minor calyces merge to form 3 larger major calyces, which further merge to form the hollow renal pelvis at the center of the kidney.

The renal pelvis exits the kidney at the renal hilum, where urine drains into the ureter.



**Figure 2.1 : shows cross section renal anatomy**

- |                        |                            |
|------------------------|----------------------------|
| 1. Renal pyramid       | 10. Inferior               |
| 2. Interlobular artery | 11. Superior renal capsule |
| 3. Renal artery        | 12. Interlobular vein      |
| 4. Renal vein          | 13. Nephron                |
| 5. Renal hilum         | 14. Minor calyx            |
| 6. Renal pelvis        | 15. Major calyx            |
| 7. Ureter              | 16. Renal papilla          |
| 8. Minor calyx         | 17. Renal column           |
| 9. Renal capsule       |                            |



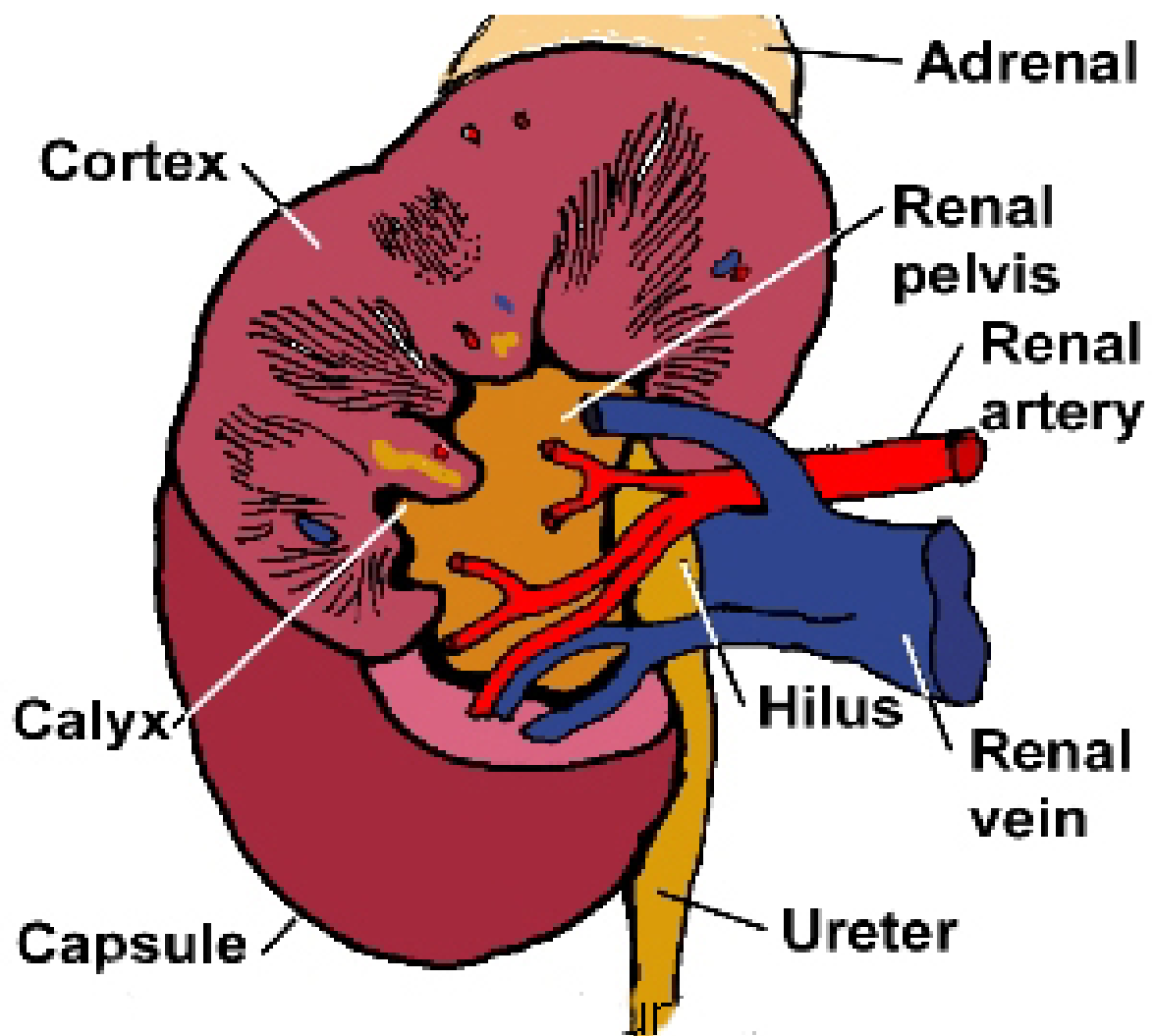


Figure 2.2 show renal site and cross section anatomy

### 2-1-3 Blood Supply

1. The renal arteries branch directly from the abdominal *aorta* and enter the kidneys through the renal hilus.
2. Inside our kidneys, *the renal arteries* diverge into the smaller afferent arterioles of the kidneys.
3. Each afferent arteriole carries blood into the renal cortex, where it separates into a bundle of capillaries known as a glomerulus.
4. From the glomerulus, the blood recollects into smaller efferent arterioles that descend into the renal medulla.
5. The efferent arterioles separate into the peritubular capillaries that surround the renal tubules.
6. Next, the peritubular capillaries merge to form veins that merge again to form the large *renal vein*.
7. Finally, the renal vein exits the kidney and joins with the *inferior vena cava*, which carries blood back to the heart.

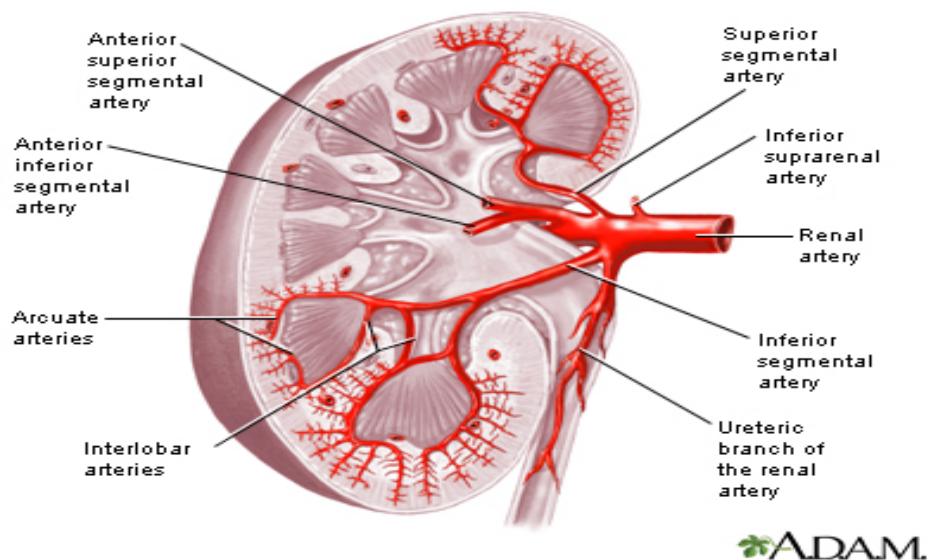


Figure 2.3 show the vascularity of the kidney

## **2-1-4TheNephron**

Each kidney contains around 1 million individual nephrons, the kidneys' microscopic functional units that filter blood to produce urine. The nephron is made of 2 main parts: the renal corpuscle and the renal tubule.

Responsible for filtering the blood, our renal corpuscle is formed by the capillaries of the glomerulus and the glomerular capsule (also known as Bowman's capsule). The glomerulus is a bundled network of capillaries that increases the surface area of blood in contact the blood vessel walls. Surrounding the glomerulus is the glomerular capsule, a cup-shaped double layer of simple squamous epithelium with a hollow space between the layers. Special epithelial cells known as podocytes form the layer of the glomerular capsule surrounding the capillaries of the glomerulus. Podocytes work with the endothelium of the capillaries to form a thin filter to separate urine from blood passing through the glomerulus. The outer layer of the glomerular capsule holds the urine separated from the blood within the capsule. At the far end of the glomerular capsule, opposite the glomerulus, is the mouth of the renal tubule.

A series of tubes called the renal tubule concentrate urine and recover non-waste solutes from the urine. The renal tubule carries urine from the glomerular capsule to the renal pelvis.

1. The curvy first section of the renal tubule is known as the proximal convoluted tubule. The tubule cells that line the proximal convoluted tubule reabsorb much of the water and nutrients initially filtered into the urine.
2. Urine next passes through the loop of Henle, a long straight tubule that carries urine into the renal medulla before making a hairpin turn and returning to the renal cortex.
3. Following the loop of Henle is the distal convoluted tubule.

4. Finally, urine from the distal convoluted tubules of several nephrons enters the collecting duct, which carries the concentrated urine through the renal medulla and into the renal pelvis.

5. From the renal pelvis urine from many collecting ducts combines and flows out of the kidneys and into the ureters.

### **2-2-1 Physiology of the Kidneys**

#### **Excretion of Wastes**

The primary function of the kidneys is the excretion of waste products resulting from protein metabolism and muscle contraction. The liver metabolizes dietary proteins to produce energy and produces toxic ammonia as a waste product. The liver is able to convert most of this ammonia into uric acid and urea, which are less toxic to the body. Meanwhile, the muscles of our body use creatine as an energy source and, in the process, produce the waste product creatinine. Ammonia, uric acid, urea, and creatinine all accumulate in the body over time and need to be removed from circulation to maintain homeostasis.

