Sudan University of Science and Technology

College of Graduate Studies

Study of Renal Stone Composition using Computed Tomography

دراسة مكونات حصاوي الكلي باستخدام الأشعة المقطعية المحو سبة

A thesis Submitted for Partial Fulfillment for the Requirement of M.sc degree in Radiological Imaging Diagnosis

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الآيـة

قال الله تعالى:

(سَنُرِيهِمْ آيَاتِنَا فِي الْآفَاقِ وَفِي أَنْفُسِهِمْ حَتَّى يَتَبَيَّنَ لَهُمْ أَنَّهُ الْحَقُّ) .

صدق الله العظيم

سوره فصلت.53.

Dedication

To my family

For their support and patience, for their love and understanding.

Acknowledgement

First and foremost, I would like to thank Allahfor achieve this work and then thanks toDr. Ahmed Mostafa Abukonna for supporting and guiding meto accomplish this work. In addition, I would to thank all staff and doctors of College of Medical Radiological Sciences-Sudan University of Sciences and Technology.

Abstract

This is analytic study conducted in Khartoum state hospitals in period from November 2016 to February 2017.the problem of study was no similar study proceeded in Sudanese populations. The data was collected from computed tomography scan to area of kidneys, ureters and urinary bladder. Classified and analyzed by stood for statistical package for the social sciences application. The aim of study was study chemical composition of renal stone in Sudanese population using computed tomography scan.

The study found that most chemical composition of renal stone among Sudanese population was uric acid(59.4%),Cystine (36.3%) then Struvite(13.3%) and calcium(5.4%). The majority of People with uric acid renal stone in Sudan were innorth of Sudanandpeople inwest of Sudan, population withcyctinewere in the west andmiddle of Sudan, while few people with calciumstone in Sudanese population. The most effective age group with renal stone was 40-50 years old (35.1%) and same age group have a uric acid stone (21.1%). furthermore the most common age group with a cyctine renal stone were the children in age between 1 years to 10 years old.

In conclusion, uric acid, Cystine, and calcium stone composition may be reliably predicted in vivo on the basis of dual-energy Computed tomography findings. In the future, a single dual-energy computed tomography examination may contribute to not only the identification but also the chemical characterization of stones in the urinary tract, and it may add to the information available from nonenhanced conventional CT performed for evaluation of nephrolithiasis.

ملخص البحث

هذه دراسه تحليليه تمت في عدد من مستشفيات ولاية الخرطوم في الفترة من نوفمبر 2016 الي فبراير2017 و تكمن مشكله البحث في انه لم تكن هناك دراسات مماثله اجريت علي السودانيين وحُصلت البياناتمن فحص الأشعة المقطعية لمنطقه الكُلي ، الحالب والمثانة. تم تصنيف و تحليل البيانات بالاستخدام برنامج الحزمةالإحصائية للعلوم الاجتماعية برزت اهميه البحث في دراسة التركيب الكيميائي لحصاوي الكلى لدى السودانيين.

وجدت الدراسة أن أكثر تركيب كيميائي للحصاوي انتشاراً بين السودانيين هو حمض اليوريك ،بنسبه (59.4%)، (36.3%)سيستين ، (13.3%)ثم استروفيت(5.4%) كالسيوم. كما وجدت الدراسة أن مظم تركيب كيميائي في شمال وغرب السودان هو حمض اليوريك اما في شرق ووسط السودان هو السيستين في حين ان عدد قليل من جميع الحصاوي تتركب من الكالسيوم. أما بالنسبة للفئه العمرية الاكثر تأثيرا بالحصاوي هي العمر من 40 الي 50 سنه بنسبه (35.1%) ونفس الفئة تتكونحصاويها من حمض اليوريك بنسبه (21.1%).وبالنسبة للأطفال في العمر من سنه واحده الي 10 سنوات اظهرت النتائج ان معظمها يتكون من السيستين.

خلصت الدراسة الي أن المحتوى الكيميائي من حمض اليوريك ، السيستينوالكالسيوم يمكن تحديدها في داخل الجسم الحيوي عن طريق أجهزه الأشعة المقطعية ذي الطاقة المزدوجة. في المستقبل في أجهزه الأشعة المقطعية ذي لطاقه الأحادية والمزدوجة يمكن ان يساهم ليس في تحديد الحصاوي واكتشافها فقط بل في تحديد الخواص الكيميائية لحصاوي المجرى البولي وهذه اضافه للمعلومات المتاحة في فحص الأشعةالمقطعيةالمعتاد لتقييم حصاوي الكُلى.

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Chapter one

Introduction

1.1 Introduction:

The morbidity associated with urolithiasis includes colic pain and kidney obstruction, which can lead to renal failure and severe urinary tract infections such as pyonephrosis and septic shock in some patients. Knowledge of the composition of urinary tract stones is a fundamental part of the preoperative patient evaluation, and this information influences treatment plans and recurrence prevention. For example, stones composed of cystine or calcium oxalate monohydrate have a firm composition that may limit the success of extracorporeal shock wave lithotripsy (Curhan, 2007). The three most common techniques for stone analysis are in vitro x-ray diffraction, infrared spectroscopy, and polarization microscopy. In addition to being costly and time consuming, these methods have a major disadvantage in that the chemical analysis of the stones is perform only after the stones were extract. Thus, they offer no benefit during preoperative treatment planning (Renner, 1999).

Non-enhanced computed tomography (CT) of the abdomen and pelvis is currently the reference-standard examination for the diagnosis and evaluation of urinary stones, and it is widely used owing to its safety and reported high sensitivity (96%)(Renner, 1999).

The prevalence and incidence of nephrolithiasis was report to be increasing across the world. Herein, we review information regarding stone incidence and prevalence from a global perspective. A literature search using PubMed and Ovid was perform to identify peer-reviewed journal articles containing information on the incidence and prevalence of kidney stones. Key words used included kidney stone prevalence, incidence, and epidemiology. Data were collected from the identified literature and sorted by demographic factors and time period. A total of 75 articles were identified containing kidney stone-related incidence or prevalence data from 20 countries; 34 provided suitable information for review. Data regarding overall prevalence or incidence for more than a single period were found for 7 countries (incidence data for 4 countries; prevalence data for 5 countries). These included 5 European countries (Italy, Germany, Scotland, Spain, and Sweden), Japan, and the United States. The body of evidence suggests that the incidence and prevalence of kidney stones is increasing globally. These increases are seen across sex, race, and age. Changes in dietary practices may be a key driving force. In addition, global warming may influence these trends (Winston-Salem, 2010).

Using computed tomography (CT) to analyze the chemical composition of renal calculi and thus aid in selecting the best treatment method after measured the ranges of CT attenuation value for chemical type of renal calculi, depend on this experiment to prospectively evaluate the chemical composition of renal and ureteric stones in Sudanese population, most of courtiers around world have data base about prevalence of renal stone disease, this study making reference for Sudanese doctor to know what is real chemical structure of renal stone in Sudanese patients.

1.2 Problem of the study

The main problem of this study there is no previous study proceed in Sudanese population to analytic the chemical composition of renal stones in Sudanese population.

1.3 Objectives of the study

1.3.1 General objective

This study ofrenalstone compositionusingcomputed tomography, directed to analysis the renal stone into chemical component in Sudanese population.

1.3.2 Specific objectives

- To study chemical composition of renal stone in Sudanese population
- To assessment prevalence of specific chemical composition of renal stone among Sudanese population according to geographic area.
- To correlate the chemical type of renal stone to patient age.

1.4 overview of the study:

The study divided into brief five chapters. First one contain on brief introduction about main subject of thesis, problems of the study and general and specific objectives. Chapter two hold all theoretical background and previous study. Chapter three descriptions the material and method were use during collecting the data. Then the result coming on chapter four and last chapter contain discussion, conclusion, same recommendation and references.

Chapter tow

2.1 Theoretical Background:

2.1.1Anatomy of urinary system

The first successful human organ transplant was a kidneytransplant performed in 1953. The **urinary system** consists of two kidneys, two ureters, the urinary bladder, and the urethra. The formation of urine is the function of the kidneys, and the rest of the system is responsible for eliminating the urine".

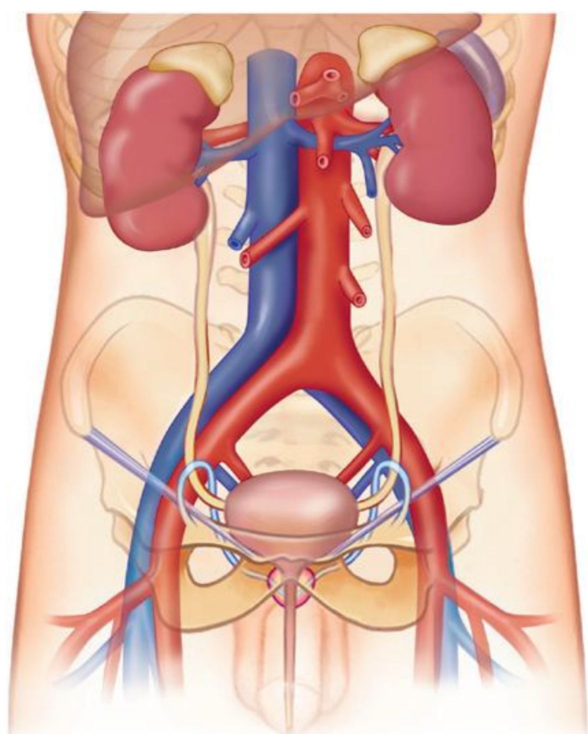


Figure2.1 The urinary system shown in anterior view. (Ronald eta.al 2012).

2.1.2 Kidneys:

The two kidneys are located in the upper abdominal cavity on either side of the vertebral column, behind the peritoneum (retroperitoneal). The upper portions of the kidneys rest on the lower surface of the diaphragm and are enclosed and protected by the lower rib cage (see Fig.1–1). The kidneys embedded in adipose tissue that acts as a cushion and is in turn cover by a fibrous connective tissue membrane called the renal fascia, which helps hold the kidneys in place. Each kidney has an indentation called the hilus (see figure 2.2) on its medial side. At the hilus, the renal artery enters the kidney, and the renal vein and ureter emerge. The renal artery is a branch of the abdominal aorta, and the renal vein returns blood to the inferior vena cava (see Fig. 1–1). The ureter carries urine from the kidney to the urinary bladder (Valerie eta.al 2007).

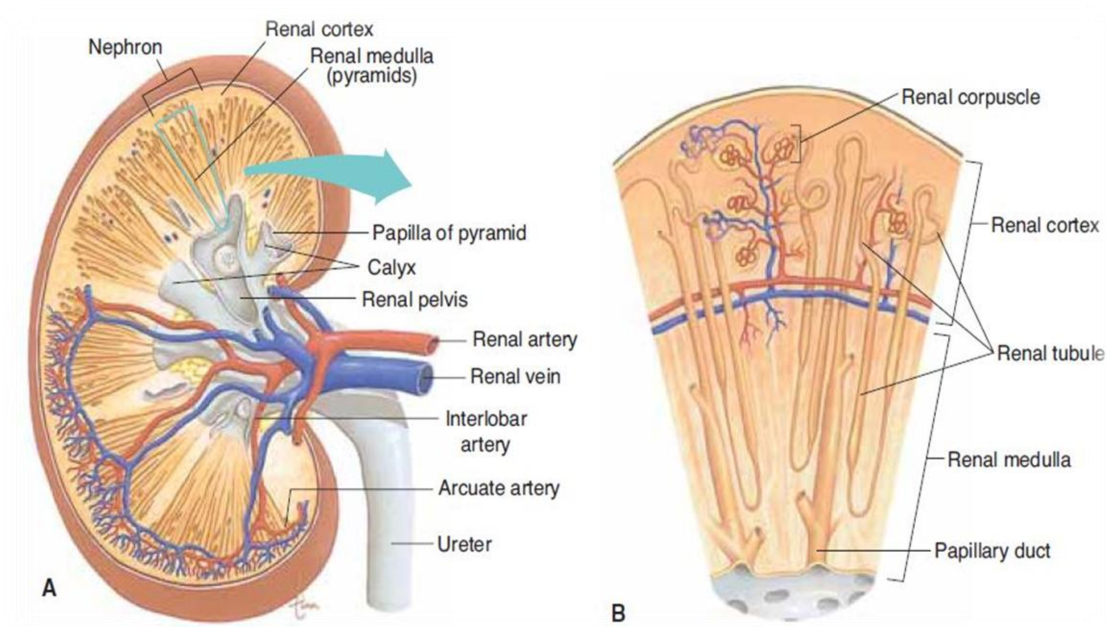


Figure 2.2 (**A**) Frontal section of the right kidney showing internal structure and blood vessels. (**B**) The magnified section of the kidney shows several nephrons (Valerie eta.al 2007).

2.1.3The Nephron:

The Nephron is the structural and functional unit of the kidney. Each kidney contains approximately1million Nephron. It is in the Nephron, with their associated blood vessels, that urine is form. Each Nephron has two major portions: a renal corpuscle and a renal tubule see figure 2.2. (Valerie eta.al 2007).

2.1.4 Ureters and urinary bladder

“Each **ureter** extends from the hilus of a kidney to the lower, posterior side of the urinary bladder (see Fig.1–1). Like the kidneys, the ureters are retroperitoneal, that is, behind the peritoneum of the dorsal abdominal cavity. The smooth muscle in the wall of the ureter contracts in peristaltic waves to propel urine toward the urinary bladder. As the bladder fills, it expands and compresses the lower ends of the ureters to prevent backflow of urine triangular area called the **trigone**, which has no rugae and does not expand the points of the triangle are the openings of the two ureters and that of the urethra”. (Valerie eta.al2007).

2.1.5 Urethra

“The **urethra** carries urine from the bladder to the exterior. The **external urethral sphincters** made of the surrounding skeletal muscle of the pelvic floor, and is under voluntary control. In women, the urethra is 1 to 1.5 inches (2.5 to 4 cm) long and is anterior to the vagina. In men, the

Urethra is 7 to 8 inches (17 to 20 cm) long. The first part just outside the bladder is call the prostatic urethra because it is surround by the prostate gland. The next inch is the membranous urethra, around, which is the external urethral sphincter. The longest portion is the cavernous urethra (or spongy or penile urethra), which passes through the cavernous (or erectile) tissue of the penis. The male urethra carries semen as well as urine”. (Valerie eta.al. 2007).

2.2 Physiology

2.2.1Functions of the Urinary System

One of the major functions of the Urinary system is the process of excretion. Excretion is the process of eliminating, from an organism, waste products of metabolism and other materials that are of no use. The urinary system maintains an appropriate fluid volume by regulating the amount of water that is excrete in the urine. Other aspects of its function include regulating the concentrations of various electrolytes in the body fluids and maintaining normal pH of the blood. Several body organs carry out excretion, but the kidneys are the most important excretory organ. The primary functions of the kidneys are to maintain a stable internal environment (homeostasis) for optimal cell and tissue metabolism. They do this by separating urea, mineral salts, toxins, and other waste products from the blood. They also do the job of conserving water, salts, and electrolytes. At least one kidney must function properly for life to be maintain. Six important roles of the kidneys are:

First, Regulation of plasma ionic composition. Ions such as sodium, potassium, calcium, magnesium, chloride, bicarbonate, and phosphate are regulate by the amount that the kidney excretes.

Second, Regulation of plasma osmolarity. The kidneys regulate osmolarity because they have direct control over how many ions and how much water a person excretes.

Third, Regulation of plasma volume. Your kidneys are so important they even have an effect on your blood pressure. The kidneys control plasma volume by controlling how much water a person excretes. The plasma volume has a direct effect on the total blood volume, which has a direct effect on your blood pressure. Salts such as NaCI can cause osmosis, the diffusion of water into the blood.

Fourth, Regulation of plasma hydrogen ion concentration (pH). The kidneys partner up with the lungs and they together control the pH. The kidneys have a major role because they control the amount of bicarbonate excreted or held onto. The kidneys help maintain the blood Ph mainly by excreting hydrogen ions and reabsorbing bicarbonate ions as needed.

Fifth, Removal of metabolic waste products and foreign substances from the plasma. One of the most important things the kidneys excrete is nitrogenous waste. As the liver breaks down amino acids, it also releases ammonia. The liver then quickly combines that ammonia with carbon dioxide, creating

2.3 Pathology

"Diseases of the kidney are as complex as its structure, but their study is facilitated by dividing them into those that affect the four basic morphologic components: glomeruli, tubules, interstitium, and blood vessels". (Kumar eta al 2012).

2.3.1 Renal Disease

2.3.1.1Clincal manifestation of renal disease:

The clinical manifestations of renal disease can be group into reasonably well defined syndromes. Some are peculiar to glomerular diseases; others are present in diseases that affect any one of the components. Before we list the syndromes, a few terms must be clarify. Azotemia refers to an elevation of blood urea nitrogen and creatinine levels and is largely relate to a decreased glomerular filtration rate (GFR). Azotemia is produce by many renal disorders, but it also arises from extrarenal disorders. Prerenal azotemia is encountere when there is hypoperfusion of the kidneys, which decreases GFR in the absence of parenchymal damage. Postrenal azotemia can result when urine flow is obstructed below the level of the kidney. Relief of the obstruction is followed by correction of the azotemia. When azotemia progresses to clinical manifestations and systemic biochemical abnormalities, it is termed uremia. Uremia is characterized not only by failure of renal excretory function but also by a host of metabolic and endocrine alterations incident to renal damage. There is, in addition, secondary gastrointestinal (e.g., uremic gastroenteritis), neuromuscular (e.g., peripheral neuropathy),

And cardiovascular (e.g., uremic fibrinous pericarditis) involvement. (Robins.2007).**The major renal syndromes are:**

1. Acute nephritic syndrome is a glomerular syndrome dominated by the acute onset of usually grossly visible hematuria (red blood cells in urine), mild to moderate proteinuria, azotemia, edema, and hypertension; it is the classic presentation of acute post streptococcal glomerulonephritis.
2. The nephrotic syndrome is a glomerular syndrome characterized by heavy proteinuria (excretion of >3.5 gm of protein/day in adults), hypoalbuminemia, severe edema, hyperlipidemia, and lipiduria (lipid in the urine).
3. Asymptomatic hematuria or proteinuria, or a combination of these two, is usually a manifestation of subtle or mild glomerular abnormalities.
4. Rapidly progressive glomerulonephritis results in loss of renal function in a few days or weeks and is manifested by microscopic hematuria, dysmorphic red blood cells and red blood cell casts in the urine sediment, and mild-to-moderate proteinuria.
5. Acute renal failure is dominated by oliguria or anuria (no urine flow), with recent onset of azotemia. It can result from glomerular injury (such as crescentic glomerulonephritis), interstitial injury, vascular injury (such as thrombotic microangiopathy), or acute tubular necrosis.

6. Chronic renal failure, characterized by prolonged symptoms and signs of uremia, is the end result of all chronic renal diseases.
7. Urinary tract infection is characterized by bacteriuria and pyuria (bacteria and leukocytes in the urine). The infection may be symptomatic or asymptomatic, and it may affect the kidney (pyelonephritis) or the bladder (cystitis) only.
8. Nephrolithiasis (renal stones) is manifested by renal colic, hematuria, and recurrent stone formation.

2.3.1.2Renal stones:

Urolithiasis is calculus formation at any level in the urinary collecting system, but most often the calculi arise in the kidney. They occur frequently, as evidenced by the finding of stones in about 1% of all autopsies. Symptomatic urolithiasis is more common in males. A familial tendency toward stone formation has long been recognized.

About 75% of renal stones are composed of either calcium oxalate or calcium oxalate mixed with calcium phosphate. Another 15% are composed of magnesium ammonium phosphate, and 10% are either uric acid or cyctine stones.

Stones may be present without producing either symptoms or significant renal damage. This is particularly true with large stones lodged in the renal pelvis. Smaller stones may pass into the ureter, producing a typical intense pain known as *renal or ureteral colic*, characterized by paroxysms of flank pain radiating toward the groin. Often at this time there is *gross hematuria.* The clinical significance of stones lies in their capacity to obstruct urine flow or to produce sufficient trauma to cause ulceration and bleeding. In either case, they *predispose the patient to bacterial infection.* Fortunately, in most cases the diagnosis is readily made radiologically.

2.3.1.2 Hydronephrosis:

Hydronephrosis refers to dilation of the renal pelvis and calyces, with accompanying atrophy of the parenchyma, caused by obstruction to the outflow of urine. The obstruction may be sudden or insidious, and it may occur at any level of the urinary tract, from the urethra to the renal pelvis. The most common causes are as follows:

A. Congenital: Atresia of the urethra, valve formations in either ureter or urethra, aberrant renal artery compressing the ureter, renal ptosis with torsion, or kinking of the ureter
B. Acquired
    1. Foreign bodies: Calculi, necrotic papillae
    2. Tumors: Benign prostatic hypertrophy, carcinoma of the prostate, bladder tumors (papilloma and carcinoma), contiguous malignant disease (retroperitoneal lymphoma, carcinoma of the cervix or uterus)
    3. Inflammation: Prostatitis, urethritis, urethritis, retroperitoneal fibrosis
    4. Neurogenic: Spinal cord damage with paralysis of the bladder

    Normal pregnancy: Mild and reversible

Bilateral hydronephrosis occurs only when the obstruction is below the level of the ureters. If blockage is at the ureters or above, the lesion is unilateral. Sometimes obstruction is complete, allowing no urine to pass; usually it is only partial. (Kumar eta al 2012).

2.3.1.3 Tumors:

Many types of benign and malignant tumors occur in the urinary tract. In general, benign tumors such as small (<0.5 cm) cortical papillary adenomas or medullary fibromas (interstitial cell tumors) have no clinical significance. The most common malignant tumor of the kidney is renalcell carcinoma, followed in frequency by nephroblastoma (Wilms tumor) and by primary tumors of the calyces andpelvis. Other types of renal cancer are rare and need notbe discussed here. Tumors of the lower urinary tract areabout twice as common as renal cell carcinomas

2.3.1.4 Renal Cell Carcinoma

These tumors are derived from the renal tubular epithelium, and hence they are located predominantly in the cortex. Renal carcinomas represent 80% to 85% of all primary malignant tumors of the kidney, and 2% to 3% of all cancers in adults. This translates into about 30,000 cases per year; 40% of patients die of the disease. Carcinomas of the kidney are most common from the sixth to seventh decades, and men are affected about twice as commonly as women. The risk of developing these tumors is higher in smokers, hypertensive or obese patients, and those who have had occupational exposure to cadmium. Smokers who are exposed to cadmium have a particularly high incidence of renal cell carcinomas. The risk of developing renal cell cancer is increased 30-fold in individuals who develop acquired polycystic disease as a complication of chronic dialysis".(Robbins.2007).

Renal cell cancers were formerly classified on the basisof morphology and growth patterns. However, recent advances in the understanding of the genetic basis of renal carcinomas have led to a new classification based on the molecular origins of these tumors. The three most common forms are as follows:

2.3.1.5 Clear Cell Carcinomas

These are the most common type, accounting for 70% to 80% of renal cell cancers. Histologically, they are made up of cells with clear or granular cytoplasm

2.3.1.6 Papillary Renal Cell Carcinomas

These comprise 10% to 15% of all renal cancers. As the name indicates, they show a papillary growth pattern. These tumors are frequently multifocal and bilateral andappear as early-stage tumors. Like clear cell carcinomasthey occur in familial and sporadic forms, but unlike these tumors, papillary renal cancers have no abnormality of chromosome 3.

Although Wilms tumor occurs infrequently in adults, it is the third most common organ cancer in children younger than the age of 10 years. It is therefore one of the major cancers of children. These tumors contain a variety of cell and tissue components, all derived from the mesoderm. Wilms tumor, like retinoblastoma, may arise sporadically or be familial, with the susceptibility to tumorigenesis inherited as an autosomal dominant trait.

Tumors of the Urinary Bladder and Collecting System (Renal Calyces, Renal Pelvis, Ureter, and Urethra)

The entire urinary collecting system from renal pelvis to urethra is lined with transitional epithelium, so its epithelial tumors assume similar morphologic patterns. Tumors in the collecting system above the bladder are relatively

Uncommon; those in the bladder, however, are an even more frequent cause of death than are kidney tumors. Nevertheless, in the individual case a small lesion in the ureter, for example, may cause urinary outflow obstruction and have greater clinical significance than a much larger mass in the capacious bladder. We consider first the range of histologic patterns as they occur in the urinary bladder and then their clinical implications.

Painless hematuria is the dominant clinical presentation of all these tumors. Because most arise in the bladder, we will consider these first. They affect men about three times as frequently as women and usually develop between the ages of 50 and 70 years. Although most occur in persons with no known history of exposure to industrial solvents, bladder tumors are 50 times more common in those exposed to β-naphthylamine. Cigarette smoking, chronic cystitis, schistosomiasis of the bladder, and certain drugs (cyclophosphamide) are also believed to induce higher rates of this cancer". (Robbins.2007).

2.4Previous study

Daniel T. Boll, MD prospectively evaluate the capability of noninvasive, simultaneous dual-energy (DE) multidetector computed tomography (CT) to improve characterization of human renal calculi in an anthropomorphic DE renal phantom by introducing advanced postprocessing techniques, with ex vivo renal stone spectroscopy as the reference standard. Fifty renal calculi were assessed: Thirty stones were of pure crystalline composition (uric acid, cystine, struvite, calcium oxalate, calcium phosphate, brushite), and 20 were of polycrystalline composition. DE CT was performed with a 64-detector CT unit. A postprocessing algorithm ($DECT_{Slope}$) was proposed as a pixel-by-pixel approach to generate Digital Imaging and Communications in Medicine dataset gray-scale–encoding ratios of relative differences in attenuation values of low- and high-energy DE CT. Graphic analysis, in which clusters of equal composition were identified, was performed by sorting attenuation values of color composition–encoded calculi in an ascending sequence. Multivariate general linear model analysis was used to determine level of significance to differentiate composition on native and postprocessed DE CT images.

The result of his study revealed that graphic analysis of native DE CT images was used to identify clusters for uric acid (453–629 HU for low-energy CT, 443–615 HU for high-energy CT), cystine (725–832 HU for low-energy CT, 513–747 HU for high-energy CT), and struvite (1337–1530 HU for low-energy CT, 1007–1100 HU for high-energy CT) stones; high-energy clusters showed attenuation value overlap. Polycrystalline calcium oxalate and calcium phosphate calculi were found throughout the entire spectrum, and dense brushite had attenuation values of more than 1500 HU for low-energy CT and more than 1100 HU for high-energy CT. The DE CT algorithm was used to generate specific identifiers for uric acid (77–80 U_{Slope}, one outlier), cystine (70–71 U_{Slope}), struvite (56–60 U_{Slope}), calcium oxalate and calcium phosphate (17–59 U_{Slope}), and brushite (4–15 U_{Slope}) stones. Statistical analysis showed that all compositions were identified unambiguously with the $\mathrm{DECT}_{\mathrm{Slope}}$ algorithm.

Chapter Three

3. Material and Method

3.1 Material

The data used in this study were collect from department of radiology of Ibn Elhaitham Diagnostic center

3.1.1 Subjects:

A total of 50 patients referred to Ibn Elhaitham diagnostic center in the period of the study suspected for renal calculi, the data include gender, age, size, Hounsfield unit (CT-number), geographic area of the patients in Sudan and position of renal stone (Pelvic-calyceal system or ureter). The stones that located in the lower part of ureter and urinary bladder were exclude.

3.1.2 Machine used:

The study use only one machine, which is 4 slice Toshiba CT scan low-energy and fan beam shape made in Japan.

Figure 3.1 show CT scan machine

3.2 Method

Using the absolute CT value measured at 120 kV, Hounsfield unit at 120 kV.), 150-250 mAs selection of exposure parameters depend on the weight and age of the patients, which were, listed in master data sheet. The data analysis program used in this study is SSPS.

3.2.1 Technique used:

The study conducted on patients referred for CT scan to kidney, ureter and bladder (CT-KUB) without contrast helical CT scan, applied 5mm slice thickness and 2mm slice thickness after reconstruction. During study the patient lie supine in CT scan couch, feet first in comfort position with Pellow under the knees and upper extremities raised above the head

3.2.2 Image interpretation:

All cases in the study requested for CT KUB, the renal calculi detection by CT Technician then confirmed and diagnosed by Radiologist.

3.2.3 Measurement

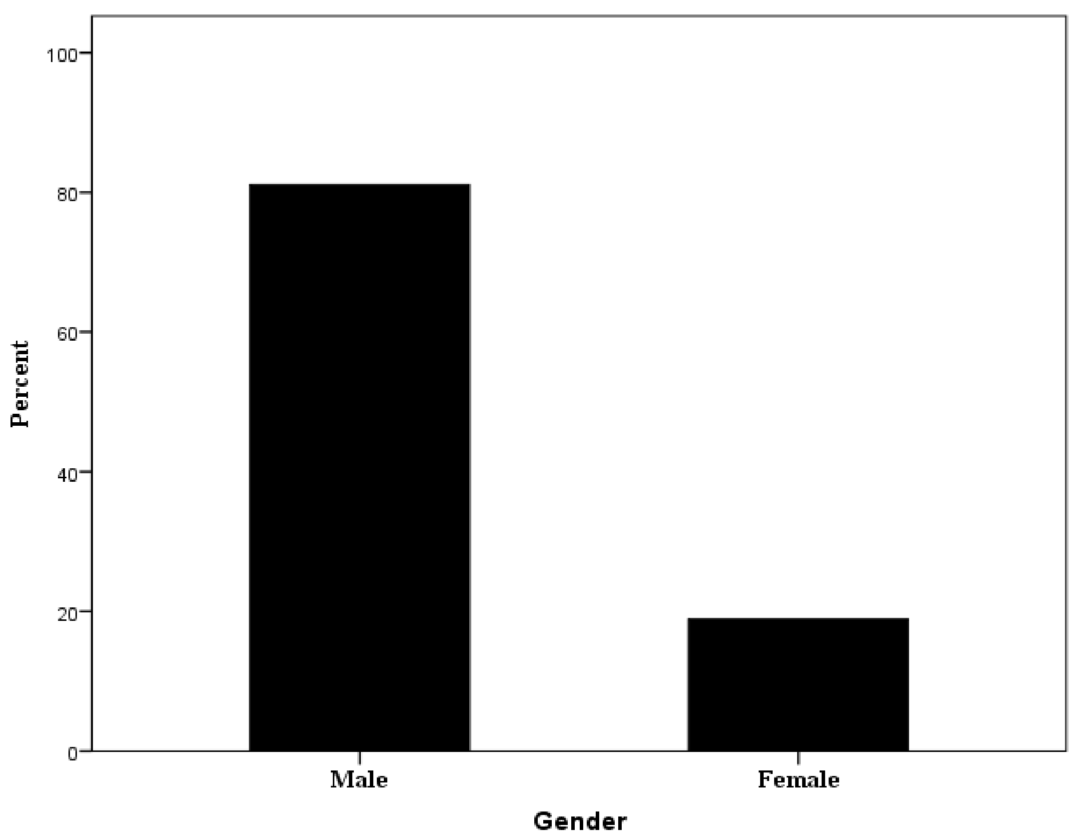
Measurement the Hounsfield unit (CT number) to renal calculi in range of low and high CT number was detected in calculi, then matched with type of renal stones (struvite, calcium, uric acid, cyctine) which is already from previous study.

Chapter four

The Results

Table 4:1 show the study population

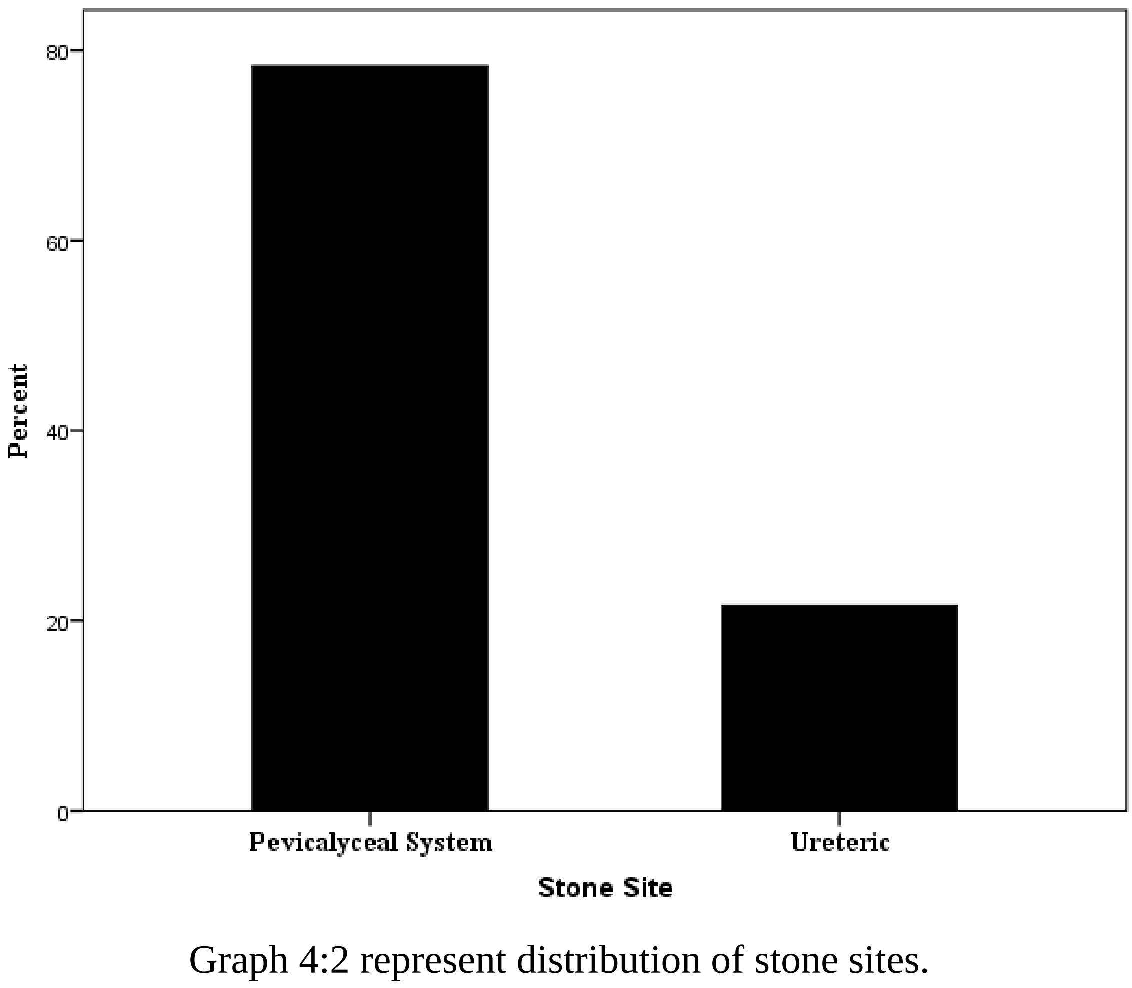
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	30	81.1	81.1	81.1
	Female	7	18.9	18.9	100.0
	Total	37	100.0	100.0	



Graph 4.1 represents gender frequency.

Table 4:2 show the Stone Site

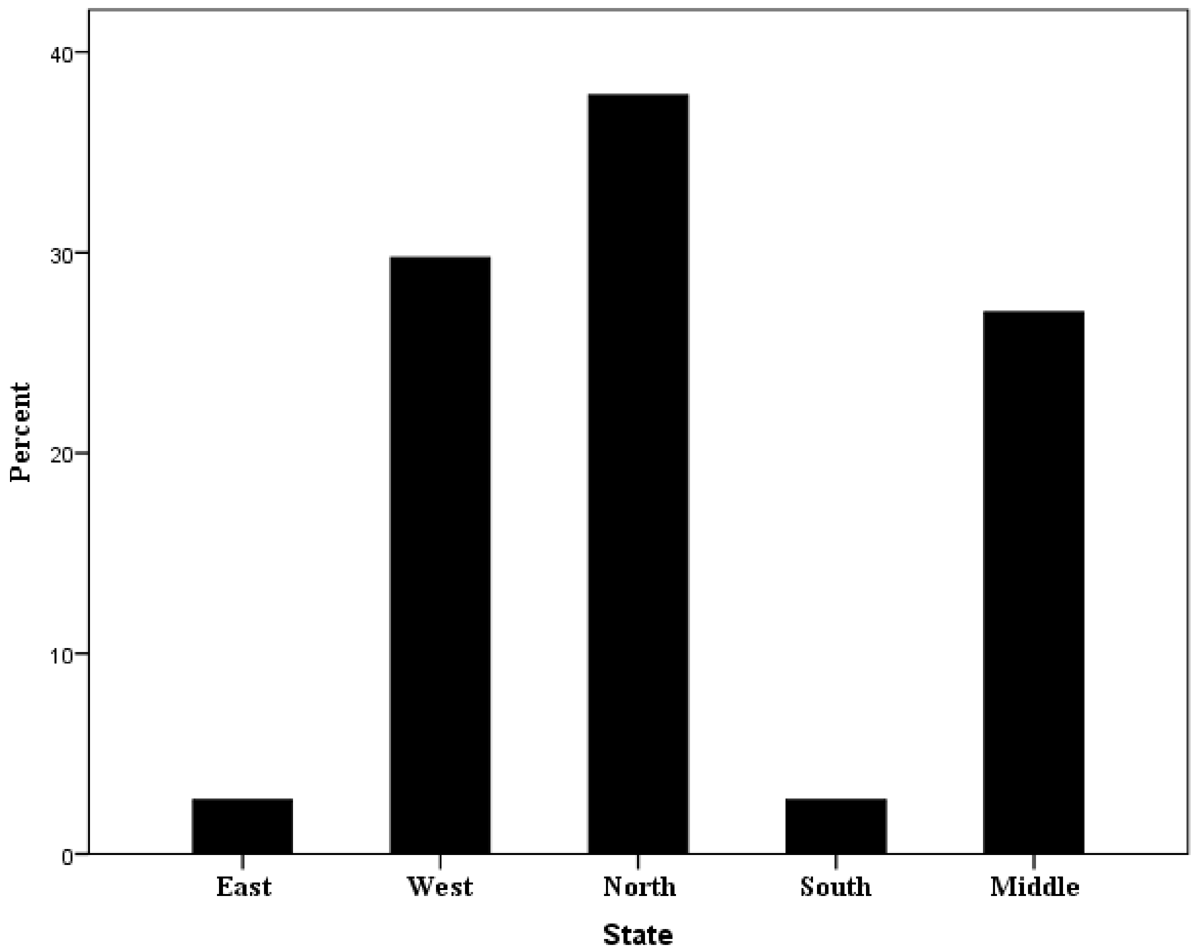
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Pelvicalyceal System	29	78.4	78.4	78.4
	Ureteric	8	21.6	21.6	100.0
	Total	37	100.0	100.0	



Graph 4:2 represent distribution of stone sites.

Table 4:3 show the State

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	East	1	2.7	2.7	2.7
	West	11	29.7	29.7	32.4
	North	14	37.8	37.8	70.3
	South	1	2.7	2.7	73.0
	Middle	10	27.0	27.0	100.0
	Total	37	100.0	100.0	



Graph 4:3 represent distribution of stone type in states.

Table 4:4 Chemical Composition.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	*Uric acid*	22	59.5	59.5	59.5
	Cystine	8	21.6	21.6	81.1
	Struvite	5	13.5	13.5	94.6
	Calcium	2	5.4	5.4	100.0
	Total	37	100.0	100.0	

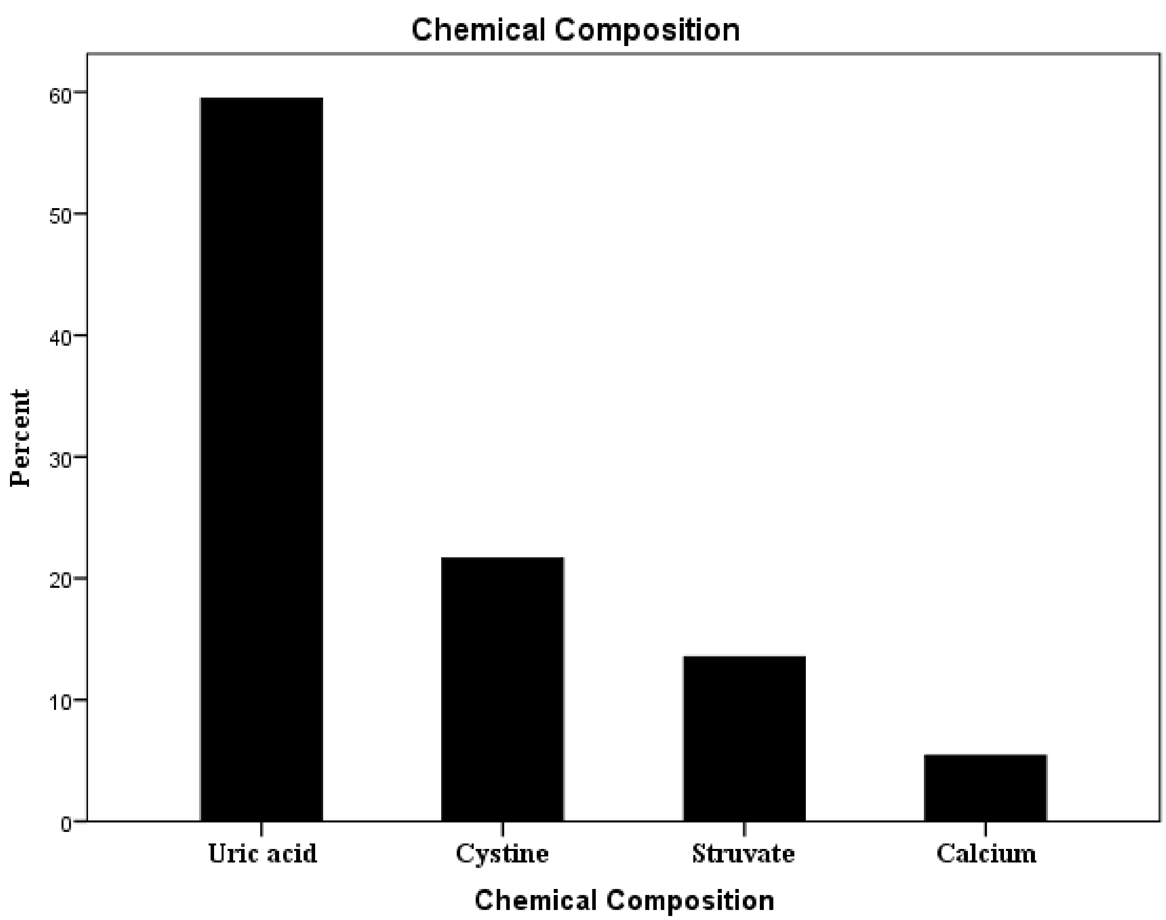


Figure 4:4 represent percent of any chemical composition

Table 4:5 State * Chemical Composition Cross tabulation

Count

		Chemical Composition				Total
		Uric acid	Cystine	Struvite	Calcium	
State	East	1	0	0	0	1
	West	7	4	0	0	11
	North	9	1	4	0	14
	South	1	0	0	0	1
	Middle	4	3	1	2	10
Total		22	8	5	2	37

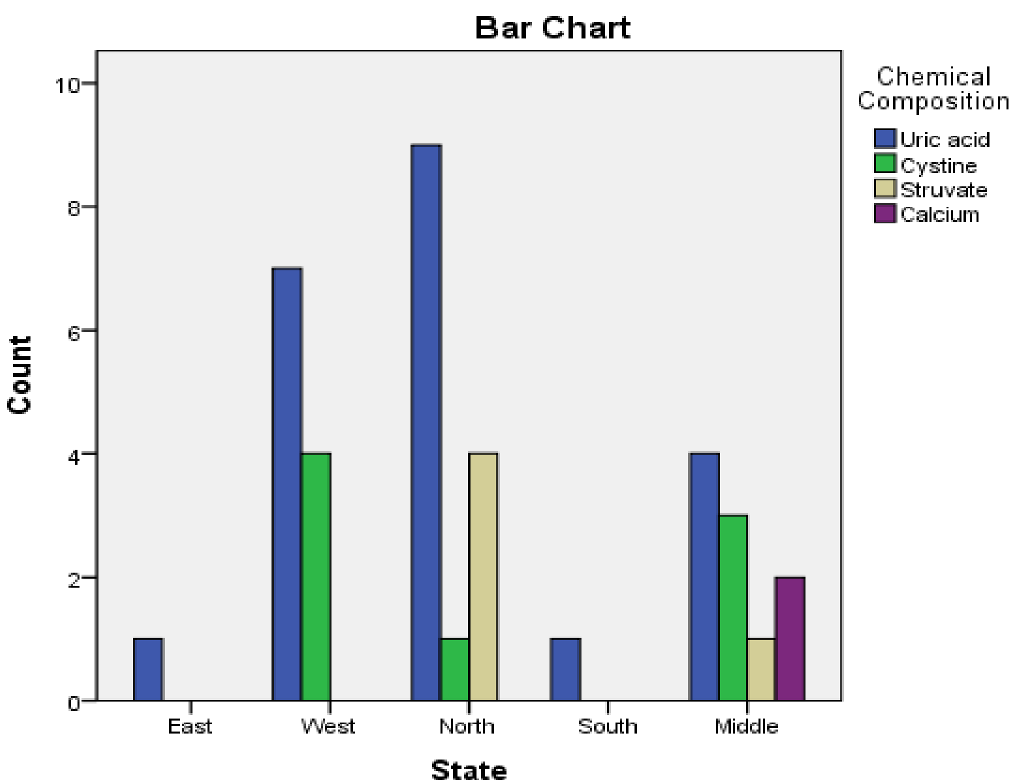


Figure 4:5 show count of stone type in geographic among Sudanese population.

Table 4:6 Stone Site * Chemical Composition Cross tabulation

Count

		Chemical Composition				
		Uric acid	Cystine	Struvate	Calcium	Total
Stone Site	Pelvicalyceal System	19	5	4	1	29
	Ureteric	3	3	1	1	8
Total		22	8	5	2	37

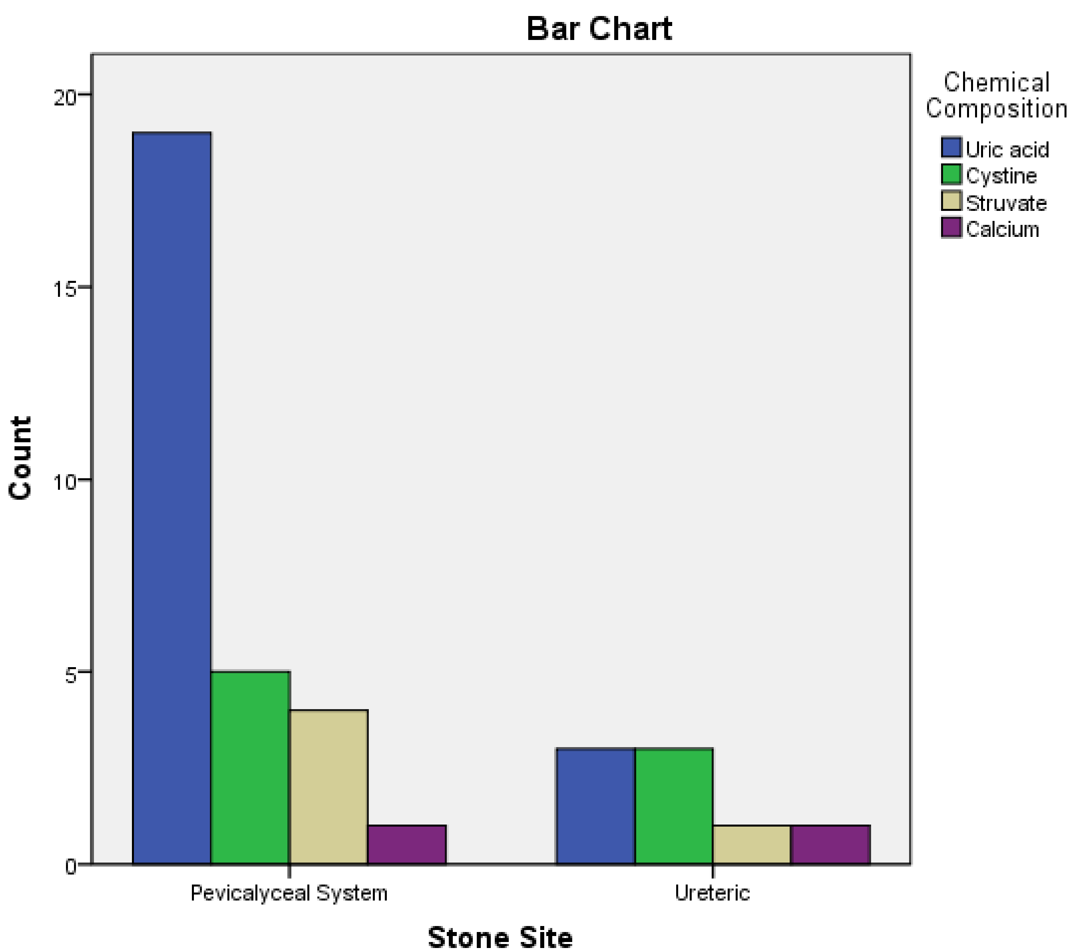


Figure 4:6 show count of the stone position.

table 4:7 Age * Chemical Composition Cross tabulation

Count

		Chemical Composition				Total
		uric acid	cyctine	struvite	calcium	
Age	0-10	2	3	1	0	6
	20-30	4	0	1	0	5
	30-40	4	1	1	0	6
	40-50	8	2	1	2	13
	50-60	3	2	0	0	5
	60-70	0	0	1	0	1
	70-80	1	0	0	0	1
Total		22	8	5	2	37

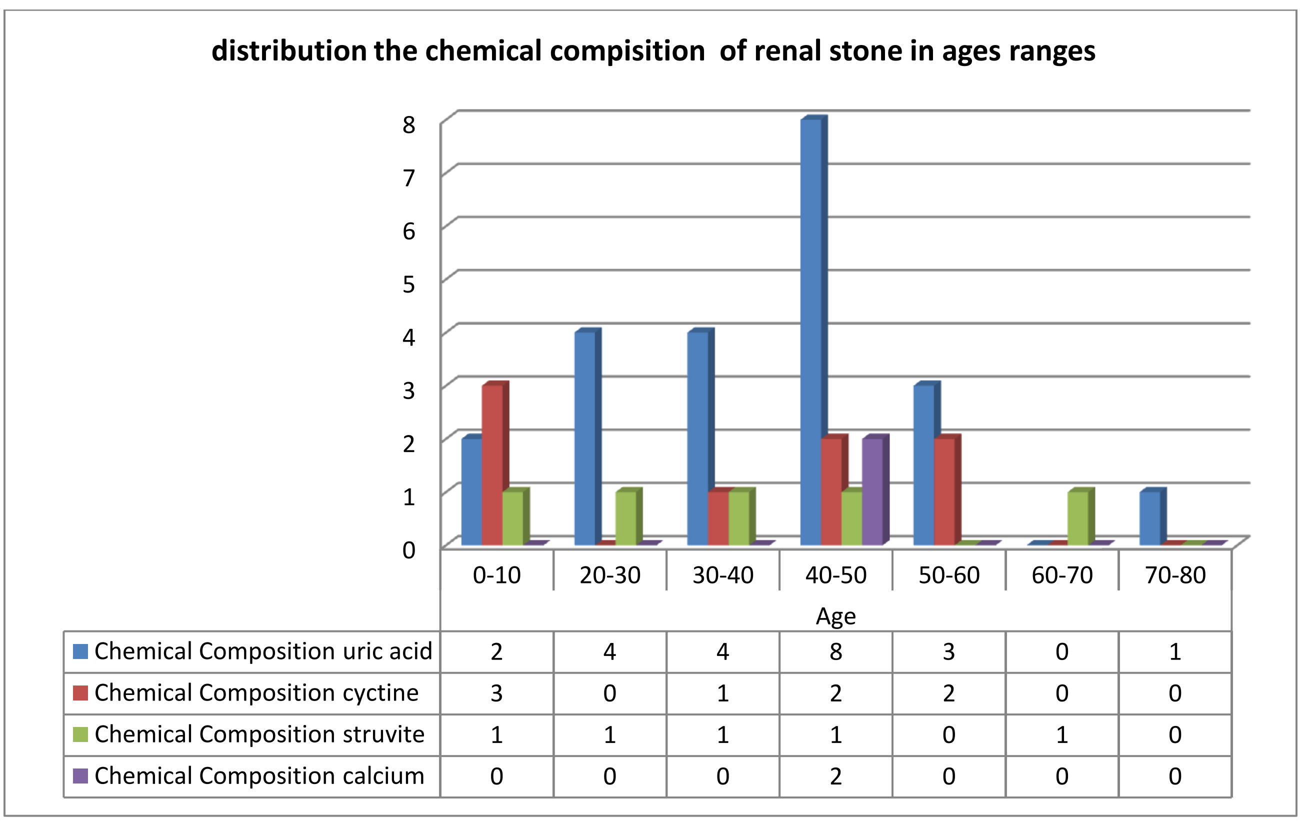


Figure 4:7 show distribution of chemical composition of renal stone among ages rang.

Chapter five

Discussion, conclusion

5.1 Discussion

In this study the patient are 37 patients 7 of them are female which is represent (18.9%) while the males are 30 which is (81.1%), According to the type of thesis all of them are CT-KUB, *show table (4:1).*

All CT-KUB scan diagnosed with stone in different sites in collecting system of urinary system, (78.4%) of all cases the stones found in pelvic-calyceal system while another (21.6%) the stones found in ureter. And the most chemical composition of stones in ureter are uric acid which represent 51.3% of all collected data. *See graph (4:2).*All cases in this study were selected randomly which the radiology department received 37 patients with renal stone, (37.8%) come from **North** of Sudan while (29.7%) were come from **West** of Sudan, (2.7%) **East**, (2.7%) and (27%) from **Middle** of Sudan in the area of Algazirah state.

According to range of CT-number (see chapter two, 2.4) the study found (59.4%) of all cases the chemical composition as ***uric acid*** stone, (36.3%) ***cystine***, (13.3%) ***struvite*** and (5.4%) ***calcium*** see result *(table 4.5).*Geographic distribution to specific chemical composition of renal stones. The study found that the East of Sudan have (2.7%) of all cases uric acid stone, West of Sudan (18.9%) uric acid. (10.8%) cystine while North of

Sudan (24.3%) uric acid, (2.7%) cystine, (10.8%) struvite. And south of Sudan (2.7%) with uric acid only one patient. Middle of Sudan have uric acid 10.8% , cystine (8.1%), struvite (2.7%) and (5.4%) calcium. Only Middle of Sudan had all types of the chemical composition of renal stones. *See (table 4:5, graph 4:5,4:4).*

The analysis of random data found the children age from neonate to 10 years 6 patients admitted to radiology department *(2Pts uric acid, 3 cyctine and 1 struvite)*. the age from 20-30 admitted five patient diagnosed with *(4 Pts uric acid and 1 struvite)*, 30-40 *(4 Pts uric acid, 1 cyctine and 1 struvite)*, 40-50 *(8 Pts uric acid, 2 cyctine, 1 struvite and 1 calcium)*, 50-60 (*3Pts uric acid and 2Pts cyctine)*, 60-70 *(1 Pts struvite)* and age from 70-80 *(1 Pts struvite). see table 4:6 and graph 4:6.*

5.2Conclusion

Study of chemical composition of renal stone in Sudanese population using CT scan in two hospitals in Khartoum state, period from November 2016 to February 2017, according to the small number of data for CT-KUB scan show a significant result and great predict to diagnose type of chemical composition of renal stone and distribution of each type of renal stone according to geographic area of the Sudanese population.

This study found most chemical composition of renal stone among Sudanese population is ***uric acid, cystine*** then ***struvite*** and ***calcium***. The most People with ***uric acid*** of renal stone in Sudan are in north of Sudan with percent (24.3%) and people in west of Sudan with percent (18.9%), population with ***cyctine*** are west and middle area, population with ***struvite*** are north of Sudan and very small people with calcium stone in Sudanese population at. All.

that most ages have renal stone 40-50 years old (35.1%) and same age affected by **uric acid stone** (21. 1%).on another hand the cystine affect the children in age between 1 years to 10 years old.

5.3 Recommendation:

- Requested for CT-KUB scanning must be generate only by qualified medical practitioners and justified by both the referring doctor and the radiologist.
- Apply justification (the benefit higher than risks) and optimization when the CT-KUB scan requested (ALARA principle).
- The initial diagnose of renal stone should be done by ultrasound.
- As advice to researcher to get significant result in this type of study should collect much enough number of data.

References:

Bellin, M.2004. Helical CT evaluation of the chemical composition of urinary tract calculi with a discriminant analysis of CT-attenuation values and density.

Bontrager KL.1993. Textbook of radiographic positioning and related anatomy, ed 3, St. Louis, MO, Mosby.

Curhan GC. 2007, Epidemiology of stone disease. Urol Clin North Am, 34(3):287–293.

Daniel T. Boll. 2008. Renal Stone Assessment with Dual-Energy Multidetector CT and Advanced Post Processing Techniques, DUMC 3808, Durham, NC 27710,1-2.

David Sutton. 1987. Textbook of radiology and imaging. 4th edition. New York. Churchill Livingstone.

Howell, W. H., Guyton, A. C., & Hall, J. E. (2005). Textbook of medical physiology: With STUDENT CONSULT online access (11th ed.). Philadelphia: Elsevier Health Sciences.

Klatt, E. C., & Kumar, V. (2000). Robbins review of pathology. Philadelphia: Saunders (W.B.) Co.

Kumar, V., A.K. Abbas. 2012. *Robbins basic pathology* Elsevier Health Sciences.

Renner C, Rassweiler J. 1999, Treatment of renal stones by extracorporeal shock wave lithotripsy. Nephron, 81(1):71–81

Standing,S. 2015. Gray's anatomy: the anatomical basis of clinical practice, Elsevier Health Sciences.

Appendices

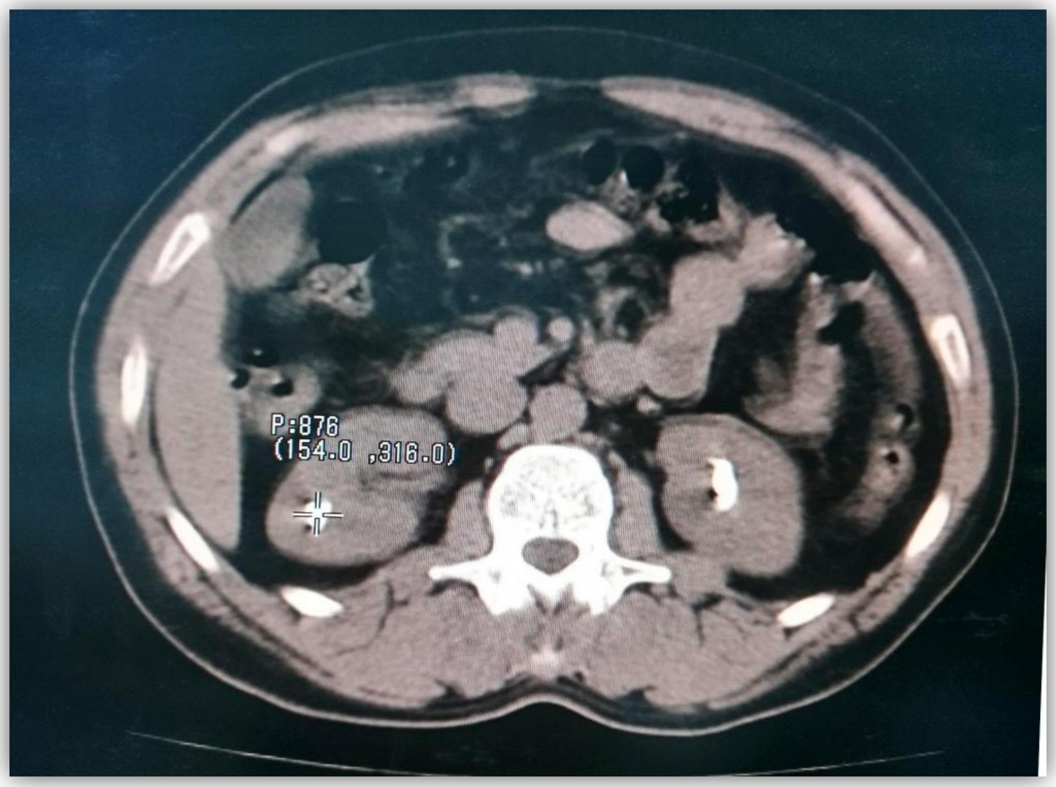


Image 1 represent the CT –KUB to the patient with bilateral renal stone with CT- Number 876.

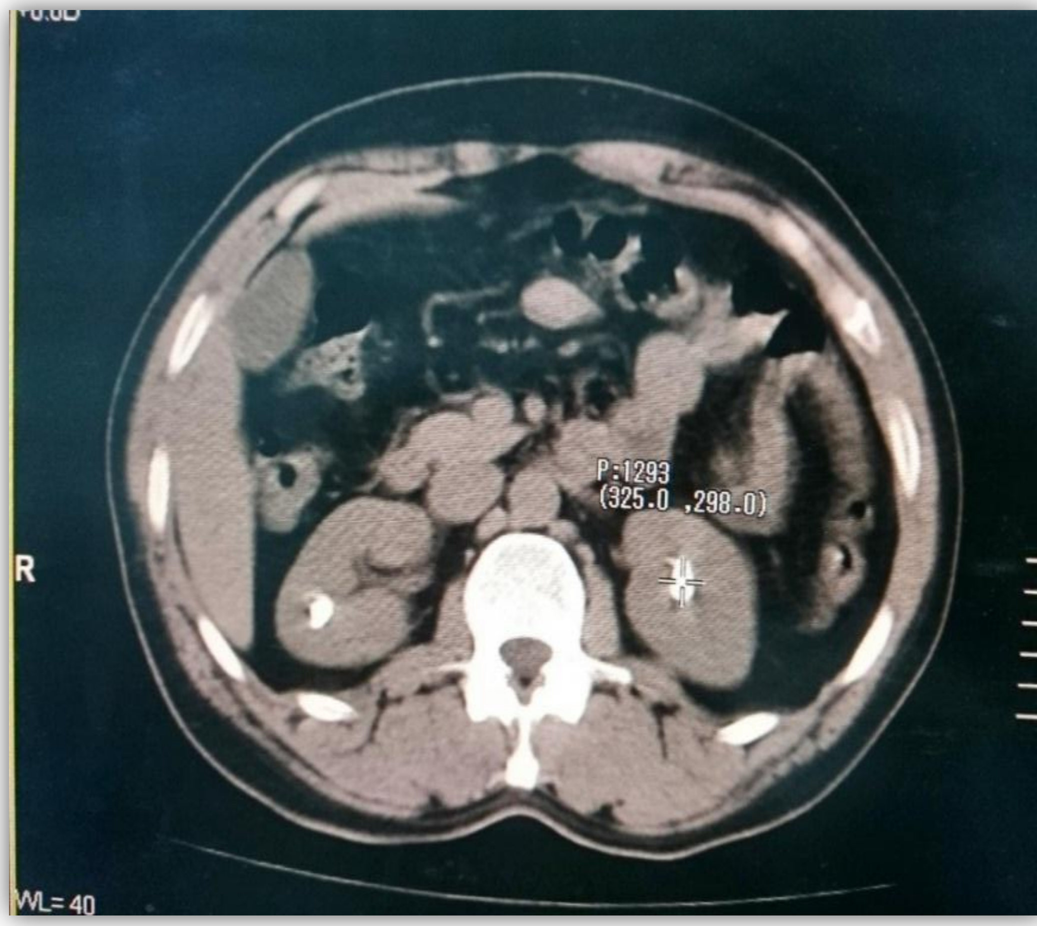


Image 2 represent the CT –KUB to same patient in previous image.

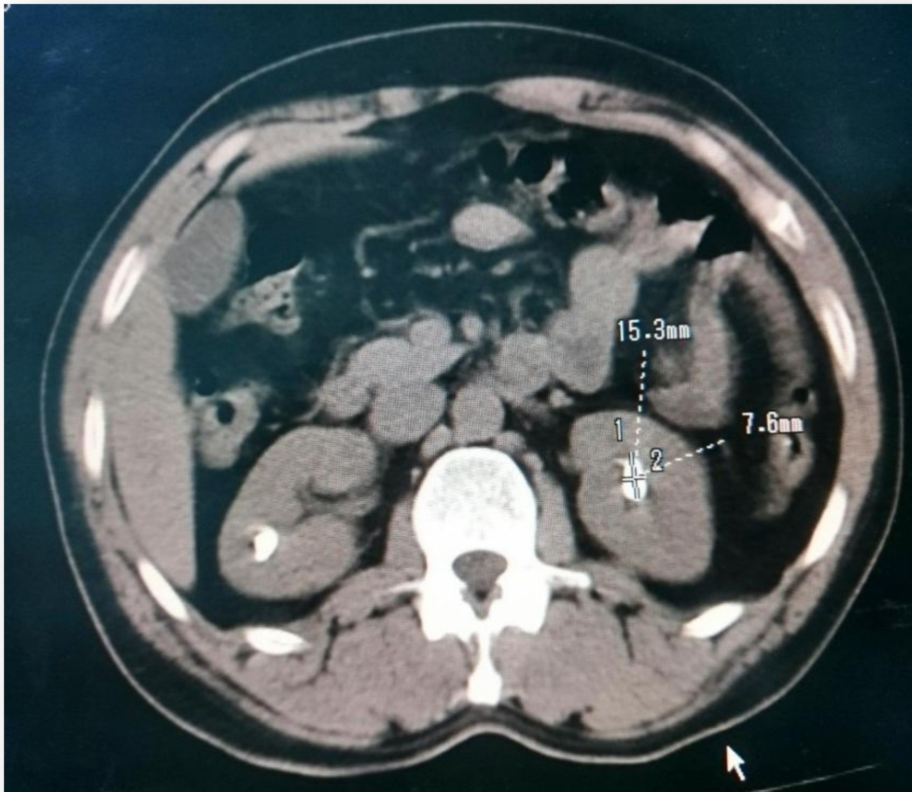


Image 3 represent the measurement of stones size by Toshiba machine tools.

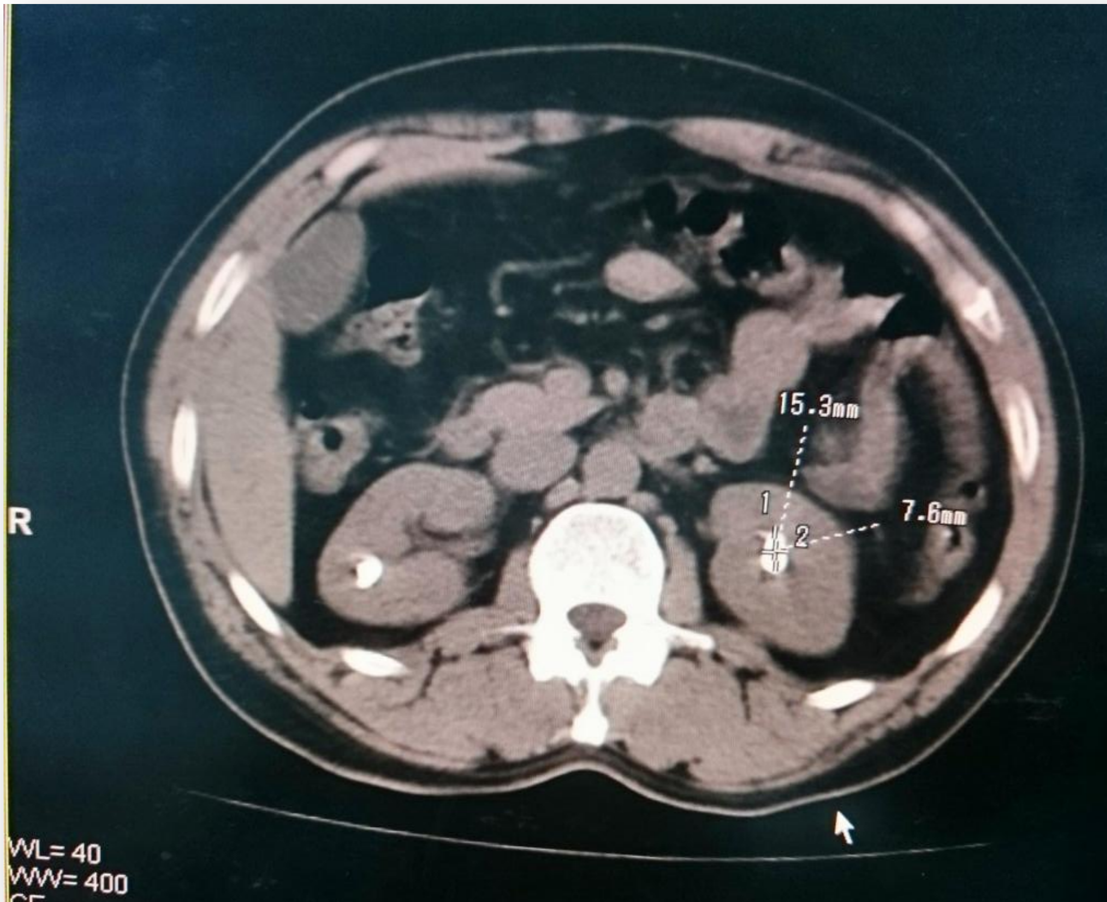


Image 4represent transverse and anteroposterior measurement of left renal stone.