SUDAN UNIVERSITY OF SCIENCES & TECHNOLOGY

College of Graduate Studies

RoleofContrast Agent in the Diagnosis of Renal Diseases in Computed Tomography

دور وسيط التباين في تشخيص امراض الجهاز البولي بواسطة الاشعة المقطعية المحوسبة

A thesis submitted for partial fulfillment for the requirement of M.Sc degree in Diagnostic Radiologic Technology

By:

RehamMahjoub Tag Aldine Mahjoub

Supervisor:

Dr. Ahmed Mostafa Abukonna

August 2016

بسم الله الرحمن الرَّحِيمِ

قال تعالى:

سورة القلم الآية رقم (1)

صدق الله العظيم

Dedication

This research is dedicated, first to whom taught me how to write a letter. To my father who bite of teeth in order to provide all means of comfort and good living, for every good word they said longing for us to sustain me.

To my brothers and sister who are giving me happiness, thanks to all what they did to me to facilitate the difficulties.

Acknowledgment

After thanking Allah Almighty I thank all who contributed and helped out in this research firstly to thank DR. Ahmed Abu Kona, who consider to be the spiritual father to me at the university, who has not tired of the tire did not give me tips and Allah made him an asset to his family and homeland. I also thank the faculty at their stand up brotherly with me.

To all employees in library, Allah may repay them all the best, and all workers in the university who have made it a source of cleaner, Allah gave them all good health.

thank also the captain of this ship Dean of the Faculty of radiological science.

Finally yet importantly, thanks to any one help me to complete my research.

LIST OF ABBREVIATIONS

ADH	Anti Duiratic Hormone
CAT	Computed Axial Tomography
CM	Contrast medium
CT	Computed Tomography
ESWL	Extracorporeal Shock Wave Lithotripsy
IVC	Inferior Vena Cava
IVP	Intra Venous Pyelography
MRI	Magnetic resonance imaging
PNL	Percutaneous Nephrolithotomy
RCC	Renal cell carcinoma
US	Ultra sound

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Renal diseases often result from combination of factors, mass of renal system are more common in people whose have a symptoms of renal diseases diet is very high in animal protein or who do not drink enough water main causes of renal diseases.

The purpose of this research was to identify the role of contrast media (CM) in the diagnosis of renal diseases in CT. Fifty consecutive patients with flank pain were examined by CT with CM over a period of 2 months, all patients were prospectively defined as either positive or negative renal diseases 16 patients out of 50 with kidney mass, 12 patients out of 50 with stone and 8 patients with renal cyst and 14 patient out of 50 with other renal diseases.

The result of this study revealed that CT is the modality of choice for detecting renal diseases; CT with CM is reserved when CT without CM is not clear. Contrast enhanced CT was able to identify the Inflammatory diseases, renal masses and Metastases. Non-enhanced lesions were simple cyst, abscess and renal ischemia.

ملخص البحث

امراض الجهاز البولي تنتج عن عدة عوامل , اورام الجهاز البولي هي اكثر الامراض شيوعا في الأشخاص الذين يعانون من امراض الجهاز البولي.

فالأشخاص الذين يتناولون البروتين الحيواني في غذائهم بكميات كبيرة او الأشخاص الذين لا يتناولون السوائل بكميات كافية تلك هي اهم المسببات الرئيسية لأمراض الجهاز البولي.

الغرض من هذه الدراسة هو التعريف بدور وسيط التباين في تشخيص امراض الجهاز البولي في الأشعة المقطعية.

تم فحص 50 مريضا يعانون من الام الخاصرة وتم فحصهم بواسطة الاشعة المقطعية وحقنهم بوسيط التباين , أجريت هذه الدراسة لمدة شهرين وجميع المرضى تم تشخيصهم بسلبيات وايجابيات المرض.

16 مريضا من اصل 50 يعانون من اورام لجهاز البولي ,12 مريضا منهم يعانون من حصوات الكلى و 8 مريضا منهم يعانون من أكياس الكلى ,كما 14 منهم يعانون امراض مختلفة أخرى.

فنتيجة هذه الدراسة أظهرت ان الاشعة المقطعية هي الخيار المتبع لاكتشاف امراض الجهاز البولي ,وان الأشعة المقطعية عن طريق حقن وسيط التباين يستخدم في حالة عدم قدرة الأشعة المقطعية توضيح التشخيص المطلوب بدون حقن وسيط التباين.

فعند الحقن فتعزيز وسيط التباين فالخلايا يجعل لها القدرة على تعريف وتشخيص الالتهابات ,اورام وانتشارها في خلايا الجهاز البولي.

اما عدم التعزيز فالخلايا يعتبر احد الامراض التالية أكياس الكلى ,خراج او نقص في تروية الكلى .

Chapter one

Introduction

1.1 Introduction

The behavior of dynamic enhancement using imaging modalities such as enhanced computed tomography (CT) ,enhanced magnetic resonance(MRI) ,and contrast- enhanced ultra sound (US) is one of the most important features of imaging characterization of kidney diseases. The enhancement pattern depends on the macro vasculature and micro vasculature and is correlated with specific pathologic features. This research focuses on the enhancement pattern of different renal condition including inflammatory, vascular, and oncologic diseases, with emphasis on the pathophysiological bases of altered perfusion (Saunders et al.1995). The administration of contrast agent is essential for imaging characterization of kidney diseases. Thanks to technological improvements, enhanced imaging modalities such as enhanced computed tomography (CT), allow a very precise identification of extrarenal and intrarenal vessels as well as qualitative and quantitative evaluation of the nephrogram that is defined as the radiographic image of enhanced renal parenchyma after the administration of contrast agents. Enhancement features depend on the disease microvasculature, type of contrast media, and the time from the beginning of contrast agent injection. Healthy parenchyma enhances homogeneously and symmetrically, and abnormalities of the enhancement pattern are associated with different renal diseases including inflammatory, vascular, and oncologic diseases. Saunders etal.1995).

1.2 Problem of the study

The enhancement pattern depends on the macrovasculature and microvasculature and is correlated with specific pathologic features. Knowledge about the enhanced and non-enhanced lesion was insufficient and may lead to misdiagnosis of renal diseases or administration of contrast media that may not needed.

1.3 Objectives of the study:

1.3.1 General objective:

The general objective of this study was to identify the role of contrast media in detecting renal diseases.

1.3.2 Specific objective:

1. To study the more common types of CM use in CT.
2. To identify the most common renal disease that can be diagnosed by CM.
3. To study the serious complication of CM

1.4 Thesis outline

This study include the following chapters

Chapter one: Introduction.

Chapter two: Literature review.

.Chapter three: Material and Method

.Chapter four: Results

Chapter five: Discussion, conclusion and recommendations. Then followed by references and appendix

Chapter two

Theoretical background and literature review

2.1 Anatomy of the renal system

The renal system consists of two kidneys, two ureters, one urinary bladder and one urethra.

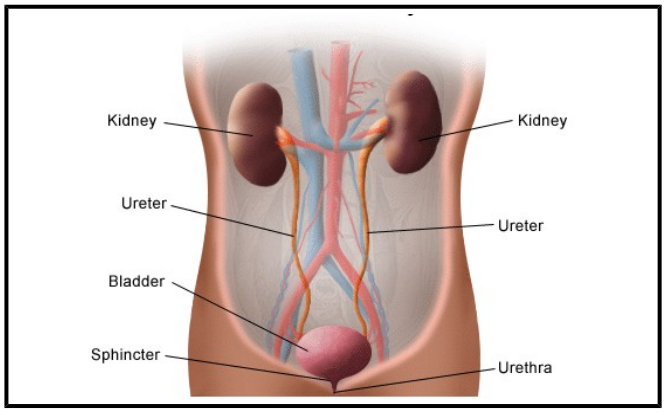

Figure 2.1 Anatomy of renal system.

2.1.1 Kidney

Two kidneys are retroperitoneal organ, bean shaped lie on either side of vertebra column between T_{12}-L_4, right kidney is slightly lower than the left because the presence of liver, surrounded by thin strong capsule of connective tissue, each kidney has a concave hilum facing medially, branches of the renal artery, vein, lymph vessels and ureter enter or leave the kidney at the hilum, ureter is expanded forming the renal pelvic. Near the upper medial part of each kidney is adrenal gland, is important gland of endocrine system are located in the fatty capsule that surround each kidney.)Wolf, 2011).

Each kidney is composed of an outer cortex and inner medulla, renal cortex is responsible for filtration of urine, whereas the medulla

consisting of segments called renal pyramids function as beginning of the collecting arising from the apices of the pyramids, cup shaped calyces which join together to form the renal pelvis system)Wolf, 2011).

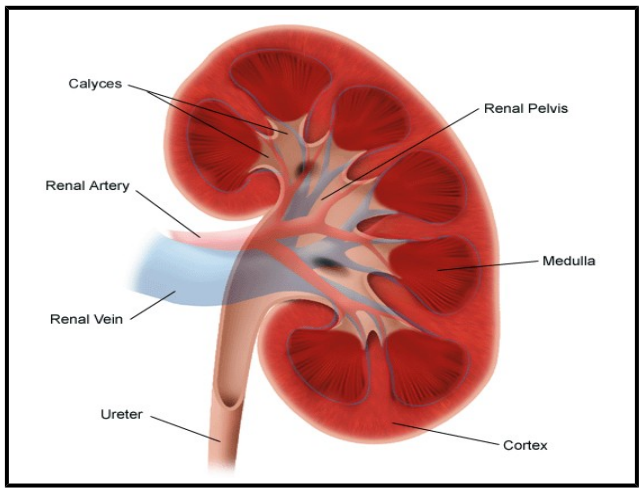

Figure 2.2 Cross section of kidney

2.1.2 Ureters

The ureters are paired muscular tubes, that transport urine to the urinary bladder, each uerter originates at the renal pelvis and descends anteriorly and medially to the psoas muscles, enter the posterior wall of the bladder at an oblique angle)Wolf, 2011).

2.1.3 Urinary bladder

Is a triangular shaped, muscular organ, which lies immediately posterior to the symphysis pubis, it functions as temporary reservoir for the storage of urine. Three openings in the floor of the bladder from the a triangular area called trigone, two of the openings at the base of the trigone are created by the ureters, third opening is located in the apex of the trigone and formed by the entrance to the urethra.) Evan et.al, 2005).

2.1.4 Urethra

The urethra is single tubular structure that drains to urinary bladder, skeletal muscle fibres are organized as the external sphincter of the urethra reverse to the internal sphincter.

2.1.5 Female urethra

Short muscular tube that drains urine to bladder, external urethral opening is located just anterior to the vagina, has lumen normally collapsed except during micturition, it is lined by a transitional epithelium near the bladder and by a stratified squamous non epithelium along the rest of its length, thin vascular coat of erectile tissue similar to the corpus spongiosum of male surrounds the mucosa, the muscular layer has an inner longitudinal and an outer circular layer of smooth muscle.)Wolf, 2011).

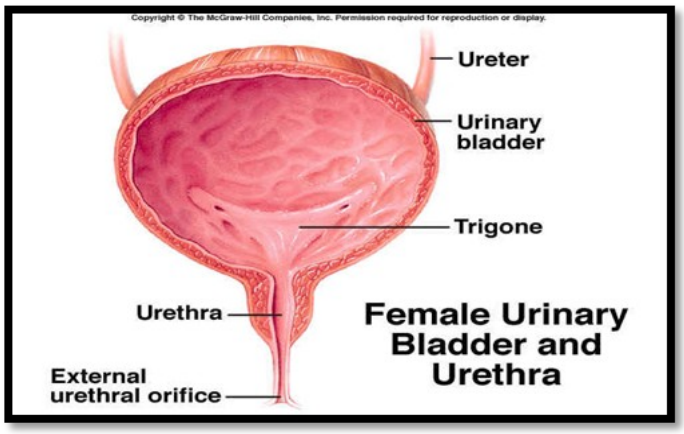

Figure 2.3 Female urinary bladder and urethra

2.1.6 Male urethra

Is much longer and extends from the bladder to the tip of the penis, it can be subdivided into three, prostatic urethra, membraous urethra and penile urethra. Prostatic urethra surrounded by the prostate gland, lined by transitional epithelium, receives openings from the two ejaculatory ducts

and multiple excretory ducts of prostate gland. Membranous urethra is the shortest and narrowest portion of the urethra and is portion that penetrates the external urethral sphincter. Penile urethra is the longest portion, extending from the external urethral sphincter to the tip of the penis, it lodges the corpus spongiosum and is lined by stratified columnar epithelium (Wolf, 2011).

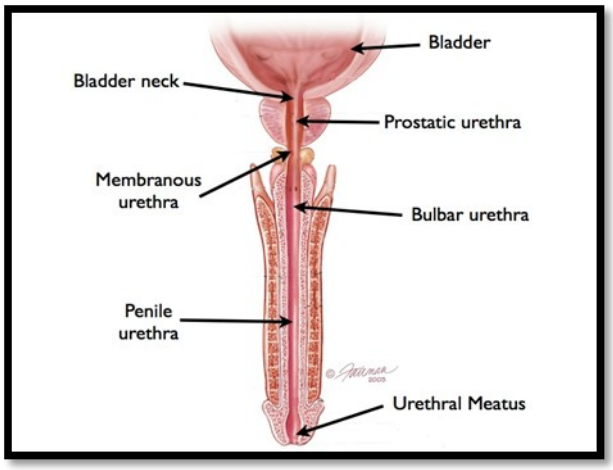

Figure 2.4 Male urethra.

2.1.7 RENAL BLOOD VESSELS

2.1.7.1 Renal arteries

They are a rise from the lateral wall of aorta just below the superior mesenteric artery, each vessel travels horizontally to the hilum of the corresponding kidney, because the position of the aorta on the left side of the vertebral column, the right renal artery is slightly longer than the left, in addition the right renal artery passes posterior to the Inferior Vena Cava (IVC) and right renal vein on its course to the right kidney)Wolf, 2011).

2.1.7.2 Renal veins

They are a rise at the hilum of the kidneys and pass anterior to the renal arteries to empty into the IVC, the left renal vein passes posterior to the superior mesenteric artery and anterior to the aorta, on its route from the left kidney to enter the left lateral wall of the IVC, the shorter right renal vein typically lower than the left renal vein, its short course to enter the right lateral wall of the IVC (Evan, 2005).

2.2 Physiology of the renal system

Function of urinary system is production of urine, eliminating wastes product, remove nitrogenous wastes, regulate water level in the body, and regulate acid base balance and electrolyte levels of blood (Thakker, 2000)

2.2.1 Microstructure of kidney

The basic functional unit of the kidney is the nephron, there are over one million nephrons in each human kidney, they are responsible for the complex water regulation and waste elimination functions of the kidneys, the heads of the nephrons are in the cortical region and the tubular component descends through the medulla and eventually drains into the renal pelvis. (Hoppe et.al, 2003).

The nephron are surrounded by a fine network of capillaries called the peritubular capillaries these perform an important role in direct secretion, selective reabsorption and regulation of water, in addition to glomerular filtration some substances are secreted directly from the adjacent capillaries into the proximal tubule, these substances include potassium ions and some hormones (Thakker, 2000)

The area between the circulatory system and the tubular part of the kidney is the glomerular capillaries in the Bowman's capsule, these liquid parts of the blood that are able to cross through the filtration membrane of the capillaries, pass into the Bowman's capsule and then into the tubular section of the nephron, filtration membrane only allows water to pass through it and small molecules that will dissolve in water and blood cells are too large to be filtered and remain in the blood (Hoppe et.al, 2003).

Filtered fluid enters the proximal tubule and then into the loop of henle which is the part of the nephron, dips in and out of the medulla, from the loop of henle the filtrate travels through the distal tubule and then into a common collecting ducts which passes through the medulla and into the renal pelvis (Thakker, 2000)

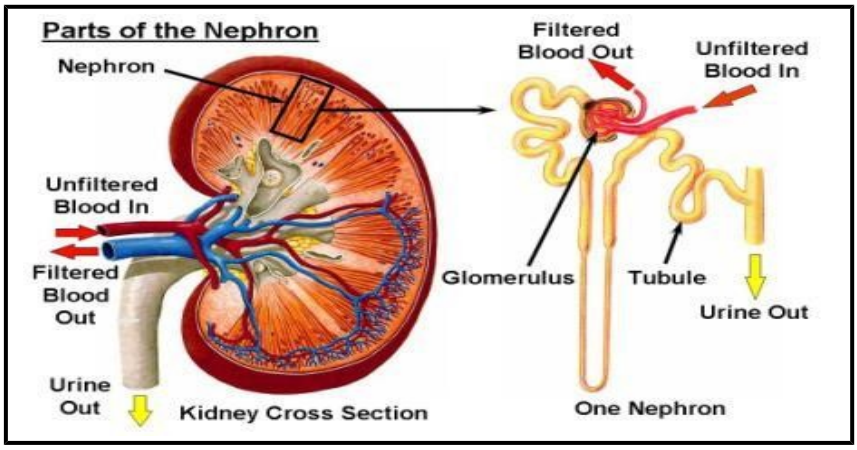

Figure 2.5 Micro structure of kidney (nephron).

2.2.2 Water regulation by the kidneys

The water content of the body can vary depending on various factors, hot weather and physical activity such as exercise make person sweat and so lose body fluids, sometimes the body has too little water and needs to save it. Most the control of water conservation takes place in the distal and collecting tubules of the nephrons under control of Anti Diuretic Hormone (ADH), this hormone is released by the posterior pituitary under control of the hypothalamus in the mid brain area, hypothalamus monitors the water content of the blood, if the blood contains too little water then more ADH is released, if the blood contains too much water then less ADH is released into the blood stream (Pietrow et.al, 2006).

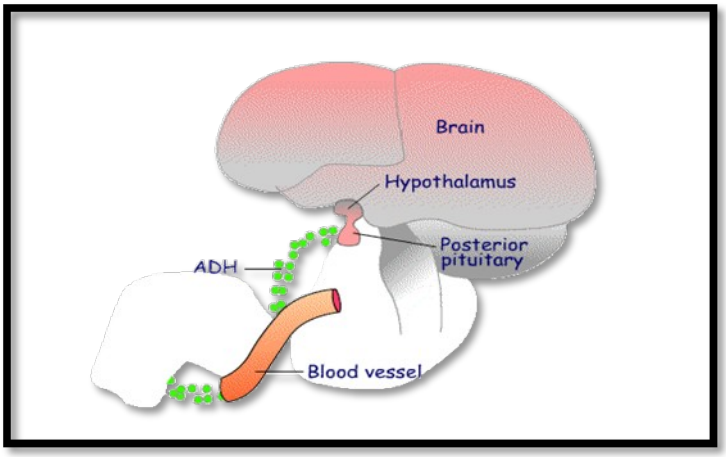

Figure 2.6 Release of ADH from posterior pituitary gland.

ADH binds to receptors on the distal and collecting tubules of the nephrons which cause water channels to open in the tubule walls, this allows water to diffuse through the tubule walls into the interstitial fluid where it is collected by the capillaries, more ADH present, the more water channels are open and the more water is reabsorbed (Pietrow et.al, 2006).

Over 99% of the filtrate produced each day can be reabsorbed, the amount of water reabsorbed from the filtrate back into the blood depends on the water situation in the body, when the body is dehydrated most of the filtrate is reabsorbed, the kidneys will continue to produce around 500 ml of urine each day in order to perform their excretory function (Thakker, 2000)

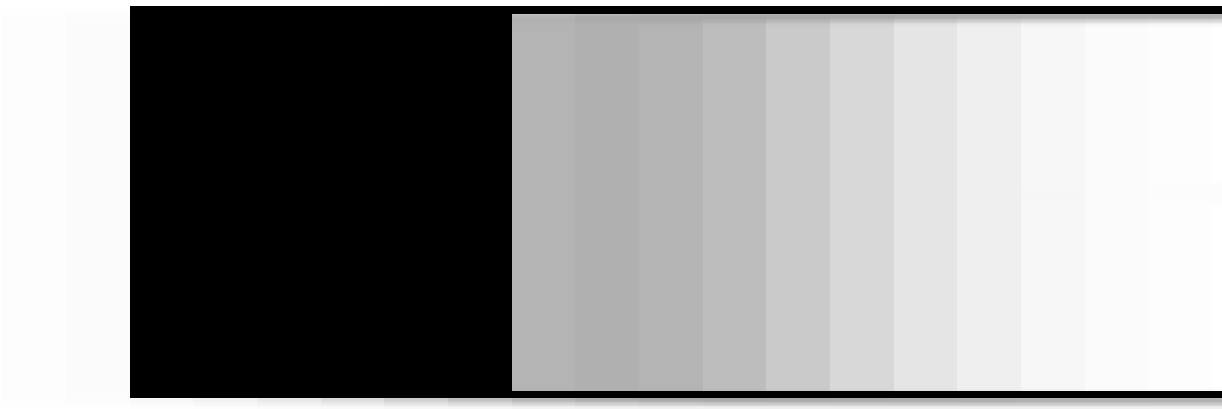

Figure 2.7 Reabsorption of water under the influence of ADH.

2.2.3 Micturition reflex

Micturition is another word for urination, as the bladder fills with urine, stretch receptors in the wall of the bladder send signals to the parasympathetic nerves to relax, as the muscle relaxes the urethra opens and urine is voided to the outside. Second sphincter external urethral sphincter is skeletal muscle controlled by motor neurons these neurons are under conscious control and this means we are able to exercise control over when and where we urinate this control is a learned response that is absent in the new born infant (Pietrow et.al, 2006).

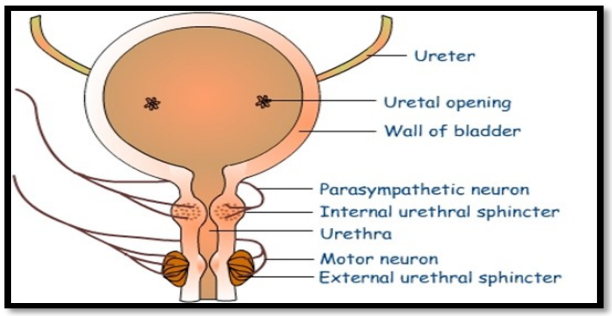

Figure 2.8 Micturation reflux.

2.3 Imaging of the renal system:

CT scan performed from the upper abdomen through the pubic with images reconstructed at 5.0 mm intervals,

Focal high attenuating opacities at CT or low attenuating show at image to differentiating between structure by contrast media, because CT some time cannot enable to detect the pathology without contrast media) Preminger, 2007(.

For each patient the CT images were reviewed prior to the CT examination with CM, size and features of renal system were recorded for the CT examinations, location of any mass or obstruction was recorded as being in either the right or the left kidney, no distinction was made in CT to detect renal stone before and after CM)Preminger, 2007(.

Renal system were diagnosed on CT images by CM, high attenuating foci in the renal system were used as criteria for the diagnosis of renal system on CT scans.

2.3.1 CT Contrast media

Contrast media, contrast agent and X-ray dye are all terms used to describe the same thing, contrast media is used in many X-ray studies, CT scans and MRI scans. Some tissues are very similar in density and thickness making it difficult for the human eye to discern any difference,

in these instances contrast media can help the doctor interpret the images by making certain organs or tissues distinctive from the rest (Vela et.al, 2007).

Several substances are used for contrast media in X-ray or CT scans, the most common one is an iodine based liquid that is injected into vein and excreted through kidneys, iodine is useful for this application because it has higher atomic number than the body tissues, making it more dense and causing the iodine to absorb more X-rays so area with contrast appear white in film (Vela et.al, 2007).

Another type of contrast is barium which may be ingested as drink and exits through GI tract, barium also is a natural substance with a high atomic number making the gastrointestinal tract also appears white on the film (Vela et.al, 2007).

Figure 2.9 Equipment needed for performed of venipuncture.

2.3.2 Common side effects of contrast media

When the dye is injected may get a flushing or warm feelings, and a metallic taste in the mouth, usually quickly go (Vela et.al, 2007). Contrast media reaction categorized as follows:

1. Mild (headedness, nausea, anxiety, vomiting, and erythema).
2. Moderate (bronchospasm, angioedema, hypotension and tachcardia).
3. Severe (hypotension, bradycardia, loss of consciousness, cardiac and respiratory arrest).

2.3.3 Patient preparation

Patient must be full bladder by drink water for several hours before the exam. No eat or drink anything for several hours before the exam especially if a contrast material will be used. Physician must asked of any medications and for any type of allergic reaction, if the patient has history of heart disease, asthma, diabetes and kidney disease Physician must ask any women about any possibility of pregnancy. Blood test to check kidney function (Vela et.al, 2007).

2.3.4 Phases of Enhancement

The administration of a contrast agent provides not only morphologic information of the renal parenchyma but also physiological information through the enhancement of the nephron structures. Correct nephrogram requires normal renal vascularization, normal glomerular filtration, tubular function, and absence of urinary tract obstruction. It also depends on the features of the contrast media, rate of injection, and the time after its intravenous (IV) administration. 2 With the use of CT, 3main phases

can be identified including the corticomedullary, nephrographic, and excretory phases. 3 The corticomedullary phase appears30-70 seconds after injection of IV contrast material, showing perfect differentiation between the cortex and the medulla. Most contrast media circulates at the cortical arteries and is not filtered through the glomeruli, and thus, it does not progress in to the more distal tubular structures. The nephron graphic phase becomes maximally intense70-180seconds after IV injection of contrast agent, showing equal enhancement of the cortex and the medulla as the contrast material enters the loop of Henle and collecting tubules (Yuh et.al, 1999).

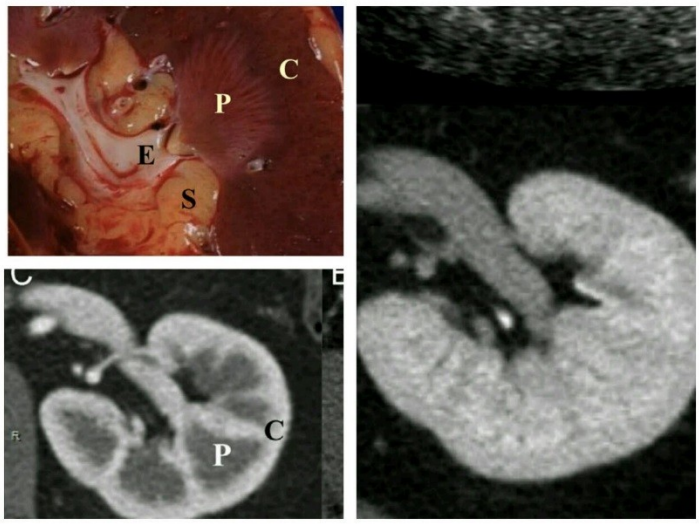

Figure 2.9 Correlation of normal kidney and enhanced imaging using CT (A)Macrophotography of a section of the kidney showing different structures(E ¼ excretory tract, S ¼ sinus fat, P ¼ pyramid, and C ¼ cortex).(C) CT images in the corticomedullary phase show enhancement of the cortex(C)without pyramid enhancement. (E) CT images in the nephrographic phase show enhancement of both the cortex and the pyramid

However, the late nephron graphic phase can show a higher density of the medulla because of higher concentrations of the contrast agent in the medulla. The excretory phase usually occurs 180seconds after the IV injection of contrast material, and the nephrogram remains homogeneous,

but less intense. Then, the contrast medium is excreted; thus, there is also enhancement of the excretory tract. Hybrid phases can be produced using a split contrast bolus that achieves concurrent phase enhancement (combining some of the arterial, nephron graphic, and excretory phases) with the advantage of a reduction in the radiation dose.

Regarding CT protocols, they evaluate the kidney precisely at the time of acquisition; thus, the phases of acquisition should be selected depending on clinical indications to avoid any unnecessary exposure to radiation in the case of CT and extra machine time of CT, Most renal diseases are better detected in the nephron graphic phase; thus, we include this phase in all kidney protocols (except to rule out kidney stones) in our center if there are no contra indications to administer contrast agents, and one or more of the other phases . And one or more of the other phases (unenhanced, cortico medullary, and excretory) are added depending on the clinical indications

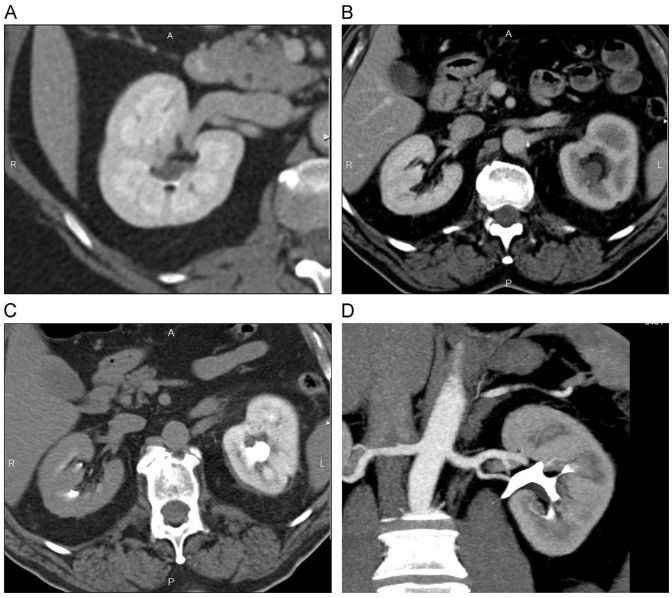

Figure 2.11 Kidney enhancement depends on the time from contrast agent injection and correct functioning of the kidney nephron. (A)The late nephron graphic phase can .show a higher density of the medulla

2.3.5 Characterization of Renal Diseases Using Contrast Agents

Both the kidneys should show symmetrical enhancement in each phase after the administration of contrast media. Renal disease can be suggested when an asymmetrical enhancement is detected, and even small asymmetries of enhancement are indicative of renal disease. CT and MR are better modalities to detect differences of enhancement between both the kidneys, as they can visualize both the kidneys at the same time. The sensitivity of enhanced CT, is now so high that very small differences of enhancement of even2-3mm can be detected. However, the accuracy of the imaging techniques in the characterization of the anomalies detected is not good when they are very small, and in most cases, lesions cannot be characterized until they measure at least10-15mm(Fig 3). To characterize renal diseases, detected enhancement abnormalities can be classified as non-enhancing, hypo enhancing, or hyper enhancing relating to the adjacent or contra lateral renal parenchyma.1 However, it is important to keep in mind that different patterns of enhancement can be found at the same time as in the case of a traumatic kidney that can depict non enhancing areas due to ischemia, hypo enhancing areas due to parenchymal contusions, and hyper enhancing areas due to parenchymal bleeding. In addition, most focal lesions show different patterns of enhancement depending on the phase studied, as clear cell renal cell carcinoma (ccRCC) usually shows hyper enhancement in the arterial phase but hypo enhancement in the nephron graphic phase. Thus, we high light the most characteristic enhancement patterns of the most common renal diseases including focal and diffuse entities.

2.3.6 Non-enhancing Lesions

The absence of enhancement reflects the lack of vascularization, and non-enhancing lesions can be classified as focal, segmental, or diffuse. Focal Absence of Enhancement. It is most commonly found in avascular lesions that contain fluid such as urine, blood, or pus. Simple renal cysts are the most common renal lesions, as these are found in more than 50% of the population older than50years (Israel et.al 2004).

Using imaging modalities, a simple cyst is characterized by a thin wall without septa and absence of vascularization in all the phases (Fig 4). Its diagnosis does not require the administration of contrast agents and can be easily obtained using grayscale hairline-thin wall without septa or solid components (Israel et.al 2004).

However, some benign cysts can have a complex appearance with the presence of hemorrhage, septations, wall thickening, or nodularity at gross in spection. These findings are changes secondary to reparative response to hemorrhage ,inflammation, or infection and can be identified by imaging modalities. The problem is that this complex appearance can also be secondary to the presence of intra cystic cancer, as upto10%of renal cancers appear as complex cystic lesions, and the use of enhanced imaging modalities is essential for differential diagnosis. Bosniak classification is an accurate and efficient method for clinical management treatment planning of complex cysts depending on the morphologic and enhancing features of the cysts. It was described based on CT findings (Bosniak, 1986).

The presence of a soft tissue enhancing mass adjacent to or extending from the wall or the septum is the most indicative warning sign suggesting malignancy, and CEUS and MR are more sensitive than CT in

detecting micro vascularization in septa and nodules (Nicolau et.al, 2014).

The most important limitation using enhancing imaging modalities in the characterization of complex cysts is the impossibility to differentiate between benign and malignant Bosniak III cysts .Both present with thickened septa or wall, and the only difference is the presence of proliferation of neoplastic cells within the thick end septa by histology Fig [3.6], which up to now cannot be identified with enhancing imaging techniques.

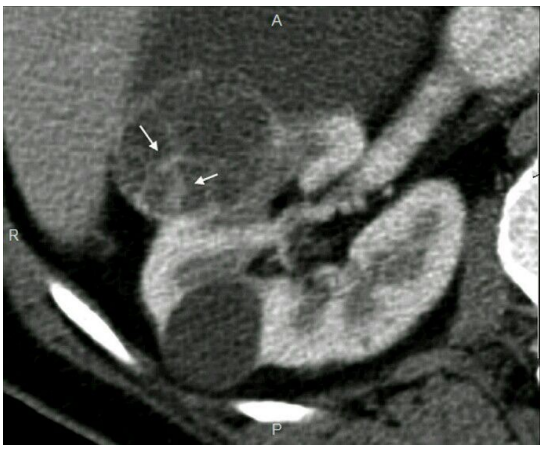

Figure 2.12 Multilocular cystic RCC.(A)The presence ofa thickened wall or septa is the main features of Bosniak III(arrows)

2.3.7 Hypo enhancing Lesions

Most renal diseases diagnosed by imaging show hypo enhancement relating to the normal renal parenchyma, especially in the nephrongraphic phase. The hypo enhancement pattern can be focal, patchy, or diffuse. Focal Hypo enhancement Most renal lesions including benign and malignant tumors show this pattern of enhancement, and a useful approach for their characterization is to differentiate between infiltrative and expansive lesions (Dyer et.al, 2008).

Regarding hypo enhancing infiltrative lesions, they have apoorly defined transition relating to the adjacent parenchyma. Other features of infiltrative lesions are the presence of invasion of the renal sinus, excretory tract, or perirenal fat. This pattern is usually found in malignant lesions such as transitional cell carcinoma (TCC), metastases, infiltrative RCC, lymphomas, sarcomas, as well as in inflammatory diseases (Pickhard et.al, 2001)

The characterization of these entities is important because their treatments are substantially different, but they frequently have over lapping imaging findings. In neoplasms, the infiltrative pattern indicates an aggressive behavior; thus, it is usually found it in uncommon, undifferentiated, or high- grade tumors. When the tumor involves the medulla and the cortex, with extension to the excretory tract, it is almost impossible to know if the origin is the excretory tract with invasion of the medulla and the cortex or if the origin is the cortex with extension to the excretory tract Fig [2.12]. In these cases, the most likely diagnoses are aggressive RCC and mainly TCC, as they are much more common than other tumor (Pickhard et.al, 2001)

2.3.8 Diffuser Patchy Hypo enhancement

This is a less common enhancement pattern that presents as decreased attenuation or delayed CT nephron gram. It can involve all the renal parenchyma in conditions with decreased glomerular filtration such as glomerulonephritis and obstructive renal disease. However, the most common pattern is the striated or segmental parenchymal pattern with heterogeneous enhancement, as observed in conditions such as pyelonephritis, vascular disease such as renal vein thrombosis, and infiltrative tumors (Pickhard et.al, 2001). To achieve a final diagnosis, correlation of imaging with clinical findings. The kidney may also show

delayed contrast staining on delayed CT scans that reflects interstitial inflammatory infiltrates, focal ischemia, obstruction of tubules, and compression by interstitial edema. Other possible findings are the presence of high-attenuated lesions on unenhanced CT.

The presence of hemorrhage, enlargement of the kidney, thickening of the urinary tract wall, and perinephric stranding secondary to involvement of the surrounding perinephric fat.(Taneja et.al, 2012).

The detection of abscesses is very important for treatment planning and prognosis. They can be differentiated from focal nephritis when non enhancing fluid collections with wall thickening are detected, reflecting the presence of cellular debris with fibrinopurulent exudate with surrounding reactive inflammatory changes. In patients with renal failure, iodinated and gadolinium-based contrast media are not recommended thus, in these cases, CEUS is very helpful to detect nephritic changes. (Fontanilla et.al, 2012)

2.3.9 Hyper enhancing Lesions

Hyper enhancement is most commonly secondary to hyper vascularity and can be found in hyper vascular tumors, vascular malformations, and trauma when there is active bleeding. Other conditions such as acute hemorrhage or hemorrhagic cysts may mimic hyper enhancement on enhanced CT, as they are hyper attenuated on unenhanced CT. (Silverman et.al, 2007).

An important issue is to evaluate if the hyper enhancement is detected in the arterial, venous, or late phase, as the differential diagnosis is different. Hyper enhancement in the arterial phase is found in richly vascularized.

Tumors such as RCC or oncocytomas (Fig 8), but they tend to become hypo vascular in the nephrographic phase when compared with the renal cortex, as has been described in the previous section. It is also found in arterial vascular malformations or active bleeding secondary to an arterial rupture.On the contrary, hyper enhancement in the venous phase is seen in venous malformations or venous bleeding. (Lee et.al, 2007)

Hyper enhancement in the excretory phase is rare, but diseases with decreased glomerular filtration such as pyelonephritis and excretory tract obstruction may show patchy cortical and medullary hyper enhancement in this late phase or even hours later because of slow flow and accumulation of contrast agent through the tubules. The detection of an acute, spontaneous, non-traumatic, sub- capsular, and perinephric hemorrhage, also known as Wunderlich syndrome, is a clinically rare, life-threatening condition. It can be secondary to sever all neoplastic and non-neoplastic renal diseases, including vascular diseases (vasculitis, renal artery aneurysms, arteriovenous malformations, and fistulas), renal tumors, and coagulation disorders (with a tendency to bleed).

The most common causes are angio myolipoma and RCC. The use of enhanced imaging confirms the presence and extension of the hematoma and allows the detection of the presence of acute bleeding and the underlying etiology (Katabathina et.al, 2011).

Imaging modalities are essential not only for the diagnosis of hyper vascular tumors but also to plan the treatment (surgery, embolization, or conservative treatment), as the risk of bleeding depends on the size of the tumor as well as the number and size of intratumoral vascularity (Fig 11). In the case of angiomyolipoma, the detection of aneurysms measuring >

(5 mm and a tumor size of 4cm or larger were found to be predictors of rupture (Yama et.al, 2002).

Moreover, all found that angiomyolipoma larger than 4cm with minimal vascularity was significantly less likely to require intervention owing to bleeding when compared with that having marked vascularity (Rimon et.al, 2006).

Regarding traumatic lesions, enhancing Imaging modalities, mainly multi detector CT, are essential to confirm the presence of active bleeding and to identify the injured vessel, areas of ischemia, and the presence of urinary extravasation (Dayal et.al, 2013).

Pseudo aneurysms can be differentiated from arterial bleeding as they enhance as adjacent arteries during all phases and do not change their size and morphology, whereas acute bleeding changes its morphology.

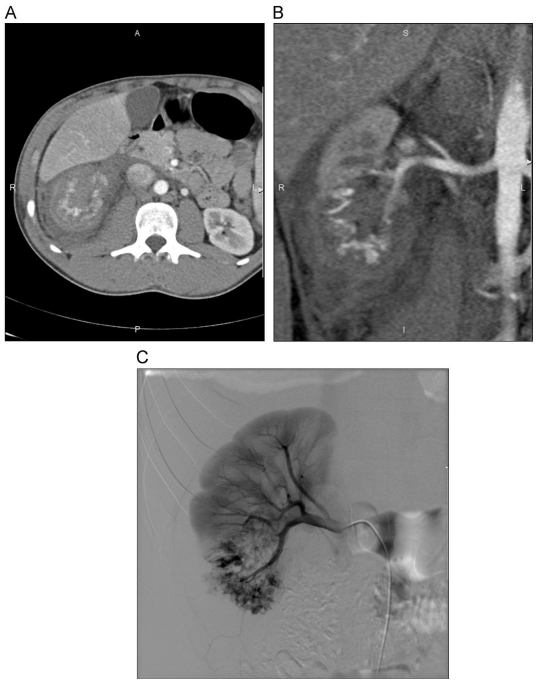

Figure 2.13 Posttraumatic shattered right kidney. (A and B) An axial and coronal reformatted CT image in the arterial phase shows extensive perinephrichematoma and heterogeneous patchy enhancement of the kidney with multiple renal lacerations, ischemic areas, pseudoaneurysms, and arteriovenous fistulas in the lower pole.

Chapter three

3. Material and Method

3.1. Material:

3.1.1Subject:

Fifty patients were enrolled in the study; all patients with flank pain at aged between (20-78 years), female or male were scanned with MDCTA. Patients with contraindications to iodinated contrast agent were excluded.

3.1.2 Machine used:

Specifications

CT machine Siemens 64 slice perspective.

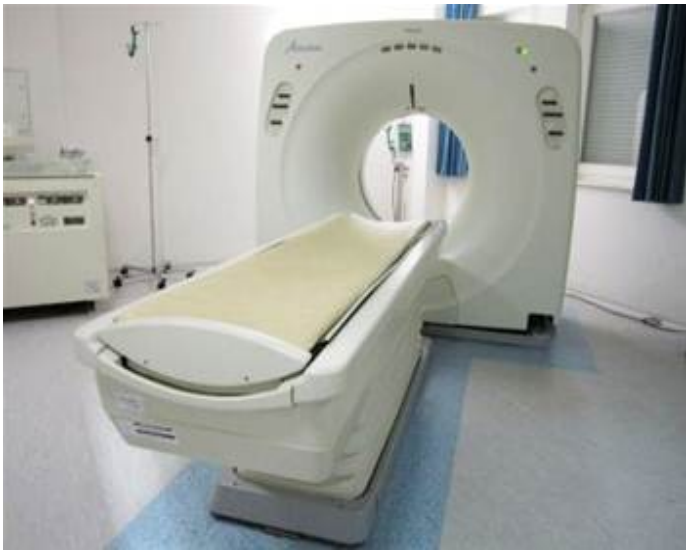

Figure (3.1) CT scan machine show gantry and couch

3.2. Method

3.2.1 Protocol:

Patients were placed in the supine position; Patients were also instructed not to breathe normal and to drink a much more fluid before the examination and not to urinate in order to see the full bladder volume and to clearly visualize the associated pathology. CT technical parameters included: matrix 512 X 512, field of view (FOV) 20 cm; tube current 685 mAs at 120kV; table feed 10mm/rotation, pitch 10/40mm. Axial images were analyzed, contrast injector (Medrao Toshiba) for flush contrast media to the patient and VITREA SYSTEMand K-PACS system for diagnosis images and reconstruction and volume rendered purposes in addition to the density data measurement and stone type estimations were used. For patient's preparation, patient instructed not to eat 24 hours before the examination time and a cretin light food was identified to the patient such as foods not having oily component also milk component in order to evacuate the large intestine from the fecal masses and the abdominal gases that may interfere with stone and affect the image quality, a 3-5 mm cuts was performed from the level just below the diaphragm to the symphysis pubic in order to visualize the kidneys, ureter, and bladder and its associated morbidity.

3.2.2 Study area:

This study was conducted at Khartoum state, Yastabshiroon Diagnostic Center.

3.2.3 Study duration:

This study was carried out from January 2016 to July 2016

3.2.4 Method of data collection:

The data were collect on master data sheet from the diagnostic stations which include all parameters need for evaluations.

3.2.5 Statistical analysis:

All data were presented as mean ± SD values. Data were analyzed by frequency distribution with the use of the SPSS (IBM SPSS version 21.0). A value of $P^{<}0.05$ was considered significant.

3.2.6 Ethical issues:

- There was official written permission to Khartoum state diagnostic centers to take the data.
- No patient data were published also the data was kept in personal computer with personal password.

Chapter 4

RESULT

Table 4.1 Descriptive Statistics for age and amount of contrast media

	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	20	78	53.80	13.118
Amount of Contrast	50	60	80	73.32	4.278

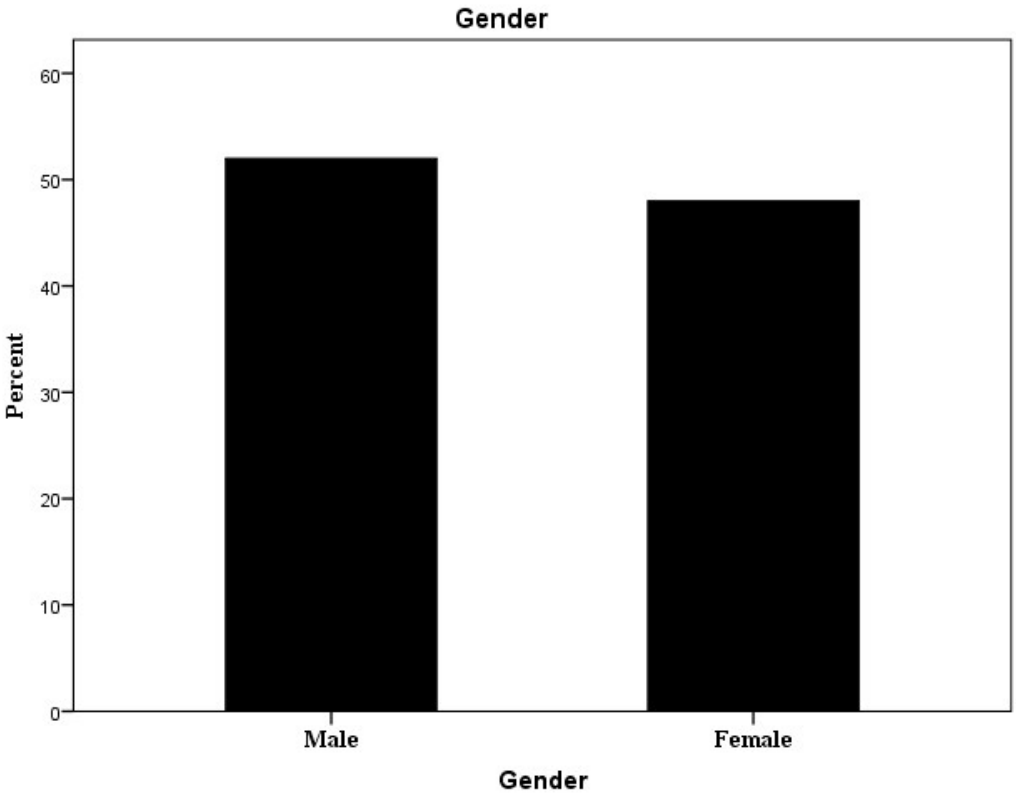

Figure 4.1 gender distribution

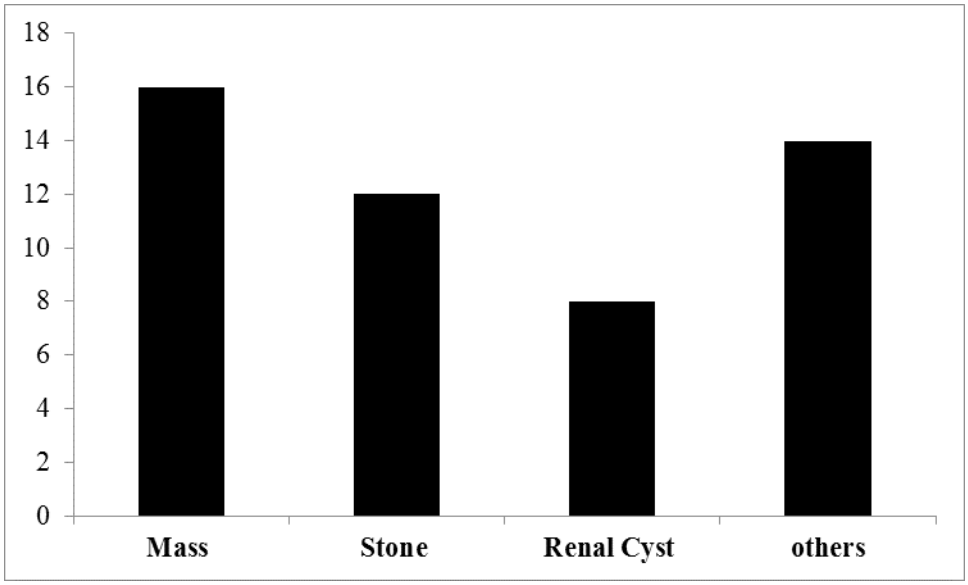

Figure 4.2 renal lesions frequency distribution

Table 4.2 non-enhancing lesions

	Non-enhanced lesions
1	Simple cyst
2	Abscess
3	Renal ischemia
4	Renal stone

Table 4.3 enhanced lesions

	Enhanced lesions
1	Inflammatory diseases
2	Renal cell carcinoma
3	Metastases

Chapter five

Discussion, conclusion and recommendation

5.1 Discussion:

The administration of a contrast agent provides not only morphologic information of the renal parenchyma but also physiological information through the enhancement of the nephron structures. This prospective study aimed to identify the role of contrast media used in CT scan in detecting renal diseases.

The result of this study revealed that the more frequent ages affected by renal diseases was between (20-78) years, according to gender male are more affected than female52% and 48% respectively. Regarding the type of diseases, there were 16 patients with renal masses, 12 of patients with renal stones, 8 patients have renal cyst and 14 of patient have other type of disease.

The non-enhanced lesion was simple cyst, abscesses, renal ischemia and renal stone. The absence of enhancement reflects the lack of vascularization, on histology; simple renal cysts have a fibrous cyst wall lined with a simple flat to cubical epithelium. Using imaging modalities, a simple cyst is characterized by a thin wall without septa and absence of vascularization in all the phases (Dyer et.al, 2008). In ischemia, absence of enhancement may be due to interruption of vascularization, thus, imaging findings can show from minimal segmental areas of parenchymal hypo perfusion in small vessel occlusive disease with good collateral circulation to a complete absence of enhancement in large emboli or thrombi without collateral circulation (Rajiah et.al, 2001).

The enhanced lesions were inflammatory diseases, RCC and metastases.

Most renal diseases diagnosed by imaging show hypoenhancement relating to the normal renal parenchyma, especially in the nephrographic phase. The hypoenhancement pattern can be focal, patchy, or diffuse. Most renal lesions including benign and malignant tumors show this pattern of enhancement, and a useful approach for their characterization is to differentiate between infiltrative and expansive lesions. Regarding hypoenhancing infiltrative lesions, they have a poorly defined transition relating to the adjacent parenchyma. Other features of infiltrative lesions are the presence of invasion of the renal sinus, excretory tract, or perirenal fat. This pattern is usually found in malignant lesions such as transitional cell carcinoma (TCC), metastases, infiltrative RCC, lymphomas, sarcomas, as well as in inflammatory diseases (Pickhard et.al, 2001).

The high sensitivity of CT for renal diseases have been established, preferred for detect of renal colic and evaluating renal disease, CT has advantages for evaluation of ureteric problem that are often difficult to visualize with US or other modalities because of overlying bowel gas. CT helps in determine size, number and position of renal diseases but the cost of CT remains a barrier to use.

5.2 Conclusion

Renal diseases are difficult to diagnose only by the CT, MRI,….etc. should be add procedure to improve and helpful the diagnoses of renal disease by administration of dye before take the image . CT has become primary imaging modality for evaluating acute flank pain and suspected renal disease, CT is particular value for detect renal disease, which often are not visualized with other imaging modalities.

CT scan without contrast material, IVP and X-ray of the abdomen along with the administration of contrast dye into the blood stream was the test most commonly used to detect urinary tract problem.

The purpose of this study to determine the role of CT with CM for detecting parenchymal, renal pelvis calculi.

The use of imaging modalities after the administration of a contrast agent is an essential tool in the diagnosis of renal lesions. Features of enhancement correlate with specific pathologic features and are very useful in the characterization of renal diseases.

5.3 Recommendations

Renal diseases prevention is most important for patients with recurrent urinary tract problem. The number of renal diseases continues to grow each year, with this growth recommend by the fallowing to reduce the incidence of renal diseases:

1. complementally to CECT for pretreatment staging and assessment of target lesion vascularity.

2. evaluation of immediate treatment effect after ablation.

3. training and development your skills is requirement meet that service need.

4. Early screening when feeling of signs and symptoms of disease and do not are ignores it.

5. CT scan must be done for its accurate diagnosis.

REFERENCES

DyerR,DiSantisDJ,McClennanBL. 2008,Simplified imaging approach for evaluation of the solid renal mass in adults ,5th edn 31–43,.

Evan, A; Worcester, E (2005). "Basic anatomy ".115 (10th edn)598–608.

FontanillaT,2012,MinayaJ,CortésC,etal.Acutecomplicatedpyelonephritis: .Contrast-enhancedCT.2nd edn,AbdomImaging,39–46

Hoppe, B; Langman, CB (2003). "physiology of renal system" 9th edn 86–91.

IsraelGM, HindmanN, BosniakMA. Radiology 2004 Evaluation of cysticrenalmasses: Comparison of CT and MR imaging by using the Bosniak classification system. 2nd edn 65–71

Johri, N; Cooper B, Robertson W, Choong S, Rickards D, Unwin R (2010). "An update and practical guide to renal stone management". Nephron Clinical Practice 116 (3rd edn)59–71.

KatabathinaVS,KatreR,PrasadSR,etal.2011,Wunder lichsyndrome :Cross -sectional imaging review .J Computed Assist Tomography 4th edn 25–33

LeeYJ,OhSN,RhaSE,etal.2007,Renaltrauma.RadiolClinNorthAm 3rd edn .81–92

NicolauC,BuñeschL,PañoB,etal. Prospective , 2014. evaluation of CT indeterminate renal masses using CT and CT contrast-enhanced. 2nd edn 22_24

Odejinmi F, Rizzuto MI, Macrae R, Olowu O, Hussain M. (2009). "diagnosis of renal stones".2009 May-Jun;16 3rd edn):354

PickhardtPJ,LonerganGJ,DavisCJ,etal . 2000, From the archives of the AFIP. Infiltrative renal lesions: Radiologic-pathologic correlation. Armed Forces Institute of Pathology.4th edn 43_44

Pietrow, PK; Karellas ME (2006). "Medical Management of Common Urinary Calculi". American Family Physician 74 1st edn : 86–94.

Preminger, GM (2007). "Chapter 148: Stones in the Urinary Tract". In Cutler, RE. The Merck Manual of Medical Information Home Edition (3rd Ed.) 07-27.

RimonU,DuvdevaniM,GarniekA,etal. 2006, Large renal angio myolipomas :Digital subtraction angiographicg radingand presentation .with bleeding. ClinRadiol 2006 12th edn;20–21

SaundersHS,DyerRB,ShifrinRY,etal. .Radiographics1995 The CT nephrogram : Implications for evaluation of urinary tract disease.3rd edn 69–85.

SilvermanSG,MorteleKJ,TuncaliK,etal.2007,Hyperattenuatingrenalmasses: Etiologies, pathogenesis, and imaging evaluation. 4th edn , Radiographics2007, 31–43 .

TanejaR,BhargavaP,CuevasC,etal. 2012, Common and less common renal masses and mass like conditions.2nd edn 45–57.

Thakker, RV (2000). "Physiology of renal system". Kidney International 57 3rd edn 87–93.

Vela G, Tulandi T. "patient preparation and indication ". Minim Invasive Gynecol. 2007Jul-Aug; 12thedition. 481-484.

WeberTM. 2006 ,Sonography of benign renal cystic disease .RadiolClin North Am. 4th edn 77–86.

Wolf Jr. JS (2011). "Anatomy of renal system". Nephrolithiasis. New York: WebMD. Retrieved 2011 2nd edn -7-27.

YuhBI, CohanRH. Roentgenol1999; Different phases of renal enhancement: Role in detecting and characterizing renal masses during helical CT.12th edn 47–55.

APPENDICES

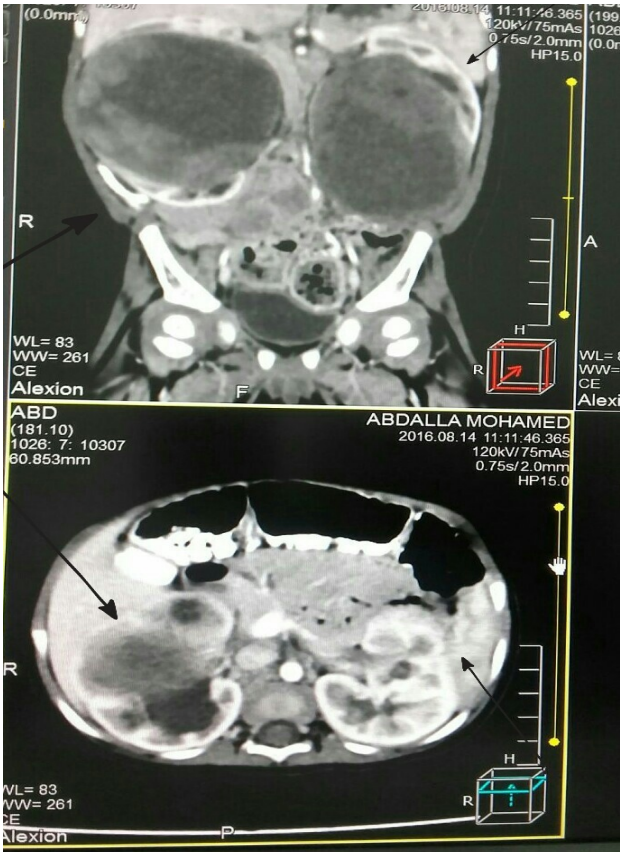

Image (1). CT pelvis axial and sagittal for Patient 13years has renal .(cell carcinoma (black arrow

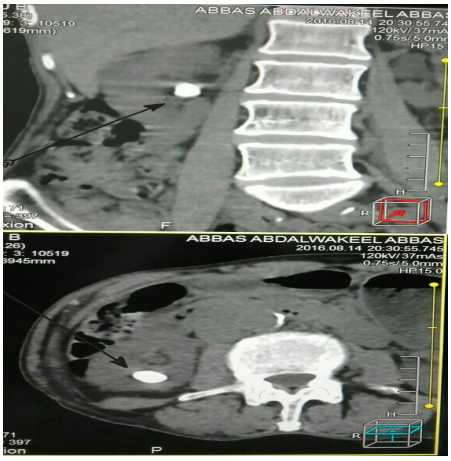

Image (2). CT abdomen axial and sagittal for Patient 33 years old .(has renal stone (black arrow

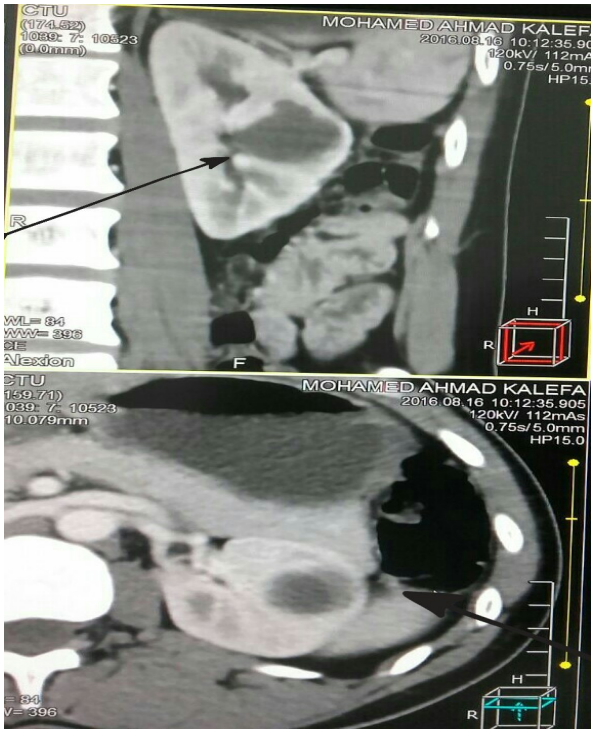

Image (3). CT abdomen axial and sagittal for Patient 40 years old .(has Lft kidney cyst (black arrow

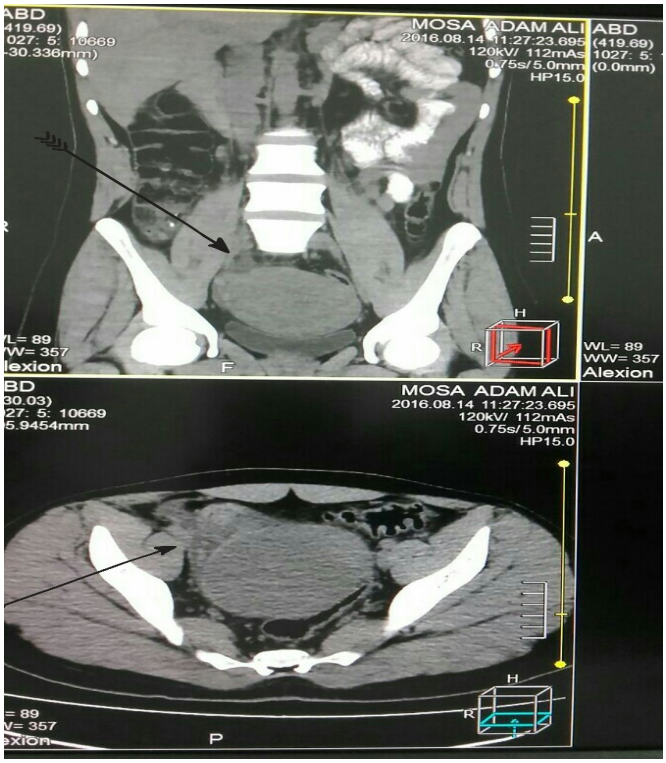

Image (4). CT pelvis axial and sagittal for Patient 66 years old has .(ureter mass (black arrow