The glomerulus in the kidneys filter all four of these waste products out of the bloodstream, allowing us to excrete them out of our bodies in urine. Around 50% of the urea found in the blood is reabsorbed by the tubule cells of the nephron and returned to the blood supply. Urea in the blood helps to concentrate other more toxic waste products in urine by maintaining the osmotic balance between urine and blood in the renal medulla.

### **2-2-2Filtration, Reabsorption, and Secretion**

1. The kidneys filter blood as it passes through the capillaries that form the glomerulus. Blood pressure forces most of the blood plasma through the lining of the capillaries and into the glomerular capsule. Blood cells are too large to pass through the capillary lining and so remain within the capillaries along with some residual plasma. The filtered plasma, now known as tubular fluid, begins to flow out of the glomerular capsule and into the proximal convoluted tubule.

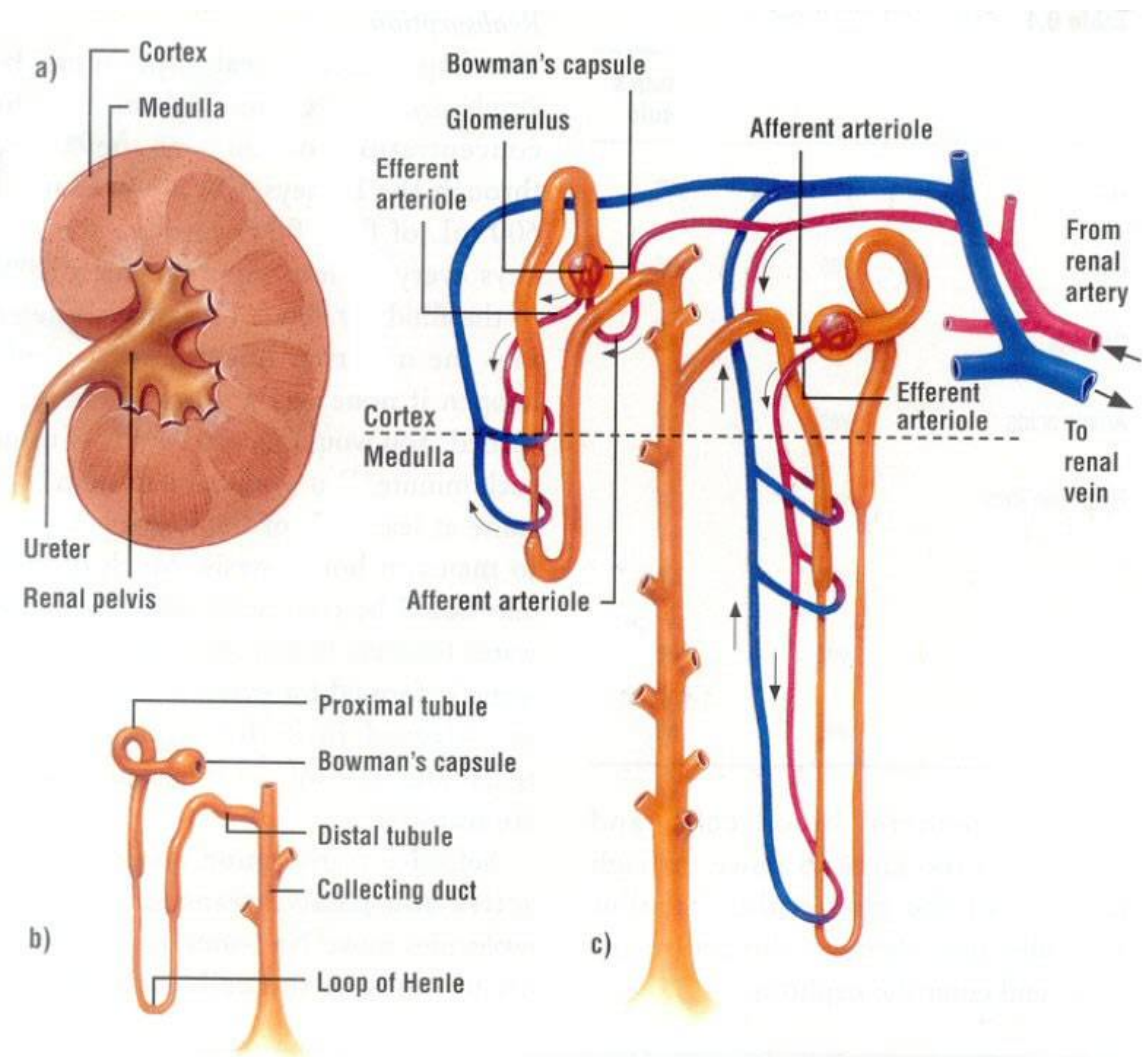
2. At the same time, the concentrated blood that remains inside the capillaries of the glomerulus moves into the efferent arterioles and on to the peritubular capillaries surrounding the proximal convoluted tubule. Epithelial cells lining the tubule actively reabsorb valuable molecules of glucose, amino acids, and ions from the filtrate and deposit them back into the blood. These cells also absorb any waste products remaining in the blood (such as ammonia and creatinine) and secrete these chemicals into the filtrate. While these solutes are being exchanged, osmotic pressure pushes water from the dilute, hypotonic filtrate back into the concentrated, hypertonic blood.

3. From the proximal convoluted tubule, the tubular fluid next enters the loop of Henle, where water and ions are reabsorbed. The descending limb of the loop of Henle is permeable to water and carries the filtrate deep into the medulla of the kidney. Tissues in the medulla surrounding the tubule contain a high concentration of ions and very little water compared to the filtrate. Osmotic pressure between the hypotonic filtrate and hypertonic medullary cells pushes water out of the filtrate and into the cells. The cells of the medulla return this water to the blood flowing through nearby capillaries.

4. Filtrate next passes through the ascending limb of the loop of Henle as it exits the medulla. The tissues surrounding the ascending limb are not permeable to water but are permeable to ions. The filtrate is very concentrated after passing through the descending limb, so ions easily diffuse out of the filtrate and into the cells lining the ascending limb. These ions are returned to the blood flowing through nearby capillaries.

5. Tubular fluid exiting the loop of Henle next passes through the distal convoluted tubule and the collecting duct of the nephron. These tubules continue to reabsorb small amounts of water and ions that are still left in the filtrate. The tissues surrounding the collecting duct actively absorb excess potassium and hydrogen ions from the nearby capillaries and secrete these excess ions as waste into the filtrate.

6. When filtrate reaches the end of the collecting duct, almost all of the valuable nutrients, ions, and water have been returned to the blood supply while waste products and a small amount of water are left to form urine. The urine exits the collecting duct and joins with urine from other collecting ducts in the renal pelvis.



**Figure 2.4 show the physiology of kidney**

### **2-2-3 Water Homeostasis**

The kidneys are able to control the volume of water in the body by changing the reabsorption of water by the tubules of the nephron. Under normal conditions, the tubule cells of the nephron tubules reabsorb (via osmosis) nearly all of the water that is filtered into urine by the glomerulus. Water reabsorption leads to very concentrated urine and the conservation of water in the body. The hormones antidiuretic hormone (ADH) and aldosterone both increase the reabsorption of water until almost 100% of the water filtered by the nephron is returned to the blood. ADH stimulates the formation of water channel proteins in the collecting ducts of the nephrons that permit water to pass from urine into the tubule cells and on to the blood. Aldosterone functions by increasing the reabsorption of  $\text{Na}^+$  and  $\text{Cl}^-$  ions, causing more water to move into the blood via osmosis.

In situations where there is too much water present in the blood, our heart secretes the hormone atrial natriuretic peptide (ANP) in order to increase the excretion of  $\text{Na}^+$  and  $\text{Cl}^-$  ions. Increased concentration of  $\text{Na}^+$  and  $\text{Cl}^-$  in urine draws water into the urine via osmosis, increasing the volume of urine produced.

### **2-2-4 Acid/Base Homeostasis**

The kidneys regulate the pH level of the blood by controlling the excretion of hydrogen ions ( $\text{H}^+$ ) and bicarbonate ions ( $\text{HCO}_3^-$ ). Hydrogen ions accumulate when proteins are metabolized in the liver and when carbon dioxide in the blood reacts with water to form carbonic acid ( $\text{H}_2\text{CO}_3$ ). Carbonic acid is a weak acid that partially dissociates in water to form hydrogen ions and bicarbonate ions. Both ions are filtered out of the blood in the glomerulus of the kidney, but the tubule cells lining the nephron selectively reabsorb bicarbonate ions while leaving hydrogen ions as a



waste product in urine. The tubule cells may also actively secrete additional hydrogen ions into the urine when the blood becomes extremely acidic.

The reabsorbed bicarbonate ions enter the bloodstream where they can neutralize hydrogen ions by forming new molecules of carbonic acid. Carbonic acid passing through the capillaries of the lungs dissociates into carbon dioxide and water, allowing us to exhale the carbon dioxide.

### **2-2-5 Electrolyte Homeostasis**

The kidneys maintain the homeostasis of important electrolytes by controlling their excretion into urine.

- Sodium ( $\text{Na}^+$ ): Sodium is a vital electrolyte for muscle function, neuron function, blood pressure regulation, and blood volume regulation. Over 99% of the sodium ions passing through the kidneys are reabsorbed into the blood from tubular filtrate. Most of the reabsorption of sodium takes place in the proximal convoluted tubule and ascending loop of Henle.
- Potassium ( $\text{K}^+$ ): Just like sodium, potassium is a vital electrolyte for muscle function, neuron function, and blood volume regulation. Unlike sodium, however, only about 60 to 80% of the potassium ions passing through the kidneys are reabsorbed. Most of the reabsorption of potassium occurs in the proximal convoluted tubule and ascending loop of Henle.
- Chloride ( $\text{Cl}^-$ ): Chloride is the most important anion (negatively charged ion) in the body. Chloride is vital to the regulation of factors such as pH and cellular fluid balance and helps to establish the electrical potential of neurons and muscle cells. The proximal convoluted tubule and ascending loop of Henle reabsorb about 90% of the chloride ions filtered by the kidneys.
- Calcium ( $\text{Ca}^{2+}$ ): Calcium is not only one of the most important minerals in the body that composes the bones and teeth, but is also a vital

electrolyte. Functioning as an electrolyte, calcium is essential for the contraction of muscle tissue, the release of neurotransmitters by neurons, and the stimulation of cardiac muscle tissue in the heart. The proximal convoluted tubule and the ascending loop of Henle reabsorb most of the calcium in tubular filtrate into the blood. Parathyroid hormone increases the reabsorption of calcium in the kidneys when blood calcium levels become too low.

- Magnesium ( $Mg^{2+}$ ): Magnesium ion is an essential electrolyte for the proper function of enzymes that work with phosphate compounds like ATP, DNA, and RNA. The proximal convoluted tubule and loop of Henle reabsorb most of the magnesium that passes through the kidney.

#### **2-2-6 Blood Pressure Homeostasis**

The kidneys help to control blood pressure in the body by regulating the excretion of sodium ions and water and by producing the enzyme renin. Because blood is mostly made of water, an increased volume of water in the body results in an increase in the volume of blood in the blood vessels. Increased blood volume means that the heart has to pump harder than usual to push blood into vessels that are crowded with excess blood. Thus, increased blood volume leads to increased blood pressure. On the other hand, when the body is dehydrated, the volume of blood and blood pressure decrease.

The kidneys are able to control blood pressure by either reabsorbing water to maintain blood pressure or by allowing more water than usual to be excreted into urine and thus reduce blood volume and pressure. Sodium ions in the body help to manage the body's osmotic pressure by drawing water towards areas of high sodium concentration. To lower blood pressure, the kidneys can excrete extra sodium ions that draw water out of

the body with them. Conversely, the kidneys may reabsorb additional sodium ions to help retain water in the body.

Finally, the kidneys produce the enzyme renin to prevent the body's blood pressure from becoming too low. The kidneys rely on a certain amount of blood pressure to force blood plasma through the capillaries in the glomerulus. If blood pressure becomes too low, cells of the kidneys release renin into the blood. Renin starts a complex process that results in the release of the hormone aldosterone by the adrenal glands. Aldosterone stimulates the cells of the kidney to increase their reabsorption of sodium and water to maintain blood volume and pressure.

### **2-2-7Hormones**

The kidneys maintain a small but important endocrine function by producing the hormones calcitriol and erythropoietin.

- Calcitriol is the active form of vitamin D in the body. Tubule cells of the proximal convoluted tubule produce calcitriol from inactive vitamin D molecules. At that point, calcitriol travels from the kidneys through the bloodstream to the intestines, where it increases the absorption of calcium from food in the intestinal lumen.
- Erythropoietin (EPO) is a hormone produced by cells of the peritubular capillaries in response to hypoxia (a low level of oxygen in the blood). EPO stimulates the cells of red bone marrow to increase their output of red blood cells. Oxygen levels in the blood increase as more red blood cells mature and enter the bloodstream. Once oxygen levels return to normal, the cells of the peritubular capillaries stop producing EPO.

Several hormones produced elsewhere in the body help to control the function of the kidneys.

- Antidiuretic hormone (ADH), also known as vasopressin, is a hormone produced by neurosecretory cells in the brain's hypothalamus. These cells extend into the posterior pituitary, which stores and releases ADH. ADH production is stimulated by a decrease in blood volume and increased blood osmolarity. ADH helps the body retain water by increasing the number of water channels in the cells of the collecting ducts of the kidneys. These water channels allow water remaining in urine to be reabsorbed into the blood, resulting in extremely concentrated urine.
- Angiotensin II is a hormone made in the liver and activated by the enzymes renin and angiotensin-converting enzyme. Once activated, angiotensin II increases the reabsorption of sodium and chloride ions in the proximal convoluted tubule, leading to an increased reabsorption of water as well.
- Aldosterone is a hormone produced in the adrenal cortex in response to Angiotensin II. Aldosterone binds to target cells in the walls of the nephron's collecting ducts. These cells reabsorb additional sodium and chloride ions that would have been excreted as urine. The target cells also remove potassium ions from the blood and excrete it into urine.
- Atrial natriuretic peptide (ANP) is a hormone produced by cardiac muscle cells in the atria of the heart. These cells produce ANP in response to high levels of sodium in the blood or increased blood pressure. In the kidneys, ANP increases the glomerular filtration rate so that more blood plasma is forced into the glomerular capsule and into the renal tubules. ANP also removes some solutes from the cells of the renal medulla, making the loop of Henle less efficient in reabsorbing water and ions from the filtrate. The net result of ANP is that more sodium and water end up being excreted into urine, blood volume decreases, and blood pressure decreases as well.

## **2-3 Pathology**

### **2-3-1 Congenital**

1-Congenital hydronephrosis

2-Congenital obstruction of urinary tract

3-Duplex kidneys , or double kidneys , occur in approximately 1% of population. This occurrence normally causes no complication , but can occasionally cause urine infections.

4-Duplicated ureter occurs in approximately one in 400 live births.

5-Nutcracker syndrome.

6-Polycystic kidney disease:

I.Autosomal dominant polycystic kidney disease afflicts patients later in life. Approximately one in 1000 people will develop this condition

II.Autosomal recessive polycystic kidney disease is far less common, but more severe, than the dominant condition. It is apparent in utero or at birth.

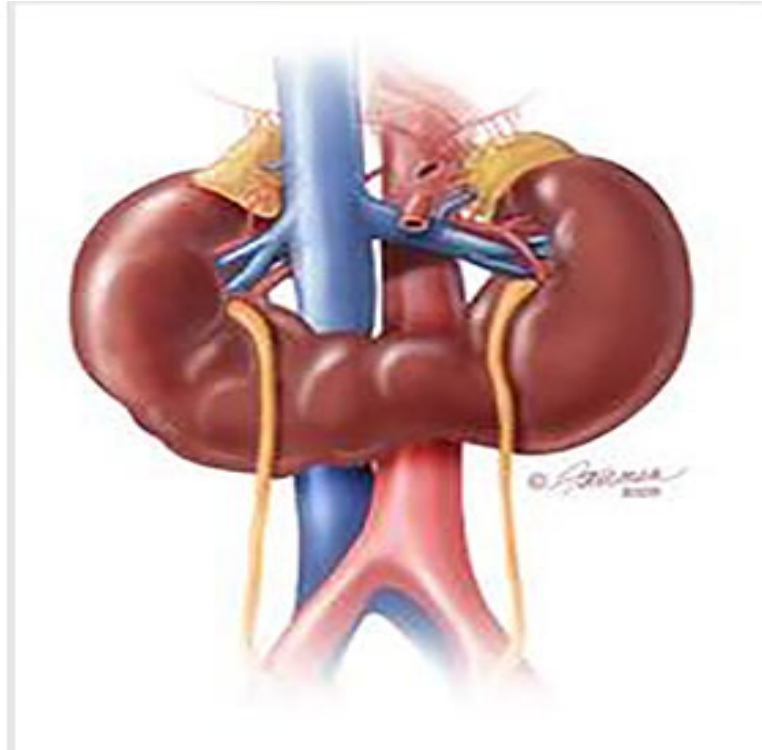
7-Renal agenesis. Failure of one kidney to form occurs in approximately one in 750 live births. Failure of both kidneys to form is invariably fatal.

8-Renal dysplasia

9-Unilateral small kidney

10-Multicystic dysplastic kidney occurs in approximately one in every 2400 live births.

11-Ureteropelvic Junction Obstruction or UPJO ; although most cases appear congenital, some appear to be an acquired condition



**Figure 2.5 :shows horseshoe kidney**



**Figure 2.6 shows multicystic kidney**

### **2-3-2Acquired**

1-Diabetic nephropathy.

2-Glomerulonephritis .

3-Hydronephrosis is the enlargement of one or both of the kidneys caused by obstruction of the flow of urine.

4-Interstitial nephritis

5-Kidney stones (nephrolithiasis) are a relatively common and particularly painful disorder.

6-Kidney tumor :

I. Wilms tumor.

II. Renal cell carcinoma.

7-Lupus nephritis.

8-Minimal change disease.

9-In nephritic syndrome, the glomerulus has been damaged so that a large amount of protein in the blood enters the urine. Other frequent features of the nephritic syndrome include swelling, low serum albumin, and high cholesterol.

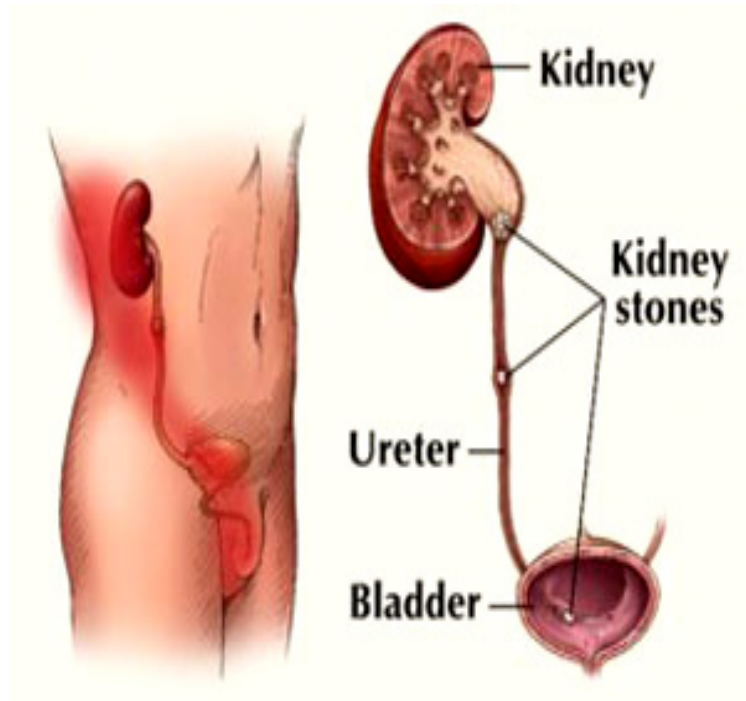
10-Pyelonephritis is infection of the kidneys and is frequently caused by complication of a urinary tract infection

11-Renal failure:

I. Acute renal failure.

II. Stage.

II. Chronic kidney disease.



**Figure 2.7: shows kidney stones**

### **2-3-3 Kidney failure**

Generally , humans can live normally with just one kidney, as one has more functioning renal tissue than is needed to survive. Only when the amount of functioning kidney tissue is greatly diminished does one develop chronic kidney disease. Renal replacement therapy, in the form of dialysis or kidney transplantation, is indicated when the glomerular filtration rate has fallen very low or if the renal dysfunction leads to severe symptoms.



### **Previous study**

According to European society of Radiology 2011

Recent studies shows that the most common lesion detect are ‘‘  
Cyst’’

In up to 27% of the patients over 50 years.

CT masses are classified as solid or complex cystic. 85% of expansive solid masses are malignant therefore , a solid, enhancing mass must be considered malignant unless proven otherwise.

Renal cell carcinoma (RCC) is the most common malignant tumor with a rising incidence of about 3% per year since 1975.

The most common type of RCC is the clear cell RCC with 65% of renal cortical tumors.

Further subtypes are papillary (basophilic and eosinophilic)

Clear –cell RCC causes 90% of metastases of all renal malignancies.

Other malignant masses include transitional cell carcinoma (TCC), lymphoma, metastases from carcinoma and primary /secondary sarcoma.

Primary tumors of the lung , breast and gastrointestinal tract are the most common sources of renal Metastases.

## **CHAPTER THREE**

### **3-1 Type of study**

This study is an evaluative study which evaluates and characterizes the renal lesion using CT imaging.

### **3-2 Area of study**

This study took place at Khartoum city.

### **3-3 Duration**

The study started from 20<sup>th</sup> December to 20<sup>th</sup> April 2015-2016.

### **3-4 Variable of study**

The variables that collected from each subject include : gender, age, pathological finding from CT KUB.

### **3-5 Population of study**

This study includes 50 subjects (male and female).

### **3-6 sampling and sample size**

The 50 patients were divided into 4 groups according to the age factor, from 0-20, 20-40, 40-60 and more than 60.

### **3-7 Data collection**

Data collection using data collecting sheet.

#### **3-7-1 inclusion criteria**

All patients with any lesion in the kidney.

### **3-8 Machine used**

The CT images were conducted using Multi-detector CT scanner.

The scan parameters (thin section 5mm or less, 120 KV, 200MA 1.5 pitch)

Features of CT scanner:

Largest couch capacity is 180 kg CT machine in Abdou Seidahamed Medical Center, Alribat Teaching Hospital and Alamel Hospital.

### **3-9 CT renal technique**

The patient lays supine on the CT scanner couch, arm elevated, scout view is obtained usually in AP projection.

Pre contrast images of kidney are obtained to demonstrate calcifications and density of renal masses followed by dynamic IV contrast enhanced images with thin section through the kidneys, extending through the abdomen .

Frequently the pelvis is also imaged to see the entire urinary tract and look for adenopathy (enlarged of lymph node).

Because scanning is so fast , dynamic images of kidneys show the arterial phase of enhancement, making it use full to obtain a third set of image through kidneys to better asses of the parenchyma .

Exception in transitional carcinoma the exam is extended in to the pelvis with delayed views of the bladder 3-5 minute delay image .

### **3-10 Data analysis**

Using of Microsoft Excel

### **3-11 Data presentation**

Bar chart and tables

### **3-12 Ethical consideration**

Study cases were selected from patient underwent to CT KUB department.

### **3-13 CT Number**

The Hounsfield scale or ct numbers name after sir “Godfery Newbold Hounsfield”.

In volumetric (3D) digital radiology , the radiographic density =(the X-ray attenuation power ) in each voxel of the volume of interest is expressed by a number called CT Number .

The scale of CT numbers is specific for each equipment ,and even for each modality therein .

The available range of CT number nowadays usually between 212 (4048) and 216 (65536, 64k) .

CT numbers correlate to gray levels, or gray shades, when the volumetric dataset is rendered in to image, which displayed on monitor (or printed).

On a regular computer monitor , a maximum of only 256 gray level can be displayed simultaneously (VGA standard ). On medical-specific monitor, a larger number of gray levels could be addressed, any way still in the hundreds.

### **Hounsfield Unit**

The Hounsfield (HU) is a linear transformation of the linear attenuation coefficient measurement in to one in which the radio density of the distill water (at standard presser and temperature) is defined as zero HU, while the radio density of air at STP is defined as -1000 HU. For a material X with linear attenuation coefficient X, the HU value is there for given by:

$$HU = \frac{\mu_X - \mu_{water}}{\mu_{water} - \mu_{air}} \times 1000$$

*Computed Medical Imaging  
Nobel Lecture, 8 December 1979  
Godfrey N. Hounsfield  
J Radiol. 1980 Jun-Jul;61(6-7):459-68*

### **Purpose of HU in medical radiology**

Identification and characterization of tumors in soft tissue (HU in the range 0-100) was the main focus in the early times of CT development, when the HU was defined.

There for the HU scale was conceived to be most effective in the short range of soft tissue radio densities.

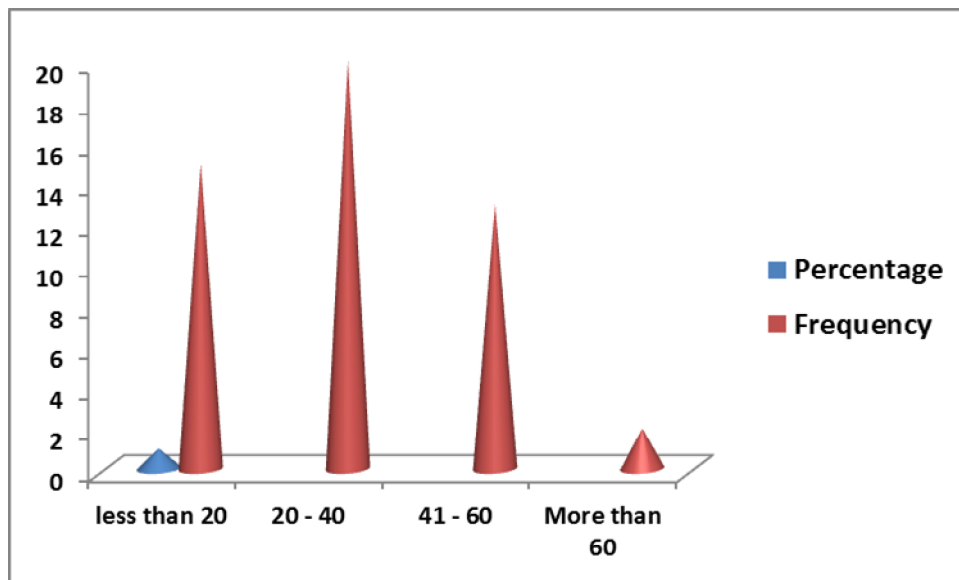
In that range , close to the water calibration point ,moderate variations of the x-ray beam chromaticity =(effective energy) have little consequence on the absolute HU reading .

## Chapter Four

### 4.1 Result

**Table 1: Show the age percentages and frequency**

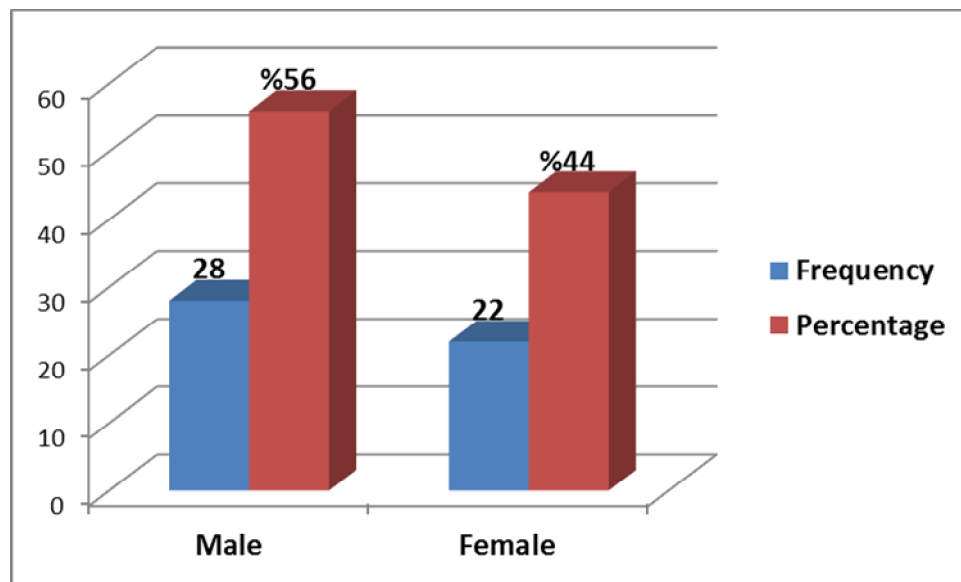
age	Frequency	Percentage
less than 20	15	30%
20 - 40	20	40%
41 - 60	13	26%
More than 60	2	4%
Total	50	100%



**Figure4.1 Showing the age percentages and frequency**

**Table 2: Show the Gender frequency and percentages**

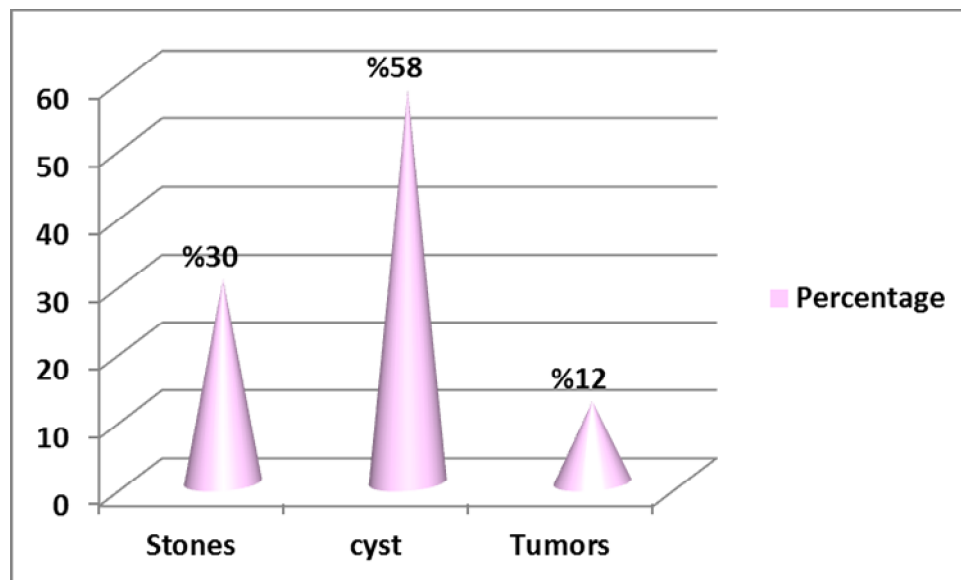
	Frequency	Percentage
Male	28	56
Female	22	44
Total	50	



**Figure4.2 Showing the Gender frequency and percentages**

**Table 3: Show the pathological finding frequency and percentages**

Finding	Frequency	Percentage	Male	Female
Stones	15	30%	9	6
cyst	29	58%	17	12
Tumors	6	12%	2	4
Total	50	100%	28	22

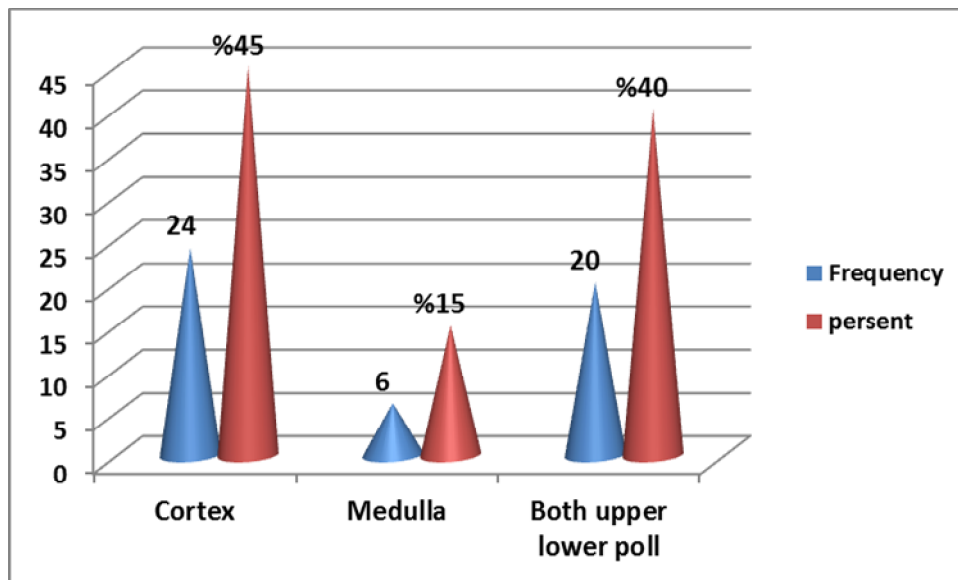


**Figure4.3 showing the pathological finding frequency and percentages**



**Table 4: Show pathological finding Sites frequency and percentages**

The site	Frequency	Percentage
Cortex	24	45%
Medulla	6	15%
Both upper lower poll	20	40%
Total	50	100%



**Figure4.4showing the pathological finding Sites frequency and percentages**

## Chapter Five

### 5.1 Discussion:

Age distribution:

Table 1 show the age percentage and frequency We divided the population in this study to 4 age groups

From 0 - 20

From 20 - 40

From 40 - 60

And more than 60

The most effected age group is between 40\_60 forming 40%

Gender distribution the majority of the sample under study were males (28) forming the incidence of (56) and the female (22) = 44% the major variation in percentage indicate for the high usage of CT for kidney in male Table 2 show the gender frequency and percentage CT finding.

Table 3 show the pathological finding and percentage.

It has been found that (58%) of the scans were Cyst, (30%) were stones and (3%)were tumor.

Affected side and area

Table 4 show finding of the affected side in frequency and percentage.

The most affected side is at the cortex (40%), left and right area.

## **5.2 conclusions**

The current study aimed to characterize the Renal Lesions by CT. Renal Lesions most common in male than female and Cyst classify as the most common lesions detected (58%) defined as {stones (9), cyst (17), tumor (2)} which we found it just close to previous study that we mentioned earlier in that the rate of detection of renal cyst has increased thanks to the CT imaging and that contrast enhanced images allow differentiation between cyst and solid renal lesion.

Complex cystic and solid lesions can be characterized further.

Therefore Radiological examination alone is most suitable in order to diagnose the normal and abnormal appearance and structure.

### **5-3 recommendation:**

CT should apply as the best tool to diagnose the renal lesions, because it provides:

The measurement, CT number, texture and type of the lesions in the cyst cases inflammation case we can determines the type of it is chronic or acute, by using the arterial and venous and the late protocols.

It can determine the type of tumor and it is stage , if its stage 1-2 which is benign or stage 3-4 which is malignant stages.

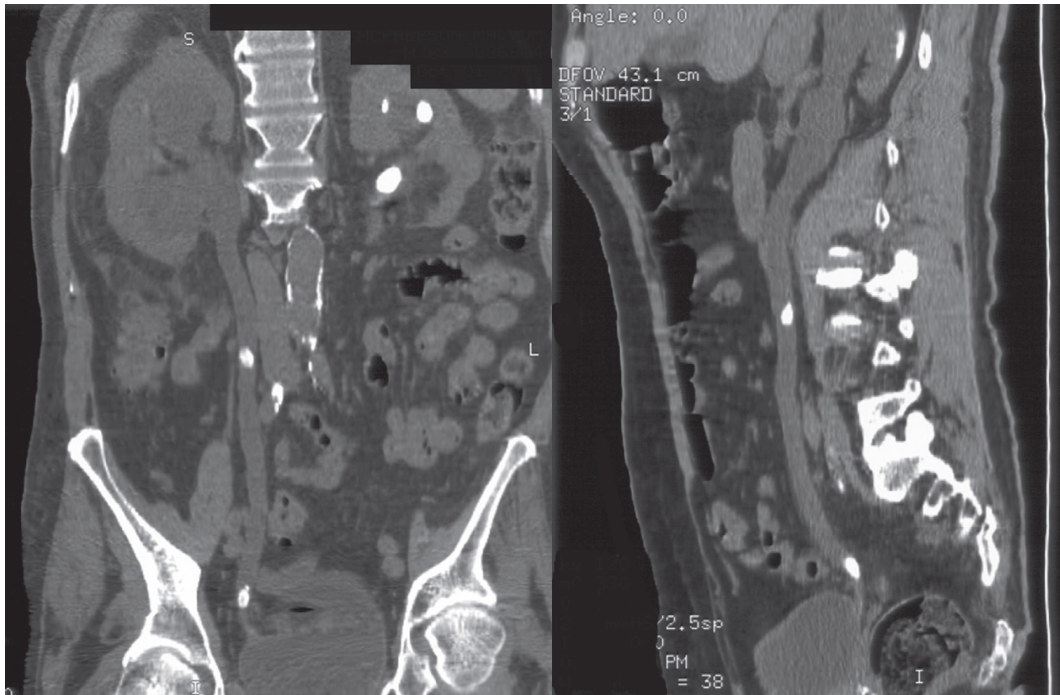
For all these application we can have early and accurate diagnosis and short treatment.

## 5-4 References

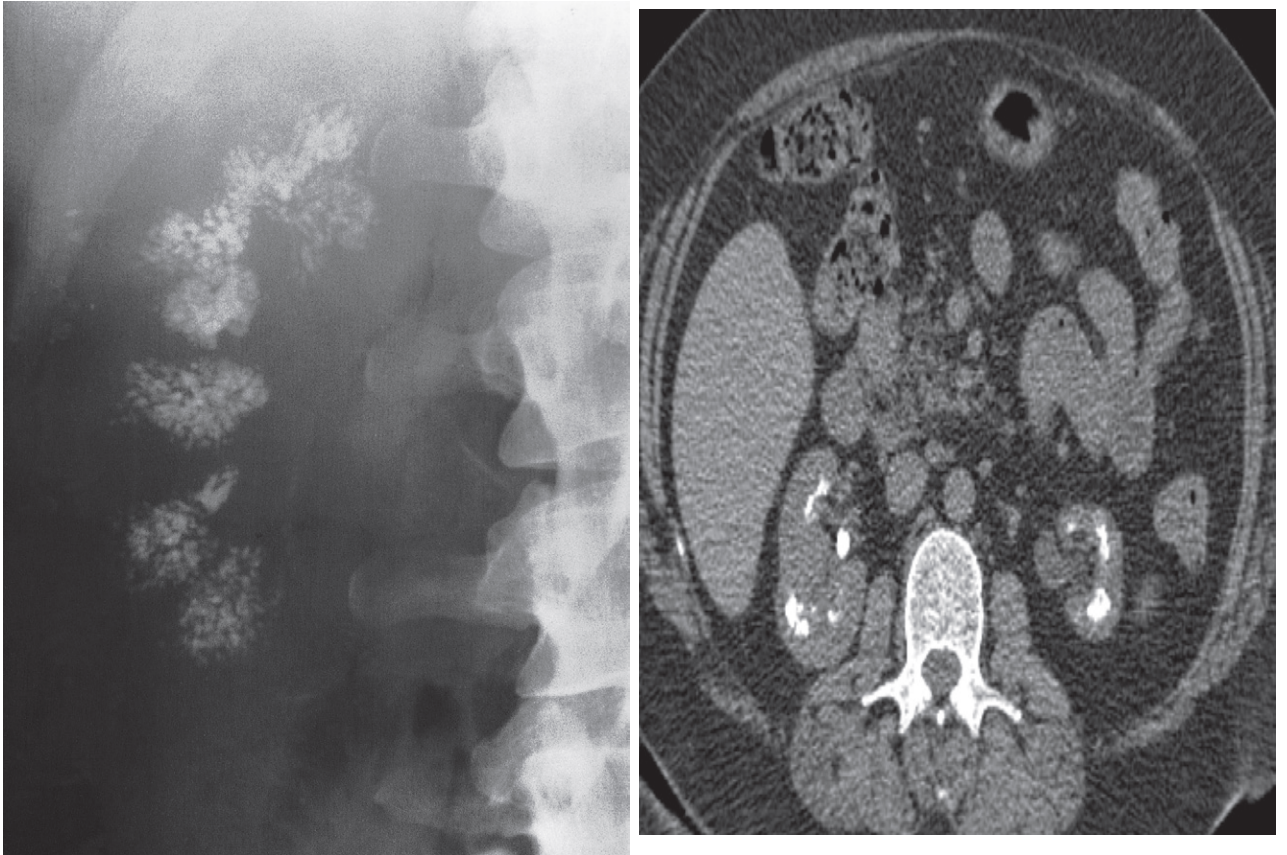
1. Bosniak MA, Megibow AJ, Hulnick DH, Horii S, Raghavendra BN, et al. CT diagnosis of renal angiomyolipoma : the importance of detecting small amounts of fat. AJR 1988; 497- 501
2. Silverman SG, Israel GM, Harts BR , Richie JP, et al. management of the incidental renal mass . Radiology 2008; 249:16-31
3. Bosniak MA, et al. problem in the radiologic diagnosis of the renal parenchymal tumors . Urol Clin North Am 1993 ; 20: 217-230
4. Beland MD, Mayo-Smith WW, Dupuy DE, Cronan JJ, Delellis RA, et al. Diagnostic yield of 58 consecutive imaging – guided biopsies of solid renal mass: should we biopsy all that is indeterminate ? AJR 2007 ; 188:792-797
5. Pandharipande PV , Gervais DA, Hartman RI, et al. Renal mass biopsy to guide treatment decisions for incidental renal tumors: a cost effectiveness analysis . Radiology 2010; 256: 836-846
6. Ramzi M, Marberger M, et al . Renal tumor biopsies for evaluation of the small renal tumors: why , in whom , and how? Eur Urol 2009; 55:359-367
7. Zhang J, Lefkowitz RA, Ishii NM, et al. solid renal cortical tumors : differentiation with CT. Radiology 2007 ; 244:494-504

## Appendix (A)

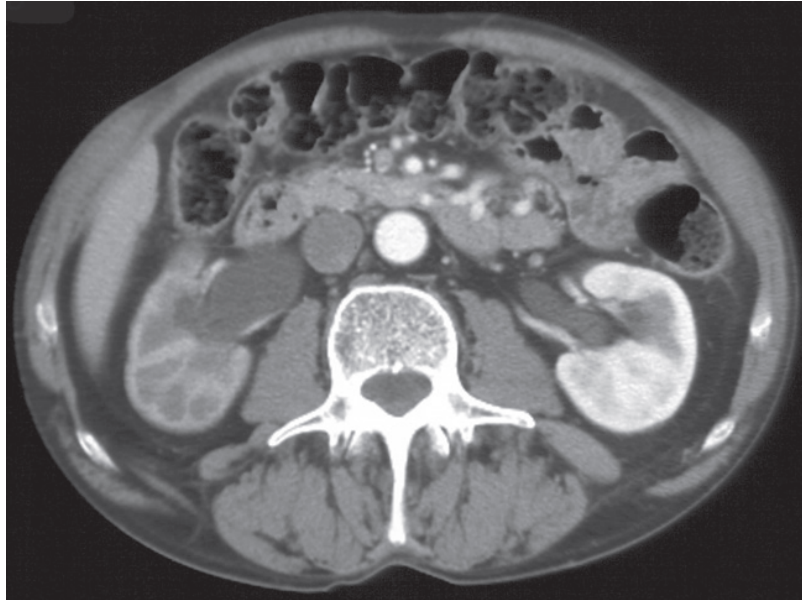
1



Cronal and Saggital CT Images for Male 52years old Hydronephrotic right kidney (RK) and two stones in the dilated right ureter .The patient also has kidney stones in the left pelvicaliceal system.

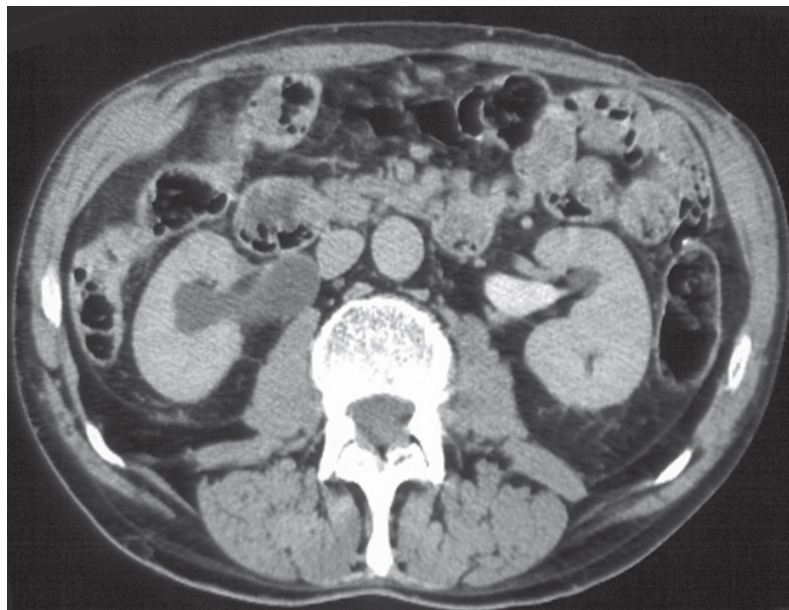


Plain Film and Axial CT Images of Male 40years old Nephrocalcinosis. On plain film bilateral renal parenchymal calcifications are demonstrated on CT KUB.



Axial CT Mages of Female 49 years old at the corticomedullary phase of enhancement.

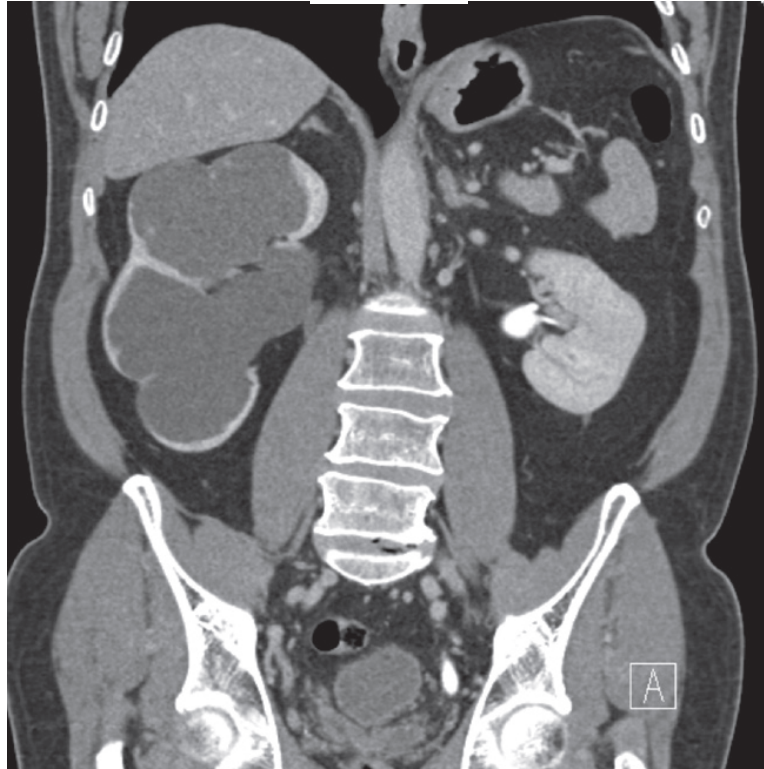
There is obstruction of the right kidney with dilatation of the pelvicaliceal system



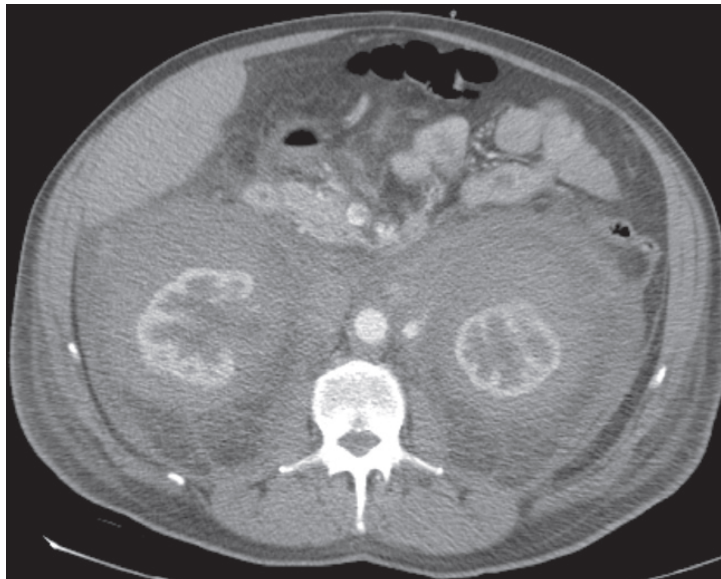
CT at the delayed phase of enhancement.

Intravenous contrast is seen in the left renal pelvis but not in the obstructed right renal pelvis.



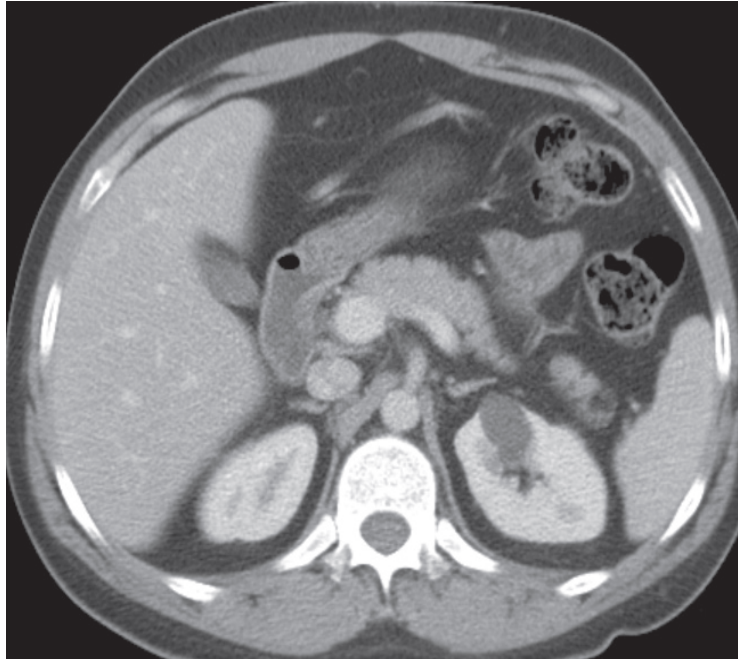


Cronal CT Images of male 60years old Intrinsic PUJ obstruction. The pelvicaliceal system is considerably dilated.



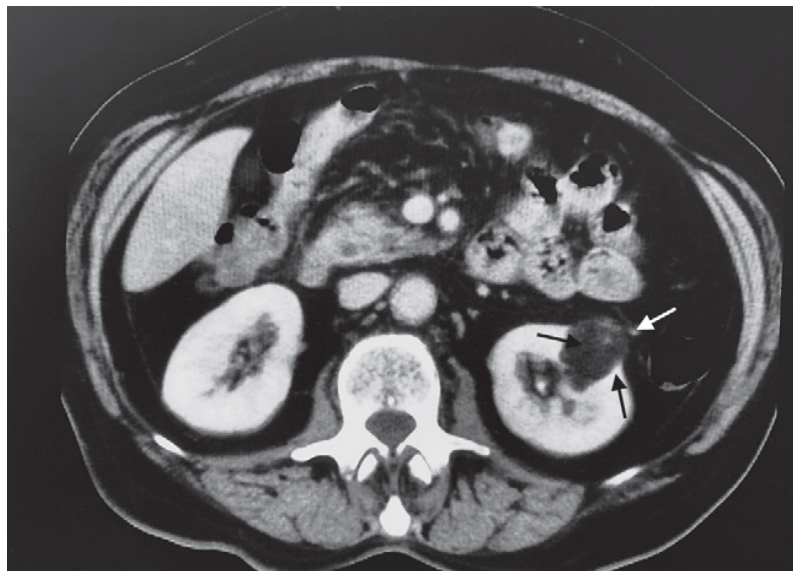
Axial CT Images Shows Mild hydronephrosis on the right. Both kidneys are surrounded by dense fibrosis.

5

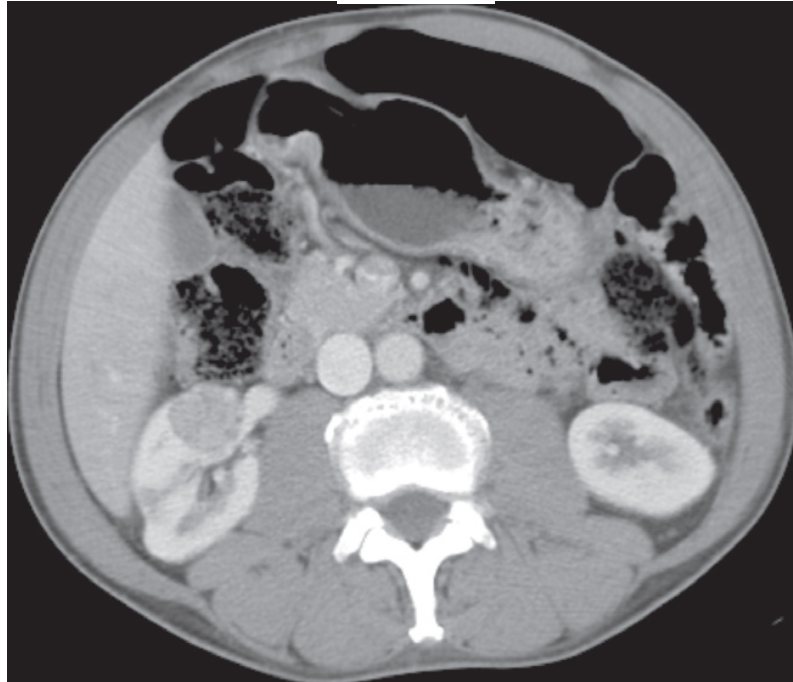


Axial CT Images of Male 50 years old Cyst in the left kidney on CT showing a well-defined edge

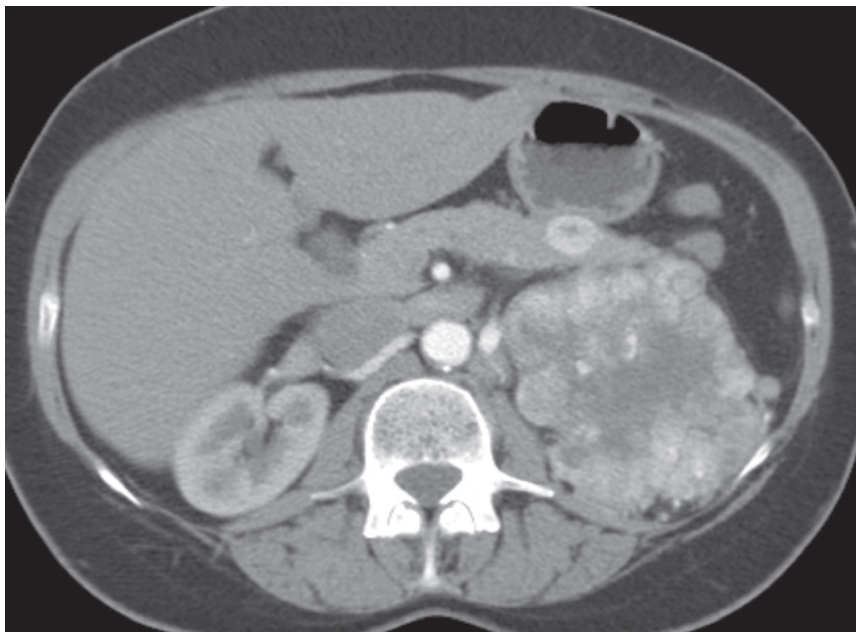
6



Axial CT Images of female 53 years old Angiomyolipoma seen as a well-defined mass of fat density on CT.

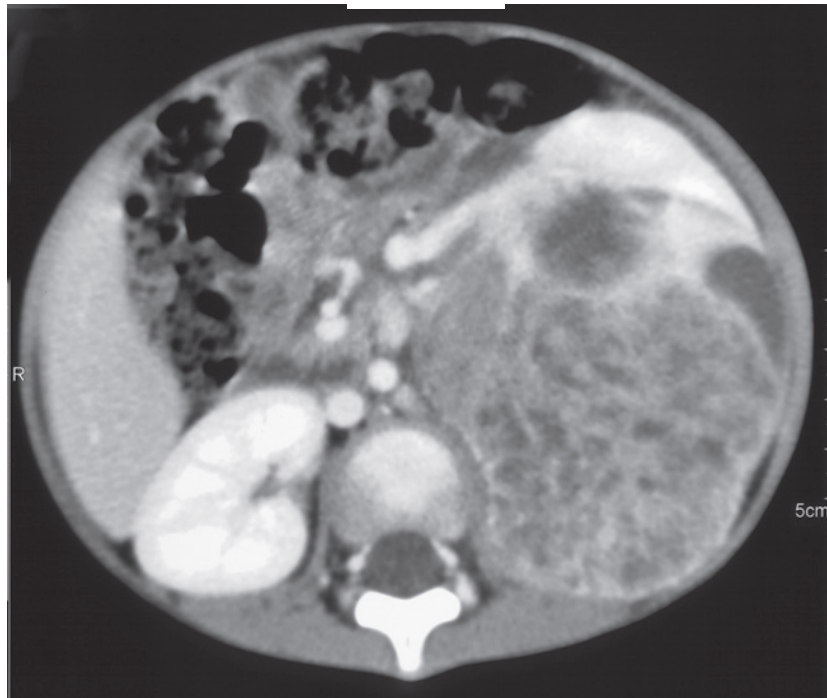


Axial CT Images of Male 63 years old Renal cell carcinoma. The mass in the right kidney shows substantial enhancement and is invading the anterior wall of the right renal vein



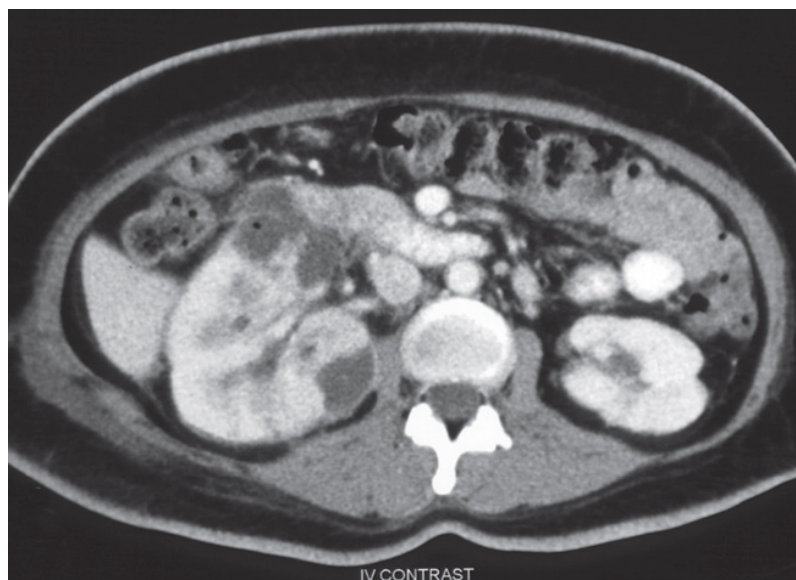
Axial CT Images of female 58 years old Staging renal carcinoma in CT scan showing a large tumour in the left kidney.

9



Axial CT Images of male 48 years old Wilms' tumour. A large heterogeneously enhancing Mass.

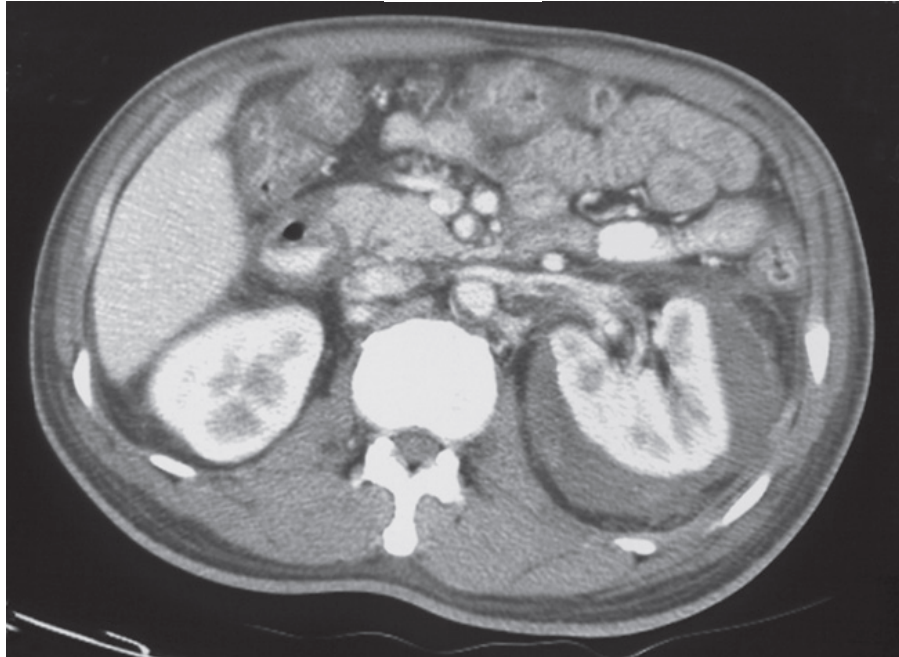
10



Axial CT Images of Female 43 years old with intravenous contrast demonstrating multiple low attenuation fluid collections in the right renal cortex, consistent with multiple renal abscesses.

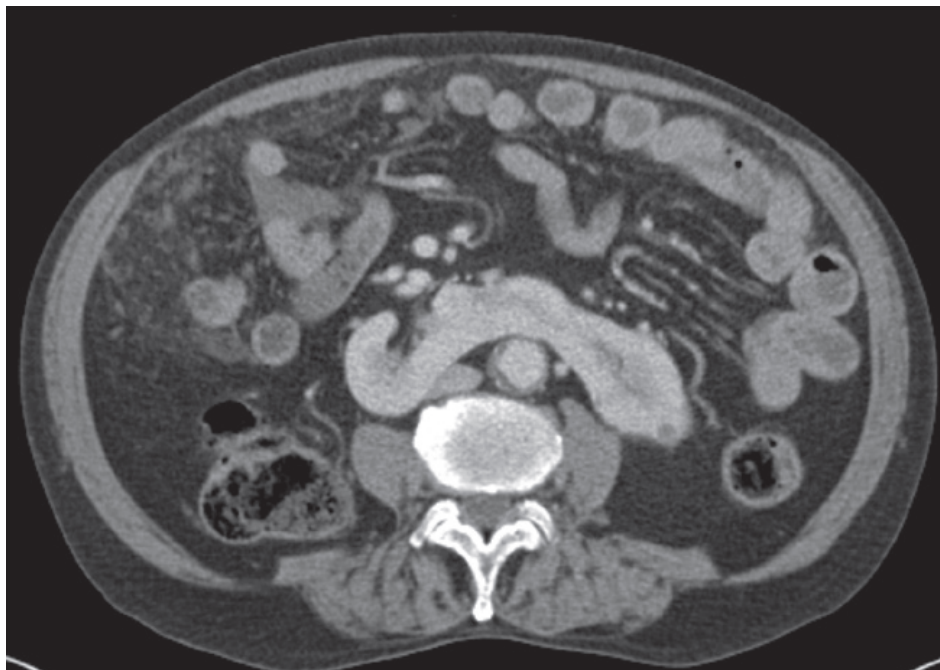


11

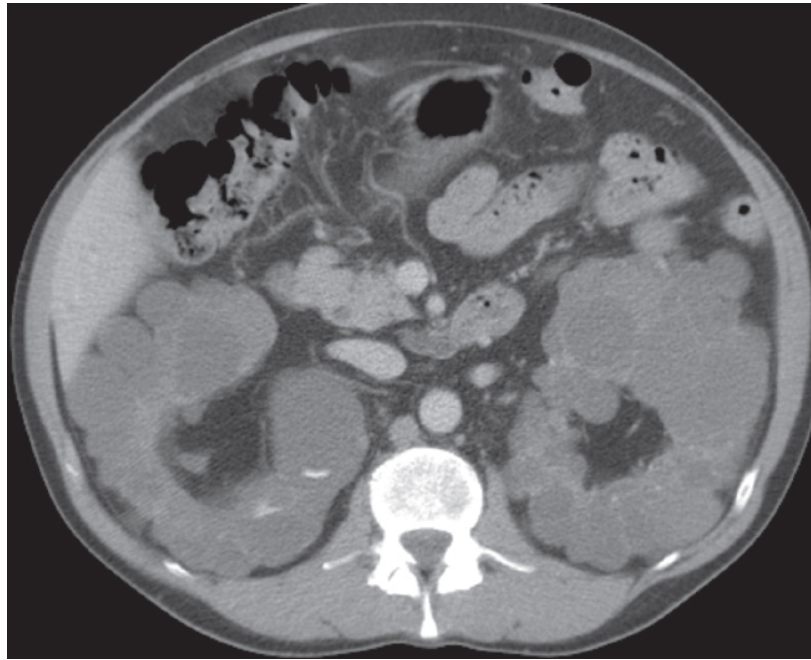


Axial CT Images of Male 51 years old Perinephric abscess. CT scan showing loculated fluid with a thick enhancing wall surrounding the left kidney.

12



Axial CT Images of Female 35 years old Horseshoe kidneys.



Axial CT Images of Male 66 years old Advanced polycystic disease in adults in CT scan,

Taken after intravenous contrast enhancement, showing that both kidneys are greatly enlarged and almost entirely replaced by cysts of variable size.

## Appendixes (B)

patient	Age	Gender	Complain/history	CT Finding				
				size	Site	w/o contrast	measurements